Rajasthan JET Physics Sample Paper-6

Duration: 40 Minutes **Maximum Marks: 160**

Instructions

- This paper contains **40** Multiple Choice Questions (Single Correct).
- Each correct answer carries **+4 marks**.
- Each incorrect answer carries: **−1 marks**.
- Use of mobile phones, smartwatches, calculators, or any electronic gadgets is strictly prohibited.

Q1. A wire of length L and radius r is clamped at one end. When a stretching force F is applied to the other end, its elongation is l. If another wire of the same material but of length $2L$ and radius $2r$ is stretched by a force $2F$, the elongation will be:

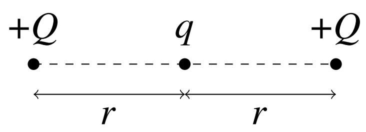
(A) l

(B) $2l$

(C) $\frac{l}{2}$

(D) $4l$

Q2. A charge q is placed at the center of the line joining two exactly equal positive charges Q. The system of three charges will be in equilibrium if q is equal to:



(A) $-\frac{Q}{4}$

(B) $+\frac{Q}{4}$

(C) $-\frac{Q}{2}$

(D) $+\frac{Q}{2}$

Q3. The fundamental frequency of a closed organ pipe is equal to the first overtone of an open organ pipe. If the length of the open pipe is 60 cm, what is the length of the closed organ pipe?

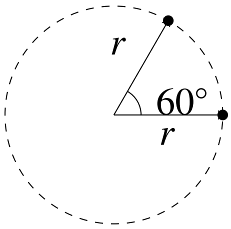
(A) 15 cm

(B) 10 cm

(C) 7.5 cm

(D) 30 cm

Q4. A particle moves along a circular path of radius r with a uniform speed v. What is the magnitude of the average acceleration of the particle when it travels through an angle of 60°?



(A) $\frac{v^2}{r}$

(B) $\frac{3v^2}{\pi r}$

(C) $\frac{3v^2}{2\pi r}$

(D) $\frac{3v^2}{\text{hr}}$

Q5. If the percentage error in the measurement of the radius of a sphere is 2%, then the maximum percentage error in the estimation of its volume will be:

(A) 2%

(B) 4%

(C) 6%

(D) 8%

Q6. Two absolute temperatures T_1 and T_2 are such that $T_1 = 300$ K and $T_2 = 400$ K. An ideal gas undergoes an isothermal expansion at T_1 and then an adiabatic expansion until its temperature drops to T_2. If the work done in the isothermal process is W, the change in internal energy during the adiabatic process for one mole of a monoatomic gas is:

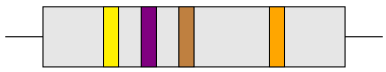
(A) $-\frac{3}{2}R(100)$

(B) $\frac{3}{2}R(100)$

(C) $-R(100)$

(D) W

Q7. A carbon resistor has colored bands in the order of Yellow, Violet, Brown, and Gold. The resistance of the resistor is:



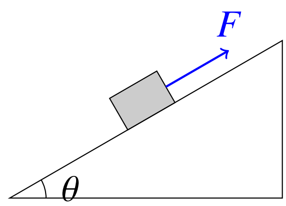
(A) $470\ \Omega \pm 5\%$

(B) $47\ \Omega \pm 10\%$

(C) $4.7\ \Omega \pm 5\%$

(D) $470\ \Omega \pm 10\%$

Q8. A body of mass m is hauled up a rough inclined plane making an angle θ with the horizontal by a force acting parallel to the plane. If the coefficient of friction is μ, the work done by the applied force in pulling the body through a distance s up the incline with a constant velocity is:



(A) $mgs(\sin\theta + \mu\cos\theta)$

(B) $mgs(\sin\theta - \mu\cos\theta)$

(C) $\mu mgs\cos\theta$

(D) $mgs\sin\theta$

Q9. In a Young's double-slit experiment, the slit separation is doubled and the distance between the slits and the screen is halved. The fringe width becomes:

(A) Two times

(B) Four times

(C) One-fourth

(D) Half

Q10. The work function of a certain metal is 4.2 eV. If radiation of wavelength 330 nm falls on this metal, the maximum kinetic energy of the emitted photoelectrons will be approximately:

(A) 0.56 eV

(B) No photoemission occurs

(C) 3.76 eV

(D) 1.24 eV

Q11. A body weighs 72 N on the surface of the Earth. What is the gravitational force on it at a height equal to half the radius of the Earth?

(A) 32 N

(B) 48 N

(C) 36 N

(D) 16 N

Q12. At what temperature is the root mean square speed of hydrogen gas molecules equal to that of oxygen gas molecules at 47°C?

(A) 20 K

(B) 80 K

(C) -253°C

(D) 40 K

Q13. In a common-emitter transistor amplifier, the audio signal voltage across the collector resistance of 2 kΩ is 2 V. If the current amplification factor (β) is 100 and the base resistance is 1 kΩ, the input signal voltage is:

(A) 10 mV

(B) 20 mV

(C) 30 mV

(D) 15 mV

Q14. A particle is moving with a constant speed along a straight line. A constant force begins to act on it in a direction perpendicular to its velocity. The path of the particle will now be:

(A) Parabolic

(B) Circular

(C) Hyperbolic

(D) Straight line inclined to the original direction

Q15. A convex lens of focal length 20 cm in air is immersed completely in water ($\mu = 4/3$). If the refractive index of glass is 1.5, its focal length in water will be:

(A) 20 cm

(B) 40 cm

(C) 80 cm

(D) 10 cm

Q16. The magnetic flux linked with a coil satisfies the relation $\Phi = (3t^2 + 4t + 9)$ Wb. The induced electromotive force in the coil at $t = 2$ seconds is:

(A) 16 V

(B) 29 V

(C) 10 V

(D) 20 V

Q17. A solid sphere, a disc, and a thin ring, all of the same mass and radius, are allowed to roll down a rough inclined plane from the same height without slipping. Which object reaches the bottom of the incline first?

(A) Solid sphere

(B) Disc

(C) Thin ring

(D) All reach at the same time

Q18. Two water droplets of equal radius r coalesce to form a single larger drop of radius R. In this process:

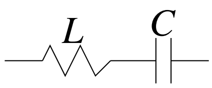
(A) Energy is liberated

(B) Energy is absorbed

(C) Temperature drops

(D) No change in energy occurs

Q19. An alternating current circuit contains an inductor of inductance L and a capacitor of capacitance C connected in series. If the resonant frequency is f, then the value of f is given by:



(A) $\frac{1}{2\pi\sqrt{LC}}$

(B) $\frac{1}{\sqrt{LC}}$

(C) $2\pi\sqrt{LC}$

(D) $\frac{\sqrt{LC}}{2\pi}$

Q20. A bullet of mass 10 g leaves a rifle barrel of length 1 m with a speed of 300 m/s. Assuming the acceleration to be uniform, the average force exerted on the bullet by the expanding gases is:

(A) 450 N

(B) 900 N

(C) 45 N

(D) 90 N

Q21. The half-life of a radioactive sample is 5 years. The time taken for the activity of this sample to decay to 6.25% of its initial value is:

(A) 15 years

(B) 20 years

(C) 25 years

(D) 10 years

Q22. An ideal gas heat engine operates in a Carnot cycle between 227°C and 127°C. It absorbs 6×10^4 cal of heat at the higher temperature. The amount of heat converted into useful work is:

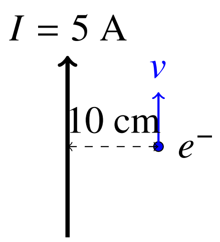
(A) 1.2×10^4 cal

(B) 4.8×10^4 cal

(C) 3.5×10^4 cal

(D) 2.4×10^4 cal

Q23. A long straight wire carries a current of 5 A. An electron is moving parallel to the wire at a distance of 10 cm from it with a speed of 10^5 m/s in the direction of the current. The magnitude of the magnetic force experienced by the electron is:



(A) 1.6×10^{-19} N

(B) 3.2×10^{-19} N

(C) 1.6×10^{-20} N

(D) Zero

Q24. A particle executing simple harmonic motion has a maximum velocity v_0 and a maximum acceleration a_0. The amplitude of its motion is given by:

(A) $\frac{v_0^2}{a_0}$

(B) $\frac{a_0^2}{v_0}$

(C) $\frac{v_0}{a_0}$

(D) $v_0 a_0$

Q25. A body moves along a straight line with a uniform acceleration. It covers a distance of 20 m in the 2^{nd} second and 40 m in the 4^{th} second of its motion. Its initial velocity was:

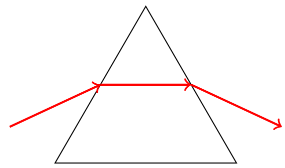
(A) 10 m/s

(B) 5 m/s

(C) 15 m/s

(D) 1 m/s

Q26. A ray of light passes through an equilateral glass prism such that the angle of incidence is equal to the angle of emergence. If the angle of emergence is 3/4 of the angle of the prism, the angle of deviation is:



(A) 30°

(B) 45°

(C) 60°

(D) 15°

Q27. Three capacitors each of capacitance 3 μF are connected in such a way that the resultant capacitance is 4.5 μF. This can be achieved by connecting:

(A) All three in series

(B) All three in parallel

(C) Two in series and one in parallel with them

(D) Two in parallel and one in series with them

Q28. According to Bohr's model, the relation between the principal quantum number n and the radius r of a stationary orbit of a hydrogen atom is:

(A) $r \propto n$

(B) $r \propto n^2$

(C) $r \propto \frac{1}{n}$

(D) $r \propto \frac{1}{n^2}$

Q29. A constant torque of 1000 N · m turns a wheel of moment of inertia 200 kg · m^2 about its central axis. The angular velocity gained by the wheel after 3 seconds starting from rest is:

