### Lakewood City Schools Science Course of Study – Ninth Grade

#### NAME OF COURSE: INTRODUCTION TO PHYSICAL SCIENCE

- Science and Technology Standard (ST)
- Scientific Inquiry Standard (SI)
- Scientific Ways of Knowing Standard (SW)
- Earth Science Standard (ES)
- Physical Science Standard (PS)

<table>
<thead>
<tr>
<th>9-10 Benchmarks</th>
<th>Grade Level Indicators</th>
<th>Teaching Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>By the end of the 9-10 program the student will:</strong></td>
<td><strong>By the end of Ninth Grade, the student will:</strong></td>
<td><strong><a href="http://www.badastronomy.com">www.badastronomy.com</a></strong> (focuses on scientific accuracy in movies)</td>
</tr>
<tr>
<td><strong>Science and Technology</strong></td>
<td><strong>Understanding Technology</strong></td>
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<tr>
<td>- Explain the ways in which the processes of technological design respond to the needs of society. (ST-A)</td>
<td>- Describe means of comparing the benefits with the risks of technology and how science can inform public policy. (ST-9-1)</td>
<td></td>
</tr>
<tr>
<td>- Explain that science and technology are interdependent; each drives the other. (ST-B)</td>
<td>** Abilities To Do Technological Design**</td>
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</tr>
<tr>
<td>- Identify a problem or need, propose designs and choose among alternative solutions for the problem. (ST-9-2)</td>
<td>- Explain why a design should be continually assessed and the ideas of the design should be tested, adapted and refined. (ST-9-3)</td>
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<tr>
<td><strong>Scientific Inquiry</strong></td>
<td><strong>Doing Scientific Inquiry</strong></td>
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<tr>
<td>- Participate in and apply the processes of scientific investigation to create models and to design, conduct, evaluate and communicate the results of</td>
<td>- Distinguish between observations and inferences given a scientific situation. (SI-9-1)</td>
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<td></td>
<td>- Research and apply appropriate safety precautions when designing and conducting scientific investigations (e.g., OSHA, Material Safety Data Sheets [MSDS], eyewash, goggles, ventilation). (SI-9-2)</td>
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<td></td>
<td>- Construct, interpret and apply physical and conceptual models that represent or explain systems, objects, events or concepts. (SI-9-3)</td>
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<tr>
<td><strong>Scientific Ways of Knowing</strong></td>
<td><strong>Nature of Science</strong></td>
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<tr>
<td>* Explain that scientific knowledge must be based on evidence, be predictive, logical, subject to modification and limited to the natural world. (SW-A)</td>
<td>* Comprehend that many scientific investigations require the contributions of women and men from different disciplines in and out of science. These people study different topics, use different techniques and have different standards of evidence but share a common purpose – to better understand a portion of our universe. (SW-9-1)</td>
<td></td>
</tr>
<tr>
<td>* Explain how scientific inquiry is guided by knowledge, observations, ideas and questions. (SW-B)</td>
<td>* Illustrate that the methods and procedures used to obtain evidence must be clearly reported to enhance opportunities for further investigations. (SW-9-2)</td>
<td></td>
</tr>
<tr>
<td>* Describe the ethical practices and guidelines in which science operates. (SW-C)</td>
<td>* Demonstrate that reliable scientific evidence improves the ability of scientists to offer accurate predictions. (SW-9-3)</td>
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</tr>
<tr>
<td>Science Draft 12/29/05 9-2</td>
<td>Ethical Practices</td>
<td></td>
</tr>
<tr>
<td>* Decide what degree of precision based on the data is adequate and round off the results of calculator operations to the proper number of significant figures to reasonably reflect those of the inputs. (SI-9-4)</td>
<td>* Explain how support of ethical practices in science (e.g., individual observations and confirmations, accurate reporting, peer review and publication) is required to reduce bias. (SW-9-4)</td>
<td></td>
</tr>
<tr>
<td>* Develop oral and written presentations using clear language, accurate data, appropriate graphs, tables, maps and available technology. (SI-9-5)</td>
<td>* Scientific Theories</td>
<td></td>
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<tr>
<td>* Draw logical conclusion based on scientific knowledge and evidence from investigations. (SI-9-6)</td>
<td>* Justify that scientific theories are explanations of large bodies of information and/or observations that withstand repeated testing. (SW-9-5)</td>
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<tr>
<td></td>
<td>* Explain that inquiry fuels observation and experimentation that produce data that are the foundation of scientific disciplines. Theories are explanations of these data. (SW-9-6)</td>
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<td></td>
<td>* Recognize that scientific knowledge and explanations have changed over time, almost always building on earlier knowledge. (SW-9-7)</td>
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</table>
| (SW-C) Recognize that scientific literacy is part of being a knowledgeable citizen. (SW-D) | **Science and Society**

