# PGIMER BSc Nursing Physics

## Sample Paper – 1

**Duration: 23 Minutes** | **Maximum Marks: 25**

### Instructions

- This paper contains **25** Multiple Choice Questions (Single Correct Answer), modelled on the Physics portion of the **PGIMER BSc Nursing** entrance exam.
- Each correct answer carries **+1 mark**. **0.25 mark** is deducted for every incorrect answer. Unattempted questions carry **0 marks**.
- Only **one** option is correct. Choose carefully.
- Syllabus level: **Class 11 and 12 (NCERT) Physics**.
- The exam is conducted as a computer-based test. Personal calculators, mobile phones, log tables, and other electronic gadgets are strictly prohibited.

**Q1.** The coefficient of viscosity $\eta$ appears in the relation $F = \eta A \dfrac{dv}{dx}$, where $F$ is force, $A$ is area and $\dfrac{dv}{dx}$ is the velocity gradient. The dimensional formula of $\eta$ is:

(A) $[ML^{-1}T^{-1}]$

(B) $[MLT^{-2}]$

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

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

**Q2.** A stone is thrown vertically upward with an initial speed of $20$ m s$^{-1}$. Taking $g = 10$ m s$^{-2}$ and neglecting air resistance, the maximum height reached by the stone is:

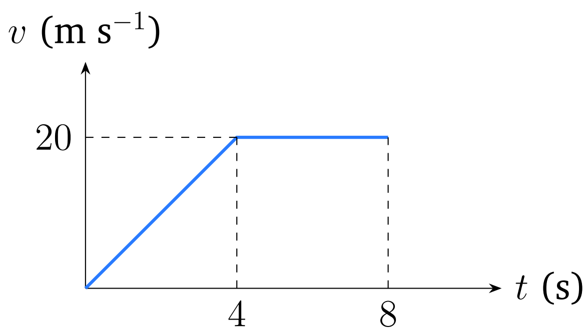
(A) $10$ m

(B) $40$ m

(C) 20 m

(D) 5 m

**Q3.** The velocity–time graph of a body moving in a straight line is shown below. The total displacement of the body in the 8 s interval is:



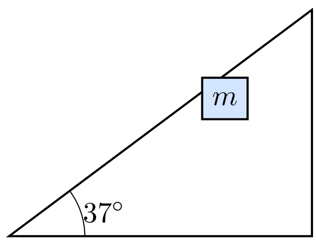

(A) 80 m

(B) 100 m

(C) 160 m

(D) 120 m

**Q4.** A block of mass 5 kg slides down a rough incline of angle $37°$ ($\sin 37° = 0.6$, $\cos 37° = 0.8$). The coefficient of kinetic friction is $\mu = 0.5$ and $g = 10$ m $s^{-2}$. The acceleration of the block down the incline is:



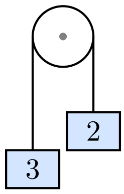

(A) 1 m $s^{-2}$

(B) 2 m $s^{-2}$

(C) 3 m $s^{-2}$

(D) 4 m $s^{-2}$

**Q5.** Two blocks of masses $3$ kg and $2$ kg hang from the two ends of a light inextensible string passing over a frictionless pulley, as shown. Taking $g = 10$ m s$^{-2}$, the tension in the string is:




(A) $24$ N

(B) $12$ N

(C) $30$ N

(D) $20$ N

**Q6.** A pump lifts $600$ kg of water to a height of $10$ m in $20$ s. Taking $g = 10$ m s$^{-2}$, the minimum power of the pump is:

(A) $2000$ W

(B) $1500$ W

(C) $3000$ W

(D) $6000$ W

**Q7.** The moment of inertia of a uniform solid sphere of mass $5$ kg and radius $0.2$ m about an axis through its centre (diameter) is $\left(I = \frac{2}{5}MR^2\right)$:

(A) $0.04$ kg m$^2$

(B) $0.16$ kg m$^2$

(C) $0.40$ kg m$^2$

(D) $0.08$ kg m$^2$

**Q8.** The acceleration due to gravity at the surface of the Earth is $g = 9.8$ m s$^{-2}$. At a height equal to the radius of the Earth above its surface, the value of acceleration due to gravity is:

