

Active Physics Correlation to the Indiana's Academic Science Standards

<p>"X" = Coverage Secondary concept of the activity or problem. Students gain a basic understanding or introduction of the concept.</p> <p>"XX" = In-depth Coverage Primary concept that is the focus of the activity or problem. Students gain thorough understanding of the concept.</p>	Communication			Home			Medicine			Predictions			Sports			Transportation		
	Chapter 1	Chapter 2	Chapter 3	Chapter 1	Chapter 2	Chapter 3	Chapter 1	Chapter 2	Chapter 3	Chapter 1	Chapter 2	Chapter 3	Chapter 1	Chapter 2	Chapter 3	Chapter 1	Chapter 2	Chapter 3

Science: Physics I : Standard 1
Principles of Physics
 Students recognize the nature and scope of physics, including its relationship to other sciences and its ability to describe the natural world. Students learn how physics describes the natural world, using quantities such as velocity, acceleration, force, energy, momentum, and charge. Through experimentation and analysis, students develop skills that enable them to understand the physical environment. They learn to make predictions about natural phenomena by using physical laws to calculate or estimate these quantities. Students learn that this description of nature can be applied to diverse phenomena at scales ranging from the subatomic to the structure of the universe and include everyday events. Students learn how the ideas they study in physics can be used in concert with the ideas of the other sciences. They also learn how physics can help to promote new technologies. Students will be able to communicate what they have learned orally,

The Properties of Matter

P.1.1 Describe matter in terms of its fundamental constituents and be able to differentiate among those constituents.											X									
P.1.2 Measure or determine the physical quantities including mass, charge, pressure, volume, temperature, and density of an object or unknown sample.																				
P.1.3 Describe and apply the kinetic molecular theory to the states of matter.																				
P.1.4 Employ correct units in describing common physical quantities.												X		X	X	X			X	X

The Relationships Between Motion and Forces

P.1.5 Use appropriate vector and scalar quantities to solve kinematics and dynamics problems in one and two dimensions.													XX	X	XX	XX	X	X	XX	X
P.1.6 Describe and measure motion in terms of position, time, and the derived quantities of velocity and acceleration.													XX	X	XX	XX	XX	XX	XX	XX

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P.1.7 Use Newton's Laws (e.g., $F = ma$) together with the kinematic equations to predict the motion of an object.											XX			XX			XX	
P.1.8 Describe the nature of centripetal force and centripetal acceleration (including the formula $a = v^2/r$), and use these ideas to predict the motion of an object.											X			X		XX		
P.1.9 Use the conservation of energy and conservation of momentum laws to predict, both conceptually and quantitatively, the results of the interactions between objects.					X								X	X	X		X	
P.1.10 Demonstrate an understanding of the inverse square nature of gravitational and electrostatic forces.						X	X						X					
The Nature of Energy																		
P.1.11 Recognize energy in its different manifestations such as kinetic ($KE = 1/2 mv^2$), gravitational potential ($PE = mgh$), thermal, chemical, nuclear, electromagnetic, or mechanical.		X		XX	XX	XX	X		X			XX	XX	X	X			
P.1.12 Use the law of conservation of energy to predict the outcome(s) of an energy transformation.					X								X	X	X		X	
P.1.13 Use the concepts of temperature, thermal energy, transfer of thermal energy, and the mechanical equivalent of heat to predict the results of an energy transfer.					XX													
P.1.14 Explain the relation between energy (E) and power (P). Explain the definition of the unit of power, the watt.					XX	X												
Momentum and Energy																		

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P.1.15 Distinguish between the concepts of momentum (using the formula $p = mv$) and energy.					X								X	X	X		XX	
P.1.16 Describe circumstances under which each conservation law may be used.					X								X	X	X		X	
The Nature of Electricity and Magnetism																		
P.1.17 Describe the interaction between stationary charges using Coulomb’s Law. Know that the force on a charged particle in an electrical field is qE , where E is the electric field at the position of the particle, and q is the charge of the particle.						X												
P.1.18 Explain the concepts of electrical charge, electrical current, electrical potential, electric field, and magnetic field. Use the definitions of the coulomb, the ampere, the volt, the volt/meter, and the tesla.					X	XX												
P.1.19 Analyze simple arrangements of electrical components in series and parallel circuits. Know that any resistive element in a DC circuit dissipates energy, which heats the resistor. Calculate the power (rate of energy dissipation), using the formula $Power = IV = I^2R$.					XX	XX						X						

