TRUMBULL PUBLIC SCHOOLS
TRUMBULL, CONNECTICUT

Curriculum Committee of the
Trumbull Board of Education

Regular Meeting

Thursday, June 15, 2023, 8:30 a.m.
Trumbull High School Main Office Conference room

AGENDA

I. Call to Order/Introduction

II. Public Comment

III. Approval/Minutes – Regular Meeting 5-18-2023

IV. New Business

a. Curriculum Guide Update- Grade 10 Biology

b. Curriculum Guide Update- Grade 11Chemistry

c. Curriculum Guide Updates- Grade 12 CP Physics & Grade 12 ACP Physics

d. Curriculum Guide Update- Grade 9 English

e. Assistant Superintendent's Report

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Regular Meeting

Thursday, May 18, 2023, 8:30 a.m.
Trumbull High School Main Office Conference room

Minutes

I. Call to Order/Introduction The meeting was called to order 8:34

II. Public Comment. No public comment was received.

III. Approval/Minutes – Regular Meeting 2-8-2023
Ms. McNamee noted areas where Board members initials should be double-checked and asked that a sentence be revised. Mrs. Nuland then motioned to approve the amended minutes. Ms. Nuland seconded. The motional passed unanimously.

IV. New Business
a. Curriculum Guide Update- Grades 10, 11, and 12- Digital Media
Nick Daddona presented the updated curriculum guide for Digital Media previously known as Video Production. He was joined by Department Chair Christina Rusate. Mr. Daddona explained that the course, which has not been updated for some time, will now cover the basics of media design production. Students will be able to take video, edit them, and learn about story boarding. He led the committee through the highlights of each unit and the software used. Students will be using state of the art equipment and Department Chair Christina Rusate, who has been supporting the program through the Perkins grant, shared the department has wanted to implement these updates for quite some time. Ms. McNamee asked if the Department thought about including anything about media literacy and manipulation. The committee then discussed being sure that ethics is covered within the class. Mr. Daddona shared ways in which the course addresses some aspects of ethics through advertising. Mrs. Nuland added that the Adobe Suite is a step up and she is excited that students will have access. Dr. Iwanicki asked about real-life experiences and field trips for students. Mr. Dadonna shared that the class has had a CBS Sport Asset Manager came to share a variety of aspects of his role, including the production and editing of pop up videos. Mrs. Nuland made motion to accept the 2023 Digital Media Curriculum Guide, Ms. McNamee seconded. The motional passed unanimously.

b. Curriculum Guide Update- Grade 9- Global Civilizations

Social Studies teachers Bryan Springsteen and Breanne Brienza presented the new Global Civilizations Curriculum Guide with joined by their Department Chair, Kathy Rubano. Mr. Springsteen shared that the curriculum guide was updated to cover more global content and align the new textbook which was approved last year. He noted that the last curriculum guide was very Eurocentric and the team's aim was to ensure the content was more global. There is a large focus on skill building, writing, and 21st century inquiry skills. Mrs. Nuland inquired about the incorporation of Judaism. It was shared that all three foundational religions (Christianity, Judaism, and Islam) are covered. Mrs. Petitti shared that supplemental resources must be selected with care. The team agreed. Mr. Springsteen shared that the new text has allowed teachers to cover more global content and the resources—interactive maps, for example, have been really helpful for students. Mrs. Rubano shared they hope to use the same text for the Honors Global Civilizations class in the future. Mrs. Petitti asked if more texts had been budgeted, emphasizing that the students should have it. Dr. Iwanicki shared that the request for this text was submitted and approved for purchase next year. Ms. McNamee mentioned that certain units, the one that addresses Imperialism, for example, could perhaps have even more cultural inclusion. Mr. Springsteen shared that there are background lessons that cover different groups and provided examples. Ms. Brienza shared students have to activities in which they explore diverse perspectives such as journal writing from the perspective of an explorer and a native American. Mrs. Rubano furthered that in addition to the units in this course, the Social Studies Department also offers a course on African American History with Latino focus in second half of year. Ms. McNamee also asked if the team was able to incorporate more writing. Mrs. Brienza replied that they have been able to incorporate multiple writing assignments that lead up to an independent inquiry project. Mrs. Petitti reminded the teachers to be sure that any materials are taught with balanced. Ms. McNamee made motion to accept the 2023 Global Civilizations Curriculum Guide, Mrs. Nuland seconded. The motional passed unanimously.

c. Curriculum Guide Update- ECE Biotechnology

Dr. Vrabel presented the Update- ECE Biotechnology Curriculum Guide, which now includes UConn SPSS3230. The course is a lecture only course at the university, but within AgriScience and two periods, they have an expansive laboratory component and also cover several health sciences, such as cancer research and study of bacteria. Scientific literacy is also a large component of the course. Students also learn ways to be successful in a college level course so they will be well-prepared to enter their college programs. The students study biology in ancient times all the way to present times. They are exposed to the every-changing nature of the science and becoming a good detective to truly understand the Science. Patents and ethics are also a part of the course. Dr. Iwanicki asked about the UConn connection and if students are able to visit to learn about UConn's current research projects. Dr. Vrabel shared the class visits UConn at least once a year and have several guest speakers. Mrs. Pettiti mentioned the strength of the program and how it provides a solid foundation which is encouraging those students with an interest in medicine, Several success stories of Trumbull Alumnae that have become veterinarians and doctors were also shared. It was also noted that ECE course should be weighted as heavily as AP course which they are not currently at Trumbull High School. Dr. Iwanicki will look into this further. Mrs. Nuland made motion to accept the 2023 Biotechnology Curriculum Guide, Ms. McNamee seconded. The motional passed unanimously.

d. New Text Proposal- Grades 11-12, Statistics. Larson, Ron. *Elementary Statistics: Picturing the World* (8th Edition)

Dr. Kristin Sroka, the Department Chair for Mathematics shared that the current text is outdated and does not have any technology included. The department reviewed 10 textbooks and selected the Larson text for their course. They made sure the reading, examples, and practice are at the appropriate rigor for the students. Dr. Sroka also shared that the text is a 2023 text and has excellent reviews. Mrs. Petitti, as a former teacher for many years that taught the course, shared that the graphics are very clear. Ms. McNamee asked why the department selected a hard copy as opposed to the online. Dr. Sroka stated that the quote for a hard copy was significantly less. Mrs. Petitti referenced the importance of vocabulary and that it is included. Ms. McNamee inquired if students that taking this course can then take AP the next year. Dr. Sroka said most are seniors, but if they are younger, they can take it the next year. Ms. McNamee made motion to approve the text *Elementary Statistics: Picturing the World* (8th Edition); Mrs. Nuland seconded. The motional passed unanimously.

e. Curriculum Resource Update: Middle School Science

Dr. Iwanicki shared that this update was being provided as a preview of the Board presentation next week to update them regarding middle school science revisions. The process of how teachers were included in the revision and surveyed for input was explained. Liz Doherty, K-5 Science Program Leader also helped to coordinate throughout the year in gathering sample materials from publishers for review, surveying districts for program use, and arranging meeting times for "The Steps to Innovation" with the team and with Discovery Museum representatives. Jody D'Addario presented highlights of the Amplify program including a sample unit, a simulation example, and activities. She also demonstrated the e-portfolio and student level aspects of the program. Ms. McNamee asked if the text of the program Lexile level differentiation capabilities and Mrs. D'Addario shared that the text is not only leveled, but here are other features such as highlighting, enlarging, and more. The programming also allows a teacher to pause a session for the whole class and for students to maintain their own portfolios. The portfolios can be leveled in order to see which support students need and group them appropriately. Mrs. Petitti inquired if the shift in using the resources for more grade levels had been budgeted and it was shared that it had. A full summary will be presented at the next Board meeting on May 23rd, 2023.

The meeting adjourned at 10:31

TRUMBULL PUBLIC SCHOOLS

Trumbull, Connecticut

GRADE 10 BIOLOGY
Science Department

2023

(Last revision date: May 2023)

Curriculum Writing Team

Thomas Edwards	**Science Department Chairperson, Trumbull High School**
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Linda Goodman	**Science Teacher, Trumbull High School**
William Heher	**Science Teacher, Trumbull High School**
Gina Moriello	**Science Teacher, Trumbull High School**
Patricia Tivadar	**Science Teacher, Trumbull High School**
Jenny Xavier	**Science Teacher, Trumbull High School**
Susan C. Iwanicki, Ed.D.	**Assistant Superintendent, Trumbull Public Schools**

Grade 10 Biology
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CORE VALUES AND BELIEFS

The Trumbull School Community engages in an environment conducive to learning which believes that all students will **read** and **write effectively**, therefore communicating in an articulate and coherent manner. All students will participate in activities **that present problem- solving through critical thinking**. Students will use technology as a tool applying it to decision making. We believe that by fostering self-confidence, self-directed and student-centered activities, we will promote **independent thinkers and learners**. We believe **ethical conduct** to be paramount in sustaining the welcoming school climate that we presently enjoy.

Approved 8/26/2011

INTRODUCTION & PHILOSOPHY

Grade 10 Biology is consistent in the continued development of scientifically literate students. Authentic scientific and engineering experiences build on one another and increase in complexity throughout students' K-12 education. In 2015, the Connecticut State Board of Education adopted the Next-Generation Science Standards (NGSS), which embody the National Research Council's *Framework for K-12 Science Education* (2012). Both the *Framework* and the NGSS stress the importance of teaching classroom scientific inquiry as practiced by scientists and engineers. The *Framework* provides a vision for American science education in the 21st century, while the NGSS provides grade-level student performance expectations, disciplinary core ideas, and crosscutting concepts. The *Framework* and NGSS indicated a paradigm shift in science education, one in which teachers are to incorporate authentic learning experiences for students that reflect the nature of doing science and engineering.

The *Framework* and NGSS provide clarity to classroom scientific inquiry by stressing the importance of the eight practices of science and engineering. The practices were designed to help students understand how scientific knowledge develops, and to stimulate students' interest in and continued study of science. Three-dimensional learning facilitates student engagement with Science and Engineering Practices and Crosscutting Concepts to deepen their understanding of Disciplinary Core Ideas in order to explain phenomena and solve problems. Three-dimensional learning promotes development of student skills in the following areas:

- Knowing, using, and interpreting scientific explanations of the natural world (Disciplinary Core Ideas, and Crosscutting Concepts)
- Generating and evaluating scientific evidence and explanations (Science and Engineering Practices)
- Participating productively in scientific practices and discourse (Science and Engineering Practices)
- Understanding the nature and development of scientific knowledge (Science and Engineering Practices, and Crosscutting Concepts)

The shift of science education reflects the interconnected nature of science as it is practiced in the real world and builds coherently across grades K-12. The NGSS focus on deeper understanding of content as well as application of content with an alignment to the Connecticut

Core Standards. A deeper understanding and application of science and engineering practices prepare students for postsecondary success and citizenship in a world fueled by innovations in science and technology.

Most systems or processes depend at some level on physical and chemical subprocesses that occur within, whether the system in question is a star, Earth's atmosphere, a river, a bicycle, the human brain, or a living cell. Large-scale systems often have emergent properties that cannot be explained on the basis of atomic-scale processes; nevertheless, to understand the physical and chemical basis of a system, one must ultimately consider the structure of matter at the atomic and subatomic scales to discover how it influences the system's larger-scale structures, properties, and functions. Similarly, understanding a process at any scale requires awareness of the interactions occurring – in terms of the forces between objects, the related energy transfers, and their consequences. Biology has much in common with the other branches of science, but it also includes a unique set of scientific pursuits. Inquiries into biology (e.g., macromolecules, genetics, evolution, and ecology) have been pursued in part as a means of understanding the unity and diversity among organisms and how organisms interact with each other and with the nonliving components of the environment.

Grade 10 Biology is offered at three separate course levels: Honors, Advanced College Preparatory (ACP), and College Preparatory (CP). All levels will explore each unit of study. The courses are differentiated by pacing of curriculum, rigor of exploration, depth of content knowledge, and the application of quantitative reasoning. The honors course will explore topics with the greatest depth, most rigorous exploration, deepest study of content, and furthest application of quantitative reasoning. More support will be offered at the ACP course level, with the most support offered at the CP course level.

COURSE GOALS

The course goals derive from the 2013 Next-Generation Science Standards, the 2010 Connecticut Core Standards, and the ISTE (International Society for Technology in Education) Technology Standards. Goals are listed specific to each unit in this curriculum guide, and developed through unit lessons using the 5-E learning model (engage, explore, explain, elaborate, evaluate) in order to encourage student engagement and foster metacognitive learning strategies through a reflective process. An important role of science education is not to teach "all the facts," but rather to prepare students with sufficient core knowledge so that they can later acquire additional information on their own.

COURSE ENDURING UNDERSTANDINGS

Students will understand that . . .

- The process of science helps biologists investigate how nature works at all levels, from the molecules in cells to the biosphere.
- Cells are the basic unit of life; the processes that occur at the cellular level provide the energy and basic structure organisms need to survive.
- DNA is the universal code for life; it enables an organism to transmit hereditary information and, along with the environment, determines an organism's characteristics.

- The human body is a complex system. The coordinated functions of its many structures support life processes and maintain homeostasis.

- The diversity of life is the result of ongoing evolutionary change. Species alive today have evolved from ancient common ancestors.

- The existence of life on earth depends on interactions among organisms and between organisms and their environment.

COURSE ESSENTIAL QUESTIONS

- What are the basic chemical principles that affect living things?
- How do plants and other organisms capture, obtain, and store energy?
- How does a cell produce a new cell?
- How does a single undifferentiated cell lead to a complex multicellular organism?
- What is the structure of DNA, and how does it function in genetic inheritance?
- How do cells make proteins?
- How can we use genetics to study human inheritance?
- How do various body systems interact with each other and with the environment to maintain homeostasis?
- What are the four factors upon which the process of evolution is based?
- How does natural selection lead to evolution?
- How do biotic and abiotic factors shape ecosystems?
- How have human activities shaped local and global ecology?
- How does evolution lead to unity within diversity?

COURSE KNOWLEDGE & SKILLS

Students will understand:

- Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

- Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.

- Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.

- Systems and system models. Defining the system under study – specifying its boundaries and making explicit a model of that system – provides tools for understanding and testing ideas that are applicable throughout science and engineering.
- Energy and matter: Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.
- Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.
- Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Students will be able to . . .

- ask questions (for science) and define problems (for engineering).
- develop and use models.
- plan and carry out investigations.
- analyze and interpret data.
- use mathematics and computational thinking.
- construct explanations (for science) and design solutions (for engineering).
- engage in arguments from evidence.
- obtain, evaluate, and communicate information

COURSE SYLLABUS

Course Name

Grade 10 Biology

Level

College-Preparatory, Advanced College-Preparatory, & Honors

Prerequisites

Successful completion of Grade 9 Integrated Physical Science

Materials Required

None

General Description of the Course

This course is aligned to the Next Generation Science Standards (NGSS) Disciplinary Core Ideas for Grade 10. Through the implementation of the Three Dimensions of NGSS (Disciplinary Core Ideas, Science and Engineering Practices and Cross Cutting Concepts), students will explore topics in life sciences. Students will engage in the Science and Engineering Practices throughout their studies in order to develop their ability to think critically, engage in analysis, effectively communicate and defend their understandings like a scientist or engineer. At the Honors level, algebraic reasoning and independent discovery are expected; the CP level mirrors the ACP level with additional guided inquiry.

Assured Assessments

Formative Assessments:

Formative assessments can include, but are not limited to:

- Questioning, discussion, and in-class activities

Summative Assessments:

- End-of-unit assessment with multiple-choice questions
- End-of-unit assessment with multiple-choice questions and interpreting and analyzing data
- Research and presentation on humans and Earth's ecosystems
- Midyear examination
- End-of-year examination

Core Texts

- Miller, Kenneth R., and Joseph S. Levine. *Biology*. New York: Pearson, 2014. Print.
- *Campbell Biology: Concepts & Connections*. 8th ed. New York: Pearson, 2015. Print.

UNIT 0
Introduction to Biology

Unit Goals
At the completion of this unit, students will:

- Be able to safely perform laboratory experiments in accordance with OSHA Lab Safety and National Fire Code Standards.
- Identify the characteristics required for determining if something is a living organism.
- Design and conduct scientific experiments

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models: ● Planning and Carrying Out Investigations Planning and carrying out in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models. Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly . ● Use a model based on evidence to illustrate the relationships between systems or between components of a system. Constructing Explanations and Designing Solutions: ● Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	LS1.A : Structure and Function: ● Systems of specialized cells within organisms help them perform the essential functions of life.	Energy and Matter: ● Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. ● Energy cannot be created or destroyed – it only moves between one place and another place, between objects and/or fields, or between systems. ● Systems and System Models Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions— including energy, matter, and information flows—within and between systems at different scales. ● Cause and Effect Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (

Unit Essential Questions

- What is the nature of science?
- What is the language of science?
- What is biology?
- How do we safely perform experiments in the science laboratory?
- How is life organized?

Unit Essential Vocabulary

Periodic Table Of Elements
Atomic Number
Subatomic Particles
Proton
Neutron
Electron
Nucleus
Atom
Element
Molecule
Ion
Ionic Bond
Covalent Bond
Hierarchy
Homeostasis
Pseudoscience
Experimental Design
Hypothesis
Observation
Claim/Evidence/Reasoning

Scope and Sequence

- Safety & Equipment
    - Lab Introduction – Identify Equipment and Uses (Icebreaker) - Biology Corner
    - Introductory Activity on Using Science Equipment - Biology Corner
    - Flinn Safety Contract for Life Science
- Language of Science
- Characteristics of living things
    - Anchor: Worm vs rock
        - Students compare and suggest characteristics of life
        - Scavenger hunt outside - students from each table find an example that represents one characteristic of life (assigned).
- Hierarchy of life
    - Jigsaw with cards
    - Atomic Structure and Bonding
- Nature of Science & Experimentation
    - Science vs. Pseudoscience
    - Observation lab
    - Pill bugs lab
    - Flowchart - how can causal questions be answered
    - Assess- design experiment to answer a scientific question

Assured Assessments

Formative Assessments:

- Science Safety Assessment
- Hierarchy Jigsaw activity
- Design an experiment

Summative Assessment

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to introductory topics.

Resources

- Lab Introduction – Identify Equipment and Uses (Icebreaker) - Biology Corner
- Introductory Activity on Using Science Equipment - Biology Corner
- Flinn Safety Contract for Life Science
- Academic Integrity Activity (Biology Corner)
- Characteristics of Life
- Hierarchy of Life
- Atomic structure and bonding - PBS Learning Media: Chemthink interactives
    - atomic structure https://simbucket.com/chemthinkserver/chemthink/index.html?as
    - ionic bonding https://simbucket.com/chemthinkserver/chemthink/index.html?ib
    - covalent bonding https://simbucket.com/chemthinkserver/chemthink/index.html?cb
- Nature of Science - flowchart and sample scientific questions in Biology Corner
    - https://drive.google.com/file/d/0Bx72aSXCBO09bFpYU3RxTDBvS3M/view?resourcekey=0-VIQmD9xJNpRqAfc7Yxvd8Q
    - https://www.biologycorner.com/worksheets/sci_method_scenarios.html

Supplemental

Lab Template

Golden Rules of Experimentation

Academic Integrity - Biology Corner

Time Allotment

- Approximately 2 weeks

UNIT 1

What is a Cell: Structure & Function

Unit Goals

At the completion of this unit, students will:

NGSS.HS-LS1-2	Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
NGSS.HS-LS1-5	Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.
NGSS.HS-LS1-6	Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.
NGSS.HS-LS1-7	Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.
NGSS.HS-LS2-3	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
CCS.ELA-Literacy.RST.9-10.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
CCS.5.MD.B	Represent and interpret data.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models: ● Use a model based on evidence to illustrate the relationships between systems or between components of a system. (NGSS.HS-LS1-5, NGSS.HS-LS1-7) Constructing Explanations and Designing Solutions: ● Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (NGSS.HS-LS1-6)	LS1.C: Organization for Matter and Energy Flow in Organisms: ● The process of photosynthesis converts light energy to stored chemical energy by converting carbon dioxide plus water into sugars plus released oxygen. (NGSS.HS-LS1-5) ● The sugar molecules thus formed contain carbon, hydrogen, and oxygen: their hydrocarbon backbones are used to make amino acids and other carbon-based molecules that can be assembled into larger molecules (such as proteins and DNA), used for example to form new cells. (NGGS.HS-LS1-6) ● As matter and energy flow through different organizational levels of living systems, chemical elements are recombined in different ways to form different products. (NGSS.HS-LS1-6, NGSS.HS-LS1-7) ● As a result of these chemical reactions, energy is transferred from one system of interacting molecules to another. Cellular respiration is a chemical process in which the bonds of food molecules and oxygen molecules are broken and new compounds are formed that can transport energy to muscles. Cellular respiration also releases the energy needed to maintain body temperature despite ongoing energy transfer to the surrounding environment. (NGSS.HS-LS1-7)	Energy and Matter: ● Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (NGSS.HS- LS1-5, NGSS.HS-LS1-6) ● Energy cannot be created or destroyed – it only moves between one place and another place, between objects and/or fields, or between systems. (NGSS.HS-LS1-7)

Unit Essential Questions

- What is the basic unit of life?
- What are the major differences between prokaryotic and eukaryotic cells?
- What are the general patterns that are similar and different between plants and animals?
- Why are cells so small?
- How are cell structures adapted to their functions?
- How do specialized cells and tissues contribute to the overall function and organization of multicellular organisms? (honors)
- How do materials move into and out of a cell and what are the components of the cell membrane?
- What is an organelle?
- What are the functions of different organelles within a eukaryotic cell, and how do they work together to support cellular processes? How does each contribute to cellular homeostasis?
- How do cells harness & utilize energy?
    - What are the processes of cellular respiration and photosynthesis, and how do they relate to energy flow within cells and ecosystems?

Unit Essential Vocabulary

Cytoskeleton
Nucleus
Nuclear Pore
Active Transport
Carrier Protein
Concentration Gradient
Diffusion
Endocytosis
Exocytosis
Facilitated Diffusion
Fluid Mosaic Model
Isotonic
Homeostasis
Hypertonic
Hypotonic
Osmosis
Passive Transport
Selective Permeability
Vesicle
Carbohydrates
Proteins
Lipids
Nucleic Acids
Monosaccharides
Disaccharides
Polysaccharides
Amino Acids
Fatty Acids
Glycerol
Stomata
Guard Cells
ATP
ADP
Adenosine
Phosphate Group
Photosynthesis
Glycolysis
Lactic Acid Fermentation
Alcoholic Fermentation
Aerobic
Anaerobic

Scope and Sequence

- Light microscope
    - Microscope lab - letter “e”, colored thread
- Anchoring Phenomenon- Red Blood Cells and Sickle Cells
- Modeling red blood cells and sickle cells - clay
- Sickle Cell Case Study
- What is a cell?
    - Microscope lab- plant and animal cells
- Prokaryote vs. eukaryote cells
- Plant and animal cell similarities and differences
- Cell Model Project
    - Stage 1- Choose a cell type
    - Stage 2- Build a cell membrane
    - Stage 3- Adding in organelles
    - Stage 4- Adding in nuclear membrane

- Cell Membrane
  - Cell Size Lab
  - Tonicity lab
  - Dialysis tubing lab
  - Onion cell/elodea plasmolysis
- Organelles
- Mitochondria and chloroplasts
  - Yeast balloon lab
  - Elodea and snails lab
  - Plant in a bag lab
  - Cellular Respiration & Photosynthesis
  - Atomic bonding
- Nucleus and Nuclear membrane

Assured Assessments

Formative Assessments:

- Questioning, group discussion, and in-class activities
- Students will construct a complete model of either a plant or animal cell, and be able to discuss the structure and function of each component added.

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions and open-ended questions regarding the structures and functions of a cell.
- Completed cell model project (Rubric)

Resources

Core

- Miller and Levine, "Biology." Textbook
- Light Microscope Intro Lab
- Red Blood Cell and Sickle Cell Lab
- Sickle Cell Modeling
- Sickle Cell Case Study
- Cell Model Project
- Tonicity Lab
- Dialysis tubing lab
- Cell Size Lab
- Yeast Lab
- Elodea and Snail Lab
- Plant in a bag lab

Supplemental

-

Time Allotment

- Approximately 6 Weeks

UNIT 2

Cell Processes

Unit Goals

At the completion of this unit, students will:

NGSS.HS-LS1-1	Construct an explanation based on evidence for how the structure of DNA determines the structure of proteins, which carry out the essential functions of life through systems of specialized cells.
NGSS.HS-LS1-4	Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
NGSS.HS-LS3-1	Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.
CCS.ELA-Literacy.RST.9-10.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
CCS.5.MD.B	Represent and interpret data.
ISTE Computational Thinker (Standard 5b)	Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions: ● Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (NGSS.HS-LS1-1) Developing and Using Models: ● Use a model based on evidence to illustrate the relationships between systems or between components of a system. (NGSS.HS-LS1-4	LS1.A: Structure and Function: ● Systems of specialized cells within organisms help them perform the essential functions of life. (NGSS.HS-LS1-1) ● All cells contain genetic information in the form of DNA molecules. Genes are regions in the DNA that contain the instructions that code for the formation of proteins, which carry out most of the work of cells. (NGGS.HS-LS1-1) LS1.B: Growth and Development of Organisms: ● In multicellular organisms individual cells grow and then divide via a process called mitosis, thereby allowing the organism to grow. The organism begins as a single cell (fertilized egg) that divides successively to produce many cells, with each parent cell passing identical genetic material (two variants of each chromosome pair) to both daughter cells. Cellular division and differentiation produce and maintain a complex organism, composed of systems of tissues and organs that work together to meet the needs of the whole organism. (NGSS.HS-LS1-4) LS3.A: Inheritance of Traits: ● Each chromosome consists of a single very long DNA molecule, and each gene on the chromosome is a particular segment of that DNA. The instructions for forming species' characteristics are carried in DNA. All cells in an organism have the same genetic content, but the genes used (expressed) by the cell may be regulated in different ways. Not all DNA codes for a protein; some segments of DNA are involved in regulatory or structural functions, and some have no as-yet known function. (NGSS.HS-LS3-)	Structure and Function: ● Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem. (NGSS.HS-LS1- 1) Cause and Effect: ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (NGSS.HS-LS3-1) Systems and System Models: ● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions – including energy, matter, and information flows – within and between systems at different scales. (NGSS.HS-LS1-4)

Unit Essential Questions

- What is the structure and function of DNA?
- How does DNA replication occur?
- How does cell reproduction differ in prokaryotic versus eukaryotic cells?
- What are the stages of the cell cycle?
- How does a complex, multicellular organism develop from a single cell?
- What happens during mitotic cell division?
- How does the structure of DNA determine the structure of proteins?

Unit Essential Vocabulary

Cell Cycle	Cytokinesis	Anticodon
Binary Fission	Purine	Protein Synthesis
Mitosis	Pyrimidine	Start Codon
Chromosomes	Helicase	Stop Codon
Chromatid	Polymerase	Adenine
Spindle Fiber	Transcription	Guanine
Centriole	Translation	Cytosine
Prophase	mRNA	Thymine
Metaphase	tRNA	Uracil
Anaphase	rRNA	Gene
Telophase	Codon	

Scope and Sequence

- Anchoring Phenomenon: Onion Root Tip
- Cell cycle / Mitosis
  - Model stages of mitosis
  - Cell cycle checkpoints and cancer [for Honors]
- DNA structure/replication
  - Creating a model of DNA
  - The structures and functions of the following enzymes: DNA polymerase, DNA helicase, Primase, RNase H, SSBPs, Gyrase [for Honors]
- Protein synthesis
  - transcription and translation model using their cell model from Unit 1

Assured Assessments

Formative Assessments:

- Modeling activities for students to demonstrate their understanding of the structure and replication of DNA
- Modeling stages of mitosis (chalk drawings)
- Modeling transcription and translation using cell model from unit 1

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to DNA structure, replication, cell cycle, and protein synthesis.

Resources

Core

- Miller, Kenneth R., and Joseph S. Levine. *Biology*. New York: Pearson, 2014. Print.
- Amoeba Sisters. "Specialized Cells: Significance and Examples." https://www.youtube.com/watch?v=wNe6RuK0FfA.
- "Modeling DNA Using Pop Beads."
- "Paper Model of DNA Replication."
- "Modeling Mitosis With Chalk and Pop-It Beads"
- "Modeling Transcription and Translation With Cell Model"

Supplemental

- Amoeba Sisters. "Introduction to Cells: The Grand Cell Tour.
- "DNA Extraction – Strawberry. https://www.biologycorner.com/worksheets/DNA_extraction.html.
- "Mitosis Flip Book." Trumbull High School.
- "Modeling Cell Cycle Petri Activity."
- "Pasta Mitosis."

Time Allotment

- Approximately 4 weeks

UNIT 3

Genetics

Unit Goals
At the completion of this unit, students will:

NGSS.HS-LS3-2	Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.
NGSS.HS-LS3-3	Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.
CCS.ELA-Literacy.RST.9-10.1	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise detail of explanations or descriptions.
CCS.ELA-Literacy.RST.9-10.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.
CCS.ELA-Literacy.RST.9-10.7	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
CCS.MP.5	Use appropriate tools strategically.
CCS.5.MD.B	Represent and interpret data.
CCS.HSS-CP.B.9	Use permutations and combinations to compute probabilities of compound events and solve problems.
ISTE Computational Thinker (Standard 5b)	Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
ISTE Creative Communicator (Standard 6b)	Create original works or responsibly repurpose or remix digital resources into new creations.
ISTE Creative Communicator (Standard 6d)	Publish or present content that customizes the message and medium for their intended audiences.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data: ● Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (NGSS.HS-LS3-3) Engaging in Argument from Evidence: ● Make and defend a claim based on evidence about the natural world that reflects scientific knowledge, and student- generated evidence. (NGSS.HS-LS3-2)	LS3.B: Variation of Traits: ● In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. (NGSS.HS-LS3-2) ● Environmental factors also affect expression of traits, and hence affect the probability of occurrences of traits in a population. Thus the variation and distribution of traits observed depends on both genetic and environmental factors. (NGGS.HS-LS3- 2, NHSS.HS-LS3-3)	Cause and Effect: ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (NGSS.HS-LS3-2) Scale, Proportion, and Quantity: ● Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth). (NGSS.HS-LS3-3) Science Is a Human Endeavor: ● Technological advances have influenced the progress of science and science has influenced advances in technology. (NGSS.HS-LS3-3) ● Science and engineering are influenced by society and society is influenced by science and engineering. (NGSS.HS-LS3-3)

Unit Essential Questions

- How are gametes produced?
- Where does an organism get its unique characteristics?
- How do crossing-over, independent assortment, mutations and random mating lead to genetic variation?
- How can we use statistics and probability to predict traits?
- What are the other modes of inheritance
- How is sex determined in humans?
- What patterns of inheritance are seen in human blood types?
- What are some of the major genetic disorders?