- Illustrate that much can be learned about the internal workings of science and the nature of science from the study of scientists, their daily work and their efforts to advance scientific knowledge in their area of study. (SW-9-8)
- Investigate how the knowledge, skills and interests learned in science classes apply to the careers students plan to pursue. (SW-9-9)

- **Historical Perspectives and Scientific Revolutions**
  - Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., heliocentric theory and plate tectonics theory). (ES-9-8)
  - Use historical examples to explain how new ideas are limited by the context in which they are conceived; are often initially rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly through contributions from many different investigators (e.g., atomic theory, quantum theory, Newtonian mechanics). (PS-9-26)

- Describe advances and issues in physical science that have important, long-lasting effects on science and society (e.g., atomic theory, quantum theory, Newtonian mechanics, nuclear energy, nanotechnology, plastics and ceramics and communication technology). (PS-9-27)

- Describe advances and issues in earth and space science that have an important long lasting effect on science and society (eg: geologic time scales, global warming, depletion of resources, and exponential population growth). (ES-10-7) |
Lakewood City Schools Science Course of Study – Introduction to Physical Science

**NAME OF COURSE: INTRODUCTION TO PHYSICAL SCIENCE**

**UNIT: EARTH SCIENCE**

**Earth Science Standard (ES)**

<table>
<thead>
<tr>
<th>9-10 Benchmarks</th>
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<tbody>
<tr>
<td>By the end of the 9-10 program, the student will:</td>
<td>By the end of Ninth Grade, the student will:</td>
</tr>
<tr>
<td><strong>Earth and Space Sciences</strong></td>
<td><strong>The Universe</strong></td>
</tr>
<tr>
<td>Explain how evidence from stars and other celestial objects provide information about the processes that cause changes in the composition and scale of the physical universe. (ES-A)</td>
<td>✪ Describe that stars produce energy from nuclear reactions and that processes in stars have led to the formation of all elements beyond hydrogen and helium. (ES-9-1)</td>
</tr>
<tr>
<td>Explain that many processes occur in patterns within the Earth’s systems. (ES-B)</td>
<td>✪ Describe the current scientific evidence that supports the theory of the explosive expansion of the universe, the Big Bang, over 10 billion years ago. (ES-9-2)</td>
</tr>
<tr>
<td>Explain the 4.5 billion-year-history of Earth and the 4 billion-year-history of life on Earth based on observable scientific evidence in the geologic record. (ES-C)</td>
<td>✪ Explain that gravitational forces govern the characteristics and movement patterns of the planets, comets and asteroids in the Solar System. (ES-9-3)</td>
</tr>
<tr>
<td>Describe the finite nature of Earth’s</td>
<td><strong>Earth Systems</strong></td>
</tr>
<tr>
<td></td>
<td>✪ Explain the relationships of the oceans to the lithosphere and atmosphere (e.g., transfer of energy, ocean currents, landforms). (ES-9-4)</td>
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<td></td>
<td>✪ Explain climate and weather patterns associated with certain geographic locations and features (e.g., tornado alley, tropical hurricanes, and lake effect snow). (ES-10-2)</td>
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<td></td>
<td>✪ Explain how geologic time can be estimated by multiple methods (e.g. rock sequences, fossil correlation, radiometric dating). (ES-10-3)</td>
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<tr>
<td></td>
<td>✪ Explain how the acquisition and use of resources, urban growth and waste disposal can accelerate natural change and impact the quality of life. (ES-10-5)</td>
</tr>
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**Teaching Resources**
resources and those human activities that can conserve or deplete Earth’s resources. (ES-D)