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P.1.20 Describe electric and magnetic forces in terms of the field concept and the relationship between moving charges and magnetic fields. Know that the magnitude of the force on a moving particle with charge q in a magnetic field is $qvB\sin\alpha$, where v and B are the magnitudes of vectors v and B and α is the angle between v and B .						XX												
P.1.21 Explain the operation of electric generators and motors in terms of Ampere’s law and Faraday’s law.					X	X												
The Behavior of Waves																		
P.1.22 Describe waves in terms of their fundamental characteristics of velocity, wavelength, frequency or period, and amplitude. Know that radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves, whose speed in a vacuum is approximately 3×10^8 m/s (186,000 miles/second).	XX	X	XX			X	X		X			X	X					X
P.1.23 Use the principle of superposition to describe the interference effects arising from propagation of several waves through the same medium.			X															
P.1.24 Use the concepts of reflection, refraction, polarization, transmission, and absorption to predict the motion of waves moving through space and matter.	XX	X	X				X	X	X			X						X

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P.1.25 Use the concepts of wave motion to predict conceptually and quantitatively the various properties of a simple optical system.	XX		X							XX								
P.1.26 Identify electromagnetic radiation as a wave phenomenon after observing refraction, reflection, and polarization of such radiation.	XX	X	X							X								
The Laws of Thermodynamics																		
P.1.27 Understand that the temperature of an object is proportional to the average kinetic energy of the molecules in it and that the thermal energy is the sum of all the microscopic potential and kinetic energies.					XX	X												
P.1.28 Describe the Laws of Thermodynamics, understanding that energy is conserved, heat does not move from a cooler object to a hotter one without the application of external energy, and that there is a lowest temperature, called absolute zero. Use these laws in calculations of the behavior of simple systems.					XX	X												
The Nature of Atomic and Subatomic Physics																		
P.1.29 Describe the nuclear model of the atom in terms of mass and spatial relationships of the electrons, protons, and neutrons.													X					

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P.1.30 Explain that the nucleus, although it contains nearly all of the mass of the atom, occupies less than the proportion of the solar system occupied by the sun. Explain that the mass of a neutron or a proton is about 2,000 times greater than the mass of an electron.										X								
P.1.31 Explain the role of the strong nuclear force in binding matter together.																		
P.1.32 Using the concept of binding energy per nucleon, explain why a massive nucleus that fissions into two medium-mass nuclei emits energy in the process.																		
P.1.33 Using the same concept, explain why two light nuclei that fuse into a more massive nucleus emit energy in the process.																		
P.1.34 Understand and explain the properties of radioactive materials, including half-life, types of emissions, and the relative penetrative powers of each type.										X								
P.1.35 Describe sources and uses of radioactivity and nuclear energy.										X								

Science: Physics I : Standard 2

Historical Perspectives of Physics

Students gain understanding of how the scientific enterprise operates through examples of historical events. Through the study of these events, students understand that new ideas are limited by the context in which they are conceived, are often rejected by the scientific establishment, sometimes spring from unexpected findings, and grow or transform slowly through the contributions of many different investigators.

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P.2.1 Explain that Isaac Newton created a unified view of force and motion in which motion everywhere in the universe can be explained by the same few rules. Note that his mathematical analysis of gravitational force and motion showed that planetary orbits had to be the very ellipses that Johannes Kepler had proposed two generations earlier.											X	X	X	X	X			X	X	
P.2.2 Describe how Newton's system was based on the concepts of mass, force, and acceleration; his three laws of motion relating to them; and a physical law stating that the force of gravity between any two objects in the universe depends only upon their masses and the distance between them.													XX	X	X	XX	XX	X	XX	XX
P.2.3 Explain that the Newtonian model made it possible to account for such diverse phenomena as tides, the orbits of the planets and moons, the motion of falling objects, and Earth's equatorial bulge.														X	X			X	X	
P.2.4 Describe how the Scottish physicist James Clerk Maxwell used Ampere's law and Faraday's law to predict the existence of electromagnetic waves and predict that light was just such a wave. Also understand that these predictions were confirmed by Heinrich Hertz, whose confirmations thus made possible the fields of radio, television, and many other technologies.																				