Unit Essential Vocabulary

Genetics
Gene
Trait
Allele
Hybrid
P- Parental Generation
F_1- First Filial
F_2- Second Filial
Homozygous
Heterozygous
Dominant
Codominance
Incomplete Dominance
Pleiotropy
Recessive
Genotype
Phenotype
Punnett Square
Monohybrid
Dihybrid
Law of Segregation
Law of Independent Assortment
Polygenic
Autosomes
X-Linked
Pedigree
Karyotype

Scope and Sequence

- Anchoring Phenomenon: Observable Human Traits & Pedigree
- Meiosis
- Mendelian genetics
- Non-Mendelian genetics (codominance, incomplete dominance, multiple alleles, sex- linked)
- Karyotype
- Pedigree
- Genetic disorders

Assured Assessments

Formative Assessments:

- Modeling activities for students to demonstrate their understanding of meiosis and non-Mendelian genetics

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to meiosis, genetics, genetic disorders, and pedigrees.

Resources

Core

- Miller, Kenneth R., and Joseph S. Levine. *Biology*. New York: Pearson, 2014. Print.
- "Baby Blood Typing Mystery." Trumbull High School.
- "Introduction to Non-Mendelian Genetics."

- “Karyotyping Analysis.”
- “Meiosis Modeling.”
- “Human Pedigree Analysis: Case Studies.”
- “Snurfle Meiosis and Genetics.” https://biomanbio.com/HTML5GamesandLabs/Genegames/snurflemeiosishtml5page.htm

Supplemental

- Amoeba Sisters. “Punnett Squares and Sex-Linked Traits.” https://www.youtube.com/watch?v=h2xufrHWG3E.
- “Genetic Disorder Project.”
- “Mendel’s Peas Genetics: Experiments That Changed the World.” https://www.youtube.com/watch?v=6NvESo3mG90.

Time Allotment

- Approximately 5 weeks

UNIT 4

Evolution

Unit Goals

At the completion of this unit, students will:

NGSS.HS-ESS2-7	Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
NGSS.HS-LS4-1	Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.
NGSS.HS-LS4-2	Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.
NGSS.HS-LS4-3	Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.
NGSS.HS-LS4-4	Construct an explanation based on evidence for how natural selection leads to adaptation of populations.
NGSS.HS-LS4-5	Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.
ISTE Computational Thinker (Standard 5b)	Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence: ● Construct an oral and written argument or counter-arguments based on data and evidence. (NGSS.HS-ESS2-7) Applying and Interpreting Data: ● Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible. (NGSS.HS-LS4-3) Constructing Explanations and Designing Solutions: ● Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (NGSS.HS-LS-4-2, NGSS.HS-LS4-4) Engaging in Argument from Evidence: ● Evaluate the evidence behind currently accepted explanations or solutions to determine the merits of arguments. (NGSS.HS- LS4-5) Obtaining, Evaluating, and Communicating Information:	ESS2.E: Biogeology ● The many dynamic and delicate feedbacks between the biosphere and other Earth systems cause a continual co-evolution of Earth's surface and the life that exists on it. (NGGS.HS-ESS2-7) LS4.A: Evidence of Common Ancestry and Diversity: ● Genetic information provides evidence of evolution. DNA sequences vary among species, but there are many overlaps; in fact, the ongoing branching that produces multiple lines of descent can be inferred by comparing the DNA sequences of different organisms. Such information is also derivable from the similarities and differences in amino acid sequences and from anatomical and embryological evidence. (NGSS.HS-LS4-1) LS4.B: Natural Selection: ● Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information – that is, trait variation – that leads to differences in performance among individuals. (NGSS.HS-LS4-2, NGSS.HS-LS4-3) ● The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. (NGSS.HS-LS4-3)	Stability and Change: ● Much of science deals with constructing explanations of how things change and how they remain stable. (NGSS.HS-ESS2-7) Patterns: ● Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (NGSS.HS- LS4-1, NGSS.HS-LS4-3) Cause and Effect: ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (NGSS.HS-LS4-2, NGSS.HS-LS4-4, NGSS.HS-LS4-5) Connections to Nature of Science: Scientific Knowledge Assumes an Order and Consistency in Natural Systems: ● Scientific knowledge is based on the assumption that natural laws operate today as they did in the past and they will continue to do so in the future. (NGSS.HS-LS4-1, NGSS.HS-LS4-4) trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. (NGSS.HS-LS4-3, NGSS.HS-LS4-4)

● Communicate scientific information (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (NGSS.HS-LS4-1) Connections to Nature of Science: Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena: ● A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence. (NGSS.HS-LS4-1)	LS4.C: Adaptation: ● Evolution is a consequence of the interaction of four factors (1) the potential for a species to increase in number, (2) the genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for an environment's limited supply of the resources that individuals need in order to survive and reproduce, and (4) the ensuing proliferation of those organisms that are better able to survive and reproduce in that environment. (NGSS.HS- LS4-2) ● Natural selection leads to adaptation, that is, to a population dominated by organisms that are anatomically, behaviorally, and physiologically well suited to survive and reproduce in a specific environment. That is, the differential survival and reproduction of organisms in a population that have an advantageous heritable	● Adaptation also means that the distribution of traits in a population can change when conditions change. (NGSS.HS-LS4- 3) ● Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline – and sometimes the extinction – of some species. (NGSS.HS-LS4-5) ● Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (NGSS.HS-LS4-5)

Unit Essential Questions

- How has the evolution of Earth itself affected or influenced the evolution of living things on planet Earth?
- What is the importance of variation among organisms? How does this variation contribute to the survival and success of a species?
- What scientific information supports common ancestry and biological evolution?
- What are the four factors upon which the process of evolution is based?
- How does natural selection lead to adaptations of populations?
- How are new species formed?

Unit Essential Vocabulary

Species	Jean-Baptiste Lamarck	Speciation
Variations	Charles Darwin	Adaptive radiation
Evolution	Galapagos Islands	Punctuated equilibrium
Fossil	Natural selection	Divergent evolution
Homologous structures	Adaptations	Parallel evolution
Analogous structures	Gene pool	Convergent evolution
Vestigial structures	Gene flow	
	Genetic drift	

Scope and Sequence

- Introduction of evolution
- Evidence for evolution: Fossil record, homologous, analogous, vestigial structures, DNA analysis, biochemistry, etc.
- Charles Darwin and Jean-Baptiste Lamarck: Contributions to evolution
- Four factors that drive evolution (Darwin's postulates)
- Natural selection vs. artificial selection
- Adaptation (behavioral and physical)
- Types of evolution (divergent, convergent, parallel, coevolution)
- Phylogenetic trees and cladograms
- Coevolution of Earth's systems and life on Earth
- Hardy-Weinberg equilibrium [Honors]

Assured Assessments

Formative Assessments:

-

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to evolution.

Resources

Core

- Miller, Kenneth R., and Joseph S. Levine. *Biology*. New York: Pearson, 2014. Print.
- National Geographic. *One Strange Rock*. https://onestrangerock.com/.
- "Peppered Moths."

Supplemental

- "Evolution Mind Map."

- “Human Change through Time Lab Activity.” Trumbull High School.
- “What Is the Evidence for Evolution?” https://www.youtube.com/watch?v=lIEoO5KdPvg.

Time Allotment

- Approximately 4 weeks

UNIT 5

Comparative Anatomy & Homeostasis

Unit Goals

At the completion of this unit, students will:

NGSS.HS-LS1-2	Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
NGSS.HS-LS1-3	Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.
ISTE Computational Thinker (Standard 5b)	Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models: ● Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. (NGSS.HS-LS1-2) Planning and Carrying Out Investigations: ● Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (NGSS.HS- LS1-3) Scientific Investigations Use a Variety of Methods: ● Scientific inquiry is characterized by a common set of values that include: logical thinking, precision, open-mindedness, objectivity, skepticism, replicability of results, and honest and ethical reporting of findings. (NGSS.HS-LS-1-3)	LS1.A: Structure and Function: ● Multicellular organisms have a hierarchical structural organization, in which any one system is made up of numerous parts and is itself a component of the next level. (NGSS.HS-LS1-2) ● Feedback mechanisms maintain a living system's internal conditions within certain limits and mediate behaviors, allowing it to remain alive and functional even as external conditions change within some range. Feedback mechanisms can encourage (through positive feedback) or discourage (negative feedback) what is going on inside the living system. (NGGS.HS-LS1- 3)	Systems and System Models: ● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions – including energy, matter, and information flows – within and between systems at different scales. (NGSS.HS-LS1-2) Stability and Change: ● Feedback (negative or positive) can stabilize or destabilize a system. (NGSS.HS-LS1-3)

Sub Unit 5a: Reproduction

Unit Essential Questions:

- How is maintaining homeostasis essential for maintaining life?
- How do negative and positive feedback systems work to maintain homeostasis within the human body?
- What are the different ways by which single and multicellular organisms pass on their DNA?
- How do human reproductive systems interact with other systems in the body to maintain homeostasis?
- How do organ systems depend on each other to complete essential functions within the body?
    - What is the endocrine system, and why is it essential for homeostasis?

Essential Vocabulary:

Homeostasis	Estrogen	Oviduct
Target Cell	Testosterone	Ovulation
Negative Feedback	Growth Hormone	Ovule
Positive Feedback	Progesterone	Petal
Hormone	Hyper	Pistil
Receptor	Hypo	Pollen
Gland	Anther	Pollination
Binary Fission	Filament	Regeneration
Budding	Flower	Sepal
Vegetative Propagation	Follicle	Stamen
Endocrine Cascade	Menstrual cycle	Stigma
LH	Menstruation	Style
TSH	Ovary	

Scope and Sequence:

Homeostasis and positive/negative feedback mechanisms

Asexual/ Sexual Reproduction Comparison

- Binary Fission
- Budding
- Regeneration
- Vegetative Propagation

Reproductive System Structure & Function:

- Adaptations for Internal & External Fertilization & Development
- System Structure
- Menstrual Cycle- hormones involved; Stabilizing or Destabilizing a system

Resources:

Core

- “Introduction to Body Systems.”
- “Homeostasis of the Eye Lab.”
- “Homeostasis Lab.” Trumbull High School. [response to exercise]
- Lab: Flower Anatomy
- Lab: Stages of the Menstrual Cycle

Supplemental

- Amoeba Sisters. “Homeostasis and Negative/Positive Feedback.” https://www.youtube.com/watch?v=Iz0Q9nTZCw4.
- Lab: Regeneration (Planaria)

Assured Assessments:

Formative Assessments:

- Analyzing and interpreting data regarding menstrual cycle
- Develop a model (constructing a graph) illustrating the impact of hormone levels on strength of contractions.

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to human body systems.

Time Allotment:

- Approximately 2 weeks

UNIT 5

Sub Unit 5b: Digestion

Unit Essential Questions:

- How have different organisms evolved to take in nutrients, as we as digest and utilize those nutrients?
- How do specific nutrients impact the body's ability to maintain homeostasis and essential life functions?

Essential Vocabulary

Bile	Enzyme	Base
Chemical Digestion	Mechanical Digestion	Gizzard
Chyme	Substrate	Internal Digestion
Colon	Active Site	External Digestion
Stomach	pH	Nutrient
Crop	Acid	

Scope and Sequence

- Evolution of different adaptations to obtain food sources
- Macronutrients to functions within the body
    - Proteins & enzymes
    - Digestion/Absorption of nutrients within different structures

Activities:

LAB: Ingestion and Digestion in Protists

LAB: What can teeth tell you about Diet?

LAB: Potato or Liver Catalase

Comparative anatomy models of human, frog, earthworm, squid

LAB: Frog Dissection

Assured Assessments:

Formative:

- Analyzing and interpreting a model of the digestive system

Summative:

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to human body systems.

Resources:

Core

- Miller, Kenneth R., and Joseph S. Levine. *Biology*. New York: Pearson, 2014. Print.
- "Earthworm Dissection."
- "Frog Dissection."

Supplemental

- LAB: Protein Digestion
- Virtual Lab https://gizmos.explorelearning.com/find-gizmos/lesson-info?resourceId=1050

Time Allotment:

- Approximately 3 weeks

UNIT 6

Body Systems: Transport & Gas Exchange

Unit Essential Questions:

- How does the movement of materials and gas exchange differ between organisms?
- How do the structures of the human circulatory system work to maintain homeostasis?
- How does the circulatory system of animals work with other body systems?
- How and why is gas exchange important in maintaining homeostasis?

Scope and Sequence:

- Evolution of different adaptations to exchange gasses and transport materials
- Mechanisms of transport and gas exchange maintain homeostasis within the body

Essential Vocabulary

Aorta	Platelet	Bronchus
Artery	Red Blood Cell	Diaphragm
Atrium	Valve	Gill
Capillary	Vein	Lung
Guard Cell	Ventricle	Respiration
Stomata	Vessel	Trachea
Phloem	White Blood Cell	
Xylem	Alveolus	

Activities:

LAB: Effect of Exercise on CO_2 Release

LAB: Celery (Xylem and Phloem)

Graphing Activity: Elodea- How temperature, amount of light affect the transpiration rate?
https://iwant2study.org/ospsg/index.php/interactive-resources/biology/1061-transpiration

Assured Assessments:

Formative:

- Analyzing and interpreting a model of transport and gas exchange in different organisms.

Summative:

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to human body systems.

Resources:

Core

- Miller, Kenneth R., and Joseph S. Levine. *Biology*. New York: Pearson, 2014. Print.

Supplemental:

- LAB: Comparing causes of decreased function in the respiratory system

Time Allotment:

- Approximately 2 weeks

UNIT 7

Body Systems: Nervous System

Unit Essential Questions:

- How do the structures of the nervous system work to carry out the essential functions?
- How does the structure of the neuron aid in sending signals to the brain?

Essential Vocabulary:

Central Nervous System	Cerebrum	Synapse
Brain	Frontal Lobe	Neurotransmitters
Spinal Cord	Temporal Lobe	Mechanoreceptors
Peripheral Nervous System	Parietal Lobe	Photoreceptors
Somatic Nervous System	Occipital Lobe	Chemoreceptors
Autonomic Nervous System	Neuron	Reflex Arc
Motor Division	Cell Body	Interneuron
Sensory Division	Axon	Sensory & Motor Neuron
Brainstem	Dendrite	Nodes of Ranvier
Cerebellum	Myelin Sheath	

Scope and Sequence:

- Nervous system structure and functions
  - Divisions of the nervous system
  - Neurons
- Reflex arc
  - Responding to stimuli in an internal or external environment
  - Neurotransmitters and chemical signaling in plants

Assured Assessments:

Formative:

- Table comparing neurotransmitters or chemical signaling in plants and animals
- Modeling neurons, parts of the brain, and the flow of a reflex chart

Summative:

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to human body systems.

Resources:

Core

- Miller, Kenneth R., and Joseph S. Levine. *Biology*. New York: Pearson, 2014. Print.
- "Body Systems Organizer and Homeostasis Modeling."
- "Brain Hat."
- "Divisions of the Central Nervous System Graphic Organizer."
- "Factors that affect Reaction Rates Lab."
- Lab: Comparing the responses of plants and humans to a stimuli in the external environment

Supplemental

- "Neuron and Synapse Active Reading."
- "Parts of the Brain Active Reading."
- "Reflex Lab."

Time Allotment:

- Approximately 2 weeks

UNIT 8
Ecology and Human Impact

Unit Goals
At the completion of this unit, students will:

NGSS.HS-LS2-3	Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
NGSS.HS-LS2-4	Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.
NGSS.HS-LS2-6	Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
NGSS.HS-LS2-8	Evaluate evidence for the role of group behavior on individual and species' chances to survive and reproduce.
NGSS.HS-LS2-1	Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.
NGSS.HS-LS2-2	Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
NGSS.HS-LS2-7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
NGSS.HS-LS4-6	Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
NGSS.HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
NGSS.HS-ESS3-3	Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.
NGSS.HS-LS2-5	Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere

CCS.ELA-Literacy.RST.9-10.1	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise detail of explanations or descriptions.
ISTE Computational Thinker (Standard 5b)	Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models: ● Develop a model based on evidence to illustrate the relationships between systems or components of a system. (NGSS.HS-LS2- 5) Using Mathematics and Computational Thinking: ● Use mathematical and/or computational representations of phenomena or design solutions to support explanations. (NGSS.HS-LS2-1) ● Use mathematical representations of phenomena or design solutions to support and revise explanations. (NGSS.HS-LS2-2) ● Use mathematical representations of phenomena or design solutions to support claims. (NGSS.HS-LS2-4) ● Create or revise a simulation of a phenomenon, designed device, process, or system. (NGSS.HS-LS4-6) ● Create a computational model or simulation of a phenomenon, designed device, process, or system. (NGSS.HS-ESS3-3) Constructing Explanations and Designing Solutions: ● Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems: ● Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. (NGGS.HS-LS2-3) ● Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. (NGSS.HS-LS2-4) ● Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. (NGSS.HS- LS2-5) PS3.D: Energy in Chemical Processes: ● The main way that solar energy is captured and stored on Earth is through the complex chemical process known as photosynthesis. (secondary to NGSS.HS- LS2-5)	Systems and System Models: ● Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions – including energy, matter, and information flows – within and between systems at different scales. (NGSS.HS-LS2-5) Energy and Matter: ● Energy cannot be created or destroyed – it only moves between one place and another place, between objects and/or fields, or between systems. (NGSS.HS-LS2-4) ● Energy drives the cycling of matter within and between systems. (NGSS.HS-LS2-3) Cause and Effect: ● Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (NGSS.HS-LS2-8, NGSS.HS-LS4-6) Scale, Proportion, and Quantity: ● The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (NGSS.HS-LS2-1) ● Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a

investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (NGSS.HS-LS-2-3) ● Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations. (NGSS.HS-LS2-7) ● Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (NGSS.HS-ESS3-4) Engaging in Argument from Evidence: ● Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. (NGSS.HS-LS2-6) ● Evaluate the evidence behind currently accepted explanations to determine the merits of arguments. (NGSS.HS-LS2-8) Connections to Nature of Science: Scientific Knowledge Is Open to Revision in Light of New Evidence: ● Most scientific knowledge is quite durable, but is, in principle, subject to change based on new evidence and/or	LS2.A: Interdependent Relationships in Organisms: ● Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. (NGSS.HS- LS2-1, NGSS.HS-LS2-2) LS2.C: Ecosystem Dynamics, Functioning, and Resilience: ● A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (NGSS.HS-LS2-2, NGSS.HS-LS2-6) ● Moreover, anthropogenic changes (induced by human activity) in the environment – including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change – can disrupt an ecosystem and threaten the survival of some species. (NGSS.HS-LS2-7)	model at another scale. (NGSS.HS-LS2-2) Stability and Change: ● Much of science deals with constructing explanations of how things change and how they remain stable. (NGSS.HS- LS2-6, NGSS.HS-LS2-7) ● Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. (NGSS.HS-ESS3-3) ● Feedback (negative or positive) can stabilize or destabilize a system. (NGSS.HS-ESS3-4) Connections to Engineering, Technology, and Applications of Science: Influence of Engineering, Technology, and Science on Society and the Natural World: ● Modern civilization depends on major technological systems. (NGSS.HS-ESS3-3) ● Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (NGSS.HS-ESS3-4) ● New technologies can have deep impacts on society and the environment, including some that were not anticipated. (NGSS.HS-ESS3-3)

reinterpretation of existing evidence. (NGSS.HS-LS2- 2, NGSS.HS-LS2-3) ● Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation. (NGSS.HS-LS2-6, NGSS.HS-LS2-8)	LS2.D: Social Interactions and Group Behavior: ● Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives. (NGSS.HS-LS2-8) LS4.C: Adaptation: ● Changes in the physical environment, whether naturally occurring or human induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline – and sometimes the extinction – of some species. (NGSS.HS-LS4-5) ● Species become extinct because they can no longer survive and reproduce in their altered environment. If members cannot adjust to change that is too fast or drastic, the opportunity for the species' evolution is lost. (NGSS.HS-LS4-6) LS4.D: Biodiversity and Humans: ● Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (secondary to NGSS.HS- LS2-7) ● Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by	Science Is a Human Endeavor: ● Science is a result of human endeavors, imagination, and creativity. (NGSS.HS- ESS3-3)

	preserving landscapes of recreational or inspirational value. (secondary to NGSS.HS-LS2-7) ETS1.B: Developing Possible Solutions: ● When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (secondary to NGSS.HS-LS2-7, secondary to NGSS.HS- LS4-6, secondary to NGSS.HS-ESS3-4) ● Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (secondary to NGSS.HS- LS4-6) ESS3.C: Human Impacts on Earth Systems: ● The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (NGSS.HS- ESS3-3) ● Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (NGSS.HS-ESS3-4)	

Unit Essential Questions

- Why are biogeochemical cycles essential in ecosystems?
- What is the relationship between energy and matter in an ecosystem?
- What are the components of an ecosystem, and how are they interdependent?
- How do biotic and abiotic factors interact within an ecosystem?
- How do limiting factors affect the carrying capacity of ecosystems?
- What is the role of group behavior on individuals' and species' chances to survive and reproduce?
- In what ways do human activities affect ecosystems?

Essential Vocabulary:

Carbon Cycle	Food web	Carnivore
Nitrogen Cycle	Organism	10 % rule
Nitrogen Fixation	Producer	Gross Primary
Nitrification	Consumer	Productivity (GPP)
Denitrification	Herbivore	Net Primary Productivity
Food chain	Omnivore	(NPP)
Population	Symbiosis	Invasive Species
Birth Rate	Predation	Biodiversity
Death Rate	Competition	Primary Succession
Immigration	Parasitism	Secondary Succession
Emigration	Mutualism	Disturbance
Carrying Capacity	Commensalism	Bioaccumulation
Community	Keystone Species	Biomagnification

Scope and Sequence

- Biogeochemical cycles (carbon and nitrogen)
- Food webs, food chains, and energy pyramids (10% rule)
- GPP (Gross Primary Productivity) and NPP (Net Primary Productivity)
- Population dynamics: Four factors that influence population growth, limiting factors, carrying capacity, survivorship curves
- Relationships in a community: Mutualism, commensalism, parasitism, predation, and competition
- Costs and benefits of group behavior: Flocking, herding, swarming, schooling
- Ecological succession: Primary vs. secondary
- Biodiversity: Invasive species, keystone species
- Human impact on ecosystems and biodiversity: Climate change, bioaccumulation/ biomagnification, eutrophication, habitat destruction, invasive species

Assured Assessments

Formative Assessments:

Constructing and Interpreting a food web

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, and interpreting and analyzing data, related to ecology.

Resources

Core

- Miller, Kenneth R., and Joseph S. Levine. *Biology*. New York: Pearson, 2014. Print.
- "Analyzing Group Behavior." Trumbull High School..
- "Carbon/Nitrogen Cycle Diagrams Guided Questioning." Trumbull High School.
- "Energy Flow in an Ecosystem." Trumbull High School.
- "Importance of Biodiversity and Invasive Species." Trumbull High School.
- "Introduction to Ecological Succession." Trumbull High School.
- "Marine Energy Pyramid." Trumbull High School.
- Human Impact Research Project- research and defend methods of mitigation

Supplemental

- Avril Gulf Tuna Population Simulation." https://sepuplhs.org/high/sgi/teachers/fishery_sim.html. Accessed January 21, 2020. Web.
- "Turtle Case Study."
- "Lesson of the Kaibab."
- "Symbiotic Scenarios."
- Avril Gulf Tuna Population Simulation."
- "Symbiotic Relationships Woods Walk."

Time Allotment

- Approximately 4 weeks

COURSE CREDIT

1.00 credits in science
Three classes every four days, for a full year

ASSURED STUDENT PERFORMANCE RUBRICS

- Trumbull High School School-Wide Writing Rubric (attached)
- Trumbull High School School-Wide Problem-Solving Rubric (attached)
- Trumbull High School School-Wide Independent Learning and Thinking Rubric (attached)

Trumbull High School School-Wide Writing Rubric

Category/ Weight	Exemplary 4 Student work:	Goal 3 Student work:	Working Toward Goal 2 Student work:	Needs Support 1-0 Student work:
Purpose X____	● Establishes and maintains a clear purpose ● Demonstrates an insightful understanding of audience and task	● Establishes and maintains a purpose ● Demonstrates an accurate awareness of audience and task	● Establishes a purpose ● Demonstrates an awareness of audience and task	● Does not establish a clear purpose ● Demonstrates limited/no awareness of audience and task
Organization X__	● Reflects sophisticated organization throughout ● Demonstrates logical progression of ideas ● Maintains a clear focus ● Utilizes effective transitions	● Reflects organization throughout ● Demonstrates logical progression of ideas ● Maintains a focus ● Utilizes transitions	● Reflects some organization throughout ● Demonstrates logical progression of ideas at times ● Maintains a vague focus ● May utilize some ineffective transitions	● Reflects little/no organization ● Lacks logical progression of ideas ● Maintains little/no focus ● Utilizes ineffective or no transitions
Content X____	● Is accurate, explicit, and vivid ● Exhibits ideas that are highly developed and enhanced by specific details and examples	● Is accurate and relevant ● Exhibits ideas that are developed and supported by details and examples	● May contain some inaccuracies ● Exhibits ideas that are partially supported by details and examples	● Is inaccurate and unclear ● Exhibits limited/no ideas supported by specific details and examples
Use of Language X _____	● Demonstrates excellent use of language ● Demonstrates a highly effective use of standard writing that enhances communication ● Contains few or no errors. Errors do not detract from meaning	● Demonstrates competent use of language ● Demonstrates effective use of standard writing conventions ● Contains few errors Most errors do not detract from meaning	● Demonstrates use of language ● Demonstrates use of standard writing conventions ● Contains errors that detract from meaning	● Demonstrates limited competency in use of language ● Demonstrates limited use of standard writing conventions ● Contains errors that make it difficult to determine meaning

Trumbull High School School-Wide Problem-Solving Rubric

Category/ Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Understanding X___	● Student demonstrates clear understanding of the problem and the complexities of the task	● Student demonstrates sufficient understanding of the problem and most of the complexities of the task	● Student demonstrates some understanding of the problem but requires assistance to complete the task	● Student demonstrates limited or no understanding of the fundamental problem after assistance with the task
Research X___	● Student gathers compelling information from multiple sources including digital, print, and interpersonal	● Student gathers sufficient information from multiple sources including digital, print, and interpersonal	● Student gathers some information from few sources including digital, print, and interpersonal	● Student gathers limited or no information
Reasoning and Strategies X_____	● Student demonstrates strong critical thinking skills to develop a comprehensive plan integrating multiple strategies	● Student demonstrates sufficient critical thinking skills to develop a cohesive plan integrating strategies	● Student demonstrates some critical thinking skills to develop a plan integrating some strategies	● Student demonstrates limited or no critical thinking skills and no plan
Final Product and/or Presentation X__	● Solution shows deep understanding of the problem and its components ● Solution shows extensive use of 21st-century technology skills	● Solution shows sufficient understanding of the problem and its components ● Solution shows sufficient use of 21st-century technology skills	● Solution shows some understanding of the problem and its components ● Solution shows some use of 21st-century technology skills	● Solution shows limited or no understanding of the problem and its components ● Solution shows limited or no use of 21st-century technology skills

Trumbull High School School-Wide Independent Learning and Thinking Rubric

Category/ Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Proposal X___	• Student demonstrates a strong sense of initiative by generating compelling questions, creating uniquely original projects/work	• Student demonstrates initiative by generating appropriate questions, creating original projects/work	• Student demonstrates some initiative by generating questions, creating appropriate projects/work	• Student demonstrates limited or no initiative by generating few questions and creating projects/work
Independent Research & Development X _____	• Student is analytical, insightful, and works independently to reach a solution	• Student is analytical, and works productively to reach a solution	• Student reaches a solution with direction	• Student is unable to reach a solution without consistent assistance
Presentation of Final Product X_	• Presentation shows compelling evidence of an independent learner and thinker • Solution shows deep understanding of the problem and its components • Solution shows extensive and appropriate application of 21st-century skills	• Presentation shows clear evidence of an independent learner and thinker • Solution shows adequate understanding of the problem and its components • Solution shows adequate application of 21st-century skills	• Presentation shows some evidence of an independent learner and thinker • Solution shows some understanding of the problem and its components • Solution shows some application of 21st-century skills	• Presentation shows limited or no evidence of an independent learner and thinker • Solution shows limited or no understanding of the problem and its components • Solution shows limited or no application of 21st-century skills

TRUMBULL PUBLIC SCHOOLS

Trumbull, Connecticut

GRADE 11 CHEMISTRY
Science Department

2023

(Last revision date: 2020)

Curriculum Revision Writing Team

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Grade 11 Chemistry
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CORE VALUES AND BELIEFS

The Trumbull School Community engages in an environment conducive to learning which believes that all students will **read** and **write effectively**, therefore communicating in an articulate and coherent manner. All students will participate in activities **that present problem-solving through critical thinking**. Students will use technology as a tool applying it to decision making. We believe that by fostering self-confidence, self-directed and student-centered activities, we will promote **independent thinkers and learners**. We believe **ethical conduct** to be paramount in sustaining the welcoming school climate that we presently enjoy.

