Activity Name Acceleration lab

Students will determine the acceleration of a rocket based on a videotape of its motion. Differences between the theoretical and observed accelerations will be thoroughly investigated in an iterative fashion. For example, at first the values will be close which was good enough for a physics concept lesson. One by one interfering variables will be eliminated until the theory matches the observation as closely as possible.

Investigation and Experimentation

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept, and to address the content the other four strands, students should develop their own questions and perform investigations. Students will:

b. identify and communicate sources of unavoidable experimental error.

c. identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.

d. formulate explanations using logic and evidence.

e. solve scientific problems using quadratic equations, and simple trigonometric, exponential, and logarithmic functions.

g. recognize the use and limitations of models and theories as scientific representations of reality.

i. analyze the locations, sequences, or time intervals of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).

j. recognize the issues of statistical variability and the need for controlled tests.

k. recognize the cumulative nature of scientific evidence.

l. analyze situations and solve problems that require combining and applying concepts from more than one area of science.

Physics — Motion and Forces

1. Newton’s laws predict the motion of most objects. As a basis for understanding this concept, students know:

c. how to apply the law F=ma to solve one-dimensional motion problems involving constant forces (Newton's Second Law).

Activity Name Age of the Sun

Students will use nuclear physics, ratios, and scientfiic notation to estimate the age of the sun.

Chemistry — Nuclear Processes

11. Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and man-made isotopes, nuclear fission, and nuclear fusion. As a basis for understanding this concept, students know:

a. protons and neutrons in the nucleus are held together by strong nuclear forces which are stronger than the electromagnetic repulsion between the protons.

b. the energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions: change in mass (calculated by E=mc^2) is small but significant in nuclear reactions.

Earth Science — Earth's Place in the Universe

1. Astronomy and planetary exploration reveal the structure, scale, and change of the solar system over time. As a basis for understanding this concept, students know:

e. the sun is a typical star and is powered by nuclear reactions, primarily the fusion of hydrogen to form helium.

e. the sun is a typical star and is powered by nuclear reactions, primarily the fusion of hydrogen to form helium.

2. Earth-based and space-based astronomy reveals the structure, scale, and change over time of stars, galaxies and the universe. As a basis for understanding this concept, students know:

c. evidence that all elements with an atomic number greater than that of Lithium have been formed by nuclear fusion in stars.

f.* evidence that the color, brightness and evolution of a star are determined by a balance between gravitational collapse and nuclear fusion.

Activity Name Centripetal Force Lab

Students will design an experimental procedure to independently discover the three major relationships in the Centripetal Force equations. Curve fitting techniques will reveal the mathematical formulas. These results will be combined into a hypothetical result for the structure of the definition of Centripetal Force.

Investigation and Experimentation

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept, and to address the content the other four strands, students should develop their own questions and perform investigations. Students will:

a. select and use appropriate tools and technology (such as computer-linked probes, spread sheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.

b. identify and communicate sources of unavoidable experimental error.

c. identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.

d. formulate explanations using logic and evidence.

i. analyze the locations, sequences, or time intervals of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).

j. recognize the issues of statistical variability and the need for controlled tests.

k. recognize the cumulative nature of scientific evidence.

Physics — Motion and Forces

1. Newton's laws predict the motion of most objects. As a basis for understanding this concept, students know:

f. applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed (for example, the Earth's gravitational force causes a satellite in a circular orbit to change direction but not speed).

g. circular motion requires application of a constant force directed toward the center of the circle.

l.* how to solve problems in circular motion, using the formula for centripetal acceleration in the following form: a=v2/r.

Activity Name Cratering Activity

Students will simulate the behavior of objects as they create artificial craters. The concept of conservation of energy will be used to explain the modeling data.

Physics — Conservation of Energy and Momentum

2. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects. As a basis for understanding this concept, students know:

a. how to calculate kinetic energy using the formula E=(1/2)mv2.

b. how to calculate changes in gravitational potential energy near the Earth using the formula (change in potential energy) =mgh (change in the elevation).

c. how to solve problems involving conservation of energy in simple systems such as falling objects.

Activity Name Distribution of Novae in M31

Students will participate in an ongoing project to detect the presence of novae in the Andromeda Galaxy. This project is sponsored by the Teacher Leaders in Research Based Science Education project.

