

**Correlation to Massachusetts Science and Technology Curriculum Framework
 Foundations of Physical Science with Earth and Space Science
 Student Text and Investigation Manual**

| Standard #: Strand | Grade | Topic | Learning Standard | student text pg | detail | investigation pg | detail |
|---|--------------|-------------------------|--|----------------------------|---|-----------------------------|---|
| CHM.01.01 Physical Sciences /Chemistry | High School | Properties of Matter | Identify and explain some of the physical properties that are used to classify matter, e.g., density, melting point, and boiling point. | 278 | mixtures can be separated by physical means | 114 | separating a homogeneous mixture |
| | | | | 284 | melting and boiling points | 119 | melting point of ice |
| | | | | 284 | melting and boiling point explained | 124 | build a density column |
| | | | | 285 | table of melting and boiling points | 212 | investigate density changes in the oceans as the cause of ocean layering |
| | | | | 291 | density explained | | |
| | | | | 291 | density is independent of amount of substance | | |
| | | | | 292 | hardness is a physical property of matter | | |
| | | | | 292 | elasticity is a physical property of matter | | |
| | | | | 293 | brittleness is a physical property of matter | | |
| | | | | 294 | malleability is a physical property of matter | | |
| | | | | 294 | tensile strength is a physical property of matter | | |
| | | | | 294 | development of Kevlar brand fiber | | |
| | | | | 296 | density of liquid water vs. ice | | |
| | | | | 297 | buoyancy explained | | |
| | | | | 298 | sinking and floating | | |
| | | | | 302 | viscosity of motor oils | | |

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| | | | | 305 | viscosity of glue mixtures | | |
| | | | | 407 | solute and solvent defined | | |
| | | | | 407 | definitions of solution and solute and solvent | | |
| | | | | 415 | saturated and supersaturated solutions | | |
| | | | | 457 | engineers use specific heat of substances to design better products | | |
| CHM.01.02 Physical Sciences /Chemistry | High School | Properties of Matter | Explain the difference between mixtures and pure substances. | 278 | compounds are composed of elements | 114 | investigating a mixture |
| | | | | 278 | pure substances cannot be separated by physical means | 114 | separating a homogeneous mixture |
| | | | | 278 | mixtures can be separated by physical means | 114 | investigate a homogeneous mixture |
| | | | | 279 | summary of matter classification | 140 | why do atoms form chemical bonds? |
| | | | | 283 | atoms and molecules | 141 | compare and contrast elements and compounds |
| | | | | 288 | create a poster of matter classification | 142 | why do atoms combine in certain ratios? |
| | | | | 407 | solutions are mixtures | 169 | investigate solutions and colloids and suspensions |
| | | | | 408 | colloids and suspensions | | |
| | | | | 426 | mixtures and emulsifying agents | | |

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| CHM.01.03 Physical Sciences /Chemistry | High School | Properties of Matter | Describe the four states of matter (solid, liquid, gas, plasma) in terms of energy, particle motion, and phase transitions. | 284 | states of matter and arrangement of molecules | 118 | observe melting process and study quantitatively |
| | | | | 284 | changes of state | 118 | investigate melting |
| | | | | 285 | characteristics of matter related to its state | 118 | molecules in a liquid |
| | | | | 405 | molecular structure of ice | 119 | investigate melting and create a graph |
| | | | | 406 | hydrogen bonding and the gaseous state of water | 119 | create a temperature vs. time graph of phase change |
| | | | | 498 | phases changes in the atmosphere | 119 | energy and phase changes |
| | | | | | | 203 | investigate the temperature/time curves as water is cooled through a phase change to ice |
| CHM.01.04 Physical Sciences /Chemistry | High School | Properties of Matter | Distinguish between chemical and physical changes. | 353 | physical and chemical changes and digestion | 146 | investigate and observe chemical and physical changes in the lab |
| | | | | 355 | physical and chemical changes in tire recycling | | |
| | | | | 372 | determine if changes are chemical or physical | | |

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| CHM.02.01 Physical Sciences /Chemistry | High School | Atomic Structure | Trace the development of atomic theory and the structure of the atom from the ancient Greeks to the present (Dalton, Thompson, Rutherford, Bohr, and modern theory). | 311 | protons/neutrons/electrons | 130 | investigate Rutherford's gold foil experiment |
| | | | | 311 | location/size/charge of subatomic particles | 132 | atomic number determines what element that atom is |
| | | | | 312 | contributions of Fermi | | |
| | | | | 313 | development of atomic theory | 132 | building atom models |
| | | | | 315 | atoms of same element have same atomic number | 133 | protons and neutrons |
| | | | | | | 133 | location of electrons in atom |
| | | | | 318 | proton/electron attraction | 136 | model stable and neutral atoms |
| | | | | 324 | research and create a poster to illustrate development of atomic model | 137 | importance of atomic number |
| | | | | 388 | showing valence electrons in a diagram | 137 | build atomic models |
| | | | | 393 | contributions of Marie and Pierre Curie | 140 | find the number of electrons in outermost level |
| | | | | | | 140 | review subatomic particles |

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| CHM.02.03 Physical Sciences /Chemistry | High School | Atomic Structure | Identify the major components of the nuclear atom (protons, neutrons, and electrons) and explain how they interact. | 311 | protons/neutrons/electrons | 132 | atomic number determines what element that atom is |
| | | | | 311 | location/size/charge of subatomic particles | 132 | building atom models |
| | | | | 315 | atoms of same element have same atomic number | 133 | protons and neutrons |
| | | | | 318 | proton/electron attraction | 133 | location of electrons in atom |
| | | | | 324 | use the periodic table to predict chemical formulas | 136 | model stable and neutral atoms |
| | | | | 324 | which element is more likely to combine with other elements? | 137 | importance of atomic number |
| | | | | 335 | chemical bonding and the periodic table | 137 | build atomic models |
| | | | | 388 | showing valence electrons in a diagram | 140 | find the number of electrons in outermost level |
| | | | | | | 140 | review subatomic particles |
| | | | | | | 141 | modeling a chemical bond |
| CHM.02.04 Physical Sciences /Chemistry | High School | Atomic Structure | Understand that matter has properties of both particles and waves. | 195 | waves transmit energy | 132 | comparing atoms |
| | | | | 311 | all matter is formed from atoms | | |
| | | | | 311 | all matter is formed from atoms | | |
| | | | | 480 | energy and radiation relationships | | |
| | | | | 626 | the sun's energy reaches Earth in the form of electromagnetic waves | | |

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| CHM.02.06 Physical Sciences /Chemistry | High School | Atomic Structure | Describe the electromagnetic spectrum in terms of wavelength and energy; identify regions of the electromagnetic spectrum. | 196 237 237 237 237 250 272 479 | waves are all around us visible light and the electromagnetic spectrum light waves and the electromagnetic spectrum radio and television signals microwave ovens identify uses of electromagnetic waves identify uses of electromagnetic waves ultraviolet and infrared light | 134 | investigating visible light with a spectrometer |
| CHM.02.08 Physical Sciences /Chemistry | High School | Atomic Structure | Describe alpha, beta, and gamma particles; discuss the properties of alpha, beta, and gamma radiation; and write balanced nuclear reactions. | 388 | nuclear vs chemical reactions | 138 160 160 | nuclear reactions radioactive decay how do you simulate nuclear decay? |
| CHM.02.09 Physical Sciences /Chemistry | High School | Atomic Structure | Compare nuclear fission and nuclear fusion and mass defect. | 387 623 | fusion and fission explained nuclear fusion and the sun | 138 | fusion and fission |

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| CHM.02.10 Physical Sciences /Chemistry | High School | Atomic Structure | Describe the process of radioactive decay as the spontaneous breakdown of certain unstable elements (radioactive) into new elements (radioactive or not) through the spontaneous emission by the nucleus of alpha or beta particles. | 387 623 | fusion and fission explained nuclear fusion and the sun | 138 160 | fusion and fission radioactive decay |
| CHM.03.01 Physical Sciences /Chemistry | High School | Periodicity | Explain the relationship of an element's position on the periodic table to its atomic number and mass. | 315 316 321 322 322 322 322 | atomic number discussed mass number discussed studying the periodic table atomic number on the periodic table chemical symbols and element names atomic mass on the periodic table mass number on the periodic table | 133 133 133 136 136 136 | identify atomic number identify mass number identify element symbol and name building and studying the periodic table mass number atomic number |

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| CHM.03.02 Physical Sciences /Chemistry | High School | Periodicity | Use the periodic table to identify metals, nonmetals, metalloids, families (groups), periods, valence electrons, and reactivity with other elements in the table. | 320 321 332 | groups of elements studying the periodic table metals nonmetals and metalloids | 133 136 | using the periodic table building and studying the periodic table |
| CHM.03.04 Physical Sciences /Chemistry | High School | Periodicity | Identify trends on the periodic table (ionization energy, electronegativity, electron affinity, and relative size of atoms and ions). | 321 321 329 330 332 335 | studying the periodic table groups of elements and valence shells periodic table columns and valence electrons bonding and periodic table position periodic table and electronegativities periodic table and oxidation numbers | 136 141 142 | building and studying the periodic table build model of Na and Cl atoms and explain why they bond to form a molecule arrangement of electrons and groups of elements |

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| CHM.04.01 Physical Sciences /Chemistry | High School | Chemical Bonding | Explain how atoms combine to form compounds through both ionic and covalent bonding. | 324 | use the periodic table to predict chemical formulas | 141 | modeling a chemical bond |
| | | | | 324 | which element is more likely to combine with other elements? | 143 | classify ionic compounds |
| | | | | 330 | ionic bonds | 143 | ionic compounds |
| | | | | 331 | covalent bonds | | |
| | | | | 332 | distinguishing between ionic and covalent bonds | | |
| | | | | 335 | chemical bonding and the periodic table | | |
| | | | | 404 | water is a polar molecule | | |
| | | | | 405 | hydrogen bonding in water | | |
| | | | | 406 | hydrogen bonding and properties of water | | |
| | | | | 409 | dissolving an ionic compound | | |
| 410 | solute dissolution depends on chemical bonds | | | | | | |
| CHM.04.02 Physical Sciences /Chemistry | High School | Chemical Bonding | Draw Lewis dot structures for simple molecules. | 330 | Lewis dot diagrams | | |

