MHT-CET Physics Sample Paper-7

Duration: 45 Minutes **Maximum Marks: 50**

Instructions

- This paper contains a total of **50** Multiple Choice Questions.
- Each correct answer carries **+1 marks**.
- No negative marking for incorrect questions.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.
- No marks will be deducted for questions that are left unattempted.

Q1. Moment of inertia of a solid sphere about its tangent is I. Its moment of inertia about its diameter is:

(A) $\frac{2}{7}I$

(B) $\frac{5}{7}I$

(C) $\frac{7}{5}I$

(D) $\frac{2}{5}I$

Q2. Two discs having moments of inertia I_1 and I_2 about their respective axes, rotating with angular frequencies ω_1 and ω_2 respectively, are brought into contact face to face with their axes of rotation coincident. The angular frequency of the composite disc will be:

(A) $\frac{I_1\omega_1+I_2\omega_2}{I_1+I_2}$

(B) $\frac{I_1\omega_1-I_2\omega_2}{I_1-I_2}$

(C) $\frac{I_1\omega_2+I_2\omega_1}{I_1+I_2}$

(D) $\frac{I_1\omega_1+I_2\omega_2}{I_1-I_2}$

Q3. The ratio of the radius of gyration of a circular disc about a tangential axis in the plane of the disc to that of a circular ring of the same radius about a tangential axis in the plane of the ring is:

(A) $\sqrt{5} : \sqrt{6}$

(B) 5 : 6

(C) 2 : 3

(D) $\sqrt{2} : \sqrt{3}$

Q4. A solid cylinder of mass M and radius R rolls down an inclined plane of length L and height h without slipping. The speed of its centre of mass when it reaches the bottom is:

(A) $\sqrt{\frac{4}{3}gh}$

(B) $\sqrt{\frac{3}{4}gh}$

(C) $\sqrt{\frac{4}{5}gh}$

(D) $\sqrt{gh}$

Q5. A particle executing linear simple harmonic motion has a maximum velocity of 40 cm/s and a maximum acceleration of 50 cm/s^2. The amplitude of the motion is:

(A) 32 cm

(B) 20 cm

(C) 25 cm

(D) 40 cm

Q6. If the length of a simple pendulum is increased by 44%, the percentage increase in its time period is:

(A) 20%

(B) 44%

(C) 22%

(D) 10%

Q7. An organ pipe closed at one end has a fundamental frequency f_1. Another pipe open at both ends has a fundamental frequency f_2. If the length of the open pipe is double the length of the closed pipe, then the ratio f_1/f_2 is:

(A) 1

(B) 2

(C) $1/2$

(D) 4

Q8. Two sounding bodies producing progressive waves are given by $y_1 = 4\sin(400\pi t)$ and $y_2 = 3\sin(404\pi t)$. The number of beats heard per second is:

(A) 4

(B) 2

(C) 3

(D) 1

Q9. The work done in bringing a charge q from infinity to the centre of a uniformly charged thin spherical shell of radius R and total charge Q is:

(A) $\frac{1}{4\pi\epsilon_0}\frac{Qq}{R}$

(B) $\frac{1}{4\pi\epsilon_0}\frac{Qq}{2R}$

(C) Zero

(D) $\frac{1}{4\pi\epsilon_0}\frac{Q^2}{2R}$

Q10. Two capacitors of $3\,\mu$F and $6\,\mu$F are connected in series across a potential difference of 120 V. The potential difference across the $3\,\mu$F capacitor is:

(A) 80 V

(B) 40 V

(C) 60 V

(D) 120 V

Q11. An electric dipole of moment p is placed normal to the lines of force of a uniform electric field E. The work done in deflecting it through an angle of $180°$ is:

(A) pE

(B) $2pE$

(C) $-2pE$

(D) Zero

Q12. Eight identical spherical drops, each charged to a potential V, combine to form a single large drop. The potential of the new drop is:

(A) $4V$

(B) $2V$

(C) $8V$

(D) V

Q13. A cell having an emf of 2 V and internal resistance $0.5\,\Omega$ is connected across a resistance of $9.5\,\Omega$. The current in the circuit is:

(A) 0.2 A

(B) 0.4 A

(C) 2.0 A

(D) 0.1 A

Q14. In a potentiometer experiment, the balancing length with a cell is 240 cm. On shunting the cell with a resistance of $2\,\Omega$, the balancing length becomes 120 cm. The internal resistance of the cell is:

(A) $1\,\Omega$

(B) $2\,\Omega$

(C) $0.5\,\Omega$

(D) $4\,\Omega$

Q15. Three unequal resistors in parallel are equivalent to a resistance R. If they were connected in series, the equivalent resistance would be:

(A) Greater than $9R$

(B) Exactly $9R$

(C) Less than $9R$

(D) Exactly $3R$

Q16. The drift velocity of electrons in a wire of radius r carrying a current I is v_d. If the radius is doubled and the current is halved, the new drift velocity will be:

(A) $v_d/8$

(B) $v_d/4$

(C) $v_d/2$

(D) v_d

Q17. A straight long wire carries a current of 10 A. The magnetic field at a perpendicular distance of 5 cm from the wire is: (Take $\mu_0 = 4\pi \times 10^{-7}$ T m/A)

(A) 4×10^{-5} T

(B) 2×10^{-5} T

(C) $4\pi \times 10^{-5}$ T

(D) $2\pi \times 10^{-5}$ T

Q18. A proton and an alpha particle, accelerated through the same potential difference, enter a uniform magnetic field perpendicularly. The ratio of their radii of curvature is:

(A) $1 : \sqrt{2}$

(B) $\sqrt{2} : 1$

(C) $1 : 2$

(D) $2 : 1$

Q19. The relative permeability of a given solid substance is 1.00002. The substance is:

(A) Paramagnetic

(B) Diamagnetic

(C) Ferromagnetic

(D) Anti-ferromagnetic

Q20. A current loop of area 0.02 m^2 carrying a current of 5 A is placed in a magnetic field of 2 T such that the plane of the loop is parallel to the field. The torque experienced by the loop is:

(A) 0.2 N m

(B) 0.1 N m

(C) Zero

(D) 0.4 N m

Q21. The magnetic flux through a circuit of resistance R changes by an amount $\Delta\phi$ in time Δt. The total charge Q that passes any point in the circuit during the time Δt is:

(A) $\frac{\Delta\phi}{R}$

(B) $\frac{\Delta\phi}{\Delta t}$

(C) $R\frac{\Delta\phi}{\Delta t}$

(D) $\frac{\Delta\phi}{R\Delta t}$

Q22. In an AC circuit, the voltage is given by $V = 100\sin(100t)$ volt and the current is $I = 100\sin\left(100t + \frac{\pi}{3}\right)$ mA. The power dissipated in the circuit is:

(A) 2.5 W

(B) 5 W

(C) 10 W

(D) 25 W

Q23. The primary winding of a transformer has 500 turns and the secondary has 5000 turns. If the primary is connected to an AC supply of 20 V, 50 Hz, the secondary output voltage will be:

