

Correlation to Missouri Science Expectations, Grade 9 - 11

Foundations of Physics

Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|--|---|---|--|---|-----------------------------|-------------------------------|
| 1.1.D.a Properties and Principles of Matter and Energy | Changes in properties and states of matter provide evidence of the atomic theory of matter | Physical changes in states of matter due to thermal changes in materials can be explained by moving particles | Using the kinetic theory model, explain the changes that occur in the distance between atoms/molecules and temperature of a substance as energy is absorbed or released during a phase change | 506 509 509 509 509 510 510 511 511 519 520 606 | temperature and addition of heat energy heat of fusion temp vs. time graph for phase change of ice to water temp vs. time graph for phase change of ice to water melting heat of vaporization boiling evaporation and condensation evaporation and condensation temp vs. time graphs for various materials temp vs. time curve question energy from sunlight stored through photosynthesis | 177 | observe a common phase change |

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|---|--|---|--|--|--|---------------------|--|
| 1.1.D.b Properties and Principles of Matter and Energy | Changes in properties and states of matter provide evidence of the atomic theory of matter | Physical changes in states of matter due to thermal changes in materials can be explained by moving particles | Predict the effect of a temperature change on the properties of a material | 512 513 522 523 524 537 | temperature and thermal energy and heat balance of thermal energy thermal equilibrium thermal conductors and insulators thermal conductivity heat flow between objects of different temperature | 178 180 | explore the connection between temperature and heat and energy investigate the thermal conductivity of various materials |
| 1.1.D.c Properties and Principles of Matter and Energy | Changes in properties and states of matter provide evidence of the atomic theory of matter | Physical changes in states of matter due to thermal changes in materials can be explained by moving particles | Predict the effect of pressure changes on the properties of a material | 548 551 558 563 | forces applied to fluids create pressure fluids flow because of pressure differences pressure and temperature of gases stress vs. pressure | 192 193 193 | investigate the mass of a volume of gas at different pressures compare gauge and absolute pressure investigate the effect of temperature on pressure |

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|---|--|--|---|--------------------|--|---------------------|---|
| 1.1.E.a Properties and Principles of Matter and Energy | Changes in properties and states of matter provide evidence of the atomic theory of matter | The atomic model describes the electrically neutral atom | Describe the atom as having a dense, positive nucleus surrounded by a cloud of negative electrons | 420 | electric charge is a property of the particles that make up the atom | 194 | basic properties of subatomic particles |
| | | | | 420 | electric charge is a property of the particles that make up the atom | 194 | subatomic particles |
| | | | | | | 203 | electrons and energy levels |
| | | | | 422 | movement of electrons in current | 203 | review subatomic particles |
| | | | | 437 | draw a model of an atom | | |
| | | | | 444 | electrons and magnetism | | |
| | | | | 444 | magnetism is a property of particles that make up the atom | | |
| | | | | 459 | atomic currents | | |
| | | | | 480 | electrons in a semiconductor | | |
| | | | | 500 | smallest piece of matter is the atom | | |
| | | | | 566 | charge and mass of electrons and protons and neutrons | | |
| | | | | 566 | three particles make up the atom | | |
| | | | | 567 | mass and the nucleus | | |
| | | | | 567 | structure of the atom | | |
| | | | | 572 | stability of nucleus and balance of protons and neutrons | | |
| 574 | Neils Bohr's theory | | | | | | |

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|---|--|--|---|--------------------|---|---------------------|---|
| | | | | 576 | Neils Bohr | | |
| | | | | 577 | energy levels explain spectral lines | | |
| | | | | 588 | properties of subatomic particles | | |
| 1.1.E.b Properties and Principles of Matter and Energy | Changes in properties and states of matter provide evidence of the atomic theory of matter | The atomic model describes the electrically neutral atom | Calculate the number of protons, neutrons, and electrons of an element (or isotopes) given its atomic mass (or mass number) and atomic number | 502 | the periodic table | 175 | identify symbol and atomic number and average atomic mass |
| | | | | 569 | elements and atoms and atomic number | 175 | record atomic number |
| | | | | 570 | chemical properties of isotopes due to atomic structure | 194 | identify symbol and atomic number and mass number |

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|---|--|--|---|--------------------|--|---------------------|---|
| 1.1.E.c Properties and Principles of Matter and Energy | Changes in properties and states of matter provide evidence of the atomic theory of matter | The atomic model describes the electrically neutral atom | Describe the information provided by the atomic number and the mass number (i.e. electrical charge, chemical stability) | 420 | electric charge is a property of the particles that make up the atom | 194 | basic properties of subatomic particles |
| | | | | 420 | electric charge is a property of the particles that make up the atom | 194 | subatomic particles |
| | | | | 422 | movement of electrons in current | 194 | isotopes |
| | | | | 437 | draw a model of an atom | 203 | review subatomic particles |
| | | | | 444 | magnetism is a property of particles that make up the atom | 213 | explore radioactive isotopes |
| | | | | 444 | electrons and magnetism | | |
| | | | | 459 | atomic currents | | |
| | | | | 480 | electrons in a semiconductor | | |
| | | | | 500 | smallest piece of matter is the atom | | |
| | | | | 566 | charge and mass of electrons and protons and neutrons | | |
| | | | | 566 | three particles make up the atom | | |
| | | | | 567 | mass and the nucleus | | |
| | | | | 567 | structure of the atom | | |
| | | | | 570 | isotopes explained | | |
| | | | | 571 | atomic mass of stable isotopes | | |

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|-------------------------|-----------|---------|--------------|--------------------|--|---------------------|--------|
| | | | | 572 | stability of nucleus and balance of protons and neutrons | | |
| | | | | 572 | chart of stable isotopes | | |
| | | | | 588 | properties of subatomic particles | | |
| | | | | 588 | carbon isotopes | | |

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|---|---|---|---|--------------------|--|---------------------|--|
| 1.2.A.a Properties and Principles of Matter and Energy | Energy has a source, can be transferred, and transformed into various forms but is conserved between and within systems | Forms of energy have a source, a means of transfer (work and heat) and a receiver | Differentiate between thermal energy, heat, and temperature | 195 | frictional energy converted to heat | 176 | investigate temperature and its effect on materials |
| | | | | 203 | friction converts input work to heat | 178 | explore the connection between temperature and heat and energy |
| | | | | 504 | temperature scales and Fahrenheit-Celsius conversions | 179 | specific heat |
| | | | | 505 | measuring temperature | | |
| | | | | 507 | the Kelvin scale and converting between Kelvin and Celsius | | |
| | | | | 509 | temperature change and thermal energy | | |
| | | | | 512 | temperature and thermal energy and heat | | |
| | | | | 513 | transfer of thermal energy | | |
| | | | | 513 | balance of thermal energy | | |
| | | | | 514 | specific heat and the heat equation | | |
| | | | | 516 | refrigerator application | | |
| | | | | 519 | understanding Fahrenheit and Celsius and Kelvin | | |
| | | | | 522 | thermal equilibrium | | |
| | | | | 523 | thermal conductors and insulators | | |
| | | | | 533 | using Kelvin for radiation calculations | | |
| | | | | 535 | sources of heat transfer in buildings | | |

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|---|---|---|--|--------------------|--|---------------------|---|
| | | | | 537 | heat flow between objects of different temperature | | |
| | | | | 558 | using temperature in Kelvins for Charles' law | | |
| 1.2.A.c Properties and Principles of Matter and Energy | Energy has a source, can be transferred, and transformed into various forms but is conserved between and within systems | Forms of energy have a source, a means of transfer (work and heat) and a receiver | Describe the relationship among wavelength, energy, and frequency as illustrated by the electromagnetic spectrum | 311 | fluorescent bulbs create UV light | 122 | study properties of the electromagnetic spectrum |
| | | | | 320 | the energy of IR and UV light | 124 | use a spectrometer to measure wavelength of different colors of light |
| | | | | 320 | visible light has just the right energy for life | | |
| | | | | 357 | relationship between frequency and energy and color of light | | |
| | | | | 359 | description and examples of infrared waves | | |
| | | | | 360 | description and examples of ultraviolet waves | | |
| | | | | 360 | visible light waves | | |
| | | | | 375 | relate color to frequency for visible light | | |
| | | | | 531 | thermal radiation and infrared light | | |
| | | | | 624 | UV light is ionizing radiation | | |

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|---|---|---|---|--------------------|---|---------------------|-----------------------------|
| 1.2.A.d Properties and Principles of Matter and Energy | Energy has a source, can be transferred, and transformed into various forms but is conserved between and within systems | Forms of energy have a source, a means of transfer (work and heat) and a receiver | Describe sources and common uses of different forms of energy | 189 | energy appears in different forms | 72 | draw an energy flow diagram |
| | | | | 190 | different forms of energy | | |
| | | | | 190 | conversions of energy | | |
| | | | | 194 | energy transformations | | |
| | | | | 196 | energy transformation hydroelectric plant | | |
| | | | | 199 | trace the energy transformations from sun to a flashing taillight | | |
| | | | | 202 | efficiency and energy conversions | | |
| | | | | 204 | efficiency of Earth | | |
| | | | | 205 | calories in food | | |
| | | | | 205 | efficiency in biological systems | | |
| | | | | 210 | energy from the sun drives the weather on Earth | | |
| | | | | 212 | energy conversion | | |
| | | | | 212 | understand basic forms of energy | | |
| | | | | 213 | the conversion process of energy flow | | |
| | | | | 215 | energy flows in biological systems | | |
| | | | | 219 | energy flow of a model solar car | | |

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|-------------------------|-----------|---------|--------------|--------------------|---|---------------------|--------|
| | | | | 256 | resonant systems accumulate energy | | |
| | | | | 277 | waves propagate by exchanging energy between two forms | | |
| | | | | 310 | light is a form of energy | | |
| | | | | 320 | photosynthesis converts light energy to chemical energy | | |
| | | | | 322 | photons are bundles of light energy | | |
| | | | | 324 | light from chemical reactions | | |
| | | | | 356 | electromagnetic waves exchange energy between electricity and magnetic parts | | |
| | | | | 378 | electrical energy | | |
| | | | | 384 | batteries use chemical energy | | |
| | | | | 393 | conversion of energy in regenerative braking | | |
| | | | | 400 | energy conversions in a series circuit | | |
| | | | | 451 | MRI--energy exchange by a nucleus in a magnetic field | | |
| | | | | 464 | electric motor uses electromagnets to convert electrical energy to mechanical energy | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|--|---------------------|--------|
| | | | | 467 | electric generators transform mechanical energy into electric energy | | |
| | | | | 552 | explanation of pressure and energy | | |
| | | | | 619 | radiation as a flow of energy | | |
| | | | | 622 | energy of x-rays | | |
| | | | | 627 | fusion reactions and the sun | | |
| | | | | 647 | energy from antimatter | | |

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|--|---|---|--|--------------------|--|---------------------|---|
| 1.2.A.e Properties and Principles of Matter and Energy | Energy has a source, can be transferred, and transformed into various forms but is conserved between and within systems | Forms of energy have a source, a means of transfer (work and heat) and a receiver | Identify and evaluate advantages/disadvantages of using various sources of energy for human activity | 196 | environmental impacts of hydroelectric power | 143 | the cost of using electrical appliances |
| | | | | 196 | hydroelectric power system | | |
| | | | | 197 | efficiency of the Hoover Dam | | |
| | | | | 217 | advantages of tidal energy | | |
| | | | | 217 | extracting tidal power | | |
| | | | | 470 | energy for generators | | |
| | | | | 602 | hydrogen as a fuel | | |
| | | | | 608 | alternate fuels to gasoline | | |
| | | | | 618 | power released by radioactive decay | | |
| | | | | 631 | nuclear power application | | |
| | | | | 631 | nuclear power application | | |
| | | | | 632 | nuclear energy | | |
| | | | | 634 | comparison of fission and fusion | | |

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|---|---|---|---|----------------------------|--|-----------------------------|--|
| 1.2.A.f Properties and Principles of Matter and Energy | Energy has a source, can be transferred, and transformed into various forms but is conserved between and within systems | Forms of energy have a source, a means of transfer (work and heat) and a receiver | Describe the effect of different frequencies of electromagnetic waves on the Earth and living organisms | 311 | fluorescent bulbs create UV light | 122 | study properties of the electromagnetic spectrum |
| | | | | 311 | fluorescent bulbs create UV light | | |
| | | | | 320 | the energy of IR and UV light | | |
| | | | | 320 | visible light has just the right energy for life | | |
| | | | | 320 | the energy of IR and UV light | | |
| | | | | 359 | description and examples of infrared waves | | |
| | | | | 359 | description and examples of infrared waves | | |
| | | | | 360 | description and examples of ultraviolet waves | | |
| | | | | 360 | visible light waves | | |
| | | | | 360 | description and examples of ultraviolet waves | | |
| | | | | 531 | thermal radiation and infrared light | | |
| | | | | 531 | thermal radiation and infrared light | | |
| | | | | 624 | UV light is ionizing radiation | | |
| 624 | UV light is ionizing radiation | | | | | | |

