Physical Science Course of Study

Science Inquiry and Application

During the years of grades 9 through 12, all students must use the following scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas:

- Identify questions and concepts that guide scientific investigations.
- Design and conduct scientific investigations.
- Use technology and mathematics to improve investigations and communications.
- Formulate and revise explanations and models using logic and evidence (critical thinking).
- Recognize and analyze explanations and models.
- Communicate and support a scientific argument.

Reading Standards

Key Ideas and Details:

1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
2. Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

Craft and Structure:

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.
5. Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).
6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

Writing Standards

Text Types and Purposes:

1. Write arguments focused on discipline-specific content.
   a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.
   b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.
   c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims.
   d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
   e. Provide a concluding statement or section that follows from or supports the argument presented.
2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical

Integration of Knowledge and Ideas:

7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
8. Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
9. Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

Range of Reading and Level of Text Complexity:

10. By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.

processes.

a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension.
b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic.
c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts.
d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers.
e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).

3. Students' narrative skills continue to grow in these grades. The Standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.

Production and Distribution of Writing:

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

	6. Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically. ***Research to Build and Present Knowledge:*** 7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. 8. Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation. 9. Draw evidence from informational texts to support analysis, reflection, and research. ***Range of Writing:*** 10. Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Physical Science Course of Study

Topic: ***Classification of Matter***

The Study of Matter

Content Elaborations

Matter was introduced in the elementary grades and the learning progression continued through middle school to include differences in the physical properties of solids, liquids and gases, elements, compounds, mixtures, molecules, kinetic and potential energy, and the particulate nature of matter. Content in the chemistry syllabus (e.g., electron configuration, molecular shapes, bond angles) will be developed from concepts in this course.

Matter can be classified in broad categories such as homogeneous and heterogeneous or classified according to its composition or by its chemical (reactivity) and physical properties (e.g., color solubility, odor, hardness, density, melting point and boiling point, viscosity and malleability). Solutions are homogenous mixtures of a solute dissolved in a solvent. The amount of a solid solute that can dissolve in a solvent generally increases as the temperature increases since the particles have more kinetic energy to overcome the attractive forces between them. Water is often used as a solvent since so many substances will dissolve in water. Physical properties can be used to separate the substances in mixtures, including solutions.

Phase changes can be represented by graphing the temperature of a sample vs. the time it has been heated. Investigations must include collecting data during heating, cooling, and solid-liquid-solid phase changes. At times, the temperature will change steadily, indicating a change in the motion of the particles and the kinetic energy of the substance. However, during a phase change, the temperature of a substance does not change, indicating there is no change in kinetic energy. Since the substance continues to gain or lose energy during phase changes, these changes in energy are potential and indicate a change in the position of the particles. When heating a substance, a phase change will occur when the kinetic energy of the particles is great enough to overcome the attractive forces between the particles; the substance then melts or boils. Conversely, when cooling a substance, a phase change will occur when the kinetic energy of the particles is no longer great enough to overcome the attractive forces between the particles; the substance then condenses or freezes. Phase changes are examples of changes that can occur when energy is absorbed from the surroundings (endothermic) or released into the surroundings (exothermic).

When thermal energy is added to a solid, liquid, or gas, most substances increase in volume because the increased kinetic energy of the particles causes an increased distance between the particles. This results in a change in density of the material. Generally, solids have greater density than liquids, which have greater density than gases due to the spacing between the particles. The density of a substance can be calculated from the slope of a mass vs. volume graph. Differences in densities can be determined by interpreting mass vs. volume graphs of the substances.

Learning Targets	Honors Learning Targets	STEM Learning Targets
Classification of Matter		
• Classify matter into broad categories such as homogenous and heterogeneous. • Classify matter by its chemical (reactivity) and	• Classify matter into specific categories (i.e., suspension, colloid, emulsion, solution, solvent, solute, alloy).	• Classify specific building materials into broad categories such as homogenous and heterogeneous.

physical properties (e.g., color, solubility, odor, hardness, density, melting and boiling point, viscosity and malleability). • Identify the states of matter and their characteristics. • Explain the phase changes that matter undergoes. • Collect and analyze data related to phase changes.	• Identify additional states of matter (e.g., plasma).	• Recognize the importance of alloys in different applications.

Additional Resources

Pacing:

Content Vocabulary

- atom
- boiling point
- chemical change
- chemical formula
- chemical property
- colloid
- compound
- condensation
- density
- ductile
- element
- endothermic
- evaporation
- exothermic
- heat
- heterogeneous
- homogenous
- kinetic energy
- malleable
- matter
- melting point
- mixture
- molecule
- phase
- physical change
- physical property
- pure substance
- solubility
- solute
- solution
- solvent
- sublimation
- suspension
- temperature
- thermal
- vaporization
- viscosity

Academic Vocabulary

- absorption
- abundant
- acronym
- analogy
- analyze
- apply
- approximate
- average
- balanced
- calculate
- characteristic
- clarify
- classify
- coefficient
- compare
- comprised
- continuum
- contract
- correlate
- criteria
- directly proportional
- displacement
- inversely proportional
- key
- label
- lack
- magnitude
- manipulate
- mean
- measure
- observe
- opaque
- opinion
- pattern
- per
- phenomenon
- plausible
- position
- postulate
- predict
- procedure
- produce
- proportional
- propose

Physical Science Course of Study

	• distinguish • dynamic • emission • emit • equals • estimate • evaluate • evidence • example • expand • expansion • explain • fate • graph • hypothesize • imply • infer • interact • interpret • qualitative • quantify • quantitative • rank • sequence • share • simultaneous • spectrum • static • stationary • subscript • trait • transfer • translucent • transparent • trend • valid • vary • yields
Formative Assessments	**Summative Assessments**
Resources	**Enrichment Strategies**
Integrations • **ELA**: • **Math**: • **Social Studies**:	**Intervention Strategies**

Physical Science Course of Study

Topic: ***Atoms***

The Study of Matter

Content Elaborations

Content introduced in middle school, where the atom was introduced as a small, indestructible sphere, is further developed in the physical science syllabus. Over time, technology was introduced that allowed the atom to be studied in more detail. The atom is composed of protons, neutrons, and electrons that have measurable properties, including mass and, in the case of protons and electrons, a characteristic charge. When bombarding thin gold foil with atomic-sized, positively charged, high-speed particles, a few of the particles were deflected slightly from their straight-line path. Even fewer bounced back toward the source. This evidence indicates that most of an atom is empty space with a very small positively charged nucleus. This experiment and other evidence indicate the nucleus is composed of protons and neutrons and electrons that move about in the empty space that surrounds the nucleus. Additional experimental evidence that led to the development of other historic atomic models will be addressed in the chemistry syllabus.

All atoms of a particular element have the same atomic number; an element may have different isotopes with different mass numbers. Atoms may gain or lose electrons to become anions or cations. Atomic number, mass number, charge, and identity of the element can be determined from the numbers of protons, neutrons, and electrons. Each element has a unique atomic spectrum that can be observed and used to identify an element. Atomic mass and explanations about how atomic spectra are produced are addressed in the chemistry syllabus.