(A) 15 rad/s

(B) 30 rad/s

(C) 5 rad/s

(D) 10 rad/s

Q30. In a plane electromagnetic wave, the electric field oscillates sinusoidally with an amplitude of 48 V/m. The amplitude of the oscillating magnetic field component of the wave is:

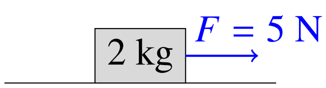
(A) 1.6×10^{-7} T

(B) 1.6×10^{-8} T

(C) 4.8×10^{-7} T

(D) 2.4×10^{-8} T

Q31. A block of mass 2 kg rests on a rough horizontal floor. The coefficient of static friction between the block and the floor is 0.4. A horizontal force of 5 N is applied to the block. The frictional force acting on the block is (take $g = 10$ m/s^2):



(A) 8 N

(B) 5 N

(C) 2 N

(D) Zero

Q32. When an unpolarized light beam of intensity I_0 is passed through a perfect polarizing sheet, the intensity of the transmitted light becomes:

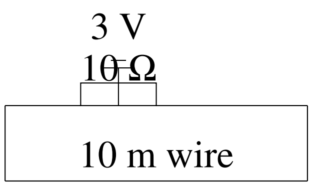
(A) I_0

(B) $\frac{I_0}{2}$

(C) $\frac{I_0}{4}$

(D) Zero

Q33. A potentiometer wire of length 10 m has a resistance of 20 Ω. It is connected in series with a battery of emf 3 V and a negligible internal resistance along with a subscription resistor of 10 Ω. The potential gradient along the wire is:



(A) 0.2 V/m

(B) 0.1 V/m

(C) 0.3 V/m

(D) 0.02 V/m

Q34. Two bodies of masses 1 kg and 4 kg possess equal kinetic energies. The ratio of the magnitudes of their linear momenta is:

(A) 1 : 2

(B) 1 : 4

(C) 2 : 1

(D) 4 : 1

Q35. The displacement of a particle taking part in a wave motion is given by $y = 0.5\sin(10\pi t - 0.1\pi x)$, where x and y are in meters and t is in seconds. The wave velocity is:

(A) 10 m/s

(B) 100 m/s

(C) 50 m/s

(D) 5 m/s

Q36. In a p-type semiconductor, the majority charge carriers are:

(A) Electrons

(B) Holes

(C) Positive ions

(D) Neutrons

Q37. A vector $\vec{A}$ points vertically upwards and another vector $\vec{B}$ points towards the North. The vector product $\vec{A} \times \vec{B}$ points along which direction?

(A) West

(B) East

(C) South

(D) Vertically downwards

Q38. If a thermodynamic system undergoes a process in which its volume remains constant, the process is called:

(A) Isothermal

(B) Isobaric

(C) Isochoric

(D) Adiabatic

Q39. An electric dipole with dipole moment p is placed oriented parallel to a uniform electric field E. The work done in rotating the dipole through an angle of 180° from its initial position is:

(A) pE

(B) $2pE$

(C) $-2pE$

(D) Zero

Q40. The dimensional formula for the universal gravitational constant G is:

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

(B) $[ML^{2}T^{-2}]$

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

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

Detailed Solutions

Q1.

Solution

Concept:

The elongation produced in a wire under an axial stretching force depends on Young's modulus of the material, the length of the wire, and its cross-sectional area. Young's modulus Y is defined as the ratio of tensile stress to tensile strain:

$$Y = \frac{\text{Stress}}{\text{Strain}} = \frac{F/A}{l/L} = \frac{FL}{Al}$$

where F is the applied force, L is the original length, $A = \pi r^2$ is the cross-sectional area for a wire of radius r, and l is the elongation. Since both wires are made of the identical material, their Young's modulus values must be exactly equal. We can rearrange the formula to express elongation explicitly as a function of the geometric dimensions and the applied force:

$$l = \frac{FL}{\pi r^2 Y}$$

By setting up a ratio between the initial state and the modified state, we can determine the new elongation.

Solution:

Step 1: Write down the expression for the initial elongation l of the first wire using its given parameters:

$$l = \frac{FL}{\pi r^2 Y}$$

Step 2: Identify the modified parameters for the second wire as specified in the problem statement. The new stretching force is $F' = 2F$, the new length is $L' = 2L$, and the new radius is $r' = 2r$.

Step 3: Substitute these newly defined parameters into the general elongation equation to find the expression for the second elongation l':

$$l' = \frac{F'L'}{\pi (r')^2 Y} = \frac{(2F)(2L)}{\pi (2r)^2 Y}$$

Step 4: Expand the denominator and simplify the mathematical fraction by canceling out the common numerical factors in the numerator and the denominator:

$$l' = \frac{4FL}{\pi (4r^2) Y} = \frac{4FL}{4\pi r^2 Y} = \frac{FL}{\pi r^2 Y}$$

Step 5: Compare the simplified expression for l' with the original equation derived in Step 1. We clearly observe that l' is completely identical to l. Thus, the total elongation remains completely unchanged.

Final Answer: l

Answer: (A)

Go Back to Question 1

Q2.

Solution

Concept:

For a system of multiple stationary point charges to be in electrostatic equilibrium, the net electrostatic force acting on each and every individual charge in the system must be precisely equal to zero. According to Coulomb's Law, the electrostatic force between any two point charges separated by a distance d is given by:

$$F = \frac{kq_1q_2}{d^2}$$

where $k = \frac{1}{4\pi\varepsilon_0}$ is the electrostatic constant. Since the middle charge q is situated exactly halfway between two identical positive charges $+Q$, the opposing forces exerted on q by both outer charges are inherently equal in magnitude and opposite in direction, ensuring that q is automatically in equilibrium for any real value of q. Therefore, to find the specific value of q, we must apply the equilibrium condition to one of the outer identical charges $+Q$ and solve the resulting force equation.

Solution: Step 1: Define the coordinates of the charges along a straight horizontal line. Let the first charge $+Q$ be located at the origin $x = 0$, the unknown central charge q be at $x = r$, and the second identical charge $+Q$ be located at $x = 2r$. Step 2: Formulate the total net electrostatic force acting on the outer charge located at $x = 2r$. This net force is the vector sum of the force exerted by the central charge q and the force exerted by the other outer charge $+Q$:

$$F_{\text{net}} = F_q + F_Q$$

Step 3: Write out the explicit algebraic expressions for each individual force component using Coulomb's law:

$$F_q = \frac{kQq}{r^2} \quad \text{and} \quad F_Q = \frac{kQQ}{(2r)^2} = \frac{kQ^2}{4r^2}$$

Step 4: Set the expression for the total net force to zero to enforce the necessary condition for complete system equilibrium:

$$\frac{kQq}{r^2} + \frac{kQ^2}{4r^2} = 0$$

Step 5: Factor out and cancel the non-zero common terms $\frac{kQ}{r^2}$ from the algebraic equation to solve directly for the unknown value of q:

$$q + \frac{Q}{4} = 0 \implies q = -\frac{Q}{4}$$

The negative sign indicates that the central charge must be negative to provide an attractive force that balances the mutual repulsion of the outer positive charges.

Final Answer: $\boxed{-\frac{Q}{4}}$

Answer: (A)

Go Back to Question 2

Q3.

Solution

Concept:
Sound waves traveling inside acoustic pipes form standing wave patterns governed by boundary conditions. An open organ pipe is open at both ends, creating displacement antinodes at both openings. The fundamental frequency of an open organ pipe is given by $f_{\text{open}} = \frac{v}{2L_o}$, and its successive harmonics or overtones are integer multiples of this base frequency. The first overtone of an open pipe corresponds to its second harmonic ($n = 2$). A closed organ pipe has one end closed and one end open, creating a displacement node at the boundary wall and an antinode at the mouth. A closed pipe only produces odd harmonics, and its fundamental frequency is given by $f_{\text{closed}} = \frac{v}{4L_c}$. By equating the specified frequency expressions, we can solve for the unknown length.

Solution: Step 1: Write down the general formula for the first overtone of an open organ pipe. The first overtone is the second harmonic, so we multiply the fundamental frequency by two:

$$f_{\text{open, 1st overtone}} = 2 \times \left(\frac{v}{2L_o}\right) = \frac{v}{L_o}$$

where v is the speed of sound in air and $L_o = 60$ cm is the length of the open pipe. Step 2: Write down the mathematical expression for the fundamental frequency of the closed organ pipe:

$$f_{\text{closed, fundamental}} = \frac{v}{4L_c}$$

where L_c is the unknown length of the closed pipe. Step 3: Set these two frequencies equal to each other as dictated by the problem criteria:

$$\frac{v}{4L_c} = \frac{v}{L_o}$$

Step 4: Cancel the speed of sound v from both sides of the relation, leaving a simple geometric proportion between the lengths:

$$\frac{1}{4L_c} = \frac{1}{L_o} \implies L_o = 4L_c$$

Step 5: Substitute the given value of the open pipe length ($L_o = 60$ cm) into the equation and solve for L_c:

$$60 = 4L_c \implies L_c = \frac{60}{4} = 15 \text{ cm}$$

Final Answer: 15 cm

Answer: (A)

Go Back to Question 3

Q4.

