

Illinois Physics Concepts & Supporting Ideas

Physics Conceptual Statements	Communication			Home			Medicine			Predictions			Sports			Transportation			
	Standard	C1	C2	C3	H1	H2	H3	M1	M2	M3	P1	P2	P3	S1	S2	S3	T1	T2	T3
Conceptual Statement 1: Kinematics Kinematics is the process of describing the motion of objects in terms of position, velocity, acceleration, and the time with respect to a reference frame. This motion can be described using algebraic equations and graphs as well as words and visual images.																			
Supporting Ideas:																			
1. Distance, a scalar quantity, is the length of the path taken by an object as it moves from place to place.												X		X				X	
2. A vector (such as velocity, acceleration, and force) has both magnitude and direction whereas a scalar (such as mass, and time) as only magnitude. Vectors can be combined graphically, algebraically or trigonometrically.																			
3. Displacement, a vector quantity, is the change of the position of an object.														X					
4. Average speed, a scalar quantity, is the rate of change of distance, while average velocity. A vector quantity, is the rate of change of displacement.																			
5. Acceleration is the rate at which velocity changes.												X		X					

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6. Graphs of distance versus time can be used to differentiate constant speed and uniformly accelerated motion. Graphs of distance versus time of uniform motion can be used to calculate speed.											X						X		
7. An analysis of speed versus time graphs can be used to calculate acceleration and displacement.											X								
Conceptual Statement 2 : Forces and Interactions Past and future values of physical quantities (position, velocity, time, and acceleration) of bodies can be calculated by applying the fundamental principles of Newton's Laws of Motion. Constant or variable unbalanced forces, which are vectors, affect the motion of objects. Important forces are the earth's gravitational force on an object, forces perpendicular to the direction of motion, and linear resorting forces.																			
Supporting Ideas:																			
1. An unbalanced force acting on an object accelerates the object in the direction of the force.											X			X				X	
2. Newton's First Law of Motion is an expression of a fundamental property of matter, its inertia, or tendency to continue moving at a constant speed in a straight line.											X			X			X		
3. Newton's Second Law of Motion expresses the relationship between the unbalanced force, the mass of the object, and the resulting acceleration.											X			X				X	

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4. Newton's Third law describes the forces acting between two interacting objects.											X			X					
5. An object moving in a circular trajectory is acted on by a centripetal force directed toward the center point.											X			X			X		
6. Weight is the local force of gravity on a mass. Near earth, objects have an acceleration of 9.8 m/s^2 towards the center of earth. Mass is a scalar quantity, while weight is a vector.											X				X				X
7. Friction is the force between objects moving in contact or through one another. Friction always acts to reduce the relative motion of the objects. Friction between objects is generally constant.											X			X	X				
8. Kepler's Laws can be used to predict the motion and trajectories of satellites, both man-made and natural.																			

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9. newton's Law of Universal Gravitation can be used to quantify the acceleration of one body towards another body. The magnitude of this force is directly proportional to the masses of the bodies and inversely proportional to the distance between the center of mass of each body.													X						X
Conceptual Statement 3: Conservation Energy, linear momentum, and angular momentum cannot be created or destroyed; the total magnitude and direction of each remains constant within a closed system. Energy can only be transformed from one form to another. Momentum can only be transferred from one object to another.														X	X				
Supporting Ideas:																			
1. Energy is always conserved and can be used to exert forces through distances (work). Power is the rate of doing work.															X				

