Fairbanks North Star Borough School District
Board Curriculum Committee
AGENDA

Date: September 7, 2023 at 5:30 p.m.
Location:

- In-person: FNSBSD Administrative Center, 520 Fifth Avenue, Boardroom, Fairbanks, AK 99701
  - Join through Zoom: https://us02web.zoom.us/j/83771652124?pwd=eVlIOFFNMEtpaVB4QmlOaHhKVnpIUT09
- Participate by phone:

1-888-788-0099 (Toll Free) Webinar ID: 837 7165 2124 *6 mutes and unmutes.
1-877 853 5247 (Toll Free) *9 raises a caller's hand.

A. PRELIMINARIES

1. **Call to Order**
2. **Land Acknowledgement Statement**: As a standing committee of the School Board, we would like to take this moment to acknowledge we are residing on the traditional land of the Dena (pronounced duhNAY) people.
3. **Mission Statement**: Our mission is to provide an excellent, equitable education in a safe, supportive environment so all students will succeed and contribute to a diverse and changing society.
4. **Roll Call**

Leslie Greenfield	Renee Peterson	**Nonvoting Members**
Loa Hubbard	Suzanne Richards	Chane Beam
Matt Mertes	Alexis Walker	Melissa Burnett
Devra Norling		

B. APPROVAL OF AGENDA

- Recommend approval of the meeting agenda for September 7, 2023.

C. APPROVAL OF MINUTES

- Recommend approval of the meeting minutes for April 20, 2023.

D. COMMITTEE INFORMATION

- 2023-24 Meeting Schedule
- Board Curriculum Committee Information Sheet
- Alaska Open Meetings Act and Robert's Rules of Order

E. CURRICULUM PROCESS

- Administrative Regulations 910 – FNSBSD Curriculum Cycle
- Draft Curriculum Calendar
  - Art, Music, and World Language
- CTE Curriculum

F. SCIENCE CURRICULUM

- Draft 1 of Science Curriculum for grades 6-12
- Summary of Public Comment
- Timeline for Draft Two

G. GENERAL COMMENTS/ QUESTIONS

H. ADJOURNMENT

Upcoming Board Curriculum Committee Meetings

October 5, 2023	January 11, 2024	April 4, 2024
November 2, 2023	February 1, 2024	April 18, 2024 (tentative)
December 7, 2023 (tentative)	March 7, 2024	

Fairbanks North Star Borough School District
Board Curriculum Committee

Minutes of April 20, 2023

Ms. Burnett called the meeting to order at 5:33 p.m. in the FNSBSD Administrative Center boardroom, 520 Fifth Avenue, Fairbanks, AK.

Members Present:

Kristen Dullen
Elizabeth Greninger
Loa Hubbard
Earnest Kincade
Raul Lopez
Devra Norling
Jeffery Porter
Graham Storey

Nonvoting Members:

Chane Beam
Melissa Burnett

Members Absent:

Joyce Harris
Matt Mertes
Alexis Walker

Guests:

Michelle Daml
Rachel Reilly
Joni Simpson

Committee Support:

Jen Morgan

APPROVAL OF THE AGENDA

Mr. Porter moved to accept the April 20, 2023, agenda; Ms. Greninger seconded. Hearing no objection or comment, the motion was approved.

APPROVAL OF THE MINUTES

Ms. Devra moved to accept the minutes from the March 2, 2023, meeting; Mr. Porter seconded. Hearing no objection or comment, the minutes were approved.

CTE INFORMATION TECHNOLOGY CURRICULUM

Ms. Simpson explained that she brought the IT curriculum to the committee for their recommendation last year, and it was approved by the School Board. Since then, an error was discovered in the curriculum. Cybersecurity 1A does not need a prerequisite of *Computer Essentials 1A/1B;* IT classes can be taught in any order. Ben Eielson High School has taught Cybersecurity a couple of times, and the instructor has stated students do not need to complete the prerequisite to take Cybersecurity. Ms. Simpson asked the committee to recommend the removal of prerequisites for Cybersecurity 1A.

Ms. Hubbard moved to recommend the removal of prerequisites for Cybersecurity 1A; Mr. Kincade seconded. The motion carried.

MATERIALS RECOMMENDATION

ELA, Health, Physical Education, Science, and High School Statistics

Mr. Beam went over the materials process for elementary English Language Arts (ELA) materials, starting with information about the grant. He informed the committee that all elementary teachers were given the opportunity to look at sample materials and provide feedback, and the materials were made available for community input. Based on educator and community input, a decision was made to recommend *Into Reading* for kindergarten through fifth grade.

Mr. Beam then explained that educators were given the opportunity to look over sample materials at their schools for Health, Physical Education, Science, and High School Statistics. Parents and the community also had the opportunity to review the materials and provide feedback. Based on educator and community input, a decision was made to recommend adoption of new materials for 6th grade ELA, grades 6-12 Health, grades 6-12 Physical Education, grades 6-12 Science, and high school Statistics. Mr. Beam presented a list of materials recommendation for each of these courses and whether these will be purchased immediately or in the future.

Mr. Kincade moved to recommend the materials be adopted by the School Board; Mr. Porter seconded. The motion carried.

Recommendation Memo to the School Board

A draft memo based of previous committee memos was provided for the committee to use. Members looked over the draft and discussed changes. Ms. Daml mentioned that elementary science teachers had selected a sample textbook as their top choice, but the recommendation is to keep the current resource for grades kindergarten through fifth grade, due to budgetary constraints.

Ms. Norling moved to change the sentence on the memo under K-5 Science to "Keep current resource, due to budgetary constraints;" Mr. Porter seconded. The motion carried.

Ms. Greninger made a motion to add columns on the right side of the table that show which materials will be purchased this year and which will be purchased in future years; Ms. Norling seconded. The motion carried.

Ms. Hubbard moved to accept the draft memo with all changes in its entirety. The motion carried.

GENERAL COMMENTS/ QUESTIONS

Mr. Beam thanked the committee, and presented Mr. Lopez, the student council representative, a certificate. Mr. Beam recognized committee members who had completed their two year term on the committee: Ms. Dullen, Dr. Greninger, Mr. Porter, Mr. Kincade, and Ms. Harris. Mr. Beam then recognized Ms. Daml, who is retiring, as an extremely valuable person in the department, who is knowledgeable and experienced, and will be sorely missed.

Ms. Burnett thanked the committee for their time, diligence, patience, and for serving on the committee.

Ms. Greninger asked which seats on the committee are open and what they can do to help. Mr. Beam mentioned that a couple parent and community positions will become available, and the committee can spread the word and encourage others to join.

ADJOURNMENT

Mr. Porter moved to adjourn the meeting; Ms. Hubbard seconded. Hearing no objection or further comment, the meeting was adjourned 7:04 p.m.

Board Curriculum Committee
2023 – 2024 Meeting Schedule

Administrative Center
Boardroom (1st Floor)
520 Fifth Avenue, Fairbanks, AK 99701

Meeting time is 5:30 – 7:30

Thursday, September 7, 2023

Thursday, October 5, 2023

Thursday, November 2, 2023

Thursday, December 7, 2023 **(tentative)**

Thursday, January 11, 2024

Thursday, February 1, 2024

Thursday, March 7, 2024

Thursday, April 4, 2024

Thursday, April 18, 2024 **(tentative)**

Agenda packet is posted on the district website at www.k12northstar.org/Page/9908.

For questions or additional information, please contact
Jennifer Morgan
Material Development Specialist
Dept. of Teaching & Learning
452-2000, ext. 11421 or
jennifer.morgan@k12northstar.org.

Revised: June 19, 2023

Fairbanks North Star Borough School District

Board Curriculum Committee Information Sheet

The Board Curriculum Committee (BCC) is established in accordance with Policy 236.1 (School Board Committees to Advise Administration and the School Board) and Policy 910 (Curriculum Development). Administrative Regulation (AR) 236.1 details the structure of administrative committees, AR 910 outlines the process for curriculum development, AR 910.1 states a review of current needs and relevant educational research must be conducted prior to curriculum revision, and AR 910.3 establishes that revised curricula will be presented to the BCC.

MEMBERSHIP OF THE COMMITTEE:

The BCC consists of 17 members, including one non-voting School Board member assigned by the Board president to chair the committee and one non-voting administrative staff member assigned by the superintendent to provide support and act as chair in the absence of the assigned Board chair. The BCC also contains one elementary and one secondary principal assigned to the committee by the Fairbanks Principals' Association (FPA) president, one elementary and one secondary teacher assigned to the committee by the Fairbanks Education Association (FEA) president, one tribal consultation representative assigned to the committee by the Fairbanks Native Association executive director, and one student assigned by the Regional Student Council. Additionally, three parents and six community-at-large members are selected to participate on the BCC via an application process, with the final selection made by the Board chair. Voluntary BCC members are limited to membership on one committee. District employees may not serve on the BCC in the capacity of a parent or community member.

LENGTH OF TERMS:

The committee meets on the school year schedule; members' terms start in September and are completed in May.

- School Board chair - appointed annually (1 year term; 2 term limit)
- Administrative Staff Member – appointed annually (no term limit)
- Principals – appointed annually (1 year term; 2 term limit)
- Teachers – appointed annually (1 year term; 2 term limit)
- Student – appointed annually (1 year term; 1 term limit)
- Tribal Consultation Member – appointed (2 year term, 1 term limit)
- Parents – selected through application process (2 year term; 1 term limit)
- Community members – selected through application process (2 year term; 1 term limit)

A committee member that wants to continue to serve after reaching their term limit must allow one year to pass prior to reapplication or request for assignment.

STAFF TO THE COMMITTEE:

The superintendent may assign additional district staff to the BCC in order to provide support and resources as necessary. The additional staff are not voting members of the committee.

MEETINGS:

As a Board committee, a quorum is required for the committee to meet. All meeting procedures will follow *Robert's Rules of Order*, and the BCC is subject to the Alaska Open Meetings of Governmental Bodies Act (AS 44.62.310). Meetings will be held prior to presenting recommendations for adopting curriculum or textbooks/materials to the School Board. The meetings will be public, and public testimony is not taken during the meetings. Committee meetings will not be held during recognized school holidays or breaks, and if

school is cancelled such as for inclement weather.

ATTENDANCE:

If a voting member misses more than 50% of meetings for the current school year, that member may be dismissed and replaced by the school board chair.

SCOPE OF RESPONSIBILITIES:

The BCC will act in an advisory capacity regarding all aspects of curriculum development. The curriculum review process requires two separate and distinct actions to be taken by the Board: adoption of the curriculum and adoption of the textbooks/materials. The BCC will review each of these recommended actions prior to it being forwarded to the Board for adoption.

Curricular issues of interest to parents, students, and staff will be addressed by the BCC. The subject areas focused on each year will be the curricula identified for evaluation and development. Committee members will gain understanding of the curriculum development process and may provide input on curriculum development from a variety of perspectives. The BCC will receive information from the administration staff and/or curriculum committees regarding the revisions under consideration. The BCC also has the option to make a committee recommendation to the School Board.

REPORTING:

BCC meeting notes will be posted on the school district's website. Recommendations from the BCC will be presented to the School Board, as appropriate, by the Board chair via written reports.

Board Curriculum Committee
Quick Reference for AK Open Meetings Act & Robert's Rules

- Board committees are governed by:
  1. state statues and the Alaska Open Meetings Act (§44.62.310-319),
  2. school board policies and administrative regulations, and
  3. in the absence of either, the latest edition of Robert's Rules of Order.
- All meetings must be properly noticed to the public a minimum of five days prior to the meeting.
- The agenda is emailed to committee members and posted on the district website. It cannot be changed once posted unless there is time to properly re-notice the change (four days before meeting). New or additional items cannot be added to the agenda at the meeting, but items can be removed or rearranged.
- All business must be conducted at a properly noticed meeting - no business can be conducted through emails, texts, etc., including providing personal opinions or discussions. Group correspondence outside properly notices meetings could be a violation of the Alaska Open Meetings Act. Emails to the group on general committee operations or to provide one-way factual data/ information is allowed.
- A quorum (simple majority of currently filled membership) must be established to conduct business.
- Meetings are recorded for public record and audio is posted on the district website.
- When speaking, identify yourself for the record, speak clearly and concisely, and obey the rules of debate.
- The structure of meeting adheres to federal law, the Open Meetings Act and/or state statute, borough ordinance, board policies, and if not addressed through any of these avenues, Robert's Rules of Order. The public needs to know when a meeting is called to order, who was in attendance, agenda items, action taken by the committee, who made motions, how the members voted, adjournment, etc.
- Public testimony is not taken during Curriculum Committee meetings.
- Closing comments should be general in nature. All comments related to agenda items should be made when the item is up for discussion to alleviate the chance of an item being rehashed after is has been disposed of, which is not fair to the public process as it does not allow for full debate or provide opportunity for response.

Robert's Rules of Order

Motions

A motion is a proposal the entire membership takes action or a stand on an issue. Individual members:

1. Call to order.
2. Move a motion.
3. Second a motion.
4. Debate motions.
5. Vote on motions.

Basic Types of Motions

- Main motions introduce items to the membership for their consideration, cannot be made when any other motion is on the floor, and yield to privileged, subsidiary, or incidental motions.

- Subsidiary motions (amendments) change or affect how a main motion is handled and are voted on before a main motion.

Presenting Motions

1. Obtaining the floor.
   a. Wait until the last speaker has finished.
   b. Address the chair.
   c. Wait until the chair recognizes you.
2. Make your motion.
   a. Speak in a clear and concise manner.
   b. Always state a motion affirmatively (e.g., "I move that we" rather than "I move that we do not").
   c. Stay on subject.
3. Another member will second your motion or the chair will call for a second. If there is no second to your motion, it is lost.
4. The chair states your motion.
   a. The chair will state "it has been moved and seconded that we…" thus placing your motion before the membership for consideration and action.
   b. The membership either debates the motion or may move directly to a vote.
   c. Once your motion is presented to the membership by the chair, it becomes "assembly property" and cannot be changed by you without the consent of the members.
5. Expanding on your motion.
   a. The time for you to speak in favor of your motion is at this point in time, rather than at the time you present it.
   b. The mover is always allowed to speak first.
   c. All comments and debate must be directed to the chair.
   d. Keep to the time limit for speaking that has been established.
   e. The mover may speak again only after other speakers are finished, unless called upon by the chair.
6. Amendments may put forward to the motion on the floor (same process as for motions) – maker of the amendment speaks first and after discussion, vote on the amendment is called. Once all amendments have been heard and addressed, you can move to vote on the main motion (as amended, if the amendment carried).
7. Putting the question to the membership.
   a. The chair asks "Are you ready to vote on the question?"
   b. If there is no more discussion, a vote is taken.

Voting on a Motion

The method of vote on any motion depends on the situation and the bylaws of policy. Options include:

- By voice – the chair asks those in favor to say "aye" and those opposed to say "no." Any member may move for an exact count.
- By roll call – each member answers "yes" or "no" as his/her name is called. This method is used when a record of each person's vote is required.

- By general consent – when a motion is not likely to be opposed, the chair says "if there is no objection…" and the membership shows agreement by their silence. However, if one member says "I object," the item must be put to a vote.

Other Motions Commonly Used

- Motion to table – this is often used in the attempt to "kill" a motion. The option is always present, however, to "take from the table" for reconsideration by the membership.
- Motion to postpone indefinitely – this is often used as a means of parliamentary strategy and allows opponents of motion to test their strength without an actual vote being taken. Also, debate is once again open on the main motion.

Draft Calendar

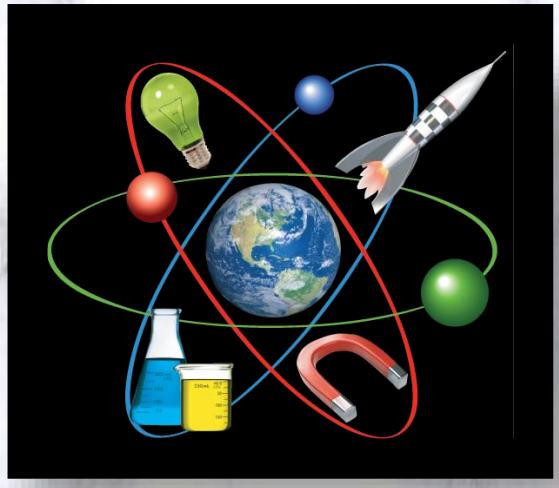
Content Area	2023-2024	2024-2025	2025-2026	2026-2027	2027-2028	2028-2029	2029-2030
Science	Develop & Define	Implement	Measure- Refine- Revise			Research, Review, & Materials	Develop & Define
Art	Research, Review, & Materials	Develop & Define	Implement	Measure- Refine- Revise			Research, Review, & Materials
Music	Research, Review, & Materials	Develop & Define	Implement	Measure- Refine- Revise			Research, Review, & Materials
World Language	Research, Review, & Materials	Develop & Define	Implement	Measure- Refine- Revise			Research, Review, & Materials
Health	Measure- Refine- Revise	Research, Review, & Materials	Develop & Define	Implement	Measure- Refine- Revise		
PE	Measure- Refine- Revise	Research, Review, & Materials	Develop & Define	Implement	Measure- Refine- Revise		
English Language Arts	Measure- Refine- Revise		Research, Review, & Materials	Develop & Define	Implement	Measure - Refine - Revise	
Social Studies	Measure- Refine- Revise			Research, Review, & Materials	Develop & Define	Implement	Measure - Refine - Revise
Math	Measure- Refine- Revise				Research, Review, & Materials	Develop & Define	Implement

Revised 5/01/2023

Fairbanks North Star Borough School District

SCIENCE CURRICULUM

Draft One



To view draft one in its entirety and to leave feedback, visit the district website at www.k12northstar.org/Page/8852.

Curriculum Revision Process

The Fairbanks North Star Borough School District is revising its Science Curriculum for grades 6-12. A strong and effective final document depends on careful deliberation of the proposed changes. Input from educators, parents, students, and the community is a critical factor in the curriculum revision process.

Per Administrative Regulations 910 Appendix A, this process began with community input, reflections on student performance in the district, and research of current trends, best practices, and alignment to Alaska Standards. Each draft is made available to the public, and all feedback is reviewed and considered by the curriculum writers and the Department of Teaching and Learning.

To view draft one in its entirety and to leave feedback, visit the district website at www.k12northstar.org/Page/8852.

Questions from the Curriculum Writers

1. The curriculum writers are proposing an increase to the science graduation requirements. The writers discovered that a majority of universities are moving towards an admissions process that requires applicants to complete four credits of science in high school. In addition, completing more science credits increases the level of the Alaska Performance Scholarship available. Science courses also prepare students for post-secondary education at technical institutes and CTE careers. The list of science course options has expanded to include more Career and Technical Education (CTE) courses to help students complete the new graduation requirements. (See the list of course options at the beginning of the high school curriculum.) Do you support this change?

Current Graduation Requirements

- Students successfully complete a total of three credits of Science to include:
  - One credit of Physical Science
  - One credit of Biological Science
  - **One credit** of additional science electives.

Proposed Graduation Requirements

- Students successfully complete four credits of Science to include:
  - One credit of Physical Science
  - One credit of Life Science
  - **Two credits** of additional science electives.

2. Do you support the expansion of science options to include multiple CTE courses (see the question #1 above for more information).
3. Do you support a new literacy focused course titled *Life Science*?
4. The writers are proposing replacing *Honors Biology* with the purchase of *Pre-AP Biology*. Do you support this change?

Proposed Changes to Draft One

Middle School

The following changes were made to the middle school science curriculum:

- Standard MS-LS2 (on ecosystem interactions, energy, and dynamics) was moved from grade 6 to grade 7.
- Grade 6: standard MS-ESS1 (develop and use a model to describe the role of gravity in the motions within galaxies and the solar system) was added.
- Standard MS-PS2 (Motion and stability: forces and interactions) was moved from grade 6 to grade 8.

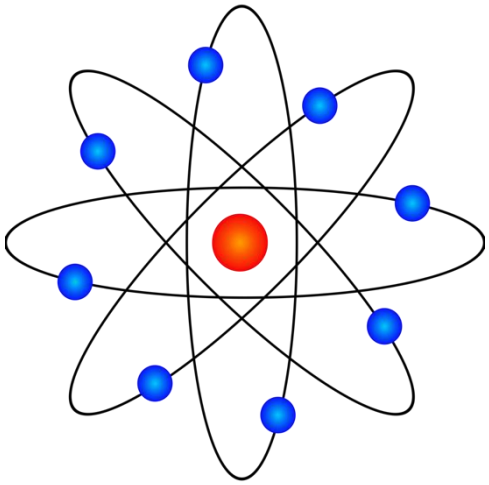
High School

1. The curriculum writers are proposing an increase in the Science graduation requirements. See a detailed explanation on the previous page.
2. New course:
   - *Environmental Science* has replaced *Natural Resources: Biology* and *Natural Resources: Physical Science*. Both Natural Resource courses already cover environmental science topics, and this new course has materials available for purchase.
   - *Pre-AP Biology* was added to replace *Honors Biology*.
   - *Wildlife Biology* is currently a pilot course offered at North Pole High School. This course has been added to the curriculum.
   - The curriculum writers are proposing a new literary focused science course title *Life Science*.
3. Course titles changed:
   - *Marine Biology* was changed to *Marine Science*, which is a more accurate description of the course.
   - *Forensic Science* and *Advanced Forensic Science* were changed to Forensic Science 1 and 2.
4. Some courses have been removed from the curriculum and archived. If a teacher or school is interested in offering one of the archived courses in the future, they can fill out a pilot proposal form and may offer the course, pending Teaching and Learning and superintendent approval. The following courses have been archived:
   - *Astrobiology*
   - *Chem Tech*
   - *Conceptual Physics*
   - *Microbiology*
   - *Natural Resources: Biology*
   - *Natural Resources: Physical Science*
5. Other major changes:
   - The standards listed in the curriculum are the Alaska Science Standards adopted in 2019, instead of the Next Generation Science Standards (NGSS). According to the published Alaska Science Standards, they are largely the same as the NGSS.

- *Chemistry* - The unit on “redox reactions and electrochemistry” was removed from the Chemistry curriculum: This unit is listed as “time permitting” under the current curriculum and is not aligned to the standards.
- *Introduction to Basic Pathophysiology* – units were added about heart disease and cancer, as these are the top two killers in the world. Also, the topic on the immune system was made into its own unit.
- *Biology* – An unit on “ecology” was added to the first semester to allow the instructor to engage in place-based learning before winter snow sets in, and an unit on “biotechnology” was added.

Fairbanks North Star Borough School District

Science Curriculum



Grades 6 – 8

2023-24 Revision – Draft 1

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Acknowledgements

Science Curriculum Writers

Tabitha Cowger – Ryan Middle School
Tara DeVaughn – Teaching & Learning
Carrie Forbes – Tanana Middle School
Brook Frost – Ryan Middle School
Michelle Heminger – Barnette Magnet School
Curtis McNeill – North Pole Middle
Shannon Morgan – Barnette Magnet School
Christina Shaw – Barnette Magnet School
Allison Shugart – North Pole Middle School
Rebbecca Siegel – Randy Smith Middle School
Eden Torredes – Ryan Middle School
Tumi Traustason – Ryan Middle School
Zachary Vehmeier – Tanana Middle School
Jed Wilde – Tanana Middle School
Brenda Zera – North Pole Middle School

Science Researchers

Grades 6-12 science teachers met during professional development in August of 2022 to discuss and begin the research for science curriculum.

Department of Teaching and Learning

Chane Beam – Executive Director of Teaching and Learning
Tara DeVaughn – Curriculum Coordinator
Rachel Reilly – Curriculum Coordinator (2022-2023 school year)

We would also like to recognize

The Board Curriculum Committee, the Fairbanks North Star Board of Education, and the many teachers, administrators, parents, and community members who have provided input during the curriculum revision process.

Philosophy & Mission Statement

Graduates should be

EMPOWERED

critical thinkers who use evidence-based reasoning, and who have a duty to the natural world and their society.

Explanation of Terms

Alaska Science Standards
Science Standards were adopted by the State Board of Education in 2019. These are general statements of what Alaskans want students to know and be able to do as a result of their public school experience. https://education.alaska.gov/standards

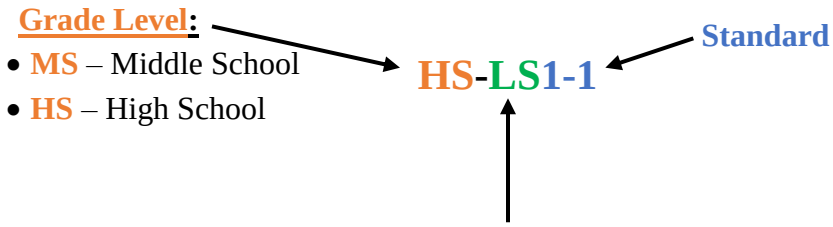
Alaska Cultural Standards
Standards endorsed by the State Board of Education that serve to encourage enrichment of the content standards. They are used as a guide to ensure that schools are aware of and sensitive to their surrounding physical and cultural environments.
https://education.alaska.gov/akstandards/#c3gtabs-cultural

Objectives
Statements that document specific, essential tasks students are expected to accomplish in a given grade level or course.

Guaranteed and Viable Curriculum (GVC)
A guaranteed and viable curriculum is one that guarantees equal opportunity for learning for all students. Similarly, it guarantees adequate time for teachers to teach content and for students to learn it. A guaranteed and viable curriculum is one that ensures that the curriculum being taught is the curriculum being assessed. It is viable when adequate time is ensured to teach all determined essential content.

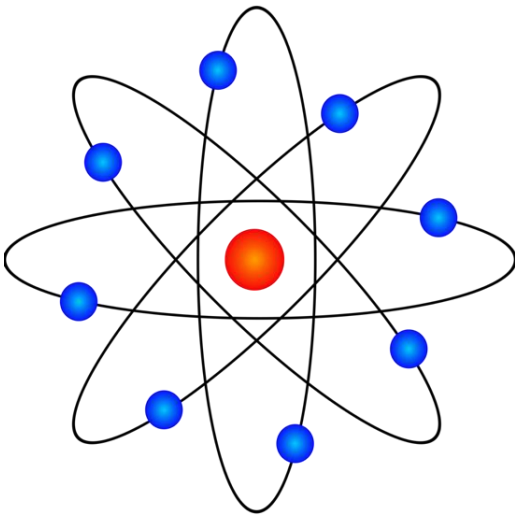
Standards Alignment Coding

This Science Curriculum is aligned to the Alaska Science Standards adopted in 2019, which are largely the same as the national Next Generation Science Standards (NGSS). The Alaska Science Standards provide a foundation for defining what students should know and be able to do in terms of scientific knowledge and skills. (https://education.alaska.gov/akstandards/science/science-standards-for-alaska.pdf)



Science Standards for Alaska Disciplinary Core Ideas	
Physical Sciences PS1: Matter and its interactions PS2: Motion and stability: Forces and interactions PS3: Energy PS4: Waves and their applications in technologies for information transfer	**Life Sciences** LS1: From molecules to organisms: Structures and processes LS2: Ecosystems: Interactions, energy, and dynamics LS3: Heredity: Inheritance and variation of traits LS4: Biological evolution: Unity and diversity
Earth and Space Sciences ESS1: Earth's place in the universe ESS2: Earth's systems ESS3: Earth and human activity	**Engineering, Technology, Applications of Science** ETS1: Engineering design

Middle School Science Courses



Grades 6 – 8

Grade 6 Science

Grade(s): 6 **Length**: two semesters	**Course Overview**: Sixth grade science focuses on Earth's systems, astronomy, and gravity. In Earth's systems, students will explore the history of our changing planet through impacts of water, rock, and soil cycles on Earth's surface processes, and construct weather and climate observations to explain influences on Earth's surface. In astronomy, the students will model the solar system to observe, describe, and predict the motion of various bodies in our solar system. In gravity, students will investigate Newton's Third Law of Motion in relation to planetary motion. Throughout the year, interwoven into the curriculum content, students will design and conduct repeatable scientific investigations to continue to develop an awareness that different ways of thinking, curiosity, and the exploration of multiple paths are involved in scientific inquiry. **Adopted Textbook**: *Into Science: Earth & Space Sciences.* HMH, 2022 Volumes: *Circulation of the Earth's Air and Water, Weather and Climate, The Dynamic Earth, Earth's Natural Hazards, Resources in Earth Systems, Human Impacts on Earth Systems, Patterns in the Solar System, The Solar System and Universe.*

Units (Recommended Order)	
Semester 1	**Semester 2**
• Circulation of Earth's Air and Water • Weather and Climate • The Dynamic Earth • Earth's Natural Hazards • Resources in Earth's Systems	• Human Impacts on Earth's Systems • Patterns in the Solar System • The Solar System and Universe • Performance Expectations*

Notes:

- The *Earth and Space Science* Unit 4 "Earth Through Time" book was intentionally skipped, as it is utilized by grade 7.
- *Science process skills are bet taught in context. Therefore, the performance expectations will be incorporated into the units below. Not all of these performance expectations will be incorporated into every activity; however, the opportunities to learn these skills will be provided throughout the course.

UNIT 1: CIRCULATION OF EARTH'S AIR & WATER				
Timing: Semester 1, Quarter 1 **Teaching Time Required:** All estimated teaching times are based on a 45 minute period **Textbook:** *Into Science* book 1: *Circulation of Earth's Air and Water*				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Circulation in the Earth's Atmosphere	5 days	• Identify and analyze movements of air masses from regions of high to low pressure (convection currents) and the effects on weather.	• Convection • Coriolis Effect • Air Pressure • Atmosphere • Circulation • Density • Energy System	• Unit 1 (Book 1, p. 3A) Lesson 1: Circulation in the Earth's Atmosphere
Circulation in the Earth's Oceans	5 days	• Describe the effects of the ocean on Earth's weather.	• Ocean Current • Density • Salinity • Temperature	• Unit 1 (Book 1, 11A) Lesson 2: Circulation in Earth's Oceans
The Water Cycle	5.5 days	• Describe and illustrate the water cycle, and the forces that drive it (gravity and sunlight).	• Evaporation • Condensation • Transpiration • Crystallization • Precipitation • Runoff • Groundwater Flow	• Unit 1 (Book 1, 19A) Lesson 3: The Water Cycle
Unit Test/ Labs	2 days			•
Standards List:	**MS ESS2-4, MS ESS2-6**			

UNIT 2: WEATHER & CLIMATE				
Timing: Semester 1, Quarter 1 **Teaching Time Required:** All estimated teaching times are based on a 45 minute period **Textbook:** *Into Science* Unit 2: *Weather and Climate*				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Weather and Weather Prediction	5.5 days	• Identify and analyze movement of air masses from regions of high to low pressure (convection currents), and the effects on the weather. • Describe the effects of the ocean and the water cycle on the weather.	• Weather • Air Mass • Front • Weather Forecast	• Unit 2 (Book 2, pg. 3A) Lesson 1: Weather and Weather Prediction
Influences on Climate	6.5 days	• Describe how unequal heating and the rotation of the Earth determines regional climates.	• Climate	• Unit 2 (Book 2, pg. 11A) Lesson 2: Influences on Climate
Unit Test/ Labs	2.5			
Standards List:	**MS-ESS2-5, MS-ESS2-5**			

UNIT 3: THE DYNAMIC EARTH				
Timing: Semester 1, Quarter 2 **Teaching Time Required:** All estimated teaching times are based on a 45 minute period **Textbook:** *Into Science* Unit 3				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Geologic Change and Surface Processes	5.5 days	• Explain how geoscience processes have changed the Earth's surface at varying time and spatial scales.	• Weathering • Sediment • Erosion • Deposition	• Unit 3: Lesson 1 Geologic Change and Surface Processes
The Rock Cycle	6.5 days	• Know that sedimentary, igneous, and metamorphic rocks contain evidence of the minerals, temperatures, and the forces that created them.	• Mineral • Igneous Rock • Sedimentary Rock • Metamorphic Rock • Rock Cycle	• Unit 3: Lesson 2 The Rock Cycle
Earth's Plates	5.5 days	• Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.	• Tectonic Plate • Plate Tectonics • Convection Current	• Unit 3: Lesson 3 Earth's Plates
Unit Assessments	2.5 days			
Standards List:	**MS ESS2-1, MS ESS2-2, MS ESS2-3**			

UNIT 4: EARTH'S NATURAL HAZARDS				
Timing: Semester 1, Quarter 2 **Teaching Time Required:** All estimated teaching times are based on a 45 minute period **Textbook:** *Into Science* Unit 5				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Natural Hazard Prediction	5.5 days	• Analyze and interpret data on natural hazards to forecast future catastrophic events.	• Natural Disaster • Natural Hazard • Historical • Interpret • Likelihood • Monitor • Prediction	• Unit 5 Lesson 1: Natural Hazard Prediction p. 3A
Reducing the Effects of Natural Hazards	5.5 days	• Define criteria and constraints of model for mitigating natural hazards.	• Mitigation • Constraint • Criterion • Engineering Design Process • Preparation • Recovery • Response • Solution • Technology	• Unit 5 Lesson 2: Engineer it: Reducing the Effects of Natural Hazards p. 11A
Unit Assessments	2.5 days			
Standards List:	**MS-ESS3-2, MS-ETS1-1**			

UNIT 5: RESOURCES IN EARTH'S SYSTEMS				
Timing: Semester 2, Quarter 3 **Teaching Time Required:** All estimated teaching times are based on a 45 minute period **Textbook:** *Into Science* Unit 6				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Natural Resources	5.5 days	• Construct an evidence-based explanation of the formation of natural resources (such as oil, propane, and natural gas) are the result of past geoscience processes. • Gather information and explain how synthetic materials come from natural resources and impact society.	• Natural Resources • Renewable Resource • Nonrenewable Resource	• Unit 6 Lesson 1: Natural Resources
Human Population and Resource Use	5 days	• Construct an argument, supported by evidence, for how increases in human population and per-capita consumption of natural resources impact Earth's systems.	• Per Capita Consumption • Population	• Unit 6 Lesson 2: Human Population and Resource Use
Resource Use and Earth's Systems	5.5 days	• Construct an argument, supported by evidence, for how increases in human population and per-capita consumption of natural resources impact Earth's systems • Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.	• Pollution • Deforestation • Extinction • Greenhouse Gas • Resource Use	• Unit 6 Lesson 3: Resource Use and Earth's Systems
Unit Materials	2.5 days			
Standards List:	**MS ESS3-1, MS ESS3-2**			

UNIT 6: HUMAN IMPACTS ON EARTH'S SYSTEMS				
Timing: Semester 2, Quarter 3 **Teaching Time Required:** All estimated teaching times are based on a 45 minute period **Textbook:** *Into Science* Unit 7				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Reducing Human Impacts on the Environment	8.5 days	• Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.		• Unit 7: Lesson 1 Engineer It: Reducing Human Impacts on the Environment.
Climate Change	5.5 days	• Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. • Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	• Greenhouse Effect	• Unit 7: Lesson 2 Climate Change
Unit Assessments	2.5 days			
Standards List:	**MS-ESS3-3, MS-ESS3-5, MS-ETS1-2**			

UNIT 7: PATTERNS IN THE SOLAR SYSTEM				
Timing: Semester 2, Quarter 4 **Teaching Time Required:** All estimated teaching times are based on a 45 minute period **Textbook:** *Into Science* Unit 8				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Earth – Sun – Moon System	7 days	• Develop and use a model of the Earth-Sun-Moon system to describe the cyclic patterns of lunar phases, and eclipses of the sun and moon.	• Orbit • Phase • Eclipse	• Unit 8 Lesson 1: The Earth-Sun-Moon System, pg. 3A
Seasons	6 days	• Develop and use a model of the Earth-Sun-Moon system to describe the seasons.	• Season	• Unit 8 Lesson 2: Seasons, pg. 15A
Unit Assessments	2.5 days			
Standards List:	**MS-ESS1-1**			

UNIT 8: THE SOLAR SYSTEM AND UNIVERSE				
Timing: Semester 2, Quarter 4 **Teaching Time Required:** All estimated teaching times are based on a 45 minute period **Textbook:** *Into Science* Unit 9: *The Solar System and Universe*				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Earth and the Solar System	5 days	• Analyze and interpret data to determine scale properties of objects in the solar system.	• Asteroid • Comet • Dwarf Planet • Meteoroid • Parallax • Moon • Telescope • Heliocentric • Retrograde • Transit	• Unit 9 Lesson 1: Earth and the Solar System
Gravity and the Universe	6.5 days	• Describe the role of gravity in the motions within galaxies and the solar system.	• Orbit • Chemical Composition • Condense • Density • Inertia • Projectile • Protoplanetary Disk • Satellite • Velocity • Speed	• Unit 9 Lesson 2: Gravity and the Universe
Modeling in Space Science	6.5 days	• Construct and present arguments to support the claim that gravitational interactions are attractive and depend on masses of interacting objects.	• Astronomical Unit • Galaxy • Light-Year • Universe Diameter • Distinguish Location • Order of Magnitude • Ratio • Scale	• Unit 9 Lesson 3: Modeling in Space Science
Unit Assessment	2.5 days			
Standards List:	**MS ESS1-2, MS ESS1-3, MS PS2-4**			

SCIENTIFIC PROCESS SKILLS
Timing: All year **Teaching Time Required:** Varies **Textbook:** Embedded throughout
Objectives
• Ask questions, predict, observe, describe, measure, classify, make generalizations, infer and communicate. • Plan and carry out scientific investigations of various types (such as systematic observations or experiments), identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions. • Select appropriate tools for collecting qualitative and quantitative data and record measurements (volume, mass, distance) in metric units. • Develop a model describe phenomenon. • Conduct research to learn how the local environment is used by a variety of competing interests (e.g. competition for habitat/resources, tourism, oil, mining companies, and hunting groups). • Use standard safety practices for all classroom laboratory and field investigations.