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| CHM.04.06 Physical Sciences /Chemistry | High School | Chemical Bonding | Predict chemical formulas based on the number of valence electrons. | 336 368 388 | writing chemical formulas predicting amount of product showing valence electrons in a diagram | 140 155 | find the number of electrons in outermost level calculating product yield |
| CHM.04.07 Physical Sciences /Chemistry | High School | Chemical Bonding | Name and write the chemical formulas for simple ionic and molecular compounds, including those that contain common polyatomic ions. | 336 338 339 344 349 419 | writing a chemical formula summary of chemical formula writing rules naming compounds calculating formula mass calculate the formula mass dissociation of water | 143 143 145 148 | predict chemical formulas name chemical compounds determine empirical formula chemical equations |
| CHM.05.01 Physical Sciences /Chemistry | High School | Chemical Reactions and Stoichiometry | Balance chemical equations by applying the law of conservation of mass. | 363 371 | history of law of conservation of mass which of the equations is balanced? | 149 150 | balance these equations investigate conservation of mass in effervescent tablet reaction |
| CHM.05.02 Physical Sciences /Chemistry | High School | Chemical Reactions and Stoichiometry | Recognize synthesis, decomposition, single displacement, double displacement, and neutralization reactions. | 375 376 377 377 | synthesis or addition reactions decomposition reactions single displacement reactions double displacement reactions | 156 | investigate double displacement reactions |

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| CHM.05.03 Physical Sciences /Chemistry | High School | Chemical Reactions and Stoichiometry | Understand the mole concept in terms of number of particles, mass, and gaseous volume. | 343 411 | what is a mole? explanation and examples of molarity calculations | | |
| CHM.05.04 Physical Sciences /Chemistry | High School | Chemical Reactions and Stoichiometry | Determine molar mass, percent compositions, empirical formulas, and molecular formulas. | 336 343 368 371 411 | writing chemical formulas what is a mole? predicting amount of product which of the equations is balanced? explanation and examples of molarity calculations | 149 155 | balance these equations calculating product yield |
| CHM.05.06 Physical Sciences /Chemistry | High School | Chemical Reactions and Stoichiometry | Calculate percent yield in a chemical reaction. | 336 364 368 | writing chemical formulas formation of petroleum is a very slow chemical reaction predicting amount of product | 155 156 | calculating product yield predict products in a double displacement reaction |

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| CHM.06.01 Physical Sciences /Chemistry | High School | Gases and Kinetic Molecular Theory | Using the kinetic molecular theory, explain the relationship between pressure and volume (Boyle's law), volume and temperature (Charles' law), and the number of particles in a gas sample (Avogadro's hypothesis). | 299 300 300 451 | Charles' law what is pressure? Boyle's law temperature is a measure of average kinetic energy | 194 196 | building a compression chamber to observe changes in atm pressure correcting your barometer's readings for the effects of temperature on a gas |
| CHM.06.02 Physical Sciences /Chemistry | High School | Gases and Kinetic Molecular Theory | Explain the relationship between temperature and average kinetic energy. | 451 | temperature is a measure of average kinetic energy | | |
| CHM.06.06 Physical Sciences /Chemistry | High School | Gases and Kinetic Molecular Theory | Use the combined gas law to determine changes in pressure, volume, or temperature. | 300 | what is pressure? | 194 196 | building a compression chamber to observe changes in atm pressure correcting your barometer's readings for the effects of temperature on a gas |

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| CHM.07.01 Physical Sciences /Chemistry | High School | Solutions | Describe the process by which solutes dissolve in solvents. | 407 | solute and solvent defined | 171 | what happened at the molecular level? |
| | | | | 407 | definitions of solution and solute and solvent | 171 | investigate the dissolving process |
| | | | | 409 | dissolution at the molecular level | | |
| | | | | 409 | dissolution of ionic compounds | | |
| | | | | 410 | dissolution of covalent compounds | | |
| | | | | 415 | saturated and supersaturated solutions | | |
| | | | | 417 | dissolution of acids in water | | |
| | | | | 418 | dissolution of bases in water | | |
| | | | | 419 | neutralization of acids and bases | | |

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| CHM.07.02 Physical Sciences /Chemistry | High School | Solutions | Identify and explain the factors that affect the rate of dissolving, i.e., temperature, concentration, and mixing. | 364 | formation of petroleum is a very slow chemical reaction | 156 | predict products in a double displacement reaction | | | | |
| | | | | 403 | why water is a nearly universal solvent | 170 | design experiments to explore dissolving rate | | | | |
| | | | | 409 | polar solutes | 170 | solubility and temperature | | | | |
| | | | | 412 | solubility value | 172 | investigate solubility of sugar | | | | |
| | | | | 412 | effect of nature of solvent on solubility | 175 | solubility and pressure | | | | |
| | | | | 412 | effect of temperature on solubility | 181 | water quality testing | | | | |
| | | | | 413 | temperature-solubility graphs | 181 | water quality testing | | | | |
| | | | | 414 | pressure and the solubility of gases | | | | | | |
| | | | | 414 | effect of pressure on solubility of gasses | | | | | | |
| | | | | 414 | effect of temperature on solubility of gasses | | | | | | |
| | | | | 416 | SCUBA diving and effects of pressure on gasses in the bloodstream | | | | | | |
| | | | | CHM.07.03 Physical Sciences /Chemistry | High School | Solutions | Describe the dynamic equilibrium that occurs in saturated solutions. | 51 | what is equilibrium? | | |
| | | | | | | | | 415 | solubility equilibrium | | |
| 415 | equilibrium and solubility | | | | | | | | | | |
| 460 | thermal equilibrium | | | | | | | | | | |

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| CHM.07.04 Physical Sciences /Chemistry | High School | Solutions | Calculate concentration in terms of molarity, molality, and percent by mass. | 409 | dissolution at the molecular level | 171 | what happened at the molecular level? |
| | | | | 409 | dissolution of ionic compounds | 171 | investigate the dissolving process |
| | | | | 410 | dissolution of covalent compounds | | |
| | | | | 417 | dissolution of acids in water | | |
| | | | | 418 | dissolution of bases in water | | |
| | | | | 419 | neutralization of acids and bases | | |
| CHM.07.05 Physical Sciences /Chemistry | High School | Solutions | Use a solubility curve to determine saturation values at different temperatures. | 412 | effect of nature of solvent on solubility | 170 | solubility and temperature |
| | | | | 412 | effect of temperature on solubility | 172 | investigate solubility of sugar |
| | | | | 413 | temperature-solubility graphs | | |
| | | | | 414 | effect of temperature on solubility of gasses | | |

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| CHM.08.01 Physical Sciences /Chemistry | High School | Acids and Bases | Define Arrhenius' theory of acids and bases in terms of the presence of hydronium and hydroxide ions, and Bronsted's theory of acids and bases in terms of proton donor and acceptor, and relate their concentrations to the pH scale. | 417 | H and OH ions | 176 | investigate acids and bases |
| | | | | 417 | properties of acids | 176 | measure pH of everyday solutions |
| | | | | 417 | acids and bases compared/contrasted | | |
| | | | | 417 | define and compare acids and bases | | |
| | | | | 418 | properties of bases | | |
| | | | | 418 | strong vs. weak acids | | |
| | | | | 418 | formulas and reactions of acids and bases | | |
| | | | | 419 | strong vs. weak bases | | |
| | | | | 419 | weak and strong acids and bases | | |
| | | | | 420 | concentration of hydronium ions determines pH and strength of acids and bases | | |
| | | | | 422 | pH and blood | | |
| | | | | 422 | examples of acid and base chemistry | | |
| | | | | 437 | concentration of ions and pH | | |
| | | | | 437 | pH of acid rain | | |

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| CHM.08.02 Physical Sciences /Chemistry | High School | Acids and Bases | Compare and contrast the nature, behavior, concentration and strength of acids and bases. a. Acid-base neutralization b. Degree of dissociation or ionization c. Electrical conductivity | 417 | acids and bases compared/contrasted | 176 | investigate acids and bases |
| | | | | 417 | define and compare acids and bases | 176 | measure pH of everyday solutions |
| | | | | 418 | strong vs. weak acids | | |
| | | | | 418 | formulas and reactions of acids and bases | | |
| | | | | 419 | strong vs. weak bases | | |
| | | | | 419 | weak and strong acids and bases | | |
| | | | | 420 | concentration of hydronium ions determines pH and strength of acids and bases | | |
| | | | | 422 | pH and blood | | |
| | | | | 422 | examples of acid and base chemistry | | |
| 437 | concentration of ions and pH | | | | | | |
| 437 | pH of acid rain | | | | | | |

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| CHM.08.06 Physical Sciences /Chemistry | High School | Acids and Bases | Calculate the pH or pOH of aqueous solutions using the hydronium or hydroxide ion concentration. | 418 | formulas and reactions of acids and bases | 176 | measure pH of everyday solutions |
| | | | | 420 | pH and pH scale | 181 | testing pH of tap water samples |
| | | | | 420 | defining and determining pH | 184 | determining pH of water as carbon dioxide dissolves |
| | | | | 420 | concentration of hydronium ions determines pH and strength of acids and bases | | |
| | | | | 421 | table of pH of common substances | | |
| | | | | 421 | pH of substances you use or consume | | |
| | | | | 422 | pH and blood | | |
| | | | | 422 | examples of acid and base chemistry | | |
| | | | | 437 | concentration of ions and pH | | |
| | | | | 437 | pH of acid rain | | |

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| CHM.10.01 Physical Sciences /Chemistry | High School | Thermochemistry (Enthalpy) | Interpret the law of conservation of energy. | 88 90 92 93 96 | potential and kinetic energy explained conservation of energy explained energy transformations and conservation different forms of energy described prove that energy is conserved | 37 38 | investigating conservation of energy with rollercoaster conservation of energy and energy transformations |
| ESS.01.01 Earth and Space Science | High School | Matter and Energy in the Earth System | Identify the earth's principal sources of internal and external energy, e.g., radioactive decay, gravity, solar energy. | 480 481 485 | distribution of incoming solar radiation Earth's "energy budget" Earth's internal energy | | |

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| ESS.01.02 Earth and Space Science | High School | Matter and Energy in the Earth System | Describe the components of the electromagnetic spectrum and give examples of its impact on our lives. | 196 237 237 237 237 250 272 479 | waves are all around us visible light and the electromagnetic spectrum radio and television signals microwave ovens light waves and the electromagnetic spectrum identify uses of electromagnetic waves identify uses of electromagnetic waves ultraviolet and infrared light | 134 | investigating visible light with a spectrometer |

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| ESS.01.03 Earth and Space Science | High School | Matter and Energy in the Earth System | Describe the characteristics of waves (wavelength, frequency, velocity, amplitude). | 179 | what is a cycle? | 83 | measure speed of a wave pulse |
| | | | | 182 | concept of frequency explained | 83 | find speed of a wave |
| | | | | 182 | concept of period explained | 86 | investigate frequency and wavelength |
| | | | | 192 | analyze systems to find cycle/period/frequency | 86 | adjust frequency of a standing wave |
| | | | | 198 | frequency and wavelength and amplitude | 90 | what is sound and how do we hear it? |
| | | | | 215 | properties of sound waves | 105 | explore relationship between color and wavelength |
| | | | | 219 | frequency of sound and pitch | | |
| | | | | 221 | importance of wavelength of sound waves | 265 | an element's spectral lines correspond to specific wavelengths of light |
| | | | | 242 | color and frequency of light waves | | |
| | | | | 242 | properties of light waves | | |