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|--|---|---|---|---|---|-----------------------------|---|
| 1.2.A.g Properties and Principles of Matter and Energy | Energy has a source, can be transferred, and transformed into various forms but is conserved between and within systems | Forms of energy have a source, a means of transfer (work and heat) and a receiver | Interpret examples of heat transfer as convection, conduction, or radiation | 522 523 524 524 526 527 528 530 535 | heat conduction heat conduction conduction in solids and liquids and gases thermal conductivity convection in liquids convection depends on speed and surface area convection and weather radiation sources of heat transfer in buildings | 180 182 | investigate the thermal conductivity of various materials investigate convection in a liquid |

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|---|---|--|--|--------------------|--|---------------------|---|
| 1.2.B.a Properties and Principles of Matter and Energy | Energy has a source, can be transferred, and transformed into various forms but is conserved between and within systems | Mechanical energy comes from the motion and/or position of an object | Relate kinetic energy to an object's mass and its velocity | 191 | the formula for potential energy | 68 | calculate potential and kinetic energy |
| | | | | 192 | the formula for kinetic energy | 72 | potential to kinetic energy conversion in a pendulum |
| | | | | 193 | deriving the formula for kinetic energy | 88 | potential to kinetic energy conversions of a pendulum |
| | | | | 194 | energy transformations | | |
| | | | | 196 | energy transformation hydroelectric plant | | |
| | | | | 199 | kinetic and potential energy conversions while bouncing in a trampoline | | |
| | | | | 212 | energy flow in a pendulum | | |
| | | | | 245 | kinetic to potential energy changes in motion of an oscillator | | |
| | | | | 253 | oscillators exchange energy back and forth between potential and kinetic | | |
| | | | | 253 | harmonic motion involves both potential and kinetic energy | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|---|--|---|--------------------|--|---------------------|---|
| 1.2.B.b Properties and Principles of Matter and Energy | Energy has a source, can be transferred, and transformed into various forms but is conserved between and within systems | Mechanical energy comes from the motion and/or position of an object | Relate an object's gravitational potential energy to its weight and height relative to the surface of the earth | 191 | the formula for potential energy | 68 | calculate potential and kinetic energy |
| | | | | 192 | the formula for kinetic energy | 72 | potential to kinetic energy conversion in a pendulum |
| | | | | 193 | deriving the formula for kinetic energy | 88 | potential to kinetic energy conversions of a pendulum |
| | | | | 194 | energy transformations | | |
| | | | | 196 | energy transformation hydroelectric plant | | |
| | | | | 199 | kinetic and potential energy conversions while bouncing in a trampoline | | |
| | | | | 212 | energy flow in a pendulum | | |
| | | | | 245 | kinetic to potential energy changes in motion of an oscillator | | |
| | | | | 253 | oscillators exchange energy back and forth between potential and kinetic | | |
| 253 | harmonic motion involves both potential and kinetic energy | | | | | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|--|---|--|--|--------------------|--|---------------------|---|
| 1.2.B.c Properties and Principles of Matter and Energy | Energy has a source, can be transferred, and transformed into various forms but is conserved between and within systems | Mechanical energy comes from the motion and/or position of an object | Distinguish between examples of kinetic and potential energy with a system | 194 | energy transformations | 66 | law of conservation of energy |
| | | | | 195 | applying conservation of energy for a marble rolling on a hilly track | 68 | find the total energy at each position |
| | | | | 196 | energy transformation hydroelectric plant | 72 | potential to kinetic energy conversion in a pendulum |
| | | | | 197 | conservation of energy for Hoover Dam | 74 | investigating collisions and conservation of energy |
| | | | | 199 | kinetic and potential energy conversions while bouncing in a trampoline | 88 | potential to kinetic energy conversions of a pendulum |
| | | | | 212 | energy flow in a pendulum | | |
| | | | | 245 | kinetic to potential energy changes in motion of an oscillator | | |
| | | | | 253 | oscillators exchange energy back and forth between potential and kinetic | | |

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|---|---|--|--|--|--|---------------------|--|
| 1.2.C.b Properties and Principles of Matter and Energy | Energy has a source, can be transferred, and transformed into various forms but is conserved between and within systems | Electromagnetic energy from the sun is a major source of energy on Earth | Describe how electromagnetic energy is transferred through space as electromagnetic waves | 262 263 272 277 362 530 574 575 638 | waves transmit energy waves are a form of traveling energy waves transfer energy through absorption energy of a wave diffraction patterns and the spectrometer energy and radiation relationships emission/absorption spectrum spectrum of hydrogen spectral-line patterns and red shift | 95 110 197 | waves carry energy from one place to another all light is produced by atoms absorption and emission of light by atomic electrons |
| 1.2.E.a Properties and Principles of Matter and Energy | Energy has a source, can be transferred, and transformed into various forms but is conserved between and within systems | Nuclear energy is a major source of energy throughout the universe | Describe how changes in the nucleus of an atom during a nuclear reaction result in the emission of radiation | 502 570 573 573 614 616 625 627 628 635 | elements past #92 are radioactive and decay radioactive isotopes fusion nuclear reactions radioactive decay energy and radioactivity nuclear reactions fusion reactions fission reactions differences between fission and fusion | 213 | fusion and fission |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|---|--|---|--|---|-----------------------------|--------------------|
| 1.2.E.b Properties and Principles of Matter and Energy | Energy has a source, can be transferred, and transformed into various forms but is conserved between and within systems | Nuclear energy is a major source of energy throughout the universe | Identify the role of nuclear energy as it serves as a source of energy for the Earth, stars, and human activity | 570 573 622 623 627 628 632 635 | use of radioactive isotopes in medicine fusion x-ray machines CAT scans fusion reactions fission reactions nuclear energy differences between fission and fusion | 213 | fusion and fission |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|---|---|---|--------------------|--|---------------------|---|
| 1.2.F.a Properties and Principles of Matter and Energy | Energy has a source, can be transferred, and transformed into various forms but is conserved between and within systems | Energy can change from one form to another within and between systems but the total amount remains the same | Describe the transformations that occur as energy changes from kinetic to potential within a system | 194 | energy transformations | 66 | law of conservation of energy |
| | | | | 195 | applying conservation of energy for a marble rolling on a hilly track | 68 | find the total energy at each position |
| | | | | 196 | energy transformation hydroelectric plant | 72 | potential to kinetic energy conversion in a pendulum |
| | | | | 197 | conservation of energy for Hoover Dam | 74 | investigating collisions and conservation of energy |
| | | | | 199 | kinetic and potential energy conversions while bouncing in a trampoline | 88 | potential to kinetic energy conversions of a pendulum |
| | | | | 212 | energy flow in a pendulum | | |
| | | | | 245 | kinetic to potential energy changes in motion of an oscillator | | |
| | | | | 253 | oscillators exchange energy back and forth between potential and kinetic | | |

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|--|---|---|---|--|---|-----------------------------|------------------------------------|
| 1.2.F.b Properties and Principles of Matter and Energy | Energy has a source, can be transferred, and transformed into various forms but is conserved between and within systems | Energy can change from one form to another within and between systems but the total amount remains the same | Compare the efficiency of simple machines | 202 203 213 219 220 236 311 393 | definition of efficiency efficiency explained efficiency of an energy flow process ideal vs. real machine calculate efficiency of model solar car fuel efficiency of turbofan engines efficiency of electric vs. fluorescent light bulbs efficiency of hybrid cars | 69 | calculate efficiency for each ball |

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|--|---|---|--|--------------------|---|---------------------|-----------------------------|
| 1.2.F.c Properties and Principles of Matter and Energy | Energy has a source, can be transferred, and transformed into various forms but is conserved between and within systems | Energy can change from one form to another within and between systems but the total amount remains the same | Classify the different forms of energy that can be observed as energy is transferred and transformed with a system when given a scenario | 189 | energy appears in different forms | 72 | draw an energy flow diagram |
| | | | | 190 | different forms of energy | | |
| | | | | 190 | conversions of energy | | |
| | | | | 194 | energy transformations | | |
| | | | | 196 | energy transformation hydroelectric plant | | |
| | | | | 199 | trace the energy transformations from sun to a flashing taillight | | |
| | | | | 202 | efficiency and energy conversions | | |
| | | | | 204 | efficiency of Earth | | |
| | | | | 205 | calories in food | | |
| | | | | 205 | efficiency in biological systems | | |
| | | | | 210 | energy from the sun drives the weather on Earth | | |
| | | | | 212 | energy conversion | | |
| | | | | 212 | understand basic forms of energy | | |
| | | | | 213 | the conversion process of energy flow | | |
| | | | | 215 | energy flows in biological systems | | |
| | | | | 219 | energy flow of a model solar car | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|---|---------------------|--------|
| | | | | 256 | resonant systems accumulate energy | | |
| | | | | 277 | waves propagate by exchanging energy between two forms | | |
| | | | | 310 | light is a form of energy | | |
| | | | | 320 | photosynthesis converts light energy to chemical energy | | |
| | | | | 322 | photons are bundles of light energy | | |
| | | | | 324 | light from chemical reactions | | |
| | | | | 356 | electromagnetic waves exchange energy between electricity and magnetic parts | | |
| | | | | 378 | electrical energy | | |
| | | | | 384 | batteries use chemical energy | | |
| | | | | 393 | conversion of energy in regenerative braking | | |
| | | | | 400 | energy conversions in a series circuit | | |
| | | | | 451 | MRI--energy exchange by a nucleus in a magnetic field | | |
| | | | | 464 | electric motor uses electromagnets to convert electrical energy to mechanical energy | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|--|---------------------|--------|
| | | | | 467 | electric generators transform mechanical energy into electric energy | | |
| | | | | 552 | explanation of pressure and energy | | |
| | | | | 619 | radiation as a flow of energy | | |
| | | | | 622 | energy of x-rays | | |
| | | | | 627 | fusion reactions and the sun | | |
| | | | | 647 | energy from antimatter | | |

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|--|---|---|--|--------------------|---|---------------------|--------|
| 1.2.F.d Properties and Principles of Matter and Energy | Energy has a source, can be transferred, and transformed into various forms but is conserved between and within systems | Energy can change from one form to another within and between systems but the total amount remains the same | Explain how energy can be transferred or transformed between and within systems as the total amount of energy remains constant | 194 | conservation of energy explained | | |
| | | | | 194 | the law of conservation of energy | | |
| | | | | 195 | conservation of energy in a closed system | | |
| | | | | 203 | efficiency and conservation of energy | | |
| | | | | 206 | connection between efficiency and time | | |
| | | | | 215 | energy flows in biological systems | | |
| | | | | 227 | kinetic energy conservation for elastic collisions | | |
| | | | | 370 | relationship and conservation of mass and energy | | |
| | | | | 469 | energy conservation and Faraday's law | | |
| | | | | 515 | thermodynamics and conservation of energy | | |
| 552 | conservation of energy in fluids | | | | | | |
| 553 | energy conservation and Bernoulli's equation | | | | | | |
| 629 | conservation of energy in nuclear reactions | | | | | | |