Grade 7 Science

Grade(s): 7 **Length**: two semesters	**Course Overview**: *Science 7* is an introductory course designed to expand 7th grade students' understanding of natural world by focusing on the characteristics of living things, cellular organization, the diversity of life, how organisms and populations change over time in terms of biological adaptation, heredity and genetics, evolution, natural selection, and changes over time in Earth's history. **Adopted Textbook**: *Into Science*. HMH, 2022

Units (Recommended Order)	
Semester 1	**Semester 2**
• Introduction • Cells and Organization in Organisms • Reproduction, Heredity, and Growth • Matter and Energy in Living Systems	• Ecosystem Dynamics • The History of Life on Earth • Evolution

UNIT 1: CELLS & ORGANIZATION IN ORGANISMS				
Suggested Pacing: Semester 1, Quarter 1 **Teaching Time Required:** 15 days **Textbook:** *Into Science*				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Cell Structure/ Function	5 days	• All living things are made of one or more cells. • Cells can be described by the types of structures they are made of. • The cell membrane serves as a barrier that allows matter and energy to enter and exit the cell. • Students use a model to describe how a cell's functions are performed by specific cell structures.	• Cell Membrane • Cell Wall • Chloroplast • Mitochondrion • Nucleus • Organelle	•
Plant Body Systems	5 days	• Students use evidence to support an explanation about how the survival needs of plants are met by systems working together.	• Leaf • Organ • Organism • Organ System • Tissue	•
Animal Body Systems	5 days	• Students use evidence to evaluate how survival needs of animals are met by systems working together.	• Behavior • Homeostasis • Memory • Sensory • Receptor	•
Standards List:	• **MS-LS1-1** Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. • **MS-LS1-2** Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function • **MS-LS1-3** Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. • **MS-LS1-8** Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.			

UNIT 2: REPRODUCTION, HEREDITY, & GROWTH				
Timing: Semester 1, Quarter 2 **Teaching Time Required:** 15.5 – 24.5 days **Textbook:** *Into Science*				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Inheritance and Reproduction	5 – 8 days	• Students investigate how genetic factors influence an organism's traits, describe how asexual reproduction results in offspring with identical genetic information, and how sexual reproduction results in offspring with genetic variation.	• Allele • Asexual Reproduction • Chromosome • DNA • Gamete • Gene • Inheritance • Offspring • Sexual Reproduction • Trait • Probability	•
Plant Reproduction & Growth	5 – 8 days	• Students explain how genetic and environmental factors affect the growth and reproduction of plants.	• Pollination • Seed Dispersal • Environmental Factor • Fertilization Genetic • Factor • Germination	•
Animal Reproduction & Growth	5.5 – 8.5 days	• Students gather evidence to explain how an animal's behavior influences its reproductive success and survival.	• Asexual Reproduction • Behavior • Environmental Factor • Fertilization • Genetic Factor • Reproductive Success • Sexual Reproduction • Variation	•
Standards List:	• **MS-LS1-4** Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. • **MS-LS1-5** Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. • **MS-LS3-2** Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.			

UNIT 3: MATTER & ENERGY IN LIVING SYSTEMS				
Timing: Semester 1, Quarter 2 **Teaching Time Required:** 24.5 – 36.5 days **Textbook:** *Into Science*				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Matter & Energy in Organisms	6 – 9 days	• Students explain the role of photosynthesis and cellular respiration in the cycling of matter and energy within and between organisms.	• Matter Molecule • Energy • Chemical Reaction • Photosynthesis • Cellular Respiration	•
Resource Availability Affects Organisms	7 – 10 days	• Students interpret data to predict the effects of resource availability on the growth of organisms and populations in an ecosystem.	• Ecosystem • Biotic Factor • Abiotic Factor • Species • Population • Community	•
Interactions in Ecosystems	5 – 8 days	• Students explain patterns of interaction between organisms.	• Predator • Prey • Herbivore • Symbiosis • Competition	•
Matter & Energy in Ecosystems	6.5 – 9.5 days	• Students develop a model to explain how matter and energy flow through ecosystems.	• Producer • Consumer Decomposer • Food Web • Energy Pyramid	•
Standards List:	• **PE MS-LS1-6** Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. • **PE MS-LS1-7** Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. • **PE MS-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. • **PE MS-LS2-2** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. • **PE MS-LS2-3** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.		

UNIT 4: ECOSYSTEM DYNAMICS				
Timing: Semester 2, Quarter 3 **Teaching Time Required:** 13 – 15 days **Textbook:** *Into Science*				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Biodiversity in Ecosystems	4 – 5 days	• Students use evidence to support an explanation of how changes in biodiversity can affect ecosystem health.	• Biodiversity • Ecological Health • Biodiversity Hotspot • Influence • Disturbance • Introduced Species • Recovery • Stability	•
Changes in Ecosystems	4 – 5 days	• Students use evidence to support an explanation of how changes in ecosystems cause changes in populations.	• Disturbance • Succession • Biodiversity • Dynamic • Gradual Change • Interconnected • Pioneer Species • Recovery	•
Maintaining Ecosystems	5 days	• Students will be able to evaluate competing design solutions for maintaining biodiversity and ecosystem services.	• Habitat Destruction • Habitat Fragmentation • Ecosystem Service	•
Standards List:	• **PE MS-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. • **PE MS-LS2-5** Evaluate competing design solutions for maintaining biodiversity and ecosystem services. • **PE MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.			

UNIT 5: THE HISTORY OF LIFE ON EARTH				
Timing: Semester 2, Quarter 4 **Teaching Time Required:** 17 – 23 days **Textbook:** *Into Science*				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Fossil Record	6 – 8 days	• Students will be able to explain how patterns in fossil data can be used to provide evidence for the history of life on Earth.	• Fossil • Radiometric Dating • Fossil Record • Extinction	•
Patterns of Change in Life on Earth	5.5 – 7.5 days	• Students will be able to analyze patterns in the fossil record to explain changes in life on Earth over time.	• Extinction	•
Evidence of Common Ancestry	5.5 – 7.5 days	• Students will be able to analyze patterns in data to provide evidence for evolutionary relationships among organisms.	• Evolution • Common Ancestry • Anatomy • Embryology	•
Standards List:	• **MS-LS4-1**: Students who demonstrate understanding can: Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past. • **MS-LS4-2**: Students who demonstrate understanding can: Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. • **MS-LS4-3**: Students who demonstrate understanding can: Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.			

UNIT 6: EVOLUTION				
Timing: Semester 2, Quarter 4 **Teaching Time Required:** 15.5 – 24.5 days **Textbook:** *Into Science*				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Genetic Change and Traits	5 – 8 days	• Students model analysis of fossil evidence, and explore relative and absolute age.	• Adaptation • DNA • Gene Mutation • Protein • Amino Acid • Chromosome • Environment • Sequence • Trait	•
Natural Selection	5 – 8 days	• Students explore evidence of change in life over time, analyze patterns in extinction data, and model analysis of rock and fossil sequences.	• Allele Frequency • Evolution • Extinction • Natural Selection • Variation • Advantage • Distribution • Genotype • Phenotype • Population	•
Human Influence on Traits	5.5 – 8.5 days	• Students identify patterns of similarities in the anatomy and embryological development across species.	• Artificial Selection • Biotechnology • Genetic Engineering • Genetically Modified Organism (GMO) • Disrupt • Ethics • Individual • Selective Breeding • Society	•

Standards List:	• **MS-LS3-1** Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. • **MS-LS4-4** Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. • **MS-LS4-5** Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. • **MS-LS4-6** Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

SCIENTIFIC PROCESS SKILLS
Timing: All year **Teaching Time Required:** Varies **Textbook:** Embedded throughout
Objectives
• Ask questions, predict, observe, describe, measure, classify, make generalizations, infer and communicate. • Plan and carry out scientific investigations of various types (such as systematic observations or experiments), identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions. • Select appropriate tools for collecting qualitative and quantitative data and record measurements (volume, mass, distance) in metric units. • Develop a model describe phenomenon. • Conduct research to learn how the local environment is used by a variety of competing interests (e.g. competition for habitat/resources, tourism, oil, mining companies, and hunting groups). • Use standard safety practices for all classroom laboratory and field investigations.

Grade 8 Science

Grade(s): 8 **Length**: two semesters	**Course Overview**: *Science 8* is designed to expand student investigation of physics and chemistry. Aspects of physics are studied through laboratory investigations including sound, light, electricity, mechanics, motion, and energy. Aspects of chemistry are studied based on the Periodic Table of the Elements and through basic chemical laboratory investigations. Laboratory work, laboratory reporting, and engineering design will be included and is an integral part of the learning process. **Adopted Textbook**: *Into Science*. HMH, 2022

Units (Recommended Order)	
Semester 1	**Semester 2**
• Structure of Matter • Chemistry of Materials • Chemical Process & Equations • Energy • Ongoing, yearlong learning objects: Scientific Process Skills and Engineering Design Concepts	• Energy Transfer • Forces and Motion • Eclectic and Magnetic Forces • Waves and Information Transfer

UNIT 1: STRUCTURE OF MATTER				
Timing: Semester 1, Quarter 1 **Teaching Time Required:** 24 days **Textbook:** *Into Science,* Unit 3				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Properties of Matter	6 days	• Investigate and explain that all matter is made up atoms, and understand that substances have physical properties that are unique to each substance.	• Matter • Mass • Volume • Density • Solid • Liquid • Gas	• *Into Science: Physical Science* Unit 3 Structure of Matter
Changes of State	5.5 days	• Investigate changes that occur in physical and chemical properties of matter using a qualitative description of changes on a molecular level, including conservation of matter.	• Change of State • Thermal Energy • Temperature • Pressure	• *Into Science: Physical Science* Unit 3 Structure of Matter
Atoms and Elements	4.5 days	• Describe the relationship between atomic mass, atomic number, and location on the periodic table, with chemical properties of the elements. • Structure of atoms and how atoms combine into compounds.	• Element • Atom • Periodic Table	• *Into Science: Physical Science* Unit 3 Structure of Matter
Molecules and Extended Structure	5.5 days	• Develop and use models to demonstrate how atoms and elements form molecules and compounds. • Classify everyday materials as elements, compounds, or mixtures.	• Pure Substance • Chemical Bond • Molecule • Compound	• *Into Science: Physical Science* Unit 3 Structure of Matter
Unit Tests/ Labs	2.5 days			• *Into Science: Physical Science* Unit 3 Structure of Matter
Standards List:	**MS-PS1-1, MS-PS1-4**			

UNIT 2: CHEMISRY OF MATERIALS				
Suggested Pacing: Semester 1, Quarter 1 **Teaching Time Required:** 13 days **Textbook:** *Into Science* Unit 5				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Natural and Synthetic Materials	5.5 days	• Collect information that supports the idea that synthetic materials come from the use of natural resources, and analyze the positive and negative effects of use and development of synthetics on society.	• Pure Substance • Natural Substance • Polymer • Synthetic Material	• *Into Science: Physical Science* Unit 5 The Chemistry of Materials
The Cycle of Synthetic Materials	5 days	• Recognize the role chemistry has in our everyday lives, including the production of synthetic materials from natural resources (e.g. soil and water testing, extraction of minerals, consumer science).		• *Into Science: Physical Science* Unit 5 The Chemistry of Materials
Unit Tests/ Labs	2.5 days			• *Into Science: Physical Science* Unit 5 The Chemistry of Materials
Standards List:	**MS-PS1-3**			

UNIT 3: CHEMICAL PROCESS & EQUATIONS				
Timing: Semester 1, Quarter 2 **Teaching Time Required:** 17.5 days **Textbook:** *Into Science* Unit 4				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Chemical Reactions	5 days	• Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.	• Chemical Reaction • Reactant • Product	• *Into Science Physical Science* Unit 4 Chemical Process & Equations
Chemical Equations	5 days	• Describe the relationship between atomic mass, atomic number, and location on the periodic table, with chemical properties of the elements.	• Chemical Formula • Chemical Equation • Law of Conservation of Matter	• *Into Science Physical Science* Unit 4 Chemical Process & Equations
Thermal Energy and Chemical Processes	5 days	• Apply scientific principles to design, construct, and test a device that either minimized or maximized thermal energy transfer.	• Heat	• *Into Science Physical Science* Unit 4 Chemical Process & Equations
Unit Tests/ Labs	2.5 days	•	•	• *Into Science Physical Science* Unit 4 Chemical Process & Equations
Standards List:	**MS-PS1-2, MS-PS1-5, MS-PS1-6**			

UNIT 4: ENERGY				
Timing: Semester 1, Quarter 2 **Teaching Time Required:** 18.5 days **Textbook:** *Into Science* Unit 1				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Introduction to Energy	5 days	• Identify various sources and forms of energy, and classify them as potential or kinetic.	• Energy • Potential Energy • Kinetic Energy	• *Into Science: Physical Science* Unit 1: Energy
Changes in Energy	5.5 days	• Investigate relationships among the amount of energy transferred, the type of matter, the mass, and the change in temperature of a sample.	• Energy Transfer • System	• *Into Science: Physical Science* Unit 1: Energy
Transforming Energy	5.5 days	• Apply the engineering and design process.		• *Into Science: Physical Science* Unit 1: Energy
Unit Tests/ Labs	2.5 days			• *Into Science: Physical Science* Unit 1: Energy
Standards List:	**MS-PS3-1, MS-PS3-2, MS-PS3-5**			

UNIT 5: ENERGY TRANSFERS				
Timing: Semester 2, Quarter 3 **Teaching Time Required:** 14.5 days **Textbook:** *Into Science* Unit 2				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Temperature and Heat	5.5 days	• Examine energy transfers, conservation of energy, and identify energy that is useful vs. energy that is unavailable	• Temperature • Thermal Energy • Heat	• *Into Science: Physical Science* Unit 2 Energy Transfer
Thermal Energy Transfers in Systems	6.5 days	• Differentiate between renewable and non-renewable energy resources. • Investigate how energy is produced and used including alternative energy sources in Alaska. Evaluate the impact of energy production methods on the environment.		• *Into Science: Physical Science* Unit 2 Energy Transfer
Unit Tests/ Labs	2.5 days			• *Into Science: Physical Science* Unit 2 Energy Transfer
Standards List:	**MS-PS3-3, MS-PS3-4**			

UNIT 6: FORCES & MOTION				
Timing: Semester 2, Quarter 3 **Teaching Time Required:** 18.5 days **Textbook:** *Into Science* Unit 6				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Introduction to Forces	5.5 days	• Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. • Conduct an investigation to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. • Investigate through experimentation and "real-life" examples the relationship among (1) force, mass, acceleration, and gravity, (2) speed, distance, time and acceleration, (3) force and friction.	• Motion • Speed • Velocity • Acceleration • Force • Gravity	• *Into Science: Physical Science* Unit 6 Forces & Motion
Newton's Laws of Motion	5.5 days	• Describe gravity as an attractive force between two objects that depends on the mass of the interacting objects. Explain how the orbital motion of planets provides evidence for this force. • Explain "real-life" examples of linear and rotational motion using Newton's Laws of Motion.	• Inertia	• *Into Science: Physical Science* Unit 6 Forces & Motion
Collisions Between Objects	5 days	• Conduct an investigation to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. • Describe gravity as an attractive force between two objects that depends on the mass of the interacting objects. Explain how the orbital motion of planets provides evidence for this force.		• *Into Science: Physical Science* Unit 6 Forces & Motion
Unit Tests/ Labs	2.5 days			• *Into Science: Physical Science* Unit 6 Forces & Motion
Standards List:	**MS-PS2-1, MS-PS2-2**			

UNIT 7: ELECTRIC & MAGNETIC FORCES				
Timing: Semester 2, Quarter 4 **Teaching Time Required:** 24.5 days **Textbook:** *Into Science* Unit 7				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
The Magnetic Force	6.5 days	• Ask questions about data to determine the factors that affect the strength of magnetic forces.	• Magnet • Magnetic Force • Magnetic Domain	• *Into Science: Physical Science* Unit 7 Electric & Magnetic Forces
The Electric Force	5.5 days	• Ask questions about data to determine the factors that affect the strength of electric forces.	• Electric Charge • Electric Force	• *Into Science: Physical Science* Unit 7 Electric & Magnetic Forces
Fields	4.5 days	• Conduct an investigation to provide evidence that fields exist between objects exerting forces on each other, even though the objects are not in contact.	• Field • Gravitational Field • Magnetic Field	• *Into Science: Physical Science* Unit 7 Electric & Magnetic Forces
Electromagnetism	5.5 days	• Demonstrate the relationship between electricity and magnetism.	• Electric Current • Electric Field • Electromagnetism • Electromagnet • Electromagnetic Induction	• *Into Science: Physical Science* Unit 7 Electric & Magnetic Forces
Unit Tests/ Labs	2.5 days			• *Into Science: Physical Science* Unit 7 Electric & Magnetic Forces
Standards List:	**MS-PS2-3, MS-PS2-5**			

UNIT 8: WAVES & INFORMATION TRANSFER				
Timing: Semester 2, Quarter 4 **Teaching Time Required:** 24.5 days **Textbook:** *Into Science* Unit 8				
Topic	**# Days**	**Objectives**	**Key Vocabulary**	**Resources & Materials**
Introduction to Waves	6 days	• Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.	• Wave • Medium • Amplitude • Frequency • Wavelength	• *Into Science: Physical Science* Unit 8 Waves & Information Transfer
The Behavior of Mechanical Waves	5 days	• Investigate the ways that light and sound interact with matter, expanding on wavelength, color, refraction, and reflection	• Mechanical Wave • Absorption • Transmission • Reflection • Refraction	• *Into Science: Physical Science* Unit 8 Waves & Information Transfer
The Behavior of Light Waves	5.5 days	• Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.	• Electromagnetic Waves	• *Into Science: Physical Science* Unit 8 Waves & Information Transfer
Information Transfer	5.5 days	• Support the claim that digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.	• Signal • Encoding • Analog Signal • Digital Signal • Noise	• *Into Science: Physical Science* Unit 8 Waves & Information Transfer
Unit Tests/ Labs	2.5 days			• *Into Science: Physical Science* Unit 8 Waves & Information Transfer
Standards List:	**MS-PS4-1, MS-PS4-2, MS-PS4-3**			

SCIENTIFIC PROCESS SKILLS

Timing: All year
Teaching Time Required: Varies
Textbook: Embedded throughout

Objectives

- Ask questions, predict, observe, describe, measure, classify, make generalizations, infer and communicate.
- Plan and carry out scientific investigations of various types (such as systematic observations or experiments), identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
- Select appropriate tools for collecting qualitative and quantitative data and record measurements (volume, mass, distance) in metric units.
- Develop a model describe phenomenon.
- Conduct research to learn how the local environment is used by a variety of competing interests (e.g. competition for habitat/resources, tourism, oil, mining companies, and hunting groups).
- Use standard safety practices for all classroom laboratory and field investigations.

The Fairbanks North Star Borough School District is an equal employment and educational opportunity institution, as well as tobacco and nicotine-free learning and work environment.

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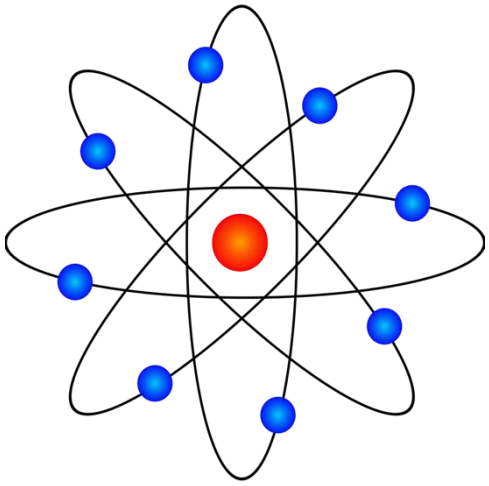
Fairbanks North Star Borough School District

Science Curriculum



Grades 9-12

2023-24 Revision – Draft 1

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Acknowledgements

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Science Researchers

Grades 6-12 science teachers met during professional development in August of 2022 to discuss and begin the research for science curriculum.

Department of Teaching and Learning

Chane Beam – Executive Director of Teaching and Learning
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Rachel Reilly – Curriculum Coordinator (2022-2023 school year)

We would also like to recognize

The Board Curriculum Committee, the Fairbanks North Star Board of Education, and the many teachers, administrators, parents, and community members who have provided input during the curriculum revision process.

Philosophy & Mission Statement

Graduates should be

EMPOWERED

critical thinkers who use evidence-based reasoning, and who have a duty to the natural world and their society.

Archived Courses

The following courses have been removed from the science curriculum and archived. If a teacher or school is interested in offering one of these courses in the future, they must fill out a pilot proposal form by the deadline listed at www.k12northstar.org/Page/8841; the course may be offered, pending Teaching and Learning and superintendent approval. If the school would like to look at the old curriculum for the course, contact Teaching and Learning at teachingandlearning@k12northstar.org or (907) 452-2000 ext. 11422.

Archived courses:

- Astrobiology
- Chem Tech
- Conceptual Physics
- Microbiology
- Natural Resources: Biology
- Natural Resources: Physical Science

Explanation of Terms

Alaska Science Standards
Science Standards were adopted by the State Board of Education in 2019. These are general statements of what Alaskans want students to know and be able to do as a result of their public school experience. https://education.alaska.gov/standards

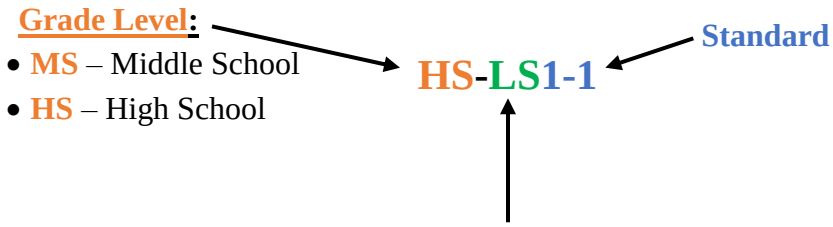
Alaska Cultural Standards
Standards endorsed by the State Board of Education that serve to encourage enrichment of the content standards. They are used as a guide to ensure that schools are aware of and sensitive to their surrounding physical and cultural environments.
https://education.alaska.gov/akstandards/#c3gtabs-cultural

Objectives
Statements that document specific, essential tasks students are expected to accomplish in a given grade level or course.

Guaranteed and Viable Curriculum (GVC)
A guaranteed and viable curriculum is one that guarantees equal opportunity for learning for all students. Similarly, it guarantees adequate time for teachers to teach content and for students to learn it. A guaranteed and viable curriculum is one that ensures that the curriculum being taught is the curriculum being assessed. It is viable when adequate time is ensured to teach all determined essential content.

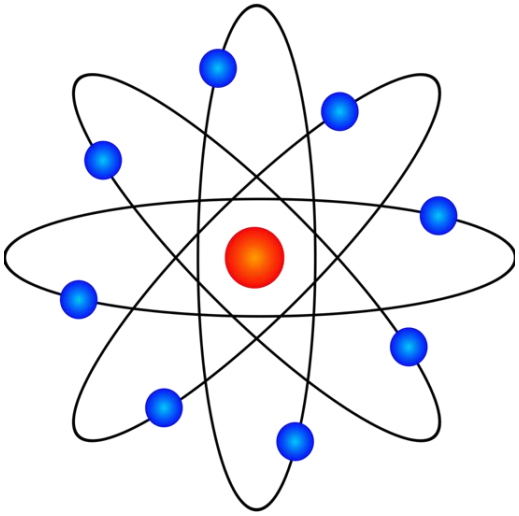
Standards Alignment Coding

This Science Curriculum is aligned to the Alaska Science Standards adopted in 2019, which are largely the same as the national Next Generation Science Standards (NGSS). The Alaska Science Standards provide a foundation for defining what students should know and be able to do in terms of scientific knowledge and skills. (https://education.alaska.gov/akstandards/science/science-standards-for-alaska.pdf)



Science Standards for Alaska Disciplinary Core Ideas	
Physical Sciences PS1: Matter and its interactions PS2: Motion and stability: Forces and interactions PS3: Energy PS4: Waves and their applications in technologies for information transfer	**Life Sciences** LS1: From molecules to organisms: Structures and processes LS2: Ecosystems: Interactions, energy, and dynamics LS3: Heredity: Inheritance and variation of traits LS4: Biological evolution: Unity and diversity
Earth and Space Sciences ESS1: Earth's place in the universe ESS2: Earth's systems ESS3: Earth and human activity	**Engineering, Technology, Applications of Science** ETS1: Engineering design

High School Science Courses



Grades 9-12

Introduction to High School Science

The Fairbanks North Star Borough School District (FNSBSD) High School Science Curriculum is designed to be interesting and rigorous. It also provides the background required to allow every student to interpret and use the scientific information that they need to make informed decisions in daily life. Upon graduation, students should be able to pursue science and technical careers if they choose.

Following national recommendations, the FNSBSD Science Curriculum Team recommends that science education in grades K-12 be built around three major dimensions. These dimensions are:

- Scientific and Engineering Practices.
- Crosscutting concepts that unify the study of science and engineering through their common application across fields.
- Core ideas in four disciplinary areas:
    - Physical Sciences
    - Life Sciences
    - Earth & Space Sciences
    - Engineering, Technology, & Applications of Science

To support students' meaningful learning in science and engineering, all three dimensions need to be integrated into standards, curriculum, instruction, and assessment. Engineering and technology are featured alongside the natural sciences (physical sciences, life sciences, and earth and space sciences) for two critical reasons:

1. To reflect the importance of understanding the human-built world, and
2. to recognize the value of better integrating the teaching and learning of science, engineering, and technology. (A Framework for K-12 Science Education, 2012)

Science Graduation Requirements

The student must complete a total of four credits (eight semesters) of high school science courses to include:

- 1.0 credits of Life Science
- 1.0 credits of Physical Science
- 2.0 credits of Science electives

Life Science Options	Physical Science Options	Science Electives
• *Alaska Zoology: Fish and Birds* • *Alaska Zoology: Mammals* • *AP Biology* • *AP Environmental Science (semester 1)* • *Biology* • *Environmental Science (semester 1)* • *Human Anatomy and Physiology* • *Introduction to Exercise Science and Sports Medicine* (CTE) • *Pre-AP Biology* • *Life Science* • *Marine Science* • *Medical Terminology* (CTE) • *Wildlife Biology*	• *Advanced Automotive Technology* (CTE) • *AP Chemistry* • *AP Environmental Science (semester 2)* • *AP Physics 1* • *AP Physics 2* • *AP Physics C: Mechanics* • *Chemistry* • *Earth & Space Science* • *Environmental Science (semester 2)* • *Physical Science* • *Physics* • *Principles of Engineering* (CTE)	• *Astronomy* • *Baking Breads and Pastry* (CTE) • *Engineering Design and Development 1A/1B* (CTE) • *Forensic Science 1* • *Forensic Science 2* • *Geology* • *Introduction to Basic Pathophysiology* • *Nutrition in Healthcare* (CTE) • *Paleontology* • *Pharmacy Technician* (CTE) • *Private Ground School 1A/1B* (CTE) • *Sports Nutrition* (CTE) • *Welding 1A/1B (CTE)* • *Welding 2A/2B* (CTE)

Life Science Options

Advanced Placement Biology

Grade(s): 11-12 **Length**: two semesters **Credit**: 1.0 **Prerequisites**: Teacher recommendation or *Biology* and *Chemistry*	**Course Overview**: *AP Biology* is an introductory college-level biology course. Students cultivate their understanding of biology through inquiry-based investigations as they explore the following topics: evolution, cellular processes, energy and communication, genetics, information transfer, ecology, and interactions. Please visit the College Board-AP Central website for more information (http://apcentral.collegeboard.com). **Adopted Textbook**: *Biology*. Glencoe/McGraw-Hill, 2017

Advanced Placement Environmental Science (semester 1)

Grade(s): 11-12 **Length**: two semesters **Credit**: 1.0 **Prerequisites**: Teacher recommendation, *Biology*, and *Chemistry*	**Course Overview**: The *AP Environmental Science* course is designed to engage students with the scientific principles, concepts, and methodologies required to understand the interrelationships within the natural world. The course requires that students identify and analyze natural and human-made environmental problems, evaluate the relative risks associated with these problems, and examine alternative solutions for resolving or preventing them. Environmental science is interdisciplinary, embracing topics from geology, biology, environmental studies, environmental science, chemistry, and geography. Please visit the College Board-AP Central website for more information (http://apcentral.collegeboard.com). **Semester one fulfills the Life Science graduation requirement and semester two fulfills the Physical Science requirement.**

Alaska Zoology: Fish & Birds

Grade(s): 9-12 **Length**: one semester **Credit**: 0.5 **Prerequisites**: Teacher recommendation or *Biology*	**Course Overview**: *Alaska Zoology: Fish & Birds* explores major Alaskan fish and bird groups. The general anatomy, physiology, and behavioral patterns of the major fish and bird groups found in Alaska are discussed. The course also includes game laws/regulations, and environmental issues including conservation. **Adopted Textbook**: "Alaska Wildlife Notebook Series" on the Alaska Department of Fish & Game (ADFG) website - http://www.adfg.alaska.gov/index.cfm?adfg=educators.notebookseries

Units (Recommended Order)
• Diversity of Organisms • Interdependence • Local Knowledge • Evolution

UNIT 1: DIVERSITY OF ORGANISMS	
Suggested Pacing: 6 weeks	**Textbook Chapter(s)/Lessons**: ADFG website
Key Objectives	**Suggested Activities & Resources**
Distinguish the patterns of similarity and diversity in the world of the major fish and bird groups of Alaska.	• Compare pictures of different Alaskan bird groups and devise unique classification schemes. • Compare pictures of different Alaskan fish groups such as salmon, halibut, pike or trout and devise unique classification schemes.
Identify the major fish and bird groups of Alaska including general anatomy, physiology, and behavioral patterns.	
Explain how the diversity of present species through evolution fills all available niches with organisms.	
Construct an explanation based on evidence that the process of evolution primarily results from four factors: • The potential for a species to increase in number. • The heritable genetic variation of individuals in a species due to mutation and sexual reproduction. • Competition for limited resources. • The proliferation of those organisms that are better able to survive and reproduce in the environment.	
Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.	
Standards List:	**LS3.A: Inheritance of Traits:** HS-LS3.1; **LS3.B: Variation of Traits:** HS-LS3.2; HS-LS3.3; **LS4.C: Adaptation:** HS-LS4.2; HS-LS4.3; HS-LS4.4; HS-LS4.5

UNIT 2: INTERDEPENDENCE	
Suggested Pacing: 4 weeks	**Textbook Chapter(s)/Lessons**: ADFG website
Key Objectives	**Suggested Activities & Resources**
Know that the living environment of the major Alaskan fish and bird groups consists of individuals, populations, and communities. Discuss Alaska ecosystems and environmental issues and their relationship and impact on the major Alaskan fish and bird groups. Evaluate the evidence supporting claims that changes in environmental conditions may result in: • Increases in the number of individuals of some species. • The emergence of new species over time. • The extinction of other species	• Dissect different Alaskan fish including salmon and halibut. • Go on a field trip to Chena Landing, Ester Dome, and/or Creamer's Field. • Invite an Alaska Native elder to share in cultural relevance.
Standards List:	**LS4.C: Adaptation:** HS-LS4.2; HS-LS4.3; HS-LS4.4; HS-LS4.5

UNIT 3: LOCAL KNOWLEDGE	
Suggested Pacing: 4 weeks	**Textbook Chapter(s)/Lessons**: ADFG website
Key Objectives	**Suggested Activities & Resources**
Read and review the laws and regulations that govern Alaska game management. Discuss the economic impact of trapping and hunting of the major fish and bird groups of Alaska. Discuss the economic impact of trapping and hunting of the major fish and bird groups of Alaska. Evaluate the 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. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.	• Invite a local falconer to speak. • Invite a subsistence fisherman to present.
Standards List:	**LS2.C: Ecosystem Dynamics, Functioning, & Resilience:** HS-LS2.6; HS-LS2.7; HS-LS2.8; **LS4.D: Biodiversity & Humans:** HS-LS4.4; HS-LS4.5; HS-LS4.6

UNIT 4: EVOLUTION	
Suggested Pacing: 4 weeks	**Textbook Chapter(s)/Lessons**: ADFG website
Key Objectives	**Suggested Activities & Resources**
Describe how species evolve over time due to recombination and mutations of genes.	• Investigate changes in morphology of bird parts (e.g., wings, beaks) over time. • Investigate genetic changes in a single fish species to take advantage of habitat (halibut: bottom feeders).
Know that variation in a species increases survival opportunities.	
Explain how the diversity of present species fills all available niches with organisms.	
Understand why natural selection is the scientific explanation for fossils and for molecular similarity of present species.	
Describe classifications based on evolutionary relationships.	
Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.	
Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.	
Make and defend a claim based on evidence that inheritable genetic variations may result from: • New genetic combinations through meiosis. • Viable errors occurring during replication. • Mutations caused by environmental factors.	
Standards List:	**LS3.A: Inheritance of Traits:** HS-LS3.1; HS-LS3.2; HS-LS3.3; **LS4.B: Natural Selection:** LS4.2; LS4.3

Alaska Zoology: Mammals

Grade(s): 9-12 **Length**: one semester **Credit**: 0.5 credits **Prerequisites**: Teacher recommendation or *Biology*	**Course Overview**: *Alaska Zoology: Mammals* explores major Alaskan mammal groups. The general anatomy, physiology, and behavioral patterns of the major Alaskan mammal groups are discussed. The course will also include game laws/regulations, and environmental issues including conservation. **Adopted Textbook**: : "Alaska Wildlife Notebook Series" on the Alaska Department of Fish & Game (ADFG) website - http://www.adfg.alaska.gov/index.cfm?adfg=educators.notebookseries

Units (Recommended Order)
• Diversity of Organisms • Interdependence • Local Knowledge • Evolution

UNIT 1: DIVERSITY OF ORGANISMS	
Suggested Pacing: 6 weeks	**Textbook Chapter(s)/Lessons**: ADFG website
Key Objectives	**Suggested Activities & Resources**
Distinguish the patterns of similarity and diversity in the world of major mammal groups of Alaska.	• Compare pictures of different Alaskan mammal groups and devise a unique classification scheme.
Identify the major mammal groups of Alaska including general anatomy, physiology, and behavioral patterns.	
Explain how the diversity of present species through evolution fills all available niches with organisms.	
Evaluate the 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.	
Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.	
Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce.	
Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.	
Standards List:	**LS2.C: Ecosystem Dynamics, Functioning, & Resilience:** HS-LS2.6, HS-LS2.7, HS-LS2.8; **LS3.A: Inheritance of Traits:** HS-LS3.1, HS-LS3.2, HS-LS3.3; **LS4.C: Adaptation:** HS-LS4.2, HS-LS4.3, HS-LS4.4, HS-LS4.5, HS-LS4.6