Approved 8/26/2011

INTRODUCTION & PHILOSOPHY

Grade 11 Chemistry is consistent in the continued development of scientifically literate students, with a concentration on matter, energy, and changes. Authentic scientific and engineering experiences build on one another and increase in complexity throughout students' K-12 education. In 2015, the Connecticut State Board of Education adopted the Next-Generation Science Standards (NGSS), which embody the National Research Council's *Framework for K-12 Science Education* (2012). Both the *Framework* and the NGSS stress the importance of teaching classroom scientific inquiry as practiced by scientists and engineers. The *Framework* provides a vision for American science education in the 21st century, while the NGSS provides grade-level student performance expectations, disciplinary core ideas, and crosscutting concepts.

The *Framework* and NGSS provide clarity to classroom scientific inquiry by stressing the importance of the eight practices of science and engineering. The practices were designed to help students understand how scientific knowledge develops, and to stimulate students' interest in and continued study of science. Three-dimensional learning facilitates student engagement with Science and Engineering Practices and Crosscutting Concepts to deepen their understanding of Disciplinary Core Ideas in order to explain phenomena and solve problems. Three-dimensional learning promotes development of student skills in the following areas:

- Knowing, using, and interpreting scientific explanations of the natural world (Disciplinary Core Ideas, and Crosscutting Concepts)
- Generating and evaluating scientific evidence and explanations (Science and Engineering Practices)
- Participating productively in scientific practices and discourse (Science and Engineering Practices)
- Understanding the nature and development of scientific knowledge (Science and Engineering Practices, and Crosscutting Concepts)

The shift of science education reflects the interconnected nature of science as it is practiced in the real world and builds coherently across grades K-12. The NGSS focus on deeper

understanding of content as well as application of content with an alignment to the Connecticut Core Standards. A deeper understanding and application of science and engineering practices prepare students for postsecondary success and citizenship in a world fueled by innovations in science and technology.

In Grade 11 Chemistry, students will further explore many of the systems and processes of the physical and chemical world by investigating the underlying submicroscopic interactions of matter through the topics of general chemistry. By focusing on the changes in matter and energy, scientifically literate students can use this deeper understanding to make predictions, analyze scientific data, and contribute to the greater scientific community.

Grade 11 Chemistry is offered at three separate course levels: Honors, Advanced College Preparatory (ACP), and College Preparatory (CP). All levels will explore each unit of study. The courses are differentiated by pacing of curriculum, rigor of exploration, depth of content knowledge, and the application of quantitative reasoning. The honors course will explore topics with the greatest depth, most rigorous exploration, deepest study of content, and furthest application of quantitative reasoning. More support will be offered at the ACP course level, with the most support offered at the CP course level.

COURSE GOALS

The course goals derive from the 2013 Next-Generation Science Standards, the 2010 Connecticut Core Standards, and the ISTE (International Society for Technology in Education) Technology Standards. Goals are listed specific to each unit in this curriculum guide, and developed through unit lessons using the 5-E learning model (engage, explore, explain, elaborate, evaluate) in order to encourage student engagement and foster metacognitive learning strategies through a reflective process. An important role of science education is not to teach "all the facts," but rather to prepare students with sufficient core knowledge so that they can later acquire additional information on their own.

COURSE ENDURING UNDERSTANDINGS

Students will understand that . . .

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons. The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states. The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms. Stable forms of matter are those in which the electric and magnetic field energy is minimized. A stable molecule has less energy,

by an amount known as the binding energy, than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart.

- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in total binding energy (i.e., the sum of all bond energies in the set of molecules) that are matched by changes in kinetic energy. In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.

- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions. Chemical processes and properties of materials underlie many important biological and geophysical phenomena.

- Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve changes in nuclear binding energies. The total number of neutrons plus protons does not change in any nuclear process. Strong and weak nuclear interactions determine nuclear stability and processes. Spontaneous radioactive decays follow a characteristic exponential decay law. Nuclear lifetimes allow radiometric dating to be used to determine the ages of rocks and other materials from the isotope ratios present.

- Attraction and repulsion between electric charges at the atomic scale explain the structure, properties, and transformations of matter, as well as the contact forces between material objects. The strong and weak nuclear interactions are important inside atomic nuclei – for example, they determine the patterns of which nuclear isotopes are stable and what kind of decays occur for unstable ones.

- Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms. At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy. "Chemical energy" generally is used to mean the energy that can be released or stored in chemical processes.

- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy; transmit sunlight; expand upon freezing; dissolve and transport materials; and lower the viscosities and melting points of rocks.

- Global climate models incorporate scientists' best knowledge of physical and chemical processes and of the interactions of relevant systems. Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and on the ways in which these gases are absorbed by the ocean and the biosphere. Hence the outcomes depend on human behaviors as well as on

natural factors that involve complex feedbacks among Earth's systems.

- Global climate models are often used to understand the process of climate change because these changes are complex and can occur slowly over Earth's history. Though the magnitudes of humans' impacts are greater than they have ever been, so too are humans' abilities to model, predict, and manage current and future impacts. Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities, as well as to changes in human activities. Thus science and engineering will be essential both to understanding the possible impacts of global climate change and to informing decisions about how to slow its rate and consequences – for humanity as well as for the rest of the planet.

COURSE ESSENTIAL QUESTIONS

- What is matter and how is it organized?
- How does the arrangement of subatomic particles affect the properties of matter?
- How does energy transfer in matter interactions?
- How is the Earth influenced by natural and man-made factors?
- How can submicroscale interactions be used to explain macroscopic observations?
- How do scientists quantitatively relate particles of matter to other properties of matter?
- How do intermolecular and intramolecular forces determine the properties of matter?
- What determines the nature of a chemical reaction?

COURSE KNOWLEDGE & SKILLS

Students will understand . . .

- Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.
- Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
- Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.
- Systems and system models. Defining the system under study – specifying its boundaries and making explicit a model of that system – provides tools for understanding and

testing ideas that are applicable throughout science and engineering.

- Energy and matter: Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.
- Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.
- Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Students will be able to . . .

- ask questions (for science) and define problems (for engineering).
- develop and use models.
- plan and carry out investigations.
- analyze and interpret data.
- use mathematics and computational thinking.
- construct explanations (for science) and design solutions (for engineering).
- engage in arguments from evidence.
- obtain, evaluate, and communicate information

COURSE SYLLABUS

Course Name

Grade 11 Chemistry

Level

College-Preparatory, Advanced College-Preparatory, & Honors

Prerequisites

Successful completion of Grade 10 Biology

Materials Required

None

General Description of the Course

This course is aligned to the Next Generation Science Standards (NGSS) Disciplinary Core Ideas for Grade 11. Through the implementation of the Three Dimensions of NGSS (Disciplinary Core Ideas, Science and Engineering Practices, and Cross Cutting Concepts), students will further explore many of the systems and processes of the physical and chemical world by investigating the underlying submicroscopic interactions of matter through the topics of general chemistry. By focusing on the changes in matter and energy, scientifically literate students can use this deeper understanding to make predictions, analyze scientific data, and contribute to the greater scientific community. At the Honors level, algebraic reasoning and independent discovery are expected; the CP level mirrors the ACP level with additional guided inquiry.

Assured Assessments

Formative Assessments:
Formative assessments can include, but are not limited to:

- Individual and group lists of safety lessons learned
- Construction of models
- Lab activities
- Creation of a periodic table
- Covalent bonding model kit activity
- Data collection and analysis

Summative Assessments:

- End-of-unit assessment with multiple-choice questions
- End-of-unit assessment with multiple-choice questions, free-response questions, and interpreting and analyzing data
- Midyear examination
- End-of-year examination

Core Texts and Resources

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman.
- *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]
- University of Colorado Boulder. *PhET Interactive Simulations*. https://phet.colorado.edu/en/simulations/category/new. Accessed January 21, 2020. Web.
- *Uranium: Twisting the Dragon's Tail*. Dir. Wain Fimeri, PBS, 2015. Film.

UNIT 1

Introduction to Matter & the Chemistry Laboratory

Unit Goals
At the completion of this unit, students will be able to:

Be able to safely perform laboratory experiments in accordance with OSHA Lab Safety and National Fire Code Standards.

NGSS.HS-PS1-2	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
NGSS.HS-PS1-7	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
NGSS.HS-PS3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative position of particles (objects).
CCS.ELA-Literacy.RST.11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
CCS.ELA-Literacy.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Empowered Learner (Standard 1d)	Understand the fundamental concepts of technology operations, demonstrate the ability to choose, use, and troubleshoot current technologies, and be able to transfer their knowledge to explore emerging technologies.
ISTE Creative Communicator (Standard 6a)	Choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication.

Unit Essential Questions

- How do we safely perform experiments in the science laboratory?
- How are properties of matter used to classify matter?
- What distinguishes a physical property from a chemical property?
- What distinguishes a physical change from a chemical change?
- How can particles of matter be represented?
- How can properties be used to identify a sample of matter?

Scope and Sequence

1. Common lab equipment
2. Lab techniques
3. Lab safety rules
4. Locations and use of safety equipment
5. Safety Data Sheets
6. Classifications of matter
7. Physical versus chemical properties and changes
8. States of matter
9. Mixtures versus pure substances
10. Particle pictures

Assured Assessments

Formative Assessment:

- Individual and group lists of safety lessons learned from Calais Weber (or similar) story
- Bunsen burner explanation and ignition
- Activity using Safety Data Sheets to determine an unknown substance
- Construction of models to demonstrate understanding on the microscopic level
- Lab activity differentiating chemical from physical properties/changes
- Lab activity based on methods of separating a mixture
- Qualitative analysis lab activity

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions related to safety in the chemistry lab. Students must score a 100% on the assessment before performing a lab experiment in the classroom.
- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to matter.

Vocabulary:

Atom	Filtrate	Precipitate
Beaker	Filtration	Pure Substances
Boiling Point	Flask	Qualitative Results
Bunsen burner	Heterogeneous Mixture	Quantitative Results
Chemical Formula	Homogeneous Mixture	Recrystallization
Chemical Properties/Changes	Hot plate	Ring Stand
Chemical Reaction	Mass	SDS
Chemical Symbol	Matter	Solubility
Chemistry	Melting Point	Test Tube
Compound	Mixtures	Volume
Density	Molecules	Well plate
Distillation	Physical Properties/Changes	Wire Gauze
Element	Pipette (pipet)	

Resources

Core

- *Flinn Scientific Safety Contract*. Print.
- *Flinn Scientific Safety Data Sheets*. https://www.flinnsci.com/sds/. Accessed January 21, 2020. Web.
- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]

Supplemental

- *After the Rainbow*. https://www.bing.com/videos/search?q=youtube+after+the+rainbow&view=detail&mid=F8646A3D7B5AC00206D1F8646A3D7B5AC00206D1&FORM=VIRE. Accessed January 21, 2020. Web.
- Modeling kits
- Online interactive review and reinforcement questions

Time Allotment

- Approximately 15 periods

UNIT 2

Atomic Structure and the Mole

Unit Goals

At the completion of this unit, students will:

NGSS.HS-PS1-1	Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
NGSS.HS-PS1-2	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
NGSS.HS-PS1-7 [Honors only]	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
CCS.ELA-Literacy.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
CCS.ELA-Literacy.RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- What defines an atom?
- How are elements identified and represented?
- What factors make one element different from another?
- How can scientists quantitatively represent groups of atoms? [Honors only]

Scope and Sequence

1. Subatomic particles
2. Periodic table and element symbolization

3. Nuclear pull
4. Mole-Mass relationships [Honors only]
5. Dimensional analysis [Honors only]

Assured Assessments

Formative Assessment:

- Simulation activity to build atoms
- Lab activity based on scientists' use of the mole to quantify very small things like atoms and molecules [Honors only]
- Lab activity analyzing the law of conservation of matter [Honors only]
- Lab activity calculating mole-mass conversions [Honors only]
- Lab activity interpreting chemical equations with the mole [Honors only]

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to atomic structure and the mole.

Vocabulary:

Atomic Number	Energy Levels	Nuclear Symbol
Average Atomic Mass	Isotope	Nucleus
Electron	Mass Number	Proton
Electron Cloud	Neutron	

Resources

Core

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]
- University of Colorado Boulder. *PhET Interactive Simulations: Build an Atom*. https://phet.colorado.edu/en/simulation/build-an-atom. Accessed January 21, 2020. Web.

Supplemental

- Online interactive review and reinforcement questions
- NOVA. *Hunting the Elements*. https://www.pbs.org/wgbh/nova/video/hunting-the-elements. Accessed January 21, 2020. Web.
- "Starstruck." Adapted from Ruth, Carolyn. "Where Do Chemical Elements Come From?" *ChemMatters* October 2009: 6-8. Print.

Time Allotment

- Approximately 12 periods

UNIT 3

Nuclear Chemistry

Unit Goals

At the completion of this unit, students will:

NGSS.HS-PS1-8	Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
CCS.ELA-Literacy.RST.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
CCS.ELA-Literacy.RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Empowered Learner (Standard 1d)	Understand the fundamental concepts of technology operations, demonstrate the ability to choose, use, and troubleshoot current technologies, and be able to transfer their knowledge to explore emerging technologies.
ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.
ISTE Innovative Designer (Standard 4d)	Exhibit a tolerance for ambiguity, perseverance, and the capacity to work with open-ended problems.

Unit Essential Questions

- What are the differences between nuclear reactions and chemical reactions?
- What happens to atoms during nuclear decay?
- What are the characteristics of alpha, beta, and gamma radiation?

- What are the benefits of and drawbacks from the use of nuclear energy in society?
- What are the differences between nuclear fission and fusion?
- How do nuclear power plants generate electricity?

Scope and Sequence

1. Early understanding and discovery of radiation
2. Isotope stability
3. Radioactive decay
4. Types of radiation
5. Fission and fusion reactions
6. Nuclear weapons
7. Nuclear power
8. Ionizing radiation
9. Applications of radiation

Assured Assessments

Formative Assessment:

- Students will participate in "check in" assignments consisting of multiple-choice questions, free- response questions, and interpreting and analyzing data, related to nuclear chemistry.

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to nuclear chemistry.

Vocabulary:

Alpha Decay / Emission
Background Radiation
Band of Stability
Beta Decay / Emission
Chain Reaction
Control Rods
Critical Mass
Gamma Decay / Emission
Geiger Counters
Ionization Radiation
Manhattan Project
Nuclear Meltdown
Nuclear Fission
Nuclear Fusion
Nuclear Power Plants
Radiation
Radioactivity

Resources

<u>Core</u>

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]
- *Uranium: Twisting the Dragon's Tail*. Dir. Wain Fimeri, PBS, 2015. Film.

Supplemental

- Activity to evaluate personal perception of risk compared to the risk of exposure to radiation
- Activity to investigate applications of nuclear chemistry
- "The Death of Alexander Litvinenko." Adapted from Keown, Audrey. "The Death of Alexander Litvinenko." *ChemMatters* April 2007: 18-19. Print.
- Lab activity on applications of nuclear reactions
- Marder, Jenny. "Mechanics of a Nuclear Meltdown Explained." *Science* March 15, 2011. https://www.pbs.org/newshour/science/mechanics-of-a-meltdown-explained. Accessed January 21, 2020. Web.
- Weatherall, Steve. "Radioactivity: Expect the Unexpected." https://www.youtube.com/watch?v=TJgc28csgV0. Accessed January 21, 2020. Web.

Time Allotment

- Approximately 12 periods

UNIT 4

The Periodic Table

Unit Goals

At the completion of this unit, students will:

NGSS.HS-PS1-1	Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.
NGSS.HS-PS1-2	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
NGSS.HS-PS1-3	Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
NGSS.HS-PS4-4	Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.
NGSS.HS-PS4-5	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.
NGSS.HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
NGSS.HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
CCSS.ELA-Literacy.RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.

ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.
ISTE Innovative Designer (Standard 4d)	Exhibit a tolerance for ambiguity, perseverance, and the capacity to work with open-ended problems.
ISTE Computational Thinker (Standard 5c)	Break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.

Unit Essential Questions

- How does an atom's electron configuration/ valence shell affect its chemical properties?
- What is the significance of core electrons versus valence electrons, and how can that be represented? [Honors only]
- What patterns exist in atoms' radii on different groups and periods of the periodic table?
- How is an element's electron configuration affected by its need for stability?
- How is the periodic table organized?
- How can physical and chemical properties be predicted and explained based on periodic table location?
- How can the periodic law be used to select materials to meet societal needs?

Scope and Sequence

1. Electron configurations and orbital diagrams [Honors only]
2. Valence electrons and stability
3. Periods and groups
4. Periodic law
5. Atomic and ionic size trend
6. Reactivity trend
7. Ionization energy and trend [for Honors & ACP only]
8. Electronegativity and trend [for Honors & ACP only]

Assured Assessments

Formative Assessment:

- Activity creating a periodic table
- Lab activity exploring periodic trends
- Lab activity investigating alloys

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to electrons and the periodic table organization.

Vocabulary:

Alkali Metals	Ion	Nuclear Pull
Alkaline earth metals	Ionization Energy	Octet Rule
Atomic & Ionic Size	Malleable	Periodic Law
Ductile	Metalloids	Periods
Electronegativity	Metals	Sea of Electrons
Groups	Noble Gases	Shielding Effect
Halogens	Nonmetals	Valence Electrons

Resources

Core

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]

Supplemental

- Lab activity based on properties of metals and nonmetals
- "Activity: From Mine to Mobile." Trumbull High School. Adapted from Prendergast, John, and Sasha Lezhnev. "From Mine to Mobile Phone: The Conflict Minerals Supply Chain." The Enough Project, n.p.: 2009. https://enoughproject.org/files/minetomobile.pdf. Accessed January 21, 2020. Print.
- NOVA. *Hunting the Elements*. https://www.pbs.org/wgbh/nova/video/hunting-the-elements. Accessed January 21, 2020. Web.
- "Secrets of the Super Elements." Dir. Laura Mulholland. BBC, 2017. https://www.bbc.co.uk/programmes/b08rv9r6. Accessed January 21, 2020. Web.
- "TBQ: The Nature of Things." Adapted from Goho, Alexandra. "The Nature of Things." *Science News* Oct. 21, 2003. https://www.sciencenews.org/article/nature-things. Accessed January 21, 2020. Web.

Time Allotment

- Approximately 15 class periods

UNIT 5

Bonding: Intramolecular Attraction

Unit Goals

At the completion of this unit, students will:

NGSS.HS-PS1-2	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
NGSS.HS-PS1-3	Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
NGSS.HS-PS1-4	Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- Why do most atoms form chemical bonds while a few do not?
- How can the positions of elements on the periodic table be used to predict how they form compounds with other elements?
- How are ionic and covalent bonds formed, and how does the bond type influence the properties of compounds?

Scope and Sequence

1. Octet Rule and valence electrons
2. Ion formation and electrostatic attraction between ions
3. Naming and writing formulas for ionic compounds
4. Naming and writing formulas for covalent compounds
5. Representing covalent molecules in drawings
6. Differences in properties of atoms, ionically bonded compounds, and covalently bonded compounds
7. Determining percent composition. [Honors and ACP only]
8. Determining empirical formulas [Honors only]

Assured Assessments

Formative Assessment:

- Lab activity forming ionic compounds
- Lab activity identifying a hydrate [for Honors]
- Covalent bonding model kit activity

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to bonding.

Vocabulary:

Anion	Double Bond	Tetrahedral
Bent	Ionic Bond	Trigonal Planar
Bohr Model	Lewis Dot Diagrams	Trigonal Pyramidal
Cation	Linear	Triple Bond
Covalent Bond	Polyatomic Ions	
Diatomic Molecules	Single Bond	

Resources

Core

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]
- University of Colorado Boulder. *PhET Interactive Simulations*. https://phet.colorado.edu/en/simulations/category/new. Accessed January 21, 2020. Web. [for online molecule simulations]

Supplemental

- Lab activity making esters
- "Speed Match: Practice with Ionic Names/Formulas." Trumbull High School.
- "ChemThink Ionic Bonding" https://cptv.pbslearningmedia.org/resource/lsps07.sci.phys.matter.ionicbonding/ionic-bonding/ Interactive tutorial. Accessed May 15, 2023. Web.
- "ChemThink Covalent Bonding" https://cptv.pbslearningmedia.org/resource/lsps07.sci.phys.matter.covalentbond/covalent-bonding/ Interactive tutorial. Accessed May 15, 2023. Web.
- "TBQ: How Does Your Nose Know?" SAT practice article adapted from Börsch, Angelika. "Small Molecules Make Scents." *Science in School* 6 (Sept. 18, 2007). https://www.scienceinschool.org/2007/issue6/scents. Accessed January 21, 2020. Web.
- "TBQ: Paintball." Adapted from Rohrig, Brian. "Paintball: Chemistry Hits Its Mark." *ChemMatters* April 2007: 4-7. Print.

Time Allotment

- Approximately 26 class periods

UNIT 6

Intermolecular Forces

Unit Goals

At the completion of this unit, students will:

NGSS.HS-PS1-2	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
NGSS.HS-PS1-3	Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
NGSS.HS-PS3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative position of particles (objects).
NGSS.HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
NGSS.HS-ESS3-5	Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems.
NGSS.HS-ESS3-6	Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How do electronegativity and molecular shape determine the polarity of a molecule?
- How do the type of bond and the polarity of a molecule determine the interactions between neighboring molecules, the characteristics of different substances, and the formation of solutions?
- What properties make water essential for life on planet Earth?
- How can the energy involved in changes in state be quantified and expressed through models?

Scope and Sequence

1. Electronegativity values and determination of bond type
2. Polarity of bonds
3. Polarity of molecules
4. Intermolecular forces between neighboring molecules due to polarity
5. Shape, polarity, and properties of water
6. Solubility, solute, solvent, and formation of solutions
7. Relationships among intermolecular forces, energy, and state of matter
8. Phase changes

Assured Assessments

Formative Assessment:

- Lab activity exploring polar and nonpolar interactions
- Lab activity determining boiling point or freezing point of substances

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to intermolecular forces.

Vocabulary

Absolute Zero
Adhesion
Boiling
Capillary action
Cohesion
Condensation
Deposition
Dipole interactions
Electronegativity
Evaporation
Freezing
Heat of Fusion
Heat of Vaporization
Hydrogen bonding
Intermolecular forces (IMF)
Melting
Nonpolar
Phase Change
Polar
Sublimation
Surface Tension
Surfactant
Vaporization

Resources

Core

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]

Supplemental

- Lab activity creating a non-Newtonian fluid
- Guided activity on water and its properties
- Online interactive review and reinforcement questions
- *Meltdown*. The Weather Channel, 2019. https://www.youtube.com/watch?v=8SwtW97xuiI Accessed May 15, 2023. Web.

Time Allotment

- Approximately 14 class periods

UNIT 7

Chemical Reactions

Unit Goals

At the completion of this unit, students will:

NGSS.HS-PS1-7 [ACP and CP]	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
NGSS.HS-PS1-2	Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
NGSS.HS-ESS2-2	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.
NGSS.HS-ESS2-4	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
NGSS.HS-ESS2-6	Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.
NGSS.HS-ESS2-7	Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.
NGSS.HS-ESS3-1	Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.
NGSS.HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
NGSS.HS-ESS3-5	Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems.
NGSS.HS-ESS3-6	Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

CCS.ELA-Literacy.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
CCS.ELA-Literacy.RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
CCS.ELA-Literacy.RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3b)	Evaluate the accuracy, perspective, credibility, and relevance of information, media, data, or other resources.
ISTE Knowledge Constructor (Standard 3d) and	Build knowledge by actively exploring real-world issues and problems, developing ideas and theories pursuing answers and solutions.
ISTE Computational Thinker (Standard 5b)	Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
ISTE Computational Thinker (Standard 5c)	Break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.

Unit Essential Questions

- How can scientists quantitatively represent groups of atoms in chemical reactions? [ACP and CP]
- What are the characteristics of the five basic reaction types?
- How can an activity series be used to predict the outcome of a single replacement reaction?
- How can a solubility chart be used to predict the outcome of a double replacement reaction?
- What are the natural parts of the carbon cycle?
- What is the difference between complete combustion and incomplete combustion?

- How does carbon monoxide affect the human body?
- What is the influence of fossil fuel combustion on the carbon cycle
- How does the greenhouse effect work?
- What is the relationship between an industrial society and rising atmospheric temperatures?
- What evidence do we have that the Earth's changing climate is due to human activity?
- How is the level of CO_2 dissolved in the ocean affected by climate change, and what impact does this have on Earth's systems?

Scope and Sequence

1. Identifying the parts of a chemical equation
2. Mole-Mass relationships [ACP and CP]
3. Dimensional analysis [ACP and CP]
4. Characteristics and general form of reaction types
5. Using an activity series
6. Using a solubility chart
7. Natural carbon cycle
8. Human influence on the carbon cycle
9. Complete combustion vs. incomplete combustion
10. Carbon monoxide
11. Types of greenhouse gases and how they are measured
12. Greenhouse effect
13. Effects of climate change

Assured Assessments

Formative Assessment:

- Lab activity analyzing the law of conservation of matter [ACP and CP]
- Lab activity calculating mole-mass conversions [ACP and CP]
- Lab activity interpreting chemical equations with the mole [ACP and CP]
- Lab activity showing chemical reactions in solution
- Lab activity/demonstration showing each type of chemical reaction
- Data collection and analysis of greenhouse gases

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to chemical reactions.

Vocabulary

Activity Series
Carbon cycle
Carbon source vs. Sink
Climate change
Combination/Synthesis Reaction
Combustion reaction
Decomposition reaction
Double replacement reaction
Greenhouse gas
Insoluble
Precipitate
Products
Reactants
Single replacement reaction
Soluble

Resources

Core

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]

Supplemental

- Online interactive review and reinforcement questions
- *Cosmos: A Spacetime Odyssey: The World Set Free*. Dir. Brannon Braga. National Geographic, 2014. Film.

Time Allotment

- Approximately 12 periods

UNIT 8

Stoichiometry

Unit Goals

At the completion of this unit, students will:

NGSS.HS-PS1-7	Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.
CCS.ELA-Literacy.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d) and	Build knowledge by actively exploring real-world issues and problems, developing ideas and theories pursuing answers and solutions.
ISTE Innovative Designer (Standard 4a) innovative	Know and use a deliberate design process for generating ideas, testing theories, creating artifacts, or solving authentic problems.
ISTE Computational Thinker digital (Standard 5b)	Collect data or identify relevant data sets, use tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
ISTE Computational Thinker (Standard 5c)	Break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.

Unit Essential Questions

- How is the law of conservation of matter represented in chemical reactions?
- How is the ideal mole ratio related to the quantity of reactants or products in a chemical reaction?
- How can we use a balanced equation to calculate chemical quantities during a reaction?
- What causes reactions to stop?
- How is the actual yield in a reaction related to the predicted yield?

Scope and Sequence

1. Translating sentences into chemical equations
2. Balancing equations and the law of conservation of matter
3. Stoichiometry, limiting reactants, and excess reactants
4. Why reactions continue, why they stop
5. Percent yield [for Honors]

Assured Assessments

Formative Assessment:

- Lab activity qualitatively determining limiting and excess reactants
- Lab activity quantitatively using the law of conservation of matter

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to stoichiometry.

Resources

Core

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]

Supplemental

- Online interactive review and reinforcement questions

Time Allotment

- Approximately 8 periods weeks

UNIT 9

Energy

Unit Goals

At the completion of this unit, students will:

NGSS.HS-PS1-4	Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.
NGSS.HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
NGSS.HS-PS3-2	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative position of particles (objects).
NGSS.HS-ESS2-4	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d) of	Build knowledge by actively exploring real-world issues and problems, including the anchoring event the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- What causes some physical and chemical changes to release energy while others gain energy?
- How is the law of conservation of energy expressed in chemical systems?
- How can the energy transferred in chemical and physical systems be quantified and expressed graphically?

Scope and Sequence

1. System vs. surroundings
2. Different types of energy (kinetic, potential, chemical, thermal)
3. Conservation of energy
4. Enthalpy changes and endothermic vs. exothermic reactions
5. Graphically depicting energy involved in physical and chemical changes
6. Calculations with heat, mass, change in temperature, and specific heat
7. Calculating the heat of chemical processes using calorimetry

Assured Assessments

Formative Assessment:

- Lab activity observing energy changes in chemical reactions
- Lab activity measuring energy changes in chemical reactions

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to energy.

Resources

Core

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]
- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]

Supplemental

- Online interactive review and reinforcement questions
- *Making Stuff Colder*. PBS, 2013. https://www.pbs.org/wgbh/nova/video/making-stuff-colder/. Accessed January 21, 2020. Web.

Time Allotment

- Approximately 12 periods

UNIT 10

Gases

Unit Goals

At the completion of this unit, students will:

ISTE Empowered Learner (Standard 1c)	Use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	Build knowledge by actively exploring real-world issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- What are the properties of gases?
- How are the properties of gases related?
- How can the properties of gases be mathematically represented and calculated?

Scope and Sequence

1. Assumptions of gases
2. Ideal gas law
3. Changes in conditions
4. Partial pressures of gases

Assured Assessments

Formative Assessment:

- Data analysis to determine trends between air pressure and altitude
- Lab activity exploring the relationships among pressure, volume, and temperature of a sample of gas

Summative Assessment:

- Students will participate in an assessment consisting of multiple-choice questions, free-response questions, and interpreting and analyzing data, related to gases.
- Following Unit 13, students will participate in the end-of-year examination.

Resources

Core

- Davis, Raymond E., Regina Frey, Mickey Sarquis, and Jerry L. Sarquis. *Modern Chemistry*. Austin: Holt, 2006. Print. [Honors]

- Phillips, John S., Victor S. Strozak, and Cheryl Wistrom. *Chemistry: Concepts and Applications*. Columbus: Glencoe, 2005. Print. [CP]
- Wilbraham, Anthony C., Dennis D. Staley, Michael S. Matta, and Edward L. Waterman. *Prentice Hall Chemistry*. Upper Saddle River, NH: Prentice Hall, 2005. Print. [ACP]
- Online simulations demonstrating relationships among pressure, volume, and temperature of a gas

<u>Supplemental</u>

- Online interactive review and reinforcement questions
- *Everest*. Dir. Greg MacGillivray. MacGillivray Freeman, 1998. Film.
- "Everest to Deep Sea." Adapted from:
    - Belleman, Melissa. "Scuba: The Chemistry of an Adventure." *ChemMatters* February 2001: 7-9. Print.
    - Rohrig, Brian. "Climbing into Thin Air." *ChemMatters* February 2000: 4-6. Print.
- "Would a Vacuum Work in a Vacuum?" Adapted from Becker, Bob. "Question from the Classroom." *ChemMatters* October 2003: 4-5. Print.

