

Wilson Area School District Planned Course Guide

Title of planned course: Advanced Science Studies

Subject Area: Science

Grade Level: 9-12

Course Description: This rigorous laboratory based course includes a detailed study of various critical topics within the major disciplines of science. The emphasis of the course is to build experience in good laboratory practices tailored to augment their current science course. As such, students taking AP Biology will be conducting advanced biology experiments, students in AP Chemistry will be conducting advanced chemistry experiments, and so on. There will be some assignments common to all students. Each student will be required to maintain an accurate laboratory notebook throughout the year. The course is recommended for students interested in a potential career in science, are taking a science AP level course, or the student who has a keen interest in going into depth and conducting laboratory experiments in a scientific discipline of their choice.

Time/Credit for this Course: One Full Academic Year / 1.0 credit

Curriculum Writing Committee: Paul Stewart

Curriculum Map

August:

- Measurement and significant figures
- Creating and organizing lab reports
- Safety procedures

September:

- Holistic Sciences
- Stress test of organic vs inorganic materials
- Pressure and volume relationships and SCUBA
- Flow of fluids through blood vessels and pipes
- Track Selection

October:

- Physics Track:
 - Understanding velocity and acceleration
 - Importance of velocity as a vector quantity
- Chemistry Track:
 - Chemical and Physical Properties
 - Atomic Structure
- Biology Track:
 - Operating a microscope
 - Examination of cheek cells and staining techniques
 - Tissue Types and Cancer Diagnosis

November:

- Physics Track:
 - Rocket Design - two stages?
 - Model Rocket Launch
 - Free Fall
- Chemistry Track:
 - The mole concept
 - Spectrophotometry
- Biology Track:
 - Cellular Transport and Osmotic Pressure
 - Photosynthesis

December:

- Physics Track: Newton's First Law
- Chemistry Track: Separations
- Biology Track:
 - Meiosis and Mitosis
 - Enzyme Catalysis

January:

- Physics Track: Newton's Second Law
- Chemistry Track: Kinetics
- Biology Track:
 - Cellular Respiration
 - Transpiration

February:

- Physics Track:
 - Newton's Third Law
 - Vectors and Forces
- Chemistry Track: Acid/Base Equilibria
- Biology Track: Genetics - population and organismal

March:

- Physics Track:
 - Circular Motion and gravitation
 - Astronomy
- Chemistry Track:
 - Calorimetry
 - Electrochemistry
- Biology Track
 - Dissolved oxygen and productivity
 - Water analysis

April:

- Physics Track: Energy and Momentum
- Chemistry Track:
 - Finding molar mass of acid
 - Creating an activity series of metals
- Biology Track: PCR technique and hardy weinburg

May:

Reconvene

- Science on the edge
 - Cancer treatment
 - FRB's
 - Gravity Waves
 - Organic Reactions

Curriculum Scope & Sequence

Planned Course: Advanced Science Studies

Unit: Scientific Measurement and Communication

Time frame: 3 weeks (8 classes)

State Standards: 3.1.10.A9, 3.1.P.A9, 3.1.P.B6, 3.1.12.C4, 3.2.10.A1, 3.2.10.A3, 3.2.C.A43.2.12.B3

Assessment Anchors: BIO.B.3.3

Essential content/objectives: At the end of the unit, students will be able to:

- Measure mass, volume, temperature, time, and length measurements using a wide variety of instruments
- Record their data in the proper number of significant figures
- Properly document their work in a laboratory notebook (electronic) with tables, graphs, and figures where appropriate
- Analyze and critique their own work and others

Core Activities: Students will complete/participate in the following:

- Accurately measure a number of different volumes requiring different instruments
- Use different balances and different glassware to find the density of a material
- Determine the mass of air in the room

Extensions:

- <https://www.warrencountyschools.org/userfiles/2268/Classes/12006/measurement%20virtual%20labs%20pdf.pdf?id=619464>

Remediation: Screencasts

Instructional Methods:

- Direct instruction
- Cooperative learning labs / activities
- Teacher and student led class discussions

Materials & Resources:

- Laboratory glassware and balances
- Chromebooks

Assessments:

- Edpuzzle
- Lab reports
- Quizizz

Curriculum Scope & Sequence

Planned Course: Advanced Science Studies

Unit: Congruence of the Sciences

Time frame: 3 weeks (7 classes)

