



National Evaluation Series™

NES

PROFILE

Physics (308)

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NES Profile: Physics (308)

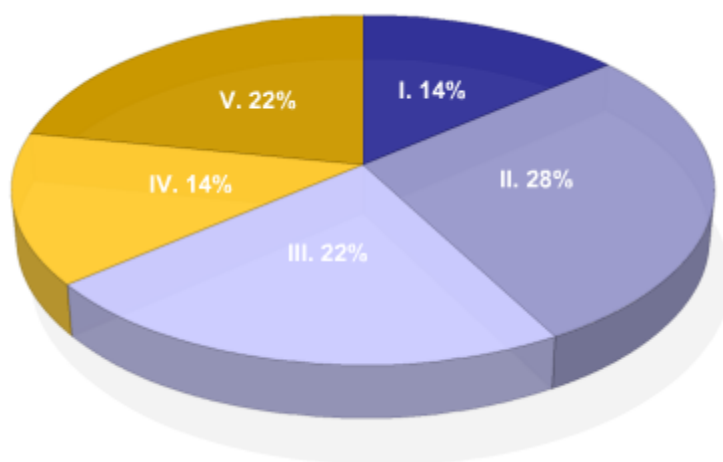
Overview

This *NES Profile* provides information about the test, including the approximate percentage of the total test score derived from each content domain. The complete set of the content domains, the test framework, is provided here and contains all of the competencies and descriptive statements that define the content of the test.

This *NES Profile* includes the following materials:

- » the test competencies associated with each content domain
- » a set of descriptive statements that further explain each competency
- » sample test questions aligned to the competencies
- » any applicable reference materials, as noted below

Test Field	Physics (308)
Test Format	Multiple-choice questions
Number of Questions	Approximately 150
Test Duration	Up to 3 hours and 45 minutes
Reference Materials	Constants and Formulas Scientific Calculator



Key	Approximate Percentage of Test	Content Domain	Range of Competencies
I.	14%	I. Nature of Science	0001–0002
II.	28%	II. Mechanics	0003–0006
III.	22%	III. Electricity and Magnetism	0007–0009
IV.	14%	IV. Waves	0010–0011
V.	22%	V. Modern Physics	0012–0014

CONSTANTS

Description	Value
Acceleration of gravity on Earth (g)	9.80 m/s ²
Speed of light in a vacuum (c)	3.00×10^8 m/s
Planck's constant (h)	6.63×10^{-34} J•s = 4.14×10^{-15} eV•s
Electron rest mass (m_e)	9.11×10^{-31} kg
Proton rest mass (m_p)	1.67×10^{-27} kg
Elementary charge (e)	1.60×10^{-19} C
Coulomb's constant (k_e)	8.99×10^9 N•m ² /C ²
Boltzmann constant (k_b)	1.38×10^{-23} J/K
Gas constant (R)	8.31 J/(mol•K)
Gravitational constant (G)	6.67×10^{-11} N•m ² /kg ²
Permeability of free space (μ_0)	$4\pi \times 10^{-7}$ T•m/A
Avogadro's number (N_A)	6.02×10^{23} particles/mole
Heat of fusion of water (L_f)	3.33×10^5 J/kg
Heat of vaporization of water (L_v)	2.26×10^6 J/kg
Specific heat of water (c_w)	4.19×10^3 J/(kg•°C)
Density of water (ρ_w)	1.00×10^3 kg/m ³