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P.2.5 Describe how among the surprising ideas of Albert Einstein’s special relativity is that nothing can travel faster than the speed of light, which is the same for all observers no matter how they or the light source happen to be moving, and that the length of time interval is not the same for observers in relative motion.												XX						
P.2.6 Explain that the special theory of relativity ($E=mc^2$) is best known for stating that any form of energy has mass and that matter itself is a form of energy.												XX						
P.2.7 Describe how general relativity theory pictures Newton’s gravitational force as a distortion of space and time.												XX						
P.2.8 Explain that Marie and Pierre Curie made radium available to researchers all over the world, increasing the study of radioactivity and leading to the realization that one kind of atom may change into another kind, and so must be made up of smaller parts. Note that these parts were demonstrated by Rutherford, Geiger, and Marsden to be small, dense nuclei that contain protons and neutrons and surrounded by clouds of electrons.										XX								
P.2.9 Explain that Ernest Rutherford and his colleagues discovered that the radioactive element radon spontaneously splits itself into a slightly lighter nucleus and a very light helium nucleus.																		

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<p>P.2.10 Describe how later, Austrian and German scientists showed that when uranium is struck by neutrons, it splits into two nearly equal parts plus two or three extra neutrons. Note that Lise Meitner, an Austrian physicist, was the first to point out that if these fragments added up to less mass than the original uranium nucleus, then Einstein’s special relativity theory predicted that a large amount of energy would be released. Also note that Enrico Fermi, an Italian working with colleagues in the United States, showed that the extra neutrons trigger more fissions and so create a sustained chain reaction in which a prodigious amount of energy is given off.</p>																		
<p>Science : Integrated Chemistry-Physics : Standard 1 Principles of Integrated Chemistry - Physics Students begin to conceptualize the general architecture of the atom and the roles played by the main constituents of the atom in determining the properties of materials. They investigate, using such methods as laboratory work, the different properties of matter. They investigate the concepts of relative motion, the action/reaction principle, wave behavior, and the interaction of matter and energy. Structure and Properties of Matter</p>																		
<p>CP.1.1 Understand and explain that atoms have a positive nucleus (consisting of relatively massive positive protons and neutral neutrons) surrounded by negative electrons of much smaller mass, some of which may be lost, gained, or shared when interacting with other atoms. MP</p>										X								

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CP.1.2 Realize that and explain how a neutral atom's atomic number and mass number can be used to determine the number of protons, neutrons, and electrons that make up an atom. MP										X								
CP.1.3 Understand, and give examples to show, that isotopes of the same element have the same numbers of protons and electrons but differ in the numbers of neutrons. MP																		
CP.1.4 Know and explain that physical properties can be used to differentiate among pure substances, solutions, and heterogeneous mixtures. MP																		
Changes in Matter																		
CP.1.5 Distinguish among chemical and physical changes in matter by identifying characteristics of these changes.																		
CP.1.6 Understand and explain how an atom can acquire an unbalanced electrical charge by gaining or losing electrons.																		
CP.1.7 Identify the substances gaining and losing electrons in simple oxidation-reduction reactions.																		
CP.1.8 Know and explain that the nucleus of a radioactive isotope is unstable and may spontaneously decay, emitting particles and/or electromagnetic radiation.																		

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CP.1.9 Show how the predictability of the nuclei decay rate allows radioactivity to be used for estimating the age of materials that contain radioactive substances.																		
CP.1.10 Understand that the Periodic Table is a listing of elements arranged by increasing atomic number, and use it to predict whether a selected atom would gain, lose, or share electrons as it interacts with other selected atoms. MP																		
CP.1.11 Understand and give examples to show that an enormous variety of biological, chemical, and physical phenomena can be explained by changes in the arrangement and motion of atoms and molecules.																		
CP.1.12 Realize and explain that because mass is conserved in chemical reactions, balanced chemical equations must be used to show that atoms are conserved.																		
CP.1.13 Explain that the rate of reactions among atoms and molecules depends on how often they encounter one another, which is in turn affected by the concentrations, pressures, and temperatures of the reacting materials.																		
CP.1.14 Understand and explain that catalysts are highly effective in encouraging the interaction of other atoms and molecules.																		
Energy Transformations																		