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| ESS.01.04 Earth and Space Science | High School | Matter and Energy in the Earth System | Describe the nature of the continuous emission and absorption spectrum that indicates the composition of stars. | 195 234 480 626 639 640 | waves transmit energy electrons and energy levels and light emission energy and radiation relationships the sun's energy reaches Earth in the form of electromagnetic waves death of small to medium stars results in white dwarfs and planetary nebula and black dwarfs death of massive stars results in supernovas and neutron stars and black holes | 134 264 265 | what does atomic structure have to do with light and color? using spectroscopy to analyze the light emitted by stars and identify most common elements an element's spectral lines correspond to specific wavelengths of light |
| ESS.01.05 Earth and Space Science | High School | Matter and Energy in the Earth System | Explain how the transfer of energy through radiation, conduction, and convection contributes to global atmospheric processes, e.g., storms, winds. | 480 481 485 493 495 502 502 503 503 | transfer of energy in and out of Earth's atmosphere greenhouse effect and greenhouse gasses Earth's internal energy convection currents in the atmosphere global wind patterns effects of moving air masses cold fronts warm fronts jet streams | 185 202 213 | effect of ocean on carbon dioxide levels in the atmosphere investigate the temperature effects of greenhouse gases exploring how temperature-dependent layering creates currents |

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| ESS.01.06 Earth and Space Science | High School | Matter and Energy in the Earth System | Explain how the layers of the atmosphere affect the dispersal of incoming radiation through reflection, absorption, and reradiation. | 480 481 481 481 485 615 | distribution of incoming solar radiation greenhouse conditions on Earth Earth's "energy budget" greenhouse effect and greenhouse gasses research the density of Venus' and Mars' atmospheres greenhouse conditions on Venus | 185 202 | effect of ocean on carbon dioxide levels in the atmosphere investigate the temperature effects of greenhouse gases |
| ESS.01.07 Earth and Space Science | High School | Matter and Energy in the Earth System | Provide examples of how the unequal heating of the earth and the Coriolis Effect influence global circulation patterns, and show their impact on Mass. weather and climate, e.g., convection cells, trade winds, westerlies, polar easterlies, ect. | 493 494 495 502 502 503 503 504 | convection currents in the atmosphere the Coriolis effect global wind patterns effects of moving air masses cold fronts warm fronts jet streams rotation of air masses due to Coriolis effect | 213 | exploring how temperature-dependent layering creates currents |

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| ESS.01.08 Earth and Space Science | High School | Matter and Energy in the Earth System | Explain how the revolution of the earth and the inclination of the axis of the earth cause the earth's seasonal variations (equinoxes and solstices). | 491 492 492 518 585 587 588 589 601 | the effects of Earth's rotation on daytime heating and nighttime cooling Earth's tilt causes seasons Earth's tilt causes seasons create a model to explain why Earth has seasons Earth's rotation and patterns of day and night axial tilt causes the seasons solar eclipses solar eclipses identify seasons | 208 209 210 211 248 | developing a hypothesis about why the seasons occur investigating factors which cause the seasons investigating how the distance of Earth from the sun affects its intensity investigating how Earth's tilt affects the sun's intensity building a sundial to keep track of daily time based on the cycles between Earth and the sun |
| ESS.01.09 Earth and Space Science | High School | Matter and Energy in the Earth System | Describe how the inclination of the incoming solar radiation can impact the amount of energy received by a given surface area. | 480 481 | distribution of incoming solar radiation Earth's "energy budget" | | |

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| Standard #: Strand | Grade | Topic | Learning Standard | student text pg | detail | investigation pg | detail |
|---|--------------|---|---|--|--|-----------------------------|--|
| ESS.01.10 Earth and Space Science | High School | Matter and Energy in the Earth System | Describe the various conditions associated with frontal boundaries and cyclonic storms (e.g., thunderstorms, winter storms [nor'easters], hurricanes, and tornadoes) and their impact on human affairs, including storm preparations. | 497 499 505 506 507 518 | factors which influence the weather cloud formation description of thunderstorms description of hurricanes description of tornadoes write an action plan to stay safe during a tornado | 219 219 220 | use radar to detect a tornado describe what safety precautions the National Weather Service recommends for tornado conditions using radar to track a hurricane |

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| Standard #: Strand | Grade | Topic | Learning Standard | student text pg | detail | investigation pg | detail |
|---|---|---|---|----------------------------|---|-----------------------------|---|
| ESS.01.11 Earth and Space Science | High School | Matter and Energy in the Earth System | Explain the dynamics of oceanic currents, including upwelling, density, and deep water currents, the local Labrador Current and the Gulf Stream, and their relationship to global circulation within the marine environment and climate. | 491 | Earth's temperature varies with latitude | 207 | research how large bodies of water affect climate |
| | | | | 493 | convection currents in the atmosphere | 207 | research how large bodies of water affect climate |
| | | | | 496 | effects of the Gulf Stream on climate of Great Britain | 213 | exploring how temperature-dependent layering creates currents |
| | | | | 496 | descriptions of ocean currents and their effects on climate | 215 | understanding the Atlantic gyre |
| | | | | 508 | causes and effects of the El Nino Southern Oscillation | 223 | research a particular biome |
| | | | | 510 | effect of cold ocean currents on formation of fog deserts | | |
| | | | | 510 | different types of deserts and how they are formed | | |
| | | | | 511 | effect of warm ocean currents on formation of tropical rainforest | | |
| | | | | 511 | how tropical rainforests are formed | | |
| | | | | 513 | effect of large bodies of water on climate | | |
| 515 | alpine tundra occurs at high altitudes | | | | | | |

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|---|-------------|---|---|--------------------|--|---------------------|---|
| ESS.01.12 Earth and Space Science | High School | Matter and Energy in the Earth System | Describe the effects of longshore currents, storms, and artificial structures (e.g., jetties, sea walls) on coastal erosion in Massachusetts. | 528 | predicting what Earth might look like in 50 million years | 230 | predicting plate movement over 50 million years and the resultant land features |
| | | | | 534 | land features resulting from divergent plate boundaries | 240 | estimating the effects of meteor impacts on Earth |
| | | | | 535 | resulting land features from subduction | 241 | identifying which geologic features on Earth were caused by meteors |
| | | | | 536 | land features resulting from transform plate boundaries | | |
| | | | | 547 | predict separation of North America and Europe in 75 million years | | |
| | | | | 548 | predict effects of divergent plate boundaries on Great Rift Valley | | |
| | | | | 555 | formation of Hawaiian Islands due to volcanic activity | | |
| | | | | 558 | volcanoes shape the Earth | | |
| | | | | 563 | mountain-building | | |
| | | | | 563 | constructive process of mountain building | | |
| | | | | 564 | changes in land features due to erosion | | |
| | | | | 564 | the destructive process of erosion | | |

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| Standard #: Strand | Grade | Topic | Learning Standard | student text pg | detail | investigation pg | detail |
|---|-------------|---|---|--------------------|---|---------------------|---|
| | | | | 565 | wind erosion | | |
| | | | | 566 | effect of glaciers on land | | |
| ESS.01.13 Earth and Space Science | High School | Matter and Energy in the Earth System | Explain what causes the tides and describe how they affect the coastal environment. | 584 | the lunar cycle | 238 | why studying the moon's surface is useful for understanding Earth |
| | | | | 588 | lunar eclipses | | |
| | | | | 589 | solar eclipses | 250 | modeling the lunar cycle |
| | | | | 607 | properties of the moon | 251 | constructing a lunar calendar |
| | | | | 608 | the moon as a satellite of Earth | | |
| | | | | 609 | the moon's effect on tides on Earth | | |
| | | | | 610 | the Earth-moon system | | |
| | | | | 611 | giant impact theory | | |
| ESS.01.14 Earth and Space Science | High School | Matter and Energy in the Earth System | Explain how scientists study the earth system through the use of a combination of ground-based observations, satellite observations, and computer models of the earth system, and why it is necessary to use all of these tools together. | 451 | thermometers | 186 | accurately measuring temperature using thermometers |
| | | | | 452 | thermometers | | |
| | | | | 474 | measuring atmospheric pressure with barometers | 194 | construct and use an aneroid barometer |
| | | | | 485 | computer modeling to predict greenhouse effects | 218 | using Doppler radar images to detect and track storms |
| | | | | 497 | slings psychrometer | 228 | reading a bathymetric map |
| | | | | 540 | where earthquakes occur | | |
| | | | | 541 | earthquake hazard map | 229 | using a geologic hazard map of frequent earthquakes |
| | | | | 567 | geologic hazard maps | | |
| | | | | 580 | using a geologic hazard map | | |

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| Standard #: Strand | Grade | Topic | Learning Standard | student text pg | detail | investigation pg | detail |
|---|-------------|----------------------------------|--|--|---|---------------------|--|
| ESS.02.01 Earth and Space Science | High School | The Earth's Sources of Energy | Recognize, describe, and differentiate between renewable (e.g., solar, wind, water, biomass) and nonrenewable (e.g., fossil fuels, nuclear [Ura-235]) sources of energy. | 172 391 391 400 414 437 438 560 627 627 | generating electric power nuclear vs. fossil fuels impact of nuclear energy reducing pollution environmental impact of electrical generating facilities effects of acid rain on the soil impact of using fossil fuels description of geothermal energy using photovoltaic cells the efficiency of photovoltaic cells | 52 262 262 | the cost of using electrical appliances solar energy can be used to generate electricity without producing pollution determine the efficiency of a photovoltaic cell |

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| Standard #: Strand | Grade | Topic | Learning Standard | student text pg | detail | investigation pg | detail |
|---|--------------|----------------------------------|---|---|--|-----------------------------|---|
| ESS.02.02 Earth and Space Science | High School | The Earth's Sources of Energy | Explain the advantage and limitations of renewable sources of energy. | 172 391 391 400 414 438 560 627 627 | generating electric power nuclear vs. fossil fuels impact of nuclear energy reducing pollution environmental impact of electrical generating facilities impact of using fossil fuels description of geothermal energy using photovoltaic cells the efficiency of photovoltaic cells | 52 262 262 | the cost of using electrical appliances solar energy can be used to generate electricity without producing pollution determine the efficiency of a photovoltaic cell |