(A) $9.8 \text{ m s}^{-2}$

(B) $4.9 \text{ m s}^{-2}$

(C) $2.45 \text{ m s}^{-2}$

(D) $1.225 \text{ m s}^{-2}$

**Q9.** A steel wire of length $2$ m and cross-sectional area $1 \times 10^{-6}$ m$^2$ is stretched by a force of $100$ N. If Young's modulus of steel is $2 \times 10^{11}$ N m$^{-2}$, the elongation of the wire is:

(A) $0.5$ mm

(B) $1$ mm

(C) $2$ mm

(D) $0.1$ mm

**Q10.** A Carnot engine operates between a source at $500$ K and a sink at $300$ K. The maximum efficiency of the engine is:

(A) $40\%$

(B) $60\%$

(C) $20\%$

(D) $30\%$

**Q11.** The absolute temperature of an ideal gas is increased from $300$ K to $600$ K. The ratio of the new root-mean-square speed of the molecules to the original one is:

(A) $2$

(B) $4$

(C) $1.5$

(D) $\sqrt{2}$

**Q12.** A block of mass $2$ kg is attached to a spring of force constant $200$ N m$^{-1}$ and executes simple harmonic motion on a frictionless surface. The time period of oscillation is (take $\pi = 3.14$):

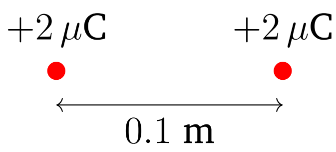
(A) $0.31$ s

(B) $0.63$ s

(C) $1.26$ s

(D) $0.10$ s

**Q13.** Two point charges, each of magnitude $+2\ \mu$C, are placed $0.1$ m apart in vacuum, as shown. Taking $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m$^2$ C$^{-2}$, the magnitude of the electrostatic force between them is:




(A) $1.8$ N

(B) $7.2$ N

(C) $3.6$ N

(D) $0.36$ N

**Q14.** A capacitor of capacitance $2\ \mu$F is charged to a potential difference of $100$ V. The energy stored in the capacitor is:

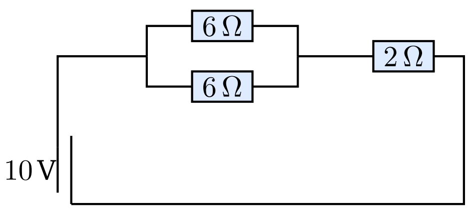
(A) $0.01$ J

(B) $0.02$ J

(C) $0.10$ J

(D) $0.005$ J

**Q15.** In the circuit shown, a battery of emf $10$ V (negligible internal resistance) is connected to two $6\ \Omega$ resistors in parallel and a $2\ \Omega$ resistor in series. The current drawn from the battery is:



(A) 1 A

(B) 2 A

(C) 5 A

(D) 0.5 A

**Q16.** A wire of resistance 2 Ω is stretched uniformly so that its length is doubled, the volume remaining constant. The new resistance of the wire is:

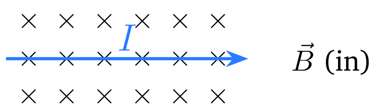
(A) 4 Ω

(B) 2 Ω

(C) 16 Ω

(D) 8 Ω

**Q17.** A straight wire of length 0.5 m carrying a current of 2 A is placed perpendicular to a uniform magnetic field of 0.5 T directed into the plane of the page, as shown. The magnitude of the force on the wire is:




(A) 0.5 N

(B) 1.0 N

(C) 2.0 N

(D) 0.25 N

**Q18.** A long solenoid has 1000 turns per metre and carries a current of 2 A. Taking $\mu_0 = 4\pi \times 10^{-7}$ T m A$^{-1}$, the magnetic field at the centre of the solenoid is:

(A) $1.25 \times 10^{-3}$ T

(B) $5.0 \times 10^{-3}$ T

(C) $2.51 \times 10^{-3}$ T

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

**Q19.** The magnetic flux linked with a coil of 100 turns changes from 0.04 Wb to 0.01 Wb in 0.03 s. The magnitude of the average induced emf in the coil is:

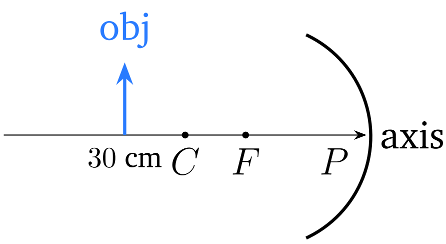
(A) 50 V

(B) 100 V

(C) 150 V

(D) 10 V

**Q20.** An object is placed 30 cm in front of a concave mirror of focal length 10 cm, as shown schematically. The distance of the image from the mirror is:




(A) 10 cm

(B) 30 cm

(C) 7.5 cm

(D) 15 cm

**Q21.** In a Young's double-slit experiment, light of wavelength 600 nm illuminates two slits separated by 0.3 mm. The fringe pattern is observed on a screen 1 m away. The fringe width is:

(A) 1 mm

(B) 3 mm

(C) 2 mm

(D) 0.5 mm

**Q22.** The work function of a metal surface is $2$ eV. When light of photon energy $5$ eV falls on it, the maximum kinetic energy of the emitted photoelectrons is:

(A) $3$ eV

(B) $2$ eV

(C) $5$ eV

(D) $7$ eV

**Q23.** In the Bohr model of the hydrogen atom, the energy of the electron in the $n$th orbit is $E_n = -\frac{13.6}{n^2}$ eV. The energy of the electron in the second orbit ($n = 2$) is:

(A) $-13.6$ eV

(B) $-3.4$ eV

(C) $-1.51$ eV

(D) $-0.85$ eV

**Q24.** A radioactive sample has a half-life of $2$ days. The time required for the activity of the sample to fall to one-eighth of its initial value is:

(A) $4$ days

(B) $8$ days

(C) $2$ days

(D) $6$ days

**Q25.** In a p-type semiconductor formed by doping pure silicon with a trivalent impurity, the majority charge carriers are:

(A) Electrons

(B) Holes

(C) Protons

(D) Positive ions

## Detailed Solutions

### Q1.

**Solution**

**Concept — Dimensional analysis:** The dimensions of a physical quantity are found by isolating it in its defining equation and substituting the dimensions of the known quantities.

**Step 1 — Rearrange the defining relation:** From $F = \eta A \dfrac{dv}{dx}$, solve for $\eta$:

$$\eta = \frac{F}{A\,(dv/dx)}.$$

**Step 2 — Write the dimensions of each quantity:** Force: $[F] = [MLT^{-2}]$.

Area: $[A] = [L^2]$.

Velocity gradient $\dfrac{dv}{dx}$: velocity is $[LT^{-1}]$ and distance is $[L]$, so $\left[\dfrac{dv}{dx}\right] = \dfrac{[LT^{-1}]}{[L]} = [T^{-1}]$.

**Step 3 — Substitute and simplify:**

$$[\eta] = \frac{[MLT^{-2}]}{[L^2]\,[T^{-1}]} = \frac{[MLT^{-2}]}{[L^2\,T^{-1}]}.$$

$$[\eta] = [M\,L^{1-2}\,T^{-2-(-1)}] = [ML^{-1}T^{-1}].$$

**Why other options are wrong:**

- Option B $[MLT^{-2}]$: this is the dimension of force itself, not viscosity.
- Option C $[ML^{-1}T^{-2}]$: this is the dimension of pressure or stress.
- Option D $[ML^{-2}T^{-1}]$: incorrect powers of length.

**Final Answer:** The dimensional formula of viscosity is $[ML^{-1}T^{-1}] \Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q1

## Q2.

**Solution**

**Concept — Vertical motion under gravity:** At the highest point of upward motion, the velocity becomes zero, and the kinematic equation $v^2 = u^2 - 2gh$ applies.

**Step 1 — List the known values:** Initial speed $u = 20$ m s$^{-1}$.

Final speed at top $v = 0$.

Acceleration $g = 10$ m s$^{-2}$ (downward).

**Step 2 — Apply the equation of motion:**

$$v^2 = u^2 - 2gh.$$

Put $v = 0$:

$$0 = u^2 - 2gh.$$

$$h = \frac{u^2}{2g}.$$

**Step 3 — Substitute the numbers:**

$$h = \frac{(20)^2}{2 \times 10} = \frac{400}{20} = 20 \text{ m}.$$

**Why other options are wrong:**

- Option A (10 m): uses $g = 20$ by mistake.
- Option B (40 m): forgets the factor of 2 in $2g$.
- Option D (5 m): arithmetic error.