State Standards: 3.1.10.A7, 3.1.P.B6, 3.2.10.A1, 3.2.10.A3, 3.2.10.B1

Assessment Anchors: CHEM.B.2.2.13.2.P.B2 3.2.12B2 3.2.12.B63.2.P.B2 3.2.12B2 3.2.12.B6

Essential content/objectives: At the end of the unit, students will be able to:

- Conduct investigations into various phenomena that require the synthesis of knowledge across disciplines. Examples include:
 - Construction of ballistics gel or crash test dummies
 - Analyze wood vs bone vs metal vs plastic
 - The relationships of pressure and volume and breathing and design of SCUBA equipment
 - Analyze the flow of fluids through human arteries and veins and relate this to viscosity and high blood pressure

Core Activities: Students will complete/participate in the following:

- Calculate the flow rate of a liquid through different diameter hoses
- Perform stress tests of organic vs inorganic materials
- Design a pair of lungs

Extensions:

- <https://scied.ucar.edu/interactive/pressure-flow-water-tanks-virtual-lab>
- <https://phet.colorado.edu/sims/cheerpj/fluid-pressure-and-flow/latest/fluid-pressure-and-flow.html?simulation=fluid-pressure-and-flow>

Remediation: Screencasts

Instructional Methods:

- Direct instruction
- Cooperative learning labs / activities
- Teacher and student led class discussions

Materials & Resources:

- Laboratory glassware and balances
- Chromebooks

Assessments:

- Edpuzzle
- Lab reports
- Quizizz

Curriculum Scope & Sequence

Planned Course: Advanced Science Studies

Unit: Specialization 1
Physics - Kinematics
Chemistry - Physical and Chemical Properties
Biology - Microscopes, cells, and tissues

Time frame: 3.5 weeks (8 classes)

State Standards: 3.1.P.B6, 3.2.10.A1, 3.2.10.A3 3.2.P.B1

Anchor(s) or adopted anchor: 3.1.12.B1, 3.1.12.B3, 3.1.12.B5, 3.1.12.C2, CHEM.A.1.2
3.2.10.B13.2.P.B2 3.2.12B2 3.2.12.B63.2.P.B2 3.2.12B2 3.2.12.B6

Essential content/objectives: At the end of the unit, students will be able to:

Physics:

- Measure velocity laboratory
- Measure changes in velocity at intervals (acceleration)
- Compare velocity measurement techniques
- Create Position/Time graphs for various motions (back, forward, slowing, accelerating, constant)

Chemistry:

- Measure different boiling points, hypothesize what is happening at the molecular level, and determine if that theory explains the observations
- Determine if density is an intensive or extensive property
- Use a measured density to approximate the volume of a material
- Perform precipitation reactions and hypothesize what is occurring at the molecular level and make predictions based on observations
- Perform electrolysis on water and hypothesize how what is occurring is both similar AND different than the boiling of water

Biology:

- Examine organisms using a dissecting microscope and a compound light microscope
- Measure the relative sizes of cells in a compound light microscope at different magnifications
- Differentiate between different tissue types
- Prepare proper slides using established staining techniques
- Make cancer diagnosis and staging by examining tissue samples

Core Activities: Students will complete/participate in the following:

- Related lab activities and report preparation
- Edpuzzle videos with assessment questions
- Quizizz

Extensions:

- https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_en.html
- <https://ny.pbslearningmedia.org/resource/phy03.sci.phys.mfw.accel/virtual-car-velocity-and-acceleration/>

Remediation:

- Screencasts
- Edpuzzle Videos

Instructional Methods:

- Direct instruction
- Cooperative learning labs / activities
- Teacher and student led class discussions

Materials & Resources:

- Laboratory glassware and balances
- Chromebooks

Assessments:

- Edpuzzle
- Lab reports
- Quizizz

Curriculum Scope & Sequence

Planned Course: Advanced Science Studies

Unit: Specialization 2

Time frame: 3.5 weeks (8 classes)

State Standards: 3.1.P.B6, 3.2.10.A1, 3.2.10.A3, 3.2.10.A5, 3.2.12.A2, 3.2.10.B1 3.2.P.B1

Anchor(s) or adopted anchor: CHEM.A.2.1, CHEM.A.2.1 CHEM.A.2.2, CHEM.A.2.2.43.2.P.B2
3.2.12B2 3.2.12.B6 3.2.P.B2 3.2.12B2 3.2.12.B6

Essential content/objectives: At the end of the unit, students will be able to:

Physics:

- Design a two stage rocket and evaluate in terms of position/time and velocity/time
- Perform a free fall lab and calculate rectilinear motion
- Determine what affects terminal velocity
- Interpret position/time and velocity vs time graphs
- Determine why things break when dropped