(A) 200 V

(B) 2 V

(C) 2000 V

(D) 20 V

Q24. In Young's double slit experiment, if the distance between the slits is halved and the distance between the slits and the screen is doubled, the fringe width will be:

(A) Quadrupled

(B) Halved

(C) Doubled

(D) Unchanged

Q25. Unpolarized light of intensity I_0 passes through two polaroids. The transmission axis of the second polaroid is at an angle of 45° to that of the first. The intensity of transmitted light is:

(A) $I_0/4$

(B) $I_0/2$

(C) $I_0/\sqrt{2}$

(D) $I_0/8$

Q26. An equiconvex lens of focal length f is cut into two identical halves by a plane perpendicular to the principal axis. The focal length of each plano-convex half is:

(A) $2f$

(B) f

(C) $f/2$

(D) $4f$

Q27. The critical angle for a medium with respect to vacuum is $30°$. The velocity of light in that medium is:

(A) 1.5×10^8 m/s

(B) 3×10^8 m/s

(C) 2×10^8 m/s

(D) 2.5×10^8 m/s

Q28. A thin prism of refracting angle $6°$ and refractive index 1.5 is combined with another thin prism of refractive index 1.6 to produce dispersion without deviation. The refracting angle of the second prism is:

(A) $5°$

(B) $4°$

(C) $6°$

(D) $7.5°$

Q29. The root mean square (rms) speed of oxygen molecules at 300 K is v. At what temperature will the rms speed become $2v$?

(A) 1200 K

(B) 600 K

(C) 900 K

(D) 150 K

Q30. A Carnot engine working between 300 K and 600 K has a work output of 800 J per cycle. The amount of heat energy supplied to the engine from the source in each cycle is:

(A) 1600 J

(B) 800 J

(C) 2400 J

(D) 3200 J

Q31. During an isobaric process, the volume of a gas increases by 0.2 m^3 under a constant pressure of 10^5 N/m^2. If the heat supplied to the gas is 3×10^4 J, the change in its internal energy is:

(A) 1×10^4 J

(B) 2×10^4 J

(C) 3×10^4 J

(D) 5×10^4 J

Q32. According to Einstein's photoelectric equation, the graph between the maximum kinetic energy of photoelectrons and the frequency of incident radiation is:

(A) A straight line with a positive slope

(B) A straight line with a negative slope

(C) A parabola

(D) An exponential curve

Q33. The ratio of the energies of the electron in the first and second excited states of a hydrogen atom is:

(A) 9 : 4

(B) 4 : 9

(C) 1 : 4

(D) 8 : 1

Q34. The half-life of a radioactive substance is 20 minutes. The time taken for 75% of the substance to decay is:

(A) 40 minutes

(B) 60 minutes

(C) 80 minutes

(D) 30 minutes

Q35. The de-Broglie wavelength of an electron accelerated from rest through a potential difference of 100 V is approximately:

(A) 1.22 Å

(B) 12.2 Å

(C) 0.12 Å

(D) 122 Å

Q36. If the binding energy per nucleon of a deuteron is 1.115 MeV, its mass defect is approximately: (Given 1 u = 931.5 MeV)

(A) 0.0024 u

(B) 0.0012 u

(C) 0.024 u

(D) 0.012 u

Q37. A projectile has a maximum horizontal range of 400 m. What is the maximum height attained by it in this case?

(A) 100 m

(B) 200 m

(C) 50 m

(D) 400 m

Q38. A block of mass 2 kg rests on a rough horizontal surface with a coefficient of static friction of 0.4. A horizontal force of 5 N is applied to the block. The frictional force acting on the block is: (Take $g = 10\ \text{m/s}^2$)

(A) 5 N

(B) 8 N

(C) 4 N

(D) Zero

Q39. A body of mass m_1 moving with velocity u collides perfectly elastically and head-on with another stationary body of mass m_2. If $m_1 \gg m_2$, the velocity of m_2 after collision is approximately:

(A) $2u$

(B) u

(C) $u/2$

(D) Zero

Q40. A particle moves from position vector $\vec{r}_1 = 2\hat{i} + 3\hat{j}$ m to $\vec{r}_2 = 4\hat{i} + 6\hat{j}$ m under the action of a constant force $\vec{F} = 3\hat{i} + 2\hat{j}$ N. The work done is:

(A) 12 J

(B) 6 J

(C) 18 J

(D) 24 J

Q41. An electric pump is used to pump water from a well 10 m deep at a rate of 600 kg/min. The power of the pump is: (Take $g = 10$ m/s^2)

(A) 1000 W

(B) 600 W

(C) 100 W

(D) 6000 W

Q42. If the escape velocity from the Earth is v_e, the escape velocity from a planet having twice the mass and twice the radius of Earth is:

(A) v_e

(B) $2v_e$

(C) $v_e/\sqrt{2}$

(D) $\sqrt{2}v_e$

Q43. The period of revolution of a satellite in a circular orbit close to the surface of the earth is T. The period of another satellite in a circular orbit at a height of three times the radius of the earth from its surface will be:

(A) $8T$

(B) $4T$

(C) $2\sqrt{2}T$

(D) $9T$

Q44. The work done in blowing a soap bubble from a radius of 1 cm to 2 cm is W. The work done in blowing it from 2 cm to 3 cm is:

(A) $\frac{5}{3}W$

(B) $\frac{3}{5}W$

(C) $\frac{4}{3}W$

(D) $2W$

Q45. Eight identical spherical drops of water fall vertically downwards in air with a terminal velocity of 2 cm/s. If they coalesce to form a single drop, the new terminal velocity will be:

(A) 8 cm/s

(B) 4 cm/s

(C) 16 cm/s

(D) 2 cm/s

Q46. The percentage errors in the measurement of mass and speed are 2% and 3% respectively. The maximum percentage error in the estimate of kinetic energy is:

(A) 8%

(B) 11%

(C) 5%

(D) 1%

Q47. The dimensional formula of the universal gravitational constant G is:

(A) $[M^{-1}L^{3}T^{-2}]$

(B) $[M^{1}L^{2}T^{-2}]$

(C) $[M^{-1}L^{2}T^{-2}]$

(D) $[M^{1}L^{3}T^{-2}]$

Q48. In a given logic circuit, the output $Y = 1$ is obtained only when both inputs A and B are 1. Which logic gate does this represent?

(A) AND gate

(B) OR gate

(C) NAND gate

(D) NOR gate

Q49. For an n-type semiconductor, which of the following statements is true?

(A) Electrons are majority carriers and trivalent atoms are dopants.

(B) Electrons are majority carriers and pentavalent atoms are dopants.

(C) Holes are majority carriers and trivalent atoms are dopants.

(D) Holes are majority carriers and pentavalent atoms are dopants.