Chemistry — Nuclear Processes

11. Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and man-made isotopes, nuclear fission, and nuclear fusion. As a basis for understanding this concept, students know:

a. protons and neutrons in the nucleus are held together by strong nuclear forces which are stronger than the electromagnetic repulsion between the protons.

b. the energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions: change in mass (calculated by E=mc^2) is small but significant in nuclear reactions.

d. the three most common forms of radioactive decay (alpha, beta, gamma) and how the nucleus changes in each type of decay.

e. alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.

f.* how to calculate the amount of a radioactive substance remaining after an integral number of half lives have passed.

g.* protons and neutrons have substructure and consist of particles called quarks.

Earth Science — Earth's Place in the Universe

2. Earth-based and space-based astronomy reveals the structure, scale, and change over time of stars, galaxies and the universe. As a basis for understanding this concept, students know:

a. the solar system is located in an outer edge of the disc-shaped Milky Way galaxy which spans 100,000 light years.

b. galaxies are made of billions of stars and form most of the visible mass of the universe.

c. evidence that all elements with an atomic number greater than that of Lithium have been formed by nuclear fusion in stars.

d. stars differ in their life cycles, and visual, radio, and X-ray telescopes collect data that reveal these differences.

f.* evidence that the color, brightness and evolution of a star are determined by a balance between gravitational collapse and nuclear fusion.

Investigation and Experimentation

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept, and to address the content the other four strands, students should develop their own questions and perform investigations. Students will:

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c. identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.

d. formulate explanations using logic and evidence.

e. solve scientific problems using quadratic equations, and simple trigonometric, exponential, and logarithmic functions.

g. recognize the use and limitations of models and theories as scientific representations of reality.

j. recognize the issues of statistical variability and the need for controlled tests.

l. analyze situations and solve problems that require combining and applying concepts from more than one area of science.

Activity Name Gravity and Orbits Activity

In this activity students will be guided through a derivation of Newton's Form of Kepler's Third Law and then use Kepler's Third Law to determine the masses of primary planets from their moons. Students will use this concept to understand how planets are detected around other stars.

Physics — Motion and Forces

1. Newton's laws predict the motion of most objects. As a basis for understanding this concept, students know:

d. when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and opposite direction. (Newton's Third Law).

e. the relationship between the universal law of gravitation and the effect of gravity on an object at the surface of the Earth.

f. applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed (for example, the Earth's gravitational force causes a satellite in a circular orbit to change direction but not speed).

f. applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed (for example, the Earth's gravitational force causes a satellite in a circular orbit to change direction but not speed).

l.* how to solve problems in circular motion, using the formula for centripetal acceleration in the following form: a=v2/r.

m.* how to solve problems involving the forces between two electric charges at a distance (Coulomb's Law) or the forces between two masses at a distance (Universal gravitation).

Activity Name Inverse Square law lab

Students will use a light sensor to determine the relationship between the brightness and distance to a light source. This will be used as an example of mathematical modeling, related to light and to gravity, and used to introduce characteristics of waves.

Physics — Waves

4. Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept, students know:

a. waves carry energy from one place to another.

e. radio waves, light and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in vacuum is approximately 3x108 m/s (186,000 miles/second).

f. how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization.

Activity Name Jupiter's moons lab

Students will analyze photographs of the moons of Jupiter to determine the orbital periods, and distances of the moons of Jupiter, and the mass of Jupiter, and the speed of light in vacuum. Photographs will be taken as original source material for this project using both local telescopes and remote controlled telescopic observations.

Earth Science — Earth's Place in the Universe

1. Astronomy and planetary exploration reveal the structure, scale, and change of the solar system over time. As a basis for understanding this concept, students know:

d. evidence that the planets are much closer than the stars.

g.* evidence for the existence of planets orbiting other stars.

Investigation and Experimentation

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c. identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.

d. formulate explanations using logic and evidence.

i. analyze the locations, sequences, or time intervals of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).

Physics — Conservation of Energy and Momentum

2. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects. As a basis for understanding this concept, students know:

b. how to calculate changes in gravitational potential energy near the Earth using the formula (change in potential energy) =mgh (change in the elevation).