Time Allotment

- Approximately 12 periods

COURSE CREDIT

1 credit in science

ASSURED STUDENT PERFORMANCE RUBRICS

- Trumbull High School School-Wide Writing Rubric (attached)
- Trumbull High School School-Wide Problem-Solving Rubric (attached)
- Trumbull High School School-Wide Independent Learning and Thinking Rubric (attached)

Trumbull High School School-Wide Writing Rubric

Category / Weight	Exemplary 4 Student work:	Goal 3 Student work:	Working Toward Goal 2 Student work:	Needs Support 1-0 Student work:
Purpose X_____	● Establishes and maintains a clear purpose ● Demonstrates an insightful understanding of audience and task	● Establishes and maintains a purpose ● Demonstrates an accurate awareness of audience and task	● Establishes a purpose ● Demonstrates an awareness of audience and task	● Does not establish a clear purpose ● Demonstrates limited/no awareness of audience and task
Organization X_____	● Reflects sophisticated organization throughout ● Demonstrates logical progression of ideas ● Maintains a clear focus ● Utilizes effective transitions	● Reflects organization throughout ● Demonstrates logical progression of ideas ● Maintains a focus ● Utilizes transitions	● Reflects some organization throughout ● Demonstrates logical progression of ideas at times ● Maintains a vague focus ● May utilize some ineffective transitions	● Reflects little/no organization ● Lacks logical progression of ideas ● Maintains little/no focus ● Utilizes ineffective or no transitions
Content X_____	● Is accurate, explicit, and vivid ● Exhibits ideas that are highly developed and enhanced by specific details and examples	● Is accurate and relevant ● Exhibits ideas that are developed and supported by details and examples	● May contain some inaccuracies ● Exhibits ideas that are partially supported by details and examples	● Is inaccurate and unclear ● Exhibits limited/no ideas supported by specific details and examples
Use of Language X_____	● Demonstrates excellent use of language ● Demonstrates a highly effective use of standard writing that enhances communication ● Contains few or no errors. Errors do not detract from meaning	● Demonstrates competent use of language ● Demonstrates effective use of standard writing conventions ● Contains few errors Most errors do not detract from meaning	● Demonstrates use of language ● Demonstrates use of standard writing conventions ● Contains errors that detract from meaning	● Demonstrates limited competency in use of language ● Demonstrates limited use of standard writing conventions ● Contains errors that make it difficult to determine meaning

Trumbull High School School-Wide Problem-Solving Rubric

Category / Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Understanding X_____	● Student demonstrates clear understanding of the problem and the complexities of the task	● Student demonstrates sufficient understanding of the problem and most of the complexities of the task	● Student demonstrates some understanding of the problem but requires assistance to complete the task	● Student demonstrates limited or no understanding of the fundamental problem after assistance with the task
Research X_____	● Student gathers compelling information from multiple sources including digital, print, and interpersonal	● Student gathers sufficient information from multiple sources including digital, print, and interpersonal	● Student gathers some information from few sources including digital, print, and interpersonal	● Student gathers limited or no information
Reasoning and Strategies X_____	● Student demonstrates strong critical thinking skills to develop a comprehensive plan integrating multiple strategies	● Student demonstrates sufficient critical thinking skills to develop a cohesive plan integrating strategies	● Student demonstrates some critical thinking skills to develop a plan integrating some strategies	● Student demonstrates limited or no critical thinking skills and no plan
Final Product and/or Presentation X_____	● Solution shows deep understanding of the problem and its components ● Solution shows extensive use of 21st-century technology skills	● Solution shows sufficient understanding of the problem and its components ● Solution shows sufficient use of 21st-century technology skills	● Solution shows some understanding of the problem and its components ● Solution shows some use of 21st-century technology skills	● Solution shows limited or no understanding of the problem and its components ● Solution shows limited or no use of 21st-century technology skills

Trumbull High School School-Wide
Independent Learning and Thinking Rubric

Category/ Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Proposal X _____	● Student demonstrates a strong sense of initiative by generating compelling questions, creating uniquely original projects/work	● Student demonstrates initiative by generating appropriate questions, creating original projects/work	● Student demonstrates some initiative by generating questions, creating appropriate projects/work	● Student demonstrates limited or no initiative by generating few questions and creating projects/work
Independent Research & Development X_____	● Student is analytical, insightful, and works independently to reach a solution	● Student is analytical, and works productively to reach a solution	● Student reaches a solution with direction	● Student is unable to reach a solution without consistent assistance
Presentation of Final Product X_____	● Presentation shows compelling evidence of an independent learner and thinker ● Solution shows deep understanding of the problem and its components ● Solution shows extensive and appropriate application of 21st-century skills	● Presentation shows clear evidence of an independent learner and thinker ● Solution shows adequate understanding of the problem and its components ● Solution shows adequate application of 21st-century skills	● Presentation shows some evidence of an independent learner and thinker ● Solution shows some understanding of the problem and its components ● Solution shows some application of 21st-century skills	● Presentation shows limited or no evidence of an independent learner and thinker ● Solution shows limited or no understanding of the problem and its components ● Solution shows limited or no application of 21st-century skills

TRUMBULL PUBLIC SCHOOLS

Trumbull, Connecticut

CP Physics Grade 12

2023

(Last revision date: 2022)

Curriculum Writing Team

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CP Physics

Grade 12

Table of Contents

The Trumbull Board of Education will continue to take Affirmative Action to ensure that no persons are discriminated against in its employment.

CORE VALUES AND BELIEFS

The Trumbull High School community engages in an environment conducive to learning which believes that all students will **read** and **write effectively**, therefore communicating in an articulate and coherent manner. All students will participate in activities **that present problem-solving through critical thinking**. Students will use technology as a tool applying it to decision making. We believe that by fostering self-confidence, self-directed and student-centered activities, we will promote **independent thinkers and learners**. We believe **ethical conduct** to be paramount in sustaining the welcoming school climate that we presently enjoy.
Approved 8/26/2011

INTRODUCTION & PHILOSOPHY

In Grade 12 Physics, students will explore many of the systems and processes of the physical world by investigating the macroscopic interactions of matter through the topics of general physics. By focusing on the changes in matter and energy, scientifically literate students can use this deeper understanding to make predictions, analyze scientific data, and contribute to the greater scientific community. Students in this course will typically have completed CP Chemistry with a focus on the microscopic interactions of matter.

This curriculum has been modified most recently (2021) to remain consistent in the continued development of scientifically literate students, with a concentration on matter, energy, and changes. Authentic scientific and engineering experiences build on one another and increase in complexity throughout students' K-12 education. In 2015, the Connecticut State Board of Education adopted the Next-Generation Science Standards (NGSS), which embody the National Research Council's *Framework for K-12 Science Education* (2012). Both the *Framework* and the NGSS stress the importance of teaching classroom scientific inquiry as practiced by scientists and engineers. The *Framework* provides a vision for American science education in the 21st century, while the NGSS provides grade-level student performance expectations, disciplinary core ideas, and crosscutting concepts. The *Framework* and NGSS indicated a paradigm shift in science education, one in which teachers are to incorporate authentic learning experiences for students that reflect the nature of doing science and engineering.

The *Framework* and NGSS provide clarity to classroom scientific inquiry by stressing the importance of eight practices of science and engineering. The practices were designed to help students understand how scientific knowledge develops, and to stimulate students' interest in and continued study of science. Three-dimensional learning facilitates student engagement with Science and Engineering Practices and Crosscutting Concepts to deepen their understanding of Disciplinary Core Ideas in order to explain phenomena and solve problems. Three-dimensional learning promotes development of student skills in the following areas:

- Knowing, using, and interpreting scientific explanations of the natural world (Disciplinary Core Ideas, and Crosscutting Concepts)
- Generating and evaluating scientific evidence and explanations (Science and Engineering Practices)
- Participating productively in scientific practices and discourse (Science and Engineering Practices)

- Understanding the nature and development of scientific knowledge (Science and Engineering Practices, and Crosscutting Concepts)

The shift of science education reflects the interconnected nature of science as it is practiced in the real world and builds coherently across grades K-12. The NGSS focus on deeper understanding of content as well as application of content with an alignment to the Connecticut Core Standards. A deeper understanding and application of science and engineering practices prepare students for postsecondary success and citizenship in a world fueled by innovations in science and technology. In accordance with the NGSS Science and Engineering Practices, students will be asked to . . .

- ask questions (for science) and define problems (for engineering).
- develop and use models.
- plan and carry out investigations.
- analyze and interpret data.
- use mathematics and computational thinking.
- construct explanations (for science) and design solutions (for engineering).
- engage in arguments from evidence.
- obtain, evaluate, and communicate information.

Grade 12 Physics is offered at two separate course levels: Advanced College Preparatory (ACP) and College Preparatory (CP). Both levels will explore each unit of study. The courses are differentiated by pacing of curriculum, rigor of exploration, depth of content knowledge, and the application of quantitative reasoning. The ACP course will explore topics with the greatest depth, most rigorous exploration, deepest study of content, and furthest application of quantitative reasoning. More support will be offered at the CP course level. In addition, study of physics principles is offered through an early college experience collaborative (UCONN Physics) and two Advanced Placement courses: Physics C (AP-C) and Physics 1 (AP-1). These advanced courses follow a different curriculum, and demand a much higher rigor of exploration, depth of content knowledge, and the application of quantitative reasoning.

COURSE GOALS

The following course goals derive from the 2021 Next Generation Science Standards.

HS-PS2-1.	Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
HS-PS2-2.	Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
HS-PS2-3.	Apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
HS-PS2-4.	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
HS-PS2-5.	Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.
HS-PS2-6.	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
HS-PS3-2.	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).
HS-PS3-3.	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

HS-PS3-4.	Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
HS-PS3-5.	Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.
HS-PS4-1.	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
HS-PS4-5.	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

The following course goals derive from the 2010 Connecticut Common Core State Standards for English Language Arts and Literacy in History/Social Studies, Science and Technical Subjects

CCSS.ELA-LITERACY.RST.11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
CCSS.ELA-LITERACY.RST.11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
CCSS.ELA-LITERACY.RST.11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
CCSS.ELA-LITERACY.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

CCSS.ELA-LITERACY.RST.11-12.5	Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
CCSS.ELA-LITERACY.RST.11-12.6	Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
CCSS.ELA-LITERACY.RST.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
CCSS.ELA-LITERACY.RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
CCSS.ELA-LITERACY.RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible
CCSS.ELA-LITERACY.RST.11-12.10	By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

The following course goals derive from the 2010 Connecticut Core Standards for Literacy.

CCSS.ELA-LITERACY.RI.11-12.1	Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.
CCSS.ELA-LITERACY.RI.11-12.2	Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.

CCSS.ELA-LITERACY.RI.11-12.5	Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.
CCSS.ELA-LITERACY.RI.11-12.6	Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness or beauty of the text.
CCSS.ELA-LITERACY.W.11-12.1.B	Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level, concerns, values, and possible biases.
CCSS.ELA-LITERACY.W.11-12.1.D	Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
CCSS.ELA-LITERACY.W.11-12.2.B	Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
CCSS.ELA-LITERACY.W.11-12.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
CCSS.ELA-LITERACY.W.11-12.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
CCSS.ELA-LITERACY.W.11-12.10	Write routinely over extended time frames (time for research, reflection, and revision) and shorter

	time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.
CCSS.ELA-LITERACY.SL.11-12.2	Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data
CCSS.ELA-LITERACY.SL.11-12.3	Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.
CCSS.ELA-LITERACY.L.11-12.3	Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.
CCSS.ELA-LITERACY.L.11-12.6	Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression

The following course goals derive from the 2016 International Society for Technology in Education (ISTE) Technology Standards

ISTE Standard 1 - Empowered Learner	Students leverage technology to take an active role in choosing, achieving, and demonstrating competency in their learning goals, informed by the learning sciences.
ISTE Standard 2 - Digital Citizen	Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical.
ISTE Standard 3 - Knowledge Constructor	Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others.
ISTE Standard 4 - Innovative Designer	Students use a variety of technologies within a

	design process to identify and solve problems by creating new, useful or imaginative solutions.
ISTE Standard 5 - Computational Thinker	Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions
ISTE Standard 6 - Creative Communicator	Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals
ISTE Standard 7 - Global Collaborator	Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally

COURSE ENDURING UNDERSTANDINGS

Students will understand that…

- scientific knowledge is acquired through inquiry, experimentation, data analysis, and interpretation.
- scientific conclusions and explanations are based on research data, and scientific results may be assessed based on the design of the investigation.
- scientific ideas and concepts evolve over time.
- the credibility of scientific information found in various media can vary.
- mathematical operations and procedures may be used to calculate, analyze, and present data and ideas.
- science and technology affect the quality of our lives.

Also, in accordance with the NGSS Cross-Cutting Concepts, students will work to understand . . .

- how observed patterns of forms and events guide organization and classification, and prompt questions about relationships and the factors that influence them.
- events have causes, sometimes simple, sometimes multifaceted and that a major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
- scale, proportion, and quantity in considering phenomena. It is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.
- that defining the system under study – specifying its boundaries and making explicit a model of that system – provides tools for understanding and testing ideas that are applicable throughout science and engineering.
- that the tracking of fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.
- structure and function, in such that the way in which an object or living thing is shaped and its substructure determine many of its properties and functions.
- that for natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

COURSE ESSENTIAL QUESTIONS

From Study.com:

- How are graphical and mathematical models created from experimental data?
- How are fields used to model physics phenomena?
- How can rules and relationships be used to predict what happens in a physical situation?
- How can physics be applied to understanding everyday life?
- How can abstract mathematics be used to describe phenomena?
- How can abstract mathematics be used to represent relationships between variables?
- To what extent does physics explain phenomena at the wide variety of scales?
- How can physics be used to solve problems?
- How does physics explain change and constancy in the universe?
- What is the value in separating the universe into systems when trying to explain it?
- Why are system boundaries important to define?
- Why are assumptions and approximations important in physics? To what extent does this limit the usefulness of your results?
- To what extent does physics explain cause and effect?
- How can scientific ideas be used to solve problems?
- How is matter and energy related?
- How is the universe constructed from the tiny scales to the largest?
- How can physics be used to create models and simulations?
- Why is correlation and causation not the same thing?
- How are physics and engineering related?
- How can scientific knowledge be communicated?
- How can scientific arguments be evaluated?
- How should scientific investigations be designed?

From NGSS (Physical Science):

- How can one explain and predict interactions of objects and systems of objects?
- How can one predict an object's continued motion, change in motion,or stability?
- What underlying forces explain the variety of interactions observed?
- Why are some physical systems more stable than others?
- How is energy transferred and conserved?
- What is meant by conservation of energy?
- How is energy transferred between objects or systems?
- How are forces related to energy?
- If energy is conserved,why do people say it is produced or used?
- How are waves used to transfer energy and information?
- What are the characteristic properties and behaviors of waves?

- What is light?
- How can one explain the varied effects that involve light?
- What other forms of electromagnetic radiation are there?
- How are instruments that transmit and detect waves used to expand human senses?

COURSE KNOWLEDGE & SKILLS

The following core knowledge and skills will be developed through students' work in this course:

Students will know . . .

- the appropriate techniques and procedures to use in a laboratory setting.
- the difference between scalar and vector quantities.
- the difference between distance and displacement.
- the difference between speed and velocity.
- the definition of the term acceleration.
- Newton's Laws of Motion.
- the various types of forces.
- the definitions of momentum and momentum conservation.
- the definition of impulse and its relationship to momentum change.
- the relationship between momentum conservation and Newton's laws of motion.
- the differences between various types of energy (kinetic, gravitational potential, elastic potential, thermal).
- the relationship between work and the change in energy of a system.
- that power is calculated as the rate at which work is done (rate of energy conversion).
- that charging of an object is the separation, not the creation, of electrical charges.
- that electrically charged objects exert forces, both attractive and repulsive.
- the ways objects become charged.
- the definition of electrical force as it relates to the charges on objects and the distance between them.
- the definitions of electric current, potential difference, resistance, and power, and their relationships to each other.
- the properties of magnets and the origin of magnetism in materials.
- the relationship between magnetic induction and the direction of force on a current-carrying wire in a magnetic field.
- the design and operation of an electric motor.
- how wave phenomena are described, using the following terms: amplitude, wave pulse, periodic wave, wavelength, frequency, period, and wave speed.
- the differences between transverse and longitudinal waves, and provide examples of each.

- what happens when two or more waves attempt to occupy the same location in a medium.
- the definition of wave resonance and its relation to an object's natural frequency.
- how light travels.
- that light is part of the electromagnetic spectrum.
- that when light strikes an object, it is absorbed, reflected from or transmitted through the substance and what happens when these occur.
- the dual nature of light.

Students will be able to . . .

- abide by the safety rules and regulations set forth by the safety contract.
- use appropriate tools and techniques to make observations and gather data.
- articulate conclusions and explanations based on research data, and assess results based on the design of the investigation.
- describe the motion of an object with constant velocity vs. constant acceleration.
- use the kinematic equations to complete one-dimensional motion problems.
- create and interpret position vs. time graphs.
- create and interpret velocity vs. time graphs.
- describe the motion of a freely-falling object.
- use the kinematic equations to complete free fall motion problems.
- describe the motion of a projectile.
- use the kinematic equations to complete two-dimensional motion problems.
- describe how friction affects the motion of two objects that are in contact with each other.
- draw free body diagrams of objects with arrows identifying the forces acting on the object.
- use a free body diagram and vector addition to determine the net force acting on an object.
- use Newton's Second Law to predict the acceleration of an object given its mass and the net force acting upon it.
- solve problems relating an object's mass, forces acting on it and its motion.
- solve collision and explosion problems using the conservation of momentum.
- quantify the amount of each type of energy a system possesses.
- quantify the amount of work done by a force.
- use the work-energy theorem to solve problems.
- use conservation of energy to solve problems.
- solve electrostatics problems using the conservation of charge.
- describe the requirements for electric current flow in circuits.
- diagram simple electric circuits.
- solve problems involving current, potential difference, resistance, power, and the use and cost of electric energy.

- compare various magnetic fields.
- solve problems involving magnetic field strength and forces on current-carrying wires, and on moving, charged particles in magnetic fields.
- solve problems involving magnetic field strength and forces and induced EMF in moving wires.
- apply the phenomenon of induced EMF to the construction of generators and transformers.
- calculate the intensity (in W/m^2 and decibels) of a sound wave.
- explain and draw how standing waves can form on a string.
- explain and draw how standing waves can form in a closed pipe.

COURSE SYLLABUS

Course Name

CP Physics

Level

College Prep

Prerequisites

CP Prerequisite: Successful completion of CP Chemistry or ACP Chemistry.

General Description of the Course

This course consists of a practical study of mechanics, heat, sound, electricity, magnetism, light, atomic physics and astrophysics, stressing technological application. The CP level is similar to ACP Physics except that there is less of a need for mathematical skills. It is designed to acquaint the student with physics, as it is applicable in everyday life. Recommended for students planning to attend college, but who are not planning to major in science. The ACP level comprises a quantitative study of mechanics, wave phenomena, optics, heat, electricity and magnetism. The course demonstrates the mathematical relationships in physics concepts and applies these relationships to problem solving situations.

Assured Assessments

Formative assessments can include, but are not limited to:

- Individual and group lists of safety lessons learned (Unit 1)
- Construction of models (Unit 2)
- Lab activities (Units 2, 3, 4, 5, 6, 7, 8, 9, 10)
- Data collection and analysis (Units 2, 3, 4, 5, 6, 7, 8, 9, 10)

Summative Assessments:

- End-of-unit assessment with multiple-choice questions (Unit 1)
- End-of-unit assessment with multiple-choice questions, free-response questions, and interpreting and analyzing data (Units 2, 3, 4, 5, 6, 7, 8, 9, 10)
- Midyear examination
- End-of-year examination

UNIT 1
Mathematical Tools

Unit Goals

At the completion of this unit, students will:

- **collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making (ISTE Technology Standards – Computational Thinking – Standard 5b)**

- know how to conduct experiments safely with a variety of physics-related equipment and technologies in accordance with the Connecticut State Department of Education (SDE) guidance document which can be found at the following link: https://portal.ct.gov/SDE/Publications/Connecticut-High-School-Science-Safety/Physics - Laboratory-Safety-Specifications

Unit Essential Questions

- How do scientists experiment safely?
- How are tools selected and utilized to gather valid data in science?

Unit Essential Vocabulary

- Accuracy
- Precision
- Error
- Observation
- Conclusion/Inference

Unit Scope and Sequence

- Scientists develop models based on observation and data to explain natural phenomena and predict the results of actions.
- Data is collected through observation and measurement, using human senses or measuring devices.
- Measuring devices are calibrated to agree with each other or agree with an accepted value.
- The accuracy of a measurement or calculation refers to its agreement with other measurements or calculations, or to an accepted value for that quantity.
- The precision of a measurement refers to the "exactness" of the quantity, and is determined by the measuring device used.
- Data trends are best conveyed and communicated through the creation of a graph.

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental

processes on the topics of scientific measurement.
Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to mathematical scientific tools.

Resources

Core

- Conceptual Physics textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

Supplemental

- Flinn Scientific's Student Safety Contract Online resources
- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 1-2 Weeks

UNIT 2
Kinematics

Unit Goals

At the completion of this unit, students will:

NGSS Practices (Developing and Using Models):

- **develop and/or use a model to generate data to support explanations, analyze systems, or solve problems.** *Example: A ball's motion is represented using graphical and pictorial models. Students are required to use one or more of these models to analyze the ball's motion, to give explanations, and to solve problems*

NGSS Practices (Analyzing and Interpreting Data):

- analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. *Example: With pictorial and graphical data representations of a ball's motion, students are asked to analyze data and make meaning of the patterns that emerge from the data sets. Students also use information from one graph in combination with data from another to determine an unknown quantity or relationship.*

NGSS Crosscutting Concepts (Patterns):

- recognize that different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. *Example: As gravity affects a ball's motion both on its way up as well as on its way back down, students discover that a ball's downward motion is just a 'mirror image' of its upward motion. This symmetry becomes clear in the ball's dot diagram, the position vs. time graph, and in the velocity vs. time graph. Such patterns are not only helpful in solving kinematics problems, they speak to gravity's constant effect on any object in free fall.*

ISTE Technology Standards

ISTE Empowered Learner (Standard 1c)	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How is motion quantified?
- How is motion predictable?

Unit Essential Vocabulary

- Scalar
- Vector
- Position
- Distance
- Displacement
- Speed
- Velocity
- Acceleration

Unit Scope and Sequence

- Scalar quantities can be described completely with magnitude alone; vector quantities are described
- completely with magnitude and direction.
- Position is a vector quantity that describes where an object is at some moment in time.
- Displacement is a vector quantity that describes how far and in what direction an object has moved; distance is a scalar quantity that describes how far an object traveled in total to get from its starting to ending location.
- Velocity is a vector quantity that describes the direction and rate at which an object changes position, usually measured in "meters per second" (m/s). Speed is a scalar quantity that is either (1) the rate at which distance traveled changes, or (2) the magnitude of the velocity.
- Instantaneous velocity refers to the velocity at one particular moment in time, regardless of previous or future moments. Average velocity refers to the average rate of change in position over a given time interval.
- Acceleration is a vector quantity that describes the direction and rate at which an object's velocity changes, usually measured in "(meters per second) per second" (or m/s^2). Instantaneous acceleration refers to the acceleration at one particular moment in time, regardless of previous or future moments; average acceleration refers to the average rate of change in velocity over a given time interval.
- A ticker tape diagram (or oil drop diagram) can be used to visually represent the motion of an object. Concepts such as displacement, velocity, and acceleration can be inferred from these diagrams.
- A position vs. time graph displays the location of an object as a function of time. The slope of this graph represents the average velocity of the object.
- A velocity vs. time graph displays the velocity of an object as a function of time. The slope of this graph represents the average acceleration of the object. The area bounded by this graph and the time axis represents the displacement of the object.
- An object is said to be in free fall any time the force of gravity is the only force acting

on the object. This includes objects dropped, objects through up or down, and projectiles (always assuming air resistance is negligible). While in free fall near the surface of the Earth, all objects experience a constant downward acceleration of approximately 9.8 m/s^2.

- The kinematic equations are a set of four mathematical equations that can be used to describe the one-dimensional motion of any object experiencing constant acceleration. The equations relate the object's acceleration, initial velocity, velocity at some time t, displacement at some time t, and time.
- Vector quantities can be added visually using either the tail-to-tip method or the parallelogram method. These methods are especially useful when the vectors are not collinear.
- An object's measured velocity and displacement are dependent on both the object's motion and the relative motion of the object and observer. The observed acceleration of the object, however, is independent of the observer's motion (as long as the observer is not accelerating).
- The two-dimensional motion of an object can be described as two independent one-dimensional motions. Commonly these two dimensions are either (1) horizontal and vertical, or (2) north-south and east-west.
- A projectile in two-dimensional motion near the surface of the Earth experiences constant velocity in the horizontal direction and a constant acceleration of 9.8 m/s^2 downward in the vertical direction.
- The kinematic equations can be used to describe two-dimensional motion by treating the motion in each dimension separately.

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of constant speed, constant velocity and uniformly accelerated motion, including the acceleration of free-fall. Experimental work with projectile motion will also occur. Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to the kinematics of moving objects in one and two dimensions.

Resources

<u>Core</u>

- Conceptual Physics textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

<u>Supplemental</u>

Online resources

- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.

- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 1-2 weeks

UNIT 3
Forces

Unit Goals

At the completion of this unit, students will:

HS-PS2-1.	**Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.**
HS-PS2-4.	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
HS-PS2-6.	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

ISTE Technology Standards ISTE Empowered Learner (Standard 1c)	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How do Newton's Motion Laws predict the effect of forces on an object's motion?

Unit Essential Vocabulary

- Force
- Net Force
- Inertia
- Normal
- Friction
- Gravitational Field Strength
- Tension
- Weight

Unit Scope and Sequence

- Forces are defined as pushes or pulls on an object.
- Forces are classified as contact versus field forces. These are further categorized as gravitational, electromagnetic, strong nuclear and weak nuclear.
- Forces are expressed as vectors having magnitude and direction.
- Friction force acts between objects that contact each other. Friction acts parallel to the contacting surface in a direction that opposes the objects' sliding relative to each other.
- Normal force between objects that contact each other. Normal force acts perpendicular to the contacting surface.
- Friction force is directly proportional to normal force.
- The proportionality constant between friction and normal force is the friction coefficient, which is a property of any two contacting surfaces.
- Static (objects not sliding past each other) friction coefficients are generally greater than kinetic (objects sliding past each other) friction coefficients.
- Forces acting on an object combine to exert a net force.
- Net force is quantified through the use of a free body diagram of an isolated object with arrows indicating the forces exerted on the object.
- A net force is necessary to change the motion state of an object. (Newton's First Law of Motion)
- All objects have mass, the measurement of the object's inertia, its tendency to maintain its motion state.
- Acceleration, the change of an object's motion, is directly proportional to the net force acting on an object and inversely proportional to the mass of an object. (Newton's Second Law of Motion)
- Forces act in pairs between two objects. The paired forces are equal in magnitude and opposite in direction. (Newton's Third Law of Motion).

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of force (including weight, tension, friction and normal force) and Newton's Laws. Experimental work on vector force addition will also occur.
Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to force and Newton's Laws of mechanics.

Resources

Core

- Conceptual Physics textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

Supplemental

Online resources

- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 2-3 weeks

UNIT 4
Momentum

Unit Goals

At the completion of this unit, students will:

HS-PS2-2.	**Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.**
HS-PS2-3.	Apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

ISTE Technology Standards ISTE Empowered Learner (Standard 1c)	technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- What is momentum?
- How does momentum conservation determine the motion of objects interacting with each other?

Unit Essential Vocabulary

- Momentum
- Impulse
- Inelastic Collision
- Elastic Collision

Unit Scope and Sequence

- Impulse is defined as a force exerted on an objects over a period of time
- Impulse causes a change in an object's momentum. An object's momentum change is equal in magnitude and direction to the impulse exerted on it.
- The impulse/momentum change equation is the original expression of Newton's Second Law.
- Momentum is always conserved. This means that the total momentum of an isolated

system of objects remains constant.
- Momentum conservation results from Newton's Third Law of Motion.
- Momentum conservation is applied to collision and explosion problems to determine objects' motion before or after a collision or explosion.

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of impulse and conservation of momentum.
Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to momentum, its transfer and its conservation.

Resources

Core
- Conceptual Physics textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

Supplemental
Online resources
- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 1-2 weeks

UNIT 5
Energy

Unit Goals

At the completion of this unit, students will:

HS-PS3-1	**Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.**
HS-PS3-2.	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).
HS-PS3-3.	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

ISTE Technology Standards ISTE Empowered Learner (Standard 1c)	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How will the increasing demand for energy be met in the future?

Unit Essential Vocabulary

- Kinetic Energy
- Gravitational Potential Energy
- Elastic Potential Energy
- Work
- Power

Unit Scope and Sequence

- Energy is an abstract, scalar quantity possessed by an object (or system of objects) that comes in a variety of forms. The SI unit for energy is the joule (J), named after James Prescott Joule, and is equivalent to N•m or $kg•m^2/s^2$. Energy is also commonly measured in calories
- Energy can be converted from one form to another through the process of work, but it cannot be created nor destroyed. The total amount of energy in the universe is constant.
- Kinetic energy is energy associated with the translational motion of an object/system. A faster moving object has more kinetic energy than an identical slower moving object. A massive object has more kinetic energy than a less massive object moving at the same speed.
- Gravitational potential energy is energy associated with the interaction (attraction) between objects with mass. The farther apart two masses are the more gravitational potential energy there is.
- Elastic potential energy is energy associated with the stretching or compressing of a spring (or other elastic substance). The more stretched/compressed a spring, the more elastic potential energy it has stored. A stiffer spring will possess more elastic potential energy than a looser spring for the same amount of stretching or compression.
- The Law of Conservation of Energy states that energy cannot be created nor destroyed, but it can be converted between the different types.
- Power is the rate at which work is done (or the rate at which energy is converted from one form to another).