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|--|--|--|---|--------------------|---|---------------------|---|
| 2.1.A.a Properties and Principles of Force and Motion | The motion of an object is described by its change in position relative to another object or point | The motion of an object is described as a change in position, direction, and speed relative to another object (frame of reference) | Represent and analyze the motion of an object graphically | 47 | position vs. time graph | 13 | graph speed versus position |
| | | | | 48 | determining speed from the slope of a position vs. time graph | 16 | create a speed vs. time graph |
| | | | | 48 | graphs showing changes in speed | 16 | create a position vs. time graph |
| | | | | 49 | speed vs. time graph for constant speed | 19 | make a speed vs. time graph |
| | | | | 50 | graphs for motion of increasing speed and decreasing speed | 20 | speed vs. time graph for uniform acceleration |
| | | | | 50 | speed vs. time graph for downhill motion | 22 | create a speed vs. time graph |
| | | | | 54 | graphing speed vs. time | 22 | create a position vs. time graph |
| | | | | 55 | analyzing distance vs. time graph | | |
| | | | | 61 | constant speed and constant acceleration | | |
| | | | | 62 | speed vs. time graph for accelerated motion | | |
| | | | | 63 | complex speed vs. time graphs | | |
| | | | | 63 | calculating acceleration from a speed vs. time graph | | |
| | | | | 65 | calculating distance from speed vs. time graph | | |
| | | | | 74 | describing motion with speed vs. time graph | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|--|--|--|--|--------------------|---|---------------------|-----------------------------------|
| | | | | 74 | sketching speed vs. time graphs for different changes of motion | | |
| | | | | 76 | analyzing graph for changes in motion | | |
| | | | | 260 | velocity vs. time graph of harmonic motion | | |
| | | | | 260 | position vs. time graph of harmonic motion | | |
| 2.1.A.b Properties and Principles of Force and Motion | The motion of an object is described by its change in position relative to another object or point | The motion of an object is described as a change in position, direction, and speed relative to another object (frame of reference) | Analyze the speed of two objects in terms of distance and time | 36 | the precise meaning of speed | 9 | calculate speed of rolling marble |
| | | | | 37 | calculating speed | | |
| | | | | 38 | compare and contrast speed and velocity | | |
| | | | | 38 | the speed formula and calculating speed | | |
| | | | | 41 | speed of a ball on a ramp | | |
| | | | | 46 | speed is the rate of change of position | | |
| | | | | 47 | average and instantaneous speed | | |
| | | | | 74 | understanding average speed and instantaneous speed | | |
| | | | | 125 | speed is the magnitude of the velocity vector | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|--|--|--|--------------------------------|--------------------|---|---------------------|---|
| 2.1.A.c Properties and Principles of Force and Motion | The motion of an object is described by its change in position relative to another object or point | The motion of an object is described as a change in position, direction, and speed relative to another object (frame of reference) | Calculate the speed of objects | 37 | how to calculate speed | 9 | collect data and calculate speed of car |
| | | | | 48 | determining speed from the slope of a position vs. time graph | 10 | make object move with speed of 1 m/sec |
| | | | | 55 | calculate the average speed and distance traveled | 12 | finding speed of ball with one photogate |
| | | | | 64 | calculate speed in accelerated motion | 14 | find the speed of the ball |
| | | | | 75 | calculations of speed | 15 | find speed of the ball |
| | | | | 146 | calculating linear speed of a moving wheel | 17 | find two speeds |
| | | | | 147 | the linear speed of a rolling wheel | 21 | calculate speed of ball |
| | | | | | | 26 | make ball roll at constant speed |
| | | | | | | 33 | calculate the predicted speed |
| | | | | | | 42 | find initial speed of ball |
| | | | | | | 50 | calculate the speed of the ball |
| | | | | | | 66 | find the speed of the ball |
| | | | | | | 68 | what is speed of the ball? |
| | | | | | | 76 | calculate speeds of projectile and target balls |
| | | | | | | 90 | calculate the speed of the wave pulse |
| | | | | | | 191 | calculate speed of air in homemade air-speed tester |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|--|--|---|--------------------|---|---------------------|---|
| 2.1.B.a Properties and Principles of Force and Motion | The motion of an object is described by its change in position relative to another object or point | An object that is accelerating is speeding up, slowing down, or changing direction | Measure and analyze an object's motion in terms of speed, velocity and acceleration | 36 | the precise meaning of speed | 9 | collect data and calculate speed of car |
| | | | | 37 | calculating speed | 9 | calculate speed of rolling marble |
| | | | | 37 | how to calculate speed | 10 | make object move with speed of 1 m/sec |
| | | | | 38 | the speed formula and calculating speed | 12 | finding speed of ball with one photogate |
| | | | | 41 | speed of a ball on a ramp | 14 | find the speed of the ball |
| | | | | 46 | speed is the rate of change of position | 15 | find speed of the ball |
| | | | | 47 | average and instantaneous speed | 16 | create a position vs. time graph |
| | | | | 47 | position vs. time graph | 17 | learn techniques for finding acceleration |
| | | | | 48 | determining speed from the slope of a position vs. time graph | 17 | studying acceleration |
| | | | | 48 | determining speed from the slope of a position vs. time graph | 17 | find two speeds |
| | | | | 55 | analyzing distance vs. time graph | 20 | understanding equation for uniform accelerated motion |
| | | | | 55 | calculate the average speed and distance traveled | 21 | calculate speed of ball |
| | | | | 58 | acceleration is the rate of change in the speed of an object | 22 | create a position vs. time graph |
| | | | | 59 | comparing speed and acceleration | 26 | make ball roll at constant speed |
| | | | | 60 | calculating acceleration from experiments | 33 | calculate the predicted speed |
| | | | | | | 42 | find initial speed of ball |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|--|---------------------|---|
| | | | | 60 | formula for acceleration | 50 | calculate the speed of the ball |
| | | | | 61 | general definition of acceleration | 66 | find the speed of the ball |
| | | | | 61 | zero acceleration vs. constant acceleration vs. acceleration with zero speed | 68 | what is speed of the ball? |
| | | | | 62 | acceleration is total change of speed divided by total change in time | 76 | calculate speeds of projectile and target balls |
| | | | | 64 | calculating the speed of an object that is accelerating | 90 | calculate the speed of the wave pulse |
| | | | | 64 | calculate speed in accelerated motion | 191 | calculate speed of air in homemade air-speed tester |
| | | | | 70 | calculating height and time of flight in free fall problems | | |
| | | | | 74 | understanding average speed and instantaneous speed | | |
| | | | | 75 | calculations of speed | | |
| | | | | 84 | direction of net force and acceleration and speed | | |
| | | | | 103 | calculate the acceleration of a car including friction | | |
| | | | | 128 | constant velocity of horizontal component of projectile motion | | |
| | | | | 129 | analyze a horizontally launched projectile | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|--|--|--|---|--------------------|--|---------------------|--------|
| | | | | 130 | analyzing changing velocity in vertical component of projectile motion | | |
| | | | | 142 | calculating acceleration for sled on slope | | |
| | | | | 146 | calculating linear speed of a moving wheel | | |
| | | | | 147 | the linear speed of a rolling wheel | | |
| | | | | 150 | centripetal acceleration | | |
| | | | | 150 | calculate the centripetal acceleration of a motorcycle | | |
| | | | | 260 | position vs. time graph of harmonic motion | | |
| 2.1.B.b Properties and Principles of Force and Motion | The motion of an object is described by its change in position relative to another object or point | An object that is accelerating is speeding up, slowing down, or changing direction | Calculate the acceleration of an object | 60 | calculating acceleration from experiments | | |
| | | | | 70 | calculating height and time of flight in free fall problems | | |
| | | | | 103 | calculate the acceleration of a car including friction | | |
| | | | | 129 | analyze a horizontally launched projectile | | |
| | | | | 142 | calculating acceleration for sled on slope | | |
| | | | | 150 | calculate the centripetal acceleration of a motorcycle | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|--|--|--|---|----------------------------|--|-----------------------------|--|
| 2.1.C.a Properties and Principles of Force and Motion | The motion of an object is described by its change in position relative to another object or point | Momentum depends on the mass of the object and the velocity with which it is traveling | Compare the momentum of two objects in terms of mass and velocity | 224 | law of conservation of momentum | 78 | which ball had a greater change in momentum? |
| | | | | 225 | conservation of momentum in collisions | | |
| | | | | 226 | applying conservation of momentum | | |
| | | | | 227 | momentum conservation for collisions in two and three dimensions | | |
| | | | | 231 | conservation of angular momentum examples | | |
| | | | | 232 | conservation of angular momentum | | |
| | | | | 235 | jet engines work because of conservation of momentum | | |
| | | | | 370 | Einstein's thinking about momentum of particles moving near the speed of light | | |
| | | | | 629 | conservation of momentum in nuclear reactions | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|--|--|--|--------------------|--|---------------------|--|
| 2.1.C.b Properties and Principles of Force and Motion | The motion of an object is described by its change in position relative to another object or point | Momentum depends on the mass of the object and the velocity with which it is traveling | Explain that the total momentum remains constant within a system | 224 | law of conservation of momentum | 78 | which ball had a greater change in momentum? |
| | | | | 225 | conservation of momentum in collisions | | |
| | | | | 226 | applying conservation of momentum | | |
| | | | | 227 | momentum conservation for collisions in two and three dimensions | | |
| | | | | 231 | conservation of angular momentum examples | | |
| | | | | 232 | conservation of angular momentum | | |
| | | | | 235 | jet engines work because of conservation of momentum | | |
| | | | | 370 | Einstein's thinking about momentum of particles moving near the speed of light | | |
| | | | | 629 | conservation of momentum in nuclear reactions | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|----------------------|---|--|--------------------|---|---------------------|--|
| 2.2.A.a Properties and Principles of Force and Motion | Forces affect motion | Forces are classified as either contact forces (pushes, pulls, friction, buoyancy) or non-contact forces (gravity, magnetism) that can be described in terms of direction and magnitude | Identify and describe the forces acting on an object | 61 | any acceleration must come from a force | 26 | study Newton's first law |
| | | | | 78 | force is an action that can change motion | 27 | were any forces acting on the ball? |
| | | | | 78 | changes in motion only occur through force | 27 | explain how Newton's first law applies |
| | | | | 79 | all objects tend to resist changes in motion | 49 | consider forces acting on the ball |
| | | | | 81 | force is related to acceleration | | |
| | | | | 85 | if there is acceleration there must be force | | |
| | | | | 94 | force calculations in different units | | |
| | | | | 99 | balanced force problems | | |
| | | | | 100 | friction is a force that resists motion | | |
| | | | | 133 | balancing forces in two dimensions | | |
| | | | | 148 | centripetal force causes circular motion | | |
| | | | | 148 | direction of force determines linear or rotational motion | | |
| | | | | 168 | Newton's first law and rotational inertia | | |
| | | | | 222 | Newton's first law and momentum | | |
| | | | | 254 | definition of periodic force | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|----------------------|---|---|--------------------|--|---------------------|--|
| 2.2.B.a Properties and Principles of Force and Motion | Forces affect motion | Every object exerts a gravitational force on every other object | Describe gravity as an attractive force among all objects | 68 | free fall and acceleration due to gravity | 23 | investigate the effect of gravity |
| | | | | 69 | motion formulas for free fall | 51 | calculate gravitational force of attraction |
| | | | | 70 | solving problems with free fall | 51 | investigate law of universal gravitation |
| | | | | 71 | acceleration of gravity does not depend on mass | | |
| | | | | 75 | problem understanding acceleration due to gravity | | |
| | | | | 97 | strength of gravity on Earth and Jupiter | | |
| | | | | 98 | gravity and acceleration and weightlessness | | |
| | | | | 124 | projectiles and trajectories | | |
| | | | | 128 | gravity only accelerates vertical motion | | |
| | | | | 129 | vertical motion of a projectile | | |
| | | | | 130 | projectiles launched at an angle | | |
| | | | | 131 | range of projectiles | | |
| | | | | 134 | resolving force of gravity in ramp coordinates | | |
| | | | | 135 | acceleration down an inclined plane | | |
| | | | | 141 | effects of gravity on motion of a projectile | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|---|---------------------|--------|
| | | | | 152 | description of law of universal gravitation | | |
| | | | | 152 | law of universal gravitation and orbital motion | | |
| | | | | 153 | formula and calculations for law of universal gravitation | | |
| | | | | 154 | orbits and gravitational force | | |
| | | | | 154 | orbital motion | | |
| | | | | 155 | centripetal force and the law of universal gravitation combine to form the orbit equation | | |
| | | | | 158 | calculate weight and acceleration due to gravity on Pluto | | |
| | | | | 158 | compare projectile motion to orbital motion | | |
| | | | | 165 | the motion of a tossed object | | |
| | | | | 166 | centers of mass and gravity may differ | | |
| | | | | 187 | work done against gravity | | |
| | | | | 191 | potential energy comes from gravity | | |
| | | | | 216 | tides are due to force of gravity | | |
| | | | | 642 | Newton's laws and gravity | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|----------------------|---|--|--------------------|---|---------------------|--|
| 2.2.B.b Properties and Principles of Force and Motion | Forces affect motion | Every object exerts a gravitational force on every other object | Compare and describe the gravitational forces between two objects in terms of their masses and the distances between them | 152 | description of law of universal gravitation | 51 | calculate gravitational force of attraction |
| | | | | 153 | formula and calculations for law of universal gravitation | 51 | investigate law of universal gravitation |
| | | | | 154 | orbital motion | | |
| | | | | 158 | calculate weight and acceleration due to gravity on Pluto | | |
| | | | | 216 | tides are due to force of gravity | | |
| | | | | 642 | Newton's laws and gravity | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|--|---|---|--------------------|---|---------------------|---------------------------|
| 2.2.B.c Properties and Principles of Force and Motion | Forces affect motion | Every object exerts a gravitational force on every other object | Describe weight in terms of the force of a planet's or moon's gravity acting on a given mass | 26 | calculating weight from mass | 34 | calculate the weight |
| | | | | 26 | weight is a measure of the force of gravity pulling on mass | 52 | converting mass to weight |
| | | | | 27 | understanding and measuring mass | | |
| | | | | 82 | English unit of force is the pound | | |
| | | | | 92 | measuring forces from a vertical jump | | |