Solution

Concept:

Average acceleration $\vec{a}_{\text{avg}}$ is defined as the change in the velocity vector $\Delta\vec{v}$ divided by the total time interval Δt taken to undergo that change:

$$\vec{a}_{\text{avg}} = \frac{\Delta\vec{v}}{\Delta t} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$$

In uniform circular motion, the speed v remains perfectly constant, but the direction of the velocity vector continuously rotates. When a particle turns through a central angle θ, the magnitude of the change in its velocity vector can be determined geometrically using vector subtraction:

$$|\Delta\vec{v}| = 2v\sin\left(\frac{\theta}{2}\right)$$

The time interval Δt can be calculated by dividing the arc distance traveled along the circle by the constant tangential speed v. Combining these relations yields the average acceleration magnitude.

Solution: Step 1: Calculate the magnitude of the change in velocity vector for a turning angle $\theta = 60^\circ$. Convert the angle or use the geometric formula directly:

$$|\Delta\vec{v}| = 2v\sin\left(\frac{60^\circ}{2}\right) = 2v\sin(30^\circ) = 2v \times \frac{1}{2} = v$$

Step 2: Determine the total time interval Δt required to travel across this arc. The angular displacement in radians is $\theta = 60^\circ \times \frac{\pi}{180^\circ} = \frac{\pi}{3}$ rad. The linear arc distance is $s = r\theta = \frac{\pi r}{3}$. Therefore, the time is:

$$\Delta t = \frac{s}{v} = \frac{\pi r}{3v}$$

Step 3: Set up the formula for the magnitude of the average acceleration vector by substituting the results of the change in velocity and the elapsed time:

$$|\vec{a}_{\text{avg}}| = \frac{|\Delta\vec{v}|}{\Delta t} = \frac{v}{\left(\frac{\pi r}{3v}\right)}$$

Step 4: Simplify the complex algebraic fraction by moving the term $3v$ from the denominator up into the numerator:

$$|\vec{a}_{\text{avg}}| = \frac{3v^2}{\pi r}$$

Final Answer: $\boxed{\frac{3v^2}{\pi r}}$

Answer: (B)

Go Back to Question 4

Q5.

Solution

Concept:
The theory of errors dictates that when a derived physical quantity is calculated from an experimental measurement raised to a power, the relative fractional error in the calculated quantity is equal to the power multiplied by the relative fractional error of the measured independent variable. The geometric volume V of a perfectly spherical body is related to its radius r by the standard formula:

$$V = \frac{4}{3}\pi r^3$$

Since the coefficient $\frac{4}{3}\pi$ is a pure mathematical constant, it introduces zero experimental uncertainty or error. Taking the natural logarithm on both sides of the equation and differentiating gives the relative fractional error relationship. Multiplying by 100 converts this relationship into a direct proportion between maximum percentage errors.

Solution: Step 1: State the algebraic function relating the volume of a sphere to its radius:

$$V = \frac{4}{3}\pi r^3$$

Step 2: Take the natural logarithm (ln) on both sides of the equation to isolate the powers as coefficients:

$$\ln(V) = \ln\left(\frac{4}{3}\pi\right) + \ln(r^3) = \ln\left(\frac{4}{3}\pi\right) + 3\ln(r)$$

Step 3: Differentiate the equation to obtain the relationship between the small fractional changes (relative errors):

$$\frac{dV}{V} = 0 + 3\frac{dr}{r} \implies \frac{\Delta V}{V} = 3\frac{\Delta r}{r}$$

Step 4: Convert the fractional error relationship into a percentage error expression by multiplying both sides of the equation by 100%:

$$\left(\frac{\Delta V}{V} \times 100\%\right) = 3 \times \left(\frac{\Delta r}{r} \times 100\%\right)$$

Step 5: Substitute the given value for the maximum percentage error in the radius measurement, which is $\frac{\Delta r}{r} \times 100\% = 2\%$, into our formula:

$$\text{Percentage Error in Volume} = 3 \times 2\% = 6\%$$

Final Answer: 6%

Answer: (C)

Go Back to Question 5

Q6.

Solution

Concept:

Internal energy U of an ideal gas is a state function, meaning its value depends solely on the current state parameters (primarily temperature) and is entirely independent of the specific thermodynamic path taken to reach that state. For n moles of a ideal gas, the change in internal energy ΔU during any process is given by:

$$\Delta U = nC_v\Delta T$$

where C_v is the molar specific heat capacity at constant volume. For a monoatomic gas, the molecules possess three translational degrees of freedom, which means $C_v = \frac{3}{2}R$. The problem explicitly outlines an adiabatic cooling step from an initial temperature $T_1 = 300$ K to a final temperature $T_2 = 400$ K. We can directly compute ΔU using the temperature values, independent of the work done in the preceding isothermal process.

Solution:

Step 1: Identify the properties of the gas and the parameters of the adiabatic expansion. The gas is monoatomic, so its molar heat capacity at constant volume is $C_v = \frac{3}{2}R$. The number of moles is $n = 1$.

Step 2: Note the initial and final temperatures of the adiabatic process. The gas starts the adiabatic process at temperature $T_1 = 300$ K and ends at temperature $T_2 = 400$ K.

Step 3: Set up the formula for the change in internal energy during this process:

$$\Delta U = nC_v(T_2 - T_1)$$

Step 4: Substitute the numerical values of the temperatures and the value of C_v into the equation:

$$\Delta U = 1 \times \left(\frac{3}{2}R\right) \times (400 - 300)$$

Step 5: Simplify the terms inside the parentheses to find the final expression for the change in internal energy:

$$\Delta U = \frac{3}{2}R(100)$$

Since the temperature increases from 300 K to 400 K, the internal energy change is positive.

Final Answer: $\boxed{\frac{3}{2}R(100)}$

Answer: (B)

Go Back to Question 6

Q7.

Solution

Concept:
The resistance value of a standard carbon composition resistor is determined using an industry color code system consisting of four distinct colored bands. The standard color code sequence for digits 0 through 9 follows the mnemonic "BBROY Great Britain Very Good Wife", which translates to: Black (0), Brown (1), Red (2), Orange (3), Yellow (4), Green (5), Blue (6), Violet (7), Gray (8), White (9). The first band represents the first significant digit, the second band represents the second significant digit, the third band denotes the decimal multiplier (10^n), and the fourth band indicates the manufacturing tolerance percentage (Gold is $\pm 5\%$, Silver is $\pm 10\%$, and No Band is $\pm 20\%$).

Solution:
Step 1: Match the first colored band, which is Yellow, to its corresponding numeric value in the standard color table. Yellow corresponds to the digit 4.
Step 2: Match the second colored band, which is Violet, to its corresponding numeric value. Violet corresponds to the digit 7. Combining the first two digits gives the value 47.
Step 3: Match the third colored band, which is Brown, to its multiplier exponent. Brown corresponds to the digit 1, which means the multiplier factor is $10^1 = 10$.
Step 4: Calculate the base nominal resistance by multiplying the two-digit number by the multiplier factor:

$$R = 47 \times 10^1 = 470\ \Omega$$

Step 5: Identify the fourth colored band, which is Gold, to find the manufacturing tolerance. Gold corresponds to an allowable tolerance of $\pm 5\%$. Combining all parts, the total resistance value is written as $470\ \Omega \pm 5\%$.

Final Answer: $470\ \Omega \pm 5\%$

Answer: (A)

Go Back to Question 7

Q8.

Solution

Concept:

When an object is moved up a rough inclined plane at a perfectly constant velocity, the net acceleration is zero, which implies that the total net force acting parallel to the incline must balance exactly to zero. The forces acting down the incline along the surface are the component of gravity pulling the block down, given by $mg\sin\theta$, and the kinetic friction force opposing the upward motion, given by $f_k = \mu N$. The normal force N pressing perpendicular to the incline is balanced by the perpendicular component of gravity, so $N = mg\cos\theta$. The total applied force F pulling up the plane must equal the sum of these downward forces. The work done by this applied force over a displacement s is $W = F \cdot s$.

Solution:

Step 1: Resolve the gravitational force acting on the mass m into components parallel and perpendicular to the inclined plane surface. The perpendicular component is $mg\cos\theta$ and the parallel component is $mg\sin\theta$.

Step 2: Calculate the normal force acting on the object, which balances the perpendicular component of gravity:

$$N = mg\cos\theta$$

Step 3: Express the kinetic friction force acting down the plane to oppose the upward motion:

$$f_k = \mu N = \mu mg\cos\theta$$

Step 4: Set up the force balance equation along the parallel axis of the incline. Since velocity is constant, the upward pulling force F must exactly balance the total downward forces:

$$F = mg\sin\theta + f_k = mg\sin\theta + \mu mg\cos\theta = mg(\sin\theta + \mu\cos\theta)$$

Step 5: Calculate the work done by multiplying this constant applied force F by the total displacement distance s along the incline:

$$W = F \cdot s = mgs(\sin\theta + \mu\cos\theta)$$

Final Answer: $mgs(\sin\theta + \mu\cos\theta)$

Answer: (A)

Go Back to Question 8

Q9.

Solution

Concept:
In a standard Young's Double Slit Experiment (YDSE), light waves emerging from two coherent slits interfere to form a pattern of alternating bright and dark fringes on a distant screen. The physical width of a single interference fringe β (the distance between two consecutive bright or dark fringes) is determined by the wavelength of the light λ, the distance between the slits and the screen D, and the separation distance between the two slits d, according to the formula:

$$\beta = \frac{\lambda D}{d}$$

By establishing a ratio between the initial fringe width β and the final fringe width β' after changing the geometric parameters D and d, we can easily determine how the size of the pattern scales.