UNIT 2: INTERDEPENDENCE	
Suggested Pacing: 4 weeks	**Textbook Chapter(s)/Lessons**: ADFG website
Key Objectives	**Suggested Activities & Resources**
Know that the environment of the major Alaskan mammal groups consists of individuals, populations, and communities. Discuss Alaska ecosystems and environmental issues and their relationship and impact on the major Alaskan mammal groups. Evaluate the evidence supporting claims that changes in environmental conditions may result in: • Increases in the number of individuals of some species. • The emergence of new species over time. • The extinction of other species.	• Dissect different Alaskan mammals. • Go on a field trip to Chena Landing, Ester Dome, or Creamer's Field. • Invite an Alaska Native elder to share the cultural relevance of Alaskan mammals.
Standards List:	**LS4.C: Adaptation:** HS-LS4.2, HS-LS4.3, HS-LS4.4, HS-LS4.5

UNIT 3: LOCAL KNOWLEDGE	
Suggested Pacing: 4 weeks	**Textbook Chapter(s)/Lessons**: ADFG website
Key Objectives	**Suggested Activities & Resources**
Read and review the laws and regulations that govern Alaska game management. Discuss the economic impact of trapping and hunting on the major mammal groups of Alaska. Evaluate the 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. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.	• Invite game wardens from U.S. Fish and Wildlife and Alaska Fish & Game speak. • Create a Student Game Guide.
Standards List:	**LS2.C: Ecosystem Dynamics, Functioning, & Resilience:** HS-LS2.6, HS-LS2.7, HS-LS2.8; **LS4.D: Biodiversity & Humans:** HS-LS4.6

<table>
<tr><th colspan="2">UNIT 4: EVOLUTION</th></tr>
<tr><td>Suggested Pacing: 4 weeks</td><td>Textbook Chapter(s)/Lessons: ADFG website</td></tr>
<tr><th>Key Objectives</th><th>Suggested Activities & Resources</th></tr>
<tr><td>Describe how species evolve over time due to recombination and mutations of genes.</td><td rowspan="8">Read and discuss The Origin of Species.
Create a 3D model of an environmental barrier.
Classify different fossils based on different characteristics.
Create a poster of stratigraphic sequence showing fossil change in one species.</td></tr>
<tr><td>Know that variation in a species increases survival opportunities.</td></tr>
<tr><td>Explain how the diversity of present species fills all available niches with organisms.</td></tr>
<tr><td>Understand why natural selection is the scientific explanation for fossils and for molecular similarity of present species.</td></tr>
<tr><td>Describe classifications based on evolutionary relationships.</td></tr>
<tr><td>Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.</td></tr>
<tr><td>Make and defend a claim based on evidence that inheritable genetic variations may result from:
New genetic combinations through meiosis.
Viable errors occurring during replication.
Mutations caused by environmental factors.</td></tr>
<tr><td>Standards List:</td><td colspan="2">LS3.A: Inheritance of Traits: HS-LS3.1; LS4.B: Natural Selection: HS-LS4.2, HS-LS4.3</td></tr>
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Biology

Grade(s): 9-12 **Length**: two semesters **Credit**: 1 **Prerequisites**: Teacher recommendation or *Earth and Space Science* or *Physical Science*	**Course Overview**: *Biology* is designed to meet the Biological Science requirement for graduation. The academic focus is to develop student reading, writing, processing, and organizational skills. The scientific focus is to improve science vocabulary, scientific observation, inquiry, experimentation, and analysis skills. Safety skills will be stressed each semester. The first semester begins with the study of cells, cell structures and their functions, protein synthesis, genetics, and the study of heredity. Second semester will include evolution, characteristics of multicellular organisms with attention to organs and organ systems, and the diversity of organisms and ecology. **Adopted Textbook**: *Inquiry Hub Storylines*. Kendall Hunt

Units (Recommended Order)	
Semester 1	**Semester 2**
• Scientific Method (throughout the course) • Ecology • Chemistry of Life • Genetics and Heredity • Biotechnology • Evolution • Cytology	• Ecology • Chemistry of Life • Evolution • Biotechnology • Genetics and Heredity • Cytology

SCIENTIFIC METHOD	
Suggested Pacing: Intermixed through other units	**Textbook Chapter(s)/Lessons**: Africa Storyline and Homeostasis Storyline
Key Objectives	**Suggested Activities & Resources**
• Design experiments that require asking questions, developing hypotheses, collecting data, interpreting data, and developing conclusions. • 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.	• Macromolecules in Food Lab • Ocean Acidification Lab • Elephant Poop Lab
• Use graphical techniques to describe data. • Use mathematical and/or computational representations of phenomena or design solutions to support explanations. • Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments. • 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.	• Labs that incorporate quantitative data • Examples: Pendulum Lab, Zookeeper Nutrition Lab, Elephants Population Lab, Calculating Evolution Lab
• Critically review current literature about scientific topics. • Practice formulating logical conclusions. • Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. • 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.	• Practice writing Claim Evidence Reasoning (CER) reports
Standards List:	**GLEs: S.A.1**-, Developing and Using Models, Planning and Carrying Out Investigations, Constructing Explanations and Designing Solutions, Using Mathematics and Computational Thinking, Engaging in Argument from Evidence, Asking Questions and Defining Problems, Analyzing and Interpreting Data, Obtaining, Evaluating, and Communicating Information

<table>
<tr><th colspan="3">UNIT 1: ECOLOGY</th></tr>
<tr><td colspan="2">Suggested Pacing: 4-6 weeks</td><td>Textbook Chapter(s)/Lessons: Africa Storyline, Homeostasis Storyline, and Melanin Storyline</td></tr>
<tr><th colspan="2">Key Objectives</th><th>Suggested Activities & Resources</th></tr>
<tr><td colspan="2">• Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem (e.g., carbon, energy, water).
• Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.</td><td>• Model ecosystem energy transfers.
• Make posters of food webs/chains from local habitats.
• Describe specific ways in which indigenous people use local species.
• Individual research projects on local plants and animal species.
• Arctic Ecosystems Lab</td></tr>
<tr><td colspan="2">• Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales, specifically in Alaskan ecosystems.
• Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.
• Describe symbiotic interactions between organisms in a community.</td><td>• What Happened to the Otters Lab
• Carrying Capacity Lab</td></tr>
<tr><td colspan="2">• Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.</td><td>• Use web-based data to graph the extent of sea ice in the Arctic Ocean since 1970.
• Explore the causes of that change and its consequences on the organisms of the Arctic.
• Invasive plant studies.
• Discussions of current ecological issues.
• Ocean Acidification Lab</td></tr>
<tr><td>Standards List:</td><td colspan="2">HS-LS2: Ecosystems: Interactions, Energy, and Dynamics, LS2.A: Interdependent Relationships in Ecosystems, LS2.B: Cycles of Matter and Energy Transfer in Ecosystems, LS2.C: Ecosystem Dynamics, Functioning, and Resilience, HS-LS4: Biological Evolution: Unity and Diversity, LS4.D: Biodiversity and Humans, GLEs: SC.2-3</td></tr>
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UNIT 2: CHEMISTRY OF LIFE	
Suggested Pacing: 4-6 weeks	**Textbook Chapter(s)/Lessons**: Africa Storyline and Homeostasis Storyline
Key Objectives	**Suggested Activities & Resources**
• Describe and model the basic atomic structure.	• PhET Digital Lab on Atoms Elements & Compounds • Animal Digestion Lab
• 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.	• Flow chart-type drawings of cellular respiration. • Cellular Respiration Lab
• Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.	• Flow chart-type drawings of photosynthesis. • Understanding Photosynthesis Activity
• 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.	• Build Models of Macromolecules • Macromolecule Food Testing Lab • Zookeeper Nutrition Lab
Standards List:	**LS1.C** Organization for Matter and Energy Flow in Organisms, HS-PS3.D: Energy in Chemical Processes

UNIT 3: GENETICS AND HEREDITY	
Suggested Pacing: 3-5 weeks	**Textbook Chapter(s)/Lessons**: Africa Storyline, Melanin Storyline, and Disease Storyline
Key Objectives	**Suggested Activities & Resources**
• Recognize that cells use DNA to store information and manage cellular functions. • Describe the role of chromosomes in gender determination.	• Student-built models of DNA.
• Make and defend a claim based on evidence that inheritable genetic variations may result from: (a) new genetic combinations through meiosis, (b) viable errors occurring during replication, and/or (c) mutations caused by environmental factors. • Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population.	• Human traits activity. • Punnett squares activity. • Lulu the Lioness Lab • Albinism & Pedigrees Lab
• 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.	• Melanin Lab • Central Dogma of Biology Activity
Standards List:	**HS-LS1**: From Molecules to Organisms: Structures and Processes, **HS-LS3: Heredity: Inheritance and Variation of Traits,** LS3.A: Inheritance of Traits, LS3.B: Variation of Traits, **GLEs**: SC.1-2

UNIT 4: BIOTECHNOLOGY	
Suggested Pacing: 4-6 weeks	**Textbook Chapter(s)/Lessons**: Africa Storyline, Melanin Storyline, and Disease Storyline
Key Objectives	**Suggested Activities & Resources**
• Recognize that cells use DNA to store information and manage cellular functions. • 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.	• Restriction Enzyme Lab • Strawberry Electrophoresis • CRISPR Activity
• Critically review current literature about scientific topics.	• Research project on current advances in biotechnology • Bioethics Research
Standards List:	Engaging in Argument from Evidence, Asking Questions and Defining Problems, Analyzing and Interpreting Data, Obtaining, Evaluating, and Communicating Information, **HS-LS1**: From Molecules to Organisms: Structures and Processes, **LS4.D**: Biodiversity and Humans

UNIT 5: EVOLUTION	
Suggested Pacing: 6-8 weeks	**Textbook Chapter(s)/Lessons**: Africa Storyline, Homeostasis Storyline, Melanin Storyline, and Disease Storyline
Key Objectives	**Suggested Activities & Resources**
• Utilize tools to categorize organisms (i.e., taxonomic keys, cladograms). • Describe the characteristics of domains and kingdoms of organisms. • Explain the relationship between structure and function in major phyla. • Describe classification based on evolutionary relationships.	• UC Berkeley Evolution website: http://evolution.berkeley.edu. • Natural selection simulations. • Build a bird.
• Describe the changes that have occurred over geologic time. • Chronicle the development of evolutionary theory by natural selection. • Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence (homologous structures, embryology, DNA, adaptive radiation, fossil record). • Construct an explanation based on evidence for how natural selection leads to adaptation of populations. • 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. • Explain how variation within a species and natural selection could result in speciation or extinction.	• Fossil building simulations. • Interpretation of fossil exercises. • Geological Time activities • Elephant Forensics Lab
• Explain how the diversity of life has arisen through evolutionary processes. • Describe how variation within species is maintained over time through recombination and mutations of genes. • 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.	• Peppered Moth activity. • Rock Pocket Mice activity. (HHMI) • Toothpick Fish. • What Happened to the Elephants Lab • Melanin Lab • Evidence for Skin Selection Lab
Standards List:	**HS-LS4**: Biological Evolution: Unity and Diversity, LS4.A Evidence of Common Ancestry and Diversity, **LS4.B**: Natural Selection, **LS4.C:** Adaptation, **LS4.D**: Biodiversity and Humans, **HS-LS1:** From Molecules to Organisms: Structures and Processes, **LS1.A**: Structure and Function, **GLEs:** S.A.1; SC.1-2; SG.1-3

UNIT 6: CYTOLOGY	
Suggested Pacing: 4-6 weeks	**Textbook Chapter(s)/Lessons**: Africa Storyline, Homeostasis Storyline, Melanin Storyline
Key Objectives	**Suggested Activities & Resources**
• Describe cell organelles and their functions. Systems of specialized cells within organisms help them perform the essential functions of life.	• Models of plant and animal cells. • Microscope skills labs including wet mounts of plant and animal cells and cell drawings.
• Describe diffusion and osmosis and the importance of these processes for cells.	• Predictions and tests of the behavior of cells in salt solutions and distilled water. • 3D molecular models of diffusion and osmosis. • Computer animations of diffusion and osmosis. • Student-built models of DNA. • Labs examining the diffusion of materials into different sized objects. • Ocean Acidification Lab
• Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms. • Describe the process of cell division and its role in reproduction and multicellular organisms (mitosis and meiosis).	• Use a cell model to work through all the steps of mitosis and meiosis.
Standards List:	**HS-LS1**: From Molecules to Organisms: Structures and Processes, LS1.A: Structure and Function, LS1.B: Growth and Development of Organisms

Environmental Science 1A/1B

Grade(s): 9-11 **Length**: two semesters **Credit**: 1 (0.5 life science credit and 0.5 physical science credit) **Prerequisites**: Teacher recommendation	**Course Overview**: Students in this course explore systems and the ways in which human systems affect and are affected by environmental systems. Students approach environmental issues by understanding ecological components and human perspectives. Students address bias and misunderstandings to develop their own opinions about environmental issues. This course focuses on climate change, natural resources, pollution, and energy, and uses all fields of sciences to help students form educated opinions and solutions based on evidence about current and future environmental problems facing society. **Semester one (1A) fulfills the Life Science graduation requirement and semester (1B) two fulfills the Physical Science requirement.** **Adopted Textbook**: To be determined (Used to develop this curriculum: *Environmental Science*. National Geographic, 2022)

Units (Recommended Order)	
Semester 1 (1A)	**Semester 2 (1B)**
• Introduction to Environmental Science • Ecology • Biodiversity • Human Populations	• Systems in Environmental Science • Climate Science • Natural Resources • Pollution and Waste Management • Concepts of Energy

UNIT 1: INTRODUCTION TO ENVIRONMENTAL SCIENCE	
Suggested Pacing: 4-5 weeks	**Textbook Chapter(s)/Lessons**: Chapters 1 and 18
Key Objectives	**Suggested Activities & Resources**
• Explain What Science Is & the focus of Environmental Science • Describe The Process Of Science • Describe the major roles of the scientific community the process of science	• Oasis Earth: Planet in Peril (free textbook)
• Describe the recent trends human population and resource consumption • Explain the relationship between economics and the environment	
• Describe ways that economics are working towards sustainability • Explain the purpose of environmental policy	
Standards List:	**GLEs: S.A.1-,** Asking Questions and Defining Problems, Obtaining, Evaluating and Communicating Information, **LS2.A:**Interdependent Relationships in Ecosystems

UNIT 2: ECOLOGY	
Suggested Pacing: 4-5 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
• Describe the different levels of organization studied by ecologists • Explain the difference between biotic and abiotic factors • Explain how limiting factors and biotic potential affect population growth	• Case Study: Caribou Conservation Conundrum • Case Study: Mystery in Alaska • Case Study: The Moose, The Wolf, and the Fir Tree • ESRI Geoinquiries • Treehugger
• Compare and contrast predation, parasitism,and herbivory • Describe mutualism and commensalism • Explain the difference between a producer and a consumer	
• Explain what a biogeochemical cycle is and recognize that nutrients cycle through the environment endlessly • Summarize the roles of producers and consumers in carbon cycle Including chemical formulas for photosynthesis and cellular respiration	
Standards List:	**GLEs: S.A.1**-, Developing and Using Models, Planning and Carrying Out Investigations, Analyzing and Interpreting Data, **LS2.A**:Interdependent Relationships in Ecosystems, **LS2.B:**Cycles of Matter and Energy Transfer in Ecosystems, **LS2.C**:Ecosystem Dynamics, Functioning and Resilience

<table>
<tr><th colspan="2">UNIT 3: BIODIVERSITY</th></tr>
<tr><td>Suggested Pacing: 4-5 weeks</td><td>Textbook Chapter(s)/Lessons: Chapters 4, 5, 6, 7, and 8</td></tr>
<tr><th>Key Objectives</th><th>Suggested Activities & Resources</th></tr>
<tr><td>• Explain how biomes are characterized
• Describe how net primary production varies among biomes
• Describe the four primary mechanisms of biological evolution</td><td rowspan="3">• HHMI Biointeractive Biome Viewer
• HHMI Biointeractive short film “From Ants to Grizzlies: A General Rule for Saving Biodiversity”
• HHMI Biointeractive: “Mystery of the Missing Tusks”
• Case Study: Complexity in Conservation
• ESRI Geoinquiries</td></tr>
<tr><td>• Describe how speciation and extinction affect the diversity life on Earth
• Differentiate the components of biodiversity
• Explain two ways in which biodiversity varies across groups or geography
• Describe how biodiversity is monitored and explain current biodiversity trends</td></tr>
<tr><td>• List the major causes of biodiversity loss
• Explain legal actions nations can take to protect biodiversity
• Explain the conditions necessary for a species to become invasive</td></tr>
<tr><td>Standards List:</td><td colspan="2">GLEs: S.A.1-, Planning and Carrying Out Investigations, Constructing Explanations and Designing Solutions, Engaging in Argument from Evidence, LS4.B: Natural Selection, LS4.C: Adaptation, LS4.D:Biodiversity and Humans, ESS3.C: Human Impacts on Earth Systems, ETS1.B: Developing Possible Solutions</td></tr>
</table>

UNIT 4: HUMAN POPULATIONS	
Suggested Pacing: 4-5 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
• Describe how technological advances have contributed to human population growth • Explain recent trends in population growth • Describe total fertility rates and replacement fertility • Explain how the age structure and sex ratio of a population define its potential for growth	• ESRI Geoinquiries
• Identify characteristics of human population that are studied by demographers • Describe the demographic transition • Discuss social factors that affect population • List the types of environmental health hazards	
• Describe how humans impact their environments • Compare and contrast epidemiology and toxicology • Discuss risk assessment • Describe how infectious diseases spread • Explain why emerging diseases are important to monitor and control • Differentiate between social hazards that are lifestyle choices and those that cannot controlled	
• **Standards List:**	**GLEs: S.A.1-,** Using Mathematics and Computational Thinking, Constructing Explanation and Designing Solutions, **LS2.A:** Interdependent Relationships in Ecosystems, **LS2.C:** Ecosystem Dynamics, Functioning and Resilience, **ESS3.A**: Natural Resources

UNIT 5: PHYSICAL SYSTEMS IN ENVIRONMENTAL SCIENCE	
Suggested Pacing: 4-5 weeks	**Textbook Chapter(s)/Lessons**: Chapter 3
Key Objectives	**Suggested Activities & Resources**
• State the definition of an environmental system and give examples • Explain that the geosphere, biosphere, atmosphere, and hydrosphere are defined according to their functions Earth's systems • Explain the importance of the cycling of nutrients, both macro and micro to all life on Earth	• Selected chapters and data-based activities from the "Earth Exploration Toolbook" • HHMI Biointeractive: "Understanding Global Change" Interactive
• Identify the layers of the atmosphere in the correct order • Explain how the ozone layer protects us from harmful ultraviolet radiation	
• Connect plate tectonics to environmental science concepts such as biogeochemical cycles, volcanoes and air pollution, geothermal energy, earthquakes, and risk assessment	
Standards List:	**GLEs: S.A.1-,** Developing and Using Models, Using Mathematics and Computational Thinking, **LS2.B:** Cycles of Matter and Energy Transfer in Ecosystems, **LS2.C:** Ecosystem Dynamics, Functioning and Resilience, **ESS2.A**: Earth's Materials and Systems, **ESS2.B:** Plate Tectonics and Large Scale System Interactions

UNIT 6: CLIMATE SCIENCE	
Suggested Pacing: 4-5 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
• Distinguish between weather and climate and list the factors that affect them • Use conduction, convection, and radiation to explain how heat is transferred in the environment • Explain the reason for the seasons	• Selected chapters and data-based activities from the "Earth Exploration Toolbook" • HHMI BioInteractive lesson: "Trends in Atmospheric Carbon Dioxide" • PBS Lab: "Seasons on Earth" • Earth Labs: "Greenhouse Gas Lab" • Data Nuggets lab on tree ring analysis: "A Window Into a Tree's World" • SPRINTT Climate Change Curriculum • Project Learning Tree Unit: "Southeastern Forests and Climate Change" • Documentary Film *Cosmos* Episode 12: "The World Set Free"
• Identify greenhouse gasses and their sources • Explain how scientists study changes in climate • Describe the evidence indicating that global warming has been caused largely by the increase in greenhouse in the atmosphere	
• Describe how global climate change is affecting aspects of human life such farming,forestry, the economy, livingspace, health,and biodiversity • List ways of reducing the production of greenhouse gasses and explain why this is important	
Standards List:	**GLEs: S.A.1-** Planning and Carrying Out Investigations, Asking Questions and Defining Problems, Analyzing and Interpreting Data, **ESS2.D**: Weather and Climate, **ESS3.D**: Global Climate Change

<table>
<tr><th colspan="3">UNIT 7: NATURAL RESOURCES</th></tr>
<tr><td colspan="2">Suggested Pacing: 3 weeks</td><td>Textbook Chapter(s)/Lessons: Chapters 11, 12, and 13</td></tr>
<tr><th colspan="2">Key Objectives</th><th>Suggested Activities & Resources</th></tr>
<tr><td colspan="2">• Explain why agricultural lands can lose productivity over time as nutrients are consumed and what are current soil conservation methods
• Describe human practices that may lead to soil erosion and techniques that can mitigate it</td><td rowspan="3">• Selected chapters and data-based activities from the “Earth Exploration Toolbook”
• Alaska Resource Education Curriculum: “The Story of Alaska’s Mineral and Energy Resources”
• Virtual Tour of Copper Mine
• Project Wet Activities - see website to access guides and resources
• Documentary Film: The Last Mountain
• Case Study: The Poopin Composting
• CaseStudy: “The Wealth of Water”</td></tr>
<tr><td colspan="2">• Describe the most common methods of mining and their environmental consequences
• Describe how different minerals are formed and are cycled through the Earth
• Identify mineral resources available in Alaska and how their mining affects humans and the environment, including mining regulations</td></tr>
<tr><td colspan="2">• Identify how water is used in society and how water use affects ecosystems.(agricultural, industrial, residential, recreational)
• Explain what a watershed is and give an example local to Fairbanks
• Identify the distribution of water on Earth. (surface, groundwater, icecaps, ocean)</td></tr>
<tr><td>Standards List:</td><td colspan="2">GLEs: S.A.1- Planning and Carrying Out Investigations, Constructing Explanations and Designing Solutions, ESS3.A: Natural Resources, ESS2.E: Biogeology, ESS3.C: Human Impacts on Earth Systems</td></tr>
</table>

UNIT 8: POLLUTION AND WASTE MANAGEMENT	
Suggested Pacing: 3 weeks	**Textbook Chapter(s)/Lessons**: Chapters 9, 10, 16, and 17
Key Objectives	**Suggested Activities & Resources**
• Describe different types of water pollution, its sources and treatment • Describe different types of air pollution caused by human activity and natural processes, its sources and treatment • List different ways environmental policies have reduced pollution in the US and globally	• Selected chapters and data-based activities from the "Earth Exploration Toolbook" • Air Actions Curriculum (background reading, labs, video labs on air quality)
• Describe the conventional methods of waste disposal; landfills, incinerators and recycling • Discuss the importance of waste reduction and what we as consumers can do about it (the 3 R's reduce, reuse, recycle)	
• Discuss hazardous waste, identify common everyday items that are hazardous waste and associated problems with its disposal. (e-waste, cfl's, batteries etc.)	
Standards List:	**GLEs: S.A.1**- Planning and Carrying Out Investigations, Constructing Explanations and Designing Solutions, **ESS2.C:** The Roles of Water in Earth's Surface Processes, **ESS3.A**: Natural Resources, **ESS3.C:** Human Impacts on Earth Systems

UNIT 9: CONCEPTS OF ENERGY	
Suggested Pacing: 3 weeks	**Textbook Chapter(s)/Lessons**: Chapter 2
Key Objectives	**Suggested Activities & Resources**
• Describe the different forms of energy and how they can be harnessed for human use • Describe how although energy cannot be created or destroyed it can be converted to less useful forms such as thermal energy in the environment	• Email Renewable Energy Alaska Project (REAP) at education@realaska.org to request a guest speaker to lead an energy activity using Kill-A-Watt Meters • "Renewable Energy Atlas of Alaska" - information about renewable energy resources in Alaska • Documentary Movie: *Who Killed the Electric Car* • *National Energy Education Development (NEED)* project curriculum guides • Case Study: "A Green Light for CFLs?"
• Make connections between types of renewable and nonrenewable energy and the sun as the initial source energy • Identify the pros and cons of using fossil fuels and other nonrenewable sources of energy • Describe types of fossil fuels used, how they have formed, and are extracted	
• Describe alternative energy resources and how they may be harnessed and used • Identify the pros and cons of using different renewable resources (solar, wind, hydro, geothermal)	
Standards List:	**GLEs: S.A.1**- Engaging in Argument from Evidence, Obtaining, Evaluating, and Communicating Information**, PS3.A**: Definitions of Energy, **PS3.B:** Conservation of Energy and Energy Transfer, **ESS3.A:** Natural Resources, ESS3.C: Human Impacts on Earth Systems, **ESS3.D**: Global Climate Change

Human Anatomy & Physiology

Grade(s): 11-12 **Length**: one semester **Credit**: 0.5 **Prerequisites**: Teacher recommendation or *Biology*	**Course Overview**: *Human Anatomy & Physiology* is a course that advanced students will learn about the major organ systems of the human body and how they work together to sustain life and maintain health. Academic skills will focus on independent reading and analysis. Content focus will be on the relationship between the structure (anatomy) of organs and organ systems and the functions (physiology) of those systems. Students will have the opportunity to study how health life choices can help to enhance the functioning of those systems; they will also be introduced to the many careers available in the modern health care system. **Adopted Textbook**: *Body Structures and Functions*. National Geographic/Cengage, 2022.

Units (Recommended Order)
• Basis of Anatomy and Physiology • Nervous and Endocrine Systems • Muscular System • Skeletal System • Circulatory and Respiratory Systems – Macro: Lungs, Heart, and Vessels • Circulatory Systems – Micro: Cells, Proteins, lymph, and Immunity • Digestive System • Reproductive System

<table>
<tr><th colspan="3">UNIT 1: BASIS OF ANATOMY AND PHYSIOLOGY</th></tr>
<tr><td colspan="2">Suggested Pacing: 1-2 weeks</td><td>Textbook Chapter(s)/Lessons: Chapters 2 and 3.</td></tr>
<tr><th colspan="2">Key Objectives</th><th>Suggested Activities & Resources</th></tr>
<tr><td colspan="2">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.</td><td rowspan="6">View and discuss Deadly Ascent; a Nova film about the challenges of high altitude.
Make drawings of examples of the four tissue types.
Dissect celery using anatomical terms.
Produce a pamphlet that describes the symptoms, causes, and treatments of a disease affecting one of the four major types of tissues.</td></tr>
<tr><td colspan="2">Describe the structure and function of the major types of cells.</td></tr>
<tr><td colspan="2">Describe levels of organization in the human body.</td></tr>
<tr><td colspan="2">Describe the structure and function of the major types of cells.</td></tr>
<tr><td colspan="2">Demonstrate understanding of homeostasis and how it is maintained by the body.</td></tr>
<tr><td colspan="2">Plan and conduct an investigation to provide evidence that feedback mechanisms maintain homeostasis.</td></tr>
<tr><td>Standards List:</td><td colspan="2">LS1.A: Structure & Function: HS-LS1.1, HS-LS1.3, HS-LS3.1</td></tr>
</table>

UNIT 2: NERVOUS AND ENDOCRINE SYSTEMS	
Suggested Pacing: 1-2 weeks	**Textbook Chapter(s)/Lessons**: Chapters 9, 10, and 12.
Key Objectives	**Suggested Activities & Resources**
Explain the role of nervous and endocrine systems in coordinating the functions of the whole organisms.	• Class visit from community experts on steroid abuse and traumatic brain injuries. • Labs testing the sensory neurons of skin. • Visit from pathologist with brain tissue. • Dissect a cow's eye. • Lab: Hormones.
Explain how a nervous impulse travels.	
Describe the major parts of the brain.	
Explain the role of sensory organs.	
Describe how negative feedback systems function to control hormone levels.	
Explain the role of hormones in responding to stress.	
Explain the function of some of the most important hormones in the body.	
Be familiar with some disorders caused by malfunctions within this system.	
Standards List:	**LS1.A: Structure & Function:** HS-LS1.1, HS-LS1.2, HS-LS1.3, HS-LS3.1

UNIT 3: MUSCULAR SYSTEM	
Suggested Pacing: 2-3 weeks	**Textbook Chapter(s)/Lessons**: Chapter 8
Key Objectives	**Suggested Activities & Resources**
Identify the three types of muscle cells and their functional differences.	• Invite a physical therapist to demonstrate the skills required for successful therapy. • Identify muscular systems and how they control movement. • Draw and label muscles on a life-sized model.
Explain the molecular mechanism for muscular contraction.	
Describe systems of opposing muscles.	
List the major groups of skeletal muscles.	
Give examples of how the skeletal system maintains homeostasis by controlling the level of calcium in the blood.	
Be familiar with some disorders caused by malfunctions within this system.	
Standards List:	**LS1.A: Structure & Function:** HS-LS1.1, HS-LS1.2, HS-LS3.1

UNIT 4: SKELETAL SYSTEM	
Suggested Pacing: 2-3 weeks	**Textbook Chapter(s)/Lessons**: Chapter 7
Key Objectives	**Suggested Activities & Resources**
Explain how bones can grow over the lifetime of the person.	
Be familiar with some disorders caused by malfunctions within this system.	
Standards List:	**LS3.B: Variation of Traits:** HS-LS3.2, HS-LS3.3

UNIT 5: CIRCULATORY AND RESPIRATORY SYSTEMS – MACRO: LUNGS, HEART AND VESSELS	
Suggested Pacing: 1-2 weeks	**Textbook Chapter(s)/Lessons**: Chapters 14, 15, and 18.
Key Objectives	**Suggested Activities & Resources**
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.	• Examine and draw a pig heart. • Learn to measure blood pressure. Examine the effects of exercise on pulse and blood pressure. • Coloring models of the four-chambered heart. • Dissect the major arteries and veins of the fetal pig. Look at the fetal circulation through the umbilical cord. • Life size sketch with major vessels drawn and labeled.
Explain the role of alveoli oxygenating blood.	
Give examples of how negative feedback loops in the circulatory system maintain homeostasis.	
Give examples of how positive feedback loops decrease homeostatic stability.	
Label the major vessels of the body.	
Explain the structure of the heart and how its form follows its function.	
Describe the structure of the body's vessels.	
Be familiar with some disorders caused by malfunctions within this system.	
Standards List:	**LS1.C: Organization for Matter and Energy Flow in Organisms:** HS-LS1.6, HS-LS1.7

UNIT 6: CIRCULATORY SYSTEMS – MICRO: CELLS, PROTEINS, LYMPH, AND IMMUNITY	
Suggested Pacing: 2-3 weeks	**Textbook Chapter(s)/Lessons**: Chapters 4 and 16
Key Objectives	**Suggested Activities & Resources**
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.	• Blood type testing with a school nurse. • Use Punnett Squares to determine the genetics of blood typing.
Describe the role of hemoglobin in oxygenating tissues.	
Describe the ABO and RH proteins on red blood cells and the genetics.	
Describe the cellular makeup of blood.	
Describe the function of each of the blood cells.	
List the different types of white blood cells and explain how they function in immunity.	
Be familiar with some disorders caused by malfunctions within this system.	
Standards List:	**LS1.C: Organization for Matter and Energy Flow in Organisms:** HS-LS1.6, HS-LS1.7

UNIT 7: DIGESTIVE SYSTEM	
Suggested Pacing: 2-3 weeks	**Textbook Chapter(s)/Lessons**: Chapters 19 and 20.
Key Objectives	**Suggested Activities & Resources**
List the functions of the digestive system. Name and describe the functions of the organs of the digestive tract and accessory organs. Describe metabolism. List the major types of nutrients and how they are used by the body. Recognize that food is chemical energy that is measured in calories. Explain the role of insulin in metabolism and the effects of diabetes. Be familiar with some disorders caused by malfunctions within this system.	• Measure the calories in various easily burned foods. • Use Biuret solution, Benedicts solution and iodine to test various foods. • Dissect the digestive system of a fetal pig. • Class visit from diabetes prevention specialist. • Digestion in a bag.
Standards List:	**LS1.A: Structure & Function:** HS-LS1.1, HS-LS1.2, HS-LS1.3, HS-LS3.1

UNIT 8: REPRODUCTIVE SYSTEM	
Suggested Pacing: 3-4 weeks	**Textbook Chapter(s)/Lessons**: Chapter 22
Key Objectives	**Suggested Activities & Resources**
Describe the organs and glands of the male and female reproductive systems.	• Finish dissecting the reproductive system of the fetal pig. • Invite medical professionals to show students how to suture their pigs closed. • Invite medical professionals to talk to students about anabolic steroids. • Lab: Birth Control. • Lab: STIs.
Use a model to illustrate the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.	
List the major hormones of the male and female reproductive system.	
Explain the relative effects of estrogen and progesterone during the female menstrual cycle.	
Explain the importance of the placenta to healthy prenatal development.	
Explain why a fetus is particularly vulnerable to damage by drugs, alcohol, or environmental contaminants.	
Describe the trimesters of pregnancy and the fetal development that is occurring during each one.	
Demonstrate knowledge of common STIs, their causes, symptoms, effects, and treatments.	
Explain the methodology of common forms of birth control, and their effectiveness in preventing STIs as well as pregnancy.	
Be familiar with some disorders caused by malfunctions within this system.	
Standards List:	**HS-LS1: Growth & Development of Organisms:** HS-LS1.4

Life Science

Grade(s): 9-12 **Length**: two semesters **Credit**: 1 **Prerequisites**: None	**Course Overview**: Life Science is a one-year course for students who learn best with extra time to approach the subject. The academic focus is to develop student reading, writing, processing and organizational skills. The scientific focus is to improve science vocabulary, literacy, scientific observation, inquiry, experimentation, and analysis skills. Safety skills will be stressed each semester. The first semester introduces the cell, cell structures and functions, genetics and human heredity. The second semester includes evolution, a survey of the diversity of organisms, and ecology. Special attention will be given to local organisms and traditional and contemporary relationships between humans and the environment. **Adopted Textbook**: To be determined.

Marine Science

Grade(s): 10-12 **Length**: one semester **Credit**: 0.5 **Prerequisites**: Teacher recommendation or *Biology*	**Course Overview**: *Marine Science* explores the adaptation of marine organisms, ecological concepts and physical processes that structure the marine environment. The course is a study of the environmental impacts of chemistry, geology, and other abiotic conditions and the organisms that live in marine environments. The course also examines human interactions with marine ecosystems and the many careers associated with it. Special attention will be given to students' knowledge of Alaska's marine environment, its importance to indigenous people, local economies, food production, and career possibilities. **Adopted Textbook**: New textbook to be determined. *Introduction to Marine Biology*. Brooks Cole/ Cengage, 2010.