Q50. A message signal of frequency 10 kHz and peak voltage 10 V is used to modulate a carrier of frequency 1 MHz and peak voltage 20 V. The modulation index is:

(A) 0.5

(B) 2.0

(C) 0.1

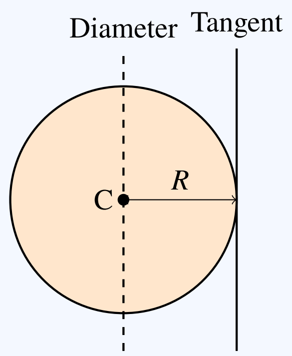
(D) 10

Detailed Solutions

Q1.

Solution

Concept: The moment of inertia of a solid sphere of mass M and radius R about its diameter is given by $I_d = \frac{2}{5}MR^2$. According to the parallel axis theorem, the moment of inertia about a tangent is $I = I_d + MR^2$.



Solution: Step 1: Write the formula for moment of inertia about the tangent: $I = \frac{2}{5}MR^2 + MR^2 = \frac{7}{5}MR^2$

Step 2: Express MR^2 in terms of I: $MR^2 = \frac{5}{7}I$

Step 3: Substitute MR^2 back into the formula for the moment of inertia about the diameter: $I_d = \frac{2}{5}MR^2 = \frac{2}{5}\left(\frac{5}{7}I\right) = \frac{2}{7}I$

Final Answer: The moment of inertia about its diameter is $\boxed{\frac{2}{7}I}$.

Answer: (A)

Q2.

Solution

Concept: When two rotating bodies are brought into contact and rotate together without external torque, angular momentum is conserved. $L_{initial} = L_{final}$

Solution: Step 1: Calculate the initial angular momentum of the system. $L_{initial} = I_1\omega_1 + I_2\omega_2$

Step 2: When the discs are combined and rotate with a common angular frequency ω, the final moment of inertia is $I_1 + I_2$. $L_{final} = (I_1 + I_2)\omega$

Step 3: Equate initial and final angular momentum. $I_1\omega_1 + I_2\omega_2 = (I_1 + I_2)\omega$

Step 4: Solve for ω. $\omega = \frac{I_1\omega_1 + I_2\omega_2}{I_1 + I_2}$

Final Answer: The composite angular frequency is $\boxed{\frac{I_1\omega_1 + I_2\omega_2}{I_1 + I_2}}$.

Answer: (A)

Q3.

Solution

Concept: The radius of gyration k is defined by the relation $I = Mk^2$, so $k = \sqrt{I/M}$. We need to find the moment of inertia for both shapes about a tangential axis in their respective planes.

Solution: Step 1: For a circular disc, $I_{diameter} = \frac{1}{4}MR^2$. Using the parallel axis theorem for a tangential axis in its plane: $I_{disc} = I_{diameter} + MR^2 = \frac{1}{4}MR^2 + MR^2 = \frac{5}{4}MR^2$. Thus, $k_{disc} = \sqrt{\frac{5}{4}}R = \frac{\sqrt{5}}{2}R$.

Step 2: For a circular ring, $I_{diameter} = \frac{1}{2}MR^2$. Using the parallel axis theorem for a tangential axis in its plane: $I_{ring} = I_{diameter} + MR^2 = \frac{1}{2}MR^2 + MR^2 = \frac{3}{2}MR^2 = \frac{6}{4}MR^2$. Thus, $k_{ring} = \sqrt{\frac{6}{4}}R = \frac{\sqrt{6}}{2}R$.

Step 3: Find the ratio. $\frac{k_{disc}}{k_{ring}} = \frac{\sqrt{5}/2}{\sqrt{6}/2} = \frac{\sqrt{5}}{\sqrt{6}}$.

Final Answer: The ratio is $\boxed{\sqrt{5} : \sqrt{6}}$.

Answer: (A)

Q4.

Solution

Concept: By conservation of mechanical energy for a rolling body: Loss in potential energy = Gain in translational KE + Gain in rotational KE $Mgh = \frac{1}{2}Mv^2 + \frac{1}{2}I\omega^2$ For rolling without slipping, $\omega = v/R$.

Solution: Step 1: Identify the moment of inertia of a solid cylinder. $I = \frac{1}{2}MR^2$.

Step 2: Substitute I and ω into the energy equation. $Mgh = \frac{1}{2}Mv^2 + \frac{1}{2}\left(\frac{1}{2}MR^2\right)\left(\frac{v}{R}\right)^2$

Step 3: Simplify the equation. $Mgh = \frac{1}{2}Mv^2 + \frac{1}{4}Mv^2$ $Mgh = \frac{3}{4}Mv^2$

Step 4: Solve for v. $v^2 = \frac{4}{3}gh \implies v = \sqrt{\frac{4}{3}gh}$

Final Answer: The speed is $\boxed{\sqrt{\frac{4}{3}gh}}$.

Answer: (A)

Q5.

Solution

Concept: For a particle executing simple harmonic motion (SHM) with amplitude A and angular frequency ω: Maximum velocity: $v_{max} = A\omega$ Maximum acceleration: $a_{max} = A\omega^2$

Solution: Step 1: Write down the given values. $A\omega = 40$ cm/s $A\omega^2 = 50$ cm/s^2

Step 2: Find the angular frequency ω by dividing a_{max} by v_{max}. $\omega = \frac{A\omega^2}{A\omega} = \frac{50}{40} = 1.25$ rad/s

Step 3: Substitute ω back into the velocity equation to find A. $A = \frac{v_{max}}{\omega} = \frac{40}{1.25} = 32$ cm.

Final Answer: The amplitude is $\boxed{32 \text{ cm}}$.

Answer: (A)

Q6.

Solution

Concept: The time period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{L}{g}}$, which means $T \propto \sqrt{L}$.
Solution: Step 1: Determine the new length. If length is increased by 44%, $L' = L + 0.44L = 1.44L$.
Step 2: Calculate the new time period. $T' = 2\pi\sqrt{\frac{1.44L}{g}} = \sqrt{1.44} \times 2\pi\sqrt{\frac{L}{g}} = 1.2T$.
Step 3: Calculate the percentage increase. % Increase = $\frac{T'-T}{T} \times 100 = \frac{1.2T-T}{T} \times 100 = 0.2 \times 100 = 20\%$.
Final Answer: The percentage increase in time period is $\boxed{20\%}$.

Answer: (A)

Q7.

Solution

Concept: For an organ pipe closed at one end, the fundamental frequency is $f_1 = \frac{v}{4L_c}$. For an organ pipe open at both ends, the fundamental frequency is $f_2 = \frac{v}{2L_o}$.
Solution: Step 1: Use the given condition relating the lengths. $L_o = 2L_c$.
Step 2: Substitute L_o into the open pipe frequency formula. $f_2 = \frac{v}{2(2L_c)} = \frac{v}{4L_c}$.
Step 3: Find the ratio f_1/f_2. Since $f_1 = \frac{v}{4L_c}$ and $f_2 = \frac{v}{4L_c}$, $\frac{f_1}{f_2} = 1$.
Final Answer: The ratio f_1/f_2 is $\boxed{1}$.

Answer: (A)

Q8.