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| Standard #: Strand | Grade | Topic | Learning Standard | student text pg | detail | investigation pg | detail |
|---|--------------|----------------------------------|--|---|--|-----------------------------|---|
| ESS.02.03 Earth and Space Science | High School | The Earth's Sources of Energy | Explain the advantage and limitations of nonrenewable sources of energy. | 172 391 391 400 414 438 560 627 627 | generating electric power nuclear vs. fossil fuels impact of nuclear energy reducing pollution environmental impact of electrical generating facilities impact of using fossil fuels description of geothermal energy using photovoltaic cells the efficiency of photovoltaic cells | 52 262 262 | the cost of using electrical appliances solar energy can be used to generate electricity without producing pollution determine the efficiency of a photovoltaic cell |

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| Standard #: Strand | Grade | Topic | Learning Standard | student text pg | detail | investigation pg | detail |
|---|--------------|----------------------------------|---|---|--|-----------------------------|---|
| ESS.02.04 Earth and Space Science | High School | The Earth's Sources of Energy | Describe ways in which people have tried to control the use of renewable and nonrenewable sources of energy, e.g., scientific advances, prices. | 391 414 414 438 443 479 482 515 627 | nuclear vs. fossil fuels effect of electrical generating facilities on dissolved oxygen in water environmental impact of electrical generating facilities impact of using fossil fuels impact of increased CO ₂ in oceans effects of CFC's on the ozone layer effects of burning fossil fuels permafrost using photovoltaic cells | 178 262 | predict the quality of surface water to be tested and justify your answer solar energy can be used to generate electricity without producing pollution |
| ESS.02.05 Earth and Space Science | High School | The Earth's Sources of Energy | Describe the effects on the environment of using both renewable and nonrenewable sources of energy. | 391 391 400 414 438 627 | nuclear vs. fossil fuels impact of nuclear energy reducing pollution environmental impact of electrical generating facilities impact of using fossil fuels using photovoltaic cells | 52 262 | the cost of using electrical appliances solar energy can be used to generate electricity without producing pollution |

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|---|--------------|----------------------------------|---|---|--|-----------------------------|---|
| ESS.02.06 Earth and Space Science | High School | The Earth's Sources of Energy | Describe ways in which scientists are addressing effects on the environment of using both renewable and nonrenewable sources of energy, e.g., creation of new technologies. | 391 400 433 439 483 538 544 | impact of nuclear energy reducing pollution the clean water act catalytic converters and scrubbing reduce acid rain hydrogen powered cars what we can learn from seismographs understanding earthquakes allows engineers to design safer buildings | 52 | the cost of using electrical appliances |

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|---|--------------|-------------------------------|--|----------------------------|--|-----------------------------|--|
| ESS.03.01 Earth and Space Science | High School | Earth Processes and Cycles | Explain that weather is the most significant source of erosion and how weathering leads to the formation of sediments and soils, affect the shape of rocks, and creates specific landscapes. | 528 | predicting what Earth might look like in 50 million years | 230 | predicting plate movement over 50 million years and the resultant land features |
| | | | | 534 | land features resulting from divergent plate boundaries | 237 | examining the magma chemistry of volcanoes and how it relates to a volcano's location |
| | | | | 535 | resulting land features from subduction | 242 | understanding how igneous rocks are formed and growing crystals to investigate their formation |
| | | | | 536 | land features resulting from transform plate boundaries | 244 | understanding how sedimentary rocks are formed and creating sedimentary deposits to investigate them |
| | | | | 547 | predict separation of North America and Europe in 75 million years | 246 | understanding and investigating how metamorphic rocks are formed |
| | | | | 548 | predict effects of divergent plate boundaries on Great Rift Valley | 247 | interpreting how different rock formations were formed |
| | | | | 554 | properties of volcanically formed rock | | |
| | | | | 559 | types of volcanic rock | | |
| | | | | 561 | describing volcanic rock | | |
| | | | | 562 | constructive and destructive processes | | |
| | | | | 563 | mountain-building | | |
| | | | | 564 | landforms shaped by water | | |
| | | | | 564 | changes in land features due to erosion | | |
| | | | | 565 | formation of soil | | |

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|-----------------------|-------|-------|----------------------|--------------------|--|---------------------|--------|
| | | | | 566 | effect of glaciers on land | | |
| | | | | 573 | formation of igneous and sedimentary and metamorphic rocks | | |
| | | | | 575 | identifying igneous and sedimentary and metamorphic rocks | | |
| | | | | 576 | the rock cycle | | |

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|---|-------------|-------------------------------|--|--------------------|--|---------------------|--|
| ESS.03.02 Earth and Space Science | High School | Earth Processes and Cycles | Describe how glaciers, gravity, wind, temperature changes, waves, and rivers cause weathering and erosion. Give examples of how the effects of these processes can be seen in our local environment. | 528 | predicting what Earth might look like in 50 million years | 230 | predicting plate movement over 50 million years and the resultant land features |
| | | | | 534 | land features resulting from divergent plate boundaries | 237 | examining the magma chemistry of volcanoes and how it relates to a volcano's location |
| | | | | 535 | resulting land features from subduction | 242 | understanding how igneous rocks are formed and growing crystals to investigate their formation |
| | | | | 536 | land features resulting from transform plate boundaries | 244 | understanding how sedimentary rocks are formed and creating sedimentary deposits to investigate them |
| | | | | 547 | predict separation of North America and Europe in 75 million years | 246 | understanding and investigating how metamorphic rocks are formed |
| | | | | 548 | predict effects of divergent plate boundaries on Great Rift Valley | 247 | interpreting how different rock formations were formed |
| | | | | 554 | properties of volcanically formed rock | | |
| | | | | 559 | types of volcanic rock | | |
| | | | | 561 | describing volcanic rock | | |
| | | | | 562 | constructive and destructive processes | | |
| | | | | 563 | mountain-building | | |
| | | | | 564 | landforms shaped by water | | |
| | | | | 564 | changes in land features due to erosion | | |
| | | | | 565 | formation of soil | | |

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| Standard #: Strand | Grade | Topic | Learning Standard | student text pg | detail | investigation pg | detail |
|--------------------------------------|-------------|----------------------------|---|--------------------|--|---------------------|--|
| | | | | 566 | effect of glaciers on land | | |
| | | | | 573 | formation of igneous and sedimentary and metamorphic rocks | | |
| | | | | 575 | identifying igneous and sedimentary and metamorphic rocks | | |
| | | | | 576 | the rock cycle | | |
| ESS.03.03 Earth and Space Science | High School | Earth Processes and Cycles | Explain the nitrogen and carbon cycles and their roles in the improvement of soils for agriculture. | 437 | effects of acid rain on natural environments | 178 | actions to take to improve water quality |
| | | | | 471 | nitrogen cycle | | |
| | | | | 562 | constructive and destructive processes | | |
| | | | | 565 | formation of soil | | |
| | | | | 576 | the rock cycle | | |
| ESS.03.04 Earth and Space Science | High School | Earth Processes and Cycles | Describe the evolution of the atmosphere. | 481 | global warming | | |
| | | | | 483 | global temperature changing over time | | |
| | | | | 528 | Earth's surface is changing | | |
| ESS.03.05 Earth and Space Science | High School | Earth Processes and Cycles | Describe how the oceans store carbon dioxide as dissolved HCO ₃ and CaCO ₃ precipitate. | 441 | sources of salts in the ocean | 212 | investigate how the ocean's salinity affects its density |
| | | | | 442 | composition of seawater | | |

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|---|--------------|-------------------------------|--|--|--|--|---|
| ESS.03.06 Earth and Space Science | High School | Earth Processes and Cycles | Explain how water flows into and through a watershed, e.g., aquifers, wells, porosity, permeability, water table, capillary water, runoff. | 522 523 562 565 569 573 575 576 | relative dating interpreting rock formations constructive and destructive processes formation of soil studying moon rocks on Earth formation of igneous and sedimentary and metamorphic rocks identifying igneous and sedimentary and metamorphic rocks the rock cycle | 225 226 242 244 246 247 | determining the relative ages of rock formations sequencing events in a geologic cross-section understanding how igneous rocks are formed and growing crystals to investigate their formation understanding how sedimentary rocks are formed and creating sedimentary deposits to investigate them understanding and investigating how metamorphic rocks are formed interpreting how different rock formations were formed |

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|---|--------------|-------------------------------|---|--|--|-----------------------------|---------------|
| ESS.03.07 Earth and Space Science | High School | Earth Processes and Cycles | Compare and contrast the processes of the hydrologic cycle including evaporation, condensation, precipitation, surface runoff and groundwater percolation, infiltration, and transpiration. | 433 434 440 440 471 472 477 478 559 564 | water quality standards importance of water analysis oceans as part of the hydrosphere oceans in the water cycle description of Earth's atmosphere effect of life on Earth's atmosphere layers of the atmosphere layers of the atmosphere volcanoes and water vapor landforms shaped by water | | |

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| Standard #: Strand | Grade | Topic | Learning Standard | student text pg | detail | investigation pg | detail |
|---|--------------|-------------------------------|--|---|--|---------------------------------|---|
| ESS.03.08 Earth and Space Science | High School | Earth Processes and Cycles | Describe the rock cycle, and the processes that are responsible for the formation of igneous, sedimentary, and metamorphic rocks. Compare the physical properties of these rock types. | 440 471 472 477 478 554 559 561 562 565 573 575 576 | oceans as part of the hydrosphere description of Earth's atmosphere effect of life on Earth's atmosphere layers of the atmosphere layers of the atmosphere properties of volcanically formed rock types of volcanic rock describing volcanic rock constructive and destructive processes formation of soil formation of igneous and sedimentary and metamorphic rocks identifying igneous and sedimentary and metamorphic rocks the rock cycle | 237 242 244 246 247 | examining the magma chemistry of volcanoes and how it relates to a volcano's location understanding how igneous rocks are formed and growing crystals to investigate their formation understanding how sedimentary rocks are formed and creating sedimentary deposits to investigate them understanding and investigating how metamorphic rocks are formed interpreting how different rock formations were formed |
| ESS.03.09 Earth and Space Science | High School | Earth Processes and Cycles | Compare the physical properties and the mineral combinations found in rocks | 570 571 572 | properties of minerals common minerals Mohs hardness scale | | |

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|---|--------------|-------------------------------|--|--|---|-----------------------------|---|
| ESS.03.10 Earth and Space Science | High School | Earth Processes and Cycles | Explain how the composition and arrangement of atoms determine a mineral's physical and chemical characteristics. | 570 571 572 | properties of minerals common minerals Mohs hardness scale | | |
| ESS.03.11 Earth and Space Science | High School | Earth Processes and Cycles | Describe the absolute and relative dating methods used to measure geologic time, e.g., index fossils, radioactive dating, law of superposition, and cross-cutting relationships. | 522 523 523 540 541 567 569 580 | relative dating interpreting rock formations faunal succession where earthquakes occur earthquake hazard map geologic hazard maps studying moon rocks on Earth using a geologic hazard map | 225 226 228 229 | determining the relative ages of rock formations sequencing events in a geologic cross-section reading a bathymetric map using a geologic hazard map of frequent earthquakes |