FORMULAS

Mathematics	Force and Motion
$C = 2\pi r$	$v_f = v_i + at$
$A = \pi r^2$	$x_f = x_i + v_i t + \frac{1}{2}at^2$
$SA = 4\pi r^2$	$v_f^2 - v_i^2 = 2a(x_f - x_i)$
$V = \frac{4}{3}\pi r^3$	$a_c = \frac{v^2}{r}$
(a, b) denotes a vector with an x -component of a and a y -component of b .	$\Sigma \mathbf{F} = m\mathbf{a}$
	$F = -kx$
	$F \leq \mu N$
	$F = \frac{Gm_1 m_2}{r^2}$
	$\theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha t^2$
	$\omega_f = \omega_i + \alpha t$
	$v = r\omega$
	$a = r\alpha$
	$\mathbf{r}_{cm} = \frac{\Sigma m\mathbf{r}}{\Sigma m}$
	$I = \Sigma mr^2$
	$\boldsymbol{\tau} = \mathbf{r} \times \mathbf{F}$
	$\Sigma \boldsymbol{\tau} = I\boldsymbol{\alpha}$
	$P = \rho gh$
	$F = \rho Vg$
	$A_1 v_1 = A_2 v_2$
	$P + \frac{1}{2}\rho v^2 + \rho gy = \text{constant}$

FORMULAS (continued)

Energy, Momentum, and Heat Transfer	Electricity and Magnetism
$W = Fd \cos \theta$	$F = \frac{k_e q_1 q_2}{r^2}$
$P = \frac{\Delta W}{\Delta t}$	$\mathbf{E} = \frac{\mathbf{F}}{q_0}$
$KE = \frac{1}{2}mv^2$	$PE = qV$
$PE = mgh$	$V = -Ed$
$PE = \frac{1}{2}kx^2$	$V = \frac{k_e q}{r}$
$\mathbf{p} = m\mathbf{v}$	$R = \frac{\rho \ell}{A}$
$\Delta \mathbf{p} = \mathbf{F}\Delta t$	$V = IR$
$\Delta \ell = \alpha \ell_0 \Delta T$	$R = \Sigma R_i$
$Q = mc\Delta T$	$\frac{1}{R} = \Sigma \frac{1}{R_i}$
$Q = mL$	$P = IV$
$\frac{\Delta Q}{\Delta t} = \frac{kA\Delta T}{d}$	$C = \frac{Q}{V}$
$PV = nRT$	$C = \Sigma C_i$
$\frac{1}{2}m\overline{v^2} = \frac{3}{2}k_b T$	$\frac{1}{C} = \Sigma \frac{1}{C_i}$
$\Delta E = Q - W$	$\mathbf{F} = q\mathbf{v} \times \mathbf{B}$
$W = P\Delta V$	$\mathbf{F} = I\boldsymbol{\ell} \times \mathbf{B}$
$e = \frac{T_h - T_c}{T_h}$	$B = \frac{\mu_0 I}{2\pi r}$
$KE = \frac{1}{2}I\omega^2$	$B = \frac{\mu_0 NI}{\ell}$
$\mathbf{L} = \mathbf{r} \times \mathbf{p}$	$\mathcal{E}_{\text{ave}} = -\frac{\Delta\phi}{\Delta t}$
$L = I\omega$	$\phi = B_{\perp}A$
$T_k = 273 + T_c$	<p>In questions on electricity and magnetism, the term <i>current</i> refers to "conventional current" and the use of the right-hand rule is assumed.</p>

FORMULAS (continued)

Waves, Sound, and Light	Modern Physics
$T = \frac{2\pi}{\omega}$	$E = hf$
$a = -\omega^2 x$	$E = \gamma mc^2$
$x = A \sin \omega t$	$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$
$T = 2\pi\sqrt{\frac{m}{k}}$	$hf = \phi + eV$
$T = 2\pi\sqrt{\frac{L}{g}}$	$\Delta x \Delta p \geq h$
$v = f\lambda$	$\Delta E \Delta t \geq h$
$v = \sqrt{\frac{T}{\mu}}$	$p = \frac{h}{\lambda}$
$v = \sqrt{\frac{\gamma RT}{M}}$	
$2L = n\lambda, n \text{ is an integer}$	
$4L = n\lambda, n \text{ is odd}$	
$n_1 \sin \theta_1 = n_2 \sin \theta_2$	
$n = \frac{c}{v}$	
$\frac{1}{f} = \frac{1}{s_i} + \frac{1}{s_o}$	
$M = \frac{h_i}{h_o} = -\frac{s_i}{s_o}$	
$d \sin \theta = m\lambda$	
$I = I_0 \cos^2 \theta$	

NOTES FOR PHYSICS TEST

Not all formulas necessary are listed, nor are all formulas listed used on this test.