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of work, power and conservation of energy.
Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to energy, its transfer and its conservation.

Resources
Core
- Conceptual Physics textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

Supplemental
Online resources
- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.

- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 2-3 week

UNIT 6
Electrostatics

Unit Goals

At the completion of this unit, students will:

HS-PS2-4.	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
HS-PS2-6.	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
HS-PS3-5.	**Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.**

ISTE Technology Standards ISTE Empowered Learner (Standard 1c)	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How does electrical charge interact with matter?
- What rules govern how charge pushes and pulls on the world?

Unit Essential Vocabulary

- Electric Charge
- Coulomb (Unit)
- Electron
- Proton
- Electric Force
- Electrical Polarization
- Electrical Induction
- Electrical Grounding
- Electrical Insulator/Conductor
- Electric Field
- Electric Field Strength
- Electric Field Potential Difference

Unit Scope and Sequence

- There are two kinds of electrical charge, positive and negative
- Electrical charge is not created or destroyed; it is conserved.
- Objects can be charged by the transfer of electrons.
- Charges added to one part of an insulator remain on that part.
- Charges added to a conductor quickly spread over the surface of the object.
- Charged objects exert forces on other charged objects. Like charges repel; unlike charges attract
- An object can be charged by conduction by touching a charged object to it
- To charge an object by induction, a charged object is first brought nearby, causing a separation of charges. Then the object to be charged is separated, trapping opposite charges on the two halves.
- Coulomb's law states that force between two charged objects varies directly with the product of their charges and inversely with the square of the distance between them.
- The SI unit of charge is the coulomb. One coulomb © is the magnitude of the charge of 6.25×10^{18} electrons or protons. The elementary charge, the charge of the proton or electron, is 1.60×10^{-19} C.
- A charged object of either sign can produce separation of charge in a neutral body. Thus a charged object attracts a neutral one.
- An electric field exists around any charged object. The field produces forces on other charged objects.
- The electric field intensity is the force per unit charge. The direction of the electric field is the direction of the force on a tiny, positive test charge.
- Electric field lines provide a picture of the electric field. They are directed away from the positive charges and toward negative charges.
- Electric potential difference is the change in potential energy per unit charge in an electric field, and is measured in volts.
- A charged object can have its excess charge removed by touching it to Earth or to an object touching Earth. This is called grounding.

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of electrostatics.
Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to electrostatic interactions.

Resources

<u>Core</u>

- Conceptual Physics textbook

- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

Supplemental
Online resources
- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 2-3 weeks

UNIT 7
Electric Current

Unit Goals

At the completion of this unit, students will:

HS-PS2-6.	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
HS-PS3-3.	**Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.**

ISTE Technology Standards ISTE Empowered Learner (Standard 1c)	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How is energy transferred in electric circuits?

Unit Essential Vocabulary

- Electrical Circuit
- Electrical Voltage Source
- Emf (Electro-Motive Force)
- Volt (Unit)
- Electrical Resistance
- Ohm (Unit)
- Resistivity
- Electrical Current
- Ampere (Unit)
- Electrical Power
- Series Connection
- Parallel Branch

Unit Scope and Sequence

- Batteries, generators, and solar cells convert various forms of energy to electric energy
- In an electric circuit, electric energy is transmitted from a device that produces electric energy to a resistor or other device that converts electrical energy to the form needed.
- As a charge moves through resistors in a circuit, its potential energy is reduced. The energy released when the charge moves around the remainder of the circuit equals the work done to give the charge its initial potential energy.
- The SI unit for electric current is the ampere (A). One ampere is one coulomb per second.
- Ohm's law states that the resistance (R) of a device is the ratio of the voltage (V) across it divided by the current (I) through it, or R = V/I.
- In a device that obeys Ohm's law, the resistance remains constant as the voltage and current change.
- The current in a circuit can be varied by changing either the voltage or the resistance, or both.
- In a circuit diagram, conventional current is used. This is the direction in which a positive charge would move.
- In long-distance transmission, current is reduced without power being reduced by increasing voltage.
- Current is the same everywhere in a series circuit.
- The equivalent resistance of a series circuit is the sum of the resistances of its parts.
- The sum of the voltage drops across resistors in series is equal to the potential difference applied across the combination.
- The voltage drops across all branches of a parallel circuit are the same.
- In a parallel circuit, the total current is equal to the sum of the currents in the branches.
- The reciprocal of the equivalent resistance of parallel resistors is equal to the sum of the reciprocals of the individual resistances.
- If any branch of a parallel circuit is opened, there is no current in that branch. The current in the other branches is unchanged.
- A fuse or circuit breaker, placed in series with appliances, creates an open circuit when dangerously high currents flow.
- An ammeter is used to measure current in a branch or part of a circuit. An ammeter always has a low resistance and is connected in series.
- A voltmeter is used to measure a potential difference (voltage) across any part or combination of parts of a circuit. A voltmeter always has high resistance and is connected in parallel with the part of the circuit being measured.

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of electrical circuitry, including Ohm's Law and series and parallel circuits.
Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:

Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to electrical current and its control.

Resources

Core
- Conceptual Physics textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

Supplemental
Online resources
- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 2-3 weeks

UNIT 8
Magnetism

Unit Goals

At the completion of this unit, students will:

HS-PS2-5.	**Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.**
HS-PS2-6.	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
HS-PS3-3.	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
HS-PS3-5.	**Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.**

ISTE Technology Standards ISTE Empowered Learner (Standard 1c)	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How are magnetism, electric charge and electricity related?
- How is electromagnetism harnessed to produce mechanical work?

Unit Essential Vocabulary

- Magnetic Field
- Tesla (Unit)
- Magnetic Force
- Magnetic Domain
- Magnetic Pole
- Electromagnet
- Motor Effect
- Electromagnetic Induction
- Generator Effect
- Transformer

Unit Scope and Sequence

- Like magnetic poles repel; unlike magnetic poles attract
- Magnetic fields exit from the north pole of a magnet and enter its south pole.
- Magnetic field lines always form closed loops.
- A magnetic field exists around any wire that carries current.
- A coil of wire that carries a current has a magnetic field. The field about the coil is like the field about a permanent magnet.
- When a current-carrying wire is placed in a magnetic field, there exists a force on the wire that is perpendicular to both the field and the wire.
- The strength of a magnetic field (B) is measured in teslas (one newton per ampere per meter).
- The force a magnetic field exerts on a current-carrying wire is the product of the magnetic field, B, the current through the wire, I, the length of the wire, L, and the sine of the angle between the magnetic field and the direction of current flow.
- An electric motor consists of a coil of wire placed in a magnetic field. When there is current in the coil, the coil rotates as the result of the force on the wire in the magnetic field.
- The force a magnetic field exerts on a charged particle depends on the velocity and charge of the particle and the strength of the field. The direction of force is perpendicular to both the field and the particle's velocity.
- Electromotive force (EMF) is the potential difference created across the moving wire, and is measured in volts.
- The EMF in a straight length of wire moving through a uniform magnetic field is the product of the magnetic field, B, the length of wire, L, and the component of the velocity of the moving wire, v, perpendicular to the field.
- A generator and a motor are similar devices. A generator converts mechanical energy to electrical energy; a motor converts electrical energy to mechanical energy.
- A transformer has two coils wound about the same core. An AC current through

the primary coil induces an alternating EMF in the secondary coil. The voltages in alternating-current circuits may be increased or decreased by transformers.

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of magnetism, including electro-magnetic induction.

Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to magnetic interactions.

Resources

Core
- Conceptual Physics textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

Supplemental
Online resources
- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 2-3 weeks

UNIT 9
Waves and Sound

Unit Goals

At the completion of this unit, students will:

HS-PS4-1.	**Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.**
HS-PS4-5.	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

ISTE Technology Standards ISTE Empowered Learner (Standard 1c)	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How does our understanding of wave phenomena affect human society?

Unit Essential Vocabulary

- Period
- Frequency
- Hertz
- Wavelength
- Amplitude
- Medium
- Transverse Wave
- Longitudinal Wave
- Wave Pulse
- Decibel
- Superposition
- Constructive Interference
- Destructive Interference
- Resonance
- Standing Wave

Unit Scope and Sequence

- A wave is a disturbance or vibration in matter that results in the transfer of energy between locations without the bulk transfer of matter.
- Most waves require a medium (matter) to travel through; energy is transmitted from particle to particle in the medium. Electromagnetic waves (light) are an exception to this as they can travel through a vacuum.
- Transverse waves are waves in which the individual particles in the medium vibrate perpendicularly to the direction the energy is traveling. Examples include light and "the wave" done during sporting events.
- Longitudinal waves are waves in which the individual particles in the medium vibrate parallel to the direction the energy is traveling, resulting in compressions and expansions of the particles. Sound is an example of a longitudinal wave.
- The amplitude of a wave is measured based on the maximum distance the particles are displaced from their rest position. Amplitude is related to the amount of energy being transmitted; a wave with a greater amplitude transmits more energy than a wave with a smaller amplitude.
- A wave pulse is a single disturbance or vibration. A periodic wave results when wave pulses occur at a regular interval/rate.
- Wave speed is the rate at which the disturbance moves through the medium. As with any speed, it is often measured in meters per second. Wave speed is determined by the properties of the medium (for example sound travels faster in water than in air due to the different properties of those media).
- Frequency is a measurement associated with a periodic wave, and it is the rate at which wave pulses are created (how many waves per second). Frequency is measured in hertz (Hz), and is determined by the source of the disturbance.
- Period is a measurement associated with a periodic wave, and it is the number of seconds between wave pulses. Period and frequency are thus inversely related to one another (seconds per wave vs. waves per second).
- Wavelength is a measurement associated with a periodic wave, and it is the distance between successive wave pulses. Wavelength is measured in meters, and is dependent upon the wave speed and frequency.
- Wave speed, wavelength, and frequency are related to each other through the wave equation: $v = \lambda f$. This equation can be used to describe any type of wave phenomena.
- Intensity is a measurement of the rate of energy delivered by a wave per unit area.
- The lowest intensity perceptible to the human ear is approximately 10^{-12} W/m^2, and the greatest intensity (when sound starts to be painful) is 1 W/m^2. Due to this huge range of values, the Decibel scale is often used.
- The Decibel scale is a logarithmic scale, where 0 dB is the threshold of hearing and 120 dB is the threshold of pain.
- When more than one wave occupies the same location in a medium, superposition occurs and the amplitudes of the waves combine. Constructive interference occurs when the overall amplitude is greater than the individual amplitudes; destructive interference occurs when the overall amplitude is smaller than the individual amplitudes.
- Standing waves can be formed in a medium under the right conditions of constructive and destructive interference. A standing wave appears to oscillate in place as the individual wave pulses travel back and forth. Certain locations in the medium (called nodes) always have destructive interference occurring, resulting in minimal vibration of

the medium. Other locations in the medium (called antinodes) alternate between destructive interference and constructive interference, resulting in maximum vibration of the medium.
- The speed of waves on a string, wire, or spring is dependent on the tension and linear mass density of the medium. Standing waves can be formed on a string, wire, or spring when the length of the medium is a multiple of half wavelengths of the periodic wave (with a node existing at each end).
- The speed of sound in air is directly related to the temperature of the air. At room temperature, the speed of sound is approximately 343 m/s.
- Standing sound waves can be created in an open pipe (open to the atmosphere at both ends) when the length of the pipe is a multiple of half wavelengths of the sound waves (with an antinode existing at each end).
- Standing sound waves can be created in a closed pipe (open to the atmosphere at only one end) when the length of the pipe is an odd multiple of quarter wavelengths of the sound waves (with a node at the closed end and an antinode at the open end).

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of waves and sound, including resonance and standing waves.
Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to waves and sound.

Resources

<u>Core</u>
- Conceptual Physics textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

<u>Supplemental</u>
Online resources
- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 2-3 weeks

UNIT 10
Light

Unit Goals

At the completion of this unit, students will:

HS-PS4-1.	**Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.**
HS-PS4-5.	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

ISTE Technology Standards ISTE Empowered Learner (Standard 1c)	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- What is the nature of light?
- How does light interact with substances?
- How can light properties be used?

Unit Essential Vocabulary

- Electromagnetic Spectrum
- Photon
- Reflection
- Refraction
- Refraction Index
- Angle Of Incidence
- Snell's Law
- Critical Angle
- Total Internal Reflection
- Real Image
- Virtual Image

Unit Scope and Sequence

- Light is part of the electromagnetic spectrum of waves that travel through space in essentially straight lines at 3 x 10^8 meters per second.
- Light also exhibits properties of particles. These particles are called photons which contain a certain amount of energy and momentum as indicated by their frequency.
- Reflected light leaves an object's surface at the same angle it hit the object's surface.
- Refraction index of a substance indicates the degree to which the light is slowed down when it is transmitted through the substance.
- When light enters an object at an angle, its direction is changed according to Snell's law and the refraction index.
- Light striking the surface can experience total internal reflection if the incident angle is greater than the critical angle.
- Light reflected off the surface of an object can be directed to form an image.
- Light refracted through an object can be directed to form an image.
- These images can be real (projectable) or virtual (not projectable)

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of light optics, including image formation.
Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to light and optics.

Resources

<u>Core</u>
- Conceptual Physics textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

<u>Supplemental</u>
Online resources
- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 2-3 weeks

CREDIT

1.0 credits in science
One class period for a full year

PREREQUISITES

Successful completion of CP or ACP Chemistry

ASSURED STUDENT PERFORMANCE RUBRICS

- Trumbull High School School-Wide Problem Solving Through Critical Thinking Rubric
- Trumbull High School School-Wide Writing Rubric
- Trumbull High School School-Wide Independent Learning and Thinking Rubric

Trumbull High School School-Wide Problem Solving Through Critical Thinking Rubric

Category/ Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Understanding X_____	• Student demonstrates clear understanding of the problem and the complexities of the task	• Student demonstrates sufficient understanding of the problem and most of the complexities of the task	• Student demonstrates some understanding of the problem but requires assistance to complete the task	• Student demonstrates limited or no understanding of the fundamental problem after assistance with the task
Research X_____	• Student gathers compelling information from multiple sources including digital, print, and interpersonal	• Student gathers sufficient information from multiple sources including digital, print, and interpersonal	• Student gathers some information from few sources including digital, print, and interpersonal	• Student gathers limited or no information
Reasoning and Strategies X_____	• Student demonstrates strong critical thinking skills to develop a comprehensive plan integrating multiple strategies	• Student demonstrates sufficient critical thinking skills to develop a cohesive plan integrating strategies	• Student demonstrates some critical thinking skills to develop a plan integrating some strategies	• Student demonstrates limited or no critical thinking skills and no plan
Final Product and/or Presentation X_____	• Solution shows deep understanding of the problem and its components • Solution shows extensive use of 21st-century technology skills	• Solution shows sufficient understanding of the problem and its components • Solution shows sufficient use of 21st-century technology skills	• Solution shows some understanding of the problem and its components • Solution shows some use of 21st-century technology skills	• Solution shows limited or no understanding of the problem and its components • Solution shows limited or no use of 21st-century technology skills

Trumbull High School School-Wide Writing Rubric

Category/ Weight	Exemplary 4 Student work:	Goal 3 Student work:	Working Toward Goal 2 Student work:	Needs Support 1-0 Student work:
Purpose X_____	• Establishes and maintains a clear purpose • Demonstrates an insightful understanding of audience and task	• Establishes and maintains a purpose • Demonstrates an accurate awareness of audience and task	• Establishes a purpose • Demonstrates an awareness of audience and task	• Does not establish a clear purpose • Demonstrates limited/no awareness of audience and task
Organization X_____	• Reflects sophisticated organization throughout • Demonstrates logical progression of ideas • Maintains a clear focus • Utilizes effective transitions	• Reflects organization throughout • Demonstrates logical progression of ideas • Maintains a focus • Utilizes transitions	• Reflects some organization throughout • Demonstrates logical progression of ideas at times • Maintains a vague focus • May utilize some ineffective transitions	• Reflects little/no organization • Lacks logical progression of ideas • Maintains little/no focus • Utilizes ineffective or no transitions
Content X_____	• Is accurate, explicit, and vivid • Exhibits ideas that are highly developed and enhanced by specific details and examples	• Is accurate and relevant • Exhibits ideas that are developed and supported by details and examples	• May contain some inaccuracies • Exhibits ideas that are partially supported by details and examples	• Is inaccurate and unclear • Exhibits limited/no ideas supported by specific details and examples
Use of Language X_____	• Demonstrates excellent use of language • Demonstrates a highly effective use of standard writing that enhances communication • Contains few or no errors. Errors do not detract from meaning	• Demonstrates competent use of language • Demonstrates effective use of standard writing conventions • Contains few errors Most errors do not detract from meaning	• Demonstrates use of language • Demonstrates use of standard writing conventions • Contains errors that detract from meaning	• Demonstrates limited competency in use of language • Demonstrates limited use of standard writing conventions • Contains errors that make it difficult to determine meaning

Trumbull High School School-Wide Independent Learning and Thinking Rubric

Category/ Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Proposal X_____	• Student demonstrates a strong sense of initiative by generating compelling questions, creating uniquely original projects/work	• Student demonstrates initiative by generating appropriate questions, creating original projects/work	• Student demonstrates some initiative by generating questions, creating appropriate projects/work	• Student demonstrates limited or no initiative by generating few questions and creating projects/work
Independent Research & Development X_____	• Student is analytical, insightful, and works independently to reach a solution	• Student is analytical, and works productively to reach a solution	• Student reaches a solution with direction	• Student is unable to reach a solution without consistent assistance
Presentation of Final Product X_____	• Presentation shows compelling evidence of an independent learner and thinker • Solution shows deep understanding of the problem and its components • Solution shows extensive and appropriate application of 21st-century skills	• Presentation shows clear evidence of an independent learner and thinker • Solution shows adequate understanding of the problem and its components • Solution shows adequate application of 21st-century skills	• Presentation shows some evidence of an independent learner and thinker • Solution shows some understanding of the problem and its components • Solution shows some application of 21st-century skills	• Presentation shows limited or no evidence of an independent learner and thinker • Solution shows limited or no understanding of the problem and its components • Solution shows limited or no application of 21st-century skills

TRUMBULL PUBLIC SCHOOLS

Trumbull, Connecticut

ACP Physics Grade 12

2023

(Last revision date: 2022)

Curriculum Writing Team

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ACP Physics

Grade 12

Table of Contents

The Trumbull Board of Education will continue to take Affirmative Action to ensure that no persons are discriminated against in its employment.

CORE VALUES AND BELIEFS

The Trumbull High School community engages in an environment conducive to learning which believes that all students will **read** and **write effectively**, therefore communicating in an articulate and coherent manner. All students will participate in activities **that present problem-solving through critical thinking**. Students will use technology as a tool applying it to decision making. We believe that by fostering self-confidence, self-directed and student-centered activities, we will promote **independent thinkers and learners**. We believe **ethical conduct** to be paramount in sustaining the welcoming school climate that we presently enjoy.
Approved 8/26/2011

INTRODUCTION & PHILOSOPHY

In Grade 12 Physics, students will explore many of the systems and processes of the physical world by investigating the macroscopic interactions of matter through the topics of general physics. By focusing on the changes in matter and energy, scientifically literate students can use this deeper understanding to make predictions, analyze scientific data, and contribute to the greater scientific community. Students in this course will typically have completed ACP Chemistry with a focus on the microscopic interactions of matter.

This curriculum has been modified most recently (2021) to remain consistent in the continued development of scientifically literate students, with a concentration on matter, energy, and changes. Authentic scientific and engineering experiences build on one another and increase in complexity throughout students' K-12 education. In 2015, the Connecticut State Board of Education adopted the Next-Generation Science Standards (NGSS), which embody the National Research Council's *Framework for K-12 Science Education* (2012). Both the *Framework* and the NGSS stress the importance of teaching classroom scientific inquiry as practiced by scientists and engineers. The *Framework* provides a vision for American science education in the 21st century, while the NGSS provides grade-level student performance expectations, disciplinary core ideas, and crosscutting concepts. The *Framework* and NGSS indicated a paradigm shift in science education, one in which teachers are to incorporate authentic learning experiences for students that reflect the nature of doing science and engineering.

The *Framework* and NGSS provide clarity to classroom scientific inquiry by stressing the importance of eight practices of science and engineering. The practices were designed to help students understand how scientific knowledge develops, and to stimulate students' interest in and continued study of science. Three-dimensional learning facilitates student engagement with Science and Engineering Practices and Crosscutting Concepts to deepen their understanding of Disciplinary Core Ideas in order to explain phenomena and solve problems. Three-dimensional learning promotes development of student skills in the following areas:

- Knowing, using, and interpreting scientific explanations of the natural world (Disciplinary Core Ideas, and Crosscutting Concepts)
- Generating and evaluating scientific evidence and explanations (Science and Engineering Practices)
- Participating productively in scientific practices and discourse (Science and Engineering Practices)

- Understanding the nature and development of scientific knowledge (Science and Engineering Practices, and Crosscutting Concepts)

The shift of science education reflects the interconnected nature of science as it is practiced in the real world and builds coherently across grades K-12. The NGSS focus on deeper understanding of content as well as application of content with an alignment to the Connecticut Core Standards. A deeper understanding and application of science and engineering practices prepare students for postsecondary success and citizenship in a world fueled by innovations in science and technology. In accordance with the NGSS Science and Engineering Practices, students will be asked to . . .

- ask questions (for science) and define problems (for engineering).
- develop and use models.
- plan and carry out investigations.
- analyze and interpret data.
- use mathematics and computational thinking.
- construct explanations (for science) and design solutions (for engineering).
- engage in arguments from evidence.
- obtain, evaluate, and communicate information.

Grade 12 Physics is offered at two separate course levels: Advanced College Preparatory (ACP) and College Preparatory (CP). Both levels will explore each unit of study. The courses are differentiated by pacing of curriculum, rigor of exploration, depth of content knowledge, and the application of quantitative reasoning. The ACP course will explore topics with the greatest depth, most rigorous exploration, deepest study of content, and furthest application of quantitative reasoning. More support will be offered at the CP course level. In addition, study of physics principles is offered through an early college experience collaborative (UCONN Physics) and two Advanced Placement courses: Physics C (AP-C) and Physics 1 (AP-1). These advanced courses follow a different curriculum, and demand a much higher rigor of exploration, depth of content knowledge, and the application of quantitative reasoning.

This newest revision of the ACP Physics curriculum has been adjusted to reflect the loss of dedicated laboratory time for the course, effectively reducing in-school contact time by 26%.

COURSE GOALS

The following course goals derive from the 2021 Next Generation Science Standards.

HS-PS2-1.	Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.
HS-PS2-2.	Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
HS-PS2-3.	Apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.
HS-PS2-4.	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
HS-PS2-5.	Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.
HS-PS2-6.	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
HS-PS3-2.	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).
HS-PS3-3.	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

HS-PS3-4.	Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
HS-PS3-5.	Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.
HS-PS4-1.	Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.
HS-PS4-5.	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

The following course goals derive from the 2010 Connecticut Common Core State Standards for English Language Arts and Literacy in History/Social Studies, Science and Technical Subjects

CCSS.ELA-LITERACY.RST.11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
CCSS.ELA-LITERACY.RST.11-12.2	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
CCSS.ELA-LITERACY.RST.11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
CCSS.ELA-LITERACY.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

CCSS.ELA-LITERACY.RST.11-12.5	Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
CCSS.ELA-LITERACY.RST.11-12.6	Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.
CCSS.ELA-LITERACY.RST.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
CCSS.ELA-LITERACY.RST.11-12.8	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
CCSS.ELA-LITERACY.RST.11-12.9	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible
CCSS.ELA-LITERACY.RST.11-12.10	By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.

The following course goals derive from the 2010 Connecticut Core Standards for Literacy.

CCSS.ELA-LITERACY.RI.11-12.1	Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.
CCSS.ELA-LITERACY.RI.11-12.2	Determine two or more central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to provide a complex analysis; provide an objective summary of the text.

CCSS.ELA-LITERACY.RI.11-12.5	Analyze and evaluate the effectiveness of the structure an author uses in his or her exposition or argument, including whether the structure makes points clear, convincing, and engaging.
CCSS.ELA-LITERACY.RI.11-12.6	Determine an author's point of view or purpose in a text in which the rhetoric is particularly effective, analyzing how style and content contribute to the power, persuasiveness or beauty of the text.
CCSS.ELA-LITERACY.W.11-12.1.B	Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level, concerns, values, and possible biases.
CCSS.ELA-LITERACY.W.11-12.1.D	Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
CCSS.ELA-LITERACY.W.11-12.2.B	Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
CCSS.ELA-LITERACY.W.11-12.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
CCSS.ELA-LITERACY.W.11-12.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
CCSS.ELA-LITERACY.W.11-12.10	Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences

CCSS.ELA-LITERACY.SL.11-12.2	Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data
CCSS.ELA-LITERACY.SL.11-12.3	Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.
CCSS.ELA-LITERACY.L.11-12.3	Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.
CCSS.ELA-LITERACY.L.11-12.6	Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression

The following course goals derive from the 2016 International Society for Technology in Education (ISTE) Technology Standards

ISTE Standard 1 - Empowered Learner	Students leverage technology to take an active role in choosing, achieving, and demonstrating competency in their learning goals, informed by the learning sciences.
ISTE Standard 2 - Digital Citizen	Students recognize the rights, responsibilities and opportunities of living, learning and working in an interconnected digital world, and they act and model in ways that are safe, legal and ethical.
ISTE Standard 3 - Knowledge Constructor	Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others.
ISTE Standard 4 - Innovative Designer	Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions.

ISTE Standard 5 - Computational Thinker	Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions
ISTE Standard 6 - Creative Communicator	Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals
ISTE Standard 7 - Global Collaborator	Students use digital tools to broaden their perspectives and enrich their learning by collaborating with others and working effectively in teams locally and globally

COURSE ENDURING UNDERSTANDING

Students will understand that…

- scientific knowledge is acquired through inquiry, experimentation, data analysis, and interpretation.
- scientific conclusions and explanations are based on research data, and scientific results may be assessed based on the design of the investigation.
- scientific ideas and concepts evolve over time.
- the credibility of scientific information found in various media can vary.
- mathematical operations and procedures may be used to calculate, analyze, and present data and ideas.
- science and technology affect the quality of our lives.

Also, in accordance with the NGSS Cross-Cutting Concepts, students will work to understand...

- how observed patterns of forms and events guide organization and classification, and prompt questions about relationships and the factors that influence them.
- events have causes, sometimes simple, sometimes multifaceted and that a major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.
- scale, proportion, and quantity in considering phenomena. It is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.
- that defining the system under study – specifying its boundaries and making explicit a model of that system – provides tools for understanding and testing ideas that are applicable throughout science and engineering.
- that the tracking of fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.
- structure and function, in such that the way in which an object or living thing is shaped and its substructure determine many of its properties and functions.
- that for natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

COURSE ESSENTIAL QUESTIONS

From Study.com:

- How are graphical and mathematical models created from experimental data?
- How are fields used to model physics phenomena?
- How can rules and relationships be used to predict what happens in a physical situation?
- How can physics be applied to understanding everyday life?
- How can abstract mathematics be used to describe phenomena?
- How can abstract mathematics be used to represent relationships between variables?
- To what extent does physics explain phenomena at the wide variety of scales?
- How can physics be used to solve problems?
- How does physics explain change and constancy in the universe?
- What is the value in separating the universe into systems when trying to explain it?
- Why are system boundaries important to define?
- Why are assumptions and approximations important in physics? To what extent does this limit the usefulness of your results?
- To what extent does physics explain cause and effect?
- How can scientific ideas be used to solve problems?
- How is matter and energy related?
- How is the universe constructed from the tiny scales to the largest?
- How can physics be used to create models and simulations?
- Why is correlation and causation not the same thing?
- How are physics and engineering related?
- How can scientific knowledge be communicated?
- How can scientific arguments be evaluated?
- How should scientific investigations be designed?

From NGSS (Physical Science):

- How can one explain and predict interactions of objects and systems of objects?
- How can one predict an object's continued motion, change in motion,or stability?
- What underlying forces explain the variety of interactions observed?
- Why are some physical systems more stable than others?
- How is energy transferred and conserved?
- What is meant by conservation of energy?
- How is energy transferred between objects or systems?
- How are forces related to energy?
- If energy is conserved,why do people say it is produced or used?
- How are waves used to transfer energy and information?
- What are the characteristic properties and behaviors of waves?

- What is light?
- How can one explain the varied effects that involve light?
- What other forms of electromagnetic radiation are there?
- How are instruments that transmit and detect waves used to expand human senses?

COURSE KNOWLEDGE & SKILLS

The following core knowledge and skills will be developed through students' work in this course:

Students will know . . .

- the appropriate techniques and procedures to use in a laboratory setting.
- the difference between scalar and vector quantities.
- the difference between distance and displacement.
- the difference between speed and velocity.
- the definition of the term acceleration.
- Newton's Laws of Motion.
- the various types of forces.
- the definitions of momentum and momentum conservation.
- the definition of impulse and its relationship to momentum change.
- the relationship between momentum conservation and Newton's laws of motion.
- the differences between various types of energy (kinetic, gravitational potential, elastic potential, thermal).
- the relationship between work and the change in energy of a system.
- that power is calculated as the rate at which work is done (rate of energy conversion).
- that charging of an object is the separation, not the creation, of electrical charges.
- that electrically charged objects exert forces, both attractive and repulsive.
- the ways objects become charged.
- the definition of electrical force as it relates to the charges on objects and the distance between them.
- the definitions of electric current, potential difference, resistance, and power, and their relationships to each other.
- the properties of magnets and the origin of magnetism in materials.
- the relationship between magnetic induction and the direction of force on a current-carrying wire in a magnetic field.
- the design and operation of an electric motor.
- how wave phenomena are described, using the following terms: amplitude, wave pulse, periodic wave, wavelength, frequency, period, and wave speed.
- the differences between transverse and longitudinal waves, and provide examples of each.