Solution:
Step 1: Write down the original relationship for the fringe width before any modifications are made:

$$\beta = \frac{\lambda D}{d}$$

Step 2: Identify the modified parameters given in the problem statement. The slit separation is doubled, meaning the new distance is $d' = 2d$. The distance from the slits to the viewing screen is cut in half, meaning $D' = \frac{D}{2}$. The wavelength λ remains constant.
Step 3: Substitute these modified terms into the expression for the new fringe width β':

$$\beta' = \frac{\lambda D'}{d'} = \frac{\lambda\left(\frac{D}{2}\right)}{2d}$$

Step 4: Simplify the algebraic fraction by combining the numerical constants in the denominator:

$$\beta' = \frac{\lambda D}{4d} = \frac{1}{4}\left(\frac{\lambda D}{d}\right)$$

Step 5: Substitute the original fringe width β back into the simplified expression:

$$\beta' = \frac{\beta}{4}$$

Therefore, the fringe width becomes exactly one-fourth of its original value.

Final Answer: One-fourth

Answer: (C)

Go Back to Question 9

Q10.

Solution

Concept:
According to Einstein's photoelectric equation, the maximum kinetic energy $K_{\max}$ of emitted photoelectrons is equal to the energy of the incident photon E minus the work function ϕ of the metallic surface:

$$K_{\max} = E - \phi$$

The energy E of an incident photon of wavelength λ can be calculated using Planck's constant h and the speed of light c:

$$E = \frac{hc}{\lambda}$$

A convenient shortcut formula for calculating photon energy in electron-volts (eV) when the wavelength is given in nanometers (nm) is $E \approx \frac{1240}{\lambda\,(\text{nm})}$. If the computed energy of the incident photon turns out to be strictly less than the work function (ϕ), then the photons do not possess enough energy to dislodge electrons, and no photoelectric emission will take place.

Solution:
Step 1: Calculate the energy of the incident photon using the wavelength $\lambda = 330$ nm with our shortcut formula:

$$E = \frac{1240}{330} \approx 3.76 \text{ eV}$$

Step 2: Identify the work function of the target metal from the problem statement, which is given as $\phi = 4.2$ eV.
Step 3: Compare the calculated photon energy E to the work function ϕ. We observe that:

$$E = 3.76 \text{ eV} < \phi = 4.2 \text{ eV}$$

Step 4: Analyze the physical implication of this inequality. Because the energy of each incoming photon is lower than the minimum energy required to liberate an electron from the metal surface, electrons cannot overcome the potential barrier.
Step 5: Conclude that no photoelectric emission occurs, meaning the kinetic energy cannot be defined as a positive value and no current flows.

Final Answer: No photoemission occurs

Answer: (B)

Go Back to Question 10

Q11.

Solution

Concept:

The weight of a body is the gravitational force exerted on it by the Earth. The acceleration due to gravity g_h at an altitude h above the Earth's surface is modified due to the increased distance from the center of mass of the Earth. The precise formula relating gravity at a height h to gravity at the surface g is:

$$g_h = \frac{g}{\left(1 + \frac{h}{R}\right)^2}$$

where R is the radius of the Earth. Multiplying both sides of this equation by the mass m of the object gives a direct expression for the gravitational force (weight) W_h at that altitude as a function of its surface weight W:

$$W_h = \frac{W}{\left(1 + \frac{h}{R}\right)^2}$$

Solution:

Step 1: Note the given parameters. The weight of the object on the Earth's surface is $W = 72$ N. The altitude is defined as half the Earth's radius, so $h = \frac{R}{2}$. Step 2: Substitute the value of h into the algebraic expression inside the denominator:

$$1 + \frac{h}{R} = 1 + \frac{\frac{R}{2}}{R} = 1 + \frac{1}{2} = \frac{3}{2}$$

Step 3: Square this term to find the scaling factor for the denominator of the gravity formula:

$$\left(1 + \frac{h}{R}\right)^2 = \left(\frac{3}{2}\right)^2 = \frac{9}{4}$$

Step 4: Set up the weight equation at height h by substituting the calculated scaling factor and the original surface weight:

$$W_h = \frac{72}{\frac{9}{4}} = 72 \times \frac{4}{9}$$

Step 5: Perform the numerical simplification to find the final force value:

$$W_h = 8 \times 4 = 32 \text{ N}$$

Final Answer: 32 N

Answer: (A)

Go Back to Question 11

Q12.

Solution

Concept:

According to the kinetic theory of gases, the root mean square (rms) speed v_{rms} of the molecules of an ideal gas is directly proportional to the square root of its absolute temperature T (in Kelvin) and inversely proportional to the square root of its molar mass M:

$$v_{rms} = \sqrt{\frac{3RT}{M}}$$

where R is the universal gas constant. For the rms speed of two different gases to be perfectly equal, their individual ratios of absolute temperature to molar mass must be equal:

$$\frac{T_1}{M_1} = \frac{T_2}{M_2}$$

We must ensure that all temperatures are converted into Kelvin before performing calculations.

Solution:

Step 1: Identify the given values and convert the Celsius temperature of oxygen into Kelvin. The temperature of oxygen is given as $t_2 = 47°C$:

$$T_2 = 47 + 273 = 320 \text{ K}$$

Step 2: State the molar masses for both gas species. The molar mass of hydrogen gas (H_2) is $M_1 = 2$ g/mol, and the molar mass of oxygen gas (O_2) is $M_2 = 32$ g/mol.

Step 3: Equate the two rms speed equations, which simplifies to equating their temperature-to-mass ratios:

$$\frac{T_{hydrogen}}{M_{hydrogen}} = \frac{T_{oxygen}}{M_{oxygen}} \implies \frac{T_1}{2} = \frac{320}{32}$$

Step 4: Simplify the right side of the equation and solve for the absolute temperature T_1 of the hydrogen gas:

$$\frac{T_1}{2} = 10 \implies T_1 = 20 \text{ K}$$

Final Answer: 20 K

Answer: (A)

Go Back to Question 12

Q13.

Solution

Concept:

In a common-emitter (CE) transistor configuration, the voltage gain A_v is defined as the ratio of the output signal voltage drop across the collector resistor (V_{out}) to the input alternating voltage applied at the base (V_{in}):

$$A_v = \frac{V_{out}}{V_{in}}$$

The voltage gain can also be expressed as the product of the alternating current amplification factor β and the resistance gain, which is the ratio of the load collector resistance R_c to the input base resistance R_b:

$$A_v = \beta \times \frac{R_c}{R_b}$$

By equating these two expressions for A_v, we can rearrange the terms to solve for the unknown input voltage signal V_{in}.

Solution:

Step 1: Write down the given values from the problem statement: collector load resistance $R_c = 2\text{ k}\Omega = 2000\ \Omega$, output signal voltage $V_{out} = 2$ V, current gain $\beta = 100$, and input base resistance $R_b = 1\text{ k}\Omega = 1000\ \Omega$. Step 2: Calculate the numerical value of the amplifier's voltage gain A_v:

$$A_v = \beta \times \frac{R_c}{R_b} = 100 \times \frac{2000}{1000} = 100 \times 2 = 200$$

Step 3: Relate the calculated voltage gain to the input and output voltages:

$$A_v = \frac{V_{out}}{V_{in}} \implies 200 = \frac{2\text{ V}}{V_{in}}$$

Step 4: Rearrange the equation to isolate and solve for the input voltage variable V_{in}:

$$V_{in} = \frac{2}{200} = \frac{1}{100} = 0.01\text{ V}$$

Step 5: Convert the final voltage value from volts into millivolts to match the option units:

$$V_{in} = 0.01 \times 1000\text{ mV} = 10\text{ mV}$$

Final Answer: 10 mV

Answer: (A)

Go Back to Question 13

Q14.

Solution

Concept:

The path of a moving particle is determined by the geometric relationship between its instantaneous velocity vector $\vec{v}$ and the net force vector $\vec{F}$ acting upon it. If a constant force acts continuously perpendicular to the direction of motion, it can be broken down into two distinct physical scenarios depending on whether the force rotates with the particle or remains fixed in space. If a force remains fixed in a single spatial direction while a particle initially moves perpendicular to it, the force acts exclusively along that single axis. This creates a constant acceleration along one axis while the velocity along the orthogonal axis remains perfectly constant, which is identical to the classical physics equations governing projectile motion.

Solution:

Step 1: Let the particle be moving initially along the horizontal x-axis with a constant velocity component $v_x = v_0$. Therefore, its initial motion is described by the straight-line path $y = 0$.

Step 2: Introduce a constant external force F acting along the vertical y-axis, which is perpendicular to the initial velocity vector. This force produces a constant vertical acceleration:

$$a_y = \frac{F}{m}$$

where m is the mass of the particle. The horizontal acceleration remains $a_x = 0$.

Step 3: Write down the equations for positions x and y as functions of time t using kinematic equations:

$$x(t) = v_0 t \implies t = \frac{x}{v_0}$$

$$y(t) = \frac{1}{2} a_y t^2$$

Step 4: Substitute the expression for time t from the x-equation into the y-equation to find the trajectory path:

$$y = \frac{1}{2}\left(\frac{F}{m}\right)\left(\frac{x}{v_0}\right)^2 = \left(\frac{F}{2mv_0^2}\right)x^2$$

Step 5: Observe that the resulting trajectory equation is of the mathematical form $y = kx^2$, which represents a parabola. Thus, the path of the particle is parabolic.

Final Answer: Parabolic

Answer: (A)

Go Back to Question 14

Q15.

Solution

Concept:

The focal length f of a thin optical lens is determined by the refractive index of the lens material relative to the surrounding medium and the radii of curvature of its two spherical surfaces, as described by the Lens Maker's Formula:

$$\frac{1}{f} = \left(\frac{\mu_{\text{lens}}}{\mu_{\text{medium}}} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

When a lens is transferred from air ($\mu = 1$) into a liquid medium like water, the relative refractive index decreases, which reduces the bending of light rays and increases the focal length. By writing the equations for both media and taking their ratio, the geometric curvature terms cancel out, allowing us to compute the new focal length.