In questions on electricity and magnetism, the term *current* refers to "conventional current" and the use of the right-hand rule is assumed.

Calculator Information

A scientific calculator will be provided with your test. You may not use your own scientific calculator or calculator manual.

Content Domain I: Nature of Science

Competencies:

0001 Understand principles and procedures of scientific inquiry.

Descriptive Statements:

- » Demonstrate knowledge of principles and procedures for designing and carrying out scientific investigations (e.g., generating and testing hypotheses).
- » Recognize methods and criteria for collecting, measuring, organizing, analyzing, and presenting scientific data.
- » Justify conclusions based on data analysis.
- » Demonstrate knowledge of safety procedures and hazards associated with physics investigations and the equipment and technology used in physics.
- » Apply appropriate mathematical procedures, including estimation, order of magnitude, statistics, and data analysis to solving problems in physics.

Sample Item:

Data for the variables x and y are collected during an experiment and given in the table below.

x	5.0	10.0	15.0	20.0	25.0	30.0
y	0.05	0.19	0.32	0.47	0.61	0.75

Which of the following best describes the relationship between x and y ?

- A. constant
- B. linear
- C. inverse
- D. quadratic

Correct Response and Explanation

B. This question requires the examinee to analyze scientific data. The x -values of the data in the table increase in increments of 5, that is, $\Delta x = 5$. The y -values increase in increments of 0.14, 0.13, 0.15, 0.14, and 0.14, respectively. Hence, the ratio $\frac{\Delta y}{\Delta x}$ is approximately constant and the relationship is best described as being linear.

0002 Understand the history of science, its connections with other sciences, and the relationships among science, technology, and society.

Descriptive Statements:

- » Demonstrate knowledge of the historical development of major scientific ideas, the contributions of eminent scientists, and the uses and limitations of models.
- » Demonstrate knowledge of current major theories, models, and concepts in chemistry, biology, and Earth and space science.
- » Identify unifying themes, principles, and relationships that connect physics with the different branches of the sciences.
- » Analyze the interrelationships between physics, technology, engineering, and society and how science and technology affect each other.
- » Demonstrate scientific literacy by critiquing the coverage of science in the media.
- » Analyze social, ethical, and economic issues associated with technological and scientific developments.

Sample Item:

Which of the following best describes how the invention of X-ray diffraction in physics contributed to the biological and chemical sciences?

- A. by generating clear images of bacteria and viruses
- B. by determining the structure of molecules
- C. by discovering missing elements in the periodic table
- D. by producing disease-resistant plant varieties

Correct Response and Explanation

B. This question requires the examinee to demonstrate knowledge of how science and technology affect each other. Because the wavelength of X-rays is of the same order as the size of molecules, X-ray diffraction allows scientists to infer structural properties of substances, such as DNA, by analyzing the patterns produced by the waves as they are diffracted from the substance.

Content Domain II: Mechanics

Competencies:

0003 Understand motion in one and two dimensions.

Descriptive Statements:

- » Use multiple representations (e.g., pictures, graphs, motion maps) to analyze the one-dimensional motion of a particle or an object.
- » Solve problems involving constant acceleration.
- » Apply properties of vectors to describe and analyze motion in two dimensions, including uniform circular motion and projectile motion.
- » Solve problems involving motion in two dimensions, including uniform circular motion and projectile motion.

Sample Item:

A ball at rest on level ground is kicked into the air. The ball strikes the ground 4.00 s later at a horizontal distance of 40.0 m from where it was kicked. What is the magnitude of the initial velocity of the ball?

