PHYSICS

Performance Indicators
Essential Questions
Suggested Activities
Suggested Resources

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PHYSICS

UNIT I
MECHANICAL
(10%)

Performance Indicators

Analysis of Linear Motion:

(E) (1.1) a. The student will be able to define acceleration.

(E) (1.2) b. The student will be able to calculate or estimate velocity or acceleration from a distance/time or acceleration/time graph.

(E) (1.3) c. The student will be able to identify distance/time graphs for uniform and non-uniform motion.

(E) (1.4) d. The student will be able to identify velocity/time graphs for uniform and non-uniform motion.

(E) (1.5) e. The student will be able to distinguish between average and instantaneous form of velocity or acceleration.

(E) (1.6) f. Given a scenario, the student will be able to select an equation to use to solve for a particular unknown motion quantity.

(E) (1.7) g. The student will be able to solve a problem for any variable from among the following equations:
$v = x/t$ $a = \Delta v/\Delta t$ $v_f = v_i + at$ $v_i^2 + 2ad$ $d = v_i t + \frac{1}{2} at^2$
$d = \frac{1}{2} (v_f + v_1)$

Essential Questions

1. Which of the following is true?

   a. If an object's acceleration is constant, then it must move in a straight line.

b. If an object's velocity remains constant, then its acceleration is zero.

c. If an object's speed remains constant, then its acceleration must be zero.

2. Describe the changes in velocity of a ball that is thrown straight up and falls straight down. Then describe its acceleration.

3. Discuss the pros and cons of driving above the legal speed limit.

4. An object is projected upward with a velocity of 125 m/s. (a) To what height will it rise? (b) How long will it take to reach that height? (c) What will be the total time elapsed until it strikes the earth?

PHYSICS

UNIT II
MECHANICAL
(10%)

Performance Indicators

Forces and Vectors:

(E) (2.1) a. The student will be able to define friction, vector, scalar, resultant, or equilibrium.

(E) (2.2) b. The student will be able to find the magnitude and direction of the resultant vector from the addition of two or more vectors.

(E) (2.3) c. The student will be able to find the vertical and horizontal components of a vector.

(E) (2.4) d. The student will be able to identify the relationship between weight and mass.

(E) (2.5) e. The student will be able to calculate the acceleration of an object on an inclined plane given the angle, mass, and initial velocity.

(E) (2.6) f. Given examples, the student will be able to identify which of Newton's three laws of motion apply.

(E) (2.7) g. Given the contributing forces, the student will be able to calculate the coefficient of friction.

(E) (2.8) h. Given a list of examples, the student will be able to distinguish between kinetic and static friction.

(E) (2.9) i. Given a diagram of two or more vectors drawn to scale, the student will be able to identify the resultant of that set of vectors.

(E) (2.10) j. Given a free-body diagram, the student will be able to, from a set of forces, identify the force which is not acting on a given body in a free-body diagram.

(E) (2.11) k. Given the magnitude and direction of two or more forces, the student will be able to calculate the resultant or the equilibrant of those forces.

(E) (2.12) l. Using the equations $F = ma$ and $F_{net} = F_{applied} - F_r$, the student will be able to calculate the acceleration of an object.

Essential Questions

1. Why does the bag of groceries on the seat fall into the floor when you apply the brakes quickly and stop?

2. A skydiver changed her terminal velocity without opening the parachute by changing her posture. Why does the different posture change the terminal velocity?

3. James is cutting the grass and his arms are getting tired. How can James increase the horizontal force he is applying to the lawn mower without having to exert any more force on the handle of the mower?

4. How can mass be judged in the absence of weight?

5. A regular Coke and a Diet Coke are placed in an aquarium full of water. Both have the same fluid ounces or grams liquid and the same type of container. The regular Coke sinks to the bottom of the container. The Diet Coke floats. Explain why one Coke floats and the other sinks.

6. A box weighing 450.0 N is pulled along a level floor at constant speed by a rope that makes an angle of 30.0^{o} with the floor. If the force on the rope is 260.0 N, calculate the coefficient of sliding friction. Include a labeled force diagram with your reasoning.

7. A truck weighs 1.0×10^{5} N. What force will give it an acceleration of 1.5 m/s^2 on a friction free surface?

8. A simple pendulum is 2.0 m long and has a period of 2.9 s. What is the acceleration of gravity at the location of the pendulum?