Solution:

Step 1: Write down the Lens Maker's formula for the lens in air, where $\mu_{\text{air}} = 1$ and $\mu_{\text{glass}} = 1.5 = \frac{3}{2}$:

$$\frac{1}{f_{\text{air}}} = (\mu_{\text{glass}} - 1) \cdot K = \left(\frac{3}{2} - 1\right) \cdot K = \frac{1}{2}K$$

where $K = \left(\frac{1}{R_1} - \frac{1}{R_2}\right)$. Given $f_{\text{air}} = 20$ cm, we find $K = \frac{2}{20} = \frac{1}{10}$. Step 2: Write down the formula for the lens immersed in water, where $\mu_{\text{water}} = \frac{4}{3}$:

$$\frac{1}{f_{\text{water}}} = \left(\frac{\mu_{\text{glass}}}{\mu_{\text{water}}} - 1\right) \cdot K = \left(\frac{3/2}{4/3} - 1\right) \cdot K$$

Step 3: Simplify the relative refractive index term inside the brackets:

$$\frac{3/2}{4/3} = \frac{3}{2} \times \frac{3}{4} = \frac{9}{8} \implies \left(\frac{9}{8} - 1\right) = \frac{1}{8}$$

Step 4: Substitute this simplified term and the value of K back into the focal length equation for water:

$$\frac{1}{f_{\text{water}}} = \frac{1}{8} \cdot K = \frac{1}{8} \times \frac{1}{10} = \frac{1}{80}$$

Step 5: Invert the equation to find the final value of the focal length in water:

$$f_{\text{water}} = 80 \text{ cm}$$

Final Answer: 80 cm

Answer: (C)

Go Back to Question 15

Q16.

Solution

Concept:

According to Faraday's Law of Electromagnetic Induction, any change in the magnetic flux Φ linked with a conducting coil induces an electromotive force (emf) across the terminals of the coil. The magnitude of this induced electromotive force, denoted by e, is equal to the time rate of change of the magnetic flux, which corresponds to the first mathematical derivative of the flux function with respect to time t:

$$e = \left|\frac{d\Phi}{dt}\right|$$

Given the magnetic flux as a time-dependent algebraic polynomial, we can differentiate it using standard calculus power rules and evaluate the resulting expression at the specified time.

Solution: Step 1: Write down the given time-dependent function for the magnetic flux linked with the coil:

$$\Phi(t) = 3t^2 + 4t + 9$$

Step 2: Differentiate this equation with respect to the time variable t using the power rule ($\frac{d}{dt}[t^n] = nt^{n-1}$):

$$\frac{d\Phi}{dt} = \frac{d}{dt}(3t^2) + \frac{d}{dt}(4t) + \frac{d}{dt}(9)$$

$$\frac{d\Phi}{dt} = 6t + 4 + 0 = 6t + 4$$

Step 3: State the magnitude of the induced electromotive force equation based on Faraday's law:

$$e = 6t + 4$$

Step 4: Substitute the specific target time value, $t = 2$ seconds, into the derivative expression to find the instantaneous induced voltage:

$$e = 6(2) + 4 = 12 + 4$$

Step 5: Perform the addition to find the final value:

$$e = 16 \text{ V}$$

Final Answer: 16 V

Answer: (A)

Go Back to Question 16

Q17.

Solution

Concept:

When a rigid body rolls down an inclined plane without slipping, its mechanical energy is conserved, transforming gravitational potential energy into a combination of translational kinetic energy and rotational kinetic energy. The linear acceleration a of an object rolling down an incline of angle θ is given by the formula:

$$a = \frac{g \sin\theta}{1 + \frac{I}{mR^2}} = \frac{g \sin\theta}{1 + k}$$

where I is the moment of inertia about the central axis, m is the mass, R is the radius, and $k = \frac{I}{mR^2}$ is a dimensionless shape factor. An object with a higher linear acceleration will reach the bottom of the incline in less time. Therefore, the object with the smallest value of k will experience the largest acceleration and win the race.

Solution:

Step 1: Determine the moment of inertia I and the corresponding shape factor k for a solid sphere rolling about its central axis:

$$I_{\text{sphere}} = \frac{2}{5}mR^2 \implies k_{\text{sphere}} = \frac{2}{5} = 0.40$$

Step 2: Determine the moment of inertia and shape factor for a uniform flat disc:

$$I_{\text{disc}} = \frac{1}{2}mR^2 \implies k_{\text{disc}} = \frac{1}{2} = 0.50$$

Step 3: Determine the moment of inertia and shape factor for a thin circular ring:

$$I_{\text{ring}} = mR^2 \implies k_{\text{ring}} = 1.00$$

Step 4: Compare the calculated shape factors to find the minimum value:

$$k_{\text{sphere}}(0.4) < k_{\text{disc}}(0.5) < k_{\text{ring}}(1.0)$$

Step 5: Relate the shape factor back to linear acceleration. Since the solid sphere has the smallest value of k, it exhibits the largest acceleration ($a = \frac{g \sin\theta}{1.4}$), meaning it gains velocity the fastest and reaches the bottom first.

Final Answer: Solid sphere

Answer: (A)

Go Back to Question 17

Q18.

Solution

Concept:
Surface energy is directly proportional to the total exposed surface area of a liquid body, defined by the relation $E = T \cdot A$, where T is the surface tension of the liquid and A is the surface area. When two small liquid droplets coalesce to form a single larger drop, the total volume remains perfectly conserved, but the total surface area changes. A sphere has the minimum surface area for a given volume. Therefore, combining two spheres into one larger sphere reduces the total surface area, which decreases the surface energy of the system. According to the law of conservation of energy, this excess surface energy must be liberated into the environment, typically as heat.

Solution:
Step 1: Write down the volume conservation equation to relate the initial radius r of the two small droplets to the final radius R of the single combined drop:

$$V_{\text{final}} = 2 \times V_{\text{initial}} \implies \frac{4}{3}\pi R^3 = 2 \times \left(\frac{4}{3}\pi r^3\right)$$

Step 2: Simplify this relation to express R in terms of r:

$$R^3 = 2r^3 \implies R = 2^{1/3} r$$

Step 3: Calculate the total initial surface area of the two separate droplets:

$$A_{\text{initial}} = 2 \times (4\pi r^2) = 8\pi r^2$$

Step 4: Calculate the final surface area of the single large combined drop:

$$A_{\text{final}} = 4\pi R^2 = 4\pi (2^{1/3} r)^2 = 4 \times 2^{2/3} \pi r^2 \approx 6.35\pi r^2$$

Step 5: Compare the initial and final surface areas. Since $A_{\text{final}} < A_{\text{initial}}$, the total surface area decreases. This reduction in surface area means the final surface energy is lower than the initial surface energy ($\Delta E < 0$). The excess energy cannot vanish, so it is liberated.

Final Answer: Energy is liberated

Answer: (A)

Go Back to Question 18

Q19.

Solution

Concept:

In a series alternating current (AC) circuit containing both an inductor and a capacitor, the components present frequency-dependent opposition to the current, known as inductive reactance X_L and capacitive reactance X_C. These quantities are defined as:

$$X_L = \omega L \quad \text{and} \quad X_C = \frac{1}{\omega C}$$

where $\omega = 2\pi f$ is the angular frequency of the AC source. Electrical resonance occurs at the specific electrical frequency where the inductive reactance matches the capacitive reactance exactly ($X_L = X_C$). At this frequency, the opposing voltages across the inductor and capacitor cancel each other out completely, minimizing the total impedance of the circuit. Solving this balance condition allows us to find the resonant frequency.

Solution: Step 1: Set up the fundamental condition for electrical resonance in a series LCR or LC circuit:

$$X_L = X_C$$

Step 2: Substitute the expressions for the reactances in terms of the angular frequency ω:

$$\omega L = \frac{1}{\omega C}$$

Step 3: Rearrange the terms to isolate ω^2 on one side of the equation:

$$\omega^2 = \frac{1}{LC} \implies \omega = \frac{1}{\sqrt{LC}}$$

Step 4: Substitute the relationship between angular frequency and cyclic frequency, $\omega = 2\pi f$, into the equation:

$$2\pi f = \frac{1}{\sqrt{LC}}$$

Step 5: Divide both sides by 2π to isolate the cyclic resonant frequency variable f:

$$f = \frac{1}{2\pi\sqrt{LC}}$$

Final Answer: $\boxed{\frac{1}{2\pi\sqrt{LC}}}$

Answer: (A)

Go Back to Question 19

Q20.

Solution

Concept:

According to Newton's Second Law of Motion and the Work-Energy Theorem, the net work done on an object by an applied force is equal to the change in its kinetic energy. Alternatively, this problem can be solved using constant acceleration kinematics. The work done W by a constant force F over a parallel displacement distance d is given by:

$$W = F \cdot d$$

The final kinetic energy K of a bullet starting from rest is given by:

$$K = \frac{1}{2}mv^2$$

Equating the work done to the final kinetic energy allows us to find the average force exerted on the bullet by the expanding gases inside the barrel. We must ensure all physical units are converted to the standard SI system (mass in kilograms).