Chemistry:

- Create and observe stability of various isotopes of elements
- <https://phet.colorado.edu/en/simulation/isotopes-and-atomic-mass>
- Calculate the wavelength of hydrogen spectral lines using a diffraction grating
- Use flame tests to determine which elements are present in an unknown
- Determine the absorption spectra for an ion and hypothesize why not all wavelengths are absorbed

Biology:

- Observe osmosis through semi-permeable membrane
- Calculate water potential
- Analyze relationship between solute size and permeability
- Examine conditions of photosynthesis under different conditions

Core Activities: Students will complete/participate in the following:

- Related lab activities and report preparation
- Edpuzzle videos with assessment questions
- Quizizz

Extensions:

- <http://smartgraphs-activities.concord.org/act4-5.html#/shared/gravity>
- <https://phet.colorado.edu/sims/cheerpj/hydrogen-atom/latest/hydrogen-atom.html?simulation=hydrogen-atom>
- <http://amrita.olabs.edu.in/?sub=79&brch=16&sim=126&cnt=4>

Remediation:

- Screencasts
- Edpuzzle Videos

Instructional Methods:

- Direct instruction
- Cooperative learning labs / activities
- Teacher and student led class discussions

Materials & Resources:

- Laboratory glassware and balances
- Chromebooks

Assessments:

- Edpuzzle
- Lab reports
- Quizizz

Curriculum Scope & Sequence

Planned Course: Advanced Science Studies

Unit: Specialization 3

Time frame: 3.5 weeks (8 classes)

State Standards: 3.1.B.B2, 3.1.P.B6, 3.2.10.A1,3.2.10.A3 , 3.2.10.B1 3.2.P.B1

Anchor(s) or adopted anchor: BIO.B.1.1, BIO.B.1.2.2, CHEM.B.2.2.2, CHEM.B.1.1 3.2.P.B2
3.2.12B2 3.2.12.B63.2.P.B2 3.2.12B2 3.2.12.B6

Essential content/objectives: At the end of the unit, students will be able to:

Physics:

- Understand the motion of water around an oval track - Newton's 1st Law
- Explain how objects behave in frictionless environments and planetary motion - Newton's 1st law
- Describe the effect of gravity on a mass - Newton's 2nd Law
- Examine a non-constant force on an object and how this influences its speed, acceleration, and position - Newton's 2nd Law

Chemistry:

- Determine how the mole was "defined" and why it is essential for counting small things like molecules and atoms
- Determine the empirical formula of:
 - Hydrated crystal
 - Binary ionic compound
- Use mole ratios to make laboratory measurements of various compounds created in chemical reactions
- Determine the % yield of a reaction
- Determine the % by mass of an element in a compound
- Prepare solutions of a certain molarity from:
 - Grams of materials
 - Stock solutions of a given material
- Predict the effect of temperature on solution concentration
- Model what a solution looks like on paper and simulation
- Use solutions of known molarities to determine a limiting reactant

Biology:

- Observe meiosis and mitosis under a microscope and identify the phases
- Calculate the relative time a cell spends in the different phases of the cell cycle
- Create a model of bacterial conjugation
- Observe and compare gametes
- Design enzyme catalysis lab choosing substrate, methods for reaction rate determination and effect of temperature and pH on enzyme activity
- Create a model of an enzyme

Core Activities: Students will complete/participate in the following:

- Related lab activities and report preparation
- Edpuzzle videos with assessment questions
- Quizizz

Extensions:

- https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_en.html
- https://phet.colorado.edu/sims/html/reactants-products-and-leftovers/latest/reactants-products-and-leftovers_en.html
- <https://www.youtube.com/watch?v=mhKTvHQVYDw>

Remediation:

- Screencasts
- Edpuzzle Videos

Instructional Methods:

- Direct instruction
- Cooperative learning labs / activities
- Teacher and student led class discussions

Materials & Resources:

- Laboratory glassware and balances
- Chromebooks

Assessments:

- Edpuzzle
- Lab reports
- Quizizz

Curriculum Scope & Sequence

Planned Course: Advanced Science Studies

Unit: Specialization 4

Time frame: 3.5 weeks (8 classes)

State Standards: 3.1.P.B6, 3.2.10.A1, 3.2.10.A3, 3.2.10.B1

Anchor(s) or adopted anchor: 3.1.10.A5, 3.1.12.A5, 3.1.12.A6, 3.1.12.A8, CHEM.B.2.1.1 3.2.P.B2
3.2.12B2 3.2.12.B6 3.2.P.B2 3.2.12B2 3.2.12.B6