Learning Targets	Honors Learning Targets	STEM Learning Targets
Classification of Matter		
• Describe how the model of the atom has changed over time as technology has improved. • Differentiate between the parts, locations, and properties of the particles that make up the atom. • Explain how atoms can become ions (cations and anions). • Explain that isotopes are atoms of the same element with different mass numbers. • Differentiate between ions and isotopes.	• Analyze the strengths and limitations of the different atomic models. • Assess evidence for the existence of subatomic particles. • Calculate the percent abundance of isotopes. • Compare the stability of isotopes.	• Calculate the percent abundance of isotopes.
Additional Resources		
Pacing:		

Physical Science Course of Study

Content Vocabulary

- anion
- atom
- atomic mass
- atomic mass unit (amu)
- atomic number
- Bohr model
- cation
- charge
- electron
- electron cloud/shell
- ion
- isotope
- Lewis dot diagram
- mass number
- negative
- neutral
- neutron
- nucleus
- positive
- proton
- valence

Academic Vocabulary

- absorption
- abundant
- acronym
- analogy
- analyze
- apply
- approximate
- average
- balanced
- calculate
- characteristic
- clarify
- classify
- coefficient
- compare
- comprised
- continuum
- contract
- correlate
- criteria
- directly proportional
- displacement
- distinguish
- dynamic
- emission
- emit
- equals
- estimate
- evaluate
- evidence
- example
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- proportional
- propose
- qualitative
- quantify
- quantitative
- rank
- sequence
- share
- simultaneous
- spectrum
- static
- stationary
- subscript
- trait
- transfer
- translucent

Physical Science Course of Study

	• hypothesize • imply • infer • interact • interpret • transparent • trend • valid • vary • yields
Formative Assessments	**Summative Assessments**
Resources	**Enrichment Strategies**
Integrations • **ELA**: • **Math**: • **Social Studies**:	**Intervention Strategies**

Physical Science Course of Study

Topic: ***Atoms***

The Study of Matter

Content Elaborations

Content introduced in middle school, where the atom was introduced as a small, indestructible sphere, is further developed in the physical science syllabus. Over time, technology was introduced that allowed the atom to be studied in more detail. The atom is composed of protons, neutrons, and electrons that have measurable properties, including mass and, in the case of protons and electrons, a characteristic charge. When bombarding thin gold foil with atomic-sized, positively charged, high-speed particles, a few of the particles were deflected slightly from their straight-line path. Even fewer bounced back toward the source. This evidence indicates that most of an atom is empty space with a very small positively charged nucleus. This experiment and other evidence indicate the nucleus is composed of protons and neutrons and electrons that move about in the empty space that surrounds the nucleus. Additional experimental evidence that led to the development of other historic atomic models will be addressed in the chemistry syllabus.

All atoms of a particular element have the same atomic number; an element may have different isotopes with different mass numbers. Atoms may gain or lose electrons to become anions or cations. Atomic number, mass number, charge, and identity of the element can be determined from the numbers of protons, neutrons, and electrons. Each element has a unique atomic spectrum that can be observed and used to identify an element. Atomic mass and explanations about how atomic spectra are produced are addressed in the chemistry syllabus.

Learning Targets	Honors Learning Targets	STEM Learning Targets
Understanding Atoms		
• Describe how the model of the atom has changed over time as technology has improved. • Differentiate between the parts, locations, and properties of the particles that make up the atom. • Explain how atoms can become ions (cations and anions). • Explain that isotopes are atoms of the same element with different mass numbers. • Differentiate between ions and isotopes.	• Analyze the strengths and limitations of the different atomic models. • Assess evidence for the existence of subatomic particles. • Calculate the percent abundance of isotopes. • Compare the stability of isotopes.	• Calculate the percent abundance of isotopes.
Additional Resources		
Pacing:		

Physical Science Course of Study

Content Vocabulary	**Academic Vocabulary**
• anion • atom • atomic mass • atomic mass unit (amu) • atomic number • Bohr model • cation • charge • electron • electron cloud/shell • ion • isotope • Lewis dot diagram • mass number • negative • neutral • neutron • nucleus • positive • proton • valence	• absorption • abundant • acronym • analogy • analyze • apply • approximate • average • balanced • calculate • characteristic • clarify • classify • coefficient • compare • comprised • continuum • contract • correlate • criteria • directly proportional • displacement • distinguish • dynamic • emission • emit • equals • estimate • evaluate • evidence • example • expand • expansion • explain • fate • graph • inversely proportional • key • label • lack • magnitude • manipulate • mean • measure • observe • opaque • opinion • pattern • per • phenomenon • plausible • position • postulate • predict • procedure • produce • proportional • propose • qualitative • quantify • quantitative • rank • sequence • share • simultaneous • spectrum • static • stationary • subscript • trait • transfer • translucent

Physical Science Course of Study

	• hypothesize • imply • infer • interact • interpret • transparent • trend • valid • vary • yields
Formative Assessments	**Summative Assessments**
Resources	**Enrichment Strategies**
Integrations • **ELA**: • **Math**: • **Social Studies**:	**Intervention Strategies**

Physical Science Course of Study

Topic: ***Periodic Trends of the Elements***

The Study of Matter

Content Elaborations

Content from the middle school level, specifically the properties of metals and nonmetals and their positions on the periodic table, is further expanded in this course. When elements are listed in order of increasing atomic number, the same sequence of properties appears over and over again; this is the periodic law. The periodic table is arranged so that elements with similar chemical and physical properties are in the same group or family. Metalloids are elements that have some properties of metals and some properties of nonmetals. Metals, nonmetals, metalloids, periods, and groups of families including the alkali metals, alkaline earth metals, halogens, and noble gases can be identified by their position on the periodic table. Elements in Groups 1, 2, and 17 have characteristic ionic charges that will be used in this course to predict the formulas of compounds. Other trends in the periodic table (e.g., atomic radius, electronegativity, ionization energies) are found in the chemistry syllabus.

Learning Targets	Honors Learning Targets	STEM Learning Targets
Periodic Trends of the Elements		
• Recognize that when elements are listed in order of increasing atomic number, the same sequence of properties appears over and over again; this is the periodic law. • Evaluate the patterns and properties of elements as they relate to the periodic table.	• Predict properties of elements.	• Predict properties of elements.

Additional Resources

Pacing:

Content Vocabulary

- alkali metals
- alkaline earth metals
- group
- halogens
- inert
- metal
- metalloid/semi-conductor
- noble gases
- nonmetal
- period
- periodic law
- periodicity
- stable
- transition metals

Academic Vocabulary

- absorption
- abundant
- acronym
- analogy
- analyze
- apply
- approximate
- average
- balanced
- inversely proportional
- key
- label
- lack
- magnitude
- manipulate
- mean
- measure
- observe

Physical Science Course of Study

	- calculate - characteristic - clarify - classify - coefficient - compare - comprised - continuum - contract - correlate - criteria - directly proportional - displacement - distinguish - dynamic - emission - emit - equals - estimate - evaluate - evidence - example - expand - expansion - explain - fate - graph - hypothesize - imply - infer - interact - interpret - opaque - opinion - pattern - per - phenomenon - plausible - position - postulate - predict - procedure - produce - proportional - propose - qualitative - quantify - quantitative - rank - sequence - share - simultaneous - spectrum - static - stationary - subscript - trait - transfer - translucent - transparent - trend - valid - vary - yields
Formative Assessments	**Summative Assessments**
Resources	**Enrichment Strategies**

Physical Science Course of Study

Integrations	Intervention Strategies
• **ELA**: • **Math**: • **Social Studies**:	

Physical Science Course of Study

Topic: ***Bonding and Compounds***

The Study of Matter

Content Elaborations

Middle school content included compounds composed of atoms of two or more elements joined together chemically. In this course, the chemical joining of atoms is studied in more detail. Atoms may be bonded together by losing, gaining, or sharing electrons to form molecules or three-dimensional lattices. An ionic bond involves the attraction of two oppositely charged ions, typically a metal cation and a nonmetal anion formed by transferring electrons between the atoms. An ion attracts oppositely charged ions from every direction, resulting in the formation of a three-dimensional lattice. Covalent bonds result from the sharing of electrons between two atoms, usually nonmetals. Covalent bonding can result in the formation of structures ranging from small individual molecules to three-dimensional lattices (e.g., diamond). The bonds in most compounds fall on a continuum between the two extreme models of bonding: ionic and covalent.