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|---|-------------|-------------------------------|--|--------------------|---|---------------------|--|
| ESS.03.12 Earth and Space Science | High School | Earth Processes and Cycles | Describe the evolution of the solid earth in terms of the major geologic eras. | 441 | the five major oceans | 228 | reading a bathymetric map |
| | | | | 447 | name the five big oceans on Earth | 229 | using a geologic hazard map of frequent earthquakes |
| | | | | 528 | predicting what Earth might look like in 50 million years | 230 | predicting plate movement over 50 million years and the resultant land features |
| | | | | 528 | definition of plate tectonics | | |
| | | | | 532 | theory of plate tectonics | 237 | finding a pattern of volcanoes related to the locations of plate boundaries |
| | | | | 534 | land features resulting from divergent plate boundaries | | |
| | | | | 535 | resulting land features from subduction | 240 | estimating the effects of meteor impacts on Earth |
| | | | | 536 | land features resulting from transform plate boundaries | 241 | identifying which geologic features on Earth were caused by meteors |
| | | | | 537 | earthquakes and plate tectonics | | |
| | | | | 540 | where earthquakes occur | | |
| | | | | 541 | earthquake hazard map | | |
| | | | | 547 | predict separation of North America and Europe in 75 million years | | |
| | | | | 548 | predict effects of divergent plate boundaries on Great Rift Valley | | |
| | | | | 552 | formation of magma in Earth's mantle | | |

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|-----------------------|-------|-------|----------------------|--------------------|--|---------------------|--------|
| | | | | 552 | geologic basis for volcanic eruptions | | |
| | | | | 553 | where volcanic activity occurs | | |
| | | | | 555 | formation of Hawaiian Islands due to volcanic activity | | |
| | | | | 555 | geologic basis for shield volcanoes | | |
| | | | | 555 | formation of shield volcanoes due to hot spots | | |
| | | | | 556 | formation of stratovolcanoes due to subduction | | |
| | | | | 556 | geologic basis for stratovolcanoes | | |
| | | | | 557 | geologic bases for cinder cone volcanoes | | |
| | | | | 558 | volcanoes shape the Earth | | |
| | | | | 563 | constructive process of mountain building | | |
| | | | | 563 | mountain-building | | |
| | | | | 564 | the destructive process of erosion | | |
| | | | | 564 | changes in land features due to erosion | | |
| | | | | 565 | wind erosion | | |

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|---|-------------|-------------------------------|---|--------------------|--|---------------------|--|
| | | | | 566 | effect of glaciers on land | | |
| | | | | 567 | geologic hazard maps | | |
| | | | | 580 | using a geologic hazard map | | |
| ESS.03.13 Earth and Space Science | High School | Earth Processes and Cycles | Explain how seismic data is used to reveal the interior structure of the layered earth. | 525 | formation of Earth's layers | 229 | identifying tectonic plates and plate boundaries |
| | | | | 526 | description of Earth's layers | | |
| | | | | 533 | describing plate boundaries | | |
| | | | | 534 | divergent plate boundaries | | |
| | | | | 535 | convergent plate boundaries | | |
| | | | | 536 | transform plate boundaries | | |
| | | | | 537 | causes and descriptions of earthquakes | | |
| | | | | 537 | conversion of energy in rocks causes seismic waves | | |
| | | | | 538 | seismic waves | | |
| | | | | 539 | earthquakes rating scales | | |
| | | | | 551 | structure of a volcano | | |
| | | | | 552 | formation of magma in Earth's mantle | | |
| | | | | 554 | figure showing structure of different types of volcanoes | | |

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|---|--------------|-------------------------------|--|----------------------------|--|-----------------------------|---------------|
| ESS.03.14 Earth and Space Science | High School | Earth Processes and Cycles | Explain how seismic data is used to locate an earthquake epicenter. | 537 | earthquakes and plate tectonics | | |
| | | | | 537 | conversion of energy in rocks causes seismic waves | | |
| | | | | 538 | seismic waves | | |
| | | | | 552 | formation of magma in Earth's mantle | | |
| | | | | 552 | geologic basis for volcanic eruptions | | |
| | | | | 553 | where volcanic activity occurs | | |
| | | | | 555 | geologic basis for shield volcanoes | | |
| | | | | 556 | geologic basis for stratovolcanoes | | |
| | | | | 557 | geologic bases for cinder cone volcanoes | | |
| ESS.03.15 Earth and Space Science | High School | Earth Processes and Cycles | Recognize the magnitude values of earthquakes as measured by the Richter Scale and give examples of relative damage that would be incurred at each magnitude. | 537 | causes and descriptions of earthquakes | | |
| | | | | 539 | earthquakes rating scales | | |

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|---|--------------|-------------------------------|---|---------------------------------|---|-----------------------------|---|
| ESS.03.16 Earth and Space Science | High School | Earth Processes and Cycles | Explain how the magnetic field of the earth is produced. | 159 163 531 531 | magnetism explained understanding magnetic fields interesting magnetic patterns on sea floor magnetic polarity of Earth | 62 64 66 | describing forces that magnets exert on each other testing materials to see if they are affected by magnets compare electromagnets and permanent magnets |
| ESS.03.17 Earth and Space Science | High School | Earth Processes and Cycles | Explain how the Van Allen Belts protect the biosphere | 440 471 472 477 478 | oceans as part of the hydrosphere description of Earth's atmosphere effect of life on Earth's atmosphere layers of the atmosphere layers of the atmosphere | | |
| ESS.03.18 Earth and Space Science | High School | Earth Processes and Cycles | Explain how paleomagnetic patterns, preserved in rocks, provide evidence of the earth's magnetic field over geologic time. | 530 531 | sea-floor spreading and mid-ocean ridges magnetic patterns on the sea floor | 228 | listing which kind of plate boundary is associated with each geologic feature |

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|---|--------------|-------------------------------|--|----------------------------|---|-----------------------------|--|
| ESS.03.19 Earth and Space Science | High School | Earth Processes and Cycles | Trace the development of a lithospheric plate from its growing margin at a divergent boundary (mid-ocean ridge) to its destructive margin at a convergent boundary (subduction zone). | 528 | definition of plate tectonics | 228 | listing which kind of plate boundary is associated with each geologic feature |
| | | | | 530 | sea-floor spreading and mid-ocean ridges | 229 | identifying tectonic plates and plate boundaries |
| | | | | 531 | magnetic patterns on the sea floor | 237 | examining the magma chemistry of volcanoes and how it relates to a volcano's location |
| | | | | 532 | theory of plate tectonics | | |
| | | | | 533 | describing plate boundaries | | |
| | | | | 534 | divergent plate boundaries | | |
| | | | | 535 | convergent plate boundaries | | |
| | | | | 536 | transform plate boundaries | | |
| | | | | 554 | properties of volcanically formed rock | | |
| | | | | 559 | types of volcanic rock | | |
| | | | | 561 | describing volcanic rock | | |

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|---|--------------|-------------------------------|---|----------------------------|--|-----------------------------|--|
| ESS.03.20 Earth and Space Science | High School | Earth Processes and Cycles | Relate earthquakes, volcanic activity, mountain building, and tectonic uplift to plate movements. | 528 | definition of plate tectonics | 228 | reading a bathymetric map |
| | | | | 528 | predicting what Earth might look like in 50 million years | 228 | listing which kind of plate boundary is associated with each geologic feature |
| | | | | 530 | sea-floor spreading and mid-ocean ridges | 229 | using a geologic hazard map of frequent earthquakes |
| | | | | 531 | magnetic patterns on the sea floor | 230 | predicting plate movement over 50 million years and the resultant land features |
| | | | | 532 | theory of plate tectonics | 236 | understanding the Volcanic Explosivity Index |
| | | | | 534 | land features resulting from divergent plate boundaries | 237 | finding a pattern of volcanoes related to the locations of plate boundaries |
| | | | | 535 | resulting land features from subduction | 240 | estimating the effects of meteor impacts on Earth |
| | | | | 536 | land features resulting from transform plate boundaries | 241 | identifying which geologic features on Earth were caused by meteors |
| | | | | 537 | earthquakes and plate tectonics | | |
| | | | | 537 | causes and descriptions of earthquakes | | |
| | | | | 539 | earthquakes rating scales | | |
| | | | | 540 | where earthquakes occur | | |
| | | | | 541 | earthquake hazard map | | |
| | | | | 547 | predict separation of North America and Europe in 75 million years | | |

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|-----------------------|-------|-------|----------------------|--------------------|--|---------------------|--------|
| | | | | 548 | predict effects of divergent plate boundaries on Great Rift Valley | | |
| | | | | 551 | structure of a volcano | | |
| | | | | 552 | formation of magma in Earth's mantle | | |
| | | | | 552 | geologic basis for volcanic eruptions | | |
| | | | | 553 | where volcanic activity occurs | | |
| | | | | 554 | types and shapes of volcanoes | | |
| | | | | 554 | figure showing structure of different types of volcanoes | | |
| | | | | 555 | formation of Hawaiian Islands due to volcanic activity | | |
| | | | | 555 | formation of shield volcanoes due to hot spots | | |
| | | | | 555 | geologic basis for shield volcanoes | | |
| | | | | 555 | shield volcanoes | | |
| | | | | 556 | formation of stratovolcanoes due to subduction | | |
| | | | | 556 | stratovolcanoes | | |

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|---|-------------|-------------------------------|--|--------------------|--|---------------------|--------|
| | | | | 556 | geologic basis for stratovolcanoes | | |
| | | | | 557 | geologic bases for cinder cone volcanoes | | |
| | | | | 558 | volcanoes shape the Earth | | |
| | | | | 563 | mountain-building | | |
| | | | | 563 | constructive process of mountain building | | |
| | | | | 564 | the destructive process of erosion | | |
| | | | | 564 | changes in land features due to erosion | | |
| | | | | 565 | wind erosion | | |
| | | | | 566 | effect of glaciers on land | | |
| | | | | 567 | geologic hazard maps | | |
| | | | | 580 | using a geologic hazard map | | |
| ESS.03.21 Earth and Space Science | High School | Earth Processes and Cycles | Relate the effects of sudden seafloor movements to the generation of tsunamis. | 537 | conversion of energy in rocks causes seismic waves | | |
| | | | | 537 | causes and descriptions of earthquakes | | |
| | | | | 538 | seismic waves | | |
| | | | | 539 | earthquakes rating scales | | |