Units (Recommended Order)
Semester 1
• Physical and Chemical Oceanography • Organisms and Their Effects on Ecosystems • Biochemical Cycles • Interdependence Between Organisms • Evolution of Marine Species • Marine Sciences and Culture

UNIT 1: PHYSICAL AND CHEMICAL OCEANOGRAPHY	
Suggested Pacing: 3 weeks	**Textbook Chapter(s)/Lessons**: TBD
Key Objectives	**Suggested Activities & Resources**
Use the properties of water, salinity, and temperature to explain water stratification.	• Use a 10-gallon aquarium to demonstrate the effects of different densities and temperatures on stratification. • Label and color code a world map with sea/ocean names and locations of currents. • Read The Perfect Storm and use it for small group discussions of weather patterns and environmental impacts of the fishing industry. • Explain the impact of atmospheric CO2 on ocean acidification.
Describe and explain periodic variations in the marine ecosystem such as tides, currents, and seasons.	
Explain how the surface of the Earth changes through plate tectonics, earthquakes, volcanoes, erosion, and deposition.	
Give examples of interactions between marine and terrestrial ecosystems.	
Describe how weather is affected by the oceans.	
Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.	
Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.	
Standards List:	**ESS2.A: Earth Materials & Systems:** HS-ESS2.1, HS-ESS2.2, **ESS2.B: Plate Tectonics & Large-Scale System Interactions:** HS-ESS2.3, **ESS2.C: The Roles of Water in Earth's Surface Processes:** HS-ESS2.5

<table>
<tr><th colspan="2">UNIT 2: ORGANISMS AND THEIR EFFECTS ON ECOSYSTEMS</th></tr>
<tr><td>Suggested Pacing: 6 weeks</td><td>Textbook Chapter(s)/Lessons: TBD</td></tr>
<tr><th>Key Objectives</th><th>Suggested Activities & Resources</th></tr>
<tr><td>Describe the major abiotic and biotic characteristics of the important ecological zones within the marine biome.</td><td rowspan="6">• Build a bulletin board showing benthic habitats.
• Use the characteristics of preserved invertebrates to develop a classification system.
• Student reports on the major phyla.
• Discussions of the abiotic challenges of various marine habitats and the physiological and behavioral responses of organisms.</td></tr>
<tr><td>Describe how biochemical and anatomical characteristics define an organism’s anatomy and physiology, its behavior, survival and reproductive capabilities.</td></tr>
<tr><td>Explain how taxonomy is used to describe the diversity of phyla and classes.</td></tr>
<tr><td>List the characteristics of major chordate and invertebrate phyla that allow them to survive in a marine environment.</td></tr>
<tr><td>Compare environmental characteristics and the adaptations organisms have to adapt and survive.</td></tr>
<tr><td>Evaluate the 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.</td></tr>
<tr><td>Standards List:</td><td colspan="2">LS2.A: Interdependent Relationships in Ecosystems: HS-LS2.1, HS-LS2.2, LS2.C: Ecosystem Dynamics, Functioning, & Resilience: HS-LS2.6</td></tr>
</table>

UNIT 3: BIOCHEMICAL CYCLES	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: TBD
Key Objectives	**Suggested Activities & Resources**
Describe the transfer of energy through marine ecosystems.	• Draw models of energy flow. • Diagram the carbon, nitrogen, and phosphorous cycles.
Describe the cycling of matter through marine ecosystems.	
Provide examples of how cycles of matter and energy link living organisms and their environment.	
Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem.	
Standards List:	**LS2.4: Interdependent Relationships in Ecosystems:** HS-LS2.1, HS-LS2.2, **LS2.B: Cycles of Matter & Energy Transfer in Ecosystems:** HS-LS2.4

UNIT 4: INTERDEPENDENCE BETWEEN ORGANISMS	
Suggested Pacing: 6 weeks	**Textbook Chapter(s)/Lessons**: TBD
Key Objectives	**Suggested Activities & Resources**
Give examples of the interdependence between marine organisms and their environment.	• Draw food webs of local marine plant and animal species. • Use individual student reports to explore the characteristics of predator/prey, symbiotic, and herbivorous organism interactions.
Describe the levels of organization in marine ecosystems from the individuals to populations and communities.	
Describe theories that explain patterns of diversity from the equator to the poles.	
Standards List:	**LS2.D: Social Interactions & Group Behavior:** HS-LS2.8; **LS4.C: Adaptation:** HS-LS4.5, HS-LS4.6; **LS4.D: Biodiversity & Humans:** HS-LS2.7

UNIT 5: EVOLUTION OF MARINE SPECIES	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: TBD
Key Objectives	**Suggested Activities & Resources**
Explain how variation in the environment provides the mechanisms for natural selection, evolution, and diversity of species.	• Do a report on one of the extinct sea species from the Cambrian.
Give examples of how the natural variation in individuals allows species to survive in changing environments.	
Describe the evidence scientists use to link the evolutionary history of organisms and their classification.	
Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.	
Construct an explanation based on evidence for how natural selection leads to adaptation of populations.	
Evaluate the evidence supporting claims that changes in environmental conditions may result in:	
Increases in the number of individuals of some species.	
The emergence of new species over time.	
The extinction of other species.	
Standards List:	**LS4.D: Biodiversity & Humans:** HS-LS2.7, HS-LS4.6; **LS4.A: Evidence of Common Ancestry & Diversity:** HS-LS4.1; **LS4.C: Adaptation:** HS-LS4.4, HS-LS4.5

UNIT 6: MARINE SCIENCES AND CULTURE	
Suggested Pacing: Ongoing throughout the course.	**Textbook Chapter(s)/Lessons**: TBD
Key Objectives	**Suggested Activities & Resources**
Recognize the importance of marine systems to society.	• Research career possibilities in the field of marine biology. • Describe the fisheries of the North Pacific.
Describe how indigenous people use local marine organisms.	
Give examples of how humans can alter ecosystems.	
Explain why it is important for citizens to be knowledgeable on current issues and policies of natural resource use.	
Give examples of specific examples of Alaskan marine use issues.	
Describe human dependence upon the marine environment, concentrating on Alaskan uses.	
List and describe marine careers.	
Give examples of how humans can alter the structures of ecosystems.	
Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.	
Standards List:	**LS4.D: Biodiversity & Humans:** HS-LS2.7, HS-LS.4-6

Pre-AP Biology

Grade(s): 9-10 **Length**: two semesters **Credit**: 1 **Prerequisites**: Teacher recommendation and *Algebra 1*	**Course Overview**: In *Pre-AP Biology*, students engage in real-world data analysis and problem solving that sparks critical thinking about our living world. As students engage in grade-level content, they utilize the kind of scientific reasoning skills needed to analyze the natural world—and to succeed in future science and social science courses in high school and college. The Pre-AP science areas of focus are vertically aligned to the science practices embedded in high school and college courses, including AP. This gives students multiple opportunities to think and work like scientists as they develop and strengthen these disciplinary reasoning skills throughout their education in the sciences: • Emphasis on analytical reading and writing: students engage in analytical reading and writing to gain, retain, and apply scientific knowledge and to carry out scientific argumentation. • Strategic use of mathematics: students use mathematics strategically in order to understand and express quantitative aspects of biology, to record and interpret experimental data, and to solve problems. • Attention to modeling: students go beyond labeling diagrams to creating, revising, and using models to explain key patterns, interactions, and relationships in biological systems. Please visit the College Board-AP Central website for more information (http://apcentral.collegeboard.com). **Adopted Textbook**: *Campbell Biology in Focus.* AP Edition, Pearson, 2017.

Wildlife Biology

Grade(s): 9-12 **Length**: two semesters **Credit**: 1 **Prerequisites**: None	**Course Overview**: *Wildlife Biology* is focused on teaching key biological concepts through the study of Alaska wildlife. Through a placed-based lens, students who take this class will learn how to connect local, indigenous, and scientific knowledge together. **Adopted Textbook**: TBD

Units (Recommended Order)	
Semester 1	**Semester 2**

• Studying Wildlife
• Ecology
• Evolution of Alaska Life
• Wildlife Nutrition
• Single Celled Life of Alaska:
  ○ Bacteria
  ○ Protist
• Viruses and Biotechnology
	• Simple Multicellular Life in Alaska
	• Complex Multicellular Life of Alaska:
	  ○ Plants
	  ○ Fungi
	• Complex Multicellular Life of Alaska
	  ○ Invertebrates
	  ○ Vertebrates
	• Wildlife Management and Human Impact

UNIT 1: STUDYING WILDLIFE	
Suggested Pacing: 2-3 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Show the methods of studying wildlife in Alaska from remote tracking, tagging, sample collection, and other methods.	Create or gather models that students can use to collect data for study of organisms & populations.
Look at the research of AK wildlife to show how we study organisms as individuals in order to look at the health of the whole population.	
Use current wildlife studies to show how & why key Alaska organisms are being studied for the longevity of life in AK.	Read through recent wildlife research to show how research drives conservation.
Look into the importance of wildlife conservation and study.	Look at past event in human history to show the importance of study & conservation (e.g. whale).
Standards List:	**GLEs: S.A.1-3, HS LS 1-4, PS 1.1**

UNIT 2: ECOLOGY	
Suggested Pacing: 2-3 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.	Create an activity to show how biogeochemical cycles work to connect the biosphere with all the other spheres on Earth.
Describe symbiotic interactions between organisms in a community.	Any symbiotic interaction activity to show students how the interaction between different organisms work.
Show how a community of organisms are built with the interactions of populations of organisms.	Build food chains and webs to illustrate the unique connection between AK wildlife & their environment.
Look at the ecosystems of Alaska & how they are made up of a unique collections of both physical & biological elements.	Play an ecosystem game to explain the interconnectedness of the physical and biological world.
Standards List:	**HS PS3.3-4, HS LS2.1-4, HS LS4.1-6, HS PS1.1**

UNIT 3: EVOLUTION OF ALASKA LIFE	
Suggested Pacing: 2-3 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.	Use a variety of activities to show the evidence of evolution such as the homologous structure coloring or the fossil building or the various natural selection simulations online (pHet or Biointerative).
Describe the mechanisms that drive the evolutionary process and how it has driven the wide diversity of AK life.	Simulation online to show the mechanisms and can be linked back to AK animals during to Pleistocene.
Explain how the diversity of AK life has arisen through geological & evolutionary processes.	
Explain how variation within a species and natural selection could result in speciation or extinction.	Create a speciation activity to show how different speciation events can happen and link them to past and current events in AK history.
Standards List:	**HS LS3.1-3, HS LS4.1-6**

UNIT 4: WILDLIFE NUTRITION	
Suggested Pacing: 2-3 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Show the importance of micro & macro nutrients to biological life by using the student own needs as a reference.	Use online nutrient calculators to figure out the needs of each kid and connect it to their current eating habits.
Build a model organism to calculate how much and what they need to eat to survive.	Design an activity to show an organisms need for nutrients and how much they would need.
Use a model to explain the process of cellular respiration & how organism release energy from the breaking of chemical bonds.	Any Cellular respiration activity found online could work.
Standards List:	**HS LS1, HS PS1, HS PS3**

UNIT 5: SINGLE CELLED LIFE OF ALASKA - BACTERIA	
Suggested Pacing: 2-3 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Describe cell organelles and their functions.	Build models of bacteria with organelles to describe their structure and function
Describe diffusion and osmosis and the importance of these processes for cells.	Gummy bear osmosis or orbeez osmosis/diffusion labs.
Show the importance of bacteria to all life in AK.	Look at the bacteria in mammal guts (ruminants &/or humans) and how many organisms cannot live without a healthy amount bacteria.
Explain how antibiotics work and how growing resistance is a large concern to the human population.	Run through a game or simulation explaining how antibiotics work & how bacteria can grow resistance to them.
Standards List:	**HS PS3, HS LS1.1-7, HS LS3.1**

UNIT 6: SINGLE CELLED LIFE OF ALASKA - PROTISTS	
Suggested Pacing: 2-3 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Describe the structure & functional differences to bacteria to introduce eukaryotes.	Build models of protists with organelles to describe their structure and function and differences to bacteria.
Explain the difference between prokaryotes & eukaryotes.	Compare the structure and function of bacteria and protists.
Show the importance of protists to other life in AK, and how protists are a crucial part of many food webs and produce 50% of the Earth's oxygen.	Numerous Algae labs online as well as algae growth activities.
Standards List:	**HS PS 3, HS LS 1.1-7, HS LS 3.1**

UNIT 7: VIRUSES AND BIOTECHNOLOGY	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Show how viruses are not living organisms but how they affect organisms.	Research viral diseases in AK life.
Describe the structure and function of viruses.	Build virus models and show how they spread.
Look into how humans are using virus in a number of ways from gene editing to new gen antibiotics.	Use CRISPR labs to see gene editing in action.
Standards List:	**HS LS1; HS LS 4; ETS 1.2; HS PS 1; HS ESS 3**

UNIT 8: SIMPLE MULTICELLULAR LIFE OF ALASKA	
Suggested Pacing:	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Utilize tools to categorize organisms (i.e., taxonomic keys, cladograms).	Build a Cladogram using multicellular organisms.
Describe the characteristics of domains and kingdoms of organisms.	
Explain the way cell communication works.	
Show how multicellular life is built of a large interconnected relationship between single cells communicating.	Tissue lab or build models of tissue and how they communicate.
Standards List:	**HS LS3.1-3, HS LS4.1-6, HS LS2.1-4, HS PS3, ETS1.2**

UNIT 9: COMPLEX MULTICELLULAR LIFE OF ALASKA - PLANTS	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.	Any photosynthesis lab or activity building the macromolecules crucial to life.
Explain the structure and function of plants, and how/why they are the foundation of most terrestrial food webs.	Study the different plants native to Alaska.
Look at how plants have been used by the indigenous peoples and organisms of Alaska for food, shelter, etc.	Gather samples of AK plants to make stuff with, or maybe even bring in a guest speaker to talk about how groups of people use different plants of AK.
Standards List:	**HS LS3.1-3, HS LS4.1-6, HS LS2.1-4, HS PS3, ETS1.2**

UNIT 10: COMPLEX MULTICELLULAR LIFE IN ALASKA - FUNGI	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Use models or samples to show the structure and function of fungi and the mycelial network they form in an area.	Mushroom dissection. Mycelial network communication articles.
Explain the importance of fungi as decomposers.	Decompose bread, fruit, or veggies using fungi in a sealed bag.
Show how mycorrhizal fungi are a crucial part of the boreal forest.	Dissect the roots of spruce trees to see the mycorrhizal fungi growing into and around the roots.
Standards List:	**HS LS3.1-3, HS LS4.1-6, HS LS2.1-4, HS PS3, ETS1.2**

UNIT 11: COMPLEX MULTICELLULAR LIFE OF ALASKA - INVERTEBRATES	
Suggested Pacing: 2-3 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Explain the relationship between structure and function of invertebrate.	Build or dissect invertebrates (build models with air dry clay).
Show the importance of many invertebrates to plant life in AK, and where they fit in the AK food web.	Simulate pollination by insects and how they are crucial to the reproduction of plants.
Identify the major invertebrate groups of Alaska, including general anatomy.	Compare the various invertebrate groups of Alaska through samples or pictures.
Look at the importance of invertebrate to human life in Alaska both for needed sustenance and economic value.	Poll the class on how many students know of or themselves rely on invertebrate. Research the nutritional &/or economic value of AK invertebrates (crab fishing, etc.).
Standards List:	**HS LS3.1-3, HS LS4.1-6, HS LS2.1-4, HS PS3, ETS1.2**

UNIT 12: COMPLEX MULTICELLULAR LIFE OF ALASKA - VERTEBRATES	
Suggested Pacing:	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Explain the relationship between structure and function of vertebrate.	Build or dissect vertebrates (build models with air dry clay).
Show the interconnectedness of many vertebrates and where they fit in the various AK ecosystems.	
Identify the major vertebrate groups of Alaska, including general anatomy, physiology, and behavioral patterns.	Compare the various vertebrate groups of Alaska through samples or pictures.
Look at the importance of vertebrates to human life in Alaska, both needed sustenance & economic value.	Poll the class on how many students know of or themselves rely on invertebrate. Research the nutritional &/or economic value of AK invertebrates (crab fishing, etc.).
Standards List:	**HS LS3.1-3, HS LS4.1-6, HS LS2.1-4, HS PS3, ETS1.2**

UNIT 13: WILDLIFE MANAGEMENT AND HUMAN IMPACT	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Look into mass extinctions to see the effect of rapid changes in an ecosystem on wildlife.	Research mass extinctions.
Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.	Human impact project (kids choose a way humans impact wildlife and research possible solutions).
Show how sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.	Biodiversity lab showing the impact of changes in ecosystems.
Study local wildlife management laws and why they are important to maintaining Alaska's biodiversity.	Read over hunting & fishing regulations and discuss their importance to the longevity of AK wildlife.
Standards List:	**HS ESS3.1-3, HS PS3.3-4, HS LS2.1-4, HS LS4.1-6, ETS1.2**

Physical Science Options

Advanced Placement Chemistry

Grade(s): 11-12 **Length**: two semesters **Credit**: 1.0 **Prerequisites**: Teacher recommendation	**Course Overview**: The *AP Chemistry* course provides students with a college-level foundation to support future advanced coursework in chemistry. Students cultivate their understanding of chemistry through inquiry-based investigations, as they explore content such as: atomic structure, intermolecular forces and bonding, chemical reactions, kinetics, thermodynamics, and equilibrium. Please visit the College Board-AP Central website for more information (http://apcentral.collegeboard.com). **Adopted Textbook**: *Chemistry: A Molecular Approach*. Savvas/Pearson, 2023

Advanced Placement Environmental Science (semester 2)

Grade(s): 11-12 **Length**: two semesters **Credit**: 1.0 **Prerequisites**: Teacher recommendation, *Biology*, and *Chemistry*	**Course Overview**: The *AP Environmental Science* course is designed to engage students with the scientific principles, concepts, and methodologies required to understand the interrelationships within the natural world. The course requires that students identify and analyze natural and human-made environmental problems, evaluate the relative risks associated with these problems, and examine alternative solutions for resolving or preventing them. Environmental science is interdisciplinary, embracing topics from geology, biology, environmental studies, environmental science, chemistry, and geography. Please visit the College Board-AP Central website for more information (http://apcentral.collegeboard.com). **Semester one fulfills the Life Science graduation requirement and semester two fulfills the Physical Science requirement.**

Advanced Placement Physics 1

Grade(s): 11-12 **Length**: two semesters **Credit**: 1.0 **Prerequisites**: Teacher recommendation	**Course Overview**: *AP Physics 1* is an algebra-based, introductory college-level physics course. Students cultivate their understanding of physics through inquiry-based investigations as they explore these topics: kinematics, dynamics, circular motion and gravitation, energy, momentum, simple harmonic motion, torque and rotational motion, electric charge and electric force, DC circuits, and mechanical waves and sound. Please visit the College Board-AP Central website for more information (http://apcentral.collegeboard.com). **Adopted Textbook**: *Cutnell & Johnson Physics*. HMH/Wiley, 2018

Advanced Placement Physics 2

Grade(s): 11-12 **Length**: two semester **Credit**: 1.0 **Prerequisites**: Teacher recommendation	**Course Overview**: *AP Physics 2* is an algebra-based, introductory college-level physics course. Students cultivate their understanding of physics through inquiry-based investigations as they explore these topics: fluids; thermodynamics; electrical force, field, and potential; electric circuits; magnetism and electromagnetic induction; geometric and physical optics; and quantum, atomic, and nuclear physics. Please visit the College Board-AP Central website for more information (http://apcentral.collegeboard.com). **Adopted Textbook**: *Cutnell & Johnson Physics*. HMH/Wiley, 2018

Advanced Placement Physics C: Mechanics

Grade(s): 11-12 **Length**: two semesters **Credit**: 1.0 **Prerequisites**: *Calculus* (May be concurrently enrolled.)	**Course Overview**: *AP Physics C: Mechanics* is a calculus-based, college-level physics course. It covers Kinematics, Newton's laws of motion, work, energy, and power, systems of particles and linear Momentum, circular motion and rotation, oscillations, and gravitation. Please visit the College Board-AP Central website for more information (http://apcentral.collegeboard.com). **Adopted Textbook**: *Physics for Scientist and Engineers*. Cengage, 2019

Chemistry

Grade(s): 10-12 **Length**: two semesters **Credit**: 1.0 **Prerequisites**: Teacher recommendation or *Algebra 1* and *Biology*	**Course Overview**: *Chemistry* is an introductory, general chemistry course that builds a foundation for college-level chemistry, physics, and biology courses. Students learn about chemical reactions and the structure of matter in order to explain how and why substances react the way they do. Laboratory work and laboratory reporting are an integral part of the course, helping students develop an understanding of the concepts as well as the process of science. **Adopted Textbook**: *Glencoe Chemistry: Matter and Change*. McGraw-Hill, 2016.

Units (Recommended Order)	
Semester 1	**Semester 2**
• Scientific Practice and Design • Changes and Interactions of Matter • Structure of Matter • Ionic and Covalent Bonding	• Stoichiometry and Chemical Reactions • Gasses • Acids and Bases

UNIT 1: SCIENTIFIC PRACTICE AND DESIGN	
Suggested Pacing: 3 weeks	**Textbook Chapter(s)/Lessons**: Chapters 1 and 2.
Key Objectives	**Suggested Activities & Resources**
Recognize SI units of measurements.	• Flinn Safety Contract and Test. • Lab safety classroom scavenger hunt. • Make a poster of conversion tips/significant digit rules. • Lab: Density of Unknown Metal (slope of the line mass vs. volume gives density). • Lab: Measurement. • Lab: Equipment Identification.
Convert data into scientific notation and from one unit to another.	
Round numbers correctly based on the certainty of the measurement.	
Use and create graphs to represent 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.	
Use mathematical representations of phenomena to support claims.	
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 to predict the relationships between systems or between components of a system.	
Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.	
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.	
Refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and trade off considerations.	
Standards List:	**PS1.A: Structure and Properties of Matter:** HS-PS1.1, HS-PS1.3; **PS1B: Chemical Reactions:** HS-PS1.2, HS-PS1.5, HS-PS1.6

<table>
<tr><th colspan="3">UNIT 2: CHANGES AND INTERACTIONS OF MATTER</th></tr>
<tr><td colspan="2">Suggested Pacing: 4 weeks</td><td>Textbook Chapter(s)/Lessons: Chapter 3</td></tr>
<tr><th colspan="2">Key Objectives</th><th>Suggested Activities & Resources</th></tr>
<tr><td colspan="2">Describe the changes and interactions that result in observable changes in the properties of matter including chemical, physical, and nuclear changes such as radioactive decay.</td><td rowspan="4">• Lab: Separation of a Mixture.
• Lab: Chemical and Physical Changes.
• Demo: Electrolysis of Water.</td></tr>
<tr><td colspan="2">Explain the Law of Conservation of Mass as it relates to chemical and physical changes.</td></tr>
<tr><td colspan="2">Distinguish between endothermic and exothermic reactions.</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td>Standards List:</td><td colspan="2">PS1.B: Chemical Reactions: HS-PS1.2, HS-PS1.4, HS-PS1.5, HS-PS1.6, HS-PS1.7; PS1.C: Nuclear Processes: HS-PS1.8</td></tr>
</table>

UNIT 3: STRUCTURE AND MATTER	
Suggested Pacing: 4 weeks	**Textbook Chapter(s)/Lessons**: Chapters 4 and 5.
Key Objectives	**Suggested Activities & Resources**
Draw or build models describing the nature of molecules, atoms, and subatomic particles.	• Lab: Isotope (pennies/Runts candy). • Periodic chart poster (trends and grouping). • Lab/Observations: Atomic Emission Spectra. • Lab: Reactivity of the Alkaline Earth Metals. • Design and construct atom model (element includes p orbitals).
Describe how the current model of the atom is related to the structure and behavior of matter.	
Explain the relationship between nuclear stability and radioactivity.	
Compare wave and particle models of light.	
Express the arrangements of electrons in atoms using orbital notation.	
Relate the group and periodic trends (periodic table) to the electron configuration of atoms.	
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.	
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.	
Standards List:	**PS1.A: Structure and Properties of Matter:** HS-PS1.1, HS-PS1.2, HS-PS1.4; **PS1.C: Nuclear Processes:** HS-PS1.8

<table>
<tr><th colspan="3">UNIT 4: IONIC AND COVALENT BONDING</th></tr>
<tr><td colspan="2">Suggested Pacing: 4 weeks</td><td>Textbook Chapter(s)/Lessons: Chapters 7 and 8.</td></tr>
<tr><th colspan="2">Key Objectives</th><th>Suggested Activities & Resources</th></tr>
<tr><td colspan="2">Define and describe chemical bonding; differentiating between ionic, covalent, and metallic bonding.</td><td rowspan="7">Lab: Formation of an Ionic Compound.
Lab: Modeling Covalent Compounds Using Computer-based Models.
Lewis Structures.
Demo: Formation of NaCl.
Demo: Polarity of Liquids.</td></tr>
<tr><td colspan="2">Describe how ions form.</td></tr>
<tr><td colspan="2">Use and understand the current model of an atom to predict the formulas of simple ionic and covalent compounds.</td></tr>
<tr><td colspan="2">Write the names and formulas of simple ionic and covalent compounds.</td></tr>
<tr><td colspan="2">Determine shapes/geometry of molecules.</td></tr>
<tr><td colspan="2">Compare and contrast polar and nonpolar molecules.</td></tr>
<tr><td colspan="2">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.</td></tr>
<tr><td>Standards List:</td><td colspan="2">PS1.A: Structure and Properties of Matter: HS-PS1.3</td></tr>
</table>

UNIT 5: STOICHIOMETRY AND CHEMICAL REACTIONS	
Suggested Pacing:	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Balance chemical equations.	• Mole poster. • Lab: Empirical Formula of Magnesium Oxide. • Lab: Formula of a Hydrate. • Lab: Formation of a Precipitate/% Yield. • Statistical Analysis: Mean, Median, Mode. • PhET Online Lab: Balancing Equations https://phet.colorado.edu.
Translate written descriptions of chemical reactions into chemical equations.	
Classify and identify chemical reactions.	
Convert among moles, mass, and number of particles.	
Calculate empirical and molecular formulas for compounds and determine formulas for hydrates.	
Solve stoichiometry problems.	
Solve limiting reactant problems.	
Determine the percent yield of a chemical reaction.	
Solve reaction stoichiometry problems.	
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.	
Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.	
Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.	
Standards List:	**PS1.B: Chemical Reactions:** HS-PS1.2, HS-PS1.4, HS-PS1.5, HS-PS1.6, HS-PS1.7

UNIT 6: GASSES	
Suggested Pacing: 3 weeks	**Textbook Chapter(s)/Lessons**: Chapter 12, section 1 and chapter 13.
Key Objectives	**Suggested Activities & Resources**
Use the kinetic molecular theory to explain physical properties of solids, liquids, and gasses.	• PhET Gas Law Online Lab: https://phet.colorado.edu
Describe the role of energy in phase changes.	
Use gas laws to calculate how pressure, temperature, volume and number of moles change.	
Apply gas laws and Avogadro's principle to chemical equations.	
Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.	
Standards List:	**PS1.B: Chemical Reactions:** HS-PS1.4, HS-PS1.5

UNIT 7: ACIDS AND BASES	
Suggested Pacing: 3 weeks	**Textbook Chapter(s)/Lessons**: Chapter 18
Key Objectives	**Suggested Activities & Resources**
Compare acids and bases and understand why strengths vary.	• Lab: Titration of Vinegar. • PhET Online Lab: PH https://phet.colorado.edu
Calculate pH and pOH of aqueous solutions.	
Standards List:	**PS1.A: Structure and Properties of Matter:** HS-PS1.3; **PS1.B: Chemical Reactions:** HS-PS1.6

Earth & Space Science

Grade(s): 9-10 **Length**: two semesters **Credit**: 1 **Prerequisites**: None	**Course Overview**: *Earth & Space Science* is often broken down into five major areas of specialization: geology, astronomy, meteorology, oceanography and environmental science. Geology is the study of the Earth's surface and below. It includes minerals, rocks, the Earth's crust and interior, and the processes that change them. Astronomy is the study of everything beyond Earth's atmosphere. This includes the Earth & moon system, the solar system, the stars, galaxies, galaxy clusters, and the universe. Meteorology is the study of Earth's atmosphere and the weather. Oceanography is the study of the 70% of Earth covered in seawater and its interactions with the rest of the Earth. Environmental science adds life to the mix, and combines all the other categories and how they support life on this planet; so environmental science is "cross disciplinary." Given Alaska's high latitude and seasons, geology in the fall before the cold, dark and heavy snow allows for fieldtrips to examine rock outcrops at road cuts, visit mining operations, etc. Astronomy in mid-winter, when it is dark, lets classes go outside and use telescopes. Weather and oceanography in spring can mean clouds will have more variety. One can vary the order, however. If hurricanes and tornadoes are in the news in the fall, some of the weather and ocean material can be slipped in early to make the class relevant to what is happening in the news. The actual units can be studied in full detail later and teachers can refer back. **Adopted Textbook**: *Earth Science: Geology, the Environment, and the Universe*. Glencoe/ McGraw-Hill, 2017

Units (Recommended Order)	
Semester 1	**Semester 2**
• Introduction to Earth and Space Science • Composition of the Earth • Dynamic Earth • Geologic Time • Surface Processes	• Beyond the Earth • Earth's Atmosphere, Weather, and Climate • Earth's Oceans and the Marine Environment • Resources and Our Environment

UNIT 1: INTRODUCTION TO EARTH AND SPACE SCIENCE	
Suggested Pacing: 10 days	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
• Science is a process, as well as a body of knowledge, and this course is taught through lab activities and experiences as well as book work. The NGSS grounding phenomenon / driving questions (storyline) teaching process is different from the traditional teaching.	"Helping Students Make Sense of the World: Using Next Generation Science & Engineering Practices" (NSTA Press 2017)
• Introduction: Earth is a System of interacting parts (Geosphere, Atmosphere, Hydrosphere/Cryosphere, & Biosphere). Exploring these requires lab activities maps to visually organize the information, remote sensing and geographic information systems (computer software that puts all the information into visual overlays that can be displayed on the maps as needed). • Students understand safe laboratory procedures and the location of all safety equipment in their classroom. • The Earth is a system made of interacting subsystems: the solid part called geosphere (or lithosphere), the water part called the hydrosphere when liquid and cryosphere when frozen into ice sheets or glaciers, the "gasses above the surface " part called atmosphere, and everything that lives on Earth called the biosphere. • In interacting systems, an event can sometimes start a series of changes that get larger and larger; this is called a positive feedback loop. In other cases, the other systems sometimes reduce the change each time the loop repeats; this is called a negative feedback loop. Changes in weather and ice cover for subsistence bowhead whale hunting at Utqiagvik (formerly Barrow, Alaska) are a good example of all four systems interacting in a positive feedback loop. Warmer ocean means sea ice forms later and is not as thick and does not last as long, but blue water absorbs sunlight better than white ice so the ocean gets warmer still. Soft ice is dangerous to hunt from, so hunters go out for shorter seasons, making the local people have to buy food from other cities. It has to be flown there by airplane. This puts extra carbon dioxide into the atmosphere making things a bit warmer. On land on the north slope, the frozen ground (permafrost) containing lenses of solid to ice start melting. They leave holes that stuff falls into. Old frozen dead leaves now thaw and decay from bacteria, fungus and molds that release methane as they eat the stuff. Methane, as a gas in the atmosphere, also makes things warmer. All spheres are interacting: Biosphere, people and whales; Atmosphere, methane	• Two Teaching Styles may be implemented depending on circumstances:: ○ Student Driven: Grounding Phenomenon/ Driving Questions/ Students' Sense Making (Storyline for short) According to the NGSS guidelines is more engaging and effective for student retention. It is also more work for the teacher and takes more time. Our textbook is not set up for this. ○ Teacher Driven: Teacher introduces & leads the discussion. It is the traditional way of teaching science. Follow the suggested lessons in the Teacher Handbook and use labs, activities and the internet software that came with the textbook. These lessons are well thought out, but not as effective as Student Driven, If a teacher has to prepare for classes on three or four different subjects or a teacher is running out of time to finish a unit; this is an option. • Module 1: Introduction: Grounding Phenomenon: The Earth (1.0 days) ○ Observe "Image of Earth" view p. 4-5 ○ Asking Driving Questions: ▪ After introductions and class rules, syllabus, etc, explain the difference between closed and open ended questions. ▪ Each group submits three to five of their best open-ended questions about the Earth (e.g. inside, outside, beyond). Help students turn any one word answer question into open-ended. ▪ As a class, sort the best twenty five or so questions into four or five categories. Store the categorized twenty five questions into Google. ▪ Jamboard - put the sticky notes on a classroom bulletin board. ▪ As you go through the unit, you will revisit the list.

released; Hydrosphere, ocean getting warmer; Cryosphere, less sea ice cover; Geosphere or Lithosphere, permafrost melting causing the ground to slump.
• Understand latitude and longitude coordinates and be able to use them when looking at a globe. Understand the difference between meridian and parallels, and generate memory clues to help keep from getting confused.
• Locate the equator, the prime meridian, northern and southern hemispheres, and eastern and western hemispheres. Correctly read off the coordinates for a city in the southern hemisphere west of the prime meridian, then a city in the northern hemisphere east of the prime meridian. Explain time zones and why they are sometimes irregular and do not follow meridians. Explain what is happening at the international date line.
• Understand the different types of maps and how to use them.
• Understand the modern Geographic System Software that greatly amplifies the utility of maps by putting visual, overlays of various types of information about the region shown in the map so one can get almost instant access for comparing things and making decisions.
• Understand the difference between GPS and GIS and how they work.
• Understand how information can be organized visually to make planning for a region, or looking for trends easier using a Geographic Information System. The computer stores the basic map information as its base data, and then can overlay other information about the area in layers added to the original map.
• Develop a mental model of how GIS systems interact with people; then, predict how that will change things. Present your prediction as a claim that is supported by reasons based on evidence from the activities and personal experiences in students' lives. Tell what evidence to look for in future that would confirm or refute the claim.
	• Lab safety (1.5 days): Flinn Lab Safety Review & contract for parents & students to sign. (OR families read page 904-905 in textbook and use the safety contract at this link https://knowledge.carolina.com/wp-content/uploads/pdfs/earth-safety-english.pdf).
	• Students draw individual lab safety maps of the classroom showing exits, fire extinguisher, fire blanket, emergency eye wash, emergency shower, phone with emergency #'s posted (1.5 days).
	• Internet Resources: Assign the students the *Brain Pop* Science Lab Safety video; it works like *Ed Puzzle*. The students stop and answer questions to be able to proceed. It is entertaining and accurate.
	• Example of Earth Systems Interacting: (4.0 days)
	  ○ Textbook: read pp. 6-9
	  ○ Internet Resources: Show these two video clips:
	  ▪ Earth Systems (2 NASA video clips 5 and 5.5 minutes linked) (0.5 days)
	  ▪ Earth System Video (Chose 9-12)
	  ○ (Teachers can make ed puzzle quizzes from all videos for easier formative testing & grade entry if desired.)
	• Investigation 1, Interacting parts of the Earth System. (3.5 days)
	  ○ Show 1st video clip "Changing Hunting at Barrow (Utqiagvik)"
	  ○ "Arctic Climate Perspective Rural Alaska Seeing Changes"
	• Class discussion about what systems are interacting making this a problem. Groups record their ideas and save for the next part.
	  ○ Work through the "What's a feedback loop and Daisy world" interactive activity.
	  ○ "Daisey World Interactive Models Feedback Loops"
	• Individuals write their final essay on notebook paper and keep it for the next discussion.
	• In light of the "feedback loop activity," class discusses and comes to consensus on what is making it harder to hunt whales in the arctic in spring.
	• When there is a class model for what is causing changes in the spring hunt, students write a first draft of their claim as to what causes it, followed by supporting evidence and the reasons showing why the evidence supports the claim.
	• Students work in teams to help each other be sure they are using complete sentences and that the grammar and spelling are correct. Now make a second draft using conjunctions "because, but, and so"

	to expand and clarify the reasoning. Present these second drafts to class either on whiteboards or projected on a slide. Classmates make positive editing suggestions to each presenter so that the corrections can be made while the presentation is happening. Then each perfected final product is checked off by the teacher for a grade.
	• Wrap it Up. Summarize the evidence you gathered from your investigations around the phenomenon and research on the questions. What conclusions did you reach about the best model for what is happening? State your conclusion as a Claim. Explain how your evidence supports your claim. Be sure to write in complete sentences.
	• Understanding Maps: (2.0 days)
	  ○ Textbook: Read pp. 28-30
	  ○ View Internet Resources:
	  ○ Map Projections: How to Make the Surface of a Ball Flat. It's Hard!
	  ○ Topographic Maps:
	  ▪ "What is a contour map?"
	  ▪ Gradients: On a topographic map find the gradient
	  ▪ Profiles: From a topographic map, draw a profile
	• Latitude and Longitude coordinates on Earth; Text pp. 30-33
	• Do a quick globe activity. Give students globes of the Earth and help them find the equator, north & south poles, and the prime meridian. Explain how the coordinates work. Next, read off some coordinates of places on Earth & help students find them. Then, ask students to find places on the globe that interest them, point to the spot and figure out the latitude and longitude, and share it with the class. Finally do a formative assessment based on what they have learned. Make copies of the worksheet from the text and have the students use the attached map to complete it.
	• From teacher resources in the textbook Chapter 2, Section 1, Teaching visual 4: The map and question worksheet. Students can work together or individually to locate positions on the map given coordinates and then give the coordinates for cities listed.
	• Textbook p. 48-49. Complete the Geo lab from the map in the book. Answer all the questions in complete sentences and draw your profile carefully. You may use graph paper if you wish. Turn both the answers and the profile in when you are finished.