Using the periodic table to determine ionic charge, formulas of ionic compounds containing elements from groups 1, 2, 17, hydrogen, and oxygen can be predicted. Given a chemical formula, a compound can be named using conventional systems that include Greek prefixes where appropriate. Prefixes will be limited to represent values from one to 10. Given the name of an ionic or covalent substance, formulas can be written. Naming organic molecules is beyond this grade level and is reserved for an advanced chemistry course. Prediction of bond types from electronegativity values, polar covalent bonds, writing formulas, and naming compounds that contain polyatomic ions or transition metals will be addressed in the chemistry syllabus.

Learning Targets	Honors Learning Targets	STEM Learning Targets
Bonding and Compounds		
• Summarize the difference between ionic bonds and covalent bonds. • Identify the elements in a formula and recognize that a chemical formula represents elements that have bonded.	• Compare the strength of ionic and covalent bonds. • Name common polyatomic ions (hydroxide, nitrate, sulfate, phosphate, carbonate). • Use the understanding of bonding to write chemical formulas and name chemical compounds.	• Compare the strength of ionic and covalent bonds.

Additional Resources

Pacing:

Content Vocabulary		Academic Vocabulary	
• bond	• ionic bond	• absorption	• inversely proportional
• chemical formula	• lattice	• abundant	• key

Physical Science Course of Study

- compound
- covalent bond
- ion
- metal cation
- molecule
- nonmetal anion

- acronym
- analogy
- analyze
- apply
- approximate
- average
- balanced
- calculate
- characteristic
- clarify
- classify
- coefficient
- compare
- comprised
- continuum
- contract
- correlate
- criteria
- directly proportional
- displacement
- distinguish
- dynamic
- emission
- emit
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- estimate
- evaluate
- evidence
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- expand
- expansion
- explain
- fate
- graph
- hypothesize
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- phenomenon
- plausible
- position
- postulate
- predict
- procedure
- produce
- proportional
- propose
- qualitative
- quantify
- quantitative
- rank
- sequence
- share
- simultaneous
- spectrum
- static
- stationary
- subscript
- trait
- transfer
- translucent
- transparent
- trend
- valid

Physical Science Course of Study

	• interact • interpret • vary • yields
Formative Assessments	**Summative Assessments**
Resources	**Enrichment Strategies**
Integrations • **ELA**: • **Math**: • **Social Studies**:	**Intervention Strategies**

Physical Science Course of Study

Topic: ***Reactions of Matter***

The Study of Matter

Content Elaborations

In middle school, the law of conversation of matter was expanded to chemical reactions, noting that the number and type of atoms and the total mass are the same before and after the reaction. In this course, conservation of matter is expressed by writing balanced chemical equations. At this level, reactants and products can be identified from an equation and simple equations can be written and balanced given either the formulas of the reactants and products or a word description of the reaction. Stoichiometric relationships beyond the coefficients in a balanced equation and classification of types of chemical reactions are addressed in the chemistry syllabus. During chemical reactions, thermal energy is either transferred from the system to the surroundings (exothermic) or transferred from the surroundings to the system (endothermic). Since the environment surrounding the system can be large, temperature changes in the surroundings may not be detectable.

While chemical changes involve changes in the electrons, nuclear reactions involve changes to the nucleus and involve much larger energies than chemical reactions. The strong nuclear force is the attractive force that binds protons and neutrons together in the nucleus. While the nuclear force is extremely weak at most distances, over the very short distances present in the nucleus the force is greater than the repulsive electrical forces among protons. When the attractive nuclear forces and repulsive electrical forces in the nucleus are not balanced, the nucleus is unstable. Through radioactive decay, the unstable nucleus emits radiation in the form of very fast-moving particles and energy to produce a new nucleus, thus changing the identity of the element. Nuclei that undergo this process are said to be radioactive. Radioactive isotopes have several medical applications. The radiation they release can be used to kill undesired cells (e.g., cancer cells). Radioisotopes can be introduced into the body to show the flow of materials in biological processes.

For any radioisotope, the half-life is unique and constant. Graphs can be constructed that show the amount of a radioisotope that remains as a function of time and can be interpreted to determine the value of the half-life. Half-life values are used in radioactive dating.

Other examples of nuclear processes include nuclear fission and nuclear fusion. Nuclear fission involves splitting a large nucleus into smaller nuclei, releasing large quantities of energy. Nuclear fusion is the joining of smaller nuclei into a larger nucleus accompanied by the release of large quantities of energy. Nuclear fusion if the process responsible for formation of all the elements in the universe beyond helium and the energy of the sun and the stars.

Further details about nuclear processes including common types of nuclear radiation, predicting the products of nuclear decay, mass-energy equivalence, and nuclear power applications are addressed in the chemistry and physics syllabi.

Learning Targets	Honors Learning Targets	STEM Learning Targets
Reactions of Matter		
• Balance equations to demonstrate that chemical reactions follow the law of conservation of	• Write balanced equations to demonstrate that chemical reactions follow the law of	• Write balanced equations to demonstrate that chemical reactions follow the law of

matter. • Recognize that chemical reactions involve the transfer of energy. • Contrast between chemical reactions and nuclear reactions. • Appraise the value of nuclear reactions in society.	conservation of matter.	conservation of matter.

Additional Resources

Pacing:

Content Vocabulary

- balanced equation
- bonds
- chemical equation
- chemical reaction
- coefficient
- disassociation
- endothermic
- exothermic
- half-life
- Law of Conservation of Matter
- nuclear fission
- nuclear fusion
- particle
- product
- radiation
- radioactive dating
- radioactive decay
- radioactive isotope
- reactant
- strong nuclear force
- subscript
- weak nuclear force

Academic Vocabulary

- absorption
- abundant
- acronym
- analogy
- analyze
- apply
- approximate
- average
- balanced
- calculate
- characteristic
- clarify
- classify
- coefficient
- compare
- comprised
- continuum
- contract
- correlate
- criteria
- directly proportional
- displacement
- distinguish
- dynamic
- inversely proportional
- key
- label
- lack
- magnitude
- manipulate
- mean
- measure
- observe
- opaque
- opinion
- pattern
- per
- phenomenon
- plausible
- position
- postulate
- predict
- procedure
- produce
- proportional
- propose
- qualitative
- quantify

	• emission • emit • equals • estimate • evaluate • evidence • example • expand • expansion • explain • fate • graph • hypothesize • imply • infer • interact • interpret • quantitative • rank • sequence • share • simultaneous • spectrum • static • stationary • subscript • trait • transfer • translucent • transparent • trend • valid • vary • yields
Formative Assessments	**Summative Assessments**
Resources	**Enrichment Strategies**
Integrations • **ELA**: • **Math**: • **Social Studies**:	**Intervention Strategies**

Physical Science Course of Study

Topic: ***Conservation of Energy***

Energy and Waves

Content Elaborations

Energy and Waves

Building upon knowledge gained in elementary and middle school, major concepts about energy and waves are further developed. Conceptual knowledge will move from qualitative understandings of energy and waves to ones that are more quantitative using mathematical formulas, manipulations, and graphical representations.

Conservation of Energy

Energy content learned in middle school, specifically conservation of energy and the basic differences between kinetic and potential energy, is elaborated on and quantified in this course. Energy has no direction and has units of Joules (J). Kinetic energy, E, can be mathematically k represented by $E = 1/2mv^2$. Gravitational potential energy, E, can be mathematically represented k g by $E = mgh$. The amount of energy of an object is measured relative to a reference that is g considered to be at a point of zero energy. The reference may be changed to help understand different situations. Only the change in the amount of energy can be measured absolutely. The conservation of energy and equations for kinetic and gravitational potential energy can be used to calculate values associated with energy (i.e., height, mass, speed) for situations involving energy transfer and transformation. Opportunities to quantify energy from data collected in experimental situations (e.g., a swinging pendulum, a car traveling down an incline) must be provided.