- A. 10.0 m/s
- B. 19.6 m/s
- C. 22.0 m/s
- D. 40.5 m/s

Correct Response and Explanation

C. This question requires the examinee to apply properties of vectors to analyze projectile motion. Since the ball travels a horizontal distance of 40.0 m in 4.00 s, the horizontal component of its initial velocity is 10.0 m/s. The ball is in flight for a total of 4.00 s, so it reaches its maximum height in 2.00 s. Using the equation $v(t) = -9.8t + v_{0y}$ and $v(2.00) = 0.00$ gives $v_{0y} = 19.6$ m/s. The magnitude of the initial velocity is therefore $v_0 = \sqrt{(10.0)^2 + (19.6)^2} = 22.0$ m/s.

0004 Understand forces as interactions and their effects on motion.

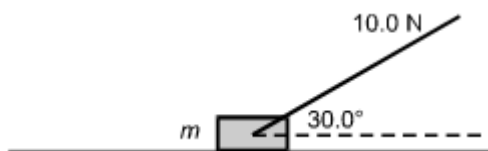
Descriptive Statements:

- » Identify characteristics of Newton's laws in a variety of situations.
- » Analyze free body diagrams.
- » Use Newton's laws to solve problems involving force and motion, including problems involving gravitational, frictional, and elastic forces.
- » Solve problems involving uniform circular motion, including satellite and planetary motion.

- » Apply Newton's laws to solve problems involving systems of particles and the statics and dynamics of fluids.

Sample Item:

A rope with a tension of 10.0 N is attached to a 2.00 kg mass. The rope makes an angle of 30.0° with the horizontal.



What is the normal force on the mass?

- A. 5.0 N
- B. 9.8 N
- C. 14.6 N
- D. 19.6 N

Correct Response and Explanation

C. This question requires the examinee to solve problems involving force and motion. There are three forces acting on the mass in the y -direction: the gravitational force, the normal force, and the vertical component of the tension in the string. The normal force is perpendicular to the surface of the mass and in the positive y -direction. From Newton's second law, $\Sigma \mathbf{F} = m\mathbf{a}$ applied in the y -direction, $\Sigma F_y = 0 = -mg + N + T \sin 30^\circ$. Using $g = 9.80 \text{ m/s}^2$, substituting the values given, and solving for the normal force gives $N = 14.6 \text{ N}$.

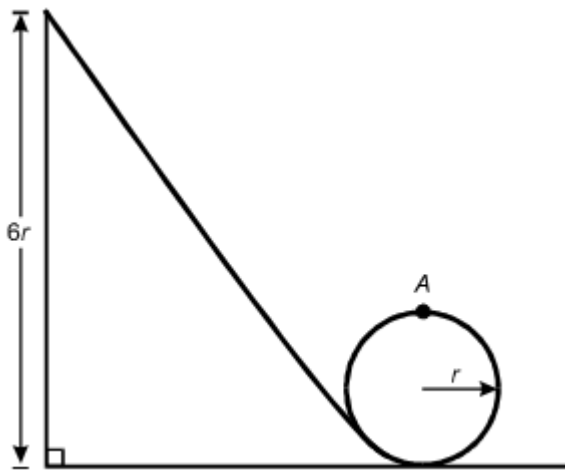
0005 Understand the conservation of energy and linear momentum.

Descriptive Statements:

- » Apply principles of work, potential energy, kinetic energy, and power to solve problems.
- » Apply the work-energy theorem to conservative and nonconservative systems.
- » Analyze the relationships among force, impulse, and momentum.
- » Solve problems involving elastic and inelastic collisions in one and two dimensions.

Sample Item:

A mass initially at rest at a height of $6r$ slides down a frictionless track and around a circular loop of radius r .



What is the speed of the mass at the top of the circular loop (point A)?

- A. $\sqrt{4gr}$
- B. $\sqrt{6gr}$
- C. $\sqrt{7gr}$
- D. $\sqrt{8gr}$

Correct Response and Explanation

D. This question requires the examinee to apply the work-energy theorem to conservative systems. Since there are no frictional forces, the work done by friction is zero and the total mechanical energy is conserved. Therefore, $mg(6r) = \frac{1}{2}mv^2 + mg(2r)$. Solving this equation for v gives $v = \sqrt{8gr}$.