Solution: Step 1: Convert the given mass of the bullet from grams into standard kilograms:

$$m = 10 \text{ g} = \frac{10}{1000} \text{ kg} = 0.01 \text{ kg} = 10^{-2} \text{ kg}$$

Step 2: State the other given kinematic parameters: length of the barrel (displacement) $d = 1$ m, and final muzzle velocity $v = 300$ m/s. The initial velocity is $u = 0$. Step 3: Set up the Work-Energy equation, equating the work done by the force to the final kinetic energy:

$$F \cdot d = \frac{1}{2}mv^2$$

Step 4: Substitute the numerical parameters into the formula:

$$F \cdot (1) = \frac{1}{2} \times (0.01) \times (300)^2$$

Step 5: Perform the squaring operation and simplify the numerical terms:

$$F = \frac{1}{2} \times 0.01 \times 90000 = \frac{1}{2} \times 900 = 450 \text{ N}$$

Final Answer: 450 N

Answer: (A)

Go Back to Question 20

Q21.

Solution

Concept:

Radioactive decay follows the first-order exponential law:

$$\frac{A}{A_0} = \left(\frac{1}{2}\right)^n$$

where $n = \frac{t}{T_{1/2}}$ represents the number of elapsed half-lives, and $T_{1/2}$ is the half-life period.

Solution:

Step 1: Convert the remaining percentage activity into a simplified fraction:

$$\frac{A}{A_0} = 6.25\% = \frac{6.25}{100} = \frac{1}{16}$$

Step 2: Express the fraction as a power of $\frac{1}{2}$ to find the number of half-lives n:

$$\frac{1}{16} = \left(\frac{1}{2}\right)^4 \implies n = 4$$

Step 3: Calculate the total elapsed time t using $T_{1/2} = 5$ years:

$$t = n \times T_{1/2} = 4 \times 5 = 20 \text{ years}$$

Final Answer: 20 years

Answer: (B)

Go Back to Question 21

Q22.

Solution

Concept:

The thermodynamic efficiency η of a Carnot heat engine is determined by its absolute operating temperatures (T_1 for the source and T_2 for the sink):

$$\eta = 1 - \frac{T_2}{T_1} = \frac{W}{Q_1}$$

where W is the net work output and Q_1 is the input thermal energy. Temperatures must be converted to Kelvin.

Solution:

Step 1: Convert the temperatures from Celsius to Kelvin:

$$T_1 = 227^\circ\text{C} = 227 + 273 = 500 \text{ K}$$

$$T_2 = 127^\circ\text{C} = 127 + 273 = 400 \text{ K}$$

Step 2: Compute the efficiency η:

$$\eta = 1 - \frac{400}{500} = 1 - \frac{4}{5} = \frac{1}{5} = 0.20$$

Step 3: Solve for the useful mechanical work output W using $Q_1 = 6 \times 10^4$ cal:

$$\frac{1}{5} = \frac{W}{6 \times 10^4} \implies W = \frac{6 \times 10^4}{5} = 1.2 \times 10^4 \text{ cal}$$

Final Answer: $\boxed{1.2 \times 10^4 \text{ cal}}$

Answer: (A)

Go Back to Question 22

Q23.

Solution

Concept:
The magnetic force acting on a moving charge is given by the Lorentz force formula:

$$F = |q|vB\sin\theta$$

According to the right-hand rule, the magnetic field lines around a long straight current-carrying wire form concentric circles. When a particle moves parallel to the wire, its velocity vector $\vec{v}$ is perpendicular to the field lines, meaning $\theta = 90°$ and $\sin(90°) = 1$.

Solution:
Step 1: Calculate the magnetic field magnitude B at a distance $r = 10$ cm $= 0.1$ m:

$$B = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 5}{2\pi \times 0.1} = \frac{2 \times 10^{-7} \times 5}{0.1} = 10^{-5}\ \text{T}$$

Step 2: Use the Lorentz force equation with $\theta = 90°$:

$$F = evB$$

Step 3: Substitute $e = 1.6 \times 10^{-19}$ C, $v = 10^5$ m/s, and $B = 10^{-5}$ T:

$$F = (1.6 \times 10^{-19}) \times 10^5 \times 10^{-5} = 1.6 \times 10^{-19}\ \text{N}$$

Final Answer: 1.6×10^{-19} N

Answer: (A)

Go Back to Question 23

Q24.

Solution

Concept:

For a particle executing Simple Harmonic Motion (SHM), the displacement is $x(t) = A\sin(\omega t)$. Differentiating with respect to time yields the maximum velocity $v_0 = A\omega$, and differentiating again yields the maximum acceleration magnitude $a_0 = A\omega^2$.

Solution:

Step 1: Express the angular frequency ω from the maximum velocity formula:

$$v_0 = A\omega \implies \omega = \frac{v_0}{A}$$

Step 2: Substitute this expression for ω into the maximum acceleration formula:

$$a_0 = A\omega^2 = A\left(\frac{v_0}{A}\right)^2$$

Step 3: Expand the term and simplify to isolate the amplitude A:

$$a_0 = \frac{v_0^2}{A} \implies A = \frac{v_0^2}{a_0}$$

Final Answer: $\boxed{\frac{v_0^2}{a_0}}$

Answer: (A)

Go Back to Question 24

Q25.

Solution

Concept:

The distance S_n covered by a uniformly accelerating body during a specific n^{th} second is determined by the kinematic formula:

$$S_n = u + \frac{a}{2}(2n - 1)$$

where u is the initial velocity and a is the constant acceleration.

Solution:

Step 1: Set up Equation 1 using the data for the second second ($n = 2$, $S_2 = 20$ m):

$$20 = u + \frac{a}{2}(2(2) - 1) \implies 20 = u + \frac{3a}{2} \quad \text{— (Eq. 1)}$$

Step 2: Set up Equation 2 using the data for the fourth second ($n = 4$, $S_4 = 40$ m):

$$40 = u + \frac{a}{2}(2(4) - 1) \implies 40 = u + \frac{7a}{2} \quad \text{— (Eq. 2)}$$

Step 3: Subtract Equation 1 from Equation 2 to eliminate u and find a:

$$40 - 20 = \left(u + \frac{7a}{2}\right) - \left(u + \frac{3a}{2}\right) \implies 20 = 2a \implies a = 10 \text{ m/s}^2$$

Step 4: Substitute $a = 10$ m/s^2 back into Equation 1 to solve for u:

$$20 = u + \frac{3(10)}{2} \implies 20 = u + 15 \implies u = 5 \text{ m/s}$$

Final Answer: 5 m/s

Answer: (B)

Go Back to Question 25

Q26.

Solution

Concept:

The fundamental relationship for refraction through a triangular prism connects the angle of incidence i, angle of emergence e, prism angle A, and angle of deviation δ:

$$i + e = A + \delta$$

For an equilateral prism, all interior angles are equal ($A = 60°$). Under symmetric refraction conditions, $i = e$.

Solution:

Step 1: Note the prism angle for an equilateral configuration:

$$A = 60°$$

Step 2: Determine the emergence angle e from the given fractional relation:

$$e = \frac{3}{4}A = \frac{3}{4} \times 60° = 45°$$

Step 3: Apply the symmetric constraint $i = e = 45°$ and solve for δ:

$$45° + 45° = 60° + \delta \implies 90° = 60° + \delta \implies \delta = 30°$$

Final Answer: $\boxed{30°}$

Answer: (A)

Go Back to Question 26

Q27.

Solution

Concept:

Capacitors combine directly when connected in parallel ($C_p = C_1 + C_2$) and reciprocally when wired in series ($\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2}$). We must find a combination of three identical 3 μF capacitors that yields a net equivalent value of 4.5 μF.

Solution:

Step 1: Test a arrangement where two capacitors are connected in series, and the third is placed in parallel with that pair.

Step 2: Find the equivalent series capacitance C_s of the first two units:

$$\frac{1}{C_s} = \frac{1}{3} + \frac{1}{3} = \frac{2}{3} \implies C_s = 1.5\ \mu\text{F}$$

Step 3: Combine this series assembly in parallel with the remaining third capacitor:

$$C_{\text{total}} = C_s + C = 1.5\ \mu\text{F} + 3\ \mu\text{F} = 4.5\ \mu\text{F}$$

This matches the target capacitance requirement precisely.

Final Answer: Two in series and one in parallel with them

Answer: (C)

Go Back to Question 27

Q28.

Solution

Concept:

The Bohr atomic model assumes stable circular electron orbits by balancing the centripetal force with the electrostatic Coulomb force:

$$\frac{mv^2}{r} = \frac{kZe^2}{r^2}$$

alongside the orbital angular momentum quantization condition: $mvr = \frac{nh}{2\pi}$.

Solution:

Step 1: Express the tangential velocity v from the quantization condition:

$$v = \frac{nh}{2\pi mr}$$

Step 2: Substitute this velocity expression into the dynamical force balance equation:

$$\frac{m}{r}\left(\frac{nh}{2\pi mr}\right)^2 = \frac{kZe^2}{r^2} \implies \frac{n^2h^2}{4\pi^2mr^3} = \frac{kZe^2}{r^2}$$

Step 3: Cancel common factors of r and isolate the orbital radius variable:

$$r = \left(\frac{h^2}{4\pi^2mkZe^2}\right)n^2 \implies r \propto n^2$$

Final Answer: $\boxed{r \propto n^2}$

Answer: (B)

Go Back to Question 28

Q29.

Solution

Concept:

The rotational form of Newton's second law couples torque τ to the moment of inertia I and angular acceleration α:

$$\tau = I \cdot \alpha$$

Under a steady torque, the angular velocity changes linearly with time according to the kinematic equation: $\omega_f = \omega_i + \alpha t$.

Solution:

Step 1: Determine the constant angular acceleration α using the parameters $\tau = 1000\ \text{N} \cdot \text{m}$ and $I = 200\ \text{kg} \cdot \text{m}^2$:

$$\alpha = \frac{\tau}{I} = \frac{1000}{200} = 5\ \text{rad/s}^2$$

Step 2: Calculate the final angular velocity ω_f after a period of $t = 3$ seconds, starting from rest ($\omega_i = 0$):

$$\omega_f = \omega_i + \alpha t = 0 + (5 \times 3) = 15\ \text{rad/s}$$

Final Answer: 15 rad/s

Answer: (A)

Go Back to Question 29

Q30.