Physics — Motion and Forces

1. Newton's laws predict the motion of most objects. As a basis for understanding this concept, students know:

g. circular motion requires application of a constant force directed toward the center of the circle.

Physics Waves

4. Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept, students know:

c. how to solve problems involving wavelength, frequency, and wave speed.

e. radio waves, light and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in vacuum is approximately 3x108 m/s (186,000 miles/second).

Activity Name Lens Lab

Students will measure the focal length of lenses and mirrors and investigate the relationship between focal length, image distance and object distance. Simple telescopes will be constructed and used to make basic observations.

Earth Science Earth's Place in the Universe

2. Earth-based and space-based astronomy reveals the structure, scale, and change over time of stars, galaxies and the universe. As a basis for understanding this concept, students know:

d. stars differ in their life cycles, and visual, radio, and X-ray telescopes collect data that reveal these differences.

Physics Waves

4. Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept, students know:

c. how to solve problems involving wavelength, frequency, and wave speed.

d. sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.

f. how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization.

Activity Name Measuring the distance to the moon through

Simultaneous photographs of the moon taken from widely separated areas show a shift in position of the moon due to parallax. The parallax shift can be used to determine the distance to the moon.

Earth Science Earth's Place in the Universe

1. Astronomy and planetary exploration reveal the structure, scale, and change of the solar system over time. As a basis for understanding this concept, students know:

g.* evidence for the existence of planets orbiting other stars.

Investigation and Experimentation

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a. select and use appropriate tools and technology (such as computer-linked probes, spread sheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.

d. formulate explanations using logic and evidence.

j. recognize the issues of statistical variability and the need for controlled tests.

n. know that when an observation does not agree with an accepted scientific theory, sometimes the observation is mistaken or fraudulent (e.g., Piltdown Man fossil or unidentified flying objects), and sometimes the theory is wrong (e.g., Ptolemaic model of the movement of the sun, moon and planets).

Activity Name Mercury Spacecraft Simulation

Using special software which simulates the behavior of the Mercury Spacecraft, principles of physics, momentum, and orbits will be demonstrated.

Physics — Conservation of Energy and Momentum

2. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects. As a basis for understanding this concept, students know:

e. momentum is a separately conserved quantity, different from energy.

f. an unbalanced force on an object produces a change in its momentum.

g. how to solve problems involving elastic and inelastic collisions in one dimension using the principles of conservation of momentum and energy.

Physics — Electronic and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications. As a basis for understanding this concept, students know:

b. how to solve problems involving Ohm's law.

Physics — Motion and Forces

1. Newton’s laws predict the motion of most objects. As a basis for understanding this concept, students know:

a. how to solve problems involving constant speed and average speed.

b. when forces are balanced no acceleration occurs, and thus an object continues to move at a constant speed or stays at rest (Newton's First Law).

c. how to apply the law F=ma to solve one-dimensional motion problems involving constant forces (Newton's Second Law).

d. when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and opposite direction. (Newton's Third Law).

e. the relationship between the universal law of gravitation and the effect of gravity on an object at the surface of the Earth.

f. applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed (for example, the Earth's gravitational force causes a satellite in a circular orbit to change direction but not speed).

i.* how to solve two-dimensional trajectory problems.

Activity Name Momentum lab

This lab will be primarily an exercise designed to review the concepts of vector addition, conservation of momentum, and presentation of data for reports. Students will videotape air hockey pucks seen from above and analyze the motion using Videopoint software.

Investigation and Experimentation

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g. recognize the use and limitations of models and theories as scientific representations of reality.

i. analyze the locations, sequences, or time intervals of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).

Physics Conservation of Energy and Momentum

2. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects. As a basis for understanding this concept, students know:

d. how to calculate momentum as product mv.

e. momentum is a separately conserved quantity, different from energy.

f. an unbalanced force on an object produces a change in its momentum.

g. how to solve problems involving elastic and inelastic collisions in one dimension using the principles of conservation of momentum and energy.

Activity Name Planet Reports

Students will research and report on planet characteristics. Patterns in characteristics will be analyzed to establish basic characteristics of the solar system.