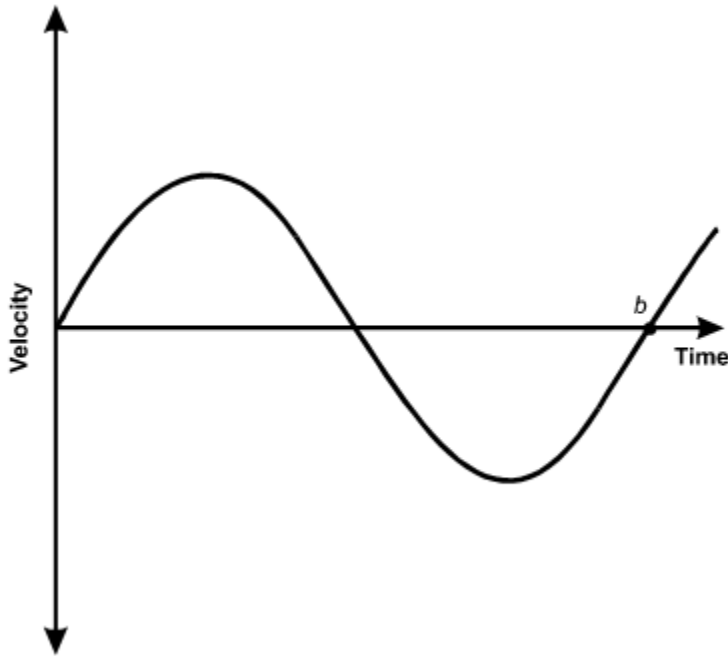
0006 Understand simple harmonic motion and rotational dynamics.

Descriptive Statements:

- » Use graphs and trigonometric functions to analyze characteristics of simple harmonic motion, such as amplitude, restoring force, frequency, and period.
- » Analyze the characteristics of kinetic and potential energy for an object undergoing simple harmonic motion.
- » Solve problems in rotational kinematics.
- » Solve static and dynamic problems involving torques and forces.
- » Analyze systems involving rotational energy and angular momentum.

Sample Item:

A mass on a spring is displaced from equilibrium and released. The graph below shows the velocity of the mass versus time.



Which statement about the mass at time b must be true?

- A. It is located at its equilibrium position.
- B. Its potential energy is equal to zero.
- C. Its kinetic energy is at a maximum.
- D. Its acceleration is at a maximum.

Correct Response and Explanation

D. This question requires the examinee to use graphs of trigonometric functions to analyze characteristics of simple harmonic motion. The graph shows the velocity of a mass oscillating on a spring. At point b the velocity is zero, so the mass is at one of its turning points and the displacement of the mass, x , is either A or $-A$, where A is the amplitude of motion. Since the slope of the line tangent to the curve at b is positive, the acceleration is positive, so $x = -A$. Since $F = ma = -kx$, the force, and therefore the acceleration, is maximum when $x = -A$.

Content Domain III: Electricity and Magnetism

Competencies:

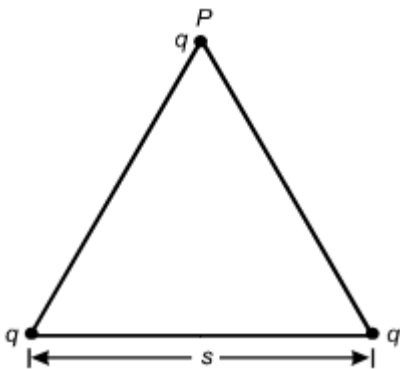
0007 Understand properties of the electric field.

Descriptive Statements:

- » Analyze phenomena related to static electricity, such as the behavior of electroscopes, induced molecular polarization, and charging by induction.
- » Describe electric forces and electric fields for various simple charge distributions.
- » Describe the motion of a charged particle in a constant electric field.
- » Demonstrate knowledge of electric potential energy and potential difference.

Sample Item:

Three identical point charges are located on the vertices of an equilateral triangle of side length s .



What is the vertical component of the electrostatic force on the charge located on vertex P ?