| | | | | 93 | explain the difference between mass and weight | | |
| | | | | 96 | differences between mass and weight | | |
| | | | | 97 | calculating weight with mass and gravity | | |
| | | | | 98 | weight and acceleration | | |
| | | | | 99 | weight calculations | | |
| | | | | 99 | weight is a force but mass is not | | |
| | | | | 115 | explain weight and mass | | |
| | | | | 116 | calculate mass from weight | | |
| 152 | attractive force between mass of person and mass of object is weight | | | | | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|---|---|---|--------------------|--|---------------------|--------------------------------------|
| 2.2.B.d Properties and Principles of Force and Motion | Forces affect motion | Every object exerts a gravitational force on every other object | Recognize that free- falling bodies accelerate at a constant rate (neglecting friction) due to gravity | 68 | free fall and acceleration due to gravity | 23 | investigate the effect of gravity |
| | | | | 69 | motion formulas for free fall | | |
| | | | | 70 | solving problems with free fall | | |
| | | | | 71 | acceleration of gravity does not depend on mass | | |
| | | | | 75 | problem understanding acceleration due to gravity | | |
| | | | | 97 | strength of gravity on Earth and Jupiter | | |
| | | | | 98 | gravity and acceleration and weightlessness | | |
| | | | | 124 | projectiles and trajectories | | |
| | | | | 128 | gravity only accelerates vertical motion | | |
| | | | | 129 | vertical motion of a projectile | | |
| | | | | 130 | projectiles launched at an angle | | |
| | | | | 131 | range of projectiles | | |
| | | | | 134 | resolving force of gravity in ramp coordinates | | |
| | | | | 135 | acceleration down an inclined plane | | |
| 141 | effects of gravity on motion of a projectile | | | | | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|---|---------------------|--------|
| | | | | 152 | law of universal gravitation and orbital motion | | |
| | | | | 154 | satellites and orbital motion | | |
| | | | | 154 | orbits and gravitational force | | |
| | | | | 155 | centripetal force and the law of universal gravitation combine to form the orbit equation | | |
| | | | | 155 | satellite motion application | | |
| | | | | 156 | HEO and geostationary orbit | | |
| | | | | 158 | compare projectile motion to orbital motion | | |
| | | | | 165 | the motion of a tossed object | | |
| | | | | 166 | centers of mass and gravity may differ | | |
| | | | | 187 | work done against gravity | | |
| | | | | 191 | potential energy comes from gravity | | |
| | | | | 243 | orbit is a type of cycle | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|----------------------|---|--|--------------------|--|---------------------|---|
| 2.2.C.a Properties and Principles of Force and Motion | Forces affect motion | Magnetic forces are related to electrical forces as different aspects of a single electromagnetic force | Recognize that changing magnetic fields can produce electrical current and electric currents can produce magnetic forces | 435 | steering the electron beam on television screen | 159 | build an electromagnet |
| | | | | 456 | magnetic field of a wire | 160 | find out what happens to strength of electromagnet when current is increased |
| | | | | 457 | force on a current in a magnetic field | 160 | what happens to the strength of an electromagnet when you increase the current? |
| | | | | 462 | electromagnets | | |
| | | | | 463 | building an electromagnet | | |
| | | | | 464 | electric motor uses electromagnets to convert electrical energy to mechanical energy | 165 | investigate electromagnetic induction |
| | | | | 465 | how electromagnets are used in electric motors | | |
| | | | | 467 | concept of electromagnetic induction | | |
| | | | | 471 | transformers operate on electromagnetic induction | | |
| | | | | 472 | electromagnet-based maglev | | |
| | | | | 475 | diagram of electromagnet | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|----------------------|---|--|--------------------|---|---------------------|---|
| 2.2.C.b Properties and Principles of Force and Motion | Forces affect motion | Magnetic forces are related to electrical forces as different aspects of a single electromagnetic force | Predict the effects of an electromagnetic force on the motion of objects (attract or repel) | 440 | magnetism explained | 152 | investigate magnetic forces |
| | | | | 443 | understanding magnetic fields | 154 | draw magnetic field lines for a bar magnet |
| | | | | 445 | alignment of domains responds to magnetic fields | 155 | test materials to see if they are affected by magnets |
| | | | | 446 | creating permanent magnets | 161 | experiment with pushes and pulls of permanent magnet in a rotor |
| | | | | 447 | the magnetic field of Earth | | |
| | | | | 448 | a compass is a magnet that lines up with Earth's magnetic field | | |
| | | | | 449 | the strength of Earth's magnetic field | | |
| | | | | 451 | magnetic field of a nucleus | | |
| | | | | 454 | magnetic field between two unlike poles | | |
| | | | | 458 | the magnetic field of loops and coils | | |
| | | | | 459 | the magnetic field of coils and permanent magnets | | |
| | | | | 460 | magnetic force on a moving charge | | |
| | | | | 461 | calculating magnetic fields and forces | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|----------------------|---|---|--|---|---------------------|--|
| 2.2.D.a Properties and Principles of Force and Motion | Forces affect motion | The interaction of mass and forces can be explained by Newton's Laws of Motion that are used to predict changes in motion | Recognize that inertia is a property of matter that can be described as an object's tendency to resist a change in motion and is dependent upon the object's mass | 26 61 78 79 79 85 87 94 148 151 168 222 249 642 | inertia is an effect of mass any acceleration must come from a force changes in motion only occur through force all objects tend to resist changes in motion descriptions of inertia and Newton's first law if there is acceleration there must be force forces always come in pairs inertia problem direction of force determines linear or rotational motion centrifugal force is actually an example of inertia Newton's first law and rotational inertia Newton's first law and momentum inertia and restoring force cause harmonic motion inertial mass | 26 27 85 | study Newton's first law explain how Newton's first law applies where is the mass that provides inertia? |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|----------------------|---|---|--------------------|---|---------------------|--|
| 2.2.D.b Properties and Principles of Force and Motion | Forces affect motion | The interaction of mass and forces can be explained by Newton's Laws of Motion that are used to predict changes in motion | Describe the effect of a change in mass of an object on the inertia of that object (Newton's First Law of Motion) | 26 | inertia is an effect of mass | 26 | study Newton's first law |
| | | | | 61 | any acceleration must come from a force | 27 | collect data on Newton's first law |
| | | | | 78 | changes in motion only occur through force | 27 | explain how Newton's first law applies |
| | | | | 79 | all objects tend to resist changes in motion | 85 | where is the mass that provides inertia? |
| | | | | 79 | descriptions of inertia and Newton's first law | | |
| | | | | 85 | if there is acceleration there must be force | | |
| | | | | 87 | forces always come in pairs | | |
| | | | | 94 | seat belt problem | | |
| | | | | 94 | inertia problem | | |
| | | | | 148 | direction of force determines linear or rotational motion | | |
| | | | | 151 | centrifugal force is actually an example of inertia | | |
| | | | | 168 | Newton's first law and rotational inertia | | |
| | | | | 222 | Newton's first law and momentum | | |
| | | | | 249 | inertia and restoring force cause harmonic motion | | |
| | | | | 642 | inertial mass | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|--------------------------------------|---|--|--------------------|--|---------------------|--|
| 2.2.D.c Properties and Principles of Force and Motion | Forces affect motion | The interaction of mass and forces can be explained by Newton's Laws of Motion that are used to predict changes in motion | Using information about the mass and acceleration of two objects, compare the forces required to move them | 81 | Newton's second law of motion | 28 | investigate Newton's second law |
| | | | | 83 | calculation using Newton's second law | 77 | relationship between force and motion and the second law |
| | | | | 84 | Newton's second law and dynamics problems | | |
| | | | | 85 | force problems | | |
| | | | | 85 | finding force from acceleration | | |
| | | | | 93 | problems using Newton's first law and second law | | |
| | | | | 106 | Newton's second law and net force | | |
| | | | | 108 | equilibrium and Newton's second law | | |
| | | | | 108 | use equilibrium to find an unknown force | | |
| | | | | 116 | calculate the acceleration of a toy | | |
| | | | | 136 | calculating acceleration on a ramp | | |
| | | | | 137 | calculating acceleration from 3-D forces | | |
| | | | | 137 | the vector form of Newton's second law | | |
| | | | | 149 | calculating centripetal force | | |
| 150 | formula for centripetal acceleration | | | | | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|---|---------------------|--------|
| | | | | 169 | Newton's second law applies to rotational motion | | |
| | | | | 171 | Newton's second law for rotational motion variables | | |
| | | | | 228 | Newton's second law relating force and momentum | | |
| | | | | 229 | momentum form of Newton's second law | | |
| | | | | 252 | Newton's second law and natural frequency | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|----------------------|---|--|--------------------|---|---------------------|-----------------------------------|
| 2.2.D.d Properties and Principles of Force and Motion | Forces affect motion | The interaction of mass and forces can be explained by Newton's Laws of Motion that are used to predict changes in motion | Identify forces acting on a falling object and the factors that affect the rate of fall (i.e., mass, volume, shape, or type of material from which the object is made) | 68 | free fall and acceleration due to gravity | 23 | investigate the effect of gravity |
| | | | | 69 | motion formulas for free fall | | |
| | | | | 70 | solving problems with free fall | | |
| | | | | 71 | acceleration of gravity does not depend on mass | | |
| | | | | 75 | problem understanding acceleration due to gravity | | |
| | | | | 97 | strength of gravity on Earth and Jupiter | | |
| | | | | 98 | gravity and acceleration and weightlessness | | |
| | | | | 124 | projectiles and trajectories | | |
| | | | | 128 | gravity only accelerates vertical motion | | |
| | | | | 129 | vertical motion of a projectile | | |
| | | | | 130 | projectiles launched at an angle | | |
| | | | | 131 | range of projectiles | | |
| | | | | 134 | resolving force of gravity in ramp coordinates | | |
| | | | | 135 | acceleration down an inclined plane | | |
| | | | | 141 | effects of gravity on motion of a projectile | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|--|----------------------|---|---|--------------------|---|---------------------|-----------------------------|
| | | | | 152 | law of universal gravitation and orbital motion | | |
| | | | | 154 | orbits and gravitational force | | |
| | | | | 155 | centripetal force and the law of universal gravitation combine to form the orbit equation | | |
| | | | | 158 | compare projectile motion to orbital motion | | |
| | | | | 165 | the motion of a tossed object | | |
| | | | | 166 | centers of mass and gravity may differ | | |
| | | | | 187 | work done against gravity | | |
| | | | | 191 | potential energy comes from gravity | | |
| 2.2.D.e Properties and Principles of Force and Motion | Forces affect motion | The interaction of mass and forces can be explained by Newton's Laws of Motion that are used to predict changes in motion | Determine the overall effect (i.e., direction and magnitude) of forces acting on an object at the same time (i.e., net force) | 83 | finding the net force | 45 | balancing a specified force |
| | | | | 84 | calculating net force | | |
| | | | | 86 | zero acceleration means net zero force | | |
| | | | | 103 | net force includes the force of friction | | |
| | | | | 106 | net force must be zero in equilibrium | | |
| | | | | 107 | net force of zero and free-body diagram | | |
| | | | | 141 | calculate the net force | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|--------------------------------------|---|--|--------------------|--|---------------------|--|
| 2.2.D.f Properties and Principles of Force and Motion | Forces affect motion | The interaction of mass and forces can be explained by Newton's Laws of Motion that are used to predict changes in motion | Predict and explain the effect of a change in force and/or mass on the motion of an object (Newton's Second Law of Motion) | 81 | Newton's second law of motion | 28 | investigate Newton's second law |
| | | | | 83 | calculation using Newton's second law | 77 | relationship between force and motion and the second law |
| | | | | 84 | Newton's second law and dynamics problems | | |
| | | | | 85 | force problems | | |
| | | | | 85 | finding force from acceleration | | |
| | | | | 93 | problems using Newton's first law and second law | | |
| | | | | 106 | Newton's second law and net force | | |
| | | | | 108 | equilibrium and Newton's second law | | |
| | | | | 108 | use equilibrium to find an unknown force | | |
| | | | | 116 | calculate the acceleration of a toy | | |
| | | | | 136 | calculating acceleration on a ramp | | |
| | | | | 137 | calculating acceleration from 3-D forces | | |
| | | | | 137 | the vector form of Newton's second law | | |
| | | | | 149 | calculating centripetal force | | |
| 150 | formula for centripetal acceleration | | | | | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|---|---------------------|--------|
| | | | | 169 | Newton's second law applies to rotational motion | | |
| | | | | 171 | Newton's second law for rotational motion variables | | |
| | | | | 228 | Newton's second law relating force and momentum | | |
| | | | | 229 | momentum form of Newton's second law | | |
| | | | | 252 | Newton's second law and natural frequency | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|----------------------|---|--|--------------------|---|---------------------|--|
| 2.2.D.g Properties and Principles of Force and Motion | Forces affect motion | The interaction of mass and forces can be explained by Newton's Laws of Motion that are used to predict changes in motion | Analyze action/reaction forces acting between two objects (e.g., handball hits concrete wall, shotgun firing) and describe their magnitude and direction | 87 | forces always occur in action-reaction pairs | 30 | Newton's third law and free body diagrams |
| | | | | 88 | Newton's third law operates on pairs of objects | 30 | investigate Newton's third law |
| | | | | 89 | solving problems with action-reaction forces | 31 | draw free body diagrams and identify action-reaction pairs |
| | | | | 89 | identifying which force is acting on which object | | |
| | | | | 102 | the normal force as the reaction in an action-reaction pair | | |
| | | | | 107 | forces on a free-body diagram | | |
| | | | | 111 | understanding reaction forces in terms of springs and deformation | | |
| | | | | 112 | analysis of forces on a bridge | | |
| | | | | 135 | normal force of an inclined plane | | |
| | | | | 224 | momentum and Newton's third law | | |
| | | | | 425 | electric forces always occur in pairs according to Newton's third law | | |
| | | | | 548 | Newton's third law and pressure in a fluid | | |
| | | | | 550 | pressure and the third law | | |
| 557 | pressure of gases | | | | | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|----------------------|---|---|--------------------|---|---------------------|--|
| 2.2.D.h Properties and Principles of Force and Motion | Forces affect motion | The interaction of mass and forces can be explained by Newton's Laws of Motion that are used to predict changes in motion | Predict the change in motion of one object when it is acted upon by the equal and opposite force of another object (i.e., action/reaction forces) | 87 | forces always occur in action-reaction pairs | 30 | Newton's third law and free body diagrams |