Learning Targets	Honors Learning Targets	STEM Learning Targets
Conservation of Energy		
• Calculate the kinetic energy and gravitational potential energy in various scenarios (e.g., at rest, in middle of free-fall, at the bottom of a fall just before impact, pendulum). • Recognize that the amount of energy of an object is measured relative to a reference that is considered to be at a point of zero energy. • Collect and use data to quantify energy transformations.	• Collect data to evaluate and calculate the potential and kinetic energy of a real life scenario (e.g., rollercoaster, elevator, car moving down a road).	• Collect data to evaluate and calculate the potential and kinetic energy of a real life scenario (e.g., rollercoaster, elevator, car moving down a road).
Additional Resources		
Pacing:		

Physical Science Course of Study

Content Vocabulary	Academic Vocabulary	
• conservation of energy • energy • energy transfer • energy transformation • $g = 9.8\ m/s^2$ • GPE - mgh • heat • $KE = 1/2mv^2$ • kinetic energy • Law of Conservation of Energy • potential energy (gravitational, elastic, chemical)	• absorption • abundant • acronym • analogy • analyze • apply • approximate • average • balanced • calculate • characteristic • clarify • classify • coefficient • compare • comprised • continuum • contract • correlate • criteria • directly proportional • displacement • distinguish • dynamic • emission • emit • equals • estimate • evaluate • evidence • example • expand • expansion • explain • fate • graph	• inversely proportional • key • label • lack • magnitude • manipulate • mean • measure • observe • opaque • opinion • pattern • per • phenomenon • plausible • position • postulate • predict • procedure • produce • proportional • propose • qualitative • quantify • quantitative • rank • sequence • share • simultaneous • spectrum • static • stationary • subscript • trait • transfer • translucent

Physical Science Course of Study

	• hypothesize • imply • infer • interact • interpret • transparent • trend • valid • vary • yields
Formative Assessments	**Summative Assessments**
Resources	**Enrichment Strategies**
Integrations • **ELA**: • **Math**: • **Social Studies**:	**Intervention Strategies**

Physical Science Course of Study

Topic: ***Transfer and Transformation of Energy***

Energy and Waves

Content Elaborations

Transfer and Transformation of Energy

In middle school, concepts of energy transfer and transformation were addressed, including conservation of energy, conduction, convection and radiation, the transformation of electrical energy, and the dissipation of energy into thermal energy. Work also was introduced as a method of energy transfer into or out of the system when an outside force moves an object over a distance. In this course, these concepts are further developed. As long as the force, F, and displacement, Δx, are in the same direction, work, W, can be calculated from the equation W = Δx. Energy transformations for a phenomenon can be represented through a series of pie graphs. Equations for work, kinetic energy, and potential energy can be combined with the law of conservation of energy to solve problems. When energy is transferred from one system to another, some of the energy is transformed to thermal energy. Since thermal energy involves the random movement of many trillions of subatomic particles, it is less able to be organized to bring about further change. Therefore, even though the total amount of energy remains constant, less energy is available for doing useful work.

Learning Targets	Honors Learning Targets	STEM Learning Targets
Transfer and Transformation of Energy (including work)		
• Assess the relationship between force, displacement, and work. • Create graphs and/or diagrams demonstrating energy transformation.	• Assess the relationship between force, displacement, angle between the force and displacement, and work (w = f Δx cos(☐)).	• Assess the relationship between force, displacement, angle between the force and displacement, and work (w = f Δx cos(☐)).

Additional Resources

Pacing:

Content Vocabulary

- conduction
- convection
- displacement
- force
- radiation
- thermal energy
- work

Academic Vocabulary

- absorption
- abundant
- acronym
- analogy
- analyze
- apply
- approximate
- average
- balanced
- inversely proportional
- key
- label
- lack
- magnitude
- manipulate
- mean
- measure
- observe

Physical Science Course of Study

	- calculate - characteristic - clarify - classify - coefficient - compare - comprised - continuum - contract - correlate - criteria - directly proportional - displacement - distinguish - dynamic - emission - emit - equals - estimate - evaluate - evidence - example - expand - expansion - explain - fate - graph - hypothesize - imply - infer - interact - interpret - opaque - opinion - pattern - per - phenomenon - plausible - position - postulate - predict - procedure - produce - proportional - propose - qualitative - quantify - quantitative - rank - sequence - share - simultaneous - spectrum - static - stationary - subscript - trait - transfer - translucent - transparent - trend - valid - vary - yields
Formative Assessments	**Summative Assessments**
Resources	**Enrichment Strategies**

Physical Science Course of Study

Integrations	**Intervention Strategies**
ELA: **Math**: **Social Studies**:	

Topic: ***Waves***

Energy and Waves

Content Elaborations

Waves

As addressed in middle school, waves transmit energy from one place to another, can transfer energy between objects, and can be described by their speed, wavelength, frequency, and amplitude. The relationship between speed, wavelength, and frequency also was addressed in middle school Earth and Space Science as the motion of seismic waves through different materials is studied. In elementary and middle school, reflection and refraction of light were introduced, as was absorption of radiant energy by transformation into thermal energy. In this course, these processes are addressed from the perspective of waves and expanded to include other types of energy that travel in waves. When a wave encounters a new material, the new material may absorb the energy of the wave by transforming it to another form of energy, usually thermal energy. Waves can be reflected off solid barriers or refracted when a wave travels from one medium into another medium. Waves may undergo diffraction around small obstacles or openings. When two waves traveling through the same medium meet, they pass through each other, then continue traveling through the medium as before. When the waves meet, they undergo superposition, demonstrating constructive and destructive interference. Sound travels in waves and undergoes reflection, refraction, interference, and diffraction. In the physics syllabus, many of these wave phenomena will be studied further and quantified.

Radiant energy travels in waves and does not require a medium. Source of light energy (e.g., the sun, a light bulb) radiate energy continually in all directions. Radiant energy has a wide range of frequencies, wavelengths, and energies arranged into the electromagnetic spectrum. The electromagnetic spectrum is divided into bands: radio (lowest energy), microwaves, infrared, visible light, X-rays, and gamma rays (highest energy) that have different applications in everyday life. Radiant energy of the entire electromagnetic spectrum travels at the same speed in a vacuum. Specific frequency, energy, or wavelength ranges of the electromagnetic spectrum are not required. However, the relative positions of the different bands, including the colors of visible light, are important (e.g., ultraviolet has more energy than microwaves). Radiant energy exhibits wave behaviors including reflection, refraction, absorption, superposition, and diffraction depending in part on the nature of the medium. For opaque objects (e.g., paper, a chair, an apple), little if any radiant energy is transmitted into the new material. However, the radiant energy can be absorbed, usually increasing the thermal energy of the object and/or the radiant energy can be reflected. For rough objects, the reflection in all directions forms a diffuse reflection and for smooth objects, reflections can result in clear images. Transparent materials transmit most of the energy through the material but smaller amounts of energy may be absorbed or reflected.

Changes in the observed frequency and wavelength of a wave can occur if the wave source and the observer are moving relative to each other. When the source and the observer are moving toward each other, the wavelength is shorter and the observed frequency is higher; when the source and the observer are moving away from each other, the wavelength is longer and the observed frequency is lower. This phenomenon is called the Doppler shift and can be explained using diagrams. This phenomenon is important to current understanding of how the universe was formed and will be applied in later sections of this course. Calculations to measure the apparent change in frequency or wavelength are not appropriate for this course.

Physical Science Course of Study

Learning Targets	Honors Learning Targets	STEM Learning Targets
Waves		
• Summarize various wave interactions including refraction, reflection, diffraction, absorption, and constructive and destructive interference. • Analyze practical applications of wave interactions. • Distinguish between electromagnetic waves and mechanical waves. • Apply the concept of the Doppler Effect to explain a number of phenomena.	• Calculate the apparent change in frequency due to the Doppler Effect.	• Calculate the apparent change in frequency due to the Doppler Effect. • Evaluate materials for their effect on wave behavior.