- A. $\frac{kq^2}{s^2} \sin 30^\circ$
- B. $\frac{kq^2}{s^2} \cos 30^\circ$
- C. $\frac{2kq^2}{s^2} \sin 30^\circ$
- D. $\frac{2kq^2}{s^2} \cos 30^\circ$

Correct Response and Explanation

D. This question requires the examinee to describe an electric force for a simple charge distribution. From Coulomb's law, the magnitude of the force on q from the left-most charge on the base of the triangle is $F = \frac{kq^2}{s^2}$, and the component in the vertical direction is $\frac{kq^2}{s^2} \cos \theta$, where $\theta = 30^\circ$. This force points in the positive y -direction. The same applies for the force from the right-most charge. The net force is the superposition of the two forces, which is $F = \frac{2kq^2}{s^2} \cos 30^\circ$.

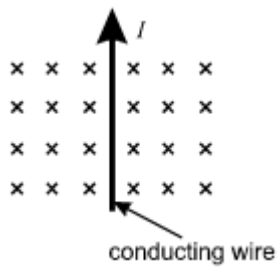
0008 Understand properties of the magnetic field and electromagnetic induction.

Descriptive Statements:





- » Demonstrate knowledge of the properties of magnets.
- » Analyze the magnetic force on a moving charge in a magnetic field.
- » Analyze the magnetic field for a current-carrying wire loop or solenoid.
- » Apply Faraday's and Lenz's laws of induction to find the direction of an induced emf or current in a conducting loop.
- » Describe the operation of devices such as electric motors, generators, and transformers.

Sample Item:

A wire that carries conventional current I in the direction shown is in a magnetic field that points into the plane of the page.



Which arrow shows the direction of the force on the wire?

- A. 
- B. 
- C. 
- D. 

Correct Response and Explanation

C. This question requires the examinee to analyze the magnetic force on a moving charge in a magnetic field. The diagram shows a magnetic field that points into the page. The wire carries conventional current, which implies positive charges moving toward the top of the page. Since $\mathbf{F} = I\hat{\ell} \times \mathbf{B}$ and $\hat{\ell}$ represents the direction of the conventional current I , the right-hand rule can be used to cross \mathbf{v} into \mathbf{B} . This shows that the force on the wire points to the left, as shown in response C.

0009 Understand properties of electric circuits.

Descriptive Statements:

- » Demonstrate knowledge of electromotive force, electric current, resistance, and Ohm's law.
- » Describe characteristics of parallel and series circuits.
- » Solve problems using Kirchhoff's laws for circuits.
- » Analyze an electric circuit or component in terms of energy or power.

Sample Item:

A resistor is connected in series across the terminals of an ideal battery of voltage V . The resistor dissipates power W from the battery. A second, identical resistor is connected in series with the first resistor. What is the total power dissipated by the two resistors?

- A. $\frac{W}{2}$
- B. W
- C. $2W$
- D. $4W$

Correct Response and Explanation

A. This question requires the examinee to analyze an electric circuit in terms of energy or power. The power dissipated by the resistor in the circuit is given by $P = IV = W$, where I is the current through the resistor.

When a second resistor is added to the circuit, the effective resistance doubles. Since the voltage of the battery is the same, the current is $\frac{1}{2}I$. Since there are two identical resistors in the circuit, the voltage across each is $\frac{1}{2}V$ and the power dissipated by each is $P = \frac{1}{4}W$. Therefore, the total power dissipated is $P = \frac{1}{2}W$.

Content Domain IV: Waves

Competencies:

0010 Understand the fundamental properties of waves.

Descriptive Statements:

- » Demonstrate knowledge of the characteristics and types of waves.
- » Demonstrate knowledge of wave propagation and how waves transfer energy and momentum.
- » Describe factors that affect the speed of a wave in different media.
- » Solve problems involving wave speed, frequency, and wavelength.
- » Analyze the reflection, refraction, and polarization of waves.
- » Apply the superposition principle to analyze wave phenomena.
- » Demonstrate knowledge of the Doppler effect.
- » Demonstrate knowledge of the relationships between a sound wave and the human perception of sound.
- » Solve problems involving standing waves, resonance, and sounds produced by waves on a string or in a pipe, given various boundary conditions.
- » Solve problems involving the intensity of sound and the decibel scale.