| | | | | 88 | Newton's third law operates on pairs of objects | 30 | investigate Newton's third law |
| | | | | 89 | solving problems with action-reaction forces | 31 | draw free body diagrams and identify action-reaction pairs |
| | | | | 89 | identifying which force is acting on which object | | |
| | | | | 102 | the normal force as the reaction in an action-reaction pair | | |
| | | | | 107 | forces on a free-body diagram | | |
| | | | | 111 | understanding reaction forces in terms of springs and deformation | | |
| | | | | 112 | analysis of forces on a bridge | | |
| | | | | 135 | normal force of an inclined plane | | |
| | | | | 224 | momentum and Newton's third law | | |
| | | | | 425 | electric forces always occur in pairs according to Newton's third law | | |
| | | | | 548 | Newton's third law and pressure in a fluid | | |
| | | | | 550 | pressure and the third law | | |
| | | | | 557 | pressure of gases | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|--------------------------------|---|---|--------------------|--|---------------------|--|
| 2.2.E.a Properties and Principles of Force and Motion | Forces affect motion | Perpendicular forces act independently of each other | Describe the force(s) that keep an object traveling in a circular path | 144 | rotation and revolution and angular speed | 46 | contrasting linear and angular motion |
| | | | | 145 | calculating angular speed in radians per second | 46 | investigating angular speed |
| | | | | 146 | the relationship between linear and angular speed | 49 | investigating centripetal force |
| | | | | 146 | angular speed of a moving wheel | | |
| | | | | 147 | speedometers and odometers | | |
| | | | | 149 | calculating centripetal force | | |
| | | | | 154 | satellites and orbital motion | | |
| | | | | 155 | satellite motion application | | |
| | | | | 155 | centripetal force and the law of universal gravitation combine to form the orbit equation | | |
| | | | | 156 | HEO and geostationary orbit | | |
| | | | | 157 | compare linear and angular speeds | | |
| | | | | 158 | calculating centripetal force | | |
| | | | | 160 | translation and rotation | | |
| | | | | 171 | rotational motion and linear motion | | |
| 231 | linear and angular momentum | | | | | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|-------------------------------------|---------------------|--------|
| | | | | 238 | compare linear and angular momentum | | |
| | | | | 243 | orbit is a type of cycle | | |
| | | | | 460 | orbital motion of a charge | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|----------------------|---|--|--------------------|--|---------------------|--------------------------------------|
| 2.2.E.b Properties and Principles of Force and Motion | Forces affect motion | Perpendicular forces act independently of each other | Describe the force(s) acting on a projectile on the Earth | 68 | free fall and acceleration due to gravity | 23 | investigate the effect of gravity |
| | | | | 69 | motion formulas for free fall | | |
| | | | | 70 | solving problems with free fall | | |
| | | | | 71 | acceleration of gravity does not depend on mass | | |
| | | | | 75 | problem understanding acceleration due to gravity | | |
| | | | | 97 | strength of gravity on Earth and Jupiter | | |
| | | | | 98 | gravity and acceleration and weightlessness | | |
| | | | | 124 | projectiles and trajectories | | |
| | | | | 128 | gravity only accelerates vertical motion | | |
| | | | | 129 | vertical motion of a projectile | | |
| | | | | 130 | projectiles launched at an angle | | |
| | | | | 131 | range of projectiles | | |
| | | | | 134 | resolving force of gravity in ramp coordinates | | |
| | | | | 135 | acceleration down an inclined plane | | |
| | | | | 141 | effects of gravity on motion of a projectile | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|---|---------------------|--------|
| | | | | 152 | law of universal gravitation and orbital motion | | |
| | | | | 154 | orbits and gravitational force | | |
| | | | | 155 | centripetal force and the law of universal gravitation combine to form the orbit equation | | |
| | | | | 158 | compare projectile motion to orbital motion | | |
| | | | | 165 | the motion of a tossed object | | |
| | | | | 166 | centers of mass and gravity may differ | | |
| | | | | 187 | work done against gravity | | |
| | | | | 191 | potential energy comes from gravity | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|----------------------|---|--|--------------------|--|---------------------|--|
| 2.2.E.c Properties and Principles of Force and Motion | Forces affect motion | Perpendicular forces act independently of each other | Predict the path of an object when the forces directing it in a given direction change | 78 | force is an action that can change motion | 27 | were any forces acting on the ball? |
| | | | | 81 | force is related to acceleration | 44 | investigating force vectors |
| | | | | 99 | balanced force problems | 49 | draw a free body diagram and label forces |
| | | | | 100 | friction is a force that resists motion | 49 | consider forces acting on the ball |
| | | | | 132 | the force vector describes the strength and direction of a force | | |
| | | | | 133 | balancing forces in two dimensions | | |
| | | | | 136 | calculate the acceleration of a skier on a slope | | |
| | | | | 148 | centripetal force causes circular motion | | |
| | | | | 186 | work done by a force at an angle to the distance | | |
| | | | | 254 | definition of periodic force | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|----------------------|---|--|--------------------|--|---------------------|---|
| 2.2.F.a Properties and Principles of Force and Motion | Forces affect motion | Simple machines affect the forces applied to an object and/or direction of movement as work is done | Describe the relationships between work, applied net force and the distance an object moves | 105 | friction is the force that keeps nails and screws in place | 59 | investigate block and tackle machine |
| | | | | 134 | forces on an inclined plane | 61 | find the mechanical advantage |
| | | | | 160 | using torque in household devices | 62 | investigate block and tackle machine |
| | | | | 161 | force on a wrench | 63 | studying the concept of work |
| | | | | 173 | changing gears in a bicycle | 64 | compare output and input work |
| | | | | 178 | input and output for simple machines | | |
| | | | | 179 | types of simple machines | | |
| | | | | 181 | how a lever works | | |
| | | | | 181 | crowbar as an example of a lever | | |
| | | | | 183 | small drills use gears | | |
| | | | | 184 | screw turns rotating motion into linear motion | | |
| | | | | 185 | physics definition of work | | |
| | | | | 186 | the work done by a force | | |
| | | | | 187 | work done against gravity | | |
| | | | | 188 | for all machines work out cannot exceed work in | | |
| | | | | 193 | deriving the formula for kinetic energy | | |
| | | | | 199 | concept of work | | |
| | | | | 200 | calculate work done | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|--|----------------------|---|---|--------------------|--|---------------------|--------------------------------------|
| | | | | 200 | calculate fulcrum point of a lever | | |
| | | | | 209 | estimating power requirements based on force | | |
| | | | | 249 | harmonic motion in machines | | |
| 2.2.F.b Properties and Principles of Force and Motion | Forces affect motion | Simple machines affect the forces applied to an object and/or direction of movement as work is done | Describe the effect of work on an object's kinetic and potential energy | 185 | work and energy | 64 | relationship between work and energy |
| | | | | 189 | relationship between work and energy | | |
| | | | | 191 | the symmetry between work and energy | | |
| 2.2.F.c Properties and Principles of Force and Motion | Forces affect motion | Simple machines affect the forces applied to an object and/or direction of movement as work is done | Explain how the efficiency of machines can be expressed as a ratio of work output to work input | 188 | for all machines work out cannot exceed work in | 64 | compare output and input work |
| | | | | 202 | definition of efficiency | 69 | calculate efficiency for each ball |
| | | | | 203 | efficiency explained | | |
| | | | | 213 | efficiency of an energy flow process | | |
| | | | | 219 | ideal vs. real machine | | |
| | | | | 220 | calculate efficiency of model solar car | | |
| | | | | 236 | fuel efficiency of turbofan engines | | |
| | | | | 311 | efficiency of electric vs. fluorescent light bulbs | | |
| | | | | 393 | efficiency of hybrid cars | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|----------------------|---|--|----------------------------|--|-----------------------------|--|
| 2.2.F.d Properties and Principles of Force and Motion | Forces affect motion | Simple machines affect the forces applied to an object and/or direction of movement as work is done | Describe power in terms of work and time | 207 | calculate power in climbing stairs | 70 | calculate person's power |
| | | | | 208 | power formulas | 71 | calculate power output for each climber |
| | | | | 210 | estimating the power in wind | | |
| | | | | 211 | power in biological systems | | |
| | | | | 220 | calculate power rating | | |
| | | | | 409 | power and efficiency of electric cars | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|----------------------|---|---|--------------------|--|---------------------|--|
| 2.2.F.e Properties and Principles of Force and Motion | Forces affect motion | Simple machines affect the forces applied to an object and/or direction of movement as work is done | Analyze and describe the relationship among work, power, and efficiency | 185 | how to calculate work | 63 | studying the concept of work |
| | | | | 185 | physics definition of work | 69 | calculate efficiency for each ball |
| | | | | 186 | the work done by a force | 70 | calculate work |
| | | | | 187 | work done against gravity | 70 | calculate person's power |
| | | | | 187 | calculating work done against gravity | 71 | calculate work done |
| | | | | 193 | deriving the formula for kinetic energy | 71 | calculate power output for each climber |
| | | | | 199 | concept of work | | |
| | | | | 200 | calculate work done | | |
| | | | | 202 | definition of efficiency | | |
| | | | | 203 | efficiency explained | | |
| | | | | 207 | calculate power in climbing stairs | | |
| | | | | 208 | power formulas | | |
| | | | | 210 | estimating the power in wind | | |
| | | | | 211 | power in biological systems | | |
| | | | | 213 | efficiency of an energy flow process | | |
| | | | | 219 | ideal vs. real machine | | |
| | | | | 220 | calculate power rating | | |
| | | | | 220 | calculate efficiency of model solar car | | |
| | | | | 236 | fuel efficiency of turbofan engines | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------------|--|---|---|--------------------|--|---------------------|--|
| | | | | 311 | efficiency of electric vs. fluorescent light bulbs | | |
| | | | | 393 | efficiency of hybrid cars | | |
| | | | | 409 | power and efficiency of electric cars | | |
| 7.1.A.a Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation | Formulate testable questions and hypotheses | 3 | using life experiences and common sense | 11 | formulate a testable hypothesis |
| | | | | 3 | inquiry starts with questions | 33 | formulate a testable hypothesis |
| | | | | 8 | formulating a hypothesis | 48 | formulate a hypothesis |
| | | | | | | 65 | form a hypothesis |
| | | | | | | 79 | write a hypothesis |
| | | | | | | 89 | what is it that moves in the case of a wave? |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------------|--|---|--|--|--|-----------------------------------|---|
| 7.1.A.b Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation | Analyzing an experiment, identify the components (i.e., independent variable, dependent variables, control of constants, multiple trials) and explain their importance to the design of a valid experiment | 2 3 9 40 42 43 45 54 251 | understanding natural laws connecting cause and effect through observation connecting cause and effect through analysis defining variables control and experimental variables dependent and independent variables in graphs recognizing patterns and cause and effect relationships importance of changing one variable at a time in an experiment changing the natural frequency of a stretched rubber band | 11 12 82 82 90 166 | recognizing and controlling variables cause and effect relationships determine which variable has the greatest effect dependent and independent variables what effect does changing the tension have? variables that affect the performance of the generator |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|----------------------------------|--|---|---------------------------------------|--------------------|--|---------------------|---|
| 7.1.A.c Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation | Design and conduct a valid experiment | 9 | testing ideas against scientific evidence | 28 | set up the ultimate pulley |
| | | | | 42 | writing lab procedures | 43 | write a procedure |
| | | | | 242 | finding a basic cycle of harmonic motion | 43 | perform experiment |
| | | | | 432 | making a simple capacitor | 65 | investigate motion on a roller coaster |
| | | | | 456 | an experiment with a wire and compass | 67 | set up the straight track |
| | | | | 463 | building an electromagnet with wire and a nail | 67 | investigate motion on a roller coaster |
| | | | | 467 | experiment demonstrating electromagnetic induction | 82 | plan three experiments to determine which variable affects the period of a pendulum |
| | | | | | | 82 | design an experiment |
| | | | | | | 85 | design and test a way to increase natural frequency |
| | | | | | | 201 | develop a procedure |
| | | | | | | 201 | determine the equipment you will need |
| | | | | | | 201 | design a procedure to separate a mixture |
| | | | | | | 202 | conduct your experiment |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------------|--|---|--|-----------------------------|--|-----------------------|--|
| 7.1.A.d Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation | Recognize that sometimes it is not possible, for practical or ethical reasons, to control some conditions | 40 42 43 54 251 | defining variables control and experimental variables dependent and independent variables in graphs importance of changing one variable at a time in an experiment changing the natural frequency of a stretched rubber band | 11 82 82 166 | recognizing and controlling variables determine which variable has the greatest effect dependent and independent variables variables that affect the performance of the generator |
| 7.1.A.e Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation | Acknowledge that some scientific explanations cannot be tested using the standard experimental “scientific method” due to the limits of the laboratory environment, resources, and/or technologies | | | 43 | follow the scientific method |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|----------------------------------|--|---|--|---|---|---------------------|---------------------------------|
| 7.1.A.f Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation | Acknowledge that there is no fixed procedure called “the scientific method”, but that some investigations involve systematic observations, carefully collected, relevant evidence, logical reasoning, and some imagination | 41 78 81 152 349 350 367 382 420 499 560 580 614 615 | Galileo and Newton conducted experiments with balls on ramps Newton's laws of motion Newton's discovery of the connection between force and mass and acceleration Sir Isaac Newton and law of universal gravitation Galileo and telescopes Newtonian reflecting telescope Einstein and theory of special relativity Ben Franklin and current Charles-Augustin de Coulomb development of atomic theory deep water submarine Alvin application Newton and classical physics Marie Curie Henri Bequerel and beta rays | 75 | the discovery of atom's nucleus |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|----------------------------------|--|---|---|-----------------------------|--|---------------------|---|