PHYSICS

UNIT III
MECHANICAL
(10%)

Performance Indicators

Nonlinear Motion:

(E) (3.1) a. The student will be able to define frame of reference, frequency, period, trajectory, range, period, uniform circular motion, torque, simple harmonic motion, or law of universal gravitation.

(E) (3.2) b. The student will be able to calculate horizontal and vertical displacements for a projectile.

(E) (3.3) c. The student will be able to identify independence and relationship of horizontal and vertical motion of projectiles and calculate horizontal and vertical velocities.

(E) (3.4) d. The student will be able to calculate period and frequency of an object in circular motion.

(E) (3.5) e. The student will be able to calculate centripetal force, centripetal acceleration, speed or radius for an object in circular motion.

(E) (3.6) f. The student will be able to calculate force or spring constant in Hooke's law.

(E) (3.7) g. The student will be able to calculate the period or frequency of simple harmonic motion or a pendulum.

(E) (3.8) h. The student will be able to calculate the force of gravity from the law of universal gravitation.

(I) (3.9) i. The student will be able to identify the points of correspondence between angular and linear velocity and acceleration.

(I) (3.10) j. The student will be able to recognize differences in moments of inertia of variously shaped objects.

(I) (3.11) k. The student will be able to calculate the energy of a spring, given the spring constant.

(I) (3.12) l. The student will be able to calculate the torque on an object.

Essential Questions

1. A roller coaster makes a loop. Why does the car stay on the track as it makes the loop?

2. What keeps a satellite in orbit?

3. A projectile is launched. Where is the vertical velocity the greatest? Where is the horizontal velocity the greatest? Where is the vertical velocity at a minimum?

4. You are riding in the semi trailer—cruising down I-40 at 70 mph. You toss a ball straight up, not hitting the roof. Where does the ball land?

5. You shoot a rifle bullet straight up. At what velocity will the bullet be traveling when it reaches the ground?

PHYSICS

UNIT IV
MECHANICAL
(10%)

Performance Indicators

Momentum and Impulse:

(E) (4.1) a. The student will be able to use the momentum equations to solve a problem in a one-dimensional collision.

(E) (4.2) b. The student will be able to use the momentum equations to solve a problem in a two-dimensional collision.

(E) (4.3) c. Given a scenario, the student will be able to calculate impulse, force, change in momentum, initial velocity, final velocity, mass or time interval in a collision.

(I) (4.4) d. The student will be able to identify how the angular momentum or its contribution factors change in a given scenario.

(E) (4.5) e. The student will be able to define impulse and momentum.

(I) (4.6) f. The student will be able to define torque, rotational inertia, angular acceleration, or angular velocity.

(E) (4.7) g. Given example collisions, the student will be able to select the elastic or inelastic collision.

Essential Questions

What is the effect on an object's momentum following a collision?

PHYSICS

UNIT V
MECHANICAL
(10%)

Performance Indicators

Work and Energy:

(E) (5.1) a. Given a diagram, the student will be able to identify simple machines or compound versions of simple machines.

(E) (5.2) b. Given a scenario, the student will be able to calculate the efficiency of a mechanical or fluid system.

(E) (5.3) c. The student will be able to solve a problem using the work-energy theorem.

(E) (5.4) d. The student will be able to use equations to solve for efficiency from actual and ideal mechanical advantage, kinetic energy, gravitational potential energy, power, and distortional energy (elastic potential energy).

(E) (5.5) e. Given the definition, the student will be able to select the correct term from the following list: work, mechanical kinetic energy, gravitational potential energy, electric potential, power.

(E) (5.6) f. The student will be able to calculate the work done, given a scenario W = Fd.

Essential Questions

1. According to the laws of physics energy is *always* conserved. If this is so, do we need to "conserve energy" in our daily activities?

2. A ball is dropped from a tall building and reaches terminal velocity as it falls. Upon release of the ball, will the potential energy of the ball equal the kinetic energy it has when striking the ground? Explain.

3. A box with a mass of 115 kg is pulled at constant velocity along an inclined plane 10.0 m long. The force is applied parallel to the plane, which makes an angle of 15.0^{O} with the horizontal. How much work is done if the coefficient of sliding friction between the box and the plane is 0.300? Include a labeled force diagram with your solution.