Earth Science — Earth's Place in the Universe

1. Astronomy and planetary exploration reveal the structure, scale, and change of the solar system over time. As a basis for understanding this concept, students know:

a. how the differences and similarities among the sun, the terrestrial planets, and the gas planets may have been established during the formation of the solar system.

b. evidence from Earth and moon rocks for the solar system's formation from a nebular cloud of dust and gas approximately 4.6 billion years ago.

c. evidence from geological studies of the Earth and other planets that the early Earth was very different from today.

d. evidence that the planets are much closer than the stars.

e. the sun is a typical star and is powered by nuclear reactions, primarily the fusion of hydrogen to form helium.

f. evidence for the dramatic effects of asteroid impacts in shaping the surface of planets and their moons, and in mass extinctions of life on Earth.

2. Earth-based and space-based astronomy reveals the structure, scale, and change over time of stars, galaxies and the universe. As a basis for understanding this concept, students know:

a. the solar system is located in an outer edge of the disc-shaped Milky Way galaxy which spans 100,000 light years.

Activity Name Radiation lab

Students will investigate a number of variables in relation to the intensity of low-level radiation in naturally occuring minerals. They will also learn about radioactive decay rates, nuclear reactions, and other related topics. They will design categories of objects to use as radiation shielding and display data in a histogram.

Chemistry — Nuclear Processes

11. Nuclear processes are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and man-made isotopes, nuclear fission, and nuclear fusion. As a basis for understanding this concept, students know:

a. protons and neutrons in the nucleus are held together by strong nuclear forces which are stronger than the electromagnetic repulsion between the protons.

b. the energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions: change in mass (calculated by E=mc^2) is small but significant in nuclear reactions.

c. many naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions.

d. the three most common forms of radioactive decay (alpha, beta, gamma) and how the nucleus changes in each type of decay.

e. alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.

f.* how to calculate the amount of a radioactive substance remaining after an integral number of half lives have passed.

Earth Science — Earth's Place in the Universe

1. Astronomy and planetary exploration reveal the structure, scale, and change of the solar system over time. As a basis for understanding this concept, students know:

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Investigation and Experimentation

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept, and to address the content the other four strands, students should develop their own questions and perform investigations. Students will:

a. select and use appropriate tools and technology (such as computer-linked probes, spread sheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.

b. identify and communicate sources of unavoidable experimental error.

c. identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.

d. formulate explanations using logic and evidence.

i. analyze the locations, sequences, or time intervals of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).

j. recognize the issues of statistical variability and the need for controlled tests.

l. analyze situations and solve problems that require combining and applying concepts from more than one area of science.

Physics — Electronic and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications. As a basis for understanding this concept, students know:

e. charged particles are sources of electric fields and experience forces due to the electric fields from other charges.

i. plasmas, the fourth state of matter, contain ions and/or free electrons and conduct electricity.

Activity Name Rocket Impulse Lab

Students will measure the impulse generated by model rocket engines in considerable detail and develop a numeric integration model to determine the total change in velocity of a model rocket.

Investigation and Experimentation

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a. select and use appropriate tools and technology (such as computer-linked probes, spread sheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.

b. identify and communicate sources of unavoidable experimental error.

e. solve scientific problems using quadratic equations, and simple trigonometric, exponential, and logarithmic functions.

g. recognize the use and limitations of models and theories as scientific representations of reality.

i. analyze the locations, sequences, or time intervals of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).

Physics — Conservation of Energy and Momentum

2. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects. As a basis for understanding this concept, students know:

d. how to calculate momentum as product mv.

f. an unbalanced force on an object produces a change in its momentum.

Physics — Motion and Forces

1. Newton’s laws predict the motion of most objects. As a basis for understanding this concept, students know:

c. how to apply the law F=ma to solve one-dimensional motion problems involving constant forces (Newton's Second Law).

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Activity Name Spectroscopic Analysis Lab

In this activity spectrograms of stars are analyzed to determine their spectral class, temperature, radial velocity, and other characteristics. This is an introductory Teacher Leaders in Research Based Science Education activity.

Chemistry — Atomic and Molecular Structure

1. The Periodic Table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure. As a basis for understanding this concept, students know:

j.* spectral lines are a result of transitions of electrons between energy levels. Their frequency is related to the energy spacing between levels using Planck's relationship (E=hn).