Additional Resources

Pacing:

Content Vocabulary

- absorption
- amplitude
- complete
- compression
- constructive interference
- crest
- cycle
- destructive interference
- diffraction
- displacement
- Doppler Effect
- electromagnetic spectrum
- frequency
- gamma rays
- incidence
- incomplete
- infrared
- interference
- longitudinal/compressional
- medium/media
- microwave
- period
- radio wave
- rarefaction
- reflection
- refraction
- sound wave
- superposition
- transverse
- trough
- ultraviolet
- visible
- wave
- wave speed
- wavelength
- x-rays

Academic Vocabulary

- absorption
- abundant
- acronym
- analogy
- analyze
- apply
- approximate
- average
- balanced
- calculate
- characteristic
- clarify
- classify
- coefficient
- compare
- comprised
- continuum
- contract
- correlate
- inversely proportional
- key
- label
- lack
- magnitude
- manipulate
- mean
- measure
- observe
- opaque
- opinion
- pattern
- per
- phenomenon
- plausible
- position
- postulate
- predict
- procedure

Physical Science Course of Study

	- criteria - directly proportional - displacement - distinguish - dynamic - emission - emit - equals - estimate - evaluate - evidence - example - expand - expansion - explain - fate - graph - hypothesize - imply - infer - interact - interpret - produce - proportional - propose - qualitative - quantify - quantitative - rank - sequence - share - simultaneous - spectrum - static - stationary - subscript - trait - transfer - translucent - transparent - trend - valid - vary - yields
Formative Assessments	**Summative Assessments**
Resources	**Enrichment Strategies**
Integrations **ELA**: **Math**: **Social Studies**:	**Intervention Strategies**

Physical Science Course of Study

Topic: ***Thermal Energy***

Energy and Waves

Content Elaborations

Thermal Energy

In middle school, thermal energy is introduced as the energy of movement of the particles that make up matter. Processes of heat transfer, including conduction, convection, and radiation, are studied. In other sections of this course, the role of thermal energy during heating, cooling, and phase changes is explored conceptually and graphically. In this course, rates of thermal energy transfer and thermal equilibrium are introduced. Thermal conductivity depends on the rate at which thermal energy is transferred from one end of a material to another. Thermal conductors have a high rate of thermal energy transfer and thermal insulators have a slow rate of thermal energy transfer. The rate at which thermal radiation is absorbed or emitted by a system depends on its temperature, color, texture, and exposed surface area. All other things being equal, in a given amount of time, black rough surfaces absorb more thermal energy than smooth white surfaces. An object or system is continually absorbing and emitting thermal radiation. If the object or system absorbs more thermal energy than it emits and there is no change in phase, the temperature increases. If the object or system emits more thermal energy than is absorbed and there is no change in phase, the temperature decreases. For an object or system in thermal equilibrium, the amount of thermal energy absorbed is equal to the amount of thermal energy emitted; therefore, the temperature remains constant. In chemistry, changes in thermal energy are quantified for substances that change their temperature.

Learning Targets	Honors Learning Targets	STEM Learning Targets
Thermal Energy		
• Describe the processes of heat transfer including convection, conduction, and radiation. • Explain why different materials have different thermal conductivities.	• Calculate and quantify the specific heats of various materials.	• Calculate a material's conductivity, resistance, and energy transfer. • Design a system that reduces or increases thermal conductivity.

Additional Resources

Pacing:

Content Vocabulary

- absorb
- albedo
- color
- conduction
- convection
- emit
- surface area
- temperature
- texture
- thermal conductivity
- thermal conductors
- thermal energy transfer

Academic Vocabulary

- absorption
- abundant
- acronym
- analogy
- analyze
- apply
- inversely proportional
- key
- label
- lack
- magnitude
- manipulate

Physical Science Course of Study

- heat - phase change - radiation - thermal equilibrium - thermal insulation	- approximate - average - balanced - calculate - characteristic - clarify - classify - coefficient - compare - comprised - continuum - contract - correlate - criteria - directly proportional - displacement - distinguish - dynamic - emission - emit - equals - estimate - evaluate - evidence - example - expand - expansion - explain - fate - graph - hypothesize - imply - infer - interact - interpret - mean - measure - observe - opaque - opinion - pattern - per - phenomenon - plausible - position - postulate - predict - procedure - produce - proportional - propose - qualitative - quantify - quantitative - rank - sequence - share - simultaneous - spectrum - static - stationary - subscript - trait - transfer - translucent - transparent - trend - valid - vary - yields

Physical Science Course of Study

Formative Assessments	Summative Assessments
Resources	**Enrichment Strategies**
Integrations • ELA: • Math: • Social Studies:	**Intervention Strategies**

Topic: ***Electricity***

Energy and Waves

Content Elaborations

Electricity

In earlier grades, these concepts were introduced: electrical conductors and insulators and a complete loop is needed for an electrical circuit that may be parallel or in a series. In this course, circuits are explained by the flow of electrons, and current, voltage, and resistance are introduced conceptually to explain what was observed in middle school. The differences between electrical conductors and insulators can be explained by how freely the electrons flow throughout the material due to how firmly electrons are held by the nucleus.

By convention, electric current is the rate at which positive charge flows in a circuit. In reality, it is the negatively charged electrons that are actually moving. Current is measured in amperes (A), which is equal to one coulomb of charge per second (C/s). In an electric circuit, the power source supplies the electrons already in the circuit with electric potential energy by doing work to separate opposite charges. For a battery, the energy is provided by a chemical reaction that separates charges on the positive and negative sides of the battery. This separation of charge is what causes the electrons to flow in the circuit. These electrons then transfer energy to other objects and transform electrical energy into other forms (e.g., light, sound, heat) in the resistors. Current continues to flow, even after the electrons transfer their energy. Resistors oppose the rate of charge flow in the circuit. The potential difference or voltage across an energy source is a measure of potential energy in Joules supplied to each coulomb of charge. The volt (V) is the unit of potential difference and is equal to one Joule of energy per coulomb of charge (J/C). Potential difference across the circuit is a property of the energy source and does not depend upon the devices in the circuit. These concepts can be used to explain why current will increase as the potential difference increases and as the resistance decreases. Experiments, investigations, and testing (3-D or virtual) must be used to construct a variety of circuits and measure and compare the potential difference (voltage) and current. Electricity concepts are dealt with conceptually in this course. Calculations with circuits will be addressed in the physics syllabus.

Learning Targets	Honors Learning Targets	STEM Learning Targets
Electricity		
• Relate the flow of electrons through conductors and insulators and the concepts of current, voltage, and resistance. • Distinguish between conductors and insulators. • Explain the two models of electric current in terms of charge and direction of flow. • Identify the SI unit for current as amperes (A). • Understand that the ampere (A) is equal to one	• Calculate the relationship between voltage, current, and resistance.	• Calculate the relationship between voltage, current, and resistance in both parallel and series circuits. • Apply Kirchhoff's rules to simple circuits.

coulomb of charge per second (C/s). • Describe how power sources, including batteries, are sources of voltage. • Define and understand the relationships between resistance, current, and voltage. • Understand that the volt (V) is the unit of potential difference and is equal to one Joule of energy per coulomb of charge (J/C). • Demonstrate how a variety of circuits are constructed as well as measure and compare the potential difference (voltage) and current.		