PHYSICS

UNIT VI
THERMODYNAMICS
(10%)

Performance Indicators

Thermodynamics:

(I) (6.1) a. Given a diagram, the student will be able to calculate the pressure, volume, or temperature of an ideal gas.

(I) (6.2) b. Given a scenario, the student will be able to determine the amount of heat lost or gained in a substance given the mass, temperature, and specific heat.

(I) (6.3) c. Given the temperature of a substance, the student will be able to calculate the root mean square velocity using the kinetic theory.

(I) (6.4) d. The student will be able to determine the linear or volume expansion of a substance due to heat, given the original length or volume, the coefficient of thermal expansion, and the change in temperature.

(I) (6.5) e. The student will be able to determine the amount of work done by a gas, given change in temperature, pressure, and/or volume.

(I) (6.6) f. Given a PV diagram, the student will be able to determine the amount of work done by a gas during a cycle.

(I) (6.7) g. Given the temperature difference or heat difference of the hot and cold sinks, determine the efficiency of a heat engine.

Essential Questions

1. If heat rises, why is it colder on top of a mountain than in the valley?

2. Which freezes faster, hot water or cold water?

PHYSICS

UNIT VII
WAVES AND SOUND
(6%)

Performance Indicators

Wave Energy and Sound:

(I) (7.3) a. The student will be able to describe a standing wave pattern (resonance) in terms of nodes and antinodes.

(E) (7.15) b. The student will be able to define longitudinal wave, transverse wave, velocity, frequency, wavelength, amplitude, reflections, refraction, interference or diffraction.

(E) (7.10) c. Given a scenario, the student will be able to apply the wave equation ($v = \lambda f$) to solve for one of the variables.

(E) (7.7) d. Given a diagram, the student will be able to identify constructive and destructive interference.

(I) (7.8) e. Given a scenario, the student will be able to identify the factors affecting sound waves: temperature, medium, pitch, and amplitude.

(I) (7.9) f. Given an equation for a wave in the form $x(t) = A \sin(\omega t + \phi)$, the student will be able to identify amplitude, angular frequency, frequency, or phase shift of the wave.

(I) (7.11) g. The student will be able to solve a problem involving the Doppler shift.

Essential Questions

You are in the upper row of the upper deck at Neyland Stadium watching UT and Alabama play football. A TV station has microphones placed all along the field at

ground level. The referee blows his whistle. Who will hear the whistle first, you or your friend in Memphis watching the game on TV?

PHYSICS

UNIT VIII
LIGHT AND OPTICS
(6%)

Performance Indicators

Light and Optics:

(E) (7.1) a. The student will be able to solve a problem for a diverging (convex) lens.

(E) (7.2) b. The student will be able to solve a problem for a converging (concave) lens.

(E) (7.5) c. The student will be able to solve a problem using the lens/mirror equation.

(E) (7.14) d. Given a ray diagram for a lens or a mirror, the student will be able to identify the characteristics of the image.

(I) (7.4) e. Given a scenario, the student will be able to solve a problem using the refraction equation.

(I) (7.6) f. The student will be able to use the equation for the energy of a photon to solve for E, f, or λ.

(I) (7.12) g. The student will be able to identify the relative frequencies, wavelengths, and energies of various types of electromagnetic radiation.

(I) (7.13) h. Given the indices of refraction of two media, the student will be able to predict the direction the wave will bend as it passes from one medium to the other.

Essential Questions

Two parallel rays of light traveling underwater hit a double convex air bubble perpendicular to its plane. What happens to the parallel rays after they pass through the bubble?

PHYSICS

UNIT IX
ELECTRICITY AND MAGNETISM I
(8%)

Performance Indicators

Electrostatics and Electric Fields:

(E) (8.1) a. The student will be able to find the magnitude and direction of the force on a point charge from either an individual point charge or a geometrical array of point charges.

(E) (8.2) b. The student will be able to find the magnitude and direction of the electric field at a point from either an individual point charge or a geometrical array of point charges.

(I) (8.3) c. The student will be able to find the electric potential at a point from either an individual point charge or a geometrical array of point charges.

(I) (8.4) d. The student will be able to use one of the equations $C = q/V$ or $C = EA/d$ in order to calculate C, q, V, A, or d for a given parallel plate capacitor.

(I) (8.5) e. The student will be able to calculate the energy stored in a capacitor, given an appropriate combination of values.