Solution

Concept: The standard equation of a progressive wave is $y = A\sin(\omega t - kx)$. For a sounding body at a fixed point, $y = A\sin(2\pi ft)$. Beat frequency is defined as the absolute difference between the frequencies of two sounding bodies: $f_{beat} = |f_1 - f_2|$.
Solution: Step 1: Extract the angular frequencies from the given equations. For $y_1 = 4\sin(400\pi t)$, $\omega_1 = 400\pi \implies 2\pi f_1 = 400\pi \implies f_1 = 200$ Hz. For $y_2 = 3\sin(404\pi t)$, $\omega_2 = 404\pi \implies 2\pi f_2 = 404\pi \implies f_2 = 202$ Hz.
Step 2: Calculate the beat frequency. $n = |f_2 - f_1| = 202 - 200 = 2$ beats per second.
Final Answer: The number of beats heard per second is $\boxed{2}$.

Answer: (B)

Q9.

Solution

Concept: The potential V everywhere inside a uniformly charged thin spherical shell is constant and equal to the potential on its surface. $V = \frac{1}{4\pi\epsilon_0}\frac{Q}{R}$ The work done in bringing a charge q from infinity to any point is $W = qV$.

Solution: Step 1: Identify the potential at the centre of the shell. Since the centre is inside the shell, $V_{centre} = V_{surface} = \frac{1}{4\pi\epsilon_0}\frac{Q}{R}$.

Step 2: Calculate the work done. $W = q \times V_{centre} = q\left(\frac{1}{4\pi\epsilon_0}\frac{Q}{R}\right) = \frac{1}{4\pi\epsilon_0}\frac{Qq}{R}$.

Final Answer: The work done is $\boxed{\frac{1}{4\pi\epsilon_0}\frac{Qq}{R}}$.

Answer: (A)

Q10.

Solution

Concept: In a series combination of capacitors, the charge Q on each capacitor is the same. The potential difference across a capacitor is $V = \frac{Q}{C}$, indicating that $V \propto \frac{1}{C}$. Using the voltage divider rule for two capacitors: $V_1 = V_{total} \times \frac{C_2}{C_1+C_2}$.

Solution: Step 1: Identify the given values. $C_1 = 3\,\mu$F, $C_2 = 6\,\mu$F, $V_{total} = 120$ V.

Step 2: Apply the voltage divider rule to find V_1 (voltage across 3 μF). $V_1 = 120 \times \frac{6}{3+6} = 120 \times \frac{6}{9}$ $V_1 = 120 \times \frac{2}{3} = 80$ V.

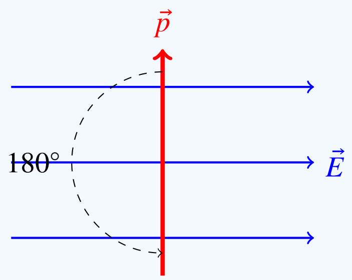
Final Answer: The potential difference across the 3 μF capacitor is $\boxed{80 \text{ V}}$.

Answer: (A)

Q11.

Solution

Concept: The work done in rotating an electric dipole in a uniform electric field from an initial angle θ_1 to a final angle θ_2 is: $W = pE(\cos\theta_1 - \cos\theta_2)$



Solution: Step 1: Determine initial and final angles. The dipole is normal to the field, so initially $\theta_1 = 90°$. It is deflected through 180°, so its final angle is $\theta_2 = 90° + 180° = 270°$.
Step 2: Substitute into the work formula. $W = pE(\cos 90° - \cos 270°)$ Since $\cos 90° = 0$ and $\cos 270° = 0$, $W = pE(0 - 0) = 0$.
Final Answer: The work done is $\boxed{\text{Zero}}$.

Answer: (D)

Q12.

Solution

Concept: When n identical spherical drops combine, volume is conserved. If r is the radius of one small drop and R is the radius of the large drop: $n \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3 \implies R = n^{1/3}r$ The charge is additive: $Q = nq$. Potential of the large drop $V' = \frac{kQ}{R}$.
Solution: Step 1: Determine the radius of the large drop. For $n = 8$, $R = 8^{1/3}r = 2r$.
Step 2: Determine total charge. $Q = 8q$.
Step 3: Calculate the new potential in terms of the old potential $V = \frac{kq}{r}$. $V' = \frac{k(8q)}{2r} = 4\left(\frac{kq}{r}\right) = 4V$.
Final Answer: The potential of the new drop is $\boxed{4V}$.

Answer: (A)

Q13.

Solution

Concept: According to Ohm's Law for a complete circuit including a real battery, the current I flowing in the circuit is given by: $I = \frac{E}{R+r}$ where E is electromotive force, R is external resistance, and r is internal resistance.

Solution: Step 1: Substitute the given values. $E = 2$ V, $R = 9.5\,\Omega$, $r = 0.5\,\Omega$. $I = \frac{2}{9.5+0.5}$

Step 2: Compute the result. $I = \frac{2}{10} = 0.2$ A.

Final Answer: The current in the circuit is $\boxed{0.2 \text{ A}}$.

Answer: (A)

Q14.

Solution

Concept: In a potentiometer experiment used to determine the internal resistance r of a cell, the formula is: $r = S\left(\frac{l_1}{l_2} - 1\right)$ where l_1 is the balancing length without shunt, l_2 is the balancing length with shunt resistance S.

Solution: Step 1: Identify given values. $l_1 = 240$ cm, $l_2 = 120$ cm, $S = 2\,\Omega$.

Step 2: Substitute into the formula. $r = 2\left(\frac{240}{120} - 1\right)$

Step 3: Simplify. $r = 2(2-1) = 2 \times 1 = 2\,\Omega$.

Final Answer: The internal resistance is $\boxed{2\,\Omega}$.

Answer: (B)

Q15.

Solution

Concept: For n equal resistors, $R_{series} = n^2 R_{parallel}$. So if 3 equal resistors give R in parallel, their series is $9R$. For n unequal resistors, the variation in resistances causes the series equivalent to always be strictly greater than n^2 times the parallel equivalent.

Solution: Step 1: Let the unequal resistors be R_1, R_2, R_3. The given parallel equivalent is $R_p = R$. Thus, $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$.

Step 2: Apply the Cauchy-Schwarz inequality or the principle of variance. $(R_1 + R_2 + R_3)\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right) > 3^2\ R_s \times \left(\frac{1}{R}\right) > 9\ R_s > 9R$.

Step 3: Conclusion. Since the resistors are distinctly unequal, the equivalent resistance in series will strictly be greater than $9R$.

Final Answer: The equivalent series resistance is $\boxed{\text{Greater than } 9R}$.

Answer: (A)

Q16.

Solution

Concept: Drift velocity v_d is related to current I by the equation: $I = neAv_d \implies v_d = \frac{I}{neA}$
Since the wire has a circular cross-section, $A = \pi r^2$. Thus, $v_d \propto \frac{I}{r^2}$.
Solution: Step 1: Express the initial drift velocity. $v_d = \frac{I}{ne\pi r^2}$.
Step 2: Apply the changes. New radius $r' = 2r$, New current $I' = I/2$. New area $A' = \pi(2r)^2 = 4\pi r^2 = 4A$.
Step 3: Calculate the new drift velocity. $v'_d = \frac{I/2}{ne(4A)} = \frac{1}{8}\left(\frac{I}{neA}\right) = \frac{v_d}{8}$.
Final Answer: The new drift velocity is $\boxed{v_d/8}$.