	• Wrap it Up. Summarize the evidence you gathered from your investigations around the phenomenon and research on the questions. What conclusions did you reach about the best model for what is happening? State your conclusion as a Claim. Explain how your evidence supports your claim. Be sure to write in complete sentences.
	• Remote sensing & GIS: (1.0 days)
	  ○ Textbook: Read pp. 41-47
	  ○ Internet Resources
	  ▪ "How GPS Works"
	  ▪ "What is a GIS"
	• National Geographic Lesson for Earth Science. "Introduction to GIS" (National Geographic Society). This prepackaged lesson gives directions, objectives, preparation, background, and vocabulary.
	• Example: *Alaska Department of Fish & Game* Example: GIS for Hunter's AK Fish & Game - Make your own Hunting Map App. Put a check in overlays that say: Special areas, subunits, and Alaska towns. In the top right corner, click the little squares to see six different base maps you can put at the bottom. Explore everything and see what happens. Exit ticket: Make a story about creating a GIS map for friends from out of town visiting where you live. Tell what overlays you would give them and why. Draw a picture of what it might look like with all the overlays in place. Make a claim about how this technology might change people's lives, support your claim with evidence from your life, and explain the reasons that the evidence supports your claim.
	• Data sources for further research if desired:
	  ○ *Fairbanks North Star Borough* website: "Get FNSB GIS Data"
	  ○ *USGS* National Map USA GIS website: "GIS Data Downoad"
	  ○ Fun Option - Video Game Version of GIS: Alaska Delta Junction Map Tour Game Explained: "MAP UPDATED The Best All-Around Map Yet?" (YouTube - Alaska Delta Junction Map Tour, Farming Simulator 19).
	• Wrap it Up. Summarize what you learned about geographic information systems while doing the National Geographic modeling a GIS system activity. Make suggestions about how to improve the lab. Be sure to write in complete sentences.

Standards List:	**HS-ESS2-2, HS-ESS3-2**

UNIT 2: COMPOSITION OF THE EARTH	
Suggested Pacing: 26 days	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
▪ Matter has mass and takes up space. Matter that cannot be turned into anything else by chemical or physical means is called an element. The smallest piece of an element that retains its property is called an atom. Atoms have a central nucleus surrounded by an electron cloud. The nucleus can contain subatomic particles called protons. Protons have an electric charge of positive one. A nucleus may also contain subatomic particles called Neutrons, which have an electric charge of zero. Protons and Neutrons are about the same atomic mass and are much more massive than an electron; electrons are about one two thousandths of the mass of a proton, and have an electric charge of negative one. Atoms are organized into rows and columns in the periodic table of elements. There are only about 92 non-radioactive elements in nature and another twenty or so radioactive elements (most of which were created artificially). ▪ The properties of elements fall into patterns which can be visualized in the periodic table of elements. The vertical columns are called families and have similar chemical properties. Atoms form chemical bonds based on the number of outside electrons they have. Atoms are also categorized as metals, nonmetals, and metalloids. Metals tend to loose their outer electrons. Nonmetals tend to take outer electrons from metals or share outer electrons (called valence electrons) among themselves. Atoms that lose electrons are called positive ions, and atoms that have extra electrons which they have taken are called negative ions. Oppositely, charged atoms stick together because of electrostatic force in alternating order forming ionic bonds. These tend to be brittle and have high melting temperatures. Nonmetals sharing pairs of valence electrons form molecules held together by covalent bonds. A large collection of metal atoms form another kind of bond. Copper is a good example. The central parts act like an ordered array of positive islands surrounded by weakly held valence electrons that form a sort of "electron sea". This makes metals good conductors of heat and electricity. They are also malleable and ductile.	• Module 2: Matter & Change: (8 days) ○ Grounding Phenomenon: How did these crystals get so big? ○ Show this video: Video Showing the Giant Crystals in Spain (*YouTube* - from BBC Travel Article) ○ (The source article is from *BBC Travel*: "The World's Largest Crystal Cave" - BBC Travel Article) • Asking Driving Questions (1 Days): ○ Students in small groups ask questions about the Pulpi Geode while watching the video at their own tables, and put them on sticky notes. ○ Each group submits three to five of their best open-ended questions. As a class, sort the best questions into five categories. Put the categorized twenty five questions into Google jamboard or on sticky notes bulletin board. As you go through the unit, revisit the list. • Matter & The Periodic Table of Elements: ○ Text: pp. 60-65 ○ Internet Resources: Structure of Atoms Interactive Lesson (*ChemThink)* • Combining Matter: ○ Chemical Bonding Text pp. 66-70 ○ Internet Resources: ▪ Ionic Bonding Interactive Lesson (*ChemThink)* ▪ Covalent Bonding Interactive Lesson (*ChemThink)* ○ Brain Pop (set to 7&8 grade quiz) ○ Chemical Bonds with quiz ○ Metallic Bonding Video: "What are Metallic Bonds, Properties of Matter, Chemistry, FuseSchool" (*YouTube* – Fuse School) • Wrap it up: Consider the following images ○ Salt spilled on table: Salt Crystals on Table ○ Salt Diagram: Salt Crystals Atomic Diagram ○ Copper Being Hammered: Artist Hammering Copper ○ Copper Diagram: Copper Metal Atomic Diagram

▪ Understanding atoms, the periodic table, and chemical bonds are important because earth's crust is made of rocks, rocks are made of minerals, and minerals are made of atoms. ▪ Identify metals, metalloids, and nonmetals in the periodic table of elements. ▪ Chemical compounds form when elements combine in fixed ratios and create new materials with different properties than the original elements. ▪ Mixtures are pure substances that retain their original properties after they are blended together. The pieces can be tiny or large. All three phases of matter can be involved. ▪ Homogeneous mixtures - the materials are so small and evenly blended that one cannot see the different parts. ▪ Heterogeneous mixtures are not that well blended and it is easy to see the different materials. ▪ States of matter and mixtures are important because rocks are solid mixtures of minerals, molten rocks are liquid mixtures of minerals, gypsum and halite are precipitates from evaporating seawater solutions which are mixtures. Sulfur deposits around volcanic vents started out as hydrogen sulfide gas in the atmosphere that came out of the vent. Extrusive lava basalt is a homogeneous solid mixture while intrusive gabbro is a heterogeneous solid mixture both came from the same source magma.	• In table groups, discuss how you would use the models you have learned about chemical bonding to explain why copper gets dented when hit with a hammer, but salt shatters. When your table comes to consensus on the explanation, share it with the class. When the class reaches consensus on the best way to write it (short and to the point, but leaving nothing out), copy it on half a sheet of paper and turn it in as an exit ticket. • Mixing ○ Text pp. 71-72 ○ Internet Resources: ▪ "What Is An Atom And How Do We Know?" (*YouTube* – Stated Clearly) ▪ *Bond Breaker* Game Classroom Edition (Be The Proton!!) ▪ "Mixtures" – (YouTube – *BioEd Online)* • States (phases) of matter: solid, liquid, gas, plasma ○ Text pp. 73-75 ○ Internet resources: ▪ "Bill Nye The Science Guy Phases of Matter" (*YouTube* – Scott Thrope) ▪ Granite: Pink Feldspar White Quartz and Black Hornblende Crystals in Granite ▪ Spoonful of Mayonnaise ▪ Example Caesar Salad ▪ Water in Dead Sea Near Palestine • Smokey Air: Canadian Wildfire Smoke in New York City Image • Wrap it up: In table groups, sort the images, identify solid, liquid, or gas mixtures, and tell if they are homogeneous or heterogeneous. Explain the reasons you chose that, citing evidence from the pictures. You may not all agree on some of them; that is fine as long as your reasoning from the evidence makes sense. Write up your final idea and turn it in as an exit ticket.
▪ Understand: ○ That a mineral is a naturally occurring, inorganic solid with a definite crystal structure and chemical composition. ○ That minerals can form four different ways; by crystallizing from molten rock, by responding to changes in temperature and pressure, by coming out of hydrothermal solutions, and by precipitating out of evaporating water solutions.	• Module 3: Minerals: (6 Days) • Grounding Phenomenon: Pulpi Geode (1.0Day) • As a class, read the 400 word article, in *BBC Travel*, on the abandoned silver mine in Pulpi, Spain. • "The World's Largest Crystal Cave" – (*BBC Travel*). Discuss the pictures. Keep this in mind as you go through the lessons coming up. At the end of the unit, decide if the crystals in the cave count as minerals and why.

○ Minerals can be identified by characteristic properties such as hardness (resistance to scratching), density, luster (how the surface looks in visible light: shiny, dull, pearly, metallic, glassy …), streak (color of the powder), etc. ○ Density is the mass of one cubic centimeter of a material. It is impractical to slice everything up so we use mathematics to give us the same answer we would get if we sliced it into one centimeter cubes and measured its mass. Measure the mass in grams, measure the volume in cubic centimeters, then divide the mass by the volume. The result is called density with units of grams/ cubic centimeter. It is the mass of a one centimeter cube of the substance. Every substance, including minerals, will have its own unique density that can be used to help identify minerals. If a solid is placed in a liquid, should the solid have a higher density than the liquid, it sinks, if the solid has a smaller density than the liquid it floats on top, and if a solid has the same density as the liquid it will remain without rising or sinking at whatever depth it is placed. ○ The elements that we encounter in Earth's crust are oxygen, silicon , aluminum, iron, sodium, potassium, and magnesium for about ninety eight and a half percent of it. The last one and a half percent is everything else. So, the most common mineral categories will often have at least one of the common elements in them. ○ The most common mineral categories are: ○ Silicates, oxides and hydroxides, sulfides and sulfates, carbonates, halides, native elements, and phosphates. ▪ Silicates - contain silicon and oxygen ▪ Oxides - contain metals and oxygen ▪ Hydroxides - contain the OH- ion ▪ Sulfides - contain a metal and sulfur ▪ Sulfates - contain a metal and the SO4 -2 ion ▪ Carbonates - contain a metal and the CO3 - ion ▪ Phosphates - contain a metal and the PO4 -3 ion ▪ Halides - contain a metal and a halogen (F, Cl, Br, I, At) ▪ Native elements - Made of atoms from a single element	• What is a mineral (2 days) ○ Watch Brain Pop Movie "Crystals" ○ Textbook Read p. 86-89 and p. 96-101 • Identify the types of minerals (3 days) ○ Watch Brain Pop Movie " Mineral Identification" ○ Textbook Read p. 90-95 • Mho's Hardness scale: "Mohs Hardness Scale - Science Educational Video for Elementary Students" (*YouTube* – Bow Tie Guy and Wife) • Mineral properties: "Identifying Minerals" (*YouTube* – Earth Rocks!) • Wrap it up - Identify minerals using various properties. If available, set up class labs using mineral sets your school has, students use common items - fingernails, streak plates, copper pennies, glass slides, iron nails, etc. - to determine hardness and ID tables or dichotomous keys to identify about twenty common minerals for themselves. Unit ends when all students have correctly identified all minerals in the kits.
• Igneous rock forms when melted rock (called magma when underground and lava when out on the surface) cools and turns from liquid to solid. The chemical composition is determined by the source	• Module 4: Types of Rocks: (12 days) ○ Grounding Phenomenon:

of the material. Magma that comes from below the ocean's crust is more than 50% iron and magnesium rich minerals and less than 50% silicates. These minerals make it dark to black in color. It is called mafic. At the other extreme, magma that comes up through continents is over 60% silicates and lighter in color than mafic volcanic rocks (gray or pink not black). It is called felsic. Continents are much higher percent silicates than sea floor. Magma rising up towards Earth's surface through cracks in continental rock melts what it travels through and incorporates that melted. In some situations the result is in between felsic and mafic in silicate content. That is called intermediate volcanic rock. • The Earth is a closed system so the rocks are constantly getting recycled. A volcano that is made of igneous rock will "weather" over time. That means rain, wind, sun, ice, falling rocks, small moss, plants etc. will gradually break the outer rock into tiny pieces which rain and wind will move downhill from the source point. This is called erosion. The rock dust or pieces, called sediment, will eventually get into streams, rivers, and then lakes or oceans where it settles to the bottom. This is called deposition. The cycle repeats year after year creating layers of sediment at the bottom of the lakebed or ocean floor. The particles in the bottom layers are squeezed together by the weight of the higher layers. This is called compaction. Then if there are sulfides dissolved in the water , or silicates or carbonates depending on circumstances will precipitate out into the spaces gluing the pieces together. This is called cementation. The materials from the igneous rock have now turned into sedimentary rock. Suppose forces in the crust crack that sedimentary rock and push magma into the cracked sedimentary rock. Now suppose the sedimentary rock near the crack gets hot but not hot enough to melt. It may also be under higher pressure. At this temperature the bonds are not stable as the minerals that formed at a lower temperature. The atoms rearrange themselves to be stable in the new temperature and pressure conditions and the rock now is made of changed minerals from when it started. We call this Metamorphic Rock. Now more magma could come in and melt everything. When it cools it will be igneous rock. • Since any rock type can become any other rock type in a continuous process over millions of years, we call that the "Rock Cycle"	○ "Mars Rock Samples Collect by the Perseverance Rover" (*NASA Science Mars Exploration)* ○ Think about single elements, compounds and minerals, types of mixtures, and phases of matter. Pause for 5 minutes and discuss what you know about these things with a classmate. Now watch the video from NASA's Jet propulsion lab about perseverance rover's rock samples, (select samples #6 & #7) video. ○ Students in small groups ask questions about the two samples of rocks while watching the video at their own tables and put them on sticky notes. ○ Each group submits three to five of their best open-ended questions. As a class, sort the best questions into five categories. Put the categorized twenty five questions into Google jamboard or on sticky notes bulletin board. As you go through the unit, revisit the list. • Internet Resources: ○ Content background for teachers for University of Houston's open source minerals & rocks: "Chapter 2: Earth Materials" (*University of Houston* website - *The Story of Earth: An Observational Guide)* ○ The Three Types of Rocks Video: "Geology Kitchen: The 3 Types of Rocks" (*YouTube* – Esteem Education Co.) • Igneous Rocks: (6 days) ○ "Identifying Igneous Rock" (*YouTube* – Earth Rocks!) ○ 1 What are igneous rocks: Text pp. 112-117 (1.o days) ○ 2 Classification of Igneous rocks: Text pp. 118-123 • Lab activity formative assessment: If school has a class set of igneous rocks, do a lab activity where students examine a set of high iron low silica, intermediate, and low iron high silica igneous rocks. Students should be able to tell if the rocks were intrusive or extrusive by the large crystals or lack thereof. They should also be able to tell by the ratio of light and dark minerals which samples are mafic (high iron), which are intermediate, and which are low iron (felsic). • Alternative: (4 days) ○ Use the Concord Consortium Rocks & Tectonics Module (2023-2024) ○ Activities 1, 3, 4 and 5. It is free, you can put your class in and it will grade the units, they are challenging and well thought out.

	○ *The Concord Consortium* "Rocks & Tectonics Module" - Earth Science Interactive lessons • Sedimentary Rocks: (1 day) ○ "Identifying Sedimentary Rocks" (*YouTube* – Earth Rocks!) ○ 1 Formation of Sedimentary Rocks Text pp. 131-140 ○ 2 Types of Sedimentary Rocks Text pp. 141-144 • Metamorphic Rocks: (4.0 days) ○ 3 Recognizing Metamorphic Rocks Text pp. 145-150 ○ "Identifying Metamorphic Rocks" (*YouTube* – Earth Rockes!) • The Rock Cycle: Text p151 (0.5 days) ○ "Bill Nye the Science Guy – Sea 03 Epis 04 Rocks & Soil" (*YouTube* - Vern Burn) ○ "The Rock Cycle" (*YouTube* – Short Simple Science)
Standards List:	**HS-ESS2-2, HS-ESS2-3**

UNIT 3: DYNAMIC EARTH	
Suggested Pacing: 37 days	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
• Heat escaping from the interior of the Earth into outer space drives plate tectonics. Earth's core is as hot as the surface of the sun and the top of the atmosphere is as cold as outer space. That makes the earth a giant heat engine. Heat leaves the core by radiation and conduction, and causes convection in the Earth's mantle which moves the crustal plates apart where it is flowing upward and drives them together where it is flowing down. The heat released by the lava flows on the surface of continents or under water in seafloor eruptions is eventually radiated into space as infrared heat radiation. • Where mantle convection is moving up, crustal plates move apart; this is called divergence. These places are associated with mid-ocean ridges, volcanoes, and earthquakes. • Where mantle convection loops are moving down, plates move towards each other; this is called convergence. Where these plates actually make contact, the denser one gets shoved under the less dense one; this is called subduction. • Where plates in contact are moving parallel to each other, this is called a transform fault, they have many earthquakes since the plates slip then jam, then break free and slip again., etc..	• Plate Tectonics ○ Drifting Continents Text pp. 468-472 ○ Seafloor Spreading Text pp. 473-479 ○ Plate Boundaries Text pp. 480-485 ○ Causes of Plate Motion pp. 486- 488 • Volcanism ○ Volcanoes Text pp. 500-507 ○ Eruptions Text pp. 508-513 ○ Intrusive Activity Text pp. 514-517 • Earthquakes ○ Forces Within the Earth Text pp. 528-533 ○ Seismic Waves and Earth's Interior Text pp. 534-538 ○ Measuring and Locating Earthquakes Text pp. 539-544 ○ Earthquakes and Society Text pp. 545-551 • Mountain Building ○ Crust Mantle Relationships Text pp. 562-566 ○ Orogeny Text pp. 567-573 ○ Other Types of Mountain Building Text pp. 574-576

• There is an exception to subduction - if both crustal plates have continents on top, continental rock is less dense than the mantle rock. It will not sink into the mantle. So when two continental crustal plates happen to hit, they crumple up at the collision point forming very high mountain ranges. The Indian plate colliding with the Eurasian plate has produced the Himalayas, which is the highest mountain range in the world. • The evidence for plate tectonics is as follows: o There are many volcanoes and earthquakes continually happening all around the boundaries of the crustal plates. Not much happens in the middle. The exception is spot volcanoes like the Hawaiian islands seamount chain. But the increase in age the farther away the seamount is from the hot spot supports the motion and direction of motion of the crustal plate. Dating the age of rocks on either side of mid ocean ridge spreading centers, finds that the the rocks closest to the center volcanoes are youngest and that rocks get progressively older moving away from the mid ocean ridges. Lava coming up from the mantle through the relatively thin seafloor crust has a lot of iron in it. When it comes out the iron minerals line up with the Earth's magnetic field like compass needles. When the lava cools to solid the minerals are frozen in place and the rocks are all magnetized the same way, aligned with Earth's north and south magnetic poles. o It turns out that, for reasons we do not understand, Earth's magnetic field reverses its north and south poles. For the last twenty million years Earth has shown a pattern of pole reversal every two hundred thousand to three hundred thousand years. o Ships carrying magnetometers (magnetic field measuring devices) can show that rocks magnetized in the same direction as Earth's present magnetic field give a higher reading (their field adds to Earth's field). Rocks magnetized in the opposite direction to Earth's present day magnetic field give lower readings (their fields subtract from the Earth's field. o There are symmetric `magnetic stripes' ' of present day and reverse direction magnetized lava rock on either side of all the mid ocean spreading centers all around the world. This evidence also supports the plate tectonic model. o Fossil beds on opposite sides of oceans match. The shapes of some continents seem to fit like puzzle pieces. Ice sheet deposits	

are found on continents that are now at the equator. Tropical plant fossils are found on land near the north and south poles. All this supports the model of moving plates creating and breaking up. • Diverging plate boundaries are associated with mid ocean ridge volcanoes. Converging plate boundaries are associated with island arc volcanoes. There is one other type of volcano that is due to hot plumes of material coming up from the outer core through the mantle and punches through the crustal plate above it. As the moving plate goes off of the hotspot that volcano stops erupting and a new volcano forms behind it. Over millions of years lines of old inactive volcanoes are visible. If the volcano is in the middle of an ocean plate the older volcanoes get eroded away on top and become seamounts. • Most earthquakes happen at plate boundaries. Pressure builds up until the rock breaks and slips releasing energy in the forms of mechanical waves. There are longitudinal waves where the back and forth motion is in the same direction as the waves are traveling, there are transverse waves where the back and forth motion is perpendicular to the direction of motion. Finally there are torsional waves which move along Earth's surface kind of twisting one way then the other in the plane of Earth's surface. Longitudinal waves travel the fastest through the Earth. The transverse travel slower than longitudinal waves and the surface waves are the slowest of all. When earthquake measuring devices, called seismometers, get a signal the longitudinal wave arrives first. It is called the primary wave, or P wave. The transverse wave arrives next. It is called the secondary or S wave. Because they start at the same place and travel away at different speeds, if you know their speed, the difference in time lets you calculate how far away the earthquake was. There are standardized distance versus time graphs for earthquake P and S waves. When you find the place on the graphs where the time difference between the p and s wave curves is the same as the seismograph showed at your station looking over at the distance scale tells how far away the Earthquake was. If three stations at different locations around the globe measured the distance to that Earthquake, Then plotting circles on a globe with centers at the stations and radii equal to the distance from the quake one can locate where it happened. The point where all three circles is the location of where the earthquake happened. Earthquakes also tell us	

information about the interior of the earth. Waves travel at different speeds through the mantle and the crust. Longitudinal waves will travel through liquids, transverse waves do not. We know that the Earth has a liquid outer core and a solid inner core, as well as an inner and outer mantle and a solid crust because of the hundreds of thousands of earthquakes that have been recorded and analyzed over the years. • Earthquakes can cause serious damage to structures depending on the construction of the building, the type of soil it is on and the depth, distance, and magnitude of the earthquake. Brick buildings have no strength in tension, so they fall apart and kill everyone inside in relatively small earthquakes. Buildings with interlocking iron reinforcing bars inside their concrete walls will flex and shake but not collapse. Buildings in rock do well. Buildings on sand or mud will be carried away in the moving mud or sand even if they do not collapse. • Mountains can form in a variety of ways. Two converging continental plates can fold very high mountains at their collision point. When oceanic plates subduct under a continental plate, islands and other features will get scraped off onto the overlying continental plate causing crumpling and folding upward on the back side of the trench. One may get volcanic mountains forming on the continent side of the magma from the melting subducting plate that works its way to the surface. Magma may be pushed up but not break through to the surface if a crustal plate is bending or flexing but not breaking due to various forces. These intrusions may force up mounds that are smaller mountains. The White mountains north of Fairbanks and the local domes, like Ester Dome, Murphy Dome, Pedro Dome , Haystack Mountain, etc. are all that sort of mountain. If there was a massive ice field that was weighing down the crust melts the release of weight will allow the underlying mantle to push up the overlying crust over time and the high places under the ice will now be pushed up higher. This is called isostatic rebound or isostasy for short. Finally, if the crust of the plate is stretching apart the crust can break in different places forming cracks or faults around blocks of the crust. Some of the blocks sink and some rise. This is called “fault block” mountain building. The “Basin and Range” mountains in the western United States are an example of this.	
Standards List:	**HS-ESS1-5, HS-ESS2-1, HS-ESS2-3, HS-ESS2-5**

UNIT 4: GEOLOGIC TIME	
Suggested Pacing: 25 days	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
• Scientists use many independent methods to figure out the history of the Earth. When they corroborate each other, one becomes more certain about the date; it is like planetary forensics. • Historically, the bible was considered a literal science history book correlating the Babylonian King Nebuchadnezzar II from history with the one described in the Bible and then counting backwards through the generations in Genesis to get an actual date. It was a good attempt, but the time was way too short. It put Earth's formation at around 4000 BC. James Hutton, Scottish doctor, farmer, and geologist showed in a paper he presented in 1788 that 6000 years was not nearly enough time for Earth. Just looking at the many layers of sedimentary rock in the hillsides around his farm, and realizing how much longer than a few thousand years would be needed to turn the kind of annual sediment runoff he was clearing drainage ditches on his farm into layers of rock. He liked to say that there was "no vestige of a beginning and no prospect of an end" for the time involved. His most famous example was an outcrop showing an "unconformity" at Siccar Point, on the east coast of Scotland. In the outcrop is a bed of layered sedimentary rock that was rotated so it was vertical. Its top had been eroded off and on top of that were layers of other sedimentary rock that was horizontal! He had no way of measuring the actual time needed for all that to happen, but it had to be a long, long, long time! Through modern radioactive dating, we now know the bottom part formed 435 million years ago. The rotation and wearing away before the new layers formed is a gap of about sixty five million years and the top horizontal layers started forming 370 million years ago. • Hutton devised a series of logical ways to determine the relative age of rocks. They are common sense ideas: ○ Original Horizontality: Sedimentary rocks get deposited in horizontal layers. ○ Superposition: the younger rocks are on top and the older rocks are on the bottom.	• Geologic Time: ○ Grounding Phenomenon: A modern picture of the Siccar point outcrop in Scotland would make a great grounding phenomena. ○ Questions like, "How did this happen?" "How long did it take?" "How do we know?" These would be great driving questions to investigate. • Fossils and the Rock Record ○ The Rock Record Text pp. 590-594 (2 days) ○ Relative Age Dating Text pp. 595- 600 (2 days) ○ Absolute Age Dating Text pp. 601-605 (1 day) ○ Fossil Remains Text pp. 606-609 (4 days) • The Precambrian Earth ○ Early Earth Text pp. 620-622 (1 day) ○ Formation of the Crust and Continents Text pp. 623-627 (2 days) ○ Formation of the Atmosphere and Oceans Text pp. 628-632 (2 days) ○ Early Life on Earth Text pp. 633-637 (3 days) • The Paleozoic, Mesozoic, and Cenozoic Eras (3 days) ○ The Paleozoic Era Text pp. 648-654 ○ The Mesozoic Era Text pp. 655-659 (2 days) ○ The Cenozoic Era Text pp. 660-665 (3 days)

○ Cross cutting relationships: A fault or crack that cuts through layers of rock has to be younger than what it is cutting through. ○ Inclusions: Fragments of a rock found inside another have to be older that the rock they became part of. ○ Unconformity: A place where one type of rock stops and seems to been eroded away and a new type was laid on top means a long time passed between the two events (like Siccar Point) • Absolute age dating determines the actual age (in years) for geologic events and rock formations. Absolute ages are determined by radiometric dating. The way this works is that some elements have nuclei whose ratio of protons to neutrons is unbalanced. The nucleus is unstable. It will go through a series of changes that will eventually turn it into a stable nucleus of an element that will not change any more. ○ Because this is going on in the nucleus, it is completely unaffected by chemical reactions, temperature, or anything else happening outside the nucleus. Also, the rate at which the changes happen is unique to that particular type of atom. ○ For example, Uranium 238 (a uranium atom with 92 protons and 146 neutrons is radioactive. If you start out with a pure sample of U238, in 4.5 billion years half of the amount you started with will have changed into stable lead atoms. In another 4.5 billion years half of what was left will change, and so on. 4.5 billion years is called the "half life" of U238. It takes ten half lives to get down to one thousandth of what you started with. It takes twenty half lives to only have one millionth left and so on. ○ Mathematically this is called an exponential decay. If you plot the theoretical graph of the amount remaining versus time, and you know how much of the radioactive material was in the sample at the beginning and you can measure how much is still there and how much is the new stable element you can use the graph to figure out the actual age in years. • For different time spans one uses different radioactive elements. If you want to date charcoal from campfires of people living in New Mexico about 25,000 years ago, use something like radioactive carbon 14 which has a half life of 5730 years. The change in u238 would be way too small to measure. On the other hand, if you	

wanted to measure a rock left over from the formation of the solar system, Uranium is great since half of the original amount would still be left, since the solar system is about four and a half billion years old. Carbon 14 would be useless; that's about seven hundred and eighty five thousand half-lives. There would be nothing left!

- Cosmic rays: High energy particles from outer space smashes into atoms at the top of Earth's atmosphere sending down showers of neutrons.
- How Carbon 14 is made: A neutron from cosmic ray collision goes into a nitrogen nucleus, kicks out and replaces a proton, turning the nitrogen atom into a radioactive Carbon 14 atom.
- How Carbon Dioxide (with C14) is made: One Carbon 14 atom hooks up with two oxygen atoms making carbon dioxide gas
- How plants get C14 in to them: Plants take in the (C14) carbon dioxide and combine it with water to make carbohydrates (leaves & wood) releasing the oxygen through photosynthesis.
- How animals get C14 into them: Animals eat the leaves with C14 in them and turn them into bone, muscle, sinew, etc.
- How radioactive dating works after a plant or animal dies: The ratio of C14 to C12 drops over time compared to the ratio for living things. The radioactive decay rate is not affected by temp, pressure, or anything. The time for half the parent C14 to change into daughter elements is 5740 years. The C14 is less than a ten thousandth of the C12 at the start. So, this method is only good for about 50,000 years. After, the amount left gets too small to measure.
- At first right after the animal dies: Parent isotope 100% and the Daughter isotopes 0%
- Carbon 14 after 1 half life (about 6000 years pass): 50% the parent isotope left and 50% of material has changed to the daughter isotope.
- Carbon 14 after 2 half lives (about 12,000 years pass): 25% of the parent isotope left and 75% of the daughter isotope produced.
- Carbon 14 after 3 half lives (about 18,000 years pass): 12.5% of the parent isotope left and 87.5% of the original material has turned into daughter isotope.
- Fossils
    - Fossils are the preserved remains or traces of living things from the distant past, usually found in sedimentary rocks. Most

fossils are formed when a plant or animal dies in a watery environment and is buried in mud and silt. ○ Cast fossils: Where the plant or animal decayed after the rock formed around it and then minerals deposited in the cavity copy of the animal that once filled that space. ○ Mold fossil: A space in a rock that has the shape of the living thing that once filled the space. ○ Trace fossils: Where footprints left in mud become turned into stone. ○ Imprint fossils: Something of the fossil, other than its parts, is left behind, such as a carbon stain in the fossilized mud. ○ Index fossils: Some organisms only existed for a limited period of time and then became extinct; these can be used as markers. When an index fossil is found, one immediately knows what time period they are looking at. • Forams (Foraminiferans): Ocean planktonic (freely floating) or benthic (bottom dwelling) very small single celled organisms that secrete calcium carbonate into shell-like hard outer coverings made up of small chambers. They use short, wiggling hair like structures, called cilia, all around their bodies to move through the water. The cilia stick out through tiny holes in their shells. Petroleum geologists love the shells they leave behind when they die because they are wonderful index fossils. • Biostratigraphy: Different planktonic forams went extinct at different times. Petroleum geologists use their knowledge about foram species to learn when they are drilling in oil producing rock. Certain species of forams lived in the water with the swamp plants during the Carboniferous Period. These plants eventually turned into oil. Find the right forams, and you know that you are drilling in the correct rock formation and getting close to the oil! • Paleoenvironmental Analysis: This is the interpretation of the environment in which the rock formed based on the fossils found in the rock. The species of foraminifera tells the depth of water, the percentage of oxygen, and ocean's salinity at the time that the forams were living there. This alerts the petroleum geologist to the environmental conditions when the sediments were being deposited. Certain environmental conditions are good for growing plants that become oil; other conditions are not.	