| 7.1.A.g Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation | Evaluate the design of an experiment and make suggestions for reasonable improvements | 2 3 7 8 9 45 | understanding natural laws connecting cause and effect through observation revising explanations through observation refining theories based on observations connecting cause and effect through analysis recognizing patterns and cause and effect relationships | 12 90 | cause and effect relationships what effect does changing the tension have? |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|----------------------------------|--|--|---|--------------------|--|---|--|
| 7.1.B.a Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Scientific inquiry relies upon gathering evidence from qualitative and quantitative observations | Make qualitative and quantitative observations using the appropriate senses, tools and equipment to gather data | 18 25 498 | measuring distance accuracy and precision of measurements listing different types of matter in your home | 1 6 6 15 43 60 67 78 82 87 89 153 153 202 206 | estimating length precision in measurement accuracy and resolution and printing collect time data measure and record the distance measure input and output forces measure vertical distance observe what happens measure the length of the string observe what happens to the motion observe the wave pulse make measurement with precision making measurements with precision find the mass to the nearest tenth of a gram record your observations |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------------|--|--|---|--------------------|--|---------------------|---|
| 7.1.B.b Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Scientific inquiry relies upon gathering evidence from qualitative and quantitative observations | Measure length to the nearest millimeter, mass to the nearest gram, volume to the nearest milliliter, force (weight) to the nearest Newton, temperature to the nearest degree Celsius, time to the nearest second | 18 | measurements of distance in units of length | 2 | practice length measurement |
| | | | | 19 | scientists use metric units | 4 | measuring time |
| | | | | 19 | description of length measured in English and metric systems | 7 | estimating mass |
| | | | | 21 | calculating volume of simple shapes | 9 | make distance measurement |
| | | | | 21 | calculating volume of simple shapes | 18 | measure the length |
| | | | | 22 | time intervals | 23 | measure the distance |
| | | | | 23 | units for measuring time | 26 | find length in centimeters |
| | | | | 24 | time intervals in physics | 29 | measure the force |
| | | | | 25 | accuracy and precision of measurements | 34 | measure the mass |
| | | | | 25 | accuracy and precision of measurements | 34 | measure the force |
| | | | | 27 | measuring mass in kg and grams | 36 | measure the mass |
| | | | | 27 | measuring mass in kg and grams | 36 | measure the mass |
| | | | | 33 | commonly used units for measuring mass | 36 | measure the new position |
| | | | | 33 | commonly used units for measuring mass | 62 | measure string length |
| | | | | 37 | units for speed | 65 | measure vertical distance |
| | | | | 58 | units of acceleration | 68 | convert grams to kilograms |
| | | | | 60 | understanding units of acceleration | 70 | measure and mark height |
| | | | | 82 | unit of force is derived | 78 | measure mass of ball |
| | | | | 82 | units of force are pounds and newtons | 78 | make the string 70 cm long |
| | | | | 83 | understanding units for using Newton's second law | 176 | investigate temperature and its effect on materials |
| | | | | 83 | understanding units for using Newton's second law | 178 | measure 100 grams of water |
| | | | | 110 | units for spring constant | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|--|---------------------|-----------------------------|
| | | | | 144 | units of angular speed | 192 | find the mass of the bottle |
| | | | | 186 | units of work are joules | 202 | find the mass |
| | | | | 428 | deriving units for measuring electric fields | | |
| | | | | 504 | temperature scales and Fahrenheit-Celsius conversions | | |
| | | | | 505 | measuring temperature | | |
| | | | | 507 | the Kelvin scale and converting between Kelvin and Celsius | | |
| | | | | 519 | understanding Fahrenheit and Celsius and Kelvin | | |
| | | | | 533 | using Kelvin for radiation calculations | | |
| | | | | 558 | using temperature in Kelvins for Charles' law | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---------------------------------|--|--|---|----------------------------|--|--|--|
| 7.1.B.c Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Scientific inquiry relies upon gathering evidence from qualitative and quantitative observations | Determine the appropriate tools and techniques to collect, analyze and interpret data | 18 25 | measuring distance accuracy and precision of measurements | 1 6 28 43 60 67 67 82 85 201 202 | estimating length accuracy and resolution and printing set up the ultimate pulley measure and record the distance measure input and output forces set up the straight track measure vertical distance measure the length of the string design and test a way to increase natural frequency determine the equipment you will need conduct your experiment |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------------|--|--|---|--------------------|--|---------------------|--|
| 7.1.B.d Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Scientific inquiry relies upon gathering evidence from qualitative and quantitative observations | Judge whether measurements and computation of quantities are reasonable | 11 | Ptolemy model vs. Copernicus model of the solar system | 13 | compare prediction to measurement |
| | | | | 25 | why accuracy and precision are important | 22 | how do you measured positions compare to model? |
| | | | | 40 | making a good model | 22 | compare calculation with graph estimate |
| | | | | 42 | controlling variables in experiments | 29 | does experiment agree with prediction? |
| | | | | 43 | graphs are a way of representing data | 43 | discuss sources of error |
| | | | | 44 | using a graphical model to make a prediction and checking the model's accuracy | 43 | how does the measurement compare to your prediction? |
| | | | | 45 | recognizing patterns using graphs | 45 | discuss sources of errors |
| | | | | 54 | understanding patterns in relationships between variables | 76 | compare predicted mass to actual mass |
| | | | | 56 | indicate relationships between variables in graphs | 114 | are there differences between your prediction and measurement? |
| | | | | 246 | understanding graphs of harmonic motion | 202 | identify two sources of experimental error |
| | | | | 297 | frequency spectrum | | |
| | | | | 304 | comparison of wave forms from guitar sounds | | |
| | | | | 307 | decibel level vs. frequency graph for human hearing | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------------|--|--|--|--------------------|--|---------------------|----------------------------------|
| | | | | 427 | diagramming electric fields using field lines | | |
| | | | | 443 | diagramming magnetic fields using magnetic field lines | | |
| | | | | 479 | current vs.voltage graph for a transistor | | |
| 7.1.B.e Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Scientific inquiry relies upon gathering evidence from qualitative and quantitative observations | Calculate the range, average/mean, percent and ratios for sets of data | 412 | average voltage and current of AC power | 10 | calculate percent difference |
| | | | | | | 13 | find percent error |
| | | | | | | 25 | find the average time |
| | | | | | | 37 | calculate percent difference |
| | | | | | | 38 | calculate percent difference |
| | | | | | | 43 | calculate percent difference |
| | | | | | | 58 | find average of three trials |
| | | | | | | 67 | calculate average of three times |
| | | | | | | 71 | calculate average work and power |
| | | | | | | 83 | calculate percent error |
| | | | | | | 202 | find percent composition |
| | | | | | | 208 | calculating percent yield |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------------|--|--|---|--|--|---------------------|--------|
| 7.1.B.f Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Scientific inquiry relies upon gathering evidence from qualitative and quantitative observations | Recognize that observation is biased by the experiences and knowledge of the observer | 62 188 292 372 440 568 576 583 637 640 641 | acceleration of cars perpetual motion machines sound in space holograms and science fiction special effects scientists have never found single magnetic poles understanding how gravity works inside atoms transporter beams the meaning of the uncertainty principle areas of active research in physics unresolved questions of history of universe research on future of the universe | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|----------------------------------|--|--|--|--------------------|--|---------------------|---|
| 7.1.C.a Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Evidence is used to formulate explanations | Use quantitative and qualitative data to construct reasonable explanations (conclusions) | 2 | understanding natural laws | 12 | was this experiment better or worse than the first? |
| | | | | 3 | connecting cause and effect through observation | 12 | cause and effect relationships |
| | | | | 7 | revising explanations through observation | 16 | what do the results tell you? |
| | | | | 8 | refining theories based on observations | 18 | are the accelerations different? |
| | | | | 9 | connecting cause and effect through analysis | 19 | does the ball accelerate? |
| | | | | 11 | acceptance of the Copernican model of the solar system on the basis of scientific evidence | 43 | what would happen if...? |
| | | | | 44 | checking a graphical model's accuracy | 58 | explain why the angular acceleration is different |
| | | | | 45 | recognizing patterns and cause and effect relationships | 80 | explain your observations |
| | | | | 103 | evaluating perpetual motion claims | 87 | explain how force applied causes the response |
| | | | | 306 | explain why hearing can be damaged by loud sounds | 90 | explain why higher tension makes waves move faster |
| | | | | | | 90 | what effect does changing the tension have? |
| | | | | | | 92 | explain how wind might cause big waves in water |
| | | | | | | 97 | reliability of a double-blind test |
| | | | | | | 97 | did the method give an accurate result? |
| | | | | | | 109 | explain how the colored filters work |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|--------|---|--------|
| | | | | | | 132 what conclusions can you draw? 133 analyze data and explain a rule | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|----------------------------------|--|--|---|--------------------|--|---------------------|--|
| 7.1.C.b Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Evidence is used to formulate explanations | Analyze experimental data to determine patterns, relationship, perspectives and credibility (e.g., predict/extrapolate data, explain the relationship between the independent and dependent variable) | 43 | graphs are a way of representing data | 13 | create a graph |
| | | | | 43 | constructing a graph | 16 | create a graph |
| | | | | 44 | graphical models | 16 | describe the graph |
| | | | | 45 | recognizing patterns using graphs | 22 | uniform acceleration model |
| | | | | 54 | constructing a graph | 22 | create graphs |
| | | | | 54 | understanding patterns in relationships between variables | 24 | create an algebraic model |
| | | | | 55 | create a graph from a data table | 28 | solve second law equation for string tension |
| | | | | 56 | indicate relationships between variables in graphs | 32 | develop a model that predicts acceleration |
| | | | | 60 | creating the acceleration formula from experiments | 37 | make a graph |
| | | | | 66 | developing the formulas for a model of motion with constant acceleration | 38 | make a graph |
| | | | | 246 | understanding graphs of harmonic motion | 43 | create algebraic model |
| | | | | 282 | write a formula relating velocity of wave to period and wavelength | 43 | sketch four graphs |
| | | | | 290 | the process of digital sound reproduction | 49 | write a formula |
| | | | | 304 | comparison of wave forms from guitar sounds | 56 | create a graph |
| | | | | | | 66 | create a graph of speed vs. position |
| | | | | | | 82 | make three different graphs |
| | | 87 | sketch a graph | | | | |
| | | 94 | give an equation that describes your observations | | | | |
| | | 135 | graph voltage vs. current | | | | |
| | | 136 | graph voltage vs. current | | | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|--|---------------------|--|
| | | | | 307 | decibel level vs. frequency graph for human hearing | 151 | make a graph of voltage vs. time |
| | | | | 312 | light intensity follows an inverse square law | 160 | create a graph |
| | | | | 411 | the waveform of AC electricity | 167 | make a graph of voltage vs. number of magnets |
| | | | | 427 | diagramming electric fields using field lines | 169 | make a current vs. voltage graph for the diode |
| | | | | 443 | diagramming magnetic fields using magnetic field lines | 189 | Bernoulli's equation |
| | | | | 479 | current vs.voltage graph for a transistor | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|----------------------------------|--|--|---|--------------------|--|---------------------|--|
| 7.1.C.c Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Evidence is used to formulate explanations | Identify the possible effects of measurement and calculation errors on the validity and reliability of data | 11 | Ptolemy model vs. Copernicus model of the solar system | 13 | compare prediction to measurement |
| | | | | 25 | why accuracy and precision are important | 22 | how do you measured positions compare to model? |
| | | | | 40 | making a good model | 22 | compare calculation with graph estimate |
| | | | | 42 | controlling variables in experiments | 29 | does experiment agree with prediction? |
| | | | | 44 | using a graphical model to make a prediction and checking the model's accuracy | 43 | discuss sources of error |
| | | | | 297 | frequency spectrum | 43 | how does the measurement compare to your prediction? |
| | | | | | | 45 | discuss sources of errors |
| | | | | | | 76 | compare predicted mass to actual mass |
| | | | | | | 114 | are there differences between your prediction and measurement? |
| | | | | | | 202 | identify two sources of experimental error |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------------|--|--|--|--------------------|---|---|--|
| 7.1.D.a Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Scientific inquiry includes evaluation of explanations (hypotheses, laws, theories) in light of scientific principles (understandings) | Make predictions supported by scientific knowledge and explanations | 7 498 | creating theories based on observations since wood is created from other matter it must not be a fundamental substance | 13 18 33 37 38 42 65 132 | predict speed of ball how would acceleration be different? calculate the predicted speed use your graph to make a prediction use your graph to make a prediction predict exact landing location predict where the ball moves fastest predict what the current will be |
| 7.1.D.b Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Scientific inquiry includes evaluation of explanations (hypotheses, laws, theories) in light of scientific principles (understandings) | Analyze whether evidence supports proposed explanations (hypotheses, laws, theories) | 188 | perpetual motion machines | 12 33 50 66 | do your results agree with hypothesis? does your experiment confirm your hypothesis? does your experiment provide confirmation? does this agree with your hypothesis? |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------------|--|--|---|--------------------|--|---------------------|---|
| 7.1.D.c Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | Scientific inquiry includes evaluation of explanations (hypotheses, laws, theories) in light of scientific principles (understandings) | Evaluate the reasonableness of an explanation (conclusions) | 4 | inquiry through observation | 12 | was this experiment better or worse than the first? |