Additional Resources

Pacing:

Content Vocabulary

- amperes (amps)
- cell
- circuit
- circuit breaker
- conductor
- coulomb
- current
- electric charge
- electric field
- electrical potential energy
- electron flow
- fuse
- insulator
- joules
- parallel circuit
- potential difference
- resistance
- resistor
- schematic diagram
- series circuit
- volt
- voltage

Academic Vocabulary

- absorption
- abundant
- acronym
- analogy
- analyze
- apply
- approximate
- average
- balanced
- calculate
- characteristic
- clarify
- classify
- coefficient
- compare
- comprised
- continuum
- contract
- correlate
- criteria
- inversely proportional
- key
- label
- lack
- magnitude
- manipulate
- mean
- measure
- observe
- opaque
- opinion
- pattern
- per
- phenomenon
- plausible
- position
- postulate
- predict
- procedure
- produce

Physical Science Course of Study

	• directly proportional • displacement • distinguish • dynamic • emission • emit • equals • estimate • evaluate • evidence • example • expand • expansion • explain • fate • graph • hypothesize • imply • infer • interact • interpret • proportional • propose • qualitative • quantify • quantitative • rank • sequence • share • simultaneous • spectrum • static • stationary • subscript • trait • transfer • translucent • transparent • trend • valid • vary • yields
Formative Assessments	**Summative Assessments**
Resources	**Enrichment Strategies**
Integrations • **ELA**: • **Math**: • **Social Studies**:	**Intervention Strategies**

Physical Science Course of Study

Topic: ***Motion***

Forces and Motion

Content Elaborations

Forces and Motion

Building upon content in elementary and middle school, major concepts of motion and forces are further developed. In middle school, speed has been dealt with conceptually, mathematically, and graphically. The concept that forces have both magnitude and direction can be represented with a force diagram, that forces can be added to find a net force, and that forces may affect motion has been addressed in middle school. At the high school level, mathematics (including graphing) is used when describing these phenomena, moving from qualitative understanding to one that is more quantitative. For the physical science course, all motion is limited to objects moving in a straight line either horizontally, vertically, up an incline, or down an incline that can be characterized in a single step (e.g., at rest, constant velocity, constant acceleration). Motions of two objects may be compared or addressed simultaneously (e.g., when or where would they meet).

Motion

The motion of an object depends on the observer's frame of reference and is described in terms of distance, position, displacement, speed, velocity, acceleration, and time. Position, displacement, velocity, and acceleration are all vector properties (magnitude and direction). All motion is relative to whatever frame of reference is chosen, for there is no motionless frame from which to judge all motion. The relative nature of motion will be addressed conceptually, not mathematically. Non-inertial reference frames are excluded. Motion diagrams can be drawn and interpreted to represent the position and velocity of an object. Showing the acceleration on motion diagrams will be reserved for physics.

The displacement or change in position of an object is a vector quantity that can be calculated by subtracting the initial position from the final position ($\Delta x = x_f - x_i$). Displacement can be positive or negative depending upon the direction of motion. Displacement is not always equal to the distance traveled. Examples should be given where the distance is not the same as the displacement. Velocity is a vector property that represents the rate at which position changes. Average velocity can be calculated by dividing displacement (change in position) by the elapsed time ($v_{avg} = (x_f-x_i)/(t_f-t_i)$). Velocity may be positive or negative depending upon the direction of motion and is not always equal to the speed. Provide examples of when the average speed is not the same as the average velocity. Objects that move with constant velocity have the same displacement for each successive time interval. While speeding up or slowing down and/or changing direction, the velocity of an object changes continuously, from instant to instant. The speed of an object at any instant (clock reading) is called instantaneous speed. An object may not travel at this instantaneous speed for any period of time or cover any distance with that particular speed, especially if the speed is continually changing.

Acceleration is a vector property that represents the rate at which velocity changes. Average acceleration can be calculated by dividing the change in velocity divided by elapsed time ($a_{avg} = (v_f - v_i)(t_f-t_i)$). At this grade level, it should be noted that acceleration can be positive or negative, but specifics about what kind of motions produce positive or negative accelerations will be addressed in the physics syllabus. The word "deceleration" should not be used because students tend to associate a negative sign of acceleration only with slowing down. Objects that have no acceleration can either be standing still or be moving with constant velocity (speed and direction). Constant acceleration occurs when the change in an object's instantaneous velocity is the same for equal successive time intervals.

Motion can be represented by position vs. time and velocity vs. time graphs. Specifics about the speed, direction, and change in motion can be determined by interpreting such graphs. For physical science, graphs will be limited to positive x-values and show only uniform motion involving constant velocity or constant acceleration. Motion must be investigated by collecting and analyzing data in the laboratory. Technology can enhance motion exploration and investigation through video analysis, the use of motion detectors, and graphing data for analysis.

Objects that move with constant velocity and have no acceleration form a straight line (not necessarily horizontal) on a position vs. time graph. Objects that are at rest will form a straight horizontal line on a position vs. time graph. Objects that are accelerating will show a curved line on a position vs. time graph. Velocity can be calculated by determining the slope of a position vs. time graph. Positive slopes on position vs. time graphs indicate motion in a positive direction. Negative slopes on position vs. time graphs indicate motion in a negative direction. While it is important that students can construct graphs by hand, computer graphing programs or graphing calculators also can be used so more time can be spent on graph interpretation and analysis.

Constant acceleration is represented by a straight line (not necessarily horizontal) on a velocity vs. time graph. Objects that have no acceleration (at rest or moving at constant velocity) will have a straight horizontal line for a velocity vs. time graph. Average acceleration can be determined by the slope of a velocity vs. time graph. The details about motion graphs should not be taught as rules to memorize but rather as generalizations that can be developed from interpreting the graphs.

Learning Targets	Honors Learning Targets	STEM Learning Targets
Motion		
• Use frame of reference to describe when an object is in motion. • Differentiate between displacement and distance. • Differentiate between speed, velocity (constant, average, and instantaneous), and acceleration. • Construct position vs. time and velocity vs. time graphs. • Interpret position vs. time and velocity vs. time graphs. • Given any position vs. time or velocity vs. time graph, predict the appearance of the other graph (e.g., if a student has a position vs. time	• Construct acceleration vs. time graphs. • Interpret acceleration vs. time graphs. • Given any position vs. time, velocity vs. time, or acceleration vs. time graph, predict the appearance of the other two (e.g., if a student has a position vs. time graph, the student will predict the appearance of the velocity vs. time and acceleration vs. time graph).	• Same as standard level.

graph, the student will predict the appearance of the velocity vs. time graph). • Identify the SI units for speed, velocity, acceleration, distance, displacement, and time.		

Additional Resources

Pacing:

Content Vocabulary

- acceleration
- average acceleration formula [$a_{avg} = v_f - v_i) / (t_f - t_i)$]
- average speed
- average velocity
- average velocity formula [$v_{avg} = (x_f - x_i) / (t_f - t_i)$]
- constant acceleration
- constant velocity
- direction
- displacement
- displacement formula ($\Delta x = x_f - x_i$)
- distance
- distance-time graph
- force
- force diagram
- frame of reference
- instantaneous speed
- magnitude
- motion
- motion diagram
- negative acceleration
- objects at rest
- position
- position-time graph
- positive acceleration
- slope
- speed
- straight-line motion
- time
- vector property
- velocity
- velocity-time graph

Academic Vocabulary

- absorption
- abundant
- acronym
- analogy
- analyze
- apply
- approximate
- average
- balanced
- calculate
- characteristic
- clarify
- classify
- coefficient
- compare
- comprised
- continuum
- contract
- correlate
- criteria
- directly proportional
- displacement
- distinguish
- dynamic
- emission
- emit
- equals
- estimate
- inversely proportional
- key
- label
- lack
- magnitude
- manipulate
- mean
- measure
- observe
- opaque
- opinion
- pattern
- per
- phenomenon
- plausible
- position
- postulate
- predict
- procedure
- produce
- proportional
- propose
- qualitative
- quantify
- quantitative
- rank
- sequence
- share