Answer: (A)

Q17.

Solution

Concept: The magnetic field B produced by a long straight wire carrying current I at a perpendicular distance r is given by Ampere's Law: $B = \frac{\mu_0 I}{2\pi r}$
Solution: Step 1: Identify parameters. $I = 10$ A, $r = 5$ cm $= 0.05$ m, $\mu_0 = 4\pi \times 10^{-7}$ T m/A.
Step 2: Substitute into the formula. $B = \frac{4\pi\times10^{-7}\times10}{2\pi\times0.05}$
Step 3: Simplify the expression. $B = \frac{2\times10^{-6}}{0.05} = \frac{200\times10^{-8}}{0.05} = 40 \times 10^{-6} = 4 \times 10^{-5}$ T.
Final Answer: The magnetic field is $\boxed{4 \times 10^{-5}\text{ T}}$.

Answer: (A)

Q18.

Solution

Concept: When a charged particle accelerates through a potential V, its kinetic energy is $K = qV$.
The radius r of the circular path in a transverse magnetic field is $r = \frac{mv}{qB} = \frac{\sqrt{2mK}}{qB} = \frac{\sqrt{2mqV}}{qB} = \frac{1}{B}\sqrt{\frac{2mV}{q}}$. Hence, for constant V and B, $r \propto \sqrt{\frac{m}{q}}$.
Solution: Step 1: Establish ratios for mass and charge. For proton: $m_p = m$, $q_p = e$. For alpha particle: $m_\alpha = 4m$, $q_\alpha = 2e$.
Step 2: Substitute into the proportionality. $\frac{r_p}{r_\alpha} = \frac{\sqrt{m_p/q_p}}{\sqrt{m_\alpha/q_\alpha}} = \sqrt{\frac{m/e}{4m/2e}} = \sqrt{\frac{1}{2}}$.
Step 3: Rationalize. $r_p : r_\alpha = 1 : \sqrt{2}$.
Final Answer: The ratio of their radii is $\boxed{1 : \sqrt{2}}$.

Answer: (A)

Q19.

Solution

Concept: Magnetic materials are classified by their relative permeability μ_r: Diamagnetic: $\mu_r < 1$ (slightly less than 1) Paramagnetic: $\mu_r > 1$ (slightly greater than 1) Ferromagnetic: $\mu_r \gg 1$ (much greater than 1)

Solution: Step 1: Analyze the given value. $\mu_r = 1.00002$.

Step 2: Compare against standard classifications. The value is slightly greater than 1, implying a weak positive susceptibility ($\chi_m = \mu_r - 1 = +0.00002$). This is the characteristic property of a paramagnetic substance.

Final Answer: The substance is $\boxed{\text{Paramagnetic}}$.

Answer: (A)

Q20.

Solution

Concept: The torque τ on a current-carrying loop in a uniform magnetic field is given by: $\tau = NIAB\sin\theta$ where θ is the angle between the normal to the loop area and the magnetic field B.

Solution: Step 1: Determine θ. The plane of the loop is parallel to the magnetic field. Therefore, the normal vector to the plane makes an angle of 90° with the field. So, $\theta = 90°$.

Step 2: Identify given variables. $N = 1$ (single loop), $I = 5$ A, $A = 0.02$ m^2, $B = 2$ T.

Step 3: Calculate the torque. $\tau = 1 \times 5 \times 0.02 \times 2 \times \sin 90° = 10 \times 0.02 \times 1 = 0.2$ N m.

Final Answer: The torque experienced is $\boxed{0.2 \text{ N m}}$.

Answer: (A)

Q21.

Solution

Concept: According to Faraday's law of electromagnetic induction, the induced emf is $e = \frac{\Delta\phi}{\Delta t}$ (magnitude). The induced current is $I = \frac{e}{R} = \frac{\Delta\phi}{R\Delta t}$. Total charge flowing through the circuit is $Q = I \times \Delta t$.

Solution: Step 1: Substitute the expression for current I into the charge equation. $Q = \left(\frac{\Delta\phi}{R\Delta t}\right) \times \Delta t$

Step 2: Simplify. The time interval Δt cancels out. $Q = \frac{\Delta\phi}{R}$

Final Answer: The total charge is $\boxed{\frac{\Delta\phi}{R}}$.

Answer: (A)

Q22.

Solution

Concept: In an AC circuit, average power dissipated is: $P = V_{rms}I_{rms}\cos\phi = \frac{V_0}{\sqrt{2}}\frac{I_0}{\sqrt{2}}\cos\phi = \frac{1}{2}V_0I_0\cos\phi$ where ϕ is the phase difference between voltage and current.

Solution: Step 1: Identify maximum voltage, maximum current, and phase difference. $V_0 = 100$ V $I_0 = 100$ mA $= 100 \times 10^{-3}$ A $= 0.1$ A Phase angle $\phi = \frac{\pi}{3} = 60°$.

Step 2: Calculate power. $P = \frac{1}{2} \times 100 \times 0.1 \times \cos 60°$ $P = \frac{1}{2} \times 10 \times \frac{1}{2} = \frac{10}{4} = 2.5$ W.

Final Answer: The power dissipated is $\boxed{2.5 \text{ W}}$.

Answer: (A)

Q23.

Solution

Concept: For an ideal transformer, the ratio of secondary voltage to primary voltage is equal to the ratio of their respective turns: $\frac{V_s}{V_p} = \frac{N_s}{N_p}$

Solution: Step 1: Identify given variables. $N_p = 500$, $N_s = 5000$, $V_p = 20$ V.

Step 2: Rearrange the formula to solve for V_s. $V_s = V_p \times \frac{N_s}{N_p}$

Step 3: Substitute and compute. $V_s = 20 \times \frac{5000}{500} = 20 \times 10 = 200$ V.

Note: The frequency (50 Hz) remains unchanged and does not affect the calculation of voltage output.

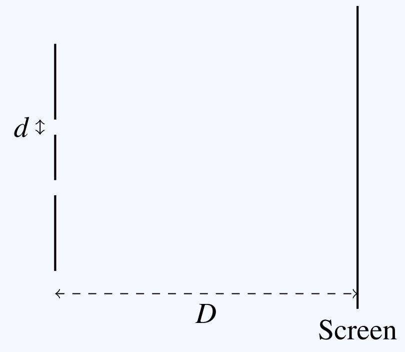
Final Answer: The secondary output voltage will be $\boxed{200 \text{ V}}$.

Answer: (A)

Q24.

Solution

Concept: In Young's double slit experiment, the fringe width β is given by: $\beta = \frac{\lambda D}{d}$ where λ is wavelength, D is the distance from slits to screen, and d is the distance between the slits.