Explain the processes that move and shape Earth’s surface. (ES-E)

Summarize the historical development of scientific theories and ideas, and describe emerging issues in the study of Earth and space sciences. (ES-F)

**Processes that Shape Earth**

* Explain how the slow movement of material within Earth results from (a) thermal energy transfer (conduction and convection) from the deep interior (b) the action of gravitational forces on regions of different density. (ES-9-5)

* Explain the results of plate tectonic activity (e.g., magma generation, igneous intrusion, metamorphism, volcanic action, earthquakes, faulting and folding). (ES-9-6)

* Explain sea-floor spreading and continental drift using scientific evidence (e.g., fossil distributions, magnetic reversals and radiometric dating). (ES-9-7)

**SUB-OBJECTIVES – Processes that shape the earth**

After completion of this unit, students will be able to…

- Describe the different types of seismic waves
- Identify the earth’s different internal layers
- State how the earth’s internal layers were discovered by the use of seismic waves
- Describe the differences and relationship between the asthenosphere and lithosphere and how they affect the earth’s surface features
- Explain that heat driven convection currents operate within the earth
- Describe the differences between oceanic and continental crust
- Describe that motion in the outer core drives earth’s magnetic field
- Describe the different types of faults and the forces that cause them
- Describe how and why earthquakes occur and the scales used to measure their intensity and magnitude
- Identify the pieces of evidence to support continental drift
- Define paleomagnetism and its relationship to continental drift
- Describe the theory of sea-floor spreading
- Understand that features of the ocean floor (magnetic patterns,
age, and sea floor topography) provide evidence of plate tectonics

- Describe the theory of plate tectonics
- Recognize, differentiate between, and provide examples of the three types of plate boundaries.
- Describe the principle structures (mountains, volcanoes, deep sea trenches, and faults) that form at the three different kinds of plate boundaries
- Describe how the formation of the different rock types relates to plate tectonics
- Explain the location and properties of volcanoes that are due to hot spots and the explanation for those that are due to subduction

**SUB-OBJECTIVES – Earth Systems**

After completion of this unit, students will be able to...

- Describe the concept of the Geologic Time Scale
- State the assumption of Uniformitarianism
- Describe the 5 principles used for relative dating
- Define radiometric dating and state its importance
- Describe the relationship between relative dating and radiometric dating
- Name some of the radioactive isotopes used for radiometric dating
- Describe several important aspects and events for each of the eras in the geologic time scale
- Name the current era, period, and epoch
- Describe how it is that we are now currently in an ice age
- Describe the role of humans in geologic time
- Describe how latitude, elevation, topography, and proximity to large bodies of water and cold or warm ocean currents affect temperature
- Describe how the differential heating of the earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat
- Describe how the heating of the earth’s surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing wind and ocean currents
- Describe the Coriolis Effect and why it exists
- Describe the interaction of wind patterns, ocean currents, and mountain ranges that result in the global pattern of rain forests and deserts at specific latitudes
- Define the term air mass and Describe the characteristics of different air masses
- Understand and describe the three different atmospheric lifting mechanisms

**SUB-OBJECTIVES – The Universe**
After completion of this unit, students will be able to…
- Distinguish between asteroids, meteoroids, and comets
- Describe how stars are born, how they live, and how they die
- Distinguish between astronomy and astrology
- Describe how big stars have relatively short lives and why
- Explain current thinking about black holes
- Describe features of galaxies
- Describe the concept of the Big Bang
**Lakewood City Schools Science Course of Study – Ninth Grade**