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CP.1.15 Understand and explain that whenever the amount of energy in one place or form diminishes, the amount in other places or forms increases by the same amount.					X								X	X	X			
CP.1.16 Explain that heat energy in a material consists of the disordered motions of its atoms or molecules.				X														
CP.1.17 Know and explain that transformations of energy usually transform some energy into the form of heat, which dissipates by radiation or conduction into cooler surroundings.				XX	X													
CP.1.18 Recognize and describe the heat transfer associated with a chemical reaction or a phase change as either exothermic or endothermic, and understand the significance of the distinction.																		
CP.1.19 Understand and explain that the energy released whenever heavy nuclei split or light nuclei combine is roughly a million times greater than the energy absorbed or released in a chemical reaction. ($E=mc^2$)																		
CP.1.20 Realize and explain that the energy in a system is the sum of both potential energy and kinetic energy.					X	X							X	X	X			
Motion																		
CP.1.21 Understand and explain that the change in motion of an object (acceleration) is proportional to the net force applied to the object and inversely proportional to the object's mass. ($a=F/m$)													XX			XX		XX

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CP.1.22 Recognize and explain that whenever one object exerts a force on another, an equal and opposite force is exerted back on it by the other object.											XX			XX				XX
CP.1.23 Understand and explain that the motion of an object is described by its position, velocity, and acceleration.											XX	XX	XX	XX	XX	XX	XX	X
CP.1.24 Recognize and explain that waves are described by their velocity, wavelength, frequency or period, and amplitude.	XX	X	XX				X	X	X			XX						X
CP.1.25 Understand and explain that waves can superpose on one another, bend around corners, reflect off surfaces, be absorbed by materials they enter, and change direction when entering a new material.	XX	X	XX				X	X	X			XX						X
CP.1.26 Realize and explain that all motion is relative to whatever frame of reference is chosen, for there is no absolute motionless frame from which to judge all motion.											X	X	X	X	X	X	X	X
Forces of Nature																		
CP.1.27 Recognize and describe that gravitational force is an attraction between masses and that the strength of the force is proportional to the masses and decreases rapidly as the square of the distance between the masses increases. ($F = G \frac{m_1 m_2}{r^2}$)												X	X	X	X			X
CP.1.28 Realize and explain that electromagnetic forces acting within and between atoms are vastly stronger than the gravitational forces acting between atoms.																		

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CP.1.29 Understand and explain that at the atomic level, electric forces between oppositely charged electrons and protons hold atoms and molecules together and thus, are involved in all chemical reactions.																		
CP.1.30 Understand and explain that in materials, there are usually equal proportions of positive and negative charges, making the materials as a whole electrically neutral. However, also know that a very small excess or deficit of negative charges will produce noticeable electric forces.																		
CP.1.31 Realize and explain that moving electric charges produce magnetic forces, and moving magnets produce electric forces.						XX												
<p>Science : Integrated Chemistry-Physics : Standard 2 Historical Perspectives of Integrated Chemistry - Physics</p> <p>Students gain understanding of how the scientific enterprise operates through examples of historical events. Through the study of these events, they understand that new ideas are limited by the context in which they are conceived, are often rejected by the scientific establishment, sometimes spring from unexpected findings, and grow or transform slowly through the contributions of many different investigators.</p>																		
CP.2.1 Explain that Antoine Lavoisier invented a whole new field of science based on a theory of materials, physical laws, and quantitative methods, with the conservation of matter at its core. Recognize that he persuaded a generation of scientists that his approach accounted for the experimental results better than other chemical systems. MP																		

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CP.2.2 Describe how Lavoisier’s system for naming substances and describing their reactions contributed to the rapid growth of chemistry by enabling scientists everywhere to share their findings about chemical reactions with one another without ambiguity. MP																		
CP.2.3 Explain that John Dalton’s modernization of the ancient Greek ideas of element, atom, compound, and molecule strengthened the new chemistry by providing physical explanations for reactions that could be expressed in quantitative terms.																		
CP.2.4 Explain that Isaac Newton created a unified view of force and motion in which motion everywhere in the universe can be explained by the same few rules. Note that his mathematical analysis of gravitational force and motion showed that planetary orbits had to be the very ellipses that Johannes Kepler had demonstrated two generations earlier.											XX	X	X	XX	X	X	XX	X
CP.2.5 Describe that Newton’s system was based on the concepts of mass, force, and acceleration, his three laws of motion relating them, and a physical law stating that the force of gravity between any two objects in the universe depends only upon their masses and the distance between them.											XX	X	X	XX	XX	X	XX	XX

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