- what happens when two or more waves attempt to occupy the same location in a medium.
- the definition of wave resonance and its relation to an object's natural frequency.
- how light travels.
- that light is part of the electromagnetic spectrum.
- that when light strikes an object, it is absorbed, reflected from or transmitted through the substance and what happens when these occur.
- the dual nature of light.

Students will be able to . . .

- abide by the safety rules and regulations set forth by the safety contract.
- use appropriate tools and techniques to make observations and gather data.
- articulate conclusions and explanations based on research data, and assess results based on the design of the investigation.
- describe the motion of an object with constant velocity vs. constant acceleration.
- use the kinematic equations to complete one-dimensional motion problems.
- create and interpret position vs. time graphs.
- create and interpret velocity vs. time graphs.
- describe the motion of a freely-falling object.
- use the kinematic equations to complete free fall motion problems.
- describe the motion of a projectile.
- use the kinematic equations to complete two-dimensional motion problems.
- describe how friction affects the motion of two objects that are in contact with each other.
- draw free body diagrams of objects with arrows identifying the forces acting on the object.
- use a free body diagram and vector addition to determine the net force acting on an object.
- use Newton's Second Law to predict the acceleration of an object given its mass and the net force acting upon it.
- solve problems relating an object's mass, forces acting on it and its motion.
- solve collision and explosion problems using the conservation of momentum.
- quantify the amount of each type of energy a system possesses.
- quantify the amount of work done by a force.
- use the work-energy theorem to solve problems.
- use conservation of energy to solve problems.
- solve electrostatics problems using the conservation of charge.
- describe the requirements for electric current flow in circuits.
- diagram simple electric circuits.
- solve problems involving current, potential difference, resistance, power, and the use and cost of electric energy.

- compare various magnetic fields.
- solve problems involving magnetic field strength and forces on current-carrying wires, and on moving, charged particles in magnetic fields.
- solve problems involving magnetic field strength and forces and induced EMF in moving wires.
- apply the phenomenon of induced EMF to the construction of generators and transformers.
- calculate the intensity (in W/m^2 and decibels) of a sound wave.
- explain and draw how standing waves can form on a string.
- explain and draw how standing waves can form in a closed pipe.

COURSE SYLLABUS

Course Name

ACP Physics

Level

Advanced College Prep

Prerequisites

ACP Prerequisite: Successful completion of ACP Chemistry.
(CP Prerequisite: Successful completion of CP Chemistry or ACP Chemistry.)

General Description of the Course

This course consists of a practical study of mechanics, heat, sound, electricity, magnetism, light, atomic physics and astrophysics, stressing technological application. The CP level is similar to ACP Physics except that there is less of a need for mathematical skills. It is designed to acquaint the student with physics, as it is applicable in everyday life. Recommended for students planning to attend college, but who are not planning to major in science. The ACP level comprises a quantitative study of mechanics, wave phenomena, optics, heat, electricity and magnetism. The course demonstrates the mathematical relationships in physics concepts and applies these relationships to problem solving situations.

Assured Assessments

Formative assessments can include, but are not limited to:

- Individual and group lists of safety lessons learned (Unit 1)
- Construction of models (Unit 2)
- Lab activities (Units 2, 3, 4, 5, 6, 7, 8, 9, 10)
- Data collection and analysis (Units 2, 3, 4, 5, 6, 7, 8, 9, 10)

Summative Assessments:

- End-of-unit assessment with multiple-choice questions (Unit 1)
- End-of-unit assessment with multiple-choice questions, free-response questions, and interpreting and analyzing data (Units 2, 3, 4, 5, 6, 7, 8, 9, 10)
- Midyear examination
- End-of-year examination

UNIT 1
Mathematical Tools

Unit Goals

At the completion of this unit, students will:

- **collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making (ISTE Technology Standards – Computational Thinking – Standard 5b)**

- know how to conduct experiments safely with a variety of physics-related equipment and technologies in accordance with the Connecticut State Department of Education (SDE) guidance document which can be found at the following link: https://portal.ct.gov/SDE/Publications/Connecticut-High-School-Science-Safety/Physics - Laboratory-Safety-Specifications

Unit Essential Questions

- How do scientists experiment safely?
- How are tools selected and utilized to gather valid data in science?

Unit Essential Vocabulary

- Accuracy
- Precision
- Error
- Observation
- Conclusion/Inference

Unit Scope and Sequence

- Scientists develop models based on observation and data to explain natural phenomena and predict the results of actions.
- Data is collected through observation and measurement, using human senses or measuring devices.
- Measuring devices are calibrated to agree with each other or agree with an accepted value.
- The accuracy of a measurement or calculation refers to its agreement with other measurements or calculations, or to an accepted value for that quantity.
- The precision of a measurement refers to the "exactness" of the quantity, and is determined by the measuring device used.
- Data trends are best conveyed and communicated through the creation of a graph.

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental

processes on the topics of scientific measurement.
Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to mathematical scientific tools.

Resources

Core
- Physics Principles and Problems textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

Supplemental
- Flinn Scientific's Student Safety Contract Online resources
- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 1-2 Weeks

UNIT 2
Kinematics

Unit Goals

At the completion of this unit, students will:

NGSS Practices (Developing and Using Models):

- **develop and/or use a model to generate data to support explanations, analyze systems, or solve problems.** *Example: A ball's motion is represented using graphical and pictorial models. Students are required to use one or more of these models to analyze the ball's motion, to give explanations, and to solve problems*

NGSS Practices (Analyzing and Interpreting Data):

- analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution. *Example: With pictorial and graphical data representations of a ball's motion, students are asked to analyze data and make meaning of the patterns that emerge from the data sets. Students also use information from one graph in combination with data from another to determine an unknown quantity or relationship.*

NGSS Crosscutting Concepts (Patterns):

- recognize that different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. *Example: As gravity affects a ball's motion both on its way up as well as on its way back down, students discover that a ball's downward motion is just a 'mirror image' of its upward motion. This symmetry becomes clear in the ball's dot diagram, the position vs. time graph, and in the velocity vs. time graph. Such patterns are not only helpful in solving kinematics problems, they speak to gravity's constant effect on any object in free fall.*

ISTE Technology Standards

ISTE Empowered Learner (Standard 1c)	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How is motion quantified?
- How is motion predictable?

Unit Essential Vocabulary

- Scalar
- Vector
- Position
- Distance
- Displacement
- Speed
- Velocity
- Acceleration

Unit Scope and Sequence

- Scalar quantities can be described completely with magnitude alone; vector quantities are described
- completely with magnitude and direction.
- Position is a vector quantity that describes where an object is at some moment in time.
- Displacement is a vector quantity that describes how far and in what direction an object has moved; distance is a scalar quantity that describes how far an object traveled in total to get from its starting to ending location.
- Velocity is a vector quantity that describes the direction and rate at which an object changes position, usually measured in "meters per second" (m/s). Speed is a scalar quantity that is either (1) the rate at which distance traveled changes, or (2) the magnitude of the velocity.
- Instantaneous velocity refers to the velocity at one particular moment in time, regardless of previous or future moments. Average velocity refers to the average rate of change in position over a given time interval.
- Acceleration is a vector quantity that describes the direction and rate at which an object's velocity changes, usually measured in "(meters per second) per second" (or m/s^2). Instantaneous acceleration refers to the acceleration at one particular moment in time, regardless of previous or future moments; average acceleration refers to the average rate of change in velocity over a given time interval.
- A ticker tape diagram (or oil drop diagram) can be used to visually represent the motion of an object. Concepts such as displacement, velocity, and acceleration can be inferred from these diagrams.
- A position vs. time graph displays the location of an object as a function of time. The slope of this graph represents the average velocity of the object.
- A velocity vs. time graph displays the velocity of an object as a function of time. The slope of this graph represents the average acceleration of the object. The area bounded by this graph and the time axis represents the displacement of the object.
- An object is said to be in free fall any time the force of gravity is the only force acting

on the object. This includes objects dropped, objects through up or down, and projectiles (always assuming air resistance is negligible). While in free fall near the surface of the Earth, all objects experience a constant downward acceleration of approximately 9.8 m/s^2.

- The kinematic equations are a set of four mathematical equations that can be used to describe the one-dimensional motion of any object experiencing constant acceleration. The equations relate the object's acceleration, initial velocity, velocity at some time t, displacement at some time t, and time.
- Vector quantities can be added visually using either the tail-to-tip method or the parallelogram method. These methods are especially useful when the vectors are not collinear.
- An object's measured velocity and displacement are dependent on both the object's motion and the relative motion of the object and observer. The observed acceleration of the object, however, is independent of the observer's motion (as long as the observer is not accelerating).
- The two-dimensional motion of an object can be described as two independent one-dimensional motions. Commonly these two dimensions are either (1) horizontal and vertical, or (2) north-south and east-west.
- A projectile in two-dimensional motion near the surface of the Earth experiences constant velocity in the horizontal direction and a constant acceleration of 9.8 m/s^2 downward in the vertical direction.
- The kinematic equations can be used to describe two-dimensional motion by treating the motion in each dimension separately.

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of constant speed, constant velocity and uniformly accelerated motion, including the acceleration of free-fall. Experimental work with projectile motion will also occur. Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to the kinematics of moving objects in one and two dimensions.

Resources

<u>Core</u>

- Physics Principles and Problems textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

<u>Supplemental</u>
Online resources

- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.

- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 1-2 weeks

UNIT 3
Forces

Unit Goals

At the completion of this unit, students will:

HS-PS2-1.	**Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.**
HS-PS2-4.	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
HS-PS2-6.	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

ISTE Technology Standards ISTE Empowered Learner (Standard 1c)	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How do Newton's Motion Laws predict the effect of forces on an object's motion?

Unit Essential Vocabulary

- Force
- Net Force
- Inertia
- Normal
- Friction
- Gravitational Field Strength
- Tension
- Weight

Unit Scope and Sequence

- Forces are defined as pushes or pulls on an object.
- Forces are classified as contact versus field forces. These are further categorized as gravitational, electromagnetic, strong nuclear and weak nuclear.
- Forces are expressed as vectors having magnitude and direction.
- Friction force acts between objects that contact each other. Friction acts parallel to the contacting surface in a direction that opposes the objects' sliding relative to each other.
- Normal force between objects that contact each other. Normal force acts perpendicular to the contacting surface.
- Friction force is directly proportional to normal force.
- The proportionality constant between friction and normal force is the friction coefficient, which is a property of any two contacting surfaces.
- Static (objects not sliding past each other) friction coefficients are generally greater than kinetic (objects sliding past each other) friction coefficients.
- Forces acting on an object combine to exert a net force.
- Net force is quantified through the use of a free body diagram of an isolated object with arrows indicating the forces exerted on the object.
- A net force is necessary to change the motion state of an object. (Newton's First Law of Motion)
- All objects have mass, the measurement of the object's inertia, its tendency to maintain its motion state.
- Acceleration, the change of an object's motion, is directly proportional to the net force acting on an object and inversely proportional to the mass of an object. (Newton's Second Law of Motion)
- Forces act in pairs between two objects. The paired forces are equal in magnitude and opposite in direction. (Newton's Third Law of Motion).

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of force (including weight, tension, friction and normal force) and Newton's Laws. Experimental work on vector force addition will also occur.
Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to force and Newton's Laws of mechanics.

Resources

Core

- Physics Principles and Problems textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

Supplemental Online resources

- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 2-3 weeks

UNIT 4
Momentum

Unit Goals

At the completion of this unit, students will:

HS-PS2-2.	**Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.**
HS-PS2-3.	Apply science and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.

ISTE Technology Standards ISTE Empowered Learner (Standard 1c)	technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- What is momentum?
- How does momentum conservation determine the motion of objects interacting with each other?

Unit Essential Vocabulary

- Momentum
- Impulse
- Inelastic Collision
- Elastic Collision

Unit Scope and Sequence

- Impulse is defined as a force exerted on an objects over a period of time
- Impulse causes a change in an object's momentum. An object's momentum change is equal in magnitude and direction to the impulse exerted on it.
- The impulse/momentum change equation is the original expression of Newton's Second Law.
- Momentum is always conserved. This means that the total momentum of an isolated

system of objects remains constant.
- Momentum conservation results from Newton's Third Law of Motion.
- Momentum conservation is applied to collision and explosion problems to determine objects' motion before or after a collision or explosion.

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of impulse and conservation of momentum.
Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to momentum, its transfer and its conservation.

Resources

Core
- Physics Principles and Problems textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

Supplemental
Online resources
- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 1-2 weeks

UNIT 5
Energy

Unit Goals

At the completion of this unit, students will:

HS-PS3-1	**Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.**
HS-PS3-2.	Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).
HS-PS3-3.	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

ISTE Technology Standards ISTE Empowered Learner (Standard 1c)	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How will the increasing demand for energy be met in the future?

Unit Essential Vocabulary

- Kinetic Energy
- Gravitational Potential Energy
- Elastic Potential Energy
- Work
- Power

Unit Scope and Sequence

- Energy is an abstract, scalar quantity possessed by an object (or system of objects) that comes in a variety of forms. The SI unit for energy is the joule (J), named after James Prescott Joule, and is equivalent to N•m or $kg•m^2/s^2$. Energy is also commonly measured in calories
- Energy can be converted from one form to another through the process of work, but it cannot be created nor destroyed. The total amount of energy in the universe is constant.
- Kinetic energy is energy associated with the translational motion of an object/system. A faster moving object has more kinetic energy than an identical slower moving object. A massive object has more kinetic energy than a less massive object moving at the same speed.
- Gravitational potential energy is energy associated with the interaction (attraction) between objects with mass. The farther apart two masses are the more gravitational potential energy there is.
- Elastic potential energy is energy associated with the stretching or compressing of a spring (or other elastic substance). The more stretched/compressed a spring, the more elastic potential energy it has stored. A stiffer spring will possess more elastic potential energy than a looser spring for the same amount of stretching or compression.
- The Law of Conservation of Energy states that energy cannot be created nor destroyed, but it can be converted between the different types.
- Power is the rate at which work is done (or the rate at which energy is converted from one form to another).

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of work, power and conservation of energy.
Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to energy, its transfer and its conservation.

Resources

<u>Core</u>

- Physics Principles and Problems textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

Resources (continued)

Supplemental

Online resources

- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 2-3 week

UNIT 6
Electrostatics

Unit Goals

At the completion of this unit, students will:

HS-PS2-4.	Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.
HS-PS2-6.	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
HS-PS3-5.	**Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.**

ISTE Technology Standards ISTE Empowered Learner (Standard 1c)	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How does electrical charge interact with matter?
- What rules govern how charge pushes and pulls on the world?

Unit Essential Vocabulary

- Electric Charge
- Coulomb (Unit)
- Electron
- Proton
- Electric Force
- Electrical Polarization
- Electrical Induction
- Electrical Grounding
- Electrical Insulator/Conductor
- Electric Field
- Electric Field Strength
- Electric Field Potential Difference

Unit Scope and Sequence

- There are two kinds of electrical charge, positive and negative
- Electrical charge is not created or destroyed; it is conserved.
- Objects can be charged by the transfer of electrons.
- Charges added to one part of an insulator remain on that part.
- Charges added to a conductor quickly spread over the surface of the object.
- Charged objects exert forces on other charged objects. Like charges repel; unlike charges attract
- An object can be charged by conduction by touching a charged object to it
- To charge an object by induction, a charged object is first brought nearby, causing a separation of charges. Then the object to be charged is separated, trapping opposite charges on the two halves.
- Coulomb's law states that force between two charged objects varies directly with the product of their charges and inversely with the square of the distance between them.
- The SI unit of charge is the coulomb. One coulomb © is the magnitude of the charge of 6.25×10^{18} electrons or protons. The elementary charge, the charge of the proton or electron, is 1.60×10^{-19} C.
- A charged object of either sign can produce separation of charge in a neutral body. Thus a charged object attracts a neutral one.
- An electric field exists around any charged object. The field produces forces on other charged objects.
- The electric field intensity is the force per unit charge. The direction of the electric field is the direction of the force on a tiny, positive test charge.
- Electric field lines provide a picture of the electric field. They are directed away from the positive charges and toward negative charges.
- Electric potential difference is the change in potential energy per unit charge in an electric field, and is measured in volts.
- A charged object can have its excess charge removed by touching it to Earth or to an object touching Earth. This is called grounding.

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of electrostatics.
Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to electrostatic interactions.

Resources

Core

- Physics Principles and Problems textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

Supplemental

Online resources

- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 2-3 weeks

UNIT 7
Electric Current

Unit Goals

At the completion of this unit, students will:

HS-PS2-6.	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
HS-PS3-3.	**Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.**

ISTE Technology Standards ISTE Empowered Learner (Standard 1c)	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How is energy transferred in electric circuits?

Unit Essential Vocabulary

- Electrical Circuit
- Electrical Voltage Source
- Emf (Electro-Motive Force)
- Volt (Unit)
- Electrical Resistance
- Ohm (Unit)
- Resistivity
- Electrical Current
- Ampere (Unit)
- Electrical Power
- Series Connection
- Parallel Branch

Unit Scope and Sequence

- Batteries, generators, and solar cells convert various forms of energy to electric energy
- In an electric circuit, electric energy is transmitted from a device that produces electric energy to a resistor or other device that converts electrical energy to the form needed.
- As a charge moves through resistors in a circuit, its potential energy is reduced. The energy released when the charge moves around the remainder of the circuit equals the work done to give the charge its initial potential energy.
- The SI unit for electric current is the ampere (A). One ampere is one coulomb per second.
- Ohm's law states that the resistance (R) of a device is the ratio of the voltage (V) across it divided by the current (I) through it, or $R = V/I$.
- In a device that obeys Ohm's law, the resistance remains constant as the voltage and current change.
- The current in a circuit can be varied by changing either the voltage or the resistance, or both.
- In a circuit diagram, conventional current is used. This is the direction in which a positive charge would move.
- In long-distance transmission, current is reduced without power being reduced by increasing voltage.
- Current is the same everywhere in a series circuit.
- The equivalent resistance of a series circuit is the sum of the resistances of its parts.
- The sum of the voltage drops across resistors in series is equal to the potential difference applied across the combination.
- The voltage drops across all branches of a parallel circuit are the same.
- In a parallel circuit, the total current is equal to the sum of the currents in the branches.
- The reciprocal of the equivalent resistance of parallel resistors is equal to the sum of the reciprocals of the individual resistances.
- If any branch of a parallel circuit is opened, there is no current in that branch. The current in the other branches is unchanged.
- A fuse or circuit breaker, placed in series with appliances, creates an open circuit when dangerously high currents flow.
- An ammeter is used to measure current in a branch or part of a circuit. An ammeter always has a low resistance and is connected in series.
- A voltmeter is used to measure a potential difference (voltage) across any part or combination of parts of a circuit. A voltmeter always has high resistance and is connected in parallel with the part of the circuit being measured.

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of electrical circuitry, including Ohm's Law and series and parallel circuits.
Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to electrical current and its control.

Resources

Core
- Physics Principles and Problems textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

Supplemental
Online resources
- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 2-3 weeks

UNIT 8
Magnetism

Unit Goals

At the completion of this unit, students will:

HS-PS2-5.	**Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.**
HS-PS2-6.	Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
HS-PS3-1	Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
HS-PS3-3.	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
HS-PS3-5.	**Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.**

ISTE Technology Standards ISTE Empowered Learner (Standard 1c)	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How are magnetism, electric charge and electricity related?
- How is electromagnetism harnessed to produce mechanical work?

Unit Essential Vocabulary

- Magnetic Field
- Tesla (Unit)
- Magnetic Force
- Magnetic Domain
- Magnetic Pole
- Electromagnet
- Motor Effect
- Electromagnetic Induction
- Generator Effect
- Transformer

Unit Scope and Sequence

- Like magnetic poles repel; unlike magnetic poles attract
- Magnetic fields exit from the north pole of a magnet and enter its south pole.
- Magnetic field lines always form closed loops.
- A magnetic field exists around any wire that carries current.
- A coil of wire that carries a current has a magnetic field. The field about the coil is like the field about a permanent magnet.
- When a current-carrying wire is placed in a magnetic field, there exists a force on the wire that is perpendicular to both the field and the wire.
- The strength of a magnetic field (B) is measured in teslas (one newton per ampere per meter).
- The force a magnetic field exerts on a current-carrying wire is the product of the magnetic field, B, the current through the wire, I, the length of the wire, L, and the sine of the angle between the magnetic field and the direction of current flow.
- An electric motor consists of a coil of wire placed in a magnetic field. When there is current in the coil, the coil rotates as the result of the force on the wire in the magnetic field.
- The force a magnetic field exerts on a charged particle depends on the velocity and charge of the particle and the strength of the field. The direction of force is perpendicular to both the field and the particle's velocity.
- Electromotive force (EMF) is the potential difference created across the moving wire, and is measured in volts.
- The EMF in a straight length of wire moving through a uniform magnetic field is the product of the magnetic field, B, the length of wire, L, and the component of the velocity of the moving wire, v, perpendicular to the field.
- A generator and a motor are similar devices. A generator converts mechanical energy to electrical energy; a motor converts electrical energy to mechanical energy.
- A transformer has two coils wound about the same core. An AC current through the primary coil induces an alternating EMF in the secondary coil. The voltages in alternating-current circuits may be increased or decreased by transformers.

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of magnetism, including electro-magnetic induction.

Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to magnetic interactions.

Resources

Core
- Physics Principles and Problems textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

Supplemental
Online resources
- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 2-3 weeks

UNIT 9
Waves and Sound

Unit Goals

At the completion of this unit, students will:

HS-PS4-1.	**Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.**
HS-PS4-5.	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

ISTE Technology Standards ISTE Empowered Learner (Standard 1c)	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- How does our understanding of wave phenomena affect human society?

Unit Essential Vocabulary

- Period
- Frequency
- Hertz
- Wavelength
- Amplitude
- Medium
- Transverse Wave
- Longitudinal Wave
- Wave Pulse
- Decibel
- Superposition
- Constructive Interference
- Destructive Interference
- Resonance
- Standing Wave

Unit Scope and Sequence

- A wave is a disturbance or vibration in matter that results in the transfer of energy between locations without the bulk transfer of matter.
- Most waves require a medium (matter) to travel through; energy is transmitted from particle to particle in the medium. Electromagnetic waves (light) are an exception to this as they can travel through a vacuum.
- Transverse waves are waves in which the individual particles in the medium vibrate perpendicularly to the direction the energy is traveling. Examples include light and "the wave" done during sporting events.
- Longitudinal waves are waves in which the individual particles in the medium vibrate parallel to the direction the energy is traveling, resulting in compressions and expansions of the particles. Sound is an example of a longitudinal wave.
- The amplitude of a wave is measured based on the maximum distance the particles are displaced from their rest position. Amplitude is related to the amount of energy being transmitted; a wave with a greater amplitude transmits more energy than a wave with a smaller amplitude.
- A wave pulse is a single disturbance or vibration. A periodic wave results when wave pulses occur at a regular interval/rate.
- Wave speed is the rate at which the disturbance moves through the medium. As with any speed, it is often measured in meters per second. Wave speed is determined by the properties of the medium (for example sound travels faster in water than in air due to the different properties of those media).
- Frequency is a measurement associated with a periodic wave, and it is the rate at which wave pulses are created (how many waves per second). Frequency is measured in hertz (Hz), and is determined by the source of the disturbance.
- Period is a measurement associated with a periodic wave, and it is the number of seconds between wave pulses. Period and frequency are thus inversely related to one another (seconds per wave vs. waves per second).
- Wavelength is a measurement associated with a periodic wave, and it is the distance between successive wave pulses. Wavelength is measured in meters, and is dependent upon the wave speed and frequency.
- Wave speed, wavelength, and frequency are related to each other through the wave equation: $v = \lambda f$. This equation can be used to describe any type of wave phenomena.
- Intensity is a measurement of the rate of energy delivered by a wave per unit area.
- The lowest intensity perceptible to the human ear is approximately 10^{-12} W/m^2, and the greatest intensity (when sound starts to be painful) is 1 W/m^2. Due to this huge range of values, the Decibel scale is often used.
- The Decibel scale is a logarithmic scale, where 0 dB is the threshold of hearing and 120 dB is the threshold of pain.
- When more than one wave occupies the same location in a medium, superposition occurs and the amplitudes of the waves combine. Constructive interference occurs when the overall amplitude is greater than the individual amplitudes; destructive interference occurs when the overall amplitude is smaller than the individual amplitudes.
- Standing waves can be formed in a medium under the right conditions of constructive and destructive interference. A standing wave appears to oscillate in place as the individual wave pulses travel back and forth. Certain locations in the medium (called nodes) always have destructive interference occurring, resulting in minimal vibration of

the medium. Other locations in the medium (called antinodes) alternate between destructive interference and constructive interference, resulting in maximum vibration of the medium.
- The speed of waves on a string, wire, or spring is dependent on the tension and linear mass density of the medium. Standing waves can be formed on a string, wire, or spring when the length of the medium is a multiple of half wavelengths of the periodic wave (with a node existing at each end).
- The speed of sound in air is directly related to the temperature of the air. At room temperature, the speed of sound is approximately 343 m/s.
- Standing sound waves can be created in an open pipe (open to the atmosphere at both ends) when the length of the pipe is a multiple of half wavelengths of the sound waves (with an antinode existing at each end).
- Standing sound waves can be created in a closed pipe (open to the atmosphere at only one end) when the length of the pipe is an odd multiple of quarter wavelengths of the sound waves (with a node at the closed end and an antinode at the open end).

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of waves and sound, including resonance and standing waves.
Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to waves and sound.

Resources

Core
- Physics Principles and Problems textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

Supplemental
Online resources
- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment

- Approximately 2-3 weeks

UNIT 10
Light

Unit Goals

At the completion of this unit, students will:

HS-PS4-1.	**Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.**
HS-PS4-5.	Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

ISTE Technology Standards ISTE Empowered Learner (Standard 1c)	use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.
ISTE Knowledge Constructor (Standard 3d)	build knowledge by actively exploring real-world (Standard 3d) issues and problems, including the anchoring event of the unit, developing ideas and theories and pursuing answers and solutions.

Unit Essential Questions

- What is the nature of light?
- How does light interact with substances?
- How can light properties be used?

Unit Essential Vocabulary

- Electromagnetic Spectrum
- Photon
- Reflection
- Refraction
- Refraction Index
- Angle Of Incidence
- Snell's Law
- Critical Angle
- Total Internal Reflection
- Real Image
- Virtual Image

Unit Scope and Sequence

- Light is part of the electromagnetic spectrum of waves that travel through space in essentially straight lines at 3 x 10^8 meters per second.
- Light also exhibits properties of particles. These particles are called photons which contain a certain amount of energy and momentum as indicated by their frequency.
- Reflected light leaves an object's surface at the same angle it hit the object's surface.
- Refraction index of a substance indicates the degree to which the light is slowed down when it is transmitted through the substance.
- When light enters an object at an angle, its direction is changed according to Snell's law and the refraction index.
- Light striking the surface can experience total internal reflection if the incident angle is greater than the critical angle.
- Light reflected off the surface of an object can be directed to form an image.
- Light refracted through an object can be directed to form an image.
- These images can be real (projectable) or virtual (not projectable)

Unit Assured Assessments

Formative Assessments:
Students will complete laboratory data collection and graphical analysis through experimental processes on the topics of light optics, including image formation.
Students will have the opportunity to assess comprehension of concepts and mastery of skills through applied quiz work.

Summative Assessments:
Students will complete an assessment consisting of multiple-choice questions, free response questions and problem solving, and/or the interpretation and analysis of data, related to light and optics.

Resources

<u>Core</u>
- Physics Principles and Problems textbook
- Use of traditional data collection tools and electronic data collection probes: e.g. Pasco

<u>Supplemental</u>
Online resources
- The Physics Classroom. https://www.physicsclassroom.com/. Web.
- Pivot Interactives. https://www.pivotinteractives.com/. Web.
- Flipping Physics. https://www.flippingphysics.com/. Web.
- Khan Academy. https://www.youtube.com/user/khanacademy. Web.
- University of Colorado Boulder. PhET Interactive Simulations. https://phet.colorado.edu/en/simulations/category/new. Web.