**NAME OF COURSE:**  INTRODUCTION TO PHYSICAL SCIENCE  
**UNIT:**  CHEMISTRY

### Physical Science Standard (PS)

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| **Physical Sciences**  
* Describe that matter is made of minute particles called atoms and atoms are comprised of even smaller components. Explain the structure and properties of atoms. (PS-A)  
* Explain how atoms react with each other to form other substances and how molecules react with each other or other atoms to form even different substances. (PS-B)  
* Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration, ductility). Explain how changes in these properties can occur without | **Nature of Matter**  
- Recognize that all atoms of the same element contain the same number of protons, and elements with the same number of protons may or may not have the same mass. Those with different masses (different numbers of neutrons) are called isotopes. (PS-9-1)  
- Illustrate that atoms with the same number of positively charged protons and negatively charged electrons are electrically neutral. (PS-9-2)  
- Describe radioactive substances as unstable nuclei that undergo random spontaneous nuclear decay emitting particles and/or high energy wavelike radiation. (PS-9-3)  
- Show that when elements are listed in order according to the number of protons (called the atomic number), the repeating patterns of physical and chemical properties identify families of elements. Recognize that the periodic table was formed as a result of the repeating pattern of electron configurations. (PS-9-4)  
- Describe how ions are formed when an atom or a group of atoms acquire an unbalanced charge by gaining or losing one or more electrons. (PS-9-5)  
- Show how atoms may be bonded together by losing, gaining or sharing electrons and that in a chemical reaction, the number, | |

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Changing the chemical nature of the substance. (PS-C)

- The type of atoms and total mass must be the same before and after the reaction (e.g., writing correct chemical formulas and writing balanced chemical equations). (PS-9-7)
  - Investigate the properties of pure substances and mixtures (e.g., density, conductivity, hardness, properties of alloys, superconductors and semiconductors). (PS-9-9)
  - Summarize how nuclear reactions convert a small amount of matter into a large amount of energy. (Fission involves the splitting of a large nucleus into smaller nuclei; fusion is the joining of two small nuclei into a larger nucleus at extremely high energies.) (PS-9-14)

**SUB-OBJECTIVES – Nature of Matter**

After completion of this unit, students will be able to...

- Describe the relationship between atoms and elements
- Compare the ages of atoms to the ages of the materials they compose
- Give examples to illustrate the small size of atoms
- Identify the parts of the atomic nucleus
- Explain the significance of the horizontal rows and the vertical columns of the periodic table
- Given the half-life of a radioactive isotope and the original amount of the isotope, predict how much of the isotope will remain at the end of some multiple of the half-life.
- Given the symbol for a radioactive isotope, and the particle it gives off, predict the product of its decay
- Explain why additional exposure to radiation is harmful
- Describe the role of neutrons in causing and sustaining nuclear fusion
- Explain how nuclear fission can be controlled in a reactor
- Describe the current problems associated with the use of fission as a source of power
- Distinguish between nuclear fission and nuclear fusion
- Describe the advantages of fusion of fission as a source of power
- Understand the nature of chemistry
- Distinguish between atoms and molecules
- Describe and explain properties of elements

- Lab: How Can Solids form in water?
- Molecular Model Kits
- Lab: Aluminum Atoms
- Element Assignment (www.webelements.com)
- Video: The Ring of Truth: Atoms
- Half-life games
- Geiger counter (see Ron)
- Analyze and explain atomic and molecular changes in a chemical reaction
- Compare and contrast chemical and physical properties
- Recognize that most materials around the student are mixtures of some sort
- Understand how mixtures can be separated by physical means and distinguish solutions and suspensions from heterogeneous mixtures
- Use various terms associated with solutions
- Apply the shell model of the atom to chemical bonding
- Distinguish between an atom and an ion
- Predict the formula of an ionic compound using the periodic table
- Distinguish between ionic and covalent bonds
- Understand how some molecules are polar
- Understand how the polarity of molecules affects macroscopic properties
### Lakewood City Schools Science Course of Study – Ninth Grade