• The Precambrian refers to the time from the formation of the Earth 4.5 billion years ago to 541 million years when fossils of multi-celled animals began to appear. • Based on moon rocks from the Apollo missions and various stony meteorites left over from the formation of the solar system, the best model we have is that the moon formed from a Mars sized planet hitting Earth, a glancing blow that vaporized it and a good portion of Earth's upper mantle and crust resulting in a ring of material orbiting the Earth that coalesced into the moon. • Precambrian - Hadean era 4.5 to 4.o billion years ago. Not long after that, we got bombarded with tremendous numbers of asteroids and other rocks. So why doesn't Earth have all the craters that the moon does? Earth has an atmosphere, which causes weathering and erosion. Earth has plate tectonics that recycles most of the crust in one or two hundred million year cycles; that would clean up any crater from four billion years ago. The moon lacks that. • Precambrian - Archean 4.0 to 2.5 Billion years ago. The less dense continental shield silicate islands that were floating on top of the denser molten mafic seas began clumping together to continental shield rock. The atmosphere was probably methane and ammonia, but water was arriving from comets and hydrated rocky asteroids hitting the Earth. Microfossils indicate that there were water oceans, and that 2.8 billion years ago there were little guys that got their energy from chemical reactions like anaerobic bacteria that get carbon from carbon dioxide. At the end of the period, the ocean floor was covered with mats of these little guys. Plate tectonics also seems to have started • Precambrian - Proterozoic (2.5 to 0.54 billion years age). Around 2.5 billion years ago. Cyanobacteria (blue green algae) appeared. They are a game changer! They are the first to use photosynthesis and use sunlight to convert water and carbon dioxide into carbohydrates. They released Oxygen as a waste product. In the next two billion years, their waste oxygen completely changed the planet. It reacted with all the iron turning it into hematite. It changed the ocean from very basic to slightly basic. It turned the atmosphere from nitrogen, ammonia, methane, and other interesting gasses to nitrogen and oxygen. That made multicellular organisms like human beings possible!	
Standards List:	**HS-ESS1-6, HS-ESS2-1,HS-ESS2-7**

UNIT 5: SURFACE PROCESSES	
Suggested Pacing: 31 days	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
• Weathering can be mechanical, chemical, or biological; all of which break rock surfaces into small pieces. • Erosion by wind, water, gravity, or glaciers move weathered rock to new locations where it can become beach sand or coastal barrier islands, river bars, river floodplain deposits, or river deltas. • Because the Earth is a closed system for water it is continually being reused. Understand that Water's movement, both on land and underground, causes weathering and erosion. Water in the atmosphere is a major feature of weather, and water must exist in all three phases simultaneously on our planet for life to be possible. This is because water in our oceans, covering 70% of our planet, prevents huge swings in temperature. This is partly due to the large amount of heat water absorbs when ice melts or water evaporates, and it is also due to the distance our planet's orbit keeps us from the sun. Finally, over half of our body weight is due to the water in our bodies.	• Weathering Erosion & Soil (8.5 days) o Weathering Text pp. 164-170 o Erosion & Deposition pp. 171-175 o Soil Text pp.176-183 o Brain Pop Weathering movie & Quiz from the textbook resources • Mass Movement (Wind & Glaciers) (7.0 days) o Landslides Text pp. 194 - 200 o Wind Text pp. 201-206 o Glaciers Text pp. 207-212 o Brain Pop Rock Cycle Movie o Brain Pop Erosion movie & Quiz (Choose question set 3, pause points for grades 7&8) • Surface Water & Groundwater o Surface Water Text pp. 224-241 (8 days) o Ground Water Text pp. 252-268 (7.5 days) • "The Water Cycle for Kids" (*YouTube* – Learn Bright) • Brain Pop "Water Cycle "Movie & Take Quiz
Standards List:	**HE-ESS2-2, HS-ESS2-5**

UNIT 6: BEYOND THE EARTH	
Suggested Pacing: 36.5 days	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
• Recognize that the patterns of the apparent motion of the sun, moon, and stars in the sky that we observe can be explained by models. Distinguish between the geocentric model used by Ptolemy and the sun centered model proposed by Copernicus. Tell what the evidence was that led to the abandonment of the Earth centered model. • Understand that the electromagnetic spectrum and the fact that the laws of physics are the same everywhere in the universe means we can use different kinds of telescopes to find out what is happening throughout the observable universe. The Doppler Effect (light waves from a moving source are slightly shorter wavelength, blue shift, if it is coming towards us and slightly longer, red shift, if it is moving away) lets us tell how fast and in what direction stars and galaxies are moving. Some wavelengths penetrate dust (Radio waves), some reach the surface of the earth (visible light), some never get through our atmosphere (x-rays and gamma rays). We have telescopes in space to observe all these frequencies and telescopes on the ground to observe in the wavelengths that make it there. All stars contain hydrogen and helium. Hydrogen atoms that are very hot emit characteristic wavelengths of light that are unique to hydrogen. The same is true for all the elements. This is the element's spectrum; the emission spectrum. If a cloud of cool gas is between the star and the observer. The elements will absorb the characteristic pattern of wavelengths of light that they would give off when hot; this is called the absorption spectrum. An object giving off all the colors of visible light produces a full spectrum. • Understand how our model explains eclipses of the sun and moon. Recognize that Earth's spin axis tilt stays the same as it orbits the sun, and that results in our predictable seasons • Explain the formation of the solar system, beginning with a supernova's shockwave passing through a cosmic dust cloud creating spinning stellar nebula, and ending with the planets in their present orbits, the Earth having plenty of water, and an unusual very large moon that stabilizes its tilt insuring the life can count on the seasons in a predictable way.	• The Sun-Earth-Moon System ○ Tools of Astronomy Text pp. 764-769 (1 day) ○ The Moon Text pp. 770-774 (2 days) ○ The Sun-Earth-Moon System Text pp. 775-784 (4 days) • Our Solar System ○ Formation of the Solar System Text pp. 796-803 (4 days) ○ "How The Universe Works: "Birth of the Earth" video ○ The Inner Planets Text pp. 804-810 (1 day) ○ The Outer Planets Text pp. 811-815 (1 day) ○ Other Solar System Objects Text pp. 816-819 (4 days) • Stars ○ The Sun Text pp. 830-836 (2.5 days) ○ Measuring Stars pp. 837-846 (2 days) ○ Stellar Evolution pp. 847-851 (3 days) • Galaxies and the Universe ○ The Milky Way Galaxy Text pp. 862-868 (3 days) ○ Other Galaxies in the Universe Text pp. 869-877 (5 days) ○ Cosmology pp. 878-881 (4 days)

• Be able to discuss why, even though the Earth & moon are very close to each other in astronomical distance, the moon has many craters and the Earth does not. • Distinguish between the inner and outer planets and their different characteristics. • Be able to discuss asteroids, comets, centaurs, dwarf planets, the Kuiper Belt, and the Oort Cloud. • Understand that during star formation the condensing gas cloud in the center of the stellar nebula is getting higher pressure and temperature, because the increasing mass makes the compression due to gravity keep increasing in the middle. When the core gets hot enough, nuclear fusion begins. Hydrogen nuclei combine to make helium nuclei converting some of the original mass into energy. The outward pressure from nuclear fusion balances the inward pressure from gravity creating a star. The life of the star is determined by that balance between gravity and fusion. • Our sun is an example; it is a medium sized yellow star that is about five billion years old and half way through its ten billion year life span. • Distance to nearby stars are measured by parallax. Farther distances are measured by cepheid variable stars. Know how that works. Motion is determined by Doppler shift in the hydrogen spectra of stars. • The structure of the sun is a central core where fusion is happening producing photons carrying the energy outward. The region surrounding the core is too compact for convection, so energy can only move outward through it by radiation; this is called the radiation zone. At great enough distance out from the core the pressure gets low enough for convection to start transferring some heat energy; this is the convection zone. On the outside the photons can escape into space as light; this is the photosphere. The energy took many thousands of years to get out from the core; it only takes eight minutes to get from the photosphere to Earth. The outside of the sun has other features. Above the photosphere is the chromosphere where excited hydrogen atoms are giving off red light and the space around the sun is filled with a glowing region of very high speed particles moving away called the corona. The sun rotates and because it is gas, the speed of rotation is different at its poles than at its equator. The rotating charged particles (remember it is too hot for protons and	

electrons to combine to form neutral atoms; it is all plasma.) produce a strong magnetic field. The magnetic field gets twisted due to the different rotational speeds and where the lines come out and go into the surface convection is suppressed and the plasma is cooler there than the surrounding surface. From Earth, these places look darker; they are called sun spots. Explosions of plasma caused by field lines disconnecting are called solar flares. Sometimes the released plasma curls back to the sun's surface because it is following curved magnetic field lines; this is called a solar prominence. If the field lines disconnect while the pasma loop is moving outward, the blob of plasma will leave the sun heading outward through the solar system. If it happens to be in Earth's direction, it will hit Earth's protective magnetic field in two days, compressing it, and causing a great deal of radio interference and power surges in electric transmission lines causing power outages and destroying circuits; this is called space weather. We have satellites and astronomers watching the sun for this. If there is a couple day's warning that its coming, preparations can be made to minimize any damage and resume normal operation once it has passed. • Stars come in many varieties depending on their mass, and have been organized into a visual chart called the Hertzsprung-Russell diagram. The H-R diagram plots temperature (or color). Color is determined by surface temperature. Red being coolest then orange, yellow, white and blue is hottest) on the horizontal axis and brightness on the vertical axis. This tells a great deal about the life of stars. • The initial mass of a star determines its fate. Stars with masses less than eight times the mass of the sun go from protostars to become adults fusing hydrogen to helium for ninety percent of their lives, then when all the hydrogen has turned to helium, the outer gasses expand and cool making a red giant star on the outside, but the core starts fusing helium into heavier elements up through carbon and iron. Once that is done and the outer gasses dissipate, all that is left is the dense hot core giving off white light. This is a white dwarf star. If the mass is between eight and twenty times the mass of the sun, life is similar up until near the end. Gravity is so strong that instead of collapsing gradually into a white dwarf the outer part collapses quickly into the middle causing a super explosion called a supernova. This produces some of the elements more massive than iron. What's left is an object crushed so much by gravity that electrical force	

cannot keep atoms as electrons around protons. Everything gets combined into neutrons that are jammed up against each other. This is a neutron star. If the star has a mass more than twenty times the mass of the sun, nuclear forces cannot stop the compression due to gravity. The gravity curves space so much that even light cannot escape; this is called a black hole. • Stars frequently form in orbiting pairs. If both are more than twenty times the mass of the sun, they will end their lives as black holes. Since gravity warps space-time, and black holes are knots in space-time, if they are moving around each other they are creating ripples or waves in space-time that are moving away from the orbiting black holes taking energy with them. When orbiting objects lose energy, the orbits get smaller. With orbiting black holes the orbits will get so small that they eventually crash into each other forming a more massive black hole. We have recently made detectors that see the gravity wave ripples when this happens. It is a new kind of telescope. We now talk about multi-messenger astronomy, so that when gravity waves from collisions are detected and the direction the signal arrives from is figured, astronomers in the world are alerted and every wavelength type of telescope is focused on it. • Stars occur in groups of hundreds of millions called galaxies. The galaxy that our solar system is a part of is a barred spiral we call the Milky Way Galaxy. • There are spiral shaped, bar spiral shaped, elliptical shaped, and irregularly shaped galaxies (which are usually galaxies in the process of colliding) Space has regions that are relatively empty and regions where galaxies are clustered together. In the early twentieth century, Edwin Hubble used cepheid variable stars in galaxies to determine their distance from us. He looked at the Doppler shift in hydrogen and helium absorption spectra for stars in those galaxies the see which way they were moving. He was surprised to find that they were all moving away from us and that the more distant ones were moving away faster than the nearby ones. • He considered two models to explain it: o We could be the center of the universe. He thought that unlikely. o The universe could be analogous to a rising loaf of raisin bread dough. As it all expands the distance between raisins increases. The distance from one raisin to far away raisins increases faster than the distance to nearby raisins. That is true for every raisin.	

• The evidence showed that the universe was expanding. The astronomer Fred Hoyle, who did not like the model, coined the term "Big Bang" during a presentation to a general audience to give them an idea of what the concept was. The term stuck. • There is more evidence that something unusual occurred to start our universe and make it expand. There is cosmic background microwave radiation coming from all different directions that could be left over from the initial flash after everything started. There are different models being proposed to explain things. A final model has not been accepted. One model proposes that gravity from the mass of the universe will be enough to stop the expansion and pull things back together in a big crunch. Another is that the expansion will continue forever. A third is that different universes pop into existence continuously analogous to the way carbon dioxide bubbles form in a soda pop when it first opened up (the multiverse model).	
Standards List:	**HS-ESS1-1, HS-ESS1-2, HS-ESS1-4**

UNIT 7: EARTH'S ATMOSPHERE, WEATHER, AND CLIMATE	
Suggested Pacing: 35.4 days	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
• The thin layer of gasses around the surface of Earth is called the atmosphere. When one plots a graph of air temperature measurements with temperature on the horizontal axis and altitude on the vertical axis, starting from the ground, one finds that the temperature first decreases with altitude, then increases, then decreases and finally increases again at the top. That is the basis for dividing the atmosphere into four layers. The bottom layer where temperature is decreasing with altitude is the troposphere. Nitrogen (80%) and Oxygen (19%), which are the main gasses in Earth's atmosphere, are transparent to visible light. It is not absorbed until it reaches the ground which warms up making the air next to it warmer. The air cools with height as one moves away from the heat source, the ground. At about twelve miles up, the ultraviolet light in the sunlight is splitting oxygen molecules (O_2) apart, which recombine to form Ozone (O_3). This prevents most ultraviolet light, which is harmful to life, from reaching the ground. It also heats the atmosphere. Above that, there is an altitude at which the atmosphere gets so thin that there is not enough oxygen to be making ozone so the temperature drops. And, above that, the top of the atmosphere is being hit by continuous streams of protons from the sun (called the solar wind) and it heats up again. These zone are thought of as layers and are named as follows: ○ The **Troposphere** is the closest to the ground, contains most of Earth's water vapor, where "weather" happens. The "boundary' at the top, where the temperature begins increasing, is called the **tropopause**. ○ The zone where the temperature is increasing due to the ozone layer formation is called the **stratosphere**. The transition above is called the **stratopause**. ○ The zone where the temperature is dropping is called the **Mesosphere**. It is still thick enough to burn up most of the meteorites hitting Earth's atmosphere, before they reach the ground. The transition is called the **mesopause**. ○ The top layer is called the **thermosphere,** which has a lower part of the thermosphere called the **ionosphere** involved in the	• Atmosphere: ○ Atmosphere Basics Text pp. 282-288 (2.5 days) ○ Properties of the Atmosphere Text pp. 289-296 (2.5 days) ○ Clouds & Precipitation Text pp. 297-303 (4 days) • Meteorology ○ The Causes of Weather Text pp. 314-317 (2 days) ○ "Real World: Earth's Energy Balance – Energy In and Energy Out" (NASA eClips) ○ Weather Systems Text pp. 318-323 (1 day) ○ Gathering Weather Data Text pp. 324-328 (1 day) ○ Weather Analysis & Precipitation Text pp. 329-332 (3 days) • The Nature of Storms ○ Thunderstorms Text pp. 344-349 (1.5 days) ○ Severe Weather Text pp. 350-354 (1 day) ○ Tropical Storms Text pp. 355-360 (2 days) ○ Recurrent Weather Text pp. 361-365 (4 days) • Climate ○ Defining Climate Text pp. 376-380 (2 days) ○ Climate Classification Text pp. 381-386 (2 days) ○ Climatic Changes Text pp. 387-392 (2 days) ○ Impact of Human Activities Text pp. 393-395 (4 days)

production of the northern lights and an upper part of the thermosphere that gradually changes into outer space. ○ It is called the **exosphere** and is where low earth satellites are found. There is no "-pause" term. • Air pressure is due to gravity pulling down on all the air molecules above the surface. Pressure is stated in units of weight per unit area. At sea level, it is about fifteen pounds per square inch of surface. Air pressure is acting in all directions on anything immersed in the air, so although there is about thirteen tons of downward force in a 3ft x 4ft lab table, there is also about thirteen tons of force underneath pushing up. They cancel each other out; the table is fine. In the center of a tornado the air pressure is close to zero. If the center of a tornado touches a building, you suddenly have 15 pounds per square inch outward pressure on the building's ceiling and walls and nothing pushing back in. All of that unbalanced outward force makes the building explode. • The percent of water vapor in solution in the air (compared to the maximum amount it could hold at that temperature) is called relative humidity. When it reaches 100% the air is "saturated". Beyond that the air can't hold it and the water has to come out of the air somehow. In a situation of sun causing water to evaporate from the surface of a lake, convection moves the warm moist air upward, but since the troposphere cools with altitude, when the air becomes saturated, water will come out of the air and stick to any small particles in the air like dust making tiny drops about the same density as the surrounding air that do not fall. This "condensation" on dust particles is how clouds form. As more and more water condenses, the drops may stick together and get more dense than the surrounding air and begin to fall. This is "precipitation". It is called rain if it is liquid and snow if it is in crystals that are flakes; it can also be sleet or hail. All are forms of precipitation. • Clouds are categorized by their shape and altitude. Low level clouds are strato-, mid level clouds are alto- and highest in the troposphere clouds are cirro-. If they are puffy they are cumulus or cumulo-, if they form a flat layer they are stratus. ○ 50,000 feet (about ten miles up) cirrus, cirrocumulus, cirro stratus, etc. ○ 6,500 to 20,000 feet (between 1.25 and 4 miles) altocumulus, altostratus, etc.	

○ Lower than 6000 feet (under a mile) stratus, cumulus, nimbus, stratocumulus, etc. ○ Thunder clouds are a bit different. If there is enough heat energy, the convection builds the cumulus water drops all the way up to the stratosphere where they begin to shear off sideways; these are called cumulonimbus or thunderheads. • Differences in the way the sun heats the Earth (least at the poles and most at the equator) and the rotation of the Earth drive weather patterns on our planet. • Prevailing wind patterns: Hot air rising from the hot equator moves north or south and is replaced by cold air moving in from the poles. Because the earth is spinning it gets more complicated, the moving air is deflected, and the two circulation loops in the northern and southern hemispheres break into six bands - three in the north and three in the south. ○ In the northern hemisphere there are the Polar Easterlies from 90°N latitude to 60°N latitude that blow from NE to SW. ○ Then there are the Prevailing Westerlies from 60°N latitude to 30° N latitude that blow from SW to NE. ○ Finally from latitude 30°N to latitude 0° (the equator) are winds that blow from NE to SE and are called the Northeast Trade Winds. ○ In the Southern Hemisphere, it is reversed. These winds drive weather systems. • Stationary air masses at the surface can take on the temperature and humidity of whatever they are over. They are named that way. Air over land is "continental," air over oceans is "maritime," air that is hot is "tropical," and air that is cold is "polar." ○ Air over water tends to be humid, and air over land tends to be dry. ○ When these air masses encounter each other, "weather" happens. ○ If a tropical-maritime air mass moves towards a polar-continental air mass, the less dense warm air moves up onto the denser cold air, causing high cirrus clouds followed by overcast, and drizzle, then rain that is steady, eventually it is warm and perhaps mostly cloudy. This is a warm front. ○ When polar-continental hits tropical-maritime, the denser cold air shoves into the less dense and moist warm air. As the warm air rises, it is rapidly cooled causing high winds and heavy	

precipitation, which is quickly followed by cold air with clear skies. This is a cold front. ○ Two air masses moving parallel but not into each other is a stationary front. ○ When a cold air mass overtakes a warm air mass moving over cold air (i.e. a cold air mass moving into a warm front in progress), there is even more rain, wind, and perhaps thunderstorms. This is an occluded front. • Satellites measuring temperature and water vapor content in Earth atmosphere with both active (laser beam from the satellite) and passive (infrared detectors), ground stations, airplanes, and weather balloons all measure temperature, humidity, wind speed and direction, air pressure, historic climate data, and precipitation, and put the information into models to predict weather. • Temperature and humidity difference cause winds and drive storms. Land heats and cools faster than water. So, a beach next to the sea will become hotter than the lake during the day and the warmer air over the beach will be pushed up by cooler, dense air over the water moving in to replace it; this is a daytime sea breeze. At night it reverses. • In Fairbanks in summer, in the morning sunlight heats the boreal forest's muskeg and small lakes evaporating water that rises producing cumulus clouds. As this continues through the long day they buildup into cumulonimbus thunderstorm clouds producing rain, lightning, and possibly hail; this is followed by the clouds going away once they are drained of moisture. This is a small scale version of what happens in the Midwest during a thunderstorm. The three stages are the: cumulus stage, mature stage and dissipation stage. • Mid latitude North America has weather patterns that move from the Pacific towards the Atlantic pushed by the Prevailing Westerlies. Because of the large flat land area in the great planes, solar heating can produce thunderstorms much larger than the ones we see in Fairbanks. The heat can generate rotating air masses called "supercells;" these are thunderstorm systems that extend for many hundreds of miles. They produce heavy rain, strong winds, hail, and possibly tornados. • Wind blowing over a flat area moves slower at ground level due to friction than higher up. This wind shear can produce rolling air, that if tilted upward at the base of a supercell, is thought to be the	

beginning of a tornado. These funnels of rotating air can have very low pressure in their centers and high winds on the outer parts. They are classified into categories based on wind speed in the enhanced fujita (EF) tornado scale. The least damaging is an EF0 with wind speeds of 65 to 85 mph. The worst is an EF5 with wind speeds over 200 mph. • Hurricane, cyclone, and typhoon are different names for the same type of tropical storm. They always begin near the equator where seawater surface temperature is 80°F or higher. o The water evaporates continuously at that temperature and releases the heat of evaporation when it condenses to become clouds. All of that energy going into the air produces high velocity winds. Rotation of the earth causes the wind to start spiraling (the Coriolis effect). This initial phase is called a tropical depression with sustained wind of about 40 mph. If it travels over warm water as it is pushed from the East to the West by the Trade winds, it will get more energy from the new evaporating warm water and intensify. o When the sustained winds are between 40 and 74 mph it becomes a tropical storm o Above 75 mph it has become a category 1 hurricane (cyclone, typhoon). The Staffir Sympson hurricane wind scale gives 74 - 95 category 1, 96- 110 category 2, 111 - 129 category 3, 130 - 156 category 4, 156 mph or higher category 5. o Hurricane hazards when they move onto land are "storm surge" due to the low pressure in the middle (called the eye), pressure on the ocean is less than on the outside so the water level is higher than normal. This extra high water adds to the flooding caused by the heavy rain when the hurricane moves onto land. . o They weaken over land or cold water but they will still dump a lot of rain as the moisture comes out of them. • Recurrent weather can be patterns that cause drought or flooding; a good example is the "Southern Oscillation." It occurs in the tropical south Pacific, but impacts weather all over Earth. • It switches between Normal, El Nino, Normal, La Nina, Normal. o Normally around December the trade winds push warm surface water to the west away from the coast of Chili. Colder bottom water full of nutrients moves up to replace it. (Chilean fishing is good!) The cooler water moving west brings seasonal rain,	

called monsoons, to Australia, China and India. (Farming is good!) ○ El Nino: This is a time that is not normal. The trade winds weaken and the warm water stays next to the coast of Chili. There is no upwelling of nutrients, fishing is terrible! Australia and Asia do not get their seasonal rains (monsoons). There are grass fires all across Australia. There is drought in China and India. Crops fail! ○ La Nina: This is when the trade winds become very strong. Offshore winds keep Chili from getting much rain. They have a drought. They also push warm surface seawater much farther west piling it up against Australia and Asia. This produces monsoons that last longer and carry more water than normal. There is a lot of flooding. • Climate is the long term pattern of temperatures and precipitation over many years due to its location, latitude or other factors that determine what it experiences. • Weather is the day-to-day changes in atmospheric conditions. Examples: ○ Weather: rain today, sunshine tomorrow ○ Climate: Since it is at 61^{o} N Latitude, next to the cold north pacific ocean, Anchorage has short cool rainy summers and long moderately cold snowy winters • Climate is caused by latitude, nearness or distance from water, the presence and orientation of mountain ranges, lack of mountain ranges, prevailing wind patterns, and altitude above (or below) sea level. • Classification of climate types ○ Tropical climates have a couple of possibilities. ▪ Tropical Dry ▪ Tropical wet and dry ○ Mild climates are ▪ Marine West Coast ▪ Humid Subtropical ▪ Mediterranean ○ Dry Climates ▪ Semiarid ▪ Arid ○ Continental Climates ▪ Warm summer	

▪ Cool summer ▪ Subarctic (Fairbanks for example) ○ Polar Climates ▪ Tundra ▪ Ice Cap ▪ Highland • Short Term Climate Change ○ Seasons? ○ The Southern Oscillation? ○ Solar activity (the 11-year sunspot/solar activity cycle)? • Long Term Climate Change ○ Ice ages ○ Interglacial • Causes: ○ The tilt of Earth's axis ○ The pattern of changes in Earth's orbit ○ Plate tectonics changing the size and location of continents. ○ Plate tectonics - causing volcanic eruptions that change the atmosphere • Human activities can change climate patterns; • Deforestation: ○ Example: The Amazon rainforest is huge and produces its own climate. Transpiration of water into the air by all those trees makes it rain every afternoon. If the rainforest is completely cleared to harvest its wood and replace it with farm or grazing land, the climate will stop being Tropical wet and will become Tropical wet and dry. • Burning Fossil Fuels: ○ Adding stored carbon the short term carbon cycle by burning fossil fuels, making concrete, and releasing stored short-term carbon by cutting down forests and draining marshes is putting extra greenhouse gasses into the air and raising the average global temperature.	
Standards List:	**HS-ESS2-2, HS-ESS2-4, HS-ESS3-5**

UNIT 8: EARTH'S OCEANS AND THE MARINE ENVIRONMENT	
Suggested Pacing: 15.5 days	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**

• The Earth's oceans are all interconnected into a world ocean. Looking at the southern hemisphere on a globe, the earth appears to be an ocean planet. Looking at the northern hemisphere it appears to be a land planet. This affects our climate. The presence of our large moon in stable orbit produces tides. Newton's law of gravity says masses pull on each other with forces directly proportional to the product of their masses and inversely proportional to the square of the distance between them. The moon is sixty two earth radii away from the middle of the Earth. So its pull on the near side (61 Earth radii away) is stronger than its pull on the middle and even more than its pull on the far side (63 Earth radii away) In effect the earth is stretched into an oval. The water moves a lot more than the rock. As the Earth rotates The water on the nearside is higher than the water half way around and the "left behind not pulled as much" water is just as high the other way.
• So, we get two high ocean tides in a day and two low (half way around) tides in a day. The sun is 23,250 earth radii distant; so, the near side only 23,249 earth radii away is pulled harder than the far side that is 23,251 earth radii distant. The mass of the sun is so huge that this is still a big deal. The sun's tides are half the size of the moon's tides. During the month takes to orbit the Earth, when the moon and sun are in a straight line (Full Moon and New Moon), the tides are the highest. When the moon is perpendicular to the sun's direction the tides are smallest. Highest tides of the month are called Spring Tides (nothing to do with the season "spring") and the lowest tides of the month are called Neap Tides.
• The energy that drives the ocean currents is the same as for weather, differences in heating of the Earth by the sun. At the poles, two things happen:
  ○ The water is colder and sea ice forms. Ice crystals will not incorporate sodium and chloride into the water molecule crystal lattice, so sea ice is analogous to a bee's honeycombs. The pure ice is like the wax comb and the rejected sodium and chlorine ions in the remaining unfrozen water pockets are like honey.
	• Earth's Oceans
	  ○ An overview of oceans Text pp. 406-412 (1.5 days)
	  ○ Seawater Text pp. 413-420 (3 days)
	  ○ Ocean Movements pp. 421-427 (3 days)
	• The Marine Environment
	  ○ Shoreline Features Text pp. 438-446 (3 days)
	  ○ Seafloor Features Text pp. 447-453 (5 days)
	• Online Resources: "Mapping the Seafloor" (*NOAA National Ocean Service)*

○ In spring when things warm up a bit, some of the frozen pure ice melts letting the saltwater (brine) pockets enlarge. When they hit each other and interconnect they form vertical tubes through the ice called brine channels and all the dense saltwater dumps out through the bottom of the sea ice and sinks through the normal seawater. This gives you a lot of cold dense salties than normal seawater at the poles. Just like with the atmosphere, the warm water rising at the equator is being replaced by the cold dense super salty seawater from the poles. • The cold water moves along the bottom from the poles to the equator and the warm water moves on top back to the poles. Because the continents get in the way it is more complicated than just described. A simplified model of these temperature/salinity density currents is called the conveyor belt model of how the oceans move heat around the planet. • Currents are also caused by winds blowing over the ocean's surface. The global winds like the trade winds and the prevailing westerlies also move water causing surface currents. Again, continents get in the way. When a current hits a continent it is deflected. The result is large circular surface currents that are called Gyres. They rotate Clockwise in the Northern Hemisphere and Counterclockwise in the Southern Hemisphere. • Waves on the surface of the ocean are transverse waves. They have amplitude, wavelength, and frequency, just like other waves we studied, but are not concerned with amplitude. They want to know the distance from the bottom of a trough to the top of a peak. That will tell if the ship will be swamped and sink. Height is distance from trough to peak or twice the amplitude. • Landslides into the ocean or earthquakes underwater that move part of the seafloor up and drop the part next to it down, produce what can be very destructive waves called tsunamis. • As water waves move onto a coast, the bottom part slows down due to friction with the seafloor. The top part does not feel the friction so it keeps moving. That is why ocean waves 'break" as they come up a beach. • Ocean coasts may consist of a coastal plane, a shore with a beach , a high tide shoreline, and a low tide shore line. There may also be various erosional features. There may be barrier islands parallel to the coast with lagoons behind them.	

- Waves coming into shore at an angle will cause longshore currents which can be quite dangerous to the swimmers.
- At a coast where tectonic plates are not converging this is called a passive continental margin. First is the coastal plane next to the sea, Then beyond the shore, the seafloor gently descends as the continental shelf, where the shelf drops down to deeper water is called the continental slope. The debris & other material that has collected at the bottom of the continental slope is called the continental rise. The final really deep part, that continues until you reach the mid-ocean ridge, is the abyssal plane. Then you cross the mid ocean ridge and everything repeats in reverse order until you are on the coastal place on the other side of the ocean.
- Active continental margins are at converging plates where a seafloor plate is being subducted under a continental plate. The Washington state and Oregon coast is an example. The Juan de Fuca plate is going under the North American plate.
  - Moving onshore there is the seafloor, then one crosses the trench when the Juan de Fuca plate is going down, then one is on the seafloor on the continent side of the trench, then up the beach onto the continental crust, and a bit inland from the coast are the continental arc volcanoes; magma from the melting plate has worked its way up through the continent and is popping out as an andesitic volcano such as Mount Rainier.
- Sealife: Continental margin waters support a variety of sea life. There are three main divisions:
  - There is the **photic** zone where sunlight penetrates and plants using the sun for photosynthesis are eaten by little creatures that are at the bottom of the food chain.
  - The next zone is **aphotic**, meaning without sunlight. No light gets down this far but it is not the bottom.
  - **Benthic** means on the bottom or near it.
- Mapping the seafloor topography and sea life living there is done with multibeam sonar. The video from NOAA does a nice job of explaining it.

Standards List:	**HS-ESS2-4, HS-ESS2-5, HS-ESS2-7**

UNIT 9: RESOURCES AND OUR ENVIRONMENT	
Suggested Pacing: 36 days	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
• Like all of Earth's land animals, human beings require land to live on, water to drink, air to breathe, and food to eat. These are basic natural resources. Humans, being intelligent, discovered ways to augment these resources to sustain larger and larger populations. Modern civilization hosts eight billion (8,000,000,000) people as of August 2023. Fifteen hundred years ago, in the time of the King Arthur legends, there were only two hundred million (200,000,000). The average adult died by age forty. The majority of children died before they were five from dysentery. The older folks died of other diseases. People starved from lack of food. We have since learned how to cure diseases, improve the soil and the crops we grow to increase the food supply, and move goods around the world so that a place having drought gets food from a place with good rainfall. If our civilization collapses, then ninety seven point five percent (97.5%) of people in the world will die, because there is no way to feed them all. We will be back to the two hundred million (200,000,000) population of the middle ages. • Natural resources are important! • All of our technology that lets us support this large population comes from natural resources that we take from the Earth's land, water, and air to make into things. • Mineral resources are not evenly distributed around the Earth. They are also nonrenewable in human lifetimes (e.g. coal deposits take hundreds of million years to form). • Mining has four steps: 1. Prospecting/Exploration (looking for profitable mineral deposits) 2. Development (clearing the overlying rock and putting in infrastructure such as roads, power lines, warehouses, repair shops, worker housing, sanitation systems, processing plants, mess halls, clinics, etc.) 3. Mining/Extraction/Tailings Management (The stage where the minerals containing the valuable elements (ores) are removed from the ground and sent to a location to be processed and refined if that is not done on site. The leftover by-product materials, called "tailings," need to be put somewhere out of the way of the	• Earth Resources: ○ Natural Resources: Text pp. 678-681 (6.0 days) ○ (*YouTube* Ken ReidUMN) • Resources in Land Text pp. 682- 686 (4.0 days) • "What is Mining?" (*YouTube* Climate and Community) A short film explaining the process of mining to people of the Solomon Islands. • "Modern Mining - How Eagle Mine Produces Nickel and Copper" (*YouTube* – Eagle Mine) A video explaining copper mining in Minnesota on a low grade intrusive body. It is almost identical to the Fort Knox gold mining operation north of Fairbanks, except the intrusion brought gold rather than copper. • "Mining" (*YouTube* – Bozeman Science) A short film, produced by Bozeman Science, explaining mining from prospecting through reclamation, but also explaining the five main types of mines. (Not ocean mining, which is new but has not started at this time.) • Air Resources Text pp. 687-692 (4 days) ○ Alternative possibility ○ *Concord Consortium: High Adventure Science* – "Factors that Affect Air Quality" Air Quality Model surface view interactive. ○ *Concord Consortium: High Adventure Science* – "Movement of Pollutants" - Factors that Affect Air Quality - Aerial View • Water Resources Text pp. 693-697 (5 days) ○ Alternative possibility: *Concord Consortium: High Adventure Science* "HASBOT Will There be Enough Fresh Water" - Concord Consortium interactive six lessons • Energy ○ Conventional Energy Resources Text pp. 708-713 ((2 days) ▪ "Fossil Fuels for Kids | Learn All About Fossil Fuels, What They Are, And Where They Come From" (*YouTube* – Learn Bright) Explanation of their origin, their extraction, and their uses. ○ Alternative Energy Resources Text pp. 714-719 ((1 day)

mining operation that does not poison the ground water, land, or air.

4. Closure/ Reclamation (This happens after the extraction of ore is no longer profitable. The operation stops and the mine is closed. The tailings and closed mine need to be closed up in a way that will not cause future pollution problems and will restore vegetation to the area so that the land again becomes suitable habitat for plants, animals, and people.)

- There are Five types of mine:
  - Surface Mines: placer mines, strip mines, open pit mines, and mountain top mines.
  - Subsurface Mines: Dig shafts down into the ground and then follow the mineral seam horizontally underground.
- Understand the effects of wind, speed and direction, rain, solar radiation, regional geography, power plant location, content of power plant smoke, and number of cars in a region on air quality. Be able to use computer models and the plotting graphs such air quality vs time to make the best decisions about locating power plants in an area and communicate the decision in the CER format.
- Understand the water continually cycles through land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.
- Understand that global movements of water and its changes are driven by differences in solar heating across our planet and gravity.
- Develop, revise, test, and then use models to describe phenomena and design systems.
- Energy: Fossil Fuels
  - We went from burning wood to burning coal and using gasoline, kerosene, and other fuels from petroleum (crude oil). Natural Gas (methane) came up with the oil and is also an energy source.
  - This inexpensive, abundant, easy to use energy made our civilization possible. Because we needed the energy, we have burned alot of fossil fuels in the last two hundred and fifty years releasing a lot of carbon dioxide. But carbon dioxide helps our atmosphere keep in heat that would otherwise be radiated into space at night, so we have accidentally increased the temperature of our planet!
- Alternative energy sources:
    - "What is renewable energy?" (*YouTube* – The Independent) Seven minute summary.
    - "Our Mr.Sun 1956- Complete" (*YouTube* – GBPPR2) Frank Kapra Bell Telephone science special. entertaining science movie for students well done.
  - Conservation of energy Resources Text pp 720-723 (5 days)
    - "Energy Conservation vs. Energy Efficiency" (*YouTube* – IGS Energy)
    - "Energy Conservation for Kids – Insulation" (*YouTube* – Horizon Utilities)
    - Watch the first video telling the difference between energy conservation and energy efficiency. Then read pages 720 – 723, and watch the second video for kids on insulating houses. Based in the first video, decide if the book and the second video have correctly labeled what they are discussing. Write up your conclusion as a claim supported by evidence from all of the materials and explain the reasons that the evidence supports your claim.
- Human Impact on Resources:
  - Populations and Use of Resources Text pp 734-736 (1 day)
    - Concord alternative (See 2,3 & 4 below)
  - Human Impact on Land Resources Text pp 737-742 (5 days)
    - Concord Alternative: "Can we Feed the Growing Population?" (*Concord Consortium High Adventure Science*)
  - Human Impact on Air Resources Text pp. 743-747 (2 days)
  - Concord Alternative: "Will the Air be Clean Enough to Breathe?" (*Concord Consortium STEM Resource Finder)*
  - " Real World: The Carbon Cycle – Essential for Life on Earth" (*Youtube* – NASA eClips)
  - Carbon Cycle Diagram (Wikimedia)
  - Human Impact on Water Resources Text pp. 748-750 (3 Days)
  - Concord Alternative: "HASBOT Will there be Enough Fresh Water?" (*Concord Consortium High Adventure Science*

○ Students should be able to use claim evidence and reasoning when discussing any topics including ways to conserve energy. • Technology and cheap energy allowed humanity to devise ways to support much larger populations than were possible in previous times. There may be limits to continuing this if we are not clever enough to reduce or curtail our use of fossil fuels, reverse climate change, and make renewable energy cheaper than fossil fuels. • Understand that we must use arable land efficiently, preserve varieties of crops, preserve the soils, and use best farming practices if we want to avoid disasters. Explain the nitrogen cycle and how it is related to growing plants. Explain why artificially turn more of the nitrogen from the air into nitrate fertilizer is leading to major ocean fish die-offs and seasonal ocean dead zones well off shore from the mouths of rivers. • Students will be able to communicate the air quality issues using scientific arguments based on observed data from which the conclusions are drawn. The presentations of the arguments will be in the form of claim, evidence, and reasoning. Students will understand how air quality is measured, what the different forms of pollutants are, and how to prevent bad air days. They will be able to explain the carbon cycle and how it affects Earth's climate, distinguish between slow carbon and fast carbon, and explain why transferring a relatively small amount of slow carbon to the fast carbon cycle is causing climate change. • Understand that water continually cycles through land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. If we do not take care of the land and cause climate change the weather patterns will be disrupted arable crops will change. Some places will become deserts and people will be forced to migrate and there will be wars over land and water resources that are being changed.	
Standards List:	**HS-ESS2-2, HS-ESS2-5, HS-ESS3-1, HS-ESS3-2, HS-ESS3-3, HS-ESS3-4, HS-ESS3-6**

Environmental Science 1B

Grade(s): 9-11 **Length**: two semesters **Credit**: 1 (0.5 life science credit and 0.5 physical science credit) **Prerequisites**: Teacher recommendation	**Course Overview**: Students in this course explore systems and the ways in which human systems affect and are affected by environmental systems. Students approach environmental issues by understanding ecological components and human perspectives. Students address bias and misunderstandings to develop their own opinions about environmental issues. This course focuses on climate change, natural resources, pollution, and energy, and uses all fields of sciences to help students form educated opinions and solutions based on evidence about current and future environmental problems facing society. **Semester one (1A) fulfills the Life Science graduation requirement and semester (1B) two fulfills the Physical Science requirement.** See the curriculum under the Life Science options (page 29).

Physical Science

Grade(s): 9-12 **Length**: two semesters **Credit**: 1.0 **Prerequisites**: None	**Course Overview**: *Physical Science* provides an introduction to the core concepts of physics and chemistry. Laboratory work is an integral part of the inquiry-based learning process, helping students develop an understanding of the concepts as well as the process of science. The first semester provides an introduction to the core concepts of chemistry (matter and its interactions) with little emphasis on mathematics. The second semester includes an exploration of mechanics (motion, forces, and energy), in addition to the development of important process skills. **Adopted Textbook**: *Physical Science*. Glencoe/ McGraw-Hill, 2017.