Time Allotment
- Approximately 2-3 weeks

CREDIT

1.0 credits in science
One class period for a full year

PREREQUISITES

Successful completion of ACP Chemistry

ASSURED STUDENT PERFORMANCE RUBRICS

- Trumbull High School School-Wide Problem Solving Through Critical Thinking Rubric
- Trumbull High School School-Wide Writing Rubric
- Trumbull High School School-Wide Independent Learning and Thinking Rubric

Trumbull High School School-Wide Problem Solving Through Critical Thinking Rubric

Category/ Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Understanding X_____	• Student demonstrates clear understanding of the problem and the complexities of the task	• Student demonstrates sufficient understanding of the problem and most of the complexities of the task	• Student demonstrates some understanding of the problem but requires assistance to complete the task	• Student demonstrates limited or no understanding of the fundamental problem after assistance with the task
Research X_____	• Student gathers compelling information from multiple sources including digital, print, and interpersonal	• Student gathers sufficient information from multiple sources including digital, print, and interpersonal	• Student gathers some information from few sources including digital, print, and interpersonal	• Student gathers limited or no information
Reasoning and Strategies X_____	• Student demonstrates strong critical thinking skills to develop a comprehensive plan integrating multiple strategies	• Student demonstrates sufficient critical thinking skills to develop a cohesive plan integrating strategies	• Student demonstrates some critical thinking skills to develop a plan integrating some strategies	• Student demonstrates limited or no critical thinking skills and no plan
Final Product and/or Presentation X_____	• Solution shows deep understanding of the problem and its components • Solution shows extensive use of 21st-century technology skills	• Solution shows sufficient understanding of the problem and its components • Solution shows sufficient use of 21st-century technology skills	• Solution shows some understanding of the problem and its components • Solution shows some use of 21st-century technology skills	• Solution shows limited or no understanding of the problem and its components • Solution shows limited or no use of 21st-century technology skills

Trumbull High School School-Wide Writing Rubric

Category/ Weight	Exemplary 4 Student work:	Goal 3 Student work:	Working Toward Goal 2 Student work:	Needs Support 1-0 Student work:
Purpose X_____	• Establishes and maintains a clear purpose • Demonstrates an insightful understanding of audience and task	• Establishes and maintains a purpose • Demonstrates an accurate awareness of audience and task	• Establishes a purpose • Demonstrates an awareness of audience and task	• Does not establish a clear purpose • Demonstrates limited/no awareness of audience and task
Organization X_____	• Reflects sophisticated organization throughout • Demonstrates logical progression of ideas • Maintains a clear focus • Utilizes effective transitions	• Reflects organization throughout • Demonstrates logical progression of ideas • Maintains a focus • Utilizes transitions	• Reflects some organization throughout • Demonstrates logical progression of ideas at times • Maintains a vague focus • May utilize some ineffective transitions	• Reflects little/no organization • Lacks logical progression of ideas • Maintains little/no focus • Utilizes ineffective or no transitions
Content X_____	• Is accurate, explicit, and vivid • Exhibits ideas that are highly developed and enhanced by specific details and examples	• Is accurate and relevant • Exhibits ideas that are developed and supported by details and examples	• May contain some inaccuracies • Exhibits ideas that are partially supported by details and examples	• Is inaccurate and unclear • Exhibits limited/no ideas supported by specific details and examples
Use of Language X_____	• Demonstrates excellent use of language • Demonstrates a highly effective use of standard writing that enhances communication • Contains few or no errors. Errors do not detract from meaning	• Demonstrates competent use of language • Demonstrates effective use of standard writing conventions • Contains few errors Most errors do not detract from meaning	• Demonstrates use of language • Demonstrates use of standard writing conventions • Contains errors that detract from meaning	• Demonstrates limited competency in use of language • Demonstrates limited use of standard writing conventions • Contains errors that make it difficult to determine meaning

Trumbull High School School-Wide Independent Learning and Thinking Rubric

Category/ Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Proposal X_____	• Student demonstrates a strong sense of initiative by generating compelling questions, creating uniquely original projects/work	• Student demonstrates initiative by generating appropriate questions, creating original projects/work	• Student demonstrates some initiative by generating questions, creating appropriate projects/work	• Student demonstrates limited or no initiative by generating few questions and creating projects/work
Independent Research & Development X_____	• Student is analytical, insightful, and works independently to reach a solution	• Student is analytical, and works productively to reach a solution	• Student reaches a solution with direction	• Student is unable to reach a solution without consistent assistance
Presentation of Final Product X_____	• Presentation shows compelling evidence of an independent learner and thinker • Solution shows deep understanding of the problem and its components • Solution shows extensive and appropriate application of 21st-century skills	• Presentation shows clear evidence of an independent learner and thinker • Solution shows adequate understanding of the problem and its components • Solution shows adequate application of 21st-century skills	• Presentation shows some evidence of an independent learner and thinker • Solution shows some understanding of the problem and its components • Solution shows some application of 21st-century skills	• Presentation shows limited or no evidence of an independent learner and thinker • Solution shows limited or no understanding of the problem and its components • Solution shows limited or no application of 21st-century skills

TRUMBULL HIGH SCHOOL
ENGLISH DEPARTMENT
Trumbull, Connecticut

ENGLISH 9
GRADE 9

2023
(last revision 2018)

Curriculum Writing Team

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English 9

Grade 9

Table of Contents

The Trumbull Board of Education will continue to take Affirmative Action to ensure that no persons are discriminated against in its employment.

CORE VALUES & BELIEFS

The Trumbull High School community engages in an environment conducive to learning which believes that all students will read and write effectively, therefore communicating in an articulate and coherent manner. All students will participate in activities that present problem solving through critical thinking. Students will use technology as a tool applying it to decision making. We believe that by fostering self-confidence, self-directed and student-centered activities, we will promote independent thinkers and learners. We believe ethical conduct to be paramount in sustaining the welcoming school climate that we presently enjoy.

INTRODUCTION & PHILOSOPHY

The transition from middle school into high school is both exciting and challenging; in addition to moving into a new building and developing new identities as high school students, freshmen are joining a classroom community of discourse with an expanding set of standards and expectations. The main focus of grade nine English is to promote student independence in critical reading, writing, speaking, and listening both within and beyond the classroom. This requires a high level of academic performance with students utilizing higher order thinking skills. The goal is for students to make their own inferences and generate their own questions in their analysis and interpretation of a text in order to become more independent readers, writers, and thinkers. The goal of the English teacher is to provide students with a "backpack" of skills that they can carry with them throughout their years at Trumbull High School. Through this process they will begin to shape their own identities not only as high school students, but also as resilient, capable, and resourceful life-long learners.

In middle school students have been exposed to an extensive variety of writing modes and literary terms; in 10th grade they will be asked to employ all the resources at hand to read, write, and think independently. Thus, the grade nine English teacher's task is to equip students with an assured core of resources – a repertoire – which every student can master and utilize to become a stronger thinker and communicator. A core group of literary and academic vocabulary terms play an integral role in the works read throughout the year, arming students with the terminology necessary for in-depth analysis.

The freshman year is the first phase of a four-year program in which students are expected to become increasingly independent readers, writers, and thinkers as they work to understand themselves and navigate the ever-changing world that they live in. Students will be asked to consistently demonstrate their learning on demand through in-class timed writing and oral communication/expression of ideas. This progression will continue into 10th grade, where they will study themselves and human behavior through literature and non-fiction, and then into 11th grade, where they will take a critical look at the literature of the United States.

In order to engage students in a rich and diverse reading experience, teachers will select one substantial course text (listed below) per unit that is representative of varied voices and/or historical time periods as well as selected readings from *Foundations of Language and Literature*. In addition, all 9th-grade English classrooms of Trumbull High School will promote a culture of independent reading: in addition to students engaging with whole-class texts over the course of the year, they have the opportunity to read choice books independently. Students will engage in informal writer's response opportunities, allowing students the space to discuss and/or write about the connections between newly learned unit content and independent reading books.

This curriculum spans all levels. Teachers will offer scaffolding and differentiation as needed, and extension activities to supplement at the Honors level. Possible extension activities are included for each literary unit.

COURSE GOALS

CCSS.ELA-LITERACY.RL.9-10.1
Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

CCSS.ELA-LITERACY.RL.9-10.2
Determine a theme or central idea of a text and analyze in detail its development over the course of the text, including how it emerges and is shaped and refined by specific details; provide an objective summary of the text

CCSS.ELA-LITERACY.RL.9-10.3
Analyze how complex characters (e.g., those with multiple or conflicting motivations) develop over the course of a text, interact with other characters, and advance the plot or develop the theme.

CCSS.ELA-Literacy.RL.9-10.4
Determine the meaning of words and phrases as they are used in the text, including figurative and connotative meanings; analyze the cumulative impact of specific word choices on meaning and tone (e.g., how the language evokes a sense of time and place; how it sets a formal or informal tone).

CCSS.ELA-LITERACY.RL.9-10.5
Analyze how an author's choices concerning how to structure a text, order events within it (e.g., parallel plots), and manipulate time (e.g., pacing, flashbacks) create such effects as mystery, tension, or surprise.

CCSS.ELA-LITERACY.RL.9-10.6
Analyze a particular point of view or cultural experience reflected in a work of literature from outside the United States, drawing on a wide reading of world literature.

CCSS.ELA-LITERACY.RL.9-10.7
Analyze the representation of a subject or a key scene in two different artistic mediums, including what is emphasized or absent in each treatment (e.g., Auden's "Musée des Beaux Arts" and Breughel's Landscape with the Fall of Icarus).

CCSS.ELA-LITERACY.RL.9-10.9
Analyze how an author draws on and transforms source material in a specific work (e.g., how Shakespeare treats a theme or topic from Ovid or the Bible or how a later author draws on a play by Shakespeare).

CCSS.ELA-LITERACY.RL.9-10.10
By the end of grade 9, read and comprehend literature, including stories, dramas, and poems, in the grades 9-10 text complexity band proficiently, with scaffolding as needed at the high end of the range.

By the end of grade 10, read and comprehend literature, including stories, dramas, and poems, at the high end of the grades 9-10 text complexity band independently and proficiently.

READING GOALS FOR INFORMATIONAL TEXTS
CCSS.ELA-LITERACY.RI.9-10.1
Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

CCSS.ELA-LITERACY.RI.9-10.2
Determine a central idea of a text and analyze its development over the course of the text, including how it emerges and is shaped and refined by specific details; provide an objective summary of the text.

CCSS.ELA-LITERACY.RI.9-10.3
Analyze how the author unfolds an analysis or series of ideas or events, including the order in which the points are made, how they are introduced and developed, and the connections that are drawn between them.

CCSS.ELA-LITERACY.RI.9-10.4
Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.

CCSS.ELA-LITERACY.RI.9-10.5
Analyze in detail how an author's ideas or claims are developed and refined by particular sentences, paragraphs, or larger portions of a text (e.g., a section or chapter).

CCSS.ELA-LITERACY.RI.9-10.6
Determine an author's point of view or purpose in a text and analyze how an author uses rhetoric to advance that point of view or purpose.

CCSS.ELA-LITERACY.RI.9-10.7
Analyze various accounts of a subject told in different mediums (e.g., a person’s life story in both print and multimedia), determining which details are emphasized in each account.

CCSS.ELA-LITERACY.RI.9-10.8
Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is valid and the evidence is relevant and sufficient; identify false statements and fallacious reasoning.

CCSS.ELA-LITERACY.RI.9-10.9
Analyze seminal U.S. documents of historical and literary significance (e.g., Washington's Farewell Address, the Gettysburg Address, Roosevelt's Four Freedoms speech, King's "Letter from Birmingham Jail"), including how they address related themes and concepts

CCSS.ELA-LITERACY.RI.9-10.10
By the end of grade 9, read and comprehend literary nonfiction in the grades 9–10 text complexity band proficiently, with scaffolding as needed at the high end of the range. By the end of grade 10, read and comprehend literary nonfiction at the high end of the grades 9–10 text complexity band independently and proficiently.

WRITING GOALS

CCSS.ELA-LITERACY.W.9-10.1
Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among claim(s), counterclaims, reasons, and evidence.
b. Develop claim(s) and counterclaims fairly, supplying evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level and concerns.
c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
e. Provide a concluding statement or section that follows from and supports the argument presented.

CCSS.ELA-LITERACY.W.9-10.2
Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

CCSS.ELA-LITERACY.W.9-10.2.A
Introduce a topic; organize complex ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aid comprehension.

CCSS.ELA-LITERACY.W.9-10.2.B
Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.

CCSS.ELA-LITERACY.W.9-10.2.C
Use appropriate and varied transitions to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts.

CCSS.ELA-LITERACY.W.9-10.2.D
Use precise language and domain-specific vocabulary to manage the complexity of the topic.

CCSS.ELA-LITERACY.W.9-10.2.E
Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.

CCSS.ELA-LITERACY.W.9-10.2.F
Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

CCSS.ELA-LITERACY.W.9-10.3
Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

CCSS.ELA.W.9-10.3.B
Use narrative techniques, such as dialogue, pacing, description, reflection, and multiple plot lines, to develop experiences, events, and/or characters.

CCSS.ELA-LITERACY.W.9-10.3.C
Use a variety of techniques to sequence events so that they build on one another to create a coherent whole.

CCSS.ELA-LITERACY.W.9-10.3.D
Use precise words and phrases, telling details, and sensory language to convey a vivid picture of the experiences, events, setting, and/or characters.

CCSS.ELA-LITERACY.W.9-10.3.E
Provide a conclusion that follows from and reflects on what is experienced, observed, or resolved over the course of the narrative.

CCSS.ELA-Literacy.W.9-10.4
Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience (Grade-specific expectations for writing types are defined in standards 1-3 above.)

CCSS.ELA-LITERACY.W.9-10.5
Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience. (Editing for conventions should demonstrate command of Language standards 1-3 up to and including grades 9-10 here.)

CCSS.ELA-LITERACY.W.9-10.6
Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

CCSS.ELA-LITERACY.W.9-10.7
Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

CCSS.ELA-LITERACY.W.9-10.8
Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

CCSS.ELA-LITERACY.W.9-10.9
Draw evidence from literary or informational texts to support analysis, reflection, and research.

CCSS.ELA-LITERACY.W.9-10.10
Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

SPEAKING AND LISTENING GOALS

CCSS.ELA-LITERACY.SL.9-10.1
Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

CCSS.ELA-LITERACY.SL.9-10.1.A
Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

CCSS.ELA-LITERACY.SL.9-10.1.C
Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.

CCSS.ELA-LITERACY.SL.9-10.1.D
Respond thoughtfully to diverse perspectives, summarize points of agreement and disagreement, and, when warranted, qualify or justify their own views and understanding and make new connections in light of the evidence and reasoning presented.

CCSS.ELA-LITERACY.SL.9-10.2
Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.
CCSS.ELA-LITERACY.SL.9-10.3
Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, identifying any fallacious reasoning or exaggerated or distorted evidence.

CCSS.ELA-LITERACY.SL.9-10.4
Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

CCSS.ELA-LITERACY.SL.9-10.5
Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

CCSS.ELA-LITERACY.SL.9-10.6
Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate. (See grades 9-10 Language standards 1 and 3 here for specific expectations.)

CONVENTIONAL OF STANDARD ENGLISH GOALS:

CCSS.ELA-LITERACY.L.9-10.1
Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

CCSS.ELA-LITERACY.L.9-10.1.A
Use parallel structure.*

CCSS.ELA-LITERACY.L.9-10.1.B
Use various types of phrases (noun, verb, adjectival, adverbial, participial, prepositional, absolute) and clauses (independent, dependent; noun, relative, adverbial) to convey specific meanings and add variety and interest to writing or presentations.

CCSS.ELA-LITERACY.L.9-10.2
Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

CCSS.ELA-LITERACY.L.9-10.2.A
Use a semicolon (and perhaps a conjunctive adverb) to link two or more closely related independent clauses.

CCSS.ELA-LITERACY.L.9-10.2.B

Use a colon to introduce a list or quotation.

CCSS.ELA-LITERACY.L.9-10.2.C
Spell correctly.

CCSS.ELA-LITERACY.L.9-10.3
Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.

CCSS.ELA-LITERACY.L.9-10.3.A
Write and edit work so that it conforms to the guidelines in a style manual (e.g., *MLA Handbook*, Turabian's *Manual for Writers*) appropriate for the discipline and writing type.

CCSS.ELA-LITERACY.L.9-10.4
Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on *grades 9-10 reading and content*, choosing flexibly from a range of strategies.

CCSS.ELA-LITERACY.L.9-10.4.A
Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.

CCSS.ELA-LITERACY.L.9-10.4.B
Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., *analyze, analysis, analytical; advocate, advocacy*).

CCSS.ELA-LITERACY.L.9-10.4.C
Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, or its etymology.

CCSS.ELA-LITERACY.L.9-10.4.D
Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).

CCSS.ELA-LITERACY.L.9-10.5
Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

CCSS.ELA-LITERACY.L.9-10.5.A
Interpret figures of speech (e.g., euphemism, oxymoron) in context and analyze their role in the text.

CCSS.ELA-LITERACY.L.9-10.5.B
Analyze nuances in the meaning of words with similar denotations.

CCSS.ELA-LITERACY.L.9-10.6
Acquire and accurately use general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

The following standards derive from the 2016 International Society for Technology in Education Standards.

Standard 2
Students recognize the rights, responsibilities, and opportunities of living, learning, and working in an interconnected digital world, and they act and model in ways that are safe, legal, and ethical.

2a. Students cultivate and manage their digital identity and reputation and are aware of the permanence of their actions in the digital world.

2b. Students engage in positive, safe, legal, and ethical behavior when using technology, including social interactions online or when using networked devices.

2c. Students demonstrate an understanding of and respect for the rights and obligations of using and sharing intellectual property.

2d. Students manage their personal data to maintain digital privacy and security and are aware of data-collection technology used to track their navigation online. Students use a variety of technologies within a design process to identify and solve problems by creating new, useful, or imaginative solutions.

Standard 3
Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others.

3a. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits.

3b. Students evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources.

3c. Students curate information from digital resources using a variety of tools and methods to create collections of artifacts that demonstrate meaningful connections or conclusions.

3d. Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.

COURSE ENDURING UNDERSTANDINGS

Students will understand that . . .

- reading is an integral part of the learning process.
- authors make informed and specific choices within their writing in order to convey meaning and purpose.
- texts, concepts, and skills can be known and understood through seeking out answers to individual questions that arise.
- effective writing and oral communication are essential to their success as learners and citizens.
- they are part of a cultural, literary, and artistic dialogue, which is a living conversation rather than a static concept, and that they are part of a larger and more diverse society than they might otherwise identify with.

COURSE ESSENTIAL QUESTIONS

- How and why do we read and write critically?
    - What tools do readers and authors use to impart meaning?
    - How do authors employ literary devices and rhetorical strategies, and how do these impact both the reader and the message?
    - What is authorial intent and what is its impact?
    - What role does and should the reader play in creating meaning for a text?
- How do we fill in the gaps in our knowledge by searching, thinking, struggling?
    - What do we do when we don't understand what we are reading?
    - How do we effectively engage in the inquiry process?
    - How do we discern if information is credible and validate its worth?
    - How do we apply our knowledge to establish a new understanding of ourselves in relation to our immediate surroundings and the world at large?
- How can we apply our reading practices and knowledge gained to our own writing?
    - As writers, how and why do we purposefully arrange diction, syntax, details, imagery, and our message in order to create the purpose for our writing?
    - How do we distinguish between what our writing says and how we deliver our message to our audience?

COURSE KNOWLEDGE & SKILLS

In *Grade 9 English*, the four assured units of study are meant to serve as building blocks; each unit builds off of skills and concepts from the previous unit. The focus in the course is to examine how and why we read, write, and think critically and how and when these skills are applicable in real life.

- **Unit 1: "Understanding What Makes Us Human"**
    - The first unit of the year asks students to reflect on universal themes such as how stories reflect the human experience through the author's purpose, while also teaching students important skills such as summarizing, close-reading, annotating, questioning, inferring, visualizing, seeing patterns, and reflecting. Students will learn and practice the skills of a strong reader, writer, and thinker and will ultimately apply these skills in an analytical essay.

- **Unit 2: "Understanding How the Past Informs Our Future"**
    - The second unit of study, meant for the second marking period, asks students to think about and reflect upon larger ideas such as how stylistic choices in writing can enhance and impact the readers' experience. By examining writer's craft and generational patterns in literature in relation to decision making, problem solving, and resilience, students will build upon the close-reading skills of the first unit with a closer understanding of how authors make choices in order to shape their stories. Students will also craft their own stories by making authorial choices that directly impact the purpose of their storytelling.

- **Unit 3: "Understanding Our Role & Responsibility to Others & Our Society"**
    - The third unit of study, meant for the third marking period, asks students to use literary research skills and strategies to consider the role of the individual in society, while also analyzing how authors use real-world problems as catalysts for their storytelling. Students will then participate in a rich, exploratory experience in which they self-select a topic of interest, conduct an extensive investigation of sources, and produce a written research paper.

- **Unit 4: "Understanding Our Call to Stand Up and Speak Out"**
    - The fourth unit of study, designated for the fourth marking period, challenges students to use rhetorical strategies to persuade an audience by thinking critically about concepts like justice, empathy, and responsibility through their analysis of nonfiction selections. Additionally, students will continue with their introductory work in understanding the foundational elements of rhetoric. Students will participate in rich classroom discussions as part of their summative understanding emphasizing their learning of speaking and listening skills.

COURSE SYLLABUS

Course/Name

English 9

Level

Advanced College Prep
Honors

Prerequisites

None

Materials Required

School Approved Electronic Device
Lined Paper
Writing Implements
Sticky Notes
Daily Agenda Pad
Binder/Notebook/Folder

General Description of the Course

The freshman year is the first phase of a four-year program in which students are expected to become increasingly independent readers, writers, and thinkers as they work to understand themselves and navigate the ever-changing world that they live in. Students will be asked to consistently demonstrate their learning on demand through in-class timed writing and oral communication/expression of ideas. This progression will continue into 10th grade, where they will study themselves and human behavior through literature and non-fiction, and then into 11th grade, where they will take a critical look at the literature of the United States.

Assured Assessments

Teachers may select additional formative or summative activities based on student skills from the following examples or other activities as aligned with Common Core Standards and NCTE.

Formative Assessments:

- Presentation Literacy Skills
- Reader Response Notebook
- Paragraph Writing and Close Passage Analysis
- Opportunities to Explore Individual Narrative Voice

Summative

- Analytical Writing
- Narrative Piece
- Research Experience
- Formal Discussion

Course Texts

In order to engage students in a rich and diverse reading experience, teachers will select one substantial course text (listed below) per unit that is representative of varied voices and/or

historical time periods as well as selected readings from *Foundations of Language and Literature*.

The Tragedy of Romeo and Juliet by William Shakespeare (*requirement for all 9th graders)
Of Mice and Men by John Steinbeck
The Secret Life of Bees by Sue Monk Kidd
Our Town by Thornton Wilder
The House on Mango Street by Sandra Cisneros
Fahrenheit 451 by Ray Bradbury
1984 by George Orwell
Animal Farm by George Orwell
The Odyssey by Homer
The Old Man and the Sea by Ernest Hemingway
Warriors Don't Cry by Melba Patillo Beals
The Book Thief by Markus Zusak
Between Shades of Gray by Ruta Sepetys
Unwind by Neal Shusterman
Matched by Ally Condie
Ready Player One by Ernest Cline
Uglies by Scott Westerfield
The Program by Suzanne Young
Delirium by Lauren Oliver
Persepolis by Marjane Sartrapi
Me Moth by Amber McBride
The Door of No Return by Kwame Alexander
Solito by Javier Zamora

Textbook
Foundations of Language & Literature by Shea, Golden, & Scholz

Supplemental Resources

- Any portion of the above listed books to supplement the core class text study
- Teachers may select additional readings and materials based on student skills as aligned with Common Core Standards and NCTE.

Unit 1
UNDERSTANDING WHAT MAKES US HUMAN

Concept & Skill Lenses	Generalizations and Enduring Understandings	Guiding Questions Content-Based(C) Skill-Based (S) Writing-Based (W)	Common Core Standards (Prioritized Standards in Bold)	Students Will Be Able to Demonstrate…
Concept Lenses: *identity, empathy, human nature, environment* **Skill Lenses:** *summarizing, close-reading, annotating, questioning, inferring, visualizing, seeing patterns, reflecting* **Content Exposure and Focus:** *voice, author's purpose, author's craft, theme, literary terms and devices (setting, motif, conflict, characterization) evidence*	● Stories reflect on the human experience through the author's purpose. ● Theme conveys a universal truth about human nature and why it is important. ● Author's make specific and intentional choices in their writing. ● Close reading contributes to our understanding of what *is intentional* on part of the writer. ● Reading a wide range of stories helps develop empathy and an understanding of self (identity) and others.	**How does understanding literary elements contribute to our understanding of theme? (C)** **Why is it important to read closely and with meaning? (S)** **How do writers select appropriate and relevant evidence for analysis? (W)**	**W. 9-10.1** W. 9-10.1a W. 9-10 1b W. 9-10 2d W. 9-10. 10 **RL. 9-10.2** RL. 9-10.3 RL. 9-10.4 RL. 9-10.5 RL. 9-10.10 **RI.9-10.4** SL. 9-10.1 SL. 9-10.4	● Students will be able to use a variety of annotation strategies to explore close-reading (see linked resources below). ● Students will be able to examine the importance of setting, motif, conflict, characterization. ● Students will be able to define human nature. ● Students will be able to define theme as a two-part statement revealing a universal truth and its importance. ● Students will be able to interpret the author's purpose and demonstrate their thinking through a variety of formative writing tasks. ● Students will be able to collaborate and discuss their individual inquiries and conclusions. ● Students will be able to identify and engage in the steps of the writing process.

UNIT 1 Teaching Strategies

- **Baseline Avoiding Plagiarism Activities:** *Foundations of Language & Literature*: Pre-AP Pathway by Shea, Golden, & Sholz - pages 139-144
- Dialectical Notebook Set-Up & Journaling
- Modeled Annotations - The strategies we use to generate strong annotations
- Examining strong & weak notebook entries
- Reflecting on individual paragraph writing
- Color-blocking paragraphs: claim, context, evidence, analysis.
- **Writer's Response:** Allow students the opportunity to discuss and/or write about the connections between newly learned unit content and independent reading books
- **Mini-Lessons On:**
    1. Selecting strong and meaningful evidence– discussions on how to evaluate for "strong" evidence
    2. Examining the parts of a literary analysis essay, a close look at what concise and developed literary analysis paragraphs include
    3. Examining the distinctions between an introduction and a conclusion
    4. Examining how evidence/ support (quotes) look and sound in a paragraph
    5. Instructional strategies on turning notes into meaningful written expression
    6. Instructional strategies on developing strong claims and topic sentences
    7. Instructional strategies on the distinction between context (summary) and analysis within a paragraph?
    8. Demonstrating *how* to think critically: **what** am I noticing, **how** is it being used in the text, **why** does it matter? Answering the "SO WHAT?" question to move beyond the text and develop interpretations
    9. Instructional strategies on the parts of the essay:
        a. Thesis statements: claims that SNAP (specific, new/nonobvious, arguable, provable)
        b. Topic sentences (mini thesis statements)
        c. Incorporating and embedding support/direct quotations
        d. Writing a general to specific introduction
        e. Writing a specific to general conclusion
    10. Using the thesis to develop an outline

UNIT 1 Assessments

Assured Formative Baseline

- All grade 9 students will engage in a common assessment the first week of school. All grade 9 students, in all classes and levels, will read the same story, over the course of the same number of days, and engage with the same writing prompt and timed writing task. This will serve as baseline information and inform teacher instruction, as well as offer teachers the ability to collaborate and calibrate student data.

Assured Formative Assessments

- Dialectical Notebook Entry/Annotation Strategies & developing a strong analytical paragraph response; using student annotations and notes to generate a cohesive response with evidence.

Assured Summative Assessment

- Literary analysis paper/ essay in which students demonstrate their ability to draw specific conclusions on a text's thematic message by examining characterization, setting, conflict.

THE ABOVE ASSURED ASSESSMENTS support the teaching of the following primary standards:

- CCSS.ELA-LITERACY.W.9-10.1
- CCSS.ELA-LITERACY.RL.9-10.2
- CCSS.ELA-LITERACY.RI.9-10.4

Unit 1 Texts

In order to engage students in a rich and diverse reading experience, teachers will select one substantial course text (listed below) per unit that is representative of varied voices and/or historical time periods as well as selected readings from *Foundations of Language and Literature*.

The Tragedy of Romeo and Juliet by William Shakespeare (*requirement for all 9th graders)
Of Mice and Men by John Steinbeck
The Secret Life of Bees by Sue Monk Kidd
Our Town by Thornton Wilder
The House on Mango Street by Sandra Cisneros
Fahrenheit 451 by Ray Bradbury
1984 by George Orwell
Animal Farm by George Orwell
The Odyssey by Homer
The Old Man and the Sea by Ernest Hemingway
Warriors Don't Cry by Melba Patillo Beals
The Book Thief by Markus Zusak
Between Shades of Gray by Ruta Sepetys
Unwind by Neal Shusterman
Matched by Ally Condie
Ready Player One by Ernest Cline
Uglies by Scott Westerfield
The Program by Suzanne Young
Delirium by Lauren Oliver
Persepolis by Marjane Sartrapi
Me Moth by Amber McBride
The Door of No Return by Kwame Alexander
Solito by Javier Zamora

Textbook

Foundations of Language & Literature by Shea, Golden, & Scholz

Supplemental Resources

- Teachers may select additional readings and materials based on student skills as aligned with Common Core Standards and NCTE including, but not limited to TED Talks, short stories, poetry, nonfiction articles/op-eds, etc.
- Ray Bradbury's "The Veldt"
- Sherman Alexie's "Reindeer Games"
- Richard Connell's "The Most Dangerous Game"
- Etgar Keret's "What, of This Goldfish, Would You Wish?"
- Edgar Allen Poe's "The Cask of Amontillado"
- Angela Flournoy's "Lelah"
- Jose Olivarez's "Home Court"
- Suheir Hammad's "What I Will"
- Rachel Richardon's "Transmission"
- Dana Gioia's "Money"
- Billy Collins's "Flames"
- Jenni B. Baker's "Find Your Way and You--American Boy"
- Nate Marshall's "Harold's Chicken Shack #86"
- Naomi Shihab Nye's "Kindness"
- Michael Ondaatje's Sweet Like a Crow"
- William Shakespeare's "Sonnet 18: Shall I compare thee to a summer's day?"
  Gwendolyn Brooks's "We Real Cool"
- David Tomas Martinez's "In Chicano Park"
- Emily Dickinson's "Because I Could Not Stop for Death"
- Amit Majmudar's "T.S.A."
- Ha Jin's "Ways of Talking"
- Classroom Library for student choice.
- Learning Commons Library for student choice.