Earth Science — Earth's Place in the Universe

2. Earth-based and space-based astronomy reveals the structure, scale, and change over time of stars, galaxies and the universe. As a basis for understanding this concept, students know:

c. evidence that all elements with an atomic number greater than that of Lithium have been formed by nuclear fusion in stars.

d. stars differ in their life cycles, and visual, radio, and X-ray telescopes collect data that reveal these differences.

f.* evidence that the color, brightness and evolution of a star are determined by a balance between gravitational collapse and nuclear fusion.

g.* how the red-shift from distant galaxies and the cosmic background radiation provide evidence for the "big bang" model that suggests that the universe has been expanding for 10 to 20 billion years.

Physics — Waves

4. Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept, students know:

e. radio waves, light and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in vacuum is approximately 3x108 m/s (186,000 miles/second).

Activity Name Stellar Evolution Game

A game developed by astronomers teaches the story of stellar evolution, which requires a basic understanding of the basic forces of nature including static electricity, magnetism, and the strong and weak nuclear forces.

Earth Science — Earth's Place in the Universe

1. Astronomy and planetary exploration reveal the structure, scale, and change of the solar system over time. As a basis for understanding this concept, students know:

e. the sun is a typical star and is powered by nuclear reactions, primarily the fusion of hydrogen to form helium.

2. Earth-based and space-based astronomy reveals the structure, scale, and change over time of stars, galaxies and the universe. As a basis for understanding this concept, students know:

c. evidence that all elements with an atomic number greater than that of Lithium have been formed by nuclear fusion in stars.

f.* evidence that the color, brightness and evolution of a star are determined by a balance between gravitational collapse and nuclear fusion.

Physics — Conservation of Energy and Momentum

2. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects. As a basis for understanding this concept, students know:

h.* how to solve problems involving conservation of energy in simple systems with various sources of potential energy, such as capacitors and springs.

Physics — Electronic and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications. As a basis for understanding this concept, students know:

e. charged particles are sources of electric fields and experience forces due to the electric fields from other charges.

g. how to determine the direction of a magnetic field produced by a current flowing in a straight wire or in a coil.

h. changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors.

j.* electric and magnetic fields contain energy and act as vector force fields.

Physics — Heat and Thermodynamics

3. Energy cannot be created or destroyed although in many processes energy is transferred to the environment as heat. As a basis for understanding this concept, students know:

c. thermal energy (commonly called heat) consists of random motion and the vibrations and rotations of atoms and molecules. The higher the temperature, the greater the atomic or molecular motion.

Physics — Waves

4. Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept, students know:

a. waves carry energy from one place to another.

Activity Name Supplementary Activity 14

In this activity students will measure the brightness of stars in a digital image using HOU software and calculate the stars magnitudes using a spreadsheet. Then they will formulate a hypothesis about the data and attempt to see if graphs of their observations support it or refute it.

Earth Science — Earth's Place in the Universe

2. Earth-based and space-based astronomy reveals the structure, scale, and change over time of stars, galaxies and the universe. As a basis for understanding this concept, students know:

a. the solar system is located in an outer edge of the disc-shaped Milky Way galaxy which spans 100,000 light years.

d. stars differ in their life cycles, and visual, radio, and X-ray telescopes collect data that reveal these differences.

Activity Name Tracking sunspots and magnetic activity

In this lab the number of sunspots on the sun is related to the current magnetic field of the earth. Variations measured over time are compared.

Physics — Electronic and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications. As a basis for understanding this concept, students know:

e. charged particles are sources of electric fields and experience forces due to the electric fields from other charges.

f. magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and experience forces due to magnetic fields of other sources.

i. plasmas, the fourth state of matter, contain ions and/or free electrons and conduct electricity.

j.* electric and magnetic fields contain energy and act as vector force fields.

n.* the force on a moving particle (with charge q) in a magnetic field is qvB sin(a) where a is the angle between v and B (v and B are the magnitudes of vectors v and B, respectively), and students use the right-hand rule to find the direction of this force.

Physics — Heat and Thermodynamics

3. Energy cannot be created or destroyed although in many processes energy is transferred to the environment as heat. As a basis for understanding this concept, students know:

c. thermal energy (commonly called heat) consists of random motion and the vibrations and rotations of atoms and molecules. The higher the temperature, the greater the atomic or molecular motion.

d. most processes tend to decrease the order of a system over time, and energy levels are eventually distributed uniformly.

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