Units (Recommended Order)	
Semester 1	**Semester 2**
• Structure and Properties of Matter • Chemical Reactions • Nuclear Processes, Energy in Chemical Processes, and Engineering Design	• Science Practice and Design • Newton's Law • Electricity and Magnetism • Work and Energy

UNIT 1: STRUCTURE AND PROPERTIES OF MATTER	
Suggested Pacing: 5 weeks	**Textbook Chapter(s)/Lessons**: Chapter 16
Key Objectives	**Suggested Activities & Resources**
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. 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.	• Phet simulation: Build an Atom http://phet.colorado.edu. • Black box experiment (for circumstantial evidence). • Adopt an element and present its "life history" in a poster. • Demo: Lithium vs. Sodium in Water. • Lab: Trends Among the Elements. • Periodic chart of objects (i.e., candy, shoes, hats).
Standards List:	**PS1.A: Structure & Properties of Matter:** [HS-PS1.1, HS-PS1.2, HS-PS1.3

UNIT 2: CHEMICAL REACTIONS	
Suggested Pacing: 5 weeks	**Textbook Chapter(s)/Lessons**: Chapters 15, 19, 21, and 22.
Key Objectives	**Suggested Activities & Resources**
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. Explain how the Law of Conservation of Mass helps to support the atomic model of matter. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction. Balance simple chemical equations. Measure solubility of solutes in solutions. Discuss the difference between concentration and saturation of solutes in solutions. Use power of ten notations to explain pH; explain the difference between acids and bases. Identify the range of the pH scale and give examples of strong and weak acids, and bases.	• Lab: Decompose water by electrolysis, noting volumes and ratios of products. • Lab: Baking Soda and Acid. • Lab: Salts and Solubility. • Lab: pH Scale. • PhET Online Lab: http://phet.colorado.edu. • Lab: Empirical Formula of Zinc Chloride.
Standards List:	**PS1.B: Chemical Reactions:** HS-PS1.2, HS-PS1.7

UNIT 3: NUCLEAR PROCESSES, ENERGY IN CHEMICAL PROCESSES, AND ENGINEERING DESIGN	
Suggested Pacing: 4 weeks	**Textbook Chapter(s)/Lessons**: Chapters 4 and 8.
Key Objectives	**Suggested Activities & Resources**
Explain the Law of Conservation of Energy as it applies to transfers of energy for physical and chemical changes. 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. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. Discuss the role nuclear power for electrical generation may play in reducing the emission of greenhouse gasses and for smaller Alaskan communities.	• Lab: Radioactive Decay. • PhET Online Labs: http://phet.colorado.edu. • Videos: Chernobyl: A Taste of Wormwood or the NOVA special Back to Chernobyl. • Activity: Design an electric power system for a small community with a given set of environmental conditions, resources, population, and power needs.
Standards List:	**ETS1.C: Optimizing the Design Solution:** HS-ETS1.2, HS-PS1.6; **PS1.C: Nuclear Processes:** HS-PS1.8; **PS3.D: Energy in Chemical Reactions:** HS-PS3.3

UNIT 4: SCIENCE PRACTICE AND DESIGN	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: Chapter 1
Key Objectives	**Suggested Activities & Resources**
Recognize that all measurements have some uncertainty. Make and interpret line graphs and scatter plots.	• Flinn Safety Contract and Test. • Lab safety classroom scavenger hunt. • Graphing skills packet. • Investigation: Graphing Volume of Water in a Test Tube vs. Height of Water.
Standards List:	**ETS1.C: Optimizing the Design Solution:** HS-ETS1.2

UNIT 5: NEWTON'S LAW	
Suggested Pacing: 5 weeks	**Textbook Chapter(s)/Lessons**: Chapters 2 and 3.
Key Objectives	**Suggested Activities & Resources**
Distinguish between the terms speed, velocity, and acceleration. Use and interpret graphs that describe the motion of objects (position-time, velocity-time, acceleration-time). 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. Apply Newton's three laws to explain inertia, acceleration when net force is not zero, and action-reaction forces. 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. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.	• Use sonic rangers (sonars) to match position vs. time; velocity vs. time graphs. • Conduct races with electric cars and fan cars or cars rolling down ramps. • Investigate collisions between spring-loaded cars. • Conduct balloon races. • Design apparatus to protect egg in free-fall using cost-effective approach.
Standards List:	**PS2.A: Forces & Motion:** HS-PS2.1, HS-PS2.2, HS-PS2.3 **ETS1.A: Defining & Delimiting the Engineering Problem:** Secondary to HS-PS2.3; **ETS1.C: Optimizing the Design Solution:** Secondary to HS-PS2.3

UNIT 6: ELECTRICITY AND MAGNETISM	
Suggested Pacing: 5 weeks	**Textbook Chapter(s)/Lessons**: Chapters 6 and 7.
Key Objectives	**Suggested Activities & Resources**
Use mathematical representations of Newton's law of gravitation and Coulomb's law to describe and predict the gravitational and electrostatic forces between objects. 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.	• Static Electric Forces Activity: Attraction and Repulsion (comparison to gravitational force). • Build a simple circuit. • Build a simple electromagnet. • Build a simple motor.
Standards List:	**PS2.B: Types of Interactions:** HS-PS2.4, HS-PS2.5; **PS3.A: Definitions of Energy:** Secondary to PS2.5

UNIT 7: WORK AND ENERGY	
Suggested Pacing: 6 weeks	**Textbook Chapter(s)/Lessons**: Chapter 4
Key Objectives	**Suggested Activities & Resources**
Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).	• Model dwelling construction and insulation used in traditional Alaskan dwellings before modern insulating materials became available.
Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.	
Build and test the efficiency for a simple machine.	
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).	
Standards List:	**PS3.A: Definitions of Energy:** HS-PS3.1, HS-PS3.2; **PS3.B: Conservation of Energy & Energy Transfer:** HS-PS3.1, **PS3.D: Energy in Chemical Properties:** HS-PS3.3, HS-PS3.4

Physics

Grade(s): 10-12 **Length**: two semesters **Credit**: 1 **Prerequisites**: Teacher recommendation or *Algebra 2* (can be taken concurrently)	**Course Overview**: Students best learn science when they do science. This physics course is organized around real world experiences (called storylines) that start with an interesting phenomenon leading students to ask questions that they investigate through hands-on activities, labs, and simulations. When they develop models that explain what is going on, they present their conclusions as a claim that is supported with reasoning from the evidence they collected. The teacher, as facilitator of the student research, can insert any questions that cover an aspect of the topic the students did not think of. **Adopted Textbook**: *Experience Physics*. Savvas, 2022.

Units (Recommended Order)	
Semester 1	**Semester 2**
• Forces and Motion • Forces at a Distance • Conservation of Energy	• Conservation of Energy • Waves and Electromagnetic Radiation • From the Nucleus to the Universe

<table>
<tr><th colspan="3">UNIT 1: FORCES AND MOTION</th></tr>
<tr><td colspan="2">Suggested Pacing: approximately 23.5 days</td><td>Textbook Chapter(s)/Lessons:</td></tr>
<tr><th colspan="2">Key Objectives</th><th>Suggested Activities & Resources</th></tr>
<tr><td colspan="2">Investigation 1:
Distinguish between distance, displacement, speed, velocity and acceleration. Represent their relationships with graphs, diagrams and equations. Free fall acceleration. Use vector representation for displacement, velocity, and acceleration.
Projectile motion involves a horizontal velocity with a perpendicular acceleration superimposed on it. The path is parabolic. Circular orbital motion of a satellite involves a horizontal velocity that is continuously being deflected by an acceleration toward the center of the orbit due to the much larger mass of the body it orbits.</td><td rowspan="2">Anchoring Phenomenon: “How will we get to Mars?” (0.5 days)
Investigation 1 Modeling Motion (10 days) Text pp (4-49)
Phenomenon: How does this rock move (0.5 days)
Experience 1 Dis[placement & Velocity (2.5 days)
Experience 2 Acceleration (2.5 days)
Experience 3 Circular & Projectile Motion (3 days)
Investigation Assessment (1.5 Days)
Investigation 2 Forces (13 Days) Text pp (50-111)
Phenomenon: “How does a self-driving car calculate stopping time?” (0.5 days)
Experience 1 Force, Mass, Acceleration (2.5 days)
Experience 2 Types of Forces (2.5 days)
Experience 3 Forces on Systems (3.0 days)
Experience 4 Earth’s Surface Forces (3.0 days)
Investigation Assessment
“Staying Fit to Mars and back”. (1.5 days)</td></tr>
<tr><td colspan="2">Investigation 2:
Newton’s three laws explain the causes of the types of motion in investigation 1. Expand the use of mathematics both graphically and with Algebra to describe forces and motion. Apply these concepts to practical situations like space travel and motions in the Earth’s crust.</td></tr>
<tr><td>Standards List:</td><td colspan="2">PS2-1, PS2-2, PS2-4, PS2-1, ESS2-1</td></tr>
</table>

UNIT 2: FORCES AT A DISTANCE	
Suggested Pacing: approximately 31 days	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Investigation 3: • Expand the concepts developed in the previous storyline to include Newton's law of Universal Gravitation to explain the behavior of planets orbiting the sun and why they obey Kepler's three laws of orbital motion. Gravitation is always attractive between masses and an inverse square law. It is described by vectors. Investigation 4 • Electric charges are two kinds (+ & -). Likes repel, opposites attract. Charge differences can be caused by transfer during contact or temporarily induced by nearness w/o contact. The force between two point charges follows an inverse square law called Coulomb's law. Electric forces are described by vectors. Gravitational forces are much smaller than electric forces. For example the electric force between a negatively charged electron and a positively charged proton in a hydrogen atom is 10^29 times larger than the gravitational force between their two masses. Graphic descriptions and calculations are similar to the mathematics used to describe gravity. Electric field and electric potential are useful ways to describe more complicated situations than point charges. Electric currents in circuits obey Ohm's and Kirchoff's laws. Calculations can be done applying these laws to parallel, series, and combined electric circuits. Investigation 5 • Magnetic fields are caused by moving electrons AND changing magnetic fields can cause electrons to move. Students will be able to use the right hand rule and mathematics to calculate the strength and direction of fields created by permanent magnets and current carrying loops. They connect magnetic flux and electromotive force to induction and calculate the relationships represented by Biot-Savart's and Faraday's Laws. Electric current loops in spinning Earth at the boundary between the liquid and solid core generates the magnetic field around us that protects us from charged particle radiation from the solar wind. Throughout this investigation students will model systems and solve problems related to electromagnetic induction.	• Anchoring Phenomenon: "How does the Moon shape our coastline?" (0.5 days) • Investigation 3 Gravitational Forces (10 days) Text pp (112-153) o Phenomenon: What causes the Seasons? (0.5 days) o Experience 1 Universal Gravitation (2.5 days) o Experience 2 Orbital Motion (2.5 days) o Experience 3 Kepler's Laws (3 days) o Investigation Assessment (1.5 Days) • Investigation 4 Electric Forces (9.5 days) Text pp (154-195) o Phenomenon: Why can't people walk through walls? (0.5 days) o Experience 1 Coulomb's Law (2.5 days) o Experience 2 Electric Fields (2.5 days) o Experience 3 Electric current (2.5 days) o Investigation Assessment (1.5 Days) • Investigation 5 Magnetic Forces (11.0 days) Text pp (196-293) o Phenomenon: How does an egg cook on a stove that does not get hot? (0.5 days) o Experience 1 Magnetism (3.0 days) o Experience 2 Magnetic Fields (3.0 days) o Experience 3 Inducing Current (3.0 days) o Investigation Assessment (1.5 days) • Investigation 6 Forces in Materials Text pp (241-277) (14 Days) **Skip until the end of 2nd semester**, then use Experience 1 "Atoms and Atomic Structure" and Experience 2 "Attractive and Repulsive Forces" to prepare students for Storyline 5 "From the Nucleus to the Universe." The 14 days are needed to complete collisions & conservation of momentum 1st semester, but storyline 5 "nuclear physics" won't make much sense without a background understanding of atoms. So, at least the first two experiences are needed to get students ready for nuclear physics at the end of 2nd semester. o Phenomenon: What happens inside a pole vaulter's pole as it bends and springs back? (0.5 days) o Experience 1 Atoms and Atomic Structure (3.0 days) o Experience 2 Attractive and Repulsive Forces (3.0 days) o Experience 3 Material Properties (3.0 days) o Experience 4 Structure and function (3.0 days) o Investigation Assessment (1.5 days)
Standards List:	**PS2-4, ESS1-4, PS1-3, PS2-4, PS2-6, PS3-5, PS2-4, PS2-5, PS3-5, PS1-3, PS2-4, PS2-6**

<table>
<tr><th colspan="2">UNIT 3: CONSERVATION OF ENERGY (PART ONE - SEMESTER ONE)</th></tr>
<tr><td>Suggested Pacing: Approximately 22 days</td><td>Textbook Chapter(s)/Lessons:</td></tr>
<tr><td>Key Objectives</td><td>Suggested Activities & Resources</td></tr>
<tr><td>Investigation 7:
Differentiating work (positive, negative and zero work) and energy, kinetic energy, and the work energy theorem. Differentiate between work and power. Mechanical energy, kinetic energy and gravitational potential energy. Elastic potential energy. Friction conversion of mechanical energy into heat. Conservation of energy. Use equations to model the kinetic energy converted into heat energy during the K-T Boundary asteroid impact that caused many extinctions sixty million years ago. Swinging pendulums and vertical and horizontal oscillating masses on springs and conservation of mechanical energy in those systems. Also oscillation decay and where that energy goes. The energy changes during a rocket launch. Energy and work are not vectors.</td><td rowspan="2">Anchoring Phenomenon: “How does this machine transfer energy?” (0.5 days)
Investigation 7 Energy (8.5 days) Text pp (278-319)
Phenomenon: “Why does a bungee jumper bounce up and down?” (0.5 days)
Experience 1: Classifying Energy and Work (2.5 days)
Experience 2: Mechanical Energy (2.0 days)
Experience 3: Conservation of Energy (2.0 days)
Investigation Assessment (1.5 days)
Investigation 8 Collisions (13.0 days) Text pp (320-363)
Phenomenon: “Why do car brakes use a pedal instead of an on off switch?” (0.5 days)
Experience 1: Momentum and Impulse (3.0 days)
Experience 2: Conservation of Momentum (4.0 days)
Experience 3: Collisions in Earth’s Crust (4.0 days)
Investigation Assessment (1.5 days)</td></tr>
<tr><td>Investigation 8:
Defining momentum. The relationship between the change in momentum of an object and the force applied to it and the length of time the force is applied. (The impulse-momentum equation). Momentum, Force and Impulse are all vectors. Elastic and Inelastic collisions. Kinetic energy and collisions. Collisions in the Earth’s crust result in Earthquakes, moving crustal plates with spreading centers causing new sea floor with associated underwater volcanoes and earthquakes, converging plates with associated mountain building, volcanoes and earthquakes, and transform faults like in California with associated earthquakes.</td></tr>
<tr><td>Standards List:</td><td colspan="2">PS3-1, PS3-2, PS3-3, PS2-2, PS2-3, ESS2-1</td></tr>
</table>

UNIT 4: CONSERVATION OF ENERGY (PART TWO - SEMESTER TWO)	
Suggested Pacing: approximately 26.5 days	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**

Investigation 9
Energy flow in both open and closed systems. Thermal energy on a microscopic scale is related to the total kinetic energy in a material, while the temperature is related to the average kinetic energy of the molecules in a material. Two objects of different temperature in contact transfer energy by conduction of motion from the fast molecules to the slow molecules. The transferring energy is called heat. The final temperature of both is in between the starting temperature. The three laws of thermal energy dynamics are Law 1: The best one could ever do is have energy in equal energy out, conservation of energy. Law 2: random motion always tends to increase over time so that some mechanical energy gets converted to thermal energy and you never get perfect conservation. The measure of increasing disorder is called entropy and it usually increases. Law 3: Increasing disorder slows down as the temperature approaches absolute zero (0°K). The Zeroth Law: Temperatures may approach absolute zero but can never get there. Compare temperature vs energy graphs will show they are not linear. The relationship between temperature, pressure and volume for gasses can be described by Boyle's Law, Charles Law, and Guy-Lussac's Law or they can be combined into the Ideal Gas Law. Specific heat describes how temperature in materials that are in the same phase respond to changes in thermal energy. Latent heat describes the heat necessary to change a material from one phase to another, liquid to gas for example, before the temperature will change. Heat is also transferred by convection and radiation. All three methods transfer heat from the hot core of the Earth into cold outer space. These processes, conduction from the core to the mantle, convection in the mantle breaking the crust into moving plates and radiation into space, drive plate tectonics. This results in seafloor spreading, mountain building, subduction zones, earthquakes at plate boundaries and volcanoes of various kinds on the surface of our planet.
 	
From Investigation 4 we know electric charges are two kinds (+ & -). Likes repel, opposites attract. Charge differences can be caused by transfer during contact or temporarily induced by nearness w/o contact. The force between two point charges follows an inverse
	• Anchoring Phenomenon: "How does this machine transfer energy?" (0.5 days)
	• Investigation 9 Thermal Energy (11.0 days) Text pp (364-407)
	  ○ Phenomenon: "How does a blanket keep you warm?" (0.5 days)
	  ○ Experience 1: Temperature (3.0 days)
	  ○ Experience 2: Thermal Equilibrium and Heat Flow (3.0 days)
	  ○ Experience 3: Heat Flow within the Earth (3.0 days)
	  ○ Investigation Assessment: (1.5 days)
	• Investigation 10 Electromagnetic Energy (15.0 days) Text pp (408-461)
	  ○ Phenomenon: "How do we sustainably generate electricity for our lives?" (0.5 days)
	  ○ Experience 1: Electric Potential (3.0 days)
	  ○ Experience 2: Energy in Electric Circuits (3.0 days)
	  ○ Experience 3: Power Generation (3.0 days)
	  ○ Experience 4: Energy Resources and Conservation (4.0 days)
	  ○ Investigation Assessment (1.5 days)

square law called Coulomb's law. Electric forces are described by vectors. Gravitational forces are much smaller than electric forces. For example the electric force between a negatively charged electron and a positively charged proton in a hydrogen atom is 10^29 times larger than the gravitational force between their two masses. Graphic descriptions and calculations are similar to the mathematics used to describe gravity. Electric field and electric potential are useful ways to describe more complicated situations than point charges. Electric force and electric potential energy equations can be made into very useful functions called electric field and electric potential. The electric field equation tells what force a complicated assembly of charges would have on a small charge at different distances from them. The electric potential equation tells what potential energy they would give the small charge at that spot. If you know the electric field and the electric potential it is much easier to predict what will happen than trying to grind through Coulomb's law for many charges. The electric field can also be represented as a picture. For example, the field around a positive charge is a plus sign with straight line arrows pointing out from it in all directions. The place where the lines are really close together the force is stronger and where they are far apart it is weaker. A negative charge would have converging arrows. Electric potential is very useful in explaining how batteries push electrons through wires. In circuits the difference in electric potential (V) between the positive and negative end of the battery pushes electrons in a wire. The metal the wire is made of determines how easily the electrons move. Resistance (R) is how these differences are described. The flowing electrons in the wires are called the current (I). Power is the rate at which electrical energy is used. The different devices in an electrical circuit can be in series or parallel. The way the current moves will differ depending on how the circuits are built. The main equations are Ohm's Law V=I•R, the power law P = I^2 • R, or P = I•V, also Total resistance for series R = R1 + R2 + R3 etc and Total resistance for parallel 1/R = 1/R1+ 1/R2 + 1/R3 ETC	

Changing magnetic fields can move electrons in conductors. This electromagnetic induction can be used to make electric motors and also electric generators. Finally, how the spinning magnets in the generators are turned relates to our climate. If water or steam turns them, the way the steam is made has different impacts on global warming. Steam from geothermal hot water sources near volcanoes does not produce greenhouse gasses. Heat from burning methane, petroleum, or coal does. Heat from nuclear fission does not. Heat from concentrated sunlight does not.	
Standards List:	**PS3-2, PS3-4, ESS2-3, PS2-5, PS3-3, PS3-5, ESS3-2, ESS3-3**

UNIT 5: WAVES AND ELECTROMAGNETIC RADIATION

Suggested Pacing: approximately 27.5 days	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**

Waves carry energy as a disturbance traveling through a medium. Waves have amplitude, frequency, wavelength, height, and can be longitudinal, transverse, or torsional. The medium can be solid, liquid, or gas; it can also be electric and magnetic fields. The electromagnetic field model assumes charged particles have associated electric fields that extend from each one out through all space. When they accelerate, they generate ripples along their field lines and also associated magnetic field ripples that travel away from them at the speed of light. These electromagnetic waves are what we call light.
 	
This range has wavelengths between 780 nanometers (red) and 390 nanometers (purple), but any other wavelengths are possible. There can be wavelengths from kilometers (radio waves) to wavelengths less than one hundredth of a nanometer (gamma rays). These electromagnetic waves are transverse waves that can be circularly, elliptically, or linearly polarized.
 	
The electromagnetic field model breaks down at very small distances, like the atomic level. Here quantum effects become dominant. At this level light can behave either as a wave or a particle depending on what it interacts with.
 	
One can transmit information from one place to another by modulating the waves either by changing the amplitude (amplitude modulation) or by changing the wavelength (frequency modulation). One can also interrupt the wave to create on and off conditions. If on is ONE and off is ZERO, binary number codes can transmit information. Information carried by electromagnetic waves can be transmitted through glass fiber cables, through outer space, and through Earth's atmosphere. There are also proposals to capture solar energy with large satellites in space and broadcast it down to Earth's surface as diffuse microwaves (which go through clouds) to be concentrated at the surface receiving power station. It must be designed well and diffuse coming down, otherwise people, birds, plants in it or passing through it might get cooked like in a microwave oven. Also, planes flying through it might have their instruments melted like a piece of aluminum foil in a microwave.
	• Anchoring Phenomenon: "How do waves transfer energy?" (0.5 days)
	• Investigation 11 Waves (8.5 days) Text pp (462-509)
	  ○ Phenomenon: "How do waves change coastlines?" (0.5)
	  ○ Experience 1: Wave Properties (2.0 days)
	  ○ Experience 2: Wave Behavior and Energy (2.5 days)
	  ○ Experience 3: Wave Optics (2.0 days)
	  ○ Investigation Assessment (1.5 days)
	• Investigation 12 Electromagnetic Radiation (9.0 days) Text pp (510-537)
	  ○ Phenomenon: "How does this 'polaroid' lens remove glare? (0.5 days)
	  ○ Experience 1: Electromagnetic Waves and their properties (2.0 days)
	  ○ Experience 2: Particle-Wave Duality (2.0 days)
	  ○ Experience 3: Electromagnetic Radiation and Matter (2.0 days)
	  ○ Investigation assessment (1.5 days)
	• Investigation 13 Information & Instrumentation (9.5 days) Text pp (538-565)
	  ○ Phenomenon: "How does a mobile device transmit information?" (0.5 days)
	  ○ Experience 1: Digital Information (2.5 days)
	  ○ Experience 2: Capturing and Transmitting Information (2.5 days)
	  ○ Experience 3: Capturing and Transmitting Energy (2.5 days)
	  ○ Investigation Assessment (1.5 days)

Standards List:	**PS3-3, PS4-1, PS4-3, PS4-5, PS4-3, PS4-4, PS4-2, PS4-5**

UNIT 6: FROM THE NUCLEUS TO THE UNIVERSE	
Suggested Pacing:	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**

From Investigation
The atomic model of matter is powerful and eventually leads to the periodic table of elements, which enables us to predict what will happen when atoms of elements interact. The negative electrons in clouds around the tiny and massive positively charged nucleus of an atom, which is made of positive protons and neutral neutrons (that hold it together); has its electrons in different energy levels associated with how many protons are in the nucleus. The electrons in the outermost energy level of one atom can interact with the outermost electrons of another atom resulting in forces between the atoms. This produces situations where the two atoms get close together and share pairs of electrons. This bonding is called "covalent bonding". In a different situation, one outer electron may be pulled from one atom to another. The element that lost the electron has a positive charge. The element that took the electron has a negative charge. The two atoms are pulled together by their opposite charges. This type of bonding is called "ionic bonding". A third possibility is that a large number of atoms of the same metal element, such as copper, are all together and the outer electrons slosh between identical atoms making the net positive inner parts somewhat like positive islands surrounded by a sea of electrons that keep them inside. This type of bonding is called "metallic bonding"
 	
The nucleus of all atoms, except for the hydrogen with only one proton in its nucleus, is made of positive protons held together by neutral neutrons. Protons that close together have VERY strong electric force pushing them apart. The neutrons are mediators on the much larger strong nuclear force . Without that it would be impossible to have atoms more complex than one proton and one electron. Mass and energy are interchangeable as denoted by the famous equation E = MC^2. When you compare the mass of a helium atom's nucleus to the total mass of the four particles that made it (2 protons and 2 neutrons), the nucleus doesn't have as much mass as the total mass of its parts. Why? The missing mass was released as light energy during the
	• Present background information on atoms using the first two Experiences from Investigation 6 " Forces in Materials',' that was skipped, to prepare students to start Investigation 14 "Nuclear Physics" Then do investigation 15 Experience 1 "Radioactive Decay". (6.5 days)
	• If there is extra time, one could teach two or more experiences that there was not time to cover, of the teacher's choice, such as:
	  ○ Radiometric Dating and Geologic Time would apply to the Age of Rocks, Investigation 15.
	  ○ The Sun and Stars would apply to The Universe, Investigation 16.
	  ○ Material Properties and Structure and Function would apply to Forces in Materials, Investigation 6
	• Storyline 5: Anchoring Phenomenon: "How did the atoms that make up your body form?" (0.5 days)
	• Investigation 14 Nuclear Physics (11 days) Text pp (566-607)
	  ○ Phenomenon: "How can your electricity come from the fusion of atoms?" (0.5 days)
	  ○ Experience 1: Nuclear Particles (3.0 days)
	  ○ Experience 2: Nuclear forces (3.0 days)
	  ○ Experience 3: Fission and Fusion (3.0)
	  ○ Investigation Assessment (1.5 days)
	• Investigation 15 Ages of Rocks (11 days) Text pp (608-651)
	  ○ Phenomenon: "How did Earth Form?" (0.5 days)
	  ○ Experience 1: Radioactive Decay (3.0 days)
	  ○ Experience 2: Radiometric Dating (3.0 days)
	  ○ Experience 3: Geologic Time (3.0)
	  ○ Investigation Assessment (1.5 days)
	• Investigation 16 The Universe (11 days) Text pp (652-691)
	  ○ Phenomenon: "How will the sun change over time?" (0.5 days)
	  ○ Experience 1: The Sun (3.0 days)
	  ○ Experience 2: Stars (3.0 days)
	  ○ Experience 3: The Big Bang (3.0)

formation of the nucleus. The apparent missing mass is called the mass deficit of the nucleus. When you look at the other elements' nuclei iron has the highest mass deficit. This means that you can combine nuclei of the lighter elements up to iron and squeeze some energy out. This is nuclear fusion. On the other side of iron, the more massive elements can, in principle, be split into smaller pieces to get out some energy. This is nuclear fission. For practical purposes, the only fusion human beings can do at this time is heavier isotopes of hydrogen fused into helium releasing large amounts of energy. The only fission we can do is creating conditions where Uranium 233, Uranium 235, or Plutonium 239 atoms can spontaneously split, releasing energy for our purposes. An exploding star going supernova sent a shock wave through a massive cloud of interstellar dust, left over from previous stars exploding. causing eddies that were swirling solar systems in the making. Most of the mass in this swirling cloud was concentrated at the center (called a protostar) and as the gravitational compression at the center became greater and greater as mass accreted, the core became dense and hot enough for the fusion of hydrogen into helium to begin. The sun was born. As long as the inward pressure from gravity balances the outward pressure from nuclear fusion in the core our sun will be a stable star. Earth and the other planets formed in the surrounding eddies orbiting the sun as static electricity first turned the dust into clumps and the lightning in the dust melted the clumps into rocks that collided to become planetesimals and eventually proto planets that smashed into each other until only five terrestrial planets remained in the inner solar system and the two gas giants and two ice giants were left in the outer solar system. One mars sized inner planet hit the Earth with a glancing blow that vaporized it and a good part of the upper mantle and crust producing a ring of hot debris that coalesced into the moon. Radioactive decay is the natural process in which unstable nuclei emit ionizing radiation to eventually turn into stable non radioactive elements. Alpha particles are pieces consisting of two protons and two neutrons (essentially a helium nucleus), beta particles are electrons emitted when neutrons turn into protons while forming an electron and throwing it out so total charge remains the same. (Other things are	○ Investigation Assessment (1.5 days)

conserved besides energy) Each radioactive element has its own pattern that is not affected by heat, chemical reactions or anything else outside the atom's nucleus. The amount of time for half the original amount of material to change is called the "half-life". In that amount of time half of the material will change. In that amount of time again half of what remains will change, and so in. It takes about TEN half lives for the starting amount of radioactive material to be one thousandth of the starting a]mount. It takes TWENTY half lives to drop to one millionth of the starting amount. The graph of material versus time is an exponential decay curve that can be used to predict remaining amounts at a given time or time to get to a particular amount. This makes it great for dating if you know how much material there was at the start. For example cosmic rays smash into oxygen and nitrogen atoms at the top of our atmosphere destroying them sending showers of protons and neutrons down into the lower atmosphere. If a neutron hits a nitrogen 14 nucleus and replaces the proton that it knocked out, you now have a carbon 14 atom. It is radioactive with a half life of 5700 years. When it goes through beta decay and a neutron becomes a proton turning it back into N14. Plants pull carbon from the air and put it in their bodies during photosynthesis. Animals eat plants etc. So living things have the same level of C14 in their bodies as is found naturally in the atmosphere. When they die, replacement stops. So comparing the C14 left in the body to the regular carbon in it one can calculate how long since it died. These are very small ratios so the method is not practical beyond 50,000 years or about ten half lives. Using uranium to lead radioactive dating the age of the earth is Four and a half billion years. The sun is one of the types of star that lives for about ten billion years. It is presently around five billion years old. As the hydrogen in the core gets used up as it is converted into helium. When the hydrogen is used up, the burned out core will collapse until it's hot enough to fuse helium into heavier elements such as carbon through iron. The new outward heat pressure will push the red outer layers out until it is a red giant. So about five billion years in the future, as the red giant stage ends, the outer gasses will expand away from the core leaving a dense hot white dwarf star that will cool by radiation over billions of years.	

How do we know the behavior and history of stars since they live so much longer than human beings? Our telescopes let us observe stars near and far and we see them in all stages of their development. This is similar to a family photo album for human beings. It shows babies, young people, adults and old people. Also we use Newton's and Kepler's Laws on binary star orbits to determine their masses, we use their electromagnetic spectra to find out what elements are are in them and how fast they are moving and in what direction (the Doppler effect), and we apply the mathematics of nuclear fusion physics to figure out what is going on inside. It is all applied physics. The easiest way to visualize what is happening is with the Hertzsprung-Russell diagram which plots the brightness of stars on the vertical axis (from dimmest to brightest) and the temperature of stars (from hottest to coldest) on the horizontal axis. Stars start out as protostars that begin fusion at their cores when they get massive enough. They become adult stars whose temperature, brightness and lifetimes are determined by their initial mass. A star that is less than eight times the mass of the sun will go through its adult main sequence stage and end as a white dwarf star. A star that is between eight and twenty times the mass of the sun will end with a supernova explosion (creating many of the elements heavier than helium and through carbon) blowing all the outer layers into space leaving a neutron star behind in the middle. A star that is more than twenty times the mass of the sun will experience a supernova explosion leaving a black hole behind. In the early twentieth century Hubble observed that the spectra of hydrogen and helium from stars in nearby galaxies were slightly longer wavelengths than found in a lab. The farther away the galaxies were in all directions from use the worse it got. Waves generated by a source moving away from an observer get slightly longer. The shift can be used to calculate the speed of motion. Hubble had found that all galaxies were moving away from us and the farther away they were the faster they were going. Either we were the center of the universe (unlikely) or the universe was expanding similar to bread dough full of raisins expanding before it gets baked. From the standpoint of any raisin, the others will be moving away and the farther away they are the faster they will be moving. Fred Hoyle, an astronomer who did not support the expanding universe model, coined the term "Big	

Bang" during a talk in 1949 to help the general audience visualize the model he was attacking. The name stuck. The Big Bang event is a physical theory that describes how the universe expanded from an initial state of high density and temperature to what it is now.	
Standards List:	**PS1-3, PS2-4, PS2-6, PS1-8, PS1-8, ESS1-5, ESS1-6, ESS2-1, ESS1-1, ESS1-2, ESS1-3**

Science Elective Options

Astronomy

Grade(s): 10-12 **Length**: one semester **Credit**: 0.5 credit **Prerequisites**: Teacher recommendation or *Geometry*	**Course Overview**: *Astronomy* is an introductory course, which will educate students about ancient and modern astronomical knowledge and research methods to build a strong foundation for college-level courses in science. Mathematics and science concepts as well as ancient and modern technology will be used to help students explore and understand the universe they live in. Astronomy focuses on historical development of astronomical knowledge, the solar system, and an introduction to modern research methods. Additional topics could include life cycles of stars, properties of star groupings and galaxies, and the use of modern research methods. **Adopted Textbook**: *Astronomy: Journey to the Cosmic Frontier*. McGraw-Hill, 2008

Units (Recommended Order)
• Classical Astronomy • The Solar System • Using Light and the Electromagnetic Spectrum to Study Space • Stars and their Life (time permitting) • Star Groupings and Galaxies (time permitting) • Cosmology (time permitting)

UNIT 1: CLASSICAL ASTRONOMY	
Suggested Pacing: 3 weeks	**Textbook Chapter(s)/Lessons**: Chapters 3, 4, 7, 8, 9, and 17.
Key Objectives	**Suggested Activities & Resources**
Be able to predict solar positions during the seasons. Model how eclipses occur. Explain early experiments to measure the size of the Earth.	• The effect of solar altitude on insolation. • Use Stonehenge to predict moon phases and eclipses. • Using Aristarchus' method for measuring Earth-Moon-Sun distance ratios. • Using Eratosthenes' method of measuring the Earth.
Standards List:	**ESS1.B: Earth and the Solar System:** HS-ESS2.4

UNIT 2: THE SOLAR SYSTEM	
Suggested Pacing: 4 weeks	**Textbook Chapter(s)/Lessons**: Chapters 5, 7, 14, 15, and 18.
Key Objectives	**Suggested Activities & Resources**
Explain how tides work. Explain how Copernicus' findings drastically changed the understanding of the universe. Use Newton's law of universal gravitation to calculate forces on bodies in the solar system. Discuss the theories of the formation of the solar system. Explain the existence of comets, meteors, and asteroids.	• Determine the orbit of Mars using a cross-staff and quadrant for astronomical observations. • Use a pinhole projection to measure the size of the sun.
Standards List:	**ESS1.A: The Universe and Its Stars:** HS-ESS1.1; **ESS1.B: Earth and the Solar System:** HS-ESS1.4 **PS2.B: Types of Interactions:** HS-PS2.4, HS-PS2.5

UNIT 3: USING LIGHT AND THE ELECTROMAGNETIC SPECTRUM TO STUDY SPACE	
Suggested Pacing: 8 weeks	**Textbook Chapter(s)/Lessons**: Chapter 6, 16, 19, 20, and 21.
Key Objectives	**Suggested Activities & Resources**
Compare and contrast the wave and particle nature of light.	• Examine the factors related to the operation of a telescope. • Lab: Wien's Law.
Discuss factors affecting angular resolution.	
Explain what the emission and absorption spectra tell scientists about the composition of stars.	
Explain what an optical telescope is and how it works.	
Describe how a radio telescope works.	
Standards List:	**PS4.A: Wave Properties:** HS-PS4.1, HS-PS4.2, HS-PS4.5; **PS4.B: Electromagnetic Radiation:** HS-PS4.3

UNIT 4: STARS AND THEIR LIFE (Time Permitting)	
Suggested Pacing: 6 weeks	**Textbook Chapter(s)/Lessons**: Chapters 17, 18, 19, 20, and 21.
Key Objectives	**Suggested Activities & Resources**
Describe the sun's composition and internal structure.	• Lab: The Doppler Effect. • Lab: The Stefan-Boltzmann Law. • Lab: The Zeeman Effect. • Search for Novae.
Explain how scientists measure the basic properties of stars.	
Use the Hertzsprung-Russell Diagrams to explain the main sequence and classification of stars.	
Describe stellar evolution and the factors which contribute to a star's demise.	
Explain how the aurora works.	
Standards List:	**ESS1.A: The Universe and Its Stars:** HS-ESS1.1, HS-ESS1.2, HS-ESS1.3

UNIT 5: STAR GROUPINGS AND GALAXIES (Time Permitting)	
Suggested Pacing: 6 weeks	**Textbook Chapter(s)/Lessons**: Chapters 2, 21, 22, 23, 24, and 25.
Key Objectives	**Suggested Activities & Resources**
Describe different types of interstellar regions. Compare and contrast methods for determining binary and multiple star systems. State the structure and theories of formation of galaxies. Describe mapping methods for galaxies. Classify galaxies and explain population distributions. Discuss the expansion of the universe.	• Examine interstellar materials and reddening. • Examine open clusters in the Milky Way Galaxy. • Use spectroscopy to examine active galactic nuclei.
Standards List:	**ESS1.A: The Universe and Its Stars:** HS-ESS1.2, HS-ESS1.3; **PS2.B: Types of Interactions:** HS-PS2.4

UNIT 6: COSMOLOGY (Time Permitting)	
Suggested Pacing: 6 weeks	**Textbook Chapter(s)/Lessons**: Chapters 26 and 27.
Key Objectives	**Suggested Activities & Resources**
Learn about early cosmologies. Explain Olbers' paradox. Examine modern mathematical cosmologies. Discuss SETI: the search for extraterrestrial life.	• Simulate sending and receiving messages to and from extraterrestrials.
Standards List:	**ESS1.A: The Universe and Its Stars:** HS-ESS1.2; **PS2.B: Types of Interactions:** HS-PS2.4; **PS4.C: Information Technologies and Instrumentation:** HS-PS4.5

Forensic Science 1

Grade(s): 11-12 **Length**: one semester **Credit**: 0.5 **Prerequisites**: Teacher recommendation or *Biology* and *Chemistry*	**Course Overview**: *Forensic Science* explores the principles & techniques of science and analyzing crime scene evidence. Emphasis is placed on laboratory techniques, scientific inquiry, communication skills, as well as aspects of the criminal justice system and the admissibility of evidence. Prior knowledge of human genetics and chemistry is preferred. **Adopted Textbook**: *Forensic Science Fundamentals and Investigations*. Cengage.