Physical Science Course of Study

	• evaluate • evidence • example • expand • expansion • explain • fate • graph • hypothesize • imply • infer • interact • interpret • simultaneous • spectrum • static • stationary • subscript • trait • transfer • translucent • transparent • trend • valid • vary • yields
Formative Assessments	**Summative Assessments**
Resources	**Enrichment Strategies**
Integrations • **ELA**: • **Math**: • **Social Studies**:	**Intervention Strategies**

Physical Science Course of Study

Topic:	***Forces*** Forces and Motion

Content Elaborations

Forces

Force is a vector quantity, having both magnitude and direction. The (SI) unit of force is a Newton. One Newton of net force will cause a 1 kg object to experience an acceleration of 1 m/s^2. A Newton also can be represented as kg·m/s2. The opportunity to measure force in the lab must be provided (e.g., with a spring scale or a force probe). Normal forces and tension forces are introduced conceptually at this level. These forces and other forces are introduced in prior grades (friction, drag, contact, gravitational, electric, and magnetic) and can be used as examples of forces that affect motion. Gravitational force (weight) can be calculated from mass, but all other forces will only be quantified from force diagrams that were introduced in middle school. In physical science, only forces in one dimension (positive and negative) will be addressed. The net force can be determined by one-dimensional vector addition. More quantitative study of friction forces, universal gravitational forces, elastic forces, and electrical forces will be addressed in the physics syllabus.

Friction is a force that opposes sliding between two surfaces. For surfaces that are sliding relative to each other, the force on an object always points in a direction opposite to the relative motion of the object. In physical science, friction will only be calculated from force diagrams. Equations for static and kinetic friction are found in the physics syllabus.

A normal force exists between two solid objects when their surfaces are pressed together due to other forces acting on one or both objects (e.g., a solid sitting on or sliding across a table, a magnet attached to a refrigerator). A normal force is always a push directed at right angles from the surfaces of the interacting objects. A tension force occurs when a non-slack rope, wire, cord, or similar device pulls on another object. The tension force always points in the direction of the pull.

In middle school, the concept of a field as a region of that space that surrounds objects with the appropriate property (mass for gravitational fields, charge for electric fields, a magnetic object for magnetic fields) was introduced to explain gravitational, magnetic, and electrical forces that occur over a distance. The field concept is further developed in physical science. The stronger the field, the greater the force exerted on objects placed in the field. The field of an object is always there, even if the object is not interacting with anything else. The gravitational force (weight) of an object is proportional to its mass. Weight, F_g can be calculated from the equation $F_g = m\,g$, where g is the gravitational field strength of an object which is equal to 9.8 N/kg (m/s^2) on the surface of Earth.

Learning Targets	Honors Learning Targets	STEM Learning Targets
Forces		
• Compare the different types of forces including gravity, friction, normal, tension. • Construct and interpret force (free body)	• Create free body diagrams with scale vectors.	• Create free body diagrams with scale vectors in two dimensions. • Compare tensile and shearing forces.

diagrams in single dimensions. • Explain the field model for forces at a distance.		

Additional Resources

Pacing:

Content Vocabulary

- field
- formula for weight ($F_g = m \cdot g$)
- friction
- $g = 9.8$ N/kg (m/s^2)
- gravitational force
- $kg \cdot m/s^2$
- net force
- Newton
- normal force
- tension force
- weight

Academic Vocabulary

- absorption
- abundant
- acronym
- analogy
- analyze
- apply
- approximate
- average
- balanced
- calculate
- characteristic
- clarify
- classify
- coefficient
- compare
- comprised
- continuum
- contract
- correlate
- criteria
- directly proportional
- displacement
- distinguish
- dynamic
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- phenomenon
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- postulate
- predict
- procedure
- produce
- proportional
- propose
- qualitative
- quantify
- quantitative
- rank
- sequence
- share
- simultaneous
- spectrum

Physical Science Course of Study

	- example - expand - expansion - explain - fate - graph - hypothesize - imply - infer - interact - interpret - static - stationary - subscript - trait - transfer - translucent - transparent - trend - valid - vary - yields
Formative Assessments	**Summative Assessments**
Resources	**Enrichment Strategies**
Integrations **ELA**: **Math**: **Social Studies**:	**Intervention Strategies**

Physical Science Course of Study

Topic: ***Dynamics***

Forces and Motion

Content Elaborations

Dynamics

An object does not accelerate (remains at rest or maintains a constant speed and direction of motion) unless an unbalanced net force acts on it. The rate at which an object changes its speed or direction (acceleration) is proportional to the vector sum of the applied forces (net force, F_{net}) and inversely proportional to the mass ($a = F_{net}/m$). When the vector sum of the forces (net force) acting on an object is zero, the object does not accelerate. For an object that is moving, this means the object will remain moving without changing its speed or direction. For an object that is not moving, the object will continue to remain stationary. These laws will be applied to systems consisting of a single object upon which multiple forces act. Vector addition will be limited to one dimension. While both horizontal and vertical forces can be acting on an object simultaneously, one of the dimensions must have a net force of zero.

A force is an interaction between two objects. Both objects in the interaction experience an equal amount of force but in opposite directions. Interacting force pairs are often confused with balanced forces. Interacting force pairs can never cancel each other out because they always act on different objects. Naming the force (e.g., gravity, friction) does not identify the two objects involved in the interacting force pair. Objects involved in an interacting force pair can be easily identified by using the format "A acts on B so B acts on A." For example, the truck hits the sign therefore the sign hits the truck with an equal force in the opposite direction. Earth pulls the book down so the book pulls Earth up with an equal force. The focus of the content is to develop a conceptual understanding of the laws of motion to explain and predict changes in motion, not to name or recite a memorized definition. In the physics syllabus, all laws will be applied to systems of many objects.

Learning Targets	Honors Learning Targets	STEM Learning Targets
Dynamics		
• Show how forces affect motion. • Distinguish between balanced and unbalanced forces and their effect on the motion of an object. • Evaluate forces with regard to objects at rest, objects moving with constant velocity, and objects that are accelerating.	• Add vectors in single dimensions.	• Construct free body diagrams that show all forces acting upon the object and the sum of all the forces/vectors. • Calculate x and y components of a given vector.
Additional Resources		
Pacing:		

Physical Science Course of Study

Content Vocabulary	Academic Vocabulary	
• balanced forces • force diagram • horizontal force • inertia • interacting force pair • momentum • unbalanced forces • vector • vector sum of applied forces • vertical force	• absorption • abundant • acronym • analogy • analyze • apply • approximate • average • balanced • calculate • characteristic • clarify • classify • coefficient • compare • comprised • continuum • contract • correlate • criteria • directly proportional • displacement • distinguish • dynamic • emission • emit • equals • estimate • evaluate • evidence • example • expand • expansion • explain • fate • graph	• inversely proportional • key • label • lack • magnitude • manipulate • mean • measure • observe • opaque • opinion • pattern • per • phenomenon • plausible • position • postulate • predict • procedure • produce • proportional • propose • qualitative • quantify • quantitative • rank • sequence • share • simultaneous • spectrum • static • stationary • subscript • trait • transfer • translucent

Physical Science Course of Study

	• hypothesize • imply • infer • interact • interpret • transparent • trend • valid • vary • yields
Formative Assessments	**Summative Assessments**
Resources	**Enrichment Strategies**
Integrations • **ELA**: • **Math**: • **Social Studies**:	**Intervention Strategies**

Physical Science Course of Study

Topic: ***History of the Universe***

The Universe

Content Elaborations

The Universe

In early elementary school, observations of the sky and space are the foundation for developing a deeper knowledge of the solar system. In late elementary school, the parts of the solar system are introduced, including characteristics of the sun and planets, orbits, and celestial bodies. At the middle school level, energy, waves, gravity, and density are emphasized in the physical sciences, and characteristics and patterns within the solar system are found.