**NAME OF COURSE:** INTRODUCTION TO PHYSICAL SCIENCE  
**UNIT:** PHYSICS

#### Physical Science Standard (PS)

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<tr>
<td><strong>Physical Sciences</strong></td>
<td><strong>Forces and Motion</strong></td>
<td></td>
</tr>
<tr>
<td>° Explain the movement of objects by applying Newton’s three laws of motion. (PS-D)</td>
<td>° Demonstrate that motion is a measurable quantity that depends on the observer’s frame of reference and describe the object’s motion in terms of position, velocity, acceleration and time. (PS-9-21)</td>
<td></td>
</tr>
<tr>
<td>° Demonstrate that energy can be considered to be either kinetic (motion) or potential (stored). (PS-E)</td>
<td>° Demonstrate that any object does not accelerate (remains at rest or maintains a constant speed and direction of motion) unless an unbalanced (net) force acts on it. (PS-9-22)</td>
<td></td>
</tr>
<tr>
<td>° Explain how energy may change form or be redistributed but the total quantity of energy is conserved. (PS-F)</td>
<td>° Explain the change in motion (acceleration) of an object. Demonstrate that the acceleration is proportional to the net force acting on the object and inversely proportional to the mass of the object. (F_{net} = ma. Note that weight is the gravitational force on a mass.) (PS-9-23)</td>
<td></td>
</tr>
<tr>
<td>° Summarize the historical</td>
<td>° Demonstrate that whenever one object exerts a force on another, an equal amount of force is exerted back on the first object. (PS-9-24)</td>
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</tr>
<tr>
<td>° Demonstrate that waves (e.g., sound, seismic, water, light) have energy and waves can transfer energy when they interact with matter. (PS-G)</td>
<td>° Demonstrate the ways in which frictional forces constrain the motion of objects (e.g., a car traveling around a curve, a block on an inclined plane, a person running, an airplane in flight). (PS-9-25)</td>
<td></td>
</tr>
<tr>
<td>° Nature of Energy</td>
<td>° Explain how thermal energy exists in the random motion and vibrations of atoms and molecules. Recognize that the higher the temperature, the greater the average atomic or molecular motion,</td>
<td></td>
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</table>

By the end of Ninth Grade, the student will:

- Demonstrate that motion is a measurable quantity that depends on the observer’s frame of reference and describe the object’s motion in terms of position, velocity, acceleration and time. (PS-9-21)
- Demonstrate that any object does not accelerate (remains at rest or maintains a constant speed and direction of motion) unless an unbalanced (net) force acts on it. (PS-9-22)
- Explain the change in motion (acceleration) of an object. Demonstrate that the acceleration is proportional to the net force acting on the object and inversely proportional to the mass of the object. (F_{net} = ma. Note that weight is the gravitational force on a mass.) (PS-9-23)
- Demonstrate that whenever one object exerts a force on another, an equal amount of force is exerted back on the first object. (PS-9-24)
- Demonstrate the ways in which frictional forces constrain the motion of objects (e.g., a car traveling around a curve, a block on an inclined plane, a person running, an airplane in flight). (PS-9-25)
- Explain how thermal energy exists in the random motion and vibrations of atoms and molecules. Recognize that the higher the temperature, the greater the average atomic or molecular motion,
| development of scientific theories and ideas, and describe emerging issues in the study of physical sciences. (PS-H) | and during changes of state the temperature remains constant. (PS-9-11) |
| | * Explain how an object’s kinetic energy depends on its mass and its speed \((KE = \frac{1}{2}mv^2)\). (PS-9-12) |
| | * Demonstrate that near Earth’s surface an object’s gravitational potential energy depends upon its weight \((mg)\) where \(m\) is the object’s mass and \(g\) is the acceleration due to gravity and height \((h)\) above a reference surface \((PE = mgh)\). (PS-9-13) |
| | * Trace the transformations of energy within a system (e.g., chemical to electrical to mechanical) and recognize that energy is conserved. Show that these transformations involve the release of some thermal energy. (PS-9-15) |
| | * Illustrate that chemical reactions are either endothermic or exothermic (e.g., cold packs, hot packs and the burning of fossil fuels). (PS-9-16) |
| | * Demonstrate that thermal energy can be transferred by conduction, convection or radiation (e.g., through materials by the collision of particles, moving air masses or across empty space by forms of electromagnetic radiation). (PS-9-17) |
| | * Demonstrate that electromagnetic radiation is a form of energy. Recognize that light acts as a wave. Show that visible light is a part of the electromagnetic spectrum (e.g., radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays). (PS-9-18) |
| | * Show how the properties of a wave depend on the properties of the medium through which it travels. Recognize that electromagnetic waves can be propagated without a medium. (PS-9-19) |
| | * Describe how waves can superimpose on one another when propagated in the same medium. Analyze conditions in which waves can bend around corners, reflect off surfaces, are absorbed by materials they enter, and change direction and speed when entering a different material. (PS-9-20) |
| | * Explain that the electric force between the nucleus and the electrons hold an atom together. Relate that on a larger scale, electric forces hold solid and liquid materials together (e.g., salt crystals, water). (PS-9-6) |
| | * Compare the conductivity of different materials and explain the role of electrons in the ability to conduct electricity. (PS-9-10) |
### SUB-OBJECTIVES