Solution

Concept:
Maxwell's electromagnetic theory states that a plane electromagnetic wave propagating through a vacuum consists of mutually perpendicular electric field ($\vec{E}$) and magnetic field ($\vec{B}$) vectors oscillating in phase. The amplitudes of these two oscillating fields are tightly coupled and related to each other by a constant ratio equal to the speed of light in a vacuum (c):

$$c = \frac{E_0}{B_0}$$

where E_0 is the amplitude of the electric field component and B_0 is the amplitude of the magnetic field component. The speed of light in a vacuum is a universal constant given by $c \approx 3 \times 10^8$ m/s. We can rearrange this ratio to solve directly for the unknown magnetic field amplitude.

Solution:
Step 1: State the values given in the problem and the universal constant required for calculation: electric field amplitude $E_0 = 48$ V/m, and speed of light $c = 3 \times 10^8$ m/s.
Step 2: Isolate the unknown magnetic field amplitude variable B_0 from the core field ratio formula:

$$B_0 = \frac{E_0}{c}$$

Step 3: Substitute the numerical values into the rearranged equation:

$$B_0 = \frac{48}{3 \times 10^8}$$

Step 4: Divide 48 by 3 and move the power of ten from the denominator to the numerator by changing the sign of its exponent:

$$B_0 = 16 \times 10^{-8}\ \text{T}$$

Step 5: Convert the calculated value into standard scientific notation to match the provided choices:

$$B_0 = 1.6 \times 10^{-7}\ \text{T}$$

Final Answer: $\boxed{1.6 \times 10^{-7}\ \text{T}}$

Answer: (A)

Go Back to Question 30

Q31.

Solution

Concept:
Friction is a self-adjusting reactive force that opposes the relative sliding motion between two surfaces in contact. The maximum possible value of static friction that can develop between two surfaces is known as the limiting friction force (f_{lim}), defined by the relation:

$$f_{\text{lim}} = \mu_s N$$

where μ_s is the coefficient of static friction and N is the normal force. If an applied horizontal force F is strictly less than this limiting friction value ($F < f_{\text{lim}}$), the object remains stationary, and the static friction force adjusts its magnitude to exactly match the applied force ($f_s = F$). If the applied force exceeds the limiting value, the object slips, and kinetic friction takes over.

Solution:
Step 1: Calculate the normal force N acting on the block resting on the flat horizontal floor. Since there is no vertical motion, the normal force balances the weight of the block:

$$N = mg = 2\text{ kg} \times 10\text{ m/s}^2 = 20\text{ N}$$

Step 2: Calculate the maximum limiting static friction force f_{lim} that can develop between the block and the floor:

$$f_{\text{lim}} = \mu_s N = 0.4 \times 20\text{ N} = 8\text{ N}$$

Step 3: Compare the applied horizontal pushing force $F = 5$ N to the calculated limiting friction force $f_{\text{lim}} = 8$ N.
Step 4: Observe that the applied force is lower than the minimum force required to break static friction:

$$F = 5\text{ N} < f_{\text{lim}} = 8\text{ N}$$

Step 5: Conclude that the block does not move. Because the block remains stationary, the static friction force must exactly balance the applied force to maintain equilibrium:

$$f_s = F = 5\text{ N}$$

Final Answer: 5 N

Answer: (B)

Go Back to Question 31

Q32.

Solution

Concept:

Natural, unpolarized light consists of electromagnetic wave packets oscillating uniformly in all possible transverse spatial directions perpendicular to the direction of propagation. A perfect linear polarizing sheet features a specific microscopic transmission axis that only allows the components of the electric field vector aligned parallel to that axis to pass through, absorbing all orthogonal components. According to Malus's Law, when a polarized beam passes through a polarizer, the transmitted intensity varies as $\cos^2\theta$. However, for an unpolarized incident beam, the electric field orientations are symmetrically distributed across all angles. To find the total transmitted intensity, we must integrate or average the cosine squared function over a full circle.

Solution:

Step 1: State the mathematical definition of Malus's law for a polarized light wave passing through an optical filter:

$$I = I_{\text{incident}} \cos^2\theta$$

Step 2: Analyze the geometric distribution of the electric field vectors in an unpolarized beam. The light contains a continuous, uniform distribution of polarization angles θ ranging from 0 to 2π radians.

Step 3: Determine the mathematical average value of the function $\cos^2\theta$ over a complete symmetric cycle of 2π:

$$\langle\cos^2\theta\rangle = \frac{1}{2\pi}\int_0^{2\pi}\cos^2\theta\, d\theta = \frac{1}{2}$$

Step 4: Apply this averaging factor to the incident unpolarized light beam of intensity I_0:

$$I_{\text{transmitted}} = I_0 \times \langle\cos^2\theta\rangle = I_0 \times \frac{1}{2} = \frac{I_0}{2}$$

Step 5: Conclude that a perfect polarizing filter always transmits exactly half of the total incident intensity of an unpolarized light beam, converting it into linearly polarized light.

Final Answer: $\boxed{\frac{I_0}{2}}$

Answer: (B)

Go Back to Question 32

Q33.

Solution

Concept:

A potentiometer is a precision laboratory instrument used to measure electromotive force or potential differences by establishing a uniform voltage drop along a standardized calibrated wire. The potential gradient k is defined as the voltage drop per unit length along this potentiometer wire:

$$k = \frac{V_{\text{wire}}}{L}$$

where V_{wire} is the actual electric potential drop across the wire and L is the total length of the wire. According to Ohm's Law, the voltage drop across the wire depends on the current I flowing through the primary circuit loop, which is determined by the total series resistance of the circuit:

$$I = \frac{E}{R_{\text{wire}} + R_{\text{series}}}$$

Once the loop current is determined, we can calculate V_{wire} and the potential gradient.

Solution:

Step 1: Calculate the total equivalent resistance R_{total} of the primary circuit loop. The potentiometer wire resistance $R_{\text{wire}} = 20\ \Omega$ is connected in series with an external resistor $R_s = 10\ \Omega$:

$$R_{\text{total}} = R_{\text{wire}} + R_s = 20 + 10 = 30\ \Omega$$

Step 2: Determine the total current I flowing through the circuit using the battery emf $E = 3$ V:

$$I = \frac{E}{R_{\text{total}}} = \frac{3\ \text{V}}{30\ \Omega} = 0.1\ \text{A}$$

Step 3: Calculate the specific voltage drop V_{wire} across the potentiometer wire using Ohm's Law:

$$V_{\text{wire}} = I \times R_{\text{wire}} = 0.1\ \text{A} \times 20\ \Omega = 2\ \text{V}$$

Step 4: Calculate the potential gradient k by dividing the wire's voltage drop by its total length ($L = 10$ m):

$$k = \frac{V_{\text{wire}}}{L} = \frac{2\ \text{V}}{10\ \text{m}} = 0.2\ \text{V/m}$$

Final Answer: 0.2 V/m

Answer: (A)

Go Back to Question 33

Q34.

Solution

Concept:

Linear momentum p and kinetic energy K are two core kinematic quantities that describe the motion of a translationally moving body. Linear momentum is defined as the product of mass and velocity ($p = mv$), while kinetic energy is defined as $K = \frac{1}{2}mv^2$. We can algebraically combine these two formulas to express linear momentum directly as a function of mass and kinetic energy:

$$K = \frac{1}{2}mv^2 = \frac{(mv)^2}{2m} = \frac{p^2}{2m} \implies p = \sqrt{2mK}$$

This formula shows that for two objects with identical kinetic energies, their linear momentum magnitudes scale as the square root of their masses. By setting up a ratio, we can easily find the relative proportion between their momenta.

Solution: Step 1: State the general formula for linear momentum as a function of mass and kinetic energy:

$$p = \sqrt{2mK}$$

Step 2: Write out the explicit momentum expressions for both bodies using their given masses ($m_1 = 1$ kg and $m_2 = 4$ kg) and their equal kinetic energy value K:

$$p_1 = \sqrt{2(1)K} = \sqrt{2K}$$

$$p_2 = \sqrt{2(4)K} = \sqrt{8K}$$

Step 3: Set up the ratio of the first momentum to the second momentum:

$$\frac{p_1}{p_2} = \frac{\sqrt{2K}}{\sqrt{8K}}$$

Step 4: Simplify the radical fraction by canceling out the common factor $2K$ from inside the square roots:

$$\frac{p_1}{p_2} = \sqrt{\frac{2K}{8K}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$$

Step 5: Express this fraction as a standard mathematical ratio:

$$p_1 : p_2 = 1 : 2$$

Final Answer: $\boxed{1 : 2}$

Answer: (A)

Go Back to Question 34

Q35.

Solution

Concept:

A continuous traveling wave propagating through a medium can be described mathematically by a sinusoidal wave function of position x and time t. The standard standard form for a wave traveling in the positive x-direction is given by:

$$y(x,t) = A\sin(\omega t - kx)$$

where A represents the wave amplitude, ω represents the angular frequency ($\omega = 2\pi f$), and k represents the angular wavenumber ($k = \frac{2\pi}{\lambda}$). The physical propagation speed v of the wave shape through space is related to these parameters by the fundamental wave velocity formula:

$$v = f\lambda = \frac{\omega}{k}$$

By comparing the given wave equation to the standard reference form, we can identify the values of ω and k and compute the wave velocity.