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2. Conservation of energy and momentum can be used to predict an object's position, velocity, and acceleration with respect to time.															X			
3. Momentum is the quantitative measure of the inertia of a moving object. The total momentum of a closed system is conserved.															X			
4. The energy of an object, such as a roller coaster cart, is distributed among potential energy, kinetic energy, and kinetic rotational energy throughout its motion.														X				
5. Collisions between objects may be elastic (with no loss of kinetic energy) or inelastic (with a loss of kinetic energy). In all collisions linear momentum is conserved.																		
6. impulse is the change in momentum.																	X	
Conceptual Statement 4: Vibrations and Waves Energy can be transferred by a series of vibrations known as waves. This is true of sound and electromagnetic radiation.																		
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1. Transverse and longitudinal waves carry energy from a vibrating source to a receiver without transferring matter from one to the other. Waves may be described in terms of wavelength, frequency, velocity, and amplitude. Wave velocity is dependent on the medium.	X	X					X		X		X								X
2. Sound is mechanical energy carried by matter in the form of longitudinal waves. Within a certain range of frequencies, these waves produce the sensation of hearing. Sound is described in terms of pitch and loudness. Resonance results when the sound vibrations correspond to the natural frequencies of the vibrator.	X						X												
3. The intensity of a sound wave is measured in decibels and is inversely proportional to the square of the distance between the source and the observer.							X												

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4. Light is electromagnetic energy in the form of transverse waves. Within a certain range of frequencies, these waves produce the sensation of sight. Light is described in terms of color, frequency, wavelength, and intensity. Because light waves are transverse, they may be polarized. Light waves do not require a medium to travel.			X																X
5. The color of an object is dependent on the frequencies of light reflected or transmitted to the eye. Different combinations of frequencies produce different colors.	X																		
6. Reflection occurs when a wave encounters a barrier and bounces off. The Law of Reflection states that the angle of incidence equals the angle of reflection. Mirrors give good evidence of this law.	X								X										

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7. Refraction occurs when a wave reaches the boundary between two media and changes speed and/or direction as it enters the new medium. Snell's Law can be used to calculate the angle of refraction of a light ray as it travels between boundaries of two different mediums.	X							X											
8. Ray tracing can be used to determine the location and height of images formed by optical elements.	X		X					X											
9. Diffraction occurs when waves bend around edges.																			
Conceptual Statement 5: Electricity and Magnetism																			
Electricity and magnetism are forms of one of the most fundamental forces in the universe.																			
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1. Electric charges can be either positive or negative. Static charges can be produced by rubbing appropriate materials (such as rubber wool, a plastic rod with fur, or a glass rod with silk) that separate positive and negative charges. Induction and conduction can also produce electric charges. Like charges repel each other and unlike charges attract each other through electric field. The force between charges can be calculated using Coulomb's Law.					X														
2. The work done to move a charge from one point to another is the potential difference (voltage) between the points times that charge. Electric current (amperage) is the rate at which a charge flows between the points.					X														

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3. The resistance of a circuit element is defined as the ratio of potential difference to current of the element and it varies greatly from substance to substance. Materials are classified as conductors, semi-conductors, or insulators depending on the magnitude of their resistance.					X														
4. A circuit is a closed conducting path incorporating a source of electrical energy. The variation in current in the circuit follows the variation in the voltage of the source. The power delivered by the source to the circuit is the product of the voltage of the source and the current.					X														
5. A series circuit has a single continuous path. A parallel circuit has several conducting paths. Different parts of a single circuit may be either connected in series or parallel.					X														

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6. Magnets have north and south poles. Like poles repel each other and unlike poles attract each other through magnetic fields. Electric currents produce magnetic fields; the strength of the magnetic field is dependent on the current, the geometry of the elements, and the presence of ferromagnetic materials.		X				X						X							
7. A magnetic force acts on an electric charge moving perpendicularly through a magnetic field, which is used to create electric motors.		X				X													
8. A changing magnetic field creates an induced voltage, which can be used in generators and transformers.		X				X													
9. A changing magnetic field creates a magnetic field, which can be used in galvanometers.						X													

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10. An alternating electric current and a changing magnetic field create magnetic and electric fields around them. The interplay between the changing fields creates electromagnetic waves, which are used in numerous household devices (e.g., televisions and microwave ovens).		X					X												
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