Solution: Step 1: Express the initial fringe width. $\beta_1 = \frac{\lambda D}{d}$.
Step 2: Substitute the new parameters. New distance between slits $d' = d/2$. New distance to screen $D' = 2D$. New fringe width $\beta_2 = \frac{\lambda D'}{d'} = \frac{\lambda(2D)}{d/2}$.
Step 3: Simplify to compare with original. $\beta_2 = \frac{4\lambda D}{d} = 4\beta_1$. The fringe width becomes 4 times its original value.
Final Answer: The fringe width will be $\boxed{\text{Quadrupled}}$.

Answer: (A)

Q25.

Solution

Concept: When unpolarized light of intensity I_0 passes through the first polaroid, it becomes linearly polarized and its intensity is halved: $I_1 = \frac{I_0}{2}$. According to Malus's Law, when this polarized light passes through a second polaroid (analyzer), the transmitted intensity is: $I_2 = I_1 \cos^2 \theta$
Solution: Step 1: Intensity after first polaroid. $I_1 = \frac{I_0}{2}$.
Step 2: Intensity after second polaroid. The angle between transmission axes is $\theta = 45°$. $I_2 = \left(\frac{I_0}{2}\right) \cos^2 45°$
Step 3: Calculate the final value. Since $\cos 45° = \frac{1}{\sqrt{2}}$, $\cos^2 45° = \frac{1}{2}$. $I_2 = \frac{I_0}{2} \times \frac{1}{2} = \frac{I_0}{4}$.
Final Answer: The intensity of transmitted light is $\boxed{I_0/4}$.

Answer: (A)

Q26.

Solution

Concept: The focal length f of a thin lens is given by the lens maker's formula: $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ For an equiconvex lens, $R_1 = R$ and $R_2 = -R$. When cut perpendicularly to the principal axis, it forms two plano-convex lenses with $R_1 = R$ and $R_2 = \infty$.

Solution: Step 1: Focal length of the original equiconvex lens. $\frac{1}{f} = (\mu-1)\left(\frac{1}{R} - \frac{1}{-R}\right) = (\mu-1)\frac{2}{R}$.

Step 2: Focal length f' of one plano-convex half. $\frac{1}{f'} = (\mu - 1)\left(\frac{1}{R} - \frac{1}{\infty}\right) = (\mu - 1)\frac{1}{R}$.

Step 3: Compare both formulas. Notice that $\frac{1}{f'} = \frac{1}{2} \times \frac{1}{f}$. Therefore, $f' = 2f$.

Final Answer: The focal length of each plano-convex half is $\boxed{2f}$.

Answer: (A)

Q27.

Solution

Concept: The critical angle C is related to the refractive index μ of the medium by: $\sin C = \frac{1}{\mu} \implies \mu = \frac{1}{\sin C}$ The velocity of light v in a medium is given by $v = \frac{c}{\mu}$, where c is the speed of light in vacuum.

Solution: Step 1: Find the refractive index of the medium. $C = 30^\circ$ $\mu = \frac{1}{\sin 30^\circ} = \frac{1}{0.5} = 2$.

Step 2: Calculate the velocity of light in the medium. $v = \frac{c}{\mu} = \frac{3\times10^8}{2}$ $v = 1.5 \times 10^8$ m/s.

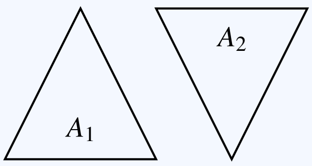
Final Answer: The velocity of light is $\boxed{1.5 \times 10^8 \text{ m/s}}$.

Answer: (A)

Q28.

Solution

Concept: For thin prisms, the angle of deviation is given by $\delta = (\mu - 1)A$. For a combination of two prisms placed oppositely to produce dispersion without deviation, the net deviation must be zero: $\delta_1 + \delta_2 = 0 \implies (\mu_1 - 1)A_1 = (\mu_2 - 1)A_2$ (magnitudes equal).



Solution: Step 1: Identify the given parameters. $\mu_1 = 1.5$, $A_1 = 6^\circ$ $\mu_2 = 1.6$, $A_2 = ?$

Step 2: Apply the condition for zero deviation. $(1.5 - 1) \times 6 = (1.6 - 1) \times A_2$

Step 3: Solve for A_2. $0.5 \times 6 = 0.6 \times A_2$ $3 = 0.6A_2 \implies A_2 = \frac{3}{0.6} = 5^\circ$.

Final Answer: The refracting angle is $\boxed{5^\circ}$.

Answer: (A)

Q29.

Solution

Concept: The root mean square (rms) speed of gas molecules is given by $v_{rms} = \sqrt{\frac{3RT}{M}}$. For a given gas (M is constant), $v_{rms} \propto \sqrt{T}$.

Solution: Step 1: Set up the proportionality for the two states. $\frac{v_2}{v_1} = \sqrt{\frac{T_2}{T_1}}$

Step 2: Substitute the known values. $v_1 = v, T_1 = 300$ K, $v_2 = 2v$. $\frac{2v}{v} = \sqrt{\frac{T_2}{300}}$ $2 = \sqrt{\frac{T_2}{300}}$

Step 3: Square both sides and solve for T_2. $4 = \frac{T_2}{300} \implies T_2 = 4 \times 300 = 1200$ K.

Final Answer: The temperature will be $\boxed{1200 \text{ K}}$.

Answer: (A)

Q30.

Solution

Concept: The efficiency of a Carnot engine is given by $\eta = 1 - \frac{T_2}{T_1}$, where T_1 is source temperature and T_2 is sink temperature in Kelvin. Efficiency is also defined as the ratio of work done to heat supplied: $\eta = \frac{W}{Q_1}$.

Solution: Step 1: Calculate the efficiency of the engine. $T_1 = 600$ K, $T_2 = 300$ K. $\eta = 1 - \frac{300}{600} = 1 - 0.5 = 0.5$.

Step 2: Use efficiency to find the heat supplied. Given $W = 800$ J. $0.5 = \frac{800}{Q_1}$

Step 3: Solve for Q_1. $Q_1 = \frac{800}{0.5} = 1600$ J.

Final Answer: The amount of heat energy supplied is $\boxed{1600 \text{ J}}$.

Answer: (A)

Q31.

Solution

Concept: The de Broglie wavelength λ of a particle is related to its momentum p by the equation $\lambda = \frac{h}{p}$. For a particle accelerated through a potential difference V, kinetic energy $K = qV$, and momentum $p = \sqrt{2mK} = \sqrt{2mqV}$.

Solution: Step 1: Write the proportionality for wavelength. $\lambda = \frac{h}{\sqrt{2mqV}} \implies \lambda \propto \frac{1}{\sqrt{V}}$

Step 2: Calculate the new wavelength when potential is quadrupled ($V' = 4V$). $\lambda' = \frac{h}{\sqrt{2mq(4V)}} = \frac{1}{2}\frac{h}{\sqrt{2mqV}} = \frac{\lambda}{2}$.