Sample Item:

A person standing 85 m from a wall shouts and hears the echo 0.50 s later. The person then plays a note of 440 Hz on a flute. What is the wavelength of the note in air?

- A. 0.39 m
- B. 0.77 m
- C. 1.3 m
- D. 2.6 m

Correct Response and Explanation

B. This question requires the examinee to solve a problem involving wave speed, frequency, and wavelength. Since the person hears the echo of the shout after 0.50 s, the speed of sound is $170 \text{ m}/0.50 \text{ s}$ or 340 m/s . Since $v = f\lambda$, the wavelength is $\lambda = 0.77 \text{ m}$.

0011 Understand the characteristics of light and electromagnetic radiation.

Descriptive Statements:

- » Demonstrate knowledge of the electromagnetic spectrum and the production and transmission of electromagnetic waves.
- » Apply the ray model of light and the thin lens equation to analyze characteristics of lenses and mirrors.
- » Solve problems using Snell's law in various situations.

- » Apply the wave model of light to describe phenomena such as interference, dispersion, diffraction, and polarization.
- » Apply properties of light to describe the operation of optical devices such as filters, magnifying devices, and diffraction gratings.
- » Describe various phenomena (e.g., electron transitions, atomic spectra, operation of a laser) using the photon model of light.

Sample Item:

A light-emitting diode (LED) on a consumer device emits 0.020 W of light of wavelength $\lambda = 650 \times 10^{-9}$ m. Which of the following expressions equals the number of photons emitted by the LED per second in terms of Planck's constant (h) and the speed of light (c)?

- A. $\frac{0.020\lambda}{hc}$
- B. $\frac{0.020hc}{\lambda}$
- C. $\frac{0.020h\lambda}{c}$
- D. $\frac{0.020}{hc\lambda}$

Correct Response and Explanation

A. This question requires the examinee to describe various phenomena using the photon model of light. The energy of a single photon is given by $E = hf$. For light, $c = f\lambda$, so $E = \frac{hc}{\lambda}$. Since the power of the LED is 0.020 W, dividing the power by the energy of a single photon gives the number of photons emitted per second.

Content Domain V: Modern Physics

Competencies:

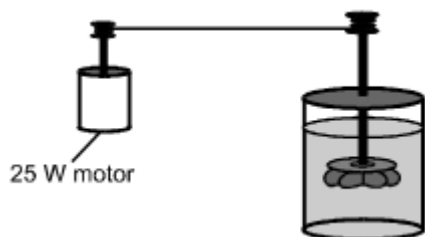
0012 Understand thermal energy and the kinetic theory of matter.

Descriptive Statements:

- » Demonstrate knowledge of the concepts of thermal energy and temperature.
- » Solve problems involving thermal expansion, specific heat, phase changes, and the first law of thermodynamics.
- » Demonstrate knowledge of the kinetic theory of matter.
- » Demonstrate knowledge of energy conversions, efficiency, heat transfer, and heat engines.
- » Demonstrate knowledge of the second law of thermodynamics, including entropy.

Sample Item:

A closed, insulated vessel consists of a paddle wheel immersed in 0.50 kg of water at room temperature. The shaft of the paddle wheel is attached to a motor that has an output of 25 W. The paddle wheel rotates, churning the water.



Disregarding the heat capacity of the vessel and paddle, what is the change in temperature of the water if the motor is run for 5.0 minutes?