Essential content/objectives: At the end of the unit, students will be able to:

Physics:

- Analyze the factors affecting a falling coffee filter and opposing or additive forces - Newton's 3rd law
- Examine sneaker soles with regard to static and sliding friction AND with regards to lateral and longitudinal motion
- Determine the breaking strength of a string...Newton's 3rd Law
- Diagram opposing forces and use one to find the other...force applied to spring

Chemistry:

- Operate a spectrophotometer properly to create a standardized curve for a variety of materials
- Operate a spectrophotometer properly to determine accurate absorption spectra for a variety of materials
- Use a spectrophotometer to determine the identity AND concentration of an unknown
- Examine potential sources of error
- Monitor a chemical reaction using spectrophotometry and create a concentration vs time plot
- Decant a mixture using a separation funnel
- Perform liquid chromatography on a mixture of plant pigments and ink and hypothesize relative polarities of molecules
- Perform electrophoresis on DNA strands and propose hypothesis as to why one strand went farther than the other
- Perform a distillation of alcohol and water and explain why the technique works
- Choose between filtration and evaporation to purify products of precipitation reactions

Biology:

- Examine the factors affecting cellular respiration rate and materials needed for the process
- Design a lab that will force fermentation and how this can create either sugar or alcohol
- Determine if plants give off CO₂ and oxygen or are they used right away
- Examine day/night cycles on cellular respiration and dissolved gases
- Analyze the factors affecting transpiration and the roles this plays in the ecosystem

Core Activities: Students will complete/participate in the following:

- Related lab activities and report preparation
- Edpuzzle videos with assessment questions
- Quizizz

Extensions:

- <https://www.biologysimulations.com/cell-energy-sim>
- <https://vlab.amrita.edu/?sub=2&brch=190&sim=338&cnt=4>

- <https://www.thephysicsaviary.com/Physics/Programs/Labs/ForceFriction/>

Remediation:

- Screencasts
- Edpuzzle Videos

Instructional Methods:

- Direct instruction
- Cooperative learning labs / activities
- Teacher and student led class discussions

Materials & Resources:

- Laboratory glassware and balances
- Chromebooks

Assessments:

- Edpuzzle
- Lab reports
- Quizizz

Curriculum Scope & Sequence

Planned Course: Advanced Science Studies

Unit: Specialization 5

Time frame: 3.5 weeks (8 classes)

State Standards: 3.1.B.B5, 3.1.B.B6, 3.1.P.B6, 3.1.12.C4, 3.2.10.A1, 3.2.10.A3

Anchor(s) or adopted anchor: BIO.B.1.2, BIO.B.3.1, 3.1.12.C1, 3.1.12.C2, 3.1.12.C3, BIO.B.3.13.2.P.B2 3.2.12B2 3.2.12.B63.2.P.B2 3.2.12B2 3.2.12.B6

Essential content/objectives: At the end of the unit, students will be able to:

Physics:

- Determine how far to another room “as the crow flies” using displacements
- Examine where a student will be if various displacements are induced
- Analyze where a boat will be as it crosses a river by examining displacements
- Analyze a horizontally launched projectile and predict its landing cone. Determination of the launch speed of projector
- Hit the target lab by evaluating the launch angle and launch speed needed to reach the target
- Examine the theoretical and actual tension of a string supporting a sign and examine the effects of mass and string angle
- Synthesize the previously recorded data on the breaking tension of a string to determine its maximum load

Chemistry

- Measure the effect of temperature of the rate of reaction
- Examine different ways to measure the rate of reaction such as change in mass over time and spectroscopy
- Demonstrate the effectiveness of enzymes AND that they are not used in a reaction AND why they must be included in the rate law
- Change the concentration of reactants to determine the order relative to that reactant

Biology:

- Grow drosophila thru P → F2 generations and examine predictions
- Look for phenotypic variation in a population
- Model hardy weinberg equilibrium in a population
- Design an experiment to test a changing environment on seed germination
- Study examples of the founder effect and bottleneck effect
- Calculate Chi Square
- Create a pedigree

Core Activities: Students will complete/participate in the following:

- Related lab activities and report preparation
- Edpuzzle videos with assessment questions
- Quizizz

Extensions:

- <https://phet.colorado.edu/en/simulation/vector-addition>
- <https://teachchemistry.org/classroom-resources/reaction-rates-simulation>
- <http://virtualbiologylab.org/population-genetics/>