Final Answer: The new de Broglie wavelength is $\boxed{\lambda/2}$.

Answer: (A)

Q32.

Solution

Concept: According to Einstein's photoelectric equation: $K_{max} = h\nu - \Phi$ where K_{max} is the maximum kinetic energy, $h\nu$ is the energy of the incident photon, and Φ is the work function.

Solution: Step 1: Identify given values. Incident energy $E = h\nu = 5$ eV. Work function $\Phi = 3$ eV.

Step 2: Calculate maximum kinetic energy. $K_{max} = 5\text{ eV} - 3\text{ eV} = 2\text{ eV}$.

Final Answer: The maximum kinetic energy of the photoelectrons is $\boxed{2\text{ eV}}$.

Answer: (A)

Q33.

Solution

Concept: The radius of the n-th orbit in a hydrogen-like atom is given by: $r_n = 0.529\frac{n^2}{Z}$ Å For a hydrogen atom, $Z = 1$.

Solution: Step 1: Calculate radius for the first orbit ($n = 1$). $r_1 = 0.529\frac{1^2}{1} = 0.529$ Å.

Step 2: Calculate radius for the second orbit ($n = 2$). $r_2 = 0.529\frac{2^2}{1} = 0.529 \times 4 = 2.116$ Å.

Final Answer: The radius of the second Bohr orbit is $\boxed{2.116\text{ Å}}$.

Answer: (A)

Q34.

Solution

Concept: The law of radioactive decay states that the amount of substance remaining after n half-lives is: $N = N_0\left(\frac{1}{2}\right)^n$ where $n = \frac{t}{T_{1/2}}$.

Solution: Step 1: Find the number of half-lives. $T_{1/2} = 5$ days. Total time $t = 15$ days. $n = \frac{15}{5} = 3$.

Step 2: Calculate the remaining fraction. $\frac{N}{N_0} = \left(\frac{1}{2}\right)^3 = \frac{1}{8}$.

Final Answer: The fraction remaining after 15 days is $\boxed{1/8}$.

Answer: (A)

Q35.

Solution

Concept: Binding energy BE is related to mass defect Δm by Einstein's mass-energy equivalence: $BE = \Delta m \times c^2$ In standard nuclear units, 1 amu of mass defect corresponds to 931.5 MeV of energy.

Solution: Step 1: Identify the mass defect. $\Delta m = 0.1$ amu.

Step 2: Convert mass defect to energy. $BE = 0.1 \times 931.5 \text{ MeV} = 93.15 \text{ MeV}$.

Final Answer: The binding energy is $\boxed{93.15 \text{ MeV}}$.

Answer: (A)

Q36.

Solution

Concept: For a semiconductor diode, the reverse bias configuration occurs when the p-type material is connected to the negative terminal of the voltage source and the n-type material is connected to the positive terminal. This widens the depletion region.

Solution: Step 1: Analyze the circuit or node potentials. Let V_p be the potential at the p-side and V_n be the potential at the n-side. Reverse bias condition: $V_p < V_n$.

Step 2: Determine bias based on node potentials. If $V_p = -5$ V and $V_n = 0$ V (ground), then $-5 \text{ V} < 0 \text{ V}$, which satisfies the reverse bias condition.

Final Answer: The condition for reverse bias is $\boxed{V_p < V_n}$.

Answer: (A)

Q37.

Solution

Concept: The current gain α of a transistor in a common-base configuration is related to the current gain β in a common-emitter configuration by the formula: $\beta = \frac{\alpha}{1-\alpha}$

Solution: Step 1: Identify given value. $\alpha = 0.98$.

Step 2: Substitute into the formula. $\beta = \frac{0.98}{1-0.98} = \frac{0.98}{0.02}$

Step 3: Calculate the result. $\beta = 49$.

Final Answer: The common-emitter current gain β is $\boxed{49}$.

Answer: (A)

Q38.

Solution

Concept: The speed of an electromagnetic wave c in a vacuum is given by the ratio of the amplitudes of the electric and magnetic fields: $c = \frac{E_0}{B_0}$

Solution: Step 1: Identify given values. $E_0 = 120$ V/m, $c = 3 \times 10^8$ m/s.

Step 2: Rearrange to solve for B_0. $B_0 = \frac{E_0}{c}$

Step 3: Substitute and compute. $B_0 = \frac{120}{3\times10^8} = 40 \times 10^{-8} = 4 \times 10^{-7}$ T.

Final Answer: The amplitude of the magnetic field is $\boxed{4 \times 10^{-7} \text{ T}}$.

Answer: (A)

Q39.

Solution

Concept: In the electromagnetic spectrum, frequency is inversely proportional to wavelength ($c = f\lambda$). The order of increasing frequency (and decreasing wavelength) is: Radio waves, Microwaves, Infrared, Visible light, Ultraviolet, X-rays, Gamma rays.

Solution: Step 1: Identify the waves given in typical problems. E.g., Microwaves, X-rays, UV rays, Infrared.

Step 2: Arrange by frequency. X-rays have the highest frequency among the given options, followed by UV rays, Infrared, and Microwaves.

Final Answer: The wave with the highest frequency is $\boxed{\text{X-rays}}$.

Answer: (A)

Q40.

Solution

Concept: For constructive interference (maxima) in Young's Double Slit Experiment, the path difference Δx must be an integer multiple of the wavelength: $\Delta x = n\lambda$ (where $n = 0, 1, 2, \ldots$) The corresponding phase difference is $\Delta\phi = \frac{2\pi}{\lambda}\Delta x = 2n\pi$.

Solution: Step 1: Relate path difference to phase difference. If path difference is λ, phase difference is 2π.

Step 2: Check the general condition. A phase difference of an even multiple of π $(0, 2\pi, 4\pi)$ yields a bright fringe.

Final Answer: The phase difference for constructive interference is $\boxed{2n\pi}$.

Answer: (A)

Q41.

Solution

Concept: The escape velocity v_e from the surface of a planet of mass M and radius R is given by: $v_e = \sqrt{\frac{2GM}{R}}$ Since density $\rho = \frac{M}{\frac{4}{3}\pi R^3}$, we can write $M = \frac{4}{3}\pi R^3 \rho$.

Solution: Step 1: Substitute mass in terms of density. $v_e = \sqrt{\frac{2G}{R}\left(\frac{4}{3}\pi R^3 \rho\right)} = \sqrt{\frac{8\pi G \rho R^2}{3}}$

Step 2: Determine proportionality. For a constant density ρ, $v_e \propto R$.

Final Answer: Escape velocity for constant density is proportional to $\boxed{R}$.

Answer: (A)

Q42.

Solution

Concept: According to Kepler's Third Law of Planetary Motion, the square of the time period T of a planet is directly proportional to the cube of the semi-major axis R of its orbit. $T^2 \propto R^3 \implies \frac{T_1^2}{T_2^2} = \frac{R_1^3}{R_2^3}$

Solution: Step 1: Identify the given changes. New radius $R_2 = 4R_1$.