| | | | | 7 | creating explanations through observation | 16 | what do the results tell you? |
| | | | | 8 | forming hypotheses and testing with experiments | 18 | are the accelerations different? |
| | | | | 10 | putting forth ideas and then testing them | 19 | does the ball accelerate? |
| | | | | 11 | acceptance of the Copernican model of the solar system on the basis of scientific evidence | 43 | test your prediction |
| | | | | | | 43 | what would happen if...? |
| | | | | 44 | checking a graphical model's accuracy | 58 | explain why the angular acceleration is different |
| | | | | 103 | evaluating perpetual motion claims | 65 | where does the marble move the fastest? |
| | | | | 306 | explain why hearing can be damaged by loud sounds | 80 | explain your observations |
| | | | | | | 87 | explain how force applied causes the response |
| | | | | 323 | using glow-in-the-dark plastic to demonstrate photon energy levels | 90 | explain why higher tension makes waves move faster |
| | | | | 423 | charge by friction | 92 | explain how wind might cause big waves in water |
| | | | | | | 97 | did the method give an accurate result? |
| | | | | | | 97 | reliability of a double-blind test |
| | | | | | | 109 | explain how the colored filters work |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|--------|---|--------|
| | | | | | | 111 do your observations support this hypothesis? 132 what conclusions can you draw? 133 analyze data and explain a rule 147 how did A and B tapes acquire different charge? | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|----------------------------------|--|--|--|--------------------|--|---------------------|--|
| 7.1.E.a Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | The nature of science relies upon communication of results and justification of explanations | Communicate the procedures and results of investigations and explanations through: oral presentations, drawings and maps, data tables, graphs, equations, and writings | 9 | physics vocabulary is very specific | 43 | create four graphs |
| | | | | 24 | making graphs of experimental results over time | 122 | communicate your findings |
| | | | | 37 | understanding the word "per" | 122 | present your findings |
| | | | | 42 | writing procedures in a lab notebook helps make sure your results are repeatable | 175 | display information you found for your element |
| | | | | 42 | writing procedures in a lab notebook helps make sure your results are repeatable | 202 | keep detailed notes as you work |
| | | | | 43 | constructing a graph | | |
| | | | | 44 | using a graph to make predictions | | |
| | | | | 45 | recognizing relationships between variables from graphs | | |
| | | | | 60 | understanding the Greek letter delta | | |
| | | | | 96 | terms of mass and weight | | |
| | | | | 97 | understanding symbols | | |
| | | | | 107 | drawing free-body diagrams | | |
| | | | | 116 | draw a free-body diagram | | |
| | | | | 125 | drawing the velocity vector | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------------|--|--|--|--------------------|--|---------------------|--|
| | | | | 212 | making an energy flow diagram | | |
| | | | | 246 | understanding graphs of harmonic motion | | |
| | | | | 333 | drawing a ray diagram | | |
| | | | | 342 | drawing ray diagrams of lenses | | |
| | | | | 380 | circuit diagrams and electrical symbols | | |
| | | | | 427 | drawing the electric field using field lines | | |
| | | | | 443 | diagramming magnetic fields using magnetic field lines | | |
| 7.1.E.b Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | The nature of science relies upon communication of results and justification of explanations | Communicate and defend a scientific argument | 42 | writing procedures in a lab notebook helps make sure your results are repeatable | 122 175 202 | communicate your findings display information you found for your element keep detailed notes as you work |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|----------------------------------|--|--|--|--------------------|--|---------------------|--|
| 7.1.E.c Scientific Inquiry | Science understanding is developed through the use of science process skills and scientific knowledge in combination with scientific investigation, reasoning, and critical thinking | The nature of science relies upon communication of results and justification of explanations | Explain the importance of the public presentation of scientific work and supporting evidence to the scientific community | 19 | problems in the real world use both metric and English units | 80 | explain the physics of a diver's somersaults |
| | | | | 52 | Dr. Harold Edgerton and strobe photography | 92 | how does sound get through tiny cracks? |
| | | | | 52 | strobe photography | 126 | explain how polarizing sunglasses work |
| | | | | 73 | antilock braking systems | | |
| | | | | 80 | applications of Newton's first law | | |
| | | | | 90 | examples of Newton's third law in the real world | | |
| | | | | 104 | reducing friction and hovercraft and maglev trains | | |
| | | | | 105 | friction is useful for brakes and tires | | |
| | | | | 109 | jack-in-the-box uses a spring | | |
| | | | | 112 | design of structures | | |
| | | | | 118 | examples of scalars | | |
| | | | | 130 | kicked soccer ball acts as a projectile launched at an angle | | |
| | | | | 131 | hang time | | |
| | | | | 133 | example of gymnast for forces applied at an angle | | |
| | | | | 138 | robot navigation application | | |
| | | | | 139 | inertial navigation system | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|---|---------------------|--------|
| | | | | 144 | examples of objects moving in a circle | | |
| | | | | 147 | speedometers and odometers | | |
| | | | | 149 | centripetal force at the amusement park | | |
| | | | | 155 | satellite motion application | | |
| | | | | 155 | first artificial human-made Earth satellite was Sputnik | | |
| | | | | 156 | HEO and geostationary orbit | | |
| | | | | 167 | SUV rollovers and center of gravity | | |
| | | | | 172 | bicycle physics application | | |
| | | | | 178 | Great Pyramid of Giza and simple machines | | |
| | | | | 227 | accident reconstruction | | |
| | | | | 232 | angular momentum of skater spinning and diver | | |
| | | | | 234 | gyroscopes and angular momentum | | |
| | | | | 250 | why airplanes have tails | | |
| | | | | 257 | Pierre and Jacques Curie and the piezoelectric effect | | |
| | | | | 262 | examples of waves | | |
| | | | | 269 | wave motion and equilibrium | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|---|---------------------|--------|
| | | | | 290 | technological breakthrough of sound recording | | |
| | | | | 290 | stereo sound | | |
| | | | | 299 | understanding human hearing | | |
| | | | | 310 | past theories of light | | |
| | | | | 323 | glow-in-the-dark plastic | | |
| | | | | 325 | history of printing | | |
| | | | | 337 | rainbows are an example of dispersion | | |
| | | | | 347 | the compound microscope | | |
| | | | | 348 | the usefulness of recorded images | | |
| | | | | 349 | the telescope | | |
| | | | | 361 | Young's double-slit experiment | | |
| | | | | 365 | polarized sunglasses and LCD computer screens | | |
| | | | | 368 | Einstein's thinking revolutionized physics | | |
| | | | | 390 | breakdown voltage and lightning | | |
| | | | | 398 | holiday lights wired in series | | |
| | | | | 401 | why aren't birds electrocuted? | | |
| | | | | 410 | paying for electricity | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|---|---------------------|--------|
| | | | | 413 | wiring application | | |
| | | | | 413 | circuits in your house | | |
| | | | | 418 | charge of everyday objects | | |
| | | | | 430 | almost all electric appliances use capacitors | | |
| | | | | 433 | cameras use capacitors to supply energy for flash bulbs | | |
| | | | | 447 | discovering and using magnetism | | |
| | | | | 448 | how does a compass work? | | |
| | | | | 458 | where coils are used | | |
| | | | | 462 | electromagnet in a toaster | | |
| | | | | 501 | search for elements and alchemy | | |
| | | | | 527 | windchill factor | | |
| | | | | 561 | the Alvin research submarine | | |
| | | | | 575 | discovery of helium | | |
| | | | | 608 | how engines work | | |
| | | | | 621 | exposure to UV radiation | | |
| | | | | 625 | turning lead into gold | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|---|--|---|----------------------------|--|-----------------------------|---------------|
| 8.1.C.a Impact of Science, Technology and Human Activity | The nature of technology is advanced by and can advance science as it seeks to apply scientific knowledge in ways that meet human needs | Technological solutions to problems often have drawbacks as well as benefits | Identify and evaluate the environmental costs and benefits of scientific or technological solutions to a given problem | 604 607 621 632 | balancing chemical equation of acid rain impact of combustion reaction of gasoline sources of radiation in the environment nuclear waste | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|---|---|--|--------------------|---|---------------------|--------|
| 8.2.A.a Impact of Science, Technology and Human Activity | A historical perspective of scientific explanations helps to improve understanding of the nature of science and how science knowledge and technology evolve over time | People from various cultures, races, and of different gender have contributed to the scientific discoveries and the invention of technological innovations | Recognize that contributions to science have not been limited to the work of one particular group, but instead have been made by a diverse group of scientists representing various cultures, races, and gender | 41 | Galileo and Newton conducted experiments with balls on ramps | | |
| | | | | 52 | Dr. Harold Edgerton and strobe photography | | |
| | | | | 78 | Newton's laws of motion | | |
| | | | | 81 | Newton's discovery of the connection between force and mass and acceleration | | |
| | | | | 152 | Sir Isaac Newton and law of universal gravitation | | |
| | | | | 155 | first artificial human-made Earth satellite was Sputnik | | |
| | | | | 178 | Great Pyramid of Giza and simple machines | | |
| | | | | 257 | Pierre and Jacques Curie and the piezoelectric effect | | |
| | | | | 269 | wave motion and equilibrium | | |
| | | | | 290 | technological breakthrough of sound recording | | |
| | | | | 310 | past theories of light | | |
| | | | | 325 | history of printing | | |
| | | | | 348 | the usefulness of recorded images | | |
| | | | | 349 | the telescope | | |
| | | | | 349 | Galileo and telescopes | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|--|---------------------|--------|
| | | | | 350 | Newtonian reflecting telescope | | |
| | | | | 361 | Young's double-slit experiment | | |
| | | | | 368 | Einstein's thinking revolutionized physics | | |
| | | | | 382 | Ben Franklin and current | | |
| | | | | 420 | Charles-Augustin de Coulomb | | |
| | | | | 447 | discovering and using magnetism | | |
| | | | | 456 | Hans Christian Oersted | | |
| | | | | 472 | Dr. D. Bruce Montgomery | | |
| | | | | 499 | Democritus | | |
| | | | | 499 | Albert Einstein | | |
| | | | | 501 | search for elements and alchemy | | |
| | | | | 561 | the Alvin research submarine | | |
| | | | | 575 | discovery of helium | | |
| | | | | 580 | Newton and classical physics | | |
| | | | | 614 | Marie Curie | | |
| | | | | 615 | Henri Bequerel and beta rays | | |
| | | | | 625 | turning lead into gold | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|---|---|---|---|---|---------------------|------------------------------------|
| 8.2.B.a Impact of Science, Technology and Human Activity | A historical perspective of scientific explanations helps to improve understanding of the nature of science and how science knowledge and technology evolve over time | Scientific theories are developed based on the body of knowledge that exists at any particular time and must be rigorously questioned and tested for validity | Identify and describe how explanations (hypotheses, laws, theories) explaining scientific phenomena have changed over time as a result of new evidence | 41 78 81 152 349 350 382 420 499 580 614 615 | Galileo and Newton conducted experiments with balls on ramps Newton's laws of motion Newton's discovery of the connection between force and mass and acceleration Sir Isaac Newton and law of universal gravitation Galileo and telescopes Newtonian reflecting telescope Ben Franklin and current Charles-Augustin de Coulomb development of atomic theory Newton and classical physics Marie Curie Henri Bequerel and beta rays | 75 | the discovery of atom's nucleus |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|---|---|--|--------------------|---|---------------------|------------------------------------|
| 8.2.B.b Impact of Science, Technology and Human Activity | A historical perspective of scientific explanations helps to improve understanding of the nature of science and how science knowledge and technology evolve over time | Scientific theories are developed based on the body of knowledge that exists at any particular time and must be rigorously questioned and tested for validity | Identify and analyze current theories that are being questioned and compare them to new theories that have emerged to challenge the older ones | 41 | Galileo and Newton conducted experiments with balls on ramps | 75 | the discovery of atom's nucleus |
| | | | | 78 | Newton's laws of motion | | |
| | | | | 81 | Newton's discovery of the connection between force and mass and acceleration | | |
| | | | | 152 | Sir Isaac Newton and law of universal gravitation | | |
| | | | | 349 | Galileo and telescopes | | |
| | | | | 350 | Newtonian reflecting telescope | | |
| | | | | 382 | Ben Franklin and current | | |
| | | | | 420 | Charles-Augustin de Coulomb | | |
| | | | | 499 | development of atomic theory | | |
| | | | | 580 | Newton and classical physics | | |
| | | | | 614 | Marie Curie | | |
| 615 | Henri Bequerel and beta rays | | | | | | |
| 639 | the big bang | | | | | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|--------------------------------|--|---|----------------------------|--|-----------------------------|---------------|
| 8.3.B.a Impact of Science, Technology and Human Activity | Science is a human endeavor | Social, political, economic, ethical, and environmental forces strongly influence and are influenced by the direction of progress of science and technology | Recognize the role funding and promotion by political and social groups has on scientific research | 14 | using analysis and problem solving and an understanding of technology to make economic decisions | | |
| | | | | 535 | designing buildings to be energy efficient | | |
| | | | | 585 | economics of laser technology | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|--------------------------------|--|--|--------------------|---|---------------------|--------|
| 8.3.B.b Impact of Science, Technology and Human Activity | Science is a human endeavor | Social, political, economic, ethical, and environmental forces strongly influence and are influenced by the direction of progress of science and technology | Analyze and evaluate the social, political, economic, ethical, and environmental factors affecting science and technology | 12 | all technology is based on fundamental laws of physics | | |
| | | | | 12 | engineers design practical devices for solving problems | | |
| | | | | 31 | use of nanotechnology | | |
| | | | | 31 | use of nanotechnology | | |
| | | | | 51 | analyzing motion with video and strobe photography | | |
| | | | | 72 | antilock brakes application | | |
| | | | | 72 | antilock brakes application | | |
| | | | | 112 | relationship between science and engineering and technology | | |
| | | | | 112 | designing a bridge | | |
| | | | | 138 | use of robots | | |
| | | | | 155 | geostationary satellites | | |
| | | | | 172 | bicycle physics application | | |
| | | | | 196 | hydroelectric power application | | |
| | | | | 196 | hydroelectric power application | | |
| | | | | 209 | range of power for common devices | | |
| | | | | 216 | energy from ocean tides | | |
| 217 | research into tidal power | | | | | | |