Remediation:

- Screencasts
- Edpuzzle Videos

Instructional Methods:

- Direct instruction
- Cooperative learning labs / activities
- Teacher and student led class discussions

Materials & Resources:

- Laboratory glassware and balances
- Chromebooks

Assessments:

- Edpuzzle
- Lab reports
- Quizizz

Curriculum Scope & Sequence

Planned Course: Advanced Science Studies

Unit: Specialization 6

Time frame: 3.5 weeks (8 classes)

State Standards: 3.1.12.B4, 3.1.12.B6, 3.1.B.B4, 3.1.P.B6, 3.2.10.A1, 3.2.10.A3 3.2.12.A4
3.2.10.B4,3.2.12.B13.2.P.B2 3.2.P.B63.3.12.B2

Anchor(s) or adopted anchor: 3.1.12.B1, 3.1.12.B3, 3.1.12.B5, 3.1.12.C2, 3.2.P.B2 3.2.12B2
3.2.12.B63.2.P.B2 3.2.12B2 3.2.12.B6

Essential content/objectives: At the end of the unit, students will be able to:

Physics:

- Examine rotational motion and forces involved
- Observe the relationship between speed and motion relative to a force
- Calculate both centripetal force and centrifugal force and create a poster presentation that explains the difference
- Analyze the orbits and speeds of planets around the sun and create predictions

Chemistry:

- Measure the pH of different common solutions and correlate to magnitude of acidity and ion concentrations
- Hypothesize how a pH meter works
- Use the pH to find the Ka of an acid and % ionization
- Examine how the % ionization of an acid is affected by concentration and provide a hypothesis for this phenomena
- Create a titration curve by monitoring the pH over time during a titration and use this to find the Ka of an acid
- Use derivative plot to find the equivalence point and $\frac{1}{2}$ equivalence point
- Determine which indicators will work best with each titration depending on the acid and base
- Prepare and test buffers of different pH's and concentrations
- Calculate the heat of solution in kJ/mol using a coffee cup calorimeter
- Calculate the heat of fusion of water using a backpacking stove
- Determine the specific heat of a metal using a coffee cup calorimeter
- Predict a temperature change based on the masses and specific heats of the materials
- Propose and design an experiment to calculate dH for a neutralization reaction
- Nickel plate a wire using electrolysis and examine the role of current in the time of reaction
- Design a galvanic cell and test the voltage difference and use the galvanic cell to charge a battery/light a bulb

Biology:

- Collect DNA samples and cleave with restriction enzymes
- Perform gel electrophoresis
- Complete a PCR with a small sample of DNA and analyze the results for a crime scene
- Complete a thorough water analysis included DO, pH, salinity, and productivity

Core Activities: Students will complete/participate in the following:

- Related lab activities and report preparation
- Edpuzzle videos with assessment questions
- Quizizz

Extensions:

- <https://www.thephysicsaviary.com/Physics/Programs/Labs/ClassicCircularForceLab/>
- <https://virtual.edu.rsc.org/titration/experiment/2>
- <https://www.biointeractive.org/classroom-resources/bacterial-identification-virtual-lab>

Remediation:

- Screencasts
- Edpuzzle Videos

Instructional Methods:

- Direct instruction
- Cooperative learning labs / activities
- Teacher and student led class discussions

Materials & Resources:

- Laboratory glassware and balances
- Chromebooks

Assessments:

- Edpuzzle
- Lab reports
- Quizizz

Curriculum Scope & Sequence

Planned Course: Advanced Science Studies

Unit: Reconvene

Time frame: 3.5 weeks (8 classes)

State Standards: 3.1.P.B6,3.2.10.A1

Anchor(s) or adopted anchor: 3.2.P.B2 3.2.12B2 3.2.12.B63.2.P.B2 3.2.12B2 3.2.12.B6

Essential content/objectives: At the end of the unit, students will be able to:

- Present on a scientific paper of their interest
- Prepare a poster to draw attention to their field and display

Core Activities: Students will complete/participate in the following:

- Related lab activities and report preparation
- Edpuzzle videos with assessment questions
- Quizizz

Remediation:

- Screencasts
- Edpuzzle Videos

Instructional Methods:

- Direct instruction
- Cooperative learning labs / activities
- Teacher and student led class discussions
- Library Assess and Research Skills

Materials & Resources:

- Laboratory glassware and balances
- Chromebooks

Assessments:

- Edpuzzle
- Lab reports
- Quizizz