Time Allotment: 8-10 weeks

UNIT 2
UNDERSTANDING HOW THE PAST INFORMS OUR FUTURE

Concept & Skill Lenses	Generalizations and Enduring Understandings	Guiding Questions Content-Based(C) Skill-Based (S) Writing-Based (W)	Common Core Standards (Prioritized Standards in Bold)	Students Will Be Able to Demonstrate…
Concept Lenses: *Decision making, problem solving, resilience, generational patterns* **Skill Lenses:** *Identifying patterns in literature, close-reading, quote analysis, questioning, annotating, analyzing, reflecting, voice & tone* **Content Exposure and Focus:** *Symbols, allusions, archetypes (symbolic, situational, character), text-structure*	● Patterns exist in storytelling and are not confined by time or culture ● Authors use symbols, allusions archetypes and text-structure to shape their story ● Reading a wide range of stories and genres reveals patterns to readers ● Characters' decisions are influenced by generational patterns and past experiences	**What are stylistic choices and how does our understanding of them enhance our reading? (C)** **How do authors guide readers in understanding the stylistic elements of their writing and the impact of those elements? (S)** **How does a writer develop and enhance their voice within the narrative genre of writing? (W)**	RL.9-10.1 RL.9-10.3 **RL.9-10.4** RL.9-10.5 RL.9-10.6 RL.9-10.7 W.9-10.3 **W.9-10. 3b** **W.9-10.4** SL.9-10.1 SL.9-10.4 SL.9-10.5	● Students will be able to define symbols, allusions, and archetypes. ● Students will be able to identify a text's structure. ● Students will be able to determine how a text's structure & symbols, allusions and archetypes contribute to a story. ● Students will be able to extend on their understanding of how author's craft contributes to theme. ● Students will be able to identify patterns in literature. ● Students will be able to explore their individual writing voice in various writing opportunities; including narrative. ● Students will be able to make choices in their own writing. ● Students will be able to compare and contrast the use of archetypes across genres and mediums. ● Students will be able to experiment with authors' stylistic choices.

UNIT 2 Teaching Strategies

- Define and Examine Author's Craft
- Define and Teach the following elements of author's craft
    - Allusion (identify for students, explore the reference, follow-up discussion on why it matters)
    - Archetype (identify for students, explore the reference, follow-up discussion on why it matters)
        - Symbolic
        - Situational
        - Character
    - Symbolism
    - Text Structure
- Close Passage Analysis to pinpoint and examine individual author's use of craft
- Students practice writing in the style of the authors in the unit
- Small informal personal writing opportunities
- Explore storytelling from both the real and fictional perspective
- Discuss and reflect on storytelling through informal discussions
- Class discussions on style
- Excerpts from a variety of literary genres (poetry, music lyrics, short-stories, passages etc.) to examine universal patterns
- Explore point of view and how it contributes to storytelling
- **Writer's Response:** Allow students the opportunity to discuss and/or write about the connections between newly learned unit content and independent reading books

Unit 2 Course Texts

In order to engage students in a rich and diverse reading experience, teachers will select one substantial course text (listed below) per unit that is representative of varied voices and/or historical time periods as well as selected readings from *Foundations of Language and Literature*.

The Tragedy of Romeo and Juliet by William Shakespeare (*requirement for all 9th graders)
Of Mice and Men by John Steinbeck
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The House on Mango Street by Sandra Cisneros
Fahrenheit 451 by Ray Bradbury
1984 by George Orwell
Animal Farm by George Orwell
The Odyssey by Homer
The Old Man and the Sea by Ernest Hemingway
Warriors Don't Cry by Melba Patillo Beals
The Book Thief by Markus Zusak
Between Shades of Gray by Ruta Sepetys
Unwind by Neal Shusterman
Matched by Ally Condie

Ready Player One by Ernest Cline
Uglies by Scott Westerfield
The Program by Suzanne Young
Delirium by Lauren Oliver
Persepolis by Marjane Sartrapi
Me Moth by Amber McBride
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Foundations of Language & Literature by Shea, Golden, & Scholz

Supplemental Resources

- Teachers may select additional readings and materials based on student skills as aligned with Common Core Standards and NCTE including, but not limited to TED Talks, short stories, poetry, nonfiction articles/op-eds, etc.
- Monique Truong's "My Father's Previous Life"
- Steven Hall's "You, Me, and the Sea"
- Sarah Vowell's "Music Lessons"
- Carrie Brownstein's from *Hunger Makes Me a Modern Girl*
- Julia Alvarez's "La Gringuita"
- Jimmy Santiago Baca's from *Coming into Language*
- Richard Wright's from *Black Boy*
- Douglas Quenqua's "They're, Like, Way Ahead of the Linguistic Currrve"
- Jessica Wolf's "The Seven Words I Cannot Say (Around My Children)"
- Amanda Palmer's from *The Art of Asking*
- Thi Bui's from *The Best We Could Do*
- Haruki Murakami's from *What I Talk about When I Talk about Running*
- Langston Hughes's "Let America Be America Again"
- Emma Lazarus's "The New Colossus"
- Concord Oral History Program's "Remembrances for 100th Anniversary of Statue of Liberty"
- Tato Laviera's "lady liberty"
- Suji Kwock Kim's "Slant"
- Michael Daly's "The Statue of Liberty Was Born a Muslim"
- Jessica Care moore's "Black Statue of Liberty"
- Classroom Library for student choice.
- Learning Commons Library for student choice.

Unit 2 Assured Assessments

Assured Formative Assessment

- *Close reading response(s) of mentor texts:* for craft, style, and surface features. Students will analyze a teacher-selected or self-selected text.

Assured Formative Assessment

- Group or individual assignment asking students to identify their knowledge and understanding of writer's craft, style, and/or surface features through either past or present stories, movies, TV shows, etc. using Powerpoint/Google Slides, Canva, or shared-discussion.

Assured Summative Assessment

- *Personal Narrative Writing*: students experiment with mimicking the stylistic choices writers use (example: vignette, exploring your own journey or odyssey).

THE ABOVE ASSURED ASSESSMENTS support the teaching of the following primary standards:

- CCSS.ELA.W.9-10.3b
- CCSS.ELA-Literacy.W.9-10.4
- CCSS.ELA-Literacy.RL.9-10.4

Time Allotment: 8-10 weeks

UNIT 3
UNDERSTANDING OUR ROLE & RESPONSIBILITY TO OTHERS & OUR SOCIETY

Concept & Skill Lenses	Generalizations and Enduring Understandings	Guiding Questions Content-Based (C) Skill- Based (S) Writing-Based (W)	Common Core Standards (Prioritized Standards in Bold)	Students Will Be Able to Demonstrate…
Concept Lenses: *conformity, individual vs. society, identity, constraints of an environment, language as a tool of manipulation and power* **Skill Lenses:** *researching, assessing sources for credibility, writing using multiple sources, synthesizing ideas and information, embedding quotations, MLA, questioning our current world and society* **Content Exposure and Focus:** *conflicts within society, social responsibility, development of fictional worlds representative of a particular aspect of society*	● Authors create fictional worlds as commentary on our existing world. ● Individuals, events, and ideas develop and interact over the course of a text. ● Our experiences shape and influence our role in society. ● Authentic ideas hold value. ● Fear of consequence prevents individuals from challenging the status quo. ● The status quo should be re-examined by individuals in society.	**How does uncertainty and fear lead people to consciously and subconsciously look to others to influence their beliefs and decisions? (C)** **How does engaging in the research process contribute to a broader understanding of ourselves and society? (S)** **How does a writer synthesize ideas and information in order to form their own conclusions? (W)**	W.9-10.1 W.9-10.1d W.9-10.2 W.9-10.4 W.9-10.7 W.9-10.8 W.9-10.9 **SL.9-10.1** SL.9-10.1a **SL.9-10.1d** SL.9-10.2 RL.9-10.1 **RL.9-10.2** RL.9-10.3 RL.9-10.5 RI.9-10.1	● Students will learn to conduct effective research (utilize effective research strategies). ● Students will be able to assess sources for credibility. ● Students will be able to write using multiple sources. ● Students will be able to synthesize ideas and information. ● Students will be able to embed and cite quotations according to MLA style. ● Students will be able to question our current world and society. ● Students will demonstrate their understanding of the above goals in a research experience. ● Students will be able to make connections between the literature and the world around them. ● Students will be able to understand the elements of dystopian literature. ● Students will be able to

				examine the importance of conflict, imagery and diction. ● Students will be introduced to rhetorical strategies and rhetorical appeals (ethos, logos, and pathos).

UNIT 3 Teaching Strategies

- Classroom Library for student choice
- Learning Commons Library for student choice
- Criteria and elements of dystopian literature and dystopian societies
- MLA Formatting
- Access to support from Learning Common Specialist on sources, scholarly articles and databases
- Various mini-lessons focused on exposing students to rhetorical appeals through visual and print advertising.
- Instruction on how to locate credible sources, **C.R.A.A.P. Testing** sources
- Developing research questions; turning research questions into claims
- Outlining writing with multiple sources

Unit 3 Texts

In order to engage students in a rich and diverse reading experience, teachers will select one substantial course text (listed below) per unit that is representative of varied voices and/or historical time periods as well as selected readings from *Foundations of Language and Literature*.

The Tragedy of Romeo and Juliet by William Shakespeare (*requirement for all 9th graders)
Of Mice and Men by John Steinbeck
The Secret Life of Bees by Sue Monk Kidd
Our Town by Thornton Wilder
The House on Mango Street by Sandra Cisneros
Fahrenheit 451 by Ray Bradbury
1984 by George Orwell
Animal Farm by George Orwell
The Odyssey by Homer
The Old Man and the Sea by Ernest Hemingway
Warriors Don't Cry by Melba Patillo Beals
The Book Thief by Markus Zusak
Between Shades of Gray by Ruta Sepetys
Unwind by Neal Shusterman
Matched by Ally Condie
Ready Player One by Ernest Cline
Uglies by Scott Westerfield
The Program by Suzanne Young
Delirium by Lauren Oliver
Persepolis by Marjane Sartrapi
Me Moth by Amber McBride
The Door of No Return by Kwame Alexander
Solito by Javier Zamora

Textbook

Foundations of Language & Literature by Shea, Golden, & Scholz

Supplemental Resources

- Teachers may select additional readings and materials based on student skills as aligned with Common Core Standards and NCTE including, but not limited to TED Talks, short stories, poetry, nonfiction articles/op-eds, etc.
- Silvia Gonzalez S.'s from *Boxcar--El Vagon*
- E.O. Wilson's from *The Social Conquest of Earth*
- Adam Piore's "Why We're Patriotic"
- David Brooks's from *People Like Us*
- Classroom Library for student choice.
- Learning Commons Library for student choice.

Unit 3 Assured Assessments

Assured Formatives

- *Close-reading response of mentor texts on elements of literature as it relates to an individual's role within their society:* conflict (man v. man, nature, society, self), imagery, diction, syntax (i.e., analysis of Old Major's speech in *Animal Farm* or Captain Beatty's speech in *Fahrenheit 451,* or a soliloquy in *The Tragedy of Romeo and Juliet*)

Assured Summative Assessment

- *Research Process Experience:* Students will explore and research a real-world problem of their choosing. Students will participate in a rich, exploratory experience in which they self-select a topic of interest, conduct an extensive investigation of sources, and craft a finished product (paper, presentation, discussion, etc.) based on this process.

THE ABOVE ASSURED ASSESSMENTS support the teaching of the following primary standards:

- CCSS.ELA-Literacy.RI.9-10.2
- CCSS.ELA-Literacy.SL.9-10.1

Time Allotment: 8-10 weeks

UNIT 4
UNDERSTANDING OUR CALL TO STAND UP AND SPEAK OUT

Concept & Skill Lenses	Generalizations and Enduring Understandings	Guiding Questions Content-Based(C) Skill- Based (S) Speaking & Listening -Based (SL)	Common Core Standards (Prioritized Standards in Bold)	Students Will Be Able to Demonstrate…
Concept Lenses: *Thinking critically about language and literature in regards to justice, empathy, responsibility, consequences,courage, integrity, greater good, community vs. self, obligation* **Skill Lenses:** *Analyzing nonfiction, developing strong arguments, examining how writers use rhetorical strategies to persuade an audience, engaging in respectful discourse* **Content Exposure and Focus:** *Speeches on historical and current events, nonfiction pieces relevant to justice, tone, diction, ethos, pathos, logos*	● Individual responsibility in regards to justice; silence and inaction can allow injustice to continue. ● Empathy, courage, and integrity are essential components of a strong community. ● Mutual respect and understanding strengthens discourse.	**What is our responsibility to our community in regard to justice? (C)** **How do writers use rhetorical strategies to persuade an audience? (S)** **How does a moment in time/event/time period inspire a text? (S)** **How does a participant engage and prepare for respectful discourse when discussing opposing viewpoints? (SL)**	SL.9-10.1 SL.9-10.1a SL.9-10.1b SL.9-10.1c **SL.9-10.1d** SL.9-10.2 SL.9-10.3 SL.9-10.4 SL.9-10.5 SL.9-10.6 RI.9-10.1 RI.9-10.2 RI.9-10.3 RI.9-10.4 RI.9-10.5 **RI.9-10.6** RI.9-10.8 W.9-10.1 W.9-10.1d W.9-10.2d W.9-10.4 W.9-10.5 W.9-10.10	● Students will be able to analyze non fiction. ● Students will be able to develop strong arguments. ● Students will be able to examine how writers use rhetorical strategies to persuade an audience. ● Students will engage in respectful discourse. ● Students will reflect on their own methods of discourse and its impact on discussion.

UNIT 4 Teaching Strategies

- Classroom Library for student choice
- Continued instruction/practice on rhetorical analysis
- Create Class Discussion Norms
- Self- Selecting Issues and Topics of Discussion - i.e. Current Events
- Accountable Talk – use of talking stems to facilitate classroom discussion
- Generating questions on demand

In order to engage students in a rich and diverse experience, teachers will select one substantial course text (listed below) per unit that is representative of varied voices and/or historical time periods as well as selected readings from *Foundations of Language and Literature*.

Unit 4 Texts

The Tragedy of Romeo and Juliet by William Shakespeare (*requirement for all 9th graders)
Of Mice and Men by John Steinbeck
The Secret Life of Bees by Sue Monk Kidd
Our Town by Thornton Wilder
The House on Mango Street by Sandra Cisneros
Fahrenheit 451 by Ray Bradbury
1984 by George Orwell
Animal Farm by George Orwell
The Odyssey by Homer
The Old Man and the Sea by Ernest Hemingway
Warriors Don't Cry by Melba Patillo Beals
The Book Thief by Markus Zusak
Between Shades of Gray by Ruta Sepetys
Unwind by Neal Shusterman
Matched by Ally Condie
Ready Player One by Ernest Cline
Uglies by Scott Westerfield
The Program by Suzanne Young
Delirium by Lauren Oliver
Persepolis by Marjane Sartrapi
Me Moth by Amber McBride
The Door of No Return by Kwame Alexander
Solito by Javier Zamora

Textbook

Foundations of Language & Literature: Pre-AP Pathway by Shea, Golden, & Scholz

Supplemental Resources

- Teachers may select additional readings and materials based on student skills as aligned with Common Core Standards and NCTE including, but not limited to TED Talks, short stories, poetry, nonfiction articles/op-eds, etc.
- Stephen King's "Stephen King"s Guide to Movie Snacks"
- Derf Backder's from *Trashed*

- Lisa Damour's "Why Teenage Girls Roll Their Eyes"
- Raph Koster's from *A Theory of Fun for Game Design*
- Peggy Orenstein's "The Battle over Dress Codes"
- Peggy Orenstein's "What's Wrong with Cinderella?"
- Tina Rosenberg's "Labeling the Danger in Soda"
- Daniel Enger's "Let's Kill All the Mosquitos"
- Sarah Kessler's from *Why Online Harassment Is Still Ruining Lives--and How We Can Stop It*
- Mark Twain's "Advice to Youth"
- Cesar Chavez's "Letter from Delano"
- Classroom Library for student choice.
- Learning Commons Library for student choice.

Unit 4 Assured Assessments

Assured Formative Assessment

- Written response and analysis of speeches, articles, and other non-fiction pieces (op-eds) to explore the unit's focus.
- Varying types of discussions requiring on demand thinking: Fishbowls, Shared Inquiry, Socratic Seminar, Prompted and Unprompted Responses.

Assured Summative Assessment

- Shared Inquiry Discussion with Written Reflections. Within a discussion students engage in insightful conversations about complex texts, ideas, and concepts. The students will explore and synthesize a particular text and/or topic. Students will be responsible for gathering evidence and preparing claims as preparation for the graded discussion. The teacher will establish discussion norms so that the students will gain a deeper understanding through meaningful collaboration and respectful sharing of ideas. Teachers will use the Trumbull High School English Department Grade 9 Speaking and Listening rubric to assess student performance. After the discussion, students will craft a written reflection on their performance and participation in the discussion.

THE ABOVE ASSURED ASSESSMENTS support the teaching of the following primary standards:

- RI.9-10.6
- SL.9-10.1.d

Time Allotment: 8-10 weeks

ACADEMIC LANGUAGE

Academic Language: English/literary study requires students to be proficient in the following literary language, most of which students learn throughout their middle school experience. High school teachers will continue to have students identify and explain significant examples of these, further deepening student understanding of how these devices and concepts operate to convey meaning in a given text. As students encounter other devices and concepts, they will expand their knowledge; however, knowledge outside of this given list is text-dependent and therefore cannot be listed explicitly:

- allusion
- antagonist
- characterization
- conflict (external and internal)
- dialogue
- diction
- foreshadowing
- flashback
- imagery
- irony (dramatic, situational, verbal)
- metaphor
- mood
- motif
- narrator
- personification
- plot
- point of view
- protagonist
- repetition
- setting
- simile
- symbolism
- theme
- tone

COURSE CREDIT

One credit in English.
One class period daily for a full year

PREREQUISITES

None.

ASSURED STUDENT PERFORMANCE RUBRICS

- Trumbull High School School-Wide Reading Rubric
- Trumbull High School School-Wide Writing Rubric
- Trumbull High School School-Wide Independent Learning and Thinking Rubric
- English 9 Writing Rubric
- English 9 Speaking & Listening/Shared Inquiry Rubric

SCHOOL-WIDE RUBRICS

Rubric 1: Read Effectively

Category/ Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Respond X_____	Demonstrates exceptional understanding of text by: • Clearly identifying the purpose of the text • Providing initial reaction richly supported by text 🎬 Providing a perceptive interpretation	Demonstrates understanding of text by: • Identifying the fundamental purpose of the text • Providing initial reaction supported by text • Providing a clear/straightforward interpretation of the text	Demonstrates general understanding of text by: • Partially identifying the purpose of the text • Providing initial reaction somewhat supported by text • Providing a superficial interpretation of the text	Demonstrates limited or no understanding of text by: • Not identifying the purpose of the text 🎬 Providing initial reaction not supported by text • Providing an interpretation not supported by the text
Interpret X_____	Demonstrates exceptional interpretation of text by: • Extensively reshaping, reflecting, revising, and/or deepening initial understanding 🎬 Constructing insightful and perceptive ideas about the text. • Actively raising critical questions and exploring multiple interpretations of the text	Demonstrates ability to interpret text by: • Reshaping, reflecting, revising, and/or deepening initial understanding • Summarizing main ideas of text 🎬 Actively interpreting text by raising questions and looking for answers in text	Demonstrates general ability to interpret text by: • Guided reflection and/or revision of initial understanding • Summarizing some of the main ideas of text • Guided interpretation of text by locating answers to given questions in text	Demonstrates limited ability to interpret text as evidenced by: • Struggle to implement guided reflection and/or revision of initial understanding • Struggle to summarize any main ideas of text • Struggle to answer questions by locating responses in text
Connect X_____	Demonstrates perceptive connections • text-to-text	Demonstrates specific connections 🎬 text-to-text	Demonstrates general connections • text-to-text • text-to-self	Struggles to make connections 🎬 text-to-text • text-to-self

	• text-to-self • text-to-world	• text-to-self • text-to-world	• text-to-world	• text-to-world
Evaluate X_____	Demonstrates insightful evaluation of text by one or more of the following: • Critical analysis to create a conclusion supported by the text Perceptive judgments about the quality of the text • Synthesis of text • Expression of a personal opinion	Demonstrates an evaluation of text by one or more of the following: • Critical analysis to form a conclusion from the text • Thoughtful judgments about the quality of the text • Evaluation of text to express personal opinion(s)	Demonstrates a general evaluation of text by one or more of the following: • Formulation of a superficial conclusion from the text • Assessment of the quality of the text • Use of text to express personal opinion(s)	Demonstrates a struggle to evaluate the text by one or more of the following: • Formulation of a conclusion from the text • Assessment of the quality of the text • Use of text to express personal opinion(s)

Rubric 2: Write Effectively

Category/ Weight	Exemplary 4 Student work:	Goal 3 Student work:	Working Toward Goal 2 Student work:	Needs Support 1-0 Student work:
Purpose X_____	• Establishes and maintains a clear purpose • Demonstrates an insightful understanding of audience and task	• Establishes and maintains a purpose • Demonstrates an accurate awareness of audience and task	• Establishes a purpose • Demonstrates an awareness of audience and task	Does not establish a clear purpose Demonstrates limited/no awareness of audience and task
Organization X_____	• Reflects sophisticated organization throughout • Demonstrates logical progression of ideas • Maintains a clear focus • Utilizes effective transitions	• Reflects organization throughout • Demonstrates logical progression of ideas • Maintains a focus • Utilizes transitions	• Reflects some organization throughout • Demonstrates logical progression of ideas at times • Maintains a vague focus • May utilize some ineffective transitions	• Reflects little/no organization Lacks logical progression of ideas Maintains little/no focus • Utilizes ineffective or no transitions
Content X_____	• Is accurate, explicit, and vivid • Exhibits ideas that are highly developed and enhanced by specific details and examples	• Is accurate and relevant • Exhibits ideas that are developed and supported by details and examples	• May contain some inaccuracies • Exhibits ideas that are partially supported by details and examples	• Is inaccurate and unclear • Exhibits limited/no ideas supported by specific details and examples
Use of Language X_____	• Demonstrates excellent use of language • Demonstrates a highly effective use of standard writing that enhances communication • Contains few or no errors. Errors do not detract from meaning	• Demonstrates competent use of language • Demonstrates effective use of standard writing conventions • Contains few errors. Most errors do not detract from meaning	• Demonstrates use of language • Demonstrates use of standard writing conventions • Contains errors that detract from meaning	• Demonstrates limited competency in use of language • Demonstrates limited use of standard writing conventions • Contains errors that make it difficult to determine meaning

Rubric 5: Independent Learners And Thinkers

Category/ Weight	Exemplary 4	Goal 3	Working Toward Goal 2	Needs Support 1-0
Proposal X_____	Student demonstrates a strong sense of initiative by generating compelling questions, creating uniquely original projects/work.	Student demonstrates initiative by generating appropriate questions, creating original projects/work.	Student demonstrates some initiative by generating questions, creating appropriate projects/work.	Student demonstrates limited or no initiative by generating few questions and creating projects/work.
Independent Research & Development X_____	Student is analytical, insightful, and works independently to reach a solution.	Student is analytical, and works productively to reach a solution.	Student reaches a solution with direction.	Student is unable to reach a solution without consistent assistance.
Presentation of Finished Product X_____	Presentation shows compelling evidence of an independent learner and thinker. Solution shows deep understanding of the problem and its components. Solution shows extensive and appropriate application of 21st Century Skills.	Presentation shows clear evidence of an independent learner and thinker. Solution shows adequate understanding of the problem and its components. Solution shows adequate application of 21st Century Skills.	Presentation shows some evidence of an independent learner and thinker. Solution shows some understanding of the problem and its components. Solution shows some application of 21st Century Skills.	Presentation shows limited or no evidence of an independent learner and thinker. Solution shows limited or no understanding of the problem. Solution shows limited or no application of 21st Century Skills.

ENGLISH DEPARTMENT WRITING RUBRIC

	Claim/Thesis	Evidence	Explanation	Writing Conventions
Exemplary (4)	Claim is clear, specific, and expresses a complex argument. It opens divergent, insightful understanding of the text.	Convincing evidence (not previously discussed in class/not obvious within the text) supports the claim. Quotes are incorporated seamlessly with appropriate introductory context.	Ideas are insightful and the explanation of thinking demonstrates a clear, thorough, and convincing connection between the evidence and the claim. Explanation thoroughly answers the questions "How do you know? and "So what?"	Writing demonstrates purposeful organization, clear coherence, and smooth progression of ideas. The writer uses appropriate language for his/her audience and purpose. The piece is free of most errors in grammar and mechanics. Quotes are cited according to MLA style.
Proficient (3)	Claim is clear, specific, and states an arguable interpretation of text.	Evidence (quotes or well-selected paraphrase previously discussed in class/more obvious within the text) adequately supports the claim. Quotes are incorporated with appropriate introductory context.	Ideas are explained adequately and connect the evidence to the claim. Explanation adequately answers the questions "How do you know?" and/or "So what?"	Writing demonstrates adequate organization, coherence, and progression of ideas. The writer uses appropriate but inconsistent language for audience and purpose. Grammatical and mechanical errors are present. Inconsistent use of correct MLA citation.
Progressing (2)	Claim attempts to demonstrate an interpretation of the text but may not be arguable and/or may not be focused on or fully addressed the prompt.	Evidence is present but may not clearly support the claim, may be more focused on repeating the claim rather than supporting it, or may merely reference a plot point. Quotes are not introduced with appropriate context.	Ideas display gaps in thinking or may merely repeat the claim or evidence. Explanation attempts to connect evidence to claim but is inadequate and/or not convincing. Explanation does not answer the questions "How do you know?" and "So what?"	Writing demonstrates limited organization with lapses in coherence and/or progression of ideas. The writer uses informal language for audience and purpose. An accumulation of grammatical and mechanical errors is present. MLA citation is incorrect.

Emerging (1)	Claim is unclear, rooted in inaccuracies, and/or a statement of fact. It does not set up an interpretation for the response.	Evidence is not present or not clearly referenced and/or not relevant to the claim. If used, evidence may simply restate a plot point (summary).	Explanation is not present, may be unrelated to claim and evidence, and/or introduces no new thinking to the response. Explanation may offer discussion about topic(s) that is unrelated to the evidence and claim.	Writing is disorganized and/or unfocused with pervasive errors in grammar and mechanics that interfere with meaning. MLA citation is not used.
(0)	Unacceptable / No Score	Unacceptable / No Score	Unacceptable / No Score	Unacceptable / No Score

SHARED INQUIRY DISCUSSION RUBRIC

	4	3	2	1	0 – unscorable
Involvement	Engagement is highly attentive and effective, responding clearly and directly to the thoughts of others. Involvement is passionate, well-balanced, and coherent. Critical questions advance the conversation, build on the ideas of peers, and offer challenging statements without being argumentative. Discourse is courteous, respectful, and genuinely interested; engagement is tempered with appreciation for a balanced discussion.	Engagement is attentive and active. Ideas are presented and correlate to the thoughts of others. Discourse is responsive, open minded, and respectful without monopolizing.	Engagement is attentive and respectful, marked by attempts to be active in the discussion. Contributions are present but may repeat ideas rather than further the discussion. Ideas are "presented," rather than discussed, or may struggle to build off of the ideas of others. The conversation may need a greater balance of talking and listening to others.	Full engagement in discourse is not evident, doing little to contribute to the conversation or build off of the ideas of the group. The ideas center around initial responses with little evidence of reshaping ideas based on the discourse. Contributions may confound or derail the discussion.	No involvement in the discussion, demonstrated by being disengaged, silent, or responding inappropriately to the ideas of others.
Ideas and Analysis	Original and insightful questions and comments continually reflect sophisticated comprehension and higher-level thinking. Creative and divergent critical thinking is consistently displayed. Ideas are challenged, bringing the class to a higher understanding of the text and the question at hand.	Questions and comments reflect clear comprehension and higher level thinking. Creative and divergent critical thinking is present. The ideas of others are respectfully challenged during the discussion.	Questions and comments reflect inconsistent higher-level thinking and/or muddied comprehension of the text or the question. Ideas may be one sided or based mainly on superficial observations. Investment of time is in supporting the obvious or rehashing prior class discussions without deepening thought.	Questions and comments may demonstrate only a very literal or misguided comprehension of the text, missing subtleties or nuances that are important. Ideas presented do not assist the group in exploring critical thought or building ideas collaboratively and may, ultimately, hold it back.	Comments, if any, reflect a flawed or incomplete understanding of the text.

Support	Clear and convincing evidence supports each assertion and effectively builds off of the ideas of others. Text evidence deepens analysis and ties directly to a clear and relevant argument. Comments refer to specific pages and/or lines in the text; quotes are read or paraphrased when appropriate, and followed up with explanation of thinking. Exemplary facility with the text is demonstrated.	Direct quotes and specific examples to support inferential ideas are introduced. Comments refer to specific pages and/or lines in the text; quotes are read and/or paraphrased when appropriate. Examples are given and stay on topic. Some facility with the text is demonstrated.	Examples from the text are used at times. Text evidence may be vague, inconsistent, repetitive, or nonessential to the argument at hand. Facility with the text is limited to only quotes prepared beforehand.	Little to no concrete evidence from the text is introduced. Examples are not specific enough, and/or demonstrate a misreading or very cursory reading of the text.	No concrete evidence from the text is utilized.
Preparation	Participation is exceptionally well-prepared. Copious and insightful notes on the reading have been taken and developed. Original and powerful questions have been developed prior to the discussion. All required materials have been brought to class.	Participation is well-prepared. Insightful notes and thoughtful questions have been developed. All required materials have been brought to class.	Required reading, thinking, and questions have been completed. Some notes and questions have been developed prior to the discussion. Some required materials have been brought to class.	Preparation is lacking. The required reading, thinking, or questions may be incomplete or rudimentary. There may be evidence of some preparation, but all materials have not been brought to class.	No preparation is evident.
Reflection	Reflection is insightful, honest, and comprehensive, making specific reference to the discussion and individual preparation, demonstrating how the	Reflection is intelligent, honest, and complete, making a mix of general and specific references to the discussion and individual	Reflection is emerging, making mostly general references to the discussion and individual preparation, which may	Reflection is confusing, unfocused, and/or sparse, making few references to the discussion or individual preparation, lacking	Reflection is limited and incomplete, making little to no specific reference to the discussion and individual

	discussion impacted individual thinking, and demonstrating authentic thinking and a strong desire for self-improvement in future discussions.	preparation, demonstrating some authentic thinking and the desire for self-improvement in future discussions.	or may not be accurate, demonstrating an attempt at authentic thinking and the recognition of a need for self- improvement in future discussions.	authentic thinking and apparent desire for self-improvement in future discussions.	preparation, and devoid of both authentic thinking and the desire for self-improvement in future discussions.