In the physical science course, the universe and galaxies are introduced, building upon the previous knowledge about space and the solar system in the earlier grades.

History of the Universe

The Big Bang Model is a broadly accepted theory for the origin and evolution of our universe. It postulates that 12 to 14 billion years ago, the portion of the universe seen today was only a few millimeters across (NASA).

According to the "big bang" theory, the contents of the known universe expanded explosively into existence from a hot, dense state 13.7 billion years ago (NAEP, 2009). After the big bang, the universe expanded quickly (and continues to expand) and then cooled down enough for atoms to form. Gravity pulled the atoms together into gas clouds that eventually became stars, which comprise young galaxies. Foundations for the big bang model can be included to introduce the supporting evidence for the expansion of the known universe (e.g., Hubble's law and red shift or cosmic microwave background radiation). A discussion of Hubble's law and red shift is found in the Galaxy formation section below.

Technology provides the basis for many new discoveries related to space and the universe. Visual, radio, and x-ray telescopes collect information from across the entire electromagnetic spectrum; computers are used to manage data and complicated computations; space probes send back data and materials from remote parts of the solar system; and accelerators provide subatomic particle energies that simulate conditions in the stars and in the early history of the universe before stars formed.

Learning Targets	Honors Learning Targets	STEM Learning Targets
History of the Universe		
• Summarize the key components of the Big Bang Model. • Provide examples of how technology has refined our understanding of the history of the universe.	• Use Hubble's Law to calculate the age of the universe.	• Same as standard level.

Physical Science Course of Study

Additional Resources

Pacing:

Content Vocabulary

- Big Bang Theory
- cosmic microwave background radiation
- galaxy
- light telescope
- particle accelerator
- radio telescope
- space probes
- universe
- x-ray telescope

Academic Vocabulary

- absorption
- abundant
- acronym
- analogy
- analyze
- apply
- approximate
- average
- balanced
- calculate
- characteristic
- clarify
- classify
- coefficient
- compare
- comprised
- continuum
- contract
- correlate
- criteria
- directly proportional
- displacement
- distinguish
- dynamic
- emission
- emit
- equals
- estimate
- evaluate
- evidence
- example
- expand
- expansion
- inversely proportional
- key
- label
- lack
- magnitude
- manipulate
- mean
- measure
- observe
- opaque
- opinion
- pattern
- per
- phenomenon
- plausible
- position
- postulate
- predict
- procedure
- produce
- proportional
- propose
- qualitative
- quantify
- quantitative
- rank
- sequence
- share
- simultaneous
- spectrum
- static
- stationary
- subscript

Physical Science Course of Study

	• explain • fate • graph • hypothesize • imply • infer • interact • interpret • trait • transfer • translucent • transparent • trend • valid • vary • yields
Formative Assessments	**Summative Assessments**
Resources	**Enrichment Strategies**
Integrations • **ELA**: • **Math**: • **Social Studies**:	**Intervention Strategies**

Physical Science Course of Study

Topic: ***Galaxy Formation***

The Universe

Content Elaborations

Galaxy Formation

A galaxy is a group of billions of individual stars, star systems, star clusters, dust, and gas bound together by gravity. There are billions of galaxies in the universe, and they are classified by size and shape. The Milky Way is a spiral galaxy. It has more than 100 billion stars and a diameter of more than 100,000 light years. At the center of the Milky Way is a bulge of stars, from which are spiral arms of gas, dust, and most of the young stars. The solar system is part of the Milky Way galaxy.

Hubble's law states that galaxies that are farther away have a greater red shift, so the speed at which a galaxy is moving away is proportional to its distance from the Earth. Red shift is a phenomenon due to Doppler shifting, so the shift of light from a galaxy to the red end of the spectrum indicates that the galaxy and the observer are moving farther away from one another. Doppler shifting also is found in the Energy and Waves section of this course.

Learning Targets	Honors Learning Targets	STEM Learning Targets
Galaxy Formation		
• Explain how galaxies form. • Differentiate between the different types of galaxies (spiral, elliptical, irregular) and classify the Milky Way. • Use the concept of red shift to predict the outcome for our universe.	• Calculate the apparent change in frequency due to the Doppler Effect.	• Same as standard level.

Additional Resources

Pacing:

Content Vocabulary

- blue shift
- cluster
- Doppler Effect
- elliptical galaxy
- galaxy
- gravity
- Hubble's Law

Academic Vocabulary

- absorption
- abundant
- acronym
- analogy
- analyze
- apply
- approximate
- inversely proportional
- key
- label
- lack
- magnitude
- manipulate
- mean

• interstellar • irregular galaxy • Milky Way • nebula • quasar • red shift • spiral galaxy • star • star system	• average • balanced • calculate • characteristic • clarify • classify • coefficient • compare • comprised • continuum • contract • correlate • criteria • directly proportional • displacement • distinguish • dynamic • emission • emit • equals • estimate • evaluate • evidence • example • expand • expansion • explain • fate • graph • hypothesize • imply • infer • interact • interpret • measure • observe • opaque • opinion • pattern • per • phenomenon • plausible • position • postulate • predict • procedure • produce • proportional • propose • qualitative • quantify • quantitative • rank • sequence • share • simultaneous • spectrum • static • stationary • subscript • trait • transfer • translucent • transparent • trend • valid • vary • yields
Formative Assessments	**Summative Assessments**

Physical Science Course of Study

Resources	Enrichment Strategies
Integrations • **ELA**: • **Math**: • **Social Studies**:	**Intervention Strategies**

Physical Science Course of Study

Topic: ***Stars***

The Universe

Content Elaborations

Stars

Early in the formation of the universe, stars coalesced out of clouds of hydrogen and helium and clumped together by gravitational attraction into galaxies. When heated to a sufficiently high temperature by gravitational attraction, stars begin nuclear reactions, which convert matter to energy and fuse the lighter elements into heavier ones. These and other fusion processes in stars have led to the formation of all the other elements (NAEP, 2009). All of the elements, except hydrogen and helium, originated from the nuclear fusion reactions of stars (College Board Standards for College Success, 2009).

Stars are classified by their color, size, luminosity, and mass. A Hertzsprung-Russell diagram must be used to estimate the sizes of stars and predict how stars will evolve. Most stars fall on the main sequence of the H-R diagram, a diagonal band running from the bright hot stars on the upper left to the dim cool stars on the lower right. A star's mass determines the star's place on the main sequence and how long it will stay there. Patterns of stellar evolution are based on the mass of the star. Stars begin to collapse as the core energy dissipates. Nuclear reactions outside the core cause expansion of the star, eventually leading to the collapse of the star.

Note: Names of stars and naming the evolutionary stage of a star from memory will not be assessed. The emphasis is on the interpretation of data (using diagrams and charts) and the criteria and processes needed to make those determinations.

Learning Targets	Honors Learning Targets	STEM Learning Targets
Stars		
• Explain the formation and stages of the evolution of stars. • Use a Hertzsprung-Russell diagram to classify stars. • Use a star's characteristics to predict how it will evolve. • Illustrate how the process of nuclear fusion in stars leads to the formation of heavier elements up to iron.	• Describe the relationships between the following star characteristics: size, temperature, brightness, color, absolute magnitude, apparent brightness, and distance.	• Same as standard level.

Physical Science Course of Study

Additional Resources

Pacing:

Content Vocabulary

- apparent brightness
- black hole
- gravitational attraction
- Hertzsprung-Russell diagram
- light year
- luminosity
- main sequence
- nebula
- neutron star
- nuclear fusion
- protostar
- red giant
- stellar life cycle
- supergiant
- supernova
- white dwarf

Academic Vocabulary

- absorption
- abundant
- acronym
- analogy
- analyze
- apply
- approximate
- average
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- calculate
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Physical Science Course of Study

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