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|---|-------------|--|---|---|---|---------------------|--------|
| ESS.03.22 Earth and Space Science | High School | Earth Processes and Cycles | Provide examples of how societies have been affected by tectonic activity (e.g., hazards from eruptions and earthquakes, bedrock type and soil conditions, building designs). | 537 552 552 553 555 556 557 | earthquakes and plate tectonics formation of magma in Earth's mantle geologic basis for volcanic eruptions where volcanic activity occurs geologic basis for shield volcanoes geologic basis for stratovolcanoes geologic bases for cinder cone volcanoes | | |
| ESS.04.01 Earth and Space Science | High School | The Origin and Evolution of the Universe | Explain the Big Bang Theory and discuss the evidence that supports it (background radiation, and Relativistic Doppler effect ~ red shift). | 611 612 621 647 648 649 | historical theories of the origin of the moon historical theories about the solar system historical theories of which objects were planets the Big Bang theory of the origin of the universe evidence for the Big Bang theory evidence for the Big Bang theory | | |

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|---|--------------|--|--|---------------------------------|---|-----------------------------|--|
| ESS.04.02 Earth and Space Science | High School | The Origin and Evolution of the Universe | Define the unit of distance called a light year. | 592 593 | calculating and using light years light years and time | | |
| ESS.04.03 Earth and Space Science | High School | The Origin and Evolution of the Universe | Use the Hertzsprung- Russell Diagram to explain the life histories of stars. | 638 639 639 640 640 | the life cycle of stars death of small to medium stars results in white dwarfs and planetary nebula and black dwarfs description and illustration of the life cycle of stars death of massive stars results in supernovas and neutron stars and black holes elements formed by nuclear fusion in stars | 255 264 | observe and describe the appearance of the moon and Jupiter and its moons using spectroscopy to analyze the light emitted by stars and identify most common elements |

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|---|--------------|--|--|----------------------------|---|-----------------------------|---|
| ESS.04.04 Earth and Space Science | High School | The Origin and Evolution of the Universe | Compare and contrast the final three outcomes of stellar evolution based on mass (black hole, neutron star, white dwarf). | 638 | the life cycle of stars | 255 | observe and describe the appearance of the moon and Jupiter and its moons |
| | | | | 639 | death of small to medium stars results in white dwarfs and planetary nebula and black dwarfs | 264 | using spectroscopy to analyze the light emitted by stars and identify most common elements |
| | | | | 639 | description and illustration of the life cycle of stars | | |
| | | | | 640 | death of massive stars results in supernovas and neutron stars and black holes | | |
| | | | | 640 | elements formed by nuclear fusion in stars | | |

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|---|-------------|--|--|--------------------|---|---------------------|---|
| ESS.04.05 Earth and Space Science | High School | The Origin and Evolution of the Universe | Compare and contrast the motions of rotation and revolution of orbiting bodies, e.g., day, year, solar/lunar eclipses. Describe the influence of gravity and inertia on these motions. | 491 | the effects of Earth's rotation on daytime heating and nighttime cooling | 208 | developing a hypothesis about why the seasons occur |
| | | | | 492 | Earth's tilt causes seasons | 210 | investigating how the distance of Earth from the sun affects its intensity |
| | | | | 584 | the lunar cycle | | |
| | | | | 585 | Earth's rotation and patterns of day and night | 211 | investigating how Earth's tilt affects the sun's intensity |
| | | | | 587 | axial tilt causes the seasons | | |
| | | | | 588 | solar eclipses | 238 | why studying the moon's surface is useful for understanding Earth |
| | | | | 588 | lunar eclipses | | |
| | | | | 589 | solar eclipses | 248 | building a sundial to keep track of daily time based on the cycles between Earth and the sun |
| | | | | 589 | solar eclipses | | |
| | | | | 601 | identify seasons | | |
| | | | | 607 | properties of the moon | 250 | modeling the lunar cycle |
| | | | | 608 | the moon as a satellite of Earth | 251 | constructing a lunar calendar |
| | | | | 609 | the moon's effect on tides on Earth | 256 | simulate an object in orbit and investigate how orbital period varies within distance |
| | | | | 610 | the Earth-moon system | | |
| | | | | 611 | giant impact theory | | |
| | | | | 612 | orbits of planets around the sun | | |
| | | | | 612 | Johannes Kepler | | |
| | | | | 613 | Kepler's elliptically shaped orbits | | |

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|--------------------------------------|-------------|--|---|--------------------|--|---------------------|---|
| | | | | 619 | asteroids and comets | | |
| | | | | 620 | meteors and meteorites and the Kuiper Belt | | |
| ESS.04.06 Earth and Space Science | High School | The Origin and Evolution of the Universe | Explain Kepler's Laws of Motion. | 612 | orbits of planets around the sun | 256 | simulate an object in orbit and investigate how orbital period varies within distance |
| | | | | 612 | Johannes Kepler | | |
| | | | | 613 | Kepler's elliptically shaped orbits | | |
| | | | | 619 | asteroids and comets | | |
| | | | | 620 | meteors and meteorites and the Kuiper Belt | | |
| ESS.04.07 Earth and Space Science | High School | The Origin and Evolution of the Universe | Compare and contrast the various instrumentation used to study deep space and the solar system, e.g., refracting telescope, reflecting telescope, radio telescope, spectrophotometer. | 594 | history of the telescope | 264 | understand why spectroscopy is an important tool of astronomers |
| | | | | 595 | types and uses of telescopes | | |
| | | | | 596 | types and uses of telescopes | 268 | measuring apparent brightness to calculate the distance to stars and galaxies |
| | | | | 597 | satellites as tools of astronomy | | |
| | | | | 598 | spacecraft as tools of astronomy | | |
| | | | | 634 | the use of spectroscopy to analyze stars | | |

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|---|--------------|--|--|----------------------------|---|-----------------------------|---------------|
| ESS.04.08 Earth and Space Science | High School | The Origin and Evolution of the Universe | Explain how the sun, earth, and solar system formed from a nebula of dust and gas in a spiral arm of the Milky Way Galaxy about 4.6 billion years ago. | 641 | the existence of other planetary systems | | |

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|--------------------------------------|--------------|--------------|--|----------------------------|--|-----------------------------|--|
| INQ.01 Earth and Space Science | High School | Inquiry | Pose questions and state hypotheses based on prior scientific experiences. | 10 | the research question and hypothesis | 6 | how do we ask questions and get answers from nature? |
| | | | | 429 | why haven't we run out of water | 170 | which method will give fastest dissolving rate? |
| | | | | 434 | what is in your tap water | | |
| | | | | 437 | what is acid rain | | |
| | | | | 441 | why are oceans salty | | |
| | | | | 451 | what is temperature | | |
| | | | | 456 | asking questions pertaining to specific heat and heat flow | | |
| | | | | 472 | why is Earth's atmosphere different from other planets | | |
| | | | | 473 | why do ears pop | | |
| | | | | 492 | why does Earth have seasons | | |
| | | | | 501 | how does rain form | | |
| | | | | 509 | how do animals survive in the desert | | |
| | | | | 515 | what is a carbon sink | | |
| | | | | 534 | why doesn't Earth get bigger and bigger | | |
| | | | | 588 | what causes eclipses | | |
| | | | | 621 | is Pluto a planet | | |

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|--------------------------------------|--------------|--------------|---|----------------------------|--|-----------------------------|---|
| INQ.02 Earth and Space Science | High School | Inquiry | Distinguish between hypothesis and theory as scientific terms. | 10 | process of reviewing hypothesis explained | | vocabulary is presented in context of investigations |
| | | | | 521 | relative dating and modern geology based on Steno's theories | 39 | review energy theory in context of everyday scenarios |
| | | | | 528 | theory of plate tectonics | | |
| | | | | 563 | Darwin's theories of the Andes formation | 151 | review your hypothesis |
| | | | | 566 | what causes ice ages | 171 | did you prove or disprove your hypothesis? |
| | | | | 611 | theories of origin of the moon | | |
| | | | | 647 | Big Bang theory | | |

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|--|-------------|---------|---|--------------------|---|---------------------|--|-----|--|
| INQ.04 Inquiry and Experimentation | High School | Inquiry | Use mathematics to analyze and support findings and to model conclusions. | 24 | interpretations of patterns in data | 13 | graph distance vs. time | | |
| | | | | 24 | making a graph | 15 | construct a quantitative graphical model | | |
| | | | | 26 | creating graphs | 15 | interpret a speed vs. time graph | | |
| | | | | 27 | reading a graph | 25 | create a mathematical model | | |
| | | | | 41 | make a graph | 27 | find math rule for lever equilibrium | | |
| | | | | 42 | interpreting distance/time graph | 28 | derive a math formula | | |
| | | | | 78 | analyze lever diagram | 37 | organize data into a graph of speed vs. height | | |
| | | | | 459 | heat equation | 51 | graph voltage vs. current | | |
| | | | | 476 | atmospheric pressure at various altitudes graph | 121 | graph mass vs. volume | | |
| | | | | 547 | average density (#5) | 129 | find average velocity | | |
| | | | | 618 | average distance from the sun | 147 | organize observations into a category table | | |
| | | | | 645 | inverse square law | 151 | does your experiment agree with law of conservation of mass? | | |
| | | | | 645 | apparent brightness vs. distance graph | 171 | average dissolving rate | | |
| | | | | 651 | arrange the items in the table (#3) | 185 | constructing a graph of drops of acid vs pH | | |
| | | | | 651 | use the diagram to answer the questions (#4) | 187 | find equation for trend line | | |
| | | | | 651 | use the diagram to answer the questions (#2) | 187 | construct a graphical model | | |
| | | | | | | | | 189 | construct a temperature vs. time graph |

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|-----------------------|-------|-------|----------------------|--------------------|--------|---------------------|--|
| | | | | | | 197 | constructing a graph from atmospheric pressure data |
| | | | | | | 203 | graphing water and ice temperature readings |
| | | | | | | 206 | constructing a graph of time vs. temperature |
| | | | | | | 217 | determining relationship between temperature of the atmosphere and relative humidity |
| | | | | | | 218 | interpreting Doppler radar images |
| | | | | | | 231 | evaluating your completed bathymetric map |
| | | | | | | 237 | finding a pattern of volcanoes on a bathymetric map |
| | | | | | | 247 | evaluate your ability to interpret rock formations |
| | | | | | | 257 | inverse square law |
| | | | | | | 268 | discovering the mathematical relationship between apparent brightness and distance |