- A. 0.03°C
- B. 1.0°C
- C. 1.8°C
- D. 3.6°C

Correct Response and Explanation

D. This question requires the examinee to solve a problem related to specific heat and the first law of thermodynamics. The first law of thermodynamics states that $\Delta E = \Delta Q - W$, where W is the work done by the system. Since the vessel is insulated, $\Delta Q = 0$. Therefore, $\Delta E = W$, since work is done on the system as the paddle wheel churns the water. Therefore, $c_w m_w \Delta T = (25 \text{ W})(5 \text{ min})(60 \text{ s/min})$. Using the value $c_w = 4.19 \times 10^3 \text{ J/(kg}\cdot\text{°C)}$ given in the Constants and Formulas and solving gives $\Delta T = 3.6^\circ\text{C}$.

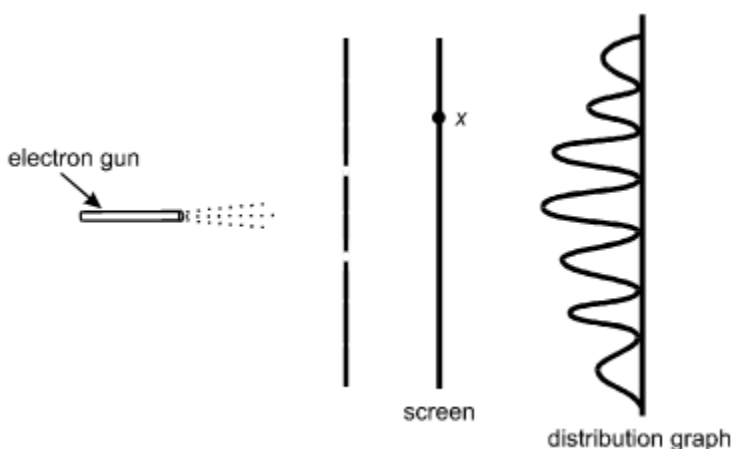
0013 Understand fundamental ideas of modern physics.

Descriptive Statements:

- » Demonstrate knowledge of the significance of the work of scientists such as Curie, Rutherford, and Planck in the development of modern physics.
- » Analyze the Bohr model of the atom.
- » Demonstrate knowledge of the basic principles of quantum mechanics, such as wave-particle duality and the uncertainty principle.
- » Demonstrate knowledge of the basic principles of special relativity.

Sample Item:

Electrons from an electron gun pass through a double slit before striking a screen. A counter records the number of electrons that arrive at the screen as a function of x , the position along the screen. The distribution of the number of electrons arriving is shown below.



According to the principles of quantum mechanics, the distribution pattern shown is a result of:

- A. electrons interfering due to their wave properties.
- B. electrons striking the edges of the slits while passing through.
- C. photons interacting with each other on either side of the slits.
- D. electrons interacting with photons prior to arriving at the screen.

Correct Response and Explanation

A. This question requires the examinee to demonstrate knowledge of the wave-particle duality. In the double-slit experiment shown, the distribution of the number of electrons arriving on the screen at various positions is a result of interference. Interference is a consequence of the wave properties of electrons.

0014 Understand the fundamental principles of nuclear physics.

Descriptive Statements:

- » Demonstrate knowledge of the structure of the nucleus, including the forces that hold it together.
- » Apply knowledge of radioactive decay processes and the concept of the half-life to analyze and solve problems.
- » Demonstrate knowledge of the processes of nuclear fission and nuclear fusion.
- » Apply the principles of conservation of charge and mass-energy to analyze nuclear reactions.

Sample Item:

If ${}^A_Z X$ represents an atomic nucleus prior to gamma decay, which of the following represents the nucleus after gamma decay?

- A. ${}^A_Z X$
- B. ${}^{A-1}_Z X$
- C. ${}^{A+1}_Z X$
- D. ${}^{A-4}_{Z-2} X$

Correct Response and Explanation

A. This question requires the examinee to apply knowledge of radioactive decay processes. Gamma rays are electromagnetic waves, or photons, emitted as the nucleus of an atom transitions from a higher energy state to a lower energy state. Hence, the number and type of nucleons in the nucleus does not change.

PEARSON

The Pearson logo consists of the word "PEARSON" in a bold, blue, sans-serif font. Below the text is a yellow curved line that starts under the 'P', goes up to touch the 'A', and then goes down to end under the 'N'.