(I) (8.6) f. The student will be able to calculate the equivalent capacitance for a set of capacitors in parallel or in series.

(E) (8.7) g. The student will be able to define: charge, dielectric constant, conductor, insulator, Coulomb's law, electric field, electric potential, capacitor.

(E) (8.8) h. The student will be able to identify charging by conduction versus charging by induction.

Essential Questions

1. When two objects are touching are they really touching?

2. Are force fields science fiction?

3. You have a gold leaf electroscope and a negatively charged hard rubber rod. Can you charge the electroscope positive using only what you have?

PHYSICS

UNIT X
ELECTRICITY AND MAGNETISM II
(10%)

Performance Indicators

Electric Current and Circuits:

(E) (9.1) a. The student will be able to distinguish between each of the following: conventional current and electron flow; alternating and direct current; series and parallel circuit; battery and cell.

(E) (9.2) b. The student will be able to define motor, generator, electric energy, electric potential, electric power.

(E) (9.3) c. The student will be able to apply the power equations to solving problems for power, voltage, or current.

(E) (9.4) d. Given a circuit, the student will be able to determine the behavior of individual components or the circuit as a whole if a single variable (voltage, current, or resistance) is changed.

(I) (9.5) e. The student will be able to calculate the efficiency of an electrical system.

(I) (9.6) f. The student will be able to calculate the resistance of a wire, given resistivity, length, and cross-sectional area.

(E) (9.7) g. The student will be able to calculate the equivalent resistance for resistors in series, parallel, or series-parallel combination.

(E) (9.8) h. The student will be able to apply Ohm's law to circuits with resistors in series, parallel, or series-parallel combination.

(E) (9.9) i. Given a location in a diagram, the student will be able to select the connections for a voltmeter or an ammeter.

(E) (9.10) j The student will be able to identify the appropriate schematic symbol for resistor, voltmeter, ammeter, power supply, capacitor, or lamp.

Essential Questions

You are in the dark, but you have a 12-volt battery, a 7-volt bulb and two 10-volt bulbs. How could you hook up the bulbs and battery to give you some light?

PHYSICS

UNIT XI
ELECTRICITY AND MAGNETISM III
(4%)

Performance Indicators

Magnetic Fields and Electromagnetic Induction:

(I) (10.1) a. Given the Magnetic Field Strength, the length of the conducting wire, the current, and the angle of orientation, the student will be able to calculate the magnetic force on the wire.

(I) (10.2) b. The student will be able to determine the force on a moving charge in a magnetic field given the charge, velocity, and magnetic field.

(I) (10.3) c. The student will be able to determine the magnetic field strength on a current carrying wire, given the radius and current in the wire.

(I) (10.4) d. The student will be able to determine the magnetic field on a current carrying loop or solenoid, given the radius, number of turns, and length.

(I) (10.5) e. The student will be able to determine the cmf, given change in magnetic flux and time or the magnetic field, area, length, and velocity.

(I) (10.6) f. Given a definition or description, the student will be able to identify: ammeter, voltmeter, ohmmeter, galvanometer, generator, AC, DC, transformer.

Essential Questions

A compass needle is really a small magnet and its N-pole end points toward the North Pole of the earth. Why isn't the compass' N-pole attracted to the earth's South Pole like it is to a magnet's S-pole?

PHYSICS

UNIT XII
ATOMIC AND NUCLEAR
(2%)

Performance Indicators

Atomic and Nuclear:

(I) (11.1) a. Given a description or definition, the student will be able to identify: photon, quantum numbers, energy levels, radiation.

(I) (11.2) b. Given the frequency of incident light and the threshold frequency of the substance, the student will be able to determine the KE of electrons emitted from the source.

(I) (11.3) c. The student will be able to determine the minimum work required to eject an electron from a substance, the work function, given the threshold wavelength of substance.

(I) (11.4) d. The student will be able to determine the de Broglie wavelength of a particle, given the mass and velocity of the particle.

(I) (11.5) e. Given the mass of the free protons and neutrons and the mass of the assembled nucleus, the student will be able to determine the binding energy.

(I) (11.6) f. Given an equation, the student will determine whether a nuclear reaction is an alpha, beta, or gamma emission.

Essential Questions

An atom of uranium-238 undergoes alpha decay and emits an alpha particle. What new isotope is produced?