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|--|--------------|--------------|--|----------------------------|---|-----------------------------|---|
| INQ.05 Inquiry and Experimentation | High School | Inquiry | Simulate physical processes or phenomena using different kinds of representations. | 9 | steps in the scientific method | 7 | compare results with hypothesis |
| | | | | 10 | forming a hypothesis | 7 | perform your own experiment |
| | | | | 19 | design your own experiment | 9 | conduct three experiments with appropriate equipment |
| | | | | 448 | describe steps you would take to determine whether pH affects frog population | 10 | conduct car/ramp experiment |
| | | | | | | 10 | selecting ramp and photogates |
| | | | | | | 12 | select equipment and set up experiment |
| | | | | | | 16 | investigate Newton's 2nd law |
| | | | | | | 30 | rigging block and tackle |
| | | | | | | 34 | investigate motion on a rollercoaster |
| | | | | | | 40 | choose circuit parts to light a bulb |
| | | | | | | 75 | plan three experiments to determine which variable affects the period of a pendulum |
| | | | | | | 75 | perform self-designed experiment |
| | | | | | | 145 | carry out procedure and select equipment |
| | | | | | | 151 | select materials from list |

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|-----------------------|-------|-------|----------------------|--------------------|--------|---------------------|---|
| | | | | | | 170 | which factor will produce fastest dissolving rate? |
| | | | | | | 182 | simulating the effect of acid rain on daphnia |
| | | | | | | 188 | conducting investigation of efficiency of immersion heater |
| | | | | | | 193 | conducting experiments on heat transfer |
| | | | | | | 205 | investigating how specific heat of water regulates Earth's temperature |
| | | | | | | 209 | measuring the intensity of light using an electric meter and solar cell and light bulb |
| | | | | | | 237 | develop a research plan for studying volcanoes |
| | | | | | | 252 | identifying the parts of a refracting telescope and making observations of the moon's surface |

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|--|-------------|---------|--|--|--|---|--|
| INQ.06 Inquiry and Experimentation | High School | Inquiry | Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions. | 11 19 20 485 543 547 605 | controlling variables in experiments did you run a controlled experiment? what factors could explain the variability in their data? what percentage comes from this source? (problem 4) determining distance to an epicenter what explains the difference in density? (#5) how big is Earth? | 7 11 76 129 151 169 169 197 199 231 247 | what variables should be controlled? calculate % error calculate % error control the height of the liquid does your experiment agree with law of conservation of mass? why was plain water tested? what does the word control mean? calculating error between your barometer and a commercial barometer importance of good record keeping in order to avoid error evaluating your completed bathymetric map evaluate your ability to interpret rock formations |
| INQ.07 Inquiry and Experimentation | High School | Inquiry | Revise scientific models. | | | 157 197 | add new rules to list based on findings evaluating your aneroid barometer design |

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| INQ.08 Inquiry and Experimentation | High School | Inquiry | Communicate and defend a scientific argument. | 20 | explain your reasoning | 9 | present conclusions to the class |
| | | | | | | 9 | reporting on an experiment |
| | | | | | | 21 | construct reasonable explanation based on data |
| | | | | | | 35 | study data and determine importance of height on speed of marble |
| | | | | | | 37 | describe the flow of energy based on experimental graph |
| | | | | | | 39 | give a brief presentation to the class |
| | | | | | | 45 | analyze data and explain a rule |
| | | | | | | 47 | present and defend an explanation |
| | | | | | | 145 | present findings to the class |
| | | | | | | 145 | present findings and methods used |
| | | | | | | 145 | present findings to the class |
| | | | | | | 151 | present results to the class |
| | | | | | | 179 | create water quality report |
| | | | | | | 181 | write paragraph to explain results |

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| | | | | | | 183 | write summary of findings |
| PHY.01.03 Physical Sciences/ Physics | High School | Motion and Forces | Distinguish between, and solve problems involving, velocity, speed, and constant acceleration. | 14 | how to calculate speed | 8 | calculating speed |
| | | | | 15 | compare and contrast speed and velocity | 9 | collect data and calculate speed of car |
| | | | | 20 | find speed of bumblebee | 10 | calculate speed of the car |
| | | | | 20 | calculate speed of car | 12 | calculate speed of moving car |
| | | | | 24 | accurate speed measurements | 12 | find speed of car at different positions |
| | | | | 32 | average speed vs. instantaneous | 14 | calculate acceleration of car on ramp |
| | | | | 32 | average speed discussed | 14 | acceleration is the rate at which speed changes |
| | | | | 33 | understanding acceleration | 14 | calculate speed of car at two places on the ramp |
| | | | | 35 | how to calculate acceleration | 17 | explore 2nd law and acceleration |
| | | | | 36 | examples of acceleration | 17 | caclulate speed of car |
| | | | | 41 | find acceleration of car | 36 | find speed of marble |
| | | | | 42 | calculate speed from distance/time graph | | |
| | | | | 49 | link between force and acceleration | | |
| | | | | 53 | acceleration due to gravity | | |

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| PHY.01.04 Physical Sciences/ Physics | High School | Motion and Forces | Create and interpret graphs of motion (position vs. time, speed vs. time, velocity vs. time, constant acceleration vs. time). | 29 30 37 37 | position vs. time graph discussion position vs. time graphs speed vs. time graphs speed vs. time graph discussion | 12 13 15 15 15 | model the car's motion graphically make a position vs. time graph make a speed vs. time graph changes in motion can be represented graphically make a speed vs. time graph |
| PHY.01.06 Physical Sciences/ Physics | High School | Motion and Forces | Interpret and apply Newton's first law of motion. | 45 48 | Newton's first law summarized Newton's first law in detail | 14 | exploring acceleration on a ramp |
| PHY.01.07 Physical Sciences/ Physics | High School | Motion and Forces | Interpret and apply Newton's second law of motion to show how an object's motion will change only when a net force is applied. | 45 49 64 | Newton's second law summarized Newton's second law in detail solving problems using $f=ma$ | 16 19 | thinking about force discover 2nd law of motion |
| PHY.01.08 Physical Sciences/ Physics | High School | Motion and Forces | Use a free body force diagram with only co-linear forces to show forces acting on an object, and determine the net force on it. | 51 | net force explained | 22 | car and ramp and Newton's 3rd law |

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| PHY.01.09 Physical Sciences/ Physics | High School | Motion and Forces | Qualitatively distinguish between static and kinetic friction, what they depend on and their effects on the motion of objects. | 56 64 | friction explained research effect of friction on human joints | 21 | effect of friction on the car |
| PHY.01.10 Physical Sciences/ Physics | High School | Motion and Forces | Interpret and apply Newton's third law of motion. | 45 59 | Newton's third law summarized Newton's third law in detail | 22 23 | car and ramp and Newton's 3rd law using 3rd law to explain common phenomena |
| PHY.01.11 Physical Sciences/ Physics | High School | Motion and Forces | Understand conceptually Newton's law of universal gravitation. | 52 54 55 606 | gravity depends on mass Newton's law of universal gravitation calculating gravitational force between objects Newton's law of universal gravitation | 257 | relating the relationship between orbital speed and distance to the equation of universal gravitation |

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| PHY.01.12 Physical Sciences/ Physics | High School | Motion and Forces | Identify appropriate standard international units of measurement for force, mass, distance, speed, acceleration, and time, and explain how they are measured. | 3 6 19 78 585 586 629 | time measurement scientists use metric units convert from english to metric use and understand mass measurements understanding time measurement in years clocks and the division of time converting light years to astronomical units | 12 16 116 249 | make metric length measurement understand and use units of force measuring mass calibrating a sundial |
| PHY.02.01 Physical Sciences/ Physics | High School | Conservation of Energy and Momentum | Interpret and provide examples that illustrate the law of conservation of energy. | 60 88 90 90 92 93 96 363 363 | conservation of momentum potential and kinetic energy explained conservation of energy conservation of energy explained energy transformations and conservation different forms of energy described prove that energy is conserved conservation of mass conservation of mass | 36 36 37 38 150 | investigate energy conservation energy conservation and the roller coaster investigating conservation of energy with rollercoaster conservation of energy and energy transformations investigate conservation of mass |

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|--|--------------|-------------------------------------|--|---|---|-----------------------------------|---|
| PHY.02.02 Physical Sciences/ Physics | High School | Conservation of Energy and Momentum | Provide examples of how energy can be transformed from kinetic to potential and vice versa. | 91 537 | following an energy transformation potential energy transformed to kinetic energy causes earthquakes | 36 38 | energy conservation and the roller coaster identify potential/kinetic energy conversions |
| PHY.02.03 Physical Sciences/ Physics | High School | Conservation of Energy and Momentum | Apply quantitatively the law of conservation of mechanical energy to simple systems. | | | 36 | energy conservation and the roller coaster |
| PHY.02.04 Physical Sciences/ Physics | High School | Conservation of Energy and Momentum | Describe the relationship among energy, work, and power both conceptually and quantitatively | 68 83 86 86 87 96 97 97 97 97 97 138 | compound machines how to calculate work how to calculate power power explained concept of energy as stored work calculate work done calculate work accomplished by a motor compare different amounts of work done calculate power calculate power of two different machines analyze power of motor how to calculate electrical power | 29 31 191 191 263 | design and construct complex gear machines calculate work done on block calculating work input and work output power of an immersion heater calculate the power output of a photovoltaic cell |

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| PHY.02.05 Physical Sciences/ Physics | High School | Conservation of Energy and Momentum | Interpret the law of conservation of momentum and provide examples that illustrate it. Calculate the momentum of an object. | 60 60 64 | law of conservation of momentum how to calculate momentum calculate momentum | | |
| PHY.02.06 Physical Sciences/ Physics | High School | Conservation of Energy and Momentum | Identify appropriate standard international units of measurement for energy, work, power, and momentum. | 83 86 86 87 96 96 97 97 97 97 97 138 | how to calculate work how to calculate power power explained concept of energy as stored work calculate work done decide whether or not work is done calculate work accomplished by a motor compare different amounts of work done calculate power calculate power of two different machines analyze power of motor how to calculate electrical power | 31 31 191 191 263 | calculate work done on block work = force X distance calculating work input and work output power of an immersion heater calculate the power output of a photovoltaic cell |

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|---|--------------|---------------------------|---|----------------------------|--|-----------------------------|--|
| PHY.03.01 Physical Sciences/ Physics | High School | Heat and Heat Transfer | Relate thermal energy to molecular motion. | 451 | increasing temperature means increasing motion of molecules | 119 | adding heat energy to melt an ice cube |
| | | | | 451 | temperature is a measure of average kinetic energy | | |
| | | | | 452 | molecular motion increases when temperature increases | | |
| PHY.03.02 Physical Sciences/ Physics | High School | Heat and Heat Transfer | Differentiate between specific heat and heat capacity. | 456 | definition of specific heat | 205 | investigating how the high specific heat of water helps regulate Earth 's temperature |
| | | | | 456 | specific heat | | |
| | | | | 458 | water's specific heat helps regulate Earth's temperature | | |
| | | | | 459 | heat equation | | |
| PHY.03.03 Physical Sciences/ Physics | High School | Heat and Heat Transfer | Explain the relationship among temperature change in a substance for a given amount of heat transferred, the amount (mass) of the substance, and the specific heat of the substance. | 454 | changes in temperature are directly related to changes in energy | 119 | investigate temperature and energy transfer in melting process |
| | | | | 455 | description and use of BTUs | 188 | investigate the increase of temperature of water as thermal energy is added |
| | | | | 456 | definition of specific heat | | |
| | | | | 456 | specific heat | | |
| | | | | 458 | water's specific heat helps regulate Earth's temperature | 205 | investigating how the high specific heat of water helps regulate Earth 's temperature |
| | | | | 459 | heat equation | | |
| | | | | 460 | thermal equilibrium | | |
| | | | | 468 | use of "R value" | | |