Solution:

Step 1: Write down the given specific mathematical wave equation from the problem statement:

$$y = 0.5\sin(10\pi t - 0.1\pi x)$$

Step 2: Compare this given equation to the standard theoretical wave template $y = A\sin(\omega t - kx)$ to find the values of the coefficients. Step 3: Extract the angular frequency coefficient ω by looking at the multiplier of the time variable t:

$$\omega = 10\pi \text{ rad/s}$$

Step 4: Extract the angular wavenumber coefficient k by looking at the multiplier of the spatial position variable x:

$$k = 0.1\pi \text{ rad/m}$$

Step 5: Calculate the wave propagation velocity v by dividing the angular frequency by the wavenumber:

$$v = \frac{\omega}{k} = \frac{10\pi}{0.1\pi} = \frac{10}{0.1} = 100 \text{ m/s}$$

Final Answer: 100 m/s

Answer: (B)

Go Back to Question 35

Q36.

Solution

Concept:

Semiconductor doping involves intentionally introducing small amounts of impurity atoms into an intrinsic crystalline semiconductor material to alter its electrical properties. Silicon and germanium are tetravalent elements with four valence electrons. When an intrinsic semiconductor is doped with a trivalent impurity element from Group 13 (such as Boron, Aluminum, Indium, or Gallium), the dopant atoms substitute into the crystal lattice. Since a trivalent atom only possesses three valence electrons, it cannot complete all four covalent bonds with its neighboring silicon atoms, leaving a localized electron vacancy. This vacancy acts as a mobile positive charge carrier, known as a hole. This creates a p-type (positive-type) semiconductor.

Solution:

Step 1: Identify the nature of a p-type semiconductor material. The letter "p" explicitly stands for positive, indicating that the dominant mobile charge carriers carry a positive charge.

Step 2: Analyze the doping mechanism that creates a p-type semiconductor. Trivalent impurity atoms are added to the host crystal lattice. Each dopant atom creates a stable covalent bonding gap due to its missing fourth electron.

Step 3: Define this electronic vacancy. This localized structural deficiency of an electron behaves exactly like a mobile point charge with a positive value $+e$, which is called a hole.

Step 4: Compare the concentrations of charge carriers. The thermal generation of electron-hole pairs contributes a tiny number of free conduction electrons, but the concentration of holes created by the dopant atoms is vastly larger.

Step 5: Conclude that holes form the majority charge carriers, while free electrons serve as the minority charge carriers.

Final Answer: Holes

Answer: (B)

Go Back to Question 36

Q37.

Solution

Concept:

The vector cross product (or mathematical vector product) of two vectors $\vec{A}$ and $\vec{B}$ yields a third vector $\vec{C} = \vec{A} \times \vec{B}$ whose orientation is strictly perpendicular to the plane containing both original vectors. The directional orientation of this resulting cross-product vector is determined using the Right-Hand Rule. To find the direction, align the fingers of your right hand along the direction of the first vector $\vec{A}$, then curl them through the smallest angle toward the second vector $\vec{B}$. Your extended thumb will point in the direction of the resulting vector $\vec{C}$. Alternatively, this can be solved using standard orthogonal unit vectors along a geographic coordinate system.

Solution:

Step 1: Set up a three-dimensional orthogonal Cartesian coordinate system mapping the geographic directions. Let the horizontal East direction line up with the positive x-axis ($\hat{i}$), the horizontal North direction line up with the positive y-axis ($\hat{j}$), and the vertical upward direction line up with the positive z-axis ($\hat{k}$).

Step 2: Express the first vector $\vec{A}$ in terms of these standard unit vectors. The problem states that $\vec{A}$ points vertically upwards, so:

$$\vec{A} = A\hat{k}$$

Step 3: Express the second vector $\vec{B}$ in terms of the unit vectors. The problem states that $\vec{B}$ points toward the North geographic direction, so:

$$\vec{B} = B\hat{j}$$

Step 4: Set up the vector cross product equation using these unit vector components:

$$\vec{A} \times \vec{B} = (A\hat{k}) \times (B\hat{j}) = AB(\hat{k} \times \hat{j})$$

Step 5: Evaluate the cross product of the unit vectors using the cyclic permutation rules ($\hat{i} \times \hat{j} = \hat{k}$, $\hat{j} \times \hat{k} = \hat{i}$, and $\hat{k} \times \hat{j} = -\hat{i}$):

$$\vec{A} \times \vec{B} = AB(-\hat{i}) = -AB\hat{i}$$

Since positive $\hat{i}$ corresponds to East, the negative unit vector $-\hat{i}$ corresponds directly to the West direction.

Final Answer: West

Answer: (A)

Go Back to Question 37

Q38.

Solution

Concept:
Thermodynamic processes describe changes in the state variables of a system, such as pressure (P), volume (V), and temperature (T). These processes are classified based on which state variable is held constant during the transformation. An isothermal process occurs at a constant temperature ($\Delta T = 0$). An isobaric process occurs at a constant operating pressure ($\Delta P = 0$). An adiabatic process involves zero thermal energy exchange with the environment ($Q = 0$). An isochoric (or isometric) process occurs at a constant volume ($\Delta V = 0$). In an isochoric process, because the boundaries of the system are rigid and fixed, the system does zero boundary work ($W = P\Delta V = 0$).

Solution:
Step 1: Review the given physical constraint from the problem statement: the system undergoes a process where its volume remains constant. This means the initial volume equals the final volume ($V_i = V_f$).
Step 2: Express this condition mathematically as a differential constraint:

$$dV = 0 \quad \text{or} \quad \Delta V = 0$$

Step 3: Evaluate the options against standard thermodynamic terminology. A process that maintains a constant volume is defined as an isochoric process. The prefix "iso-" means equal, and "choric" relates to space or volume.
Step 4: Note the physical consequence of this condition using the definition of thermodynamic work:

$$W = \int P\, dV = 0$$

Step 5: Match this definition with the provided options to confirm that a constant-volume process is called an isochoric process.

Final Answer: Isochoric

Answer: (C)

Go Back to Question 38

Q39.

Solution

Concept:
An electric dipole placed inside a uniform external electric field $\vec{E}$ experiences a torque that acts to align its dipole moment vector $\vec{p}$ parallel to the field lines. The electrostatic potential energy U of the dipole configuration depends on its orientation angle θ relative to the electric field vector, according to the dot product relation:

$$U(\theta) = -\vec{p} \cdot \vec{E} = -pE\cos\theta$$

The work done W by an external agent to rotate the dipole from an initial orientation angle θ_1 to a final orientation angle θ_2 is equal to the change in its potential energy:

$$W = \Delta U = U(\theta_2) - U(\theta_1) = -pE\cos\theta_2 - (-pE\cos\theta_1) = pE(\cos\theta_1 - \cos\theta_2)$$

Solution: Step 1: Identify the initial orientation angle θ_1. The problem states that the dipole is initially oriented parallel to the electric field lines, so:

$$\theta_1 = 0^\circ$$

Step 2: Determine the final orientation angle θ_2 after the rotation. The dipole is rotated through an angle of 180°, so:

$$\theta_2 = 180^\circ$$

Step 3: Recall or evaluate the values of the cosine function for these two angles:

$$\cos(0^\circ) = 1 \quad \text{and} \quad \cos(180^\circ) = -1$$

Step 4: Set up the work expression using the change in potential energy formula:

$$W = pE(\cos(0^\circ) - \cos(180^\circ))$$

Step 5: Substitute the cosine values into the equation and simplify:

$$W = pE(1 - (-1)) = pE(1 + 1) = 2pE$$

Final Answer: $\boxed{2pE}$

Answer: (B)

Go Back to Question 39

Q40.

Solution

Concept:

The dimensional formula of any physical quantity expresses how it relates to the base dimensions—typically Mass (M), Length (L), and Time (T)—using exponential powers. To find the dimensional formula for an unknown constant, we can rearrange a known physical law that includes that constant. Newton's Law of Universal Gravitation states that the attractive gravitational force F between two point masses m_1 and m_2 separated by a distance r is given by:

$$F = \frac{Gm_1m_2}{r^2}$$

where G is the universal gravitational constant. We can isolate G in this equation and substitute the known dimensional formulas for force, mass, and length to derive the dimensional formula for G.

Solution:

Step 1: Rearrange Newton's gravitational force equation to isolate the universal constant G on one side:

$$G = \frac{F \cdot r^2}{m_1 \cdot m_2}$$

Step 2: State the standard dimensional formulas for each of the individual physical quantities in this expression. Force is mass times acceleration, so:

$$[F] = [MLT^{-2}]$$

The distance r is a length, so $[r^2] = [L^2]$. The masses m_1 and m_2 are base masses, so $[m_1 \cdot m_2] = [M^2]$. Step 3: Substitute these dimensional expressions into our isolated equation for G:

$$[G] = \frac{[MLT^{-2}] \cdot [L^2]}{[M^2]}$$

Step 4: Combine the length dimensions in the numerator by adding their exponents:

$$[G] = \frac{[ML^3T^{-2}]}{[M^2]}$$

Step 5: Simplify the mass dimensions by subtracting the exponent in the denominator from the exponent in the numerator to find the final dimensional formula:

$$[G] = [M^{1-2}L^3T^{-2}] = [M^{-1}L^3T^{-2}]$$

Final Answer: $[M^{-1}L^3T^{-2}]$

Answer: (A)

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Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	A	3	A	4	B	5	C
6	B	7	A	8	A	9	C	10	B
11	A	12	A	13	A	14	A	15	C
16	A	17	A	18	A	19	A	20	A
21	B	22	A	23	A	24	A	25	B
26	A	27	C	28	B	29	A	30	A
31	B	32	B	33	A	34	A	35	B
36	B	37	A	38	C	39	B	40	A