Units (Recommended Order)
• Crime Scene Investigation and Documentation • Forensic Pathology • Forensic Serology • Fingerprints and Other Impressions • Forensic Anthropology

<table>
<tr><th colspan="3">UNIT 1: CRIME SCENE INVESTIGATION AND DOCUMENTAION</th></tr>
<tr><td colspan="2">Suggested Pacing: 2-3 weeks</td><td>Textbook Chapter(s)/Lessons: Chapters 1 and 2.</td></tr>
<tr><th colspan="2">Key Objectives</th><th>Suggested Activities & Resources</th></tr>
<tr><td colspan="2">Define forensic science.</td><td rowspan="8">• Mock crime scene to show how crime scenes are properly sketched, photographed, and how evidence is collected.
• Digital camera to practice taking overall, medium, and close-up pictures with placards, scales, and using a photo page/photolog.
• Faces computer identification software.</td></tr>
<tr><td colspan="2">Demonstrate understanding of Locard’s Principle of Exchange.</td></tr>
<tr><td colspan="2">Develop observation skills and understand their importance to forensic science.</td></tr>
<tr><td colspan="2">Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.</td></tr>
<tr><td colspan="2">Define and provide examples of physical evidence, circumstantial evidence, and trace evidence.</td></tr>
<tr><td colspan="2">Discuss the responsibilities of law enforcement at crime scenes.</td></tr>
<tr><td colspan="2">Describe the responsibilities of expert witnesses in the judicial system.</td></tr>
<tr><td>Standards List:</td><td colspan="2">ETS1.B: Developing Possible Solutions: HS-ETS1.3, HS-ETS1.4 HS-ESS3.2, HS-ESS3.4</td></tr>
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<table>
<tr><th colspan="3">UNIT 2: FORENSIC PATHOLOGY</th></tr>
<tr><td colspan="2">Suggested Pacing: 2-3 weeks</td><td>Textbook Chapter(s)/Lessons: Chapter 12</td></tr>
<tr><th colspan="2">Key Objectives</th><th>Suggested Activities & Resources</th></tr>
<tr><td colspan="2">Determine time of death using various methods including insect life cycle, livor, algor, and rigor mortis.</td><td rowspan="5">• Set up entomology experiments outside, using meat samples to attract insects and document decay processes.
• Lab: Blunt and Sharp Force Trauma.
• Post-mortem interval determination.
• Guest Speakers: Handlers of search and rescue dogs.</td></tr>
<tr><td colspan="2">Investigate autopsy procedures through simulation.</td></tr>
<tr><td colspan="2">Be familiar with the training and usefulness of search and rescue dogs.</td></tr>
<tr><td colspan="2">List job descriptions and training required for coroners and medical examiners.</td></tr>
<tr><td colspan="2">Identify various wounds as blunt force, sharp force, and high velocity.</td></tr>
<tr><td>Standards List:</td><td colspan="2">LS1.A. Structure & Function: HS-LS1-1, HS-LS1-2; LS1.B: HS-LS1-7, HS-LS2-3, HS-LS2-4, HS-LS2-5, LS2.A: HS-LS2-1, HS-LS2-6, HS-LS2-8</td></tr>
</table>

UNIT 3: FORENSIC SEROLOGY	
Suggested Pacing: 3-4 weeks	**Textbook Chapter(s)/Lessons**: Chapter 7
Key Objectives	**Suggested Activities & Resources**
Explain the antigen/antibody system of blood typing in humans. [SC.2]	• Lab: Saliva and Secretions. • Lab: Blood Splatter. • Lab: Electrophoresis. • Lab: Presumptive Fluids.
Describe the use of saliva and blood to identify and eliminate individuals from suspicion.	
Demonstrate understanding of presumptive tests.	
Explain the difference between a secretor and non-secretor.	
Experiment with and analyze blood splatter patterns.	
Experiment with an analyze genetic profiling.	
Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.	
Explain the principles behind the polymerase chain reactions.	
Explain how DNA techniques such as DQ alpha, restriction length polymorphism, short tandem repeats, and PCR can be used to narrow the list of suspects.	
Detail the advantages and disadvantages of mitochondrial and nuclear DNA for use in forensic analysis.	
Standards List:	**LS1.A: Structure and Function:** HS-LS1.1, **LS3.A: Inheritance of Traits:** HS-LS3.1

UNIT 4: FINGERPRINTS AND OTHER IMPRESSIONS	
Suggested Pacing: 2-3 weeks	**Textbook Chapter(s)/Lessons**: Chapter 6 and 16
Key Objectives	**Suggested Activities & Resources**
Explain why a fingerprint is a permanent feature of human anatomy.	• Use a variety of powders to collect fingerprints on porous and non-porous surfaces. • Iodine, ninhydrin, super-glue lifts. • Cast tire tracks or shoe prints using dental stone. • http://www.scafo.org.
Classify a set of fingerprints.	
Identify ridge characteristics (minutiae) in fingerprints.	
Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.	
Define latent, patent, and plastic and patent prints.	
Describe the chemistry of different techniques for developing latent fingerprints.	
Practice collecting fingerprints from a variety of surfaces.	
Describe the process of casting shoe and tire-track impressions.	
Analyze impressions in dental stone.	
Standards List:	**PS1.A: Structure and Properties of Matter:** HS-ETS1.2; **ETS1.B: Developing Possible Solutions:** HS-ETS1.4, HS-ESS3.2, HS-ESS3.4

<table>
<tr><th colspan="3">UNIT 5: FORENSIC ANTHROPOLOGY</th></tr>
<tr><td colspan="2">Suggested Pacing: 3-4 weeks</td><td>Textbook Chapter(s)/Lessons: Chapter 14</td></tr>
<tr><th colspan="2">Key Objectives</th><th>Suggested Activities & Resources</th></tr>
<tr><td colspan="2">Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</td><td rowspan="4">• Bone Lab: Determine gender, height, age, and general health.
• Facial reconstruction project.</td></tr>
<tr><td colspan="2">Identify characteristics of a crime victim by using bones.</td></tr>
<tr><td colspan="2">Describe how a victim is identified through forensic odontology. Give examples of how forensic anthropologists can assist in crime solving.</td></tr>
<tr><td colspan="2">Participate in the art and science of facial reconstruction.</td></tr>
<tr><td>Standards List:</td><td colspan="2">ETS1.B: Developing Possible Solutions: HS-ESS3.2, HS-ESS3.4; ETS1.C: Optimizing the Design Solution: HS-ETS1.2</td></tr>
</table>

Forensic Science 2

Grade(s): 11-12 **Length**: one semester **Credit**: 0.5 **Prerequisites**: • Teacher recommendation, • Forensic Science 1, • Chemistry (may be concurrently enrolled)	**Course Overview**: *Forensic Science 2* is intended for the more serious forensic science students. They will build upon their forensic knowledge by investigating advanced forensic science techniques. Students will continue to apply the principles and techniques of science to analyzing crime scene evidence. Emphasis will be placed on both qualitative and quantitative engineering design, as well as aspects of the criminal justice system and the admissibility of evidence. Being familiar with human genetics and chemistry is preferred. **Adopted Textbook**: *Forensic Science Fundamentals and Investigations*. Cengage.

Units (Recommended Order)
• Forensic Psychology • Questioned Documents • Forensic Toxicology • Fire Science/ Investigation • Tool Marks and Firearms/ Ballistics • Trace Evidence Analysis • Advanced DNA Analysis • Accident Reconstruction

UNIT 1: FORENSIC PSYCHOLOGY	
Suggested Pacing: 3 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
• Define and apply common legal terms. • Identify the roles of prosecuting and defense attorneys in court cases.	• Guest Speaker: Lawyer.
• Explain how criminal profiling can be helpful in solving crimes. • Use an understanding of brain development, genetics, and environmental factors to explain risk factors of criminal behavior.	• Watch/discuss videos on serial killers' behaviors. • Serial Killer Box Profile Gallery
• Identify behaviors associated with lying and truth-telling.	• Play Malarky and other lying behavior games.
Standards List:	**LS1.A: Structure and Function, HS-LS2: Ecosystems: Interactions, Energy, and Dynamics** **LS2.D: Social Interactions and Group Behavior, GLEs**: SA.1-3; SC.1-2; SF.1-3; SG.1-4

UNIT 2: QUESTIONED DOCUMENTS	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: Chapter 10
Key Objectives	**Suggested Activities & Resources**
• Describe and demonstrate handwriting exemplars. • List some important guidelines to be followed in collecting known writing samples for use as comparisons with a questioned document. • Identify the major goals of a forensic handwriting analysis.	• Handwriting Analysis Lab
• Identify several ways in which businesses prevent check forgery. • Identify real and counterfeit U.S. money.	• Microscopic Examination of Currency • Expert Analysis of Representation in Media • Catch Me If You Can - Film/Book
Standards List:	**ETS1.A: Defining and Delimiting Engineering Problems, GLEs**: SA.1-3; SF.1-3; SG.1-4

UNIT 3: FORENSIC TOXICOLOGY	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: Chapter 9
Key Objectives	**Suggested Activities & Resources**
• Identify common drugs of abuse by description. • Describe the proper collection and preservation of drug evidence.	• Guest Presenter: State Troopers & Fairbanks PD Officer • Flipbook of controlled substances
• Describe the chemistry behind various ways of identifying and quantifying chemicals and drugs.	• Identify (unknown) over-the-counter drugs using chemical and physical characteristics.
• Explain the Controlled Substances Act.	•
Standards List:	**HS-LS1: From Molecules to Organisms: Structures and Processes, LS1.A: Structure and Function, HS-LS3: Heredity: Inheritance and Variation of Traits, LS3.A: Inheritance of Traits, GLEs**: SA.1-3; SB.1-2; SF.1-3; SG.1-4

UNIT 4: FIRE SCIENCE/ INVESTIGATION	
Suggested Pacing: 3 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
• Define the heat of combustion and ignition temperature.	• Testing the Fire Triangle.
• Use the fire triangle to explain what elements are required for combustion. • Describe the characteristics and effects of Alaskan wildfires.	• Lab: Matchstick Forest. • Lab: Dollhouse Arson
• Identify the types of evidence left in a fire. • Describe how physical evidence is collected at the scene of a suspected arson.	• Guest Speaker: Fire Marshal
Standards List:	**HS-PS1: Matter and Its Interactions, PS1.B: Chemical Reactions, GLEs**: SA.1-3; SB.1; SF.1-3; SG.1-4

UNIT 5: TOOL MARKS & FIREARMS/ BALLISTICS	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: Chapter 18
Key Objectives	**Suggested Activities & Resources**
• Describe and identify types of tool mark impressions. • Explain how bullets are test-fired and matched.	• Lab: Match twist patterns of Bullets
• Describe the characteristic of handguns, rifles, and shotguns and their ammunition. • List procedures for the proper collection and preservation of firearm and tool mark evidence.	• Basics of Ballistics Booklet
• Determine the position of the shooter based on bullet trajectory. • Describe the rifling on a gun barrel and how it affects the flight of projectiles.	• Lab: NERF Dart Gun Ballistics
Standards List:	**HS-PS1: Matter and Its Interactions, PS1.B: Chemical Reactions**

UNIT 6: TRACE EVIDENCE ANALYSIS	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
• Describe the properties of fibers that are most useful for forensic comparisons.	• Fiber identification using chemical and physical properties. • Fiber identification using microscopy.
• List the important forensic properties of soil. • Describe the chemical components of paint. • Determine how density can help identify substances. • Describe the behavior of light as it travels through various substances.	• Soil collections. • Glass density experiments. • Glass impact patterns. • Patterns of bullet holes. • Refractive index.
• Practice analyzing trace evidence including hairs, fibers, paints, coating, explosive, fire residues, glass, and soil.	•
Standards List:	**HS-PS1: Matter and Its Interactions, PS1.A: Structure and Properties of Matter, GLEs**: SA.1-3; SB.1-2; SF.1-3; SG.1-4

UNIT 7: ADVANCED DNA ANALYSIS	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
• Explain the differences between nuclear DNA and mitochondrial DNA. • 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.	• Study how mitochondrial DNA was used to solve the Anny Anderson/Princess Anastasia mystery. • Apply the mitochondria DNA technique to Argentina's missing children situation of the 1980's.
• Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.	•
• Explain the training and technology required to carry out current DNA analysis.	• Isolate DNA from bone and/or plant material. • Use pollen analysis to identify its source.
Standards List:	**HS-LS1: From Molecules to Organisms: Structures and Processes,** LS1.A: Structure and Function, **HS-LS3: Heredity: Inheritance and Variation of Traits,** LS3.A: Inheritance of Traits, **GLEs**: SA.1-3; SC.1; SF.1-3; SG.1-4

UNIT 8: ACCIDENT RECONSTRUCTION	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: Chapter 16
Key Objectives	**Suggested Activities & Resources**
• Use physics to analyze the dynamics of a collision.	• Analysis of Skid Marks
• Use measurements, sketches, after-accident diagrams and photographs to systematically investigate traffic collisions. • Make scale drawings of the accident scene.	• Measure an accident scene and make a scale drawing. • Lab: Mario Kart Accident Reconstruction
• Determine blood alcohol content (BAC) from suspect's drinking history.	• Determine a suspect's BAC using drinking history and math formulas.
Standards List:	**HS-ETS1: Engineering Design, ETS1.B: Developing Possible Solutions, GLEs**: SA.1-3; SB.4; SF.1-3; SG.1-4

Geology

Grade(s): 11-12 **Length**: one semester **Credit**: 0.5 **Prerequisites**: Teacher recommendation or one semester of *Chemistry* or *Physical Science*	**Course Overview**: Geology is designed to provide students with a better understanding of geology; it provides an introduction to current events related to geology, and explore the multiple career pathways in the field. Over the course, students will discuss careers, employment, and current issues related to geology. Geology teaches fundamental science techniques and concepts through an exploration of the world around us. Physical concepts, such as density and heat transfer, will be explored through an in-depth study of rocks, geological formations, minerals, volcanoes, earthquakes, aquifers, groundwater pollutants, glaciers, petroleum and natural gas, metals, and mining. **Adopted Textbook**: None at this time.

Units (Recommended Order)
• Aquifers and Pollutants in Groundwater • Rock Forming Minerals • Earthquakes and Plate Tectonics • Volcanoes • Metals and Mining • Petroleum and Natural Gas • Glaciers • Independent Student Research Project

UNIT 1: AQUIFERS AND POLLUTANTS IN GROUNDWATER	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: N/A
Key Objectives	**Suggested Activities & Resources**
Identify metals and non-metals on the periodic table. 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. Identify an aquifer and determine criteria for sustainability. Show how pollutants can move into and through an aquifer. Analyze geoscience data to make the claim that one-change to the Earth's surface can create feedbacks that cause changes to other Earth systems. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.	• Flinn Lab Safety Contract and Test. • Lab safety scavenger hunt. • Table-top demo of sand, water, and food coloring to show movement of groundwater. • pH & D.O. measurements. • Septic system design and calculations. • Arsenic in Fairbanks water. • Sulpholane in North Pole water. • DEC (SPAR) plume mapping and predicting. • Superfund sites.
Standards List:	**PS1.A: Structure & Properties of Matter:** HS-PS1.1; **ESS2.A: Earth Materials and Systems:** HS-ESS2.1, HS-ESS2.2; **ESS2.C: The Roles of Water in the Earth's Surface Processes:** HS-ESS2.5

UNIT 2: ROCK FORMING MINERALS	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: N/A
Key Objectives	**Suggested Activities & Resources**
Identify common rock forming minerals. Identify common rocks.	• Lab: Mineral Identification • Mineral chemical formula matching • Minerals vs. gems • Mineral mines
Standards List:	**ESS2.a: Earth Materials & Systems:** HS-ESS2.3; **ESS2.C: The Roles of Water in Earth's Surface Processes:** HS-ESS2.5; **ESS3.A: Natural Resources:** HS-ESS3.1, HS-ESS3.2

UNIT 3: EARTHQUAKES AND PLATE TECTONICS	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: N/A
Key Objectives	**Suggested Activities & Resources**
Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. 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.	• Phet plate tectonics. • Examine geologic maps. • Contact/visit the Alaska Earthquake Information Center (AEIC).
Standards List:	**ESS1.C: The History of Planet Earth:** HS-ESS1.5; **ESS2.B: Plate Tectonics and Large-Scale System Interactions:** HS-ESS2.1; **ESS2.A: Earth Materials & Systems:** HS-ESS2.3; **ESS3.A: Natural Resources:** HS-ESS3.1

UNIT 4: VOLCANOES	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: N/A
Key Objectives	**Suggested Activities & Resources**
Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. 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.	• Map the Ring of Fire and explain its origin. • Compare and contrast shield, composite, and cinder volcanoes. • Yellowstone history. • Volcanology on other planets. • Contact/visit the Alaska Volcano Observatory (AVO).
Standards List:	**ESS1.C: The History of Planet Earth:** HS-ESS1.5; **ESS2.B: Plate Tectonics & Large-Scale System Interactions:** HS-ESS2.1; **ESS2.A: Earth Materials & Systems:** HS-ESS2.3; **ESS3.A: Natural Resources:** HS-ESS3.1

UNIT 5: METALS AND MINING	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: N/A
Key Objectives	**Suggested Activities & Resources**
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. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.	• Identify metals on the periodic table. • Uses of metals. • Mines in Alaska. • Price of gold history. • Prices of other traded metals. • Recycling costs of metals. • Mining standards in the U.S. vs. other countries.
Standards List:	**ESS3.A: Natural Resources:** HS-ESS3.1, HS-ESS3.2

UNIT 6: PETROLEUM AND NATURAL GAS	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: N/A
Key Objectives	**Suggested Activities & Resources**
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. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.	• Geologic Formations: Folds, faults, anticlines, and synclines. • Source, reservoir, and trap rocks. • Stratigraphy/fence mapping.
Standards List:	**ESS2.B: Plate Tectonics & Large-Scale System Interactions:** HS-ESS2.3; **ESS3.A: Natural Resources:** [HS-ESS3.1] [HS-ESS3.2]

UNIT 7: GLACIERS	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: N/A
Key Objectives	**Suggested Activities & Resources**
Analyze geoscience data to make the claim that one-change to Earth's surface can create feedbacks that cause changes to other Earth systems. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. 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 systems.	• Identify glacial features using topographic maps and aerial photos. • Glacier ice cream terminology. • Mapping changes in glacier extents.
Standards List:	**ESS2.A: Earth Materials & Systems:** HS-ESS2.1, HS-ESS2.2, HS-ESS2.3; **ESS1.B: Earth & the Solar System:** HS-ESS2.4; **ESS3.D: Global Climate Change:** HS-ESS3.5

UNIT 8: INDEPENDENT STUDENT RESEACH – PAPER AND POSTER PROJECT	
Suggested Pacing: 3 weeks	**Textbook Chapter(s)/Lessons**: N/A
Key Objectives	**Suggested Activities & Resources**
Choose a research topic appropriate to grade level. Review scientific articles and develop background research. Write a paper or develop a poster using multiple teacher/mentor-reviewed drafts. Present the results of research to the public as scientific paper/poster and oral presentation.	• Invite UAF grad students to share their research with the class. • Develop a list of interests. • Draft proposal for teacher's review. • Students conduct research inside and outside the classroom. • Multiple peer revisions in class. • Research poster presentations.
Standards List:	**ETS1.B: Developing Possible Solutions:** HS-ESS3.2, HS-ESS3.4

Introduction to Basic Pathophysiology

Grade(s): 11-12 **Length**: one semester **Credit**: 0.5 **Prerequisites**: Teacher recommendation or *Biology* and *Human Anatomy and Physiology*	**Course Overview**: *Intro to Basic Pathophysiology* applies knowledge of normal human anatomy and physiology to promote a clear understanding of common disease processes. The course will review basic cellular function, tissue types, and body systems to compare to the body's response to injury or illness. This course is highly recommended for students interested in pursuing a career in health science. **Adopted Textbook**: *Human Disease*. Delmar, 2015

Units (Recommended Order)
• Introduction to Basic Pathophysiology and Mechanism of Disease • Neoplasms/ Cancer • Heart Disease – Cardiovascular System • Immune Systems – Our Body's Defense and Treatment • Microorganisms as Infectious Agents • Pharmacology and Drug Development • Hereditary/ Genetic Disorders

UNIT 1: INTRODUCTION TO BASIC PATHOPHYSIOLOGY AND MECHANISM OF DISEASE	
Suggested Pacing: 2-3 weeks	**Textbook Chapter(s)/Lessons**: Chapter 1
Key Objectives	**Suggested Activities & Resources**
Review A&P body systems, tissue types, homeostasis, and medical terminology	• Create and label a life size body poster • Research diseases of the tissue types • Use prefix, root words, and suffixes to build medical terms
Understand Pathology: acute vs chronic disease, signs vs symptoms, eitology, pathogenesis, morphology, and prognosis	• Define and practice terms with case studies • Choose a system (ex: skeletal system) and disease of that system and research the pathology • Practice application of terms with case studies
Mechanisms of Disease: heredity, trauma, infection/inflammation, hyperplasias/neoplasms, nutritional imbalance, and impaired immunity	• Practice application of terms with case studies • Case study: When eating makes you sick (Inflammatory Bowel Syndrome) • Scientific Process of Diagnosis Lab • This Podcast Will Kill You
Standards List:	**Structure and Function:** HS-LS1-1, HS-LS1-2, HS-LS1-3

UNIT 2: NEOPLASMS/ CANCER	
Suggested Pacing: 1-2 weeks	**Textbook Chapter(s)/Lessons**: Chapter 2
Key Objectives	**Suggested Activities & Resources**
What is cancer, how are cancer cells different than normal cells, causes, statistics, and treatments (current and future)	• Cancer stations (explore different topics)
Types of cancer and current cancer research	• Independent research and presentations • TED Talk and partner share
Cancer risk factors and preventative measures	• Interactive website • Cancer sniffing dogs and ants
Standards List:	**Structure and Function:** HS-LS1-1, HS-LS1-2, HS-LS1-3**; Inheritance and Variation of Traits**: HS-LS1-4, HS-LS3-1, HS-LS3-2, HS-LS3-3; **Natural Selection and Evolution:** HS-LS4-1, HS-LS4-2, HS-LS4-3, HS-LS4-4, HS-LS4-5

UNIT 3: HEART DISEASE – CARDIOVASCULAR SYSTEM	
Suggested Pacing: 2-3 weeks	**Textbook Chapter(s)/Lessons**: Chapter 8
Key Objectives	**Suggested Activities & Resources**
Review Cardiovascular system anatomy and physiology	• Heart and blood flow stop motion video • Build a heart model from clay
Heart disease is the number 1 killer. Learn the signs, symptoms, risk factors and treatments.	• Case studies of risk factors • Read ECGs • Virtual Cardiology Lab- HHMI Biointeractive • Live from the Heart (case study and open heart surgery video)
Standards List:	**Structure and Function:** HS-LS1-1, HS-LS1-2, HS-LS1-3**; Inheritance and Variation of Traits:** HS-LS1-4, HS-LS3-1, HS-LS3-2, HS-LS3-3; **Natural Selection and Evolution:** HS-LS4-1, HS-LS4-2, HS-LS4-3, HS-LS4-4, HS-LS4-5

UNIT 4: IMMUNE SYSTEM – OUR BODY'S DEFENSE AND TREATMENT	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: Chapters 4 and 5
Key Objectives	**Suggested Activities & Resources**
Understand the inflammatory response, and innate vs adaptive immunity including the cells of the immune system (neutrophil, macrophage, T-cells, B-cells, antibodies, memory B-cells)	• Sutures and wound healing • Immune system comic • Blood typing simulation lab
Diseases of the immune system	• Research and presentations • Case study
Standards List:	**Structure and Function:** HS-LS1-1, HS-LS1-2, HS-LS1-3**; Interdependent Relationships in Ecosystems:** HS-LS2-7, HS-LS3-1, HS-LS3-2, HS-LS3-3; **Natural Selection and Evolution:** HS-LS4-1, HS-LS4-2, HS-LS4-3, HS-LS4-4, HS-LS4-5

UNIT 5: MICROORGANISMS AS INFECTIOUS AGENTS	
Suggested Pacing: 2-3 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Bacteria as an infectious agent: structure, reproduction, size, mode of transmission, types of diseases	• Research specific disease, presentation (Battle of Infectious Diseases in March Madness format) • Culture bacterial plates
Viruses as an infectious agent: structure, reproduction, size, mode of transmission, types of diseases	
Protozoans as an infectious agent: structure, reproduction, size, mode of transmission, types of diseases	
Fungi as an infectious agent: structure, reproduction, size, mode of transmission, types of diseases	
Helminths as an infectious agent: structure, reproduction, size, mode of transmission, types of diseases	
Standards List:	**Structure and Function:** HS-LS1-1, HS-LS1-2, HS-LS1-3**; Matter and Energy in Organisms and Ecosystems:** HS-LS1-6, HS-LS1-7, HS-LS2-4; **Inheritance and Variation of Traits:** HS-LS1-4, HS-LS3-1, HS-LS3-2, HS-LS3-3; **Interdependent Relationships in Ecosystems:** HS-LS2-7, HS-LS3-1, HS-LS3-2, HS-LS3-3; **Natural Selection and Evolution:** HS-LS4-1, HS-LS4-2, HS-LS4-3, HS-LS4-4, HS-LS4-**5**

UNIT 6: PHARMACOLOGY AND DRUG DEVELOPMENT	
Suggested Pacing: 2-3 weeks	**Textbook Chapter(s)/Lessons**:
Key Objectives	**Suggested Activities & Resources**
Development and types of vaccines. How do vaccines work and what diseases do we have vaccines for?	• NOVA- Vaccines, Calling the Shots • Research the diseases vaccines prevent
Antibiotics- how they work, antibiotic resistance, replacing antibiotics with bacteriphage therapy	• On cultured bacteria, place antibiotic discs and view zone of inhibition • Antibiotic Resistance Simulation: http://antibiotics.inquiry-hub.net • Gram positive vs gram negative bacteria
Drug Development- the process of clinical trials, and the careers associated with the development of new pharmaceuticals	• HIV Drug Development role play
Standards List:	**Structure and Function:** HS-LS1-1, HS-LS1-2, HS-LS1-3**; Matter and Energy in Organisms and Ecosystems:** HS-LS1-6, HS-LS1-7, HS-LS2-4; **Inheritance and Variation of Traits:** HS-LS1-4, HS-LS3-1, HS-LS3-2, HS-LS3-3; **Interdependent Relationships in Ecosystems:** HS-LS2-7, HS-LS3-1, HS-LS3-2, HS-LS3-3; **Natural Selection and Evolution:** HS-LS4-1, HS-LS4-2, HS-LS4-3, HS-LS4-4, HS-LS4-5

UNIT 7: HEREDITARY/ GENETIC DISORDERS	
Suggested Pacing: 1 week	**Textbook Chapter(s)/Lessons**: Chapter 19
Key Objectives	**Suggested Activities & Resources**
Understand the pathogenesis of congenital, chromosomal, and genetic diseases/disorders.	• Case studies • Karyotype lab (chromosomal disorders) • Research genetic disorder, present or share
Standards List:	**Inheritance and Variation of Traits:** HS-LS1-4, HS-LS3-1, HS-LS3-2, HS-LS3-3; **Natural Selection and Evolution:** HS-LS4-1, HS-LS4-2, HS-LS4-3, HS-LS4-4, HS-LS4-5

Paleontology

Grade(s): 11-12 **Length**: one semester **Credit**: 0.5 **Prerequisites**: Teacher recommendation or *Biology* and *Chemistry*	**Course Overview**: *Paleontology* is designed to provide students an opportunity to further investigate and describe the temporal and spatial changes in Earth's flora and fauna within the context of geological processes, stratigraphy, and evolution. Another goal of the course is to demonstrate the interdependence of scientific disciplines in any investigation of large-scale patterns and events in the natural world. Consequently, the study of paleontology requires a working knowledge of more than one discipline. The course will be reading intensive with advanced articles on the subject of paleontology. **Adopted Textbook**: None at this time.

Units (Recommended Order)
• What are Fossils and How are They Created? • What can Fossils Tell Us? • Geologic Time and Extinctions • Invertebrate Fossils • Vertebrate Fossils • Independent Student Research Paper and Poster Project

UNIT 1: WHAT ARE FOSSILS AND HOW ARE THEY CREATED?	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: N/A
Key Objectives	**Suggested Activities & Resources**
• Design and conduct scientific investigation using appropriate instruments and safety precautions.	• Flinn Lab Safety Contract and Test. • Lab safety scavenger hunt. • Lab: Making fossils from different mediums; what works and what doesn't. • Write a story that describes how an animal becomes a fossil. • Identify current environments and required conditions suitable for the preservation of fossils.
Standards List:	**ESS2.A: Earth Materials & Systems:** HS-ESS2.1, HS-ESS2.2, HS-ESS2.3; **ESS2.B: Plate Tectonics & Large-Scale System Interactions:** HS-ESS2.3

UNIT 2: WHAT CAN FOSSILS TELL US?	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: N/A
Key Objectives	**Suggested Activities & Resources**
Review scientific articles and develop background research.	• PhET Online Lab: http://phet.colorado.edu/en/simulation/redating-game.
Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.	
Analyze geoscience data to make the claim that one-change to Earth's surface can create feedbacks that cause changes to other Earth systems.	
Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.	
Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.	
Standards List:	**ESS1.C: The History of Planet Earth:** HS-ESS1.6; **ESS2.A: Earth Materials & Systems:** HS-ESS2.2; **ESS2.D: Weather & Climate:** HS-ESS2.4, HS-ESS2.6, HS-ESS2.7

UNIT 3: GEOLOGIC TIME AND EXTINCTIONS	
Suggested Pacing: 2 weeks	**Textbook Chapter(s)/Lessons**: N/A
Key Objectives	**Suggested Activities & Resources**
Review scientific articles and develop background research.	• Measure out geologic time to scale. • Analyze Jurassic Park movie for scientific accuracy. • Compare extinction events. • Examine claims of current extinction event. • Examine geologic maps.
Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.	
Analyze geoscience data to make the claim that one-change to Earth's surface can create feedbacks that cause changes to other Earth systems.	
Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.	
Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.	
Communicate scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.	
Construct an explanation based on evidence that the process of evolution primarily results from four factors: • The potential for a species to increase in number. • The heritable genetic variation of individuals in a species due to mutation and sexual reproduction. • Competition for limited resources. • The proliferation of those organisms that are better able to survive and reproduce in the environment.	
Evaluate the 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.	
Standards List:	**ESS1.C: The History of Planet Earth:** HS-ESS1.6; **ESS2.A: Earth Materials & Systems:** HS-ESS1.1, HS-ESS2.2; HS-ESS2.4; **ESS2.D: Weather & Climate:** HS-ESS2.7; **LS4.A: Evidence of Common Ancestry & Diversity:** HS-LS4.1, HS-LS4-2; **LS2.C: Exosystem Dynamics, Functioning, and Resilience:** HS-LS2-6

UNIT 4: INVERTEBRATE FOSSILS	
Suggested Pacing: 4 weeks	**Textbook Chapter(s)/Lessons**: N/A
Key Objectives	**Suggested Activities & Resources**
Review scientific articles and develop background research	• Lab: Invertebrate Fossil Identification. • Mollusk dissection. • Gastropod dissection. • Use microscopes to examine microfossils.
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.	
Construct an explanation based on evidence for how natural selection leads to adaptation of populations.	
Evaluate the evidence supporting claims that changes in environmental conditions may result in: • Increases in the number of individuals of some species. • The emergence of new species over time. • The extinction of other species.	
Standards List:	**ESS1.C: The History of Planet Earth:** HS-ESS1.5, HS-ESS1.6; **ESS2.B: Plate Tectonics & Large-Scale System Interactions:** HS-ESS2.1, HS-ESS2.3; **LS4.B: Natural Selection:** HS-LS4.3; **LS4.C: Adaptation:** HS-LS4.4, HS-LS4.5

UNIT 5: VERTEBRATE FOSSILS	
Suggested Pacing: 4 weeks	**Textbook Chapter(s)/Lessons**: N/A
Key Objectives	**Suggested Activities & Resources**
Review scientific articles and develop background research.	• Lab: Vertebrate Fossil Identification. • Making molds and casts of fossils. • UAF Museum tour. • Video: What killed the Dinosaurs. • Video: Making the Baby Mammoth.
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.	
Construct an explanation based on evidence for how natural selection leads to adaptation of populations.	
Evaluate the evidence supporting claims that changes in environmental conditions may result in: • Increases in the number of individuals of some species. • The emergence of new species over time. • The extinction of other species.	
Standards List:	**ESS1.C: The History of Planet Earth:** HS-ESS1.5, HS-ESS1.6; **ESS2.B: Plate Tectonics & Large-Scale System Interactions:** HS-ESS2.3, HS-ESS2.1; **LS4.A: Evidence of Common Ancestry & Diversity:** HS-LS4.1; **LS4.B: Natural Selection:** HS-LS4.3; **LS4.C: Adaptation:** HS-LS4.4, HS-LS4.5

<table>
<tr><th colspan="3">UNIT 6: INDEPENDENT STUDENT RESEARCH PAPER AND POSTER PROJECT</th></tr>
<tr><td colspan="2">Suggested Pacing: 3 weeks</td><td>Textbook Chapter(s)/Lessons: N/A</td></tr>
<tr><th colspan="2">Key Objectives</th><th>Suggested Activities & Resources</th></tr>
<tr><td colspan="2">Choose a research topic appropriate to grade level.</td><td rowspan="4">• Invite UAF grad students to share their research with the class.
• Develop a list of interests.
• Draft proposal for teacher’s review.
• Students conduct research inside and outside the classroom.
• Multiple peer revisions in class.
• Research poster presentations.</td></tr>
<tr><td colspan="2">Review scientific articles and develop background research.</td></tr>
<tr><td colspan="2">Write paper or develop poster using multiple teacher/mentor-reviewed drafts.</td></tr>
<tr><td colspan="2">Present the results of research to the public as scientific paper/poster and oral presentation.</td></tr>
<tr><td>Standards List:</td><td colspan="2">ETS1.B: Developing Possible Solutions: HS-ESS3.2, HS-ESS3.4</td></tr>
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The Fairbanks North Star Borough School District is an equal employment and educational opportunity institution, as well as tobacco and nicotine-free learning and work environment.

Fairbanks North Star Borough School District
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