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|---|--------------|---------------------------|---|----------------------------|---|-----------------------------|--|
| PHY.03.04 Physical Sciences/ Physics | High School | Heat and Heat Transfer | Recognize that matter exists in four phases, and explain what happens during a phase change. | 284 | melting and boiling points | 118 | observe melting process and study quantitatively |
| | | | | 284 | melting and boiling point explained | 118 | investigate melting |
| | | | | 284 | states of matter and arrangement of molecules | 118 | molecules in a liquid |
| | | | | 284 | changes of state | 119 | melting point of ice |
| | | | | 285 | table of melting and boiling points | 119 | investigate melting and create a graph |
| | | | | 285 | characteristics of matter related to its state | 119 | create a temperature vs. time graph of phase change |
| | | | | 405 | molecular structure of ice | 119 | energy and phase changes |
| | | | | 498 | phases changes in the atmosphere | 203 | investigate the temperature/time curves as water is cooled through a phase change to ice |
| | | | | 204 | compare the shape of the water line and the ice line on the temperature/time graph | | |

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|--|-------------|-------|--|---|--|----------------------------|--|
| PHY.04.01 Physical Sciences/ Physics | High School | Waves | Differentiate between wave motion (simple harmonic nonlinear motion) and the motion of objects (nonharmonic). | 180 184 195 197 205 480 626 | oscillators explained understanding graphs of harmonic motion waves transmit energy transverse and longitudinal waves standing waves on a string energy and radiation relationships the sun's energy reaches Earth in the form of electromagnetic waves | 82 84 | study wave pulses on elastic cord make different types of waves in a ripple tank |
| PHY.04.02 Physical Sciences/ Physics | High School | Waves | Recognize the measurable properties of waves (e.g., velocity, frequency, wavelength) and explain the relationships among them. | 179 182 182 192 198 215 219 221 242 | what is a cycle? concept of frequency explained concept of period explained analyze systems to find cycle/period/frequency frequency and wavelength and amplitude properties of sound waves frequency of sound and pitch importance of wavelength of sound waves properties of light waves | 83 83 86 86 90 | measure speed of a wave pulse find speed of a wave investigate frequency and wavelength adjust frequency of a standing wave what is sound and how do we hear it? |

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|---|--------------|--------------|--|--|--|--------------------------------|---|
| PHY.04.03 Physical Sciences/ Physics | High School | Waves | Distinguish between transverse and longitudinal waves | 197 205 538 | transverse and longitudinal waves standing waves on a string body waves | 82 84 | study wave pulses on elastic cord make different types of waves in a ripple tank |
| PHY.04.04 Physical Sciences/ Physics | High School | Waves | Distinguish between mechanical and electromagnetic waves. | 480 | electromagnetic radiation | | |
| PHY.04.05 Physical Sciences/ Physics | High School | Waves | Interpret and be able to apply the laws of reflection and refraction (qualitatively) to all waves. | 201 201 201 202 245 258 260 261 263 263 | waves and refraction waves and reflection reflection in water waves and light waves refraction and eyeglasses we see color in terms of reflected light refraction in optical systems reflection and mirrors refraction and lenses index of refraction index of refraction | 85 106 107 108 108 | observing reflection in water waves investigate reflection of light plot reflected rays from a mirror tracing incident and refracted rays explore refraction with a prism |

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|--|-------------|-------|---|--|---|---|---|
| PHY.04.06 Physical Sciences/ Physics | High School | Waves | Recognize the effects of polarization, wave interaction, and the Doppler effect. | 201 201 201 201 202 206 210 223 225 240 261 648 | waves and absorption waves and refraction waves and reflection reflection in water waves and light waves refraction and eyeglasses constructive and destructive interference can wave interference sink a ship? interference of sound waves consonance and dissonance and beats polarization of light refraction and lenses the Doppler effect | 85 95 95 101 102 102 103 108 | observing reflection in water waves interference and sound waves investigate interference with sound waves examine light through diffraction grating polarization of a spring wave polarization of water waves polarization of light explore refraction with a prism |
| PHY.04.07 Physical Sciences/ Physics | High School | Waves | Explain, graph, and interpret graphs of constructive and destructive interference of waves. | 184 | understanding graphs of harmonic motion | | |
| PHY.04.08 Physical Sciences/ Physics | High School | Waves | Explain the relationship between the speed of a wave (e.g., sound) and the medium it travels through. | 197 205 | transverse and longitudinal waves standing waves on a string | 82 84 | study wave pulses on elastic cord make different types of waves in a ripple tank |

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|---|--------------|------------------|--|---------------------------------|---|-----------------------------|---|
| PHY.04.09 Physical Sciences/ Physics | High School | Waves | Recognize the characteristics of a standing wave and explain the conditions under which two waves on a string or in a pipe can interfere to produce a standing wave. | 204 210 | resonance explained natural frequency of a building and earthquakes | 87 88 96 | investigating resonance natural frequency and resonance of standing waves on a string investigating sound resonance |
| PHY.05.01 Physical Sciences/ Physics | High School | Electromagnetism | Recognize the characteristics of static charge, and explain how a static charge is generated. | 105 106 107 108 108 | charge is a fundamental property of matter static charge discussed explanation of coulomb electroscopes how an electroscope works | 42 | investigate electric charge |
| PHY.05.04 Physical Sciences/ Physics | High School | Electromagnetism | Develop a qualitative and quantitative understanding of current, voltage, resistance, and the connection between them. | 106 106 131 132 | electrical forces electrical force is incredibly strong! Ohm's law explained using Ohm's law to analyze circuits | 50 | Ohm's law |

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|---|--------------|------------------|--|----------------------------|---|-----------------------------|---|
| PHY.05.05 Physical Sciences/ Physics | High School | Electromagnetism | Identify appropriate units of measurement for current, voltage, and resistance, and explain how they are measured. | 101 | concept of electric current | 44 | investigate concept of voltage |
| | | | | 114 | voltage and potential energy | 46 | investigate concept of electric current |
| | | | | 115 | how to measure voltage | 48 | measuring resistance |
| | | | | 123 | understand the concept of electrical resistance | | |
| | | | | 136 | potentiometer explained | | |

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|--|-------------|------------------|--|--------------------|---|---------------------|--|
| PHY.05.06 Physical Sciences/ Physics | High School | Electromagnetism | Analyze circuits (find the current at any point and the potential difference between any two points in the circuit) using Kirchoff's and Ohm's laws. | 102 | concept of electric circuits | 45 | battery chemicals and electrical charge |
| | | | | 103 | circuit diagrams | 50 | Ohm's law |
| | | | | 113 | battery uses chemical energy to produce electrical charge | 56 | build a parallel circuit |
| | | | | 131 | Ohm's law explained | 56 | build a series circuit |
| | | | | 132 | using Ohm's law to analyze circuits | 57 | compare brightness of bulbs in series vs. parallel |
| | | | | 145 | single path vs. branching paths | 58 | build a series circuit and find total resistance |
| | | | | 145 | holiday lights as series or parallel | 60 | parallel circuit and Ohm's law |
| | | | | 145 | parallel circuit defined | 61 | compare current and voltage and resistance in each type of circuit |
| | | | | 145 | series circuit defined | | |
| | | | | 146 | household wiring | | |
| | | | | 147 | current and voltage in series circuits | | |
| | | | | 151 | voltage and resistance in parallel circuits | | |
| | | | | 155 | analyze a parallel circuit | | |
| | | | | 156 | analyze a series circuit | | |

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|---|--------------|------------------------------|---|---------------------------------|--|-----------------------------|---|
| PHY.06.01 Physical Sciences/ Physics | High School | Electromagnetic Radiation | Describe the electromagnetic spectrum in terms of wavelength and energy, and be able to identify specific regions such as visible light. | 237 237 242 479 | visible light and the electromagnetic spectrum light waves and the electromagnetic spectrum color and frequency of light waves ultraviolet and infrared light | 105 134 265 | explore relationship between color and wavelength investigating visible light with a spectrometer an element's spectral lines correspond to specific wavelengths of light |
| PHY.06.02 Physical Sciences/ Physics | High School | Electromagnetic Radiation | Explain how the various wavelengths in the electromagnetic spectrum have many useful applications such as radio, television, microwave appliances, and cellular telephones. | 196 237 237 250 272 | waves are all around us radio and television signals microwave ovens identify uses of electromagnetic waves identify uses of electromagnetic waves | | |
| PHY.06.03 Physical Sciences/ Physics | High School | Electromagnetic Radiation | Calculate the frequency and energy of an electromagnetic wave from the wavelength. | 195 242 480 626 | waves transmit energy color and frequency of light waves energy and radiation relationships the sun's energy reaches Earth in the form of electromagnetic waves | 105 265 | explore relationship between color and wavelength an element's spectral lines correspond to specific wavelengths of light |

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|--|-------------|---------------------------|--|--------------------|--|---------------------|--|
| PHY.06.04 Physical Sciences/ Physics | High School | Electromagnetic Radiation | Recognize and explain the ways in which the direction of visible light can be changed. | 245 | we see color in terms of reflected light | 101 | observing white light through diffraction grating |
| | | | | 258 | refraction in optical systems | 106 | tracing incident and reflected rays |
| | | | | 258 | forming images with lenses | 106 | investigate reflection of light |
| | | | | 260 | reflection and mirrors | 107 | investigate how light interacts with mirrors |
| | | | | 263 | index of refraction | 107 | plot reflected rays from a mirror |
| | | | | 263 | index of refraction | 107 | plot reflected rays from a mirror |
| | | | | 268 | total internal reflection and fiber optics | 108 | tracing incident and refracted rays |
| | | | | 273 | find the angle of reflection | 108 | explore refraction with lenses |
| | | | | 480 | absorption and emission | 108 | investigate how light interacts with a prism |
| | | | | | | 110 | finding focal point and focal length of a lens |
| | | | | | | 111 | plotting images formed when light is refracted by a lens |
| | | | | | | 113 | observe internal reflection and relate to fiber optics |
| | | | | | | 253 | using a retractive telescope |
| | | | | | | 254 | calculate the magnification of a telescope |