- After completion of this unit, students will be able to:
  - Distinguish between Aristotle’s classifications of natural and unnatural motion
  - State the difference between Aristotle’s focus on classification and Galileo’s focus on experimentation
  - Describe Galileo’s contribution to the science of motion
  - Distinguish between speed and velocity
  - Define inertia
  - State Newton’s first law of motion
  - Distinguish between force and net force
  - Explain what the Equilibrium rule and $\Sigma F=0$ means
  - Define support force
  - Distinguish between static equilibrium and dynamic equilibrium
  - Explain how an object not connected to the ground continues moving with the moving earth
  - Define acceleration and distinguish it from velocity
  - State the relationship between acceleration and net force
  - Distinguish between volume, weight, and inertia
  - State the relationship between acceleration and mass
  - Distinguish between the concepts of directly proportional and inversely proportional to
  - State Newton’s second law of motion
  - Explain how friction affects motion
  - Explain Newton’s second law to explain why the acceleration of an object in freefall does not depend on the mass of an object
  - Describe what happens to the acceleration and the velocity of a falling object in the presence of air drag
  - Define force in terms of interaction
  - Explain why at least two objects are involved whenever a force acts
  - State Newton’s third law of motion
  - Explain why the accelerations caused by an action force and by a reaction force do not have to be equal
  - Explain why action and reaction forces don’t cancel
  - Determine the amount of work done when given the force and

- Gravity and Orbits Lab
- Space Basics Video
- Constant Speed Vehicles
- Reaction Time Lab
- Newton’s Laws Demos
- Lab: Measuring Work
- Lab: Pendulums
- Lab: Fulcrums
- Lab: Temperature and convection
- Lab: How does sunshine affect air?
- ID Heat Transfer
- Lab: Radiation
- Traveling Wave Machine
- Demo Slinkies
- Sound Demos
- Video: The Right Stuff (1st half hour about breaking sound barrier)
- Tuning Forks
- Search websites for Doppler Effect
- Bill Nye: Electricity Video
- Electric Times Newspaper
the distance moved
- Determine the amount of power when work done and time are given
- Calculate work as the product of force and distance
- Calculate the amount of power when work done and time are given
- Define work in terms of energy
- Distinguish between potential and kinetic energy
- Describe how the kinetic energy of an object depends on mass and speed
- State the law of conservation of energy
- Describe the function of a lever
- Define efficiency in terms of work done and work input
- Describe the relationship between temperature and kinetic energy
- Define heat and explain why it is incorrect to think of matter as containing heat
- Describe what determines if heat will flow into or out of a substance
- Distinguish between thermal energy and heat
- Describe the concept of absolute zero
- Explain why two materials at the same temperature may not feel like the same temperature when touched
- Explain why porous materials with air spaces are better insulators than non-porous materials
- Explain how heat is transmitted through empty space
- Compare the ability of an object to emit radiant energy with its ability to absorb it
- Describe electrical forces between objects
- Explain, from the point of view of electron transfer, how an object becomes positively charged or negatively charged and relate this to the object’s net charge
- Describe the relationship of the electrical force between two charged objects, the charge of each object, and the distance between the charges
- Distinguish between a conductor and an insulator
- Relate the pitch of a sound to its frequency
- Describe what happens to air when sound moves through it
- Compare the transmission of sound through air with its transmission through solids, liquids, and a vacuum
- Describe factors that affect the speed of sound
- Give examples of forced vibrations
- Describe the conditions for resonance
- Describe the nature of light and the electromagnetic spectrum