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Foundations of Physics

Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|---|---------------------|--------|
| | | | | 228 | seat belts and air bags | | |
| | | | | 235 | jet engines application | | |
| | | | | 235 | jet engines application | | |
| | | | | 243 | oscillators are used in communications and music and clocks | | |
| | | | | 257 | quartz crystals application | | |
| | | | | 257 | quartz crystals application | | |
| | | | | 263 | waves can carry information | | |
| | | | | 280 | microwave ovens application | | |
| | | | | 280 | microwave ovens application | | |
| | | | | 293 | uses of Doppler radar | | |
| | | | | 311 | invention of electric light | | |
| | | | | 325 | the printing press | | |
| | | | | 325 | the printing press | | |
| | | | | 349 | the telescope | | |
| | | | | 369 | technological advances have allowed discovery of the expanding universe | | |
| | | | | 372 | holography application | | |
| | | | | 378 | importance of electricity | | |
| | | | | 392 | hybrid gas/electric cars application | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|--|---------------------|--------|
| | | | | 392 | hybrid gas/electric cars application | | |
| | | | | 413 | wiring application | | |
| | | | | 413 | wiring application | | |
| | | | | 429 | electron beam accelerators | | |
| | | | | 434 | how television works application | | |
| | | | | 434 | how television works application | | |
| | | | | 451 | MRI application | | |
| | | | | 451 | MRI application | | |
| | | | | 472 | maglev train application | | |
| | | | | 473 | how magplanes levitate | | |
| | | | | 490 | why computers are useful | | |
| | | | | 492 | computers and electronic addition of numbers application | | |
| | | | | 516 | refrigerator application | | |
| | | | | 534 | energy-efficient building application | | |
| | | | | 534 | energy-efficient building application | | |
| | | | | 560 | deep water submarine Alvin application | | |
| | | | | 585 | laser application | | |
| | | | | 615 | smoke detectors | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|---------------------------|---------------------|--------|
| | | | | 623 | creation of CAT scans | | |
| | | | | 623 | creation of CAT scans | | |
| | | | | 631 | nuclear power application | | |
| | | | | 631 | nuclear power application | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|--------------------------------|--|---|--------------------|--|---------------------|--|
| 8.3.B.c Impact of Science, Technology and Human Activity | Science is a human endeavor | Social, political, economic, ethical, and environmental forces strongly influence and are influenced by the direction of progress of science and technology | Identify and describe major scientific and technological challenges to society and their ramifications for public policy | 13 | x-ray and ultrasound technology are used in medicine | 143 | the cost of using electrical appliances |
| | | | | 196 | environmental impacts of hydroelectric power | | |
| | | | | 196 | hydroelectric power system | | |
| | | | | 197 | efficiency of the Hoover Dam | | |
| | | | | 217 | advantages of tidal energy | | |
| | | | | 217 | extracting tidal power | | |
| | | | | 219 | using energy efficient products | | |
| | | | | 263 | medical technology using waves | | |
| | | | | 289 | stethoscopes used to hear sound vibrations | | |
| | | | | 296 | ultrasound technology | | |
| | | | | 336 | fiber optics are used for surgical inspections | | |
| | | | | 392 | environmental impact of auto pollution | | |
| | | | | 392 | hybrid cars combine advantages of gasoline fuel and electric power | | |
| | | | | 443 | magnetic resonance imaging | | |
| | | | | 451 | MRI application | | |
| 470 | energy for generators | | | | | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|--|---------------------|--------|
| | | | | 531 | infrared thermometers | | |
| | | | | 534 | energy-efficient building application | | |
| | | | | 602 | hydrogen as a fuel | | |
| | | | | 604 | balancing chemical equation of acid rain | | |
| | | | | 607 | impact of combustion reaction of gasoline | | |
| | | | | 608 | alternate fuels to gasoline | | |
| | | | | 618 | power released by radioactive decay | | |
| | | | | 621 | sources of radiation in the environment | | |
| | | | | 621 | human technology contributes to radiation in environment | | |
| | | | | 622 | x-ray machines | | |
| | | | | 623 | CAT scans | | |
| | | | | 628 | nuclear waste | | |
| | | | | 631 | nuclear power application | | |
| | | | | 631 | nuclear power application | | |
| | | | | 632 | nuclear energy | | |
| | | | | 632 | nuclear waste | | |
| | | | | 634 | comparison of fission and fusion | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|--------------------------------|--|--|--------------------|--|---------------------|--------|
| 8.3.B.d Impact of Science, Technology and Human Activity | Science is a human endeavor | Social, political, economic, ethical, and environmental forces strongly influence and are influenced by the direction of progress of science and technology | Recognize that the gender, ethnicity, and culture of scientists often influence the questions asked and/or the methods used in scientific research and may limit or advance science knowledge and/or technology | 7 | in science inquiry is used to uncover truth | | |
| | | | | 52 | Dr. Harold Edgerton and strobe photography | | |
| | | | | 155 | first artificial human-made Earth satellite was Sputnik | | |
| | | | | 178 | Great Pyramid of Giza and simple machines | | |
| | | | | 257 | Pierre and Jacques Curie and the piezoelectric effect | | |
| | | | | 269 | wave motion and equilibrium | | |
| | | | | 290 | technological breakthrough of sound recording | | |
| | | | | 310 | past theories of light | | |
| | | | | 325 | history of printing | | |
| | | | | 348 | the usefulness of recorded images | | |
| | | | | 349 | the telescope | | |
| | | | | 361 | Young's double-slit experiment | | |
| | | | | 368 | Einstein's thinking revolutionized physics | | |
| | | | | 447 | discovering and using magnetism | | |
| | | | | 501 | search for elements and alchemy | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|-------------------------|-----------|---------|--------------|--------------------|---|---------------------|--------|
| | | | | 560 | deep water submarine Alvin application | | |
| | | | | 561 | the Alvin research submarine | | |
| | | | | 575 | discovery of helium | | |
| | | | | 625 | turning lead into gold | | |
| | | | | 641 | research on future of the universe | | |
| | | | | 644 | proof of Einstein's theory of general relativity | | |
| | | | | 645 | astronomers find black holes by what is around them | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|--------------------------------|---|--|--------------------|--|---------------------|--------|
| 8.3.C.a Impact of Science, Technology and Human Activity | Science is a human endeavor | Scientific ethics require that scientists must not knowingly subject people or the community to health or property risks without their knowledge and consent | Identify and evaluate the need for informed consent in experimentation | 52 | Dr. Harold Edgerton and strobe photography | | |
| | | | | 155 | first artificial human-made Earth satellite was Sputnik | | |
| | | | | 178 | Great Pyramid of Giza and simple machines | | |
| | | | | 257 | Pierre and Jacques Curie and the piezoelectric effect | | |
| | | | | 269 | wave motion and equilibrium | | |
| | | | | 290 | technological breakthrough of sound recording | | |
| | | | | 310 | past theories of light | | |
| | | | | 325 | history of printing | | |
| | | | | 348 | the usefulness of recorded images | | |
| | | | | 349 | the telescope | | |
| | | | | 361 | Young's double-slit experiment | | |
| | | | | 368 | Einstein's thinking revolutionized physics | | |
| | | | | 447 | discovering and using magnetism | | |
| | | | | 501 | search for elements and alchemy | | |
| | | | | 561 | the Alvin research submarine | | |
| | | | | 575 | discovery of helium | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|--------------------------------|---|--|----------------------------|---|-----------------------------|---------------|
| | | | | 625 | turning lead into gold | | |
| 8.3.C.b Impact of Science, Technology and Human Activity | Science is a human endeavor | Scientific ethics require that scientists must not knowingly subject people or the community to health or property risks without their knowledge and consent | Identify the ethical issues involved in experimentation (i.e., risks to organisms or environment) | 112 621 | impact of technology UV radiation and thinning of ozone layer | | |

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Student Text and Investigation Manual

| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|-----------------------------|--|--|--------------------|--|---------------------|--|
| 8.3.C.c Impact of Science, Technology and Human Activity | Science is a human endeavor | Scientific ethics require that scientists must not knowingly subject people or the community to health or property risks without their knowledge and consent | Identify and evaluate the role of models as an ethical alternative to direct experimentation | 7 | developing models to explain observations | 13 | create a graph |
| | | | | 11 | Ptolemy model vs. Copernicus model of the solar system | 13 | compare prediction to measurement |
| | | | | 40 | making a good model | 16 | create a graph |
| | | | | 40 | creating useful models | 16 | describe the graph |
| | | | | 43 | constructing a graph | 22 | how do you measured positions compare to model? |
| | | | | 44 | graphical models | 22 | compare calculation with graph estimate |
| | | | | 44 | using a graphical model to make a prediction and checking the model's accuracy | 22 | model for uniform accelerated motion |
| | | | | 54 | constructing a graph | 22 | create graphs |
| | | | | 55 | create a graph from a data table | 29 | does experiment agree with prediction? |
| | | | | 101 | a model for friction | 37 | make a graph |
| | | | | 102 | a model for static friction | 38 | make a graph |
| | | | | 290 | the process of digital sound reproduction | 43 | how does the measurement compare to your prediction? |
| | | | | 297 | frequency spectrum | 43 | sketch four graphs |
| | | | | 330 | optics and optical instruments | 56 | create a graph |
| | | | | 411 | the waveform of AC electricity | 66 | create a graph of speed vs. position |
| | | | | 492 | the binary number system and its use in computers | 76 | compare predicted mass to actual mass |
| | | | | | | 82 | make three different graphs |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|-----------------------------|---|--|--------------------------------|---|--|--------|
| | | | | | | 87 sketch a graph 114 are there differences between your prediction and measurement? 135 graph voltage vs. current 136 graph voltage vs. current 151 make a graph of voltage vs. time 160 create a graph 167 make a graph of voltage vs. number of magnets 169 make a current vs. voltage graph for the diode | |
| 8.3.D.a Impact of Science, Technology and Human Activity | Science is a human endeavor | Scientific information is presented through a number of credible sources, but is at times influenced in such a way to become non-credible | Evaluate a given source for its scientific credibility (e.g., articles in new periodical quoting an “eye witness”, a scientist speaking within or outside his/her area of expertise) | 62 188 292 372 576 | acceleration of cars perpetual motion machines sound in space holograms and science fiction special effects transporter beams | | |

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| Standard #: Standard | Objective | Concept | Expectations | student text pg | detail | investigation pg | detail |
|---|--------------------------------|---|--|--------------------------------|---|-----------------------------|---------------|
| 8.3.D.b Impact of Science, Technology and Human Activity | Science is a human endeavor | Scientific information is presented through a number of credible sources, but is at times influenced in such a way to become non-credible | Explain why accurate record- keeping, openness, and replication are essential for maintaining an investigator's credibility with other scientists and society | 62 188 292 372 576 | acceleration of cars perpetual motion machines sound in space holograms and science fiction special effects transporter beams | | |