Step 2: Apply the law. $\left(\frac{T_2}{T_1}\right)^2 = \left(\frac{4R_1}{R_1}\right)^3 = 4^3 = 64$.

Step 3: Solve for T_2. $\frac{T_2}{T_1} = \sqrt{64} = 8 \implies T_2 = 8T_1$.

Final Answer: The new time period will be $\boxed{8T}$.

Answer: (A)

Q43.

Solution

Concept: According to Bernoulli's principle, for a horizontal flow of an ideal fluid, the sum of pressure energy and kinetic energy per unit volume is constant: $P + \frac{1}{2}\rho v^2 = \text{constant}$ Where velocity is high, pressure is low, and vice versa.

Solution: Step 1: Apply the equation to two points. $P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$.

Step 2: Relate to the problem. If a pipe narrows, by the equation of continuity ($A_1 v_1 = A_2 v_2$), velocity increases ($v_2 > v_1$). Therefore, pressure must decrease ($P_2 < P_1$).

Final Answer: Where the velocity is maximum, the pressure is $\boxed{\text{Minimum}}$.

Answer: (A)

Q44.

Solution

Concept: According to Stefan-Boltzmann Law, the total energy radiated per unit surface area of a black body per unit time is proportional to the fourth power of its absolute temperature: $E = \sigma T^4$

Solution: Step 1: Formulate the ratio for two different temperatures. $\frac{E_2}{E_1} = \left(\frac{T_2}{T_1}\right)^4$

Step 2: Substitute given values. If temperature is doubled ($T_2 = 2T_1$): $\frac{E_2}{E_1} = \left(\frac{2T_1}{T_1}\right)^4 = 2^4 = 16$.

Final Answer: The energy radiated increases by a factor of $\boxed{16}$.

Answer: (A)

Q45.

Solution

Concept: According to Wien's Displacement Law, the wavelength λ_m corresponding to maximum emission of radiation from a black body is inversely proportional to its absolute temperature T: $\lambda_m T = b$ (Wien's constant)

Solution: Step 1: Set up the equation for two states. $\lambda_{m1}T_1 = \lambda_{m2}T_2$.

Step 2: Substitute the known values. If temperature is doubled, $T_2 = 2T_1$. $\lambda_{m1}T_1 = \lambda_{m2}(2T_1) \implies \lambda_{m2} = \frac{\lambda_{m1}}{2}$.

Final Answer: The peak emission wavelength is $\boxed{\text{Halved}}$.

Answer: (A)

Q46.

Solution

Concept: The kinetic energy is given by $K = \frac{1}{2}mv^2$. When estimating errors, the maximum relative error in a physical quantity expressed as a product/power is the sum of the individual relative errors multiplied by their respective powers. $\frac{\Delta K}{K} = \frac{\Delta m}{m} + 2\frac{\Delta v}{v}$

Solution: Step 1: Identify given percentage errors. Percentage error in mass: $\frac{\Delta m}{m} \times 100 = 2\%$. Percentage error in speed: $\frac{\Delta v}{v} \times 100 = 3\%$.

Step 2: Calculate maximum percentage error in kinetic energy. $\%\Delta K = 2\% + 2 \times (3\%) = 2\% + 6\% = 8\%$.

Final Answer: The maximum percentage error in kinetic energy is $\boxed{8\%}$.

Answer: (A)

Q47.

Solution

Concept: Newton's law of universal gravitation is $F = G\frac{m_1 m_2}{r^2}$. To find the dimensional formula of the universal gravitational constant G, we rearrange the formula: $G = \frac{F \cdot r^2}{m_1 m_2}$

Solution: Step 1: Write down the dimensional formulas for the constituent quantities. Force $F = [M^1 L^1 T^{-2}]$ Distance squared $r^2 = [L^2]$ Mass squared $m_1 m_2 = [M^2]$

Step 2: Substitute these into the rearranged equation. $[G] = \frac{[M^1 L^1 T^{-2}][L^2]}{[M^2]}$

Step 3: Simplify the expression. $[G] = [M^{1-2} L^{1+2} T^{-2}] = [M^{-1} L^3 T^{-2}]$.

Final Answer: The dimensional formula is $\boxed{[M^{-1} L^3 T^{-2}]}$.

Answer: (A)

Q48.

Solution

Concept: In digital electronics, logic gates have specific truth tables relating input and output: - OR Gate: Output is 1 if *any* input is 1. - AND Gate: Output is 1 *only* if *all* inputs are 1. - NOR/NAND Gates: Inverse of OR and AND gates.

Solution: Step 1: Analyze the given condition. The problem states that output $Y = 1$ is obtained *only* when both $A = 1$ and $B = 1$.

Step 2: Match with standard logic gates. This strictly defines the logical multiplication function ($Y = A \cdot B$), which corresponds to the truth table of a 2-input AND gate.

Final Answer: The logic circuit represents an $\boxed{\text{AND gate}}$.

Answer: (A)

Q49.

Solution

Concept: An extrinsic semiconductor is formed by doping an intrinsic semiconductor. - **n-type:** Doped with pentavalent impurities (e.g., Phosphorus, Arsenic). These atoms have 5 valence electrons, donating 1 extra electron to the crystal lattice. Hence, electrons become the majority charge carriers. - **p-type:** Doped with trivalent impurities (e.g., Boron, Gallium). These create "holes" (electron deficiencies), making holes the majority carriers.

Solution: Step 1: Identify the characteristics of an n-type semiconductor. The "n" stands for negative, indicating that the majority carriers are negatively charged electrons. To provide these extra electrons, the dopant atoms must have more valence electrons than the base material (Silicon/Germanium, which have 4). Thus, pentavalent atoms are used.

Final Answer: $\boxed{\text{Electrons are majority carriers and pentavalent atoms are dopants.}}$

Answer: (B)

Q50.

Solution

Concept: In amplitude modulation (AM), the modulation index μ (or m) is defined as the ratio of the peak voltage of the message (modulating) signal to the peak voltage of the carrier signal. $\mu = \frac{A_m}{A_c}$ where A_m is the amplitude of the message signal and A_c is the amplitude of the carrier signal.

Solution: Step 1: Identify the given values from the problem statement. Message signal peak voltage, $A_m = 10$ V. Carrier signal peak voltage, $A_c = 20$ V. (Note: the frequencies 10 kHz and 1 MHz are not needed for calculating the modulation index).

Step 2: Calculate the modulation index. $\mu = \frac{10}{20} = 0.5$.

Final Answer: The modulation index is $\boxed{0.5}$.

Answer: (A)

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	A	3	A	4	A	5	A
6	A	7	A	8	B	9	A	10	A
11	D	12	A	13	A	14	B	15	A
16	A	17	A	18	A	19	A	20	A
21	A	22	A	23	A	24	A	25	A
26	A	27	A	28	A	29	A	30	A
31	A	32	A	33	A	34	A	35	A
36	A	37	A	38	A	39	A	40	A
41	A	42	A	43	A	44	A	45	A
46	A	47	A	48	A	49	B	50	A