**Final Answer:** Maximum height $= 20$ m $\Rightarrow$ $\boxed{\text{C}}$

**Answer: (C)** Go Back to Q2

## Q3.

**Solution**

**Concept — Area under a velocity–time graph:** The displacement of a body equals the area enclosed between the $v$–$t$ graph and the time axis.

**Step 1 — Break the graph into shapes:** From $t = 0$ to $t = 4$ s the velocity rises linearly from 0 to 20 m s$^{-1}$ (a triangle).

From $t = 4$ s to $t = 8$ s the velocity stays constant at 20 m s$^{-1}$ (a rectangle).

**Step 2 — Area of the triangle (first 4 s):**

$$A_1 = \frac{1}{2} \times \text{base} \times \text{height} = \frac{1}{2} \times 4 \times 20 = 40 \text{ m}.$$

**Step 3 — Area of the rectangle (next 4 s):**

$$A_2 = \text{length} \times \text{breadth} = 4 \times 20 = 80 \text{ m}.$$

**Step 4 — Add the two areas:**

$$\text{Total displacement} = A_1 + A_2 = 40 + 80 = 120 \text{ m}.$$

**Why other options are wrong:**

- Option A (80 m): counts only the rectangle.
- Option B (100 m): arithmetic slip.
- Option C (160 m): treats the whole 8 s as a rectangle of height 20.

**Final Answer:** Total displacement $= 120$ m $\Rightarrow$ $\boxed{\text{D}}$

**Answer: (D)** Go Back to Q3

## Q4.

**Solution**

**Concept — Block on a rough incline:** The net force down the incline is the component of gravity along the slope minus the kinetic friction acting up the slope.

**Step 1 — Gravity component along the incline:**

$$F_{\parallel} = mg\sin\theta = 5 \times 10 \times 0.6 = 30 \text{ N}.$$

**Step 2 — Normal force and friction:** Normal force: $N = mg\cos\theta = 5 \times 10 \times 0.8 = 40$ N.

Kinetic friction: $f = \mu N = 0.5 \times 40 = 20$ N.

**Step 3 — Net force down the incline:**

$$F_{\text{net}} = F_{\parallel} - f = 30 - 20 = 10 \text{ N}.$$

**Step 4 — Acceleration:**

$$a = \frac{F_{\text{net}}}{m} = \frac{10}{5} = 2 \text{ m s}^{-2}.$$

**Why other options are wrong:**

- Option A ($1 \text{ m s}^{-2}$): uses wrong friction value.
- Option C ($3 \text{ m s}^{-2}$): ignores friction partially.
- Option D ($4 \text{ m s}^{-2}$): uses $\sin\theta$ for both terms.

**Final Answer:** Acceleration $= 2 \text{ m s}^{-2} \Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q4

## Q5.

### Solution

**Concept — Atwood machine:** For two masses over a frictionless pulley, both have the same magnitude of acceleration, and the tension is found from Newton's second law on either block.

**Step 1 — Find the acceleration:**

$$a = \frac{(m_1 - m_2)g}{m_1 + m_2} = \frac{(3-2)\times 10}{3+2} = \frac{10}{5} = 2 \text{ m s}^{-2}.$$

**Step 2 — Apply Newton's law to the lighter block (2 kg), which moves up:**

$$T - m_2 g = m_2 a.$$

$$T = m_2(g+a) = 2 \times (10+2) = 2 \times 12 = 24 \text{ N}.$$

**Step 3 — Check with the heavier block (3 kg), which moves down:**

$$m_1 g - T = m_1 a.$$

$$T = m_1(g-a) = 3 \times (10-2) = 3 \times 8 = 24 \text{ N}.$$

Both give the same value, confirming the result.

**Why other options are wrong:**

- Option B (12 N): uses only one mass without the acceleration term correctly.
- Option C (30 N): equals $3g$, ignoring acceleration.

- Option D (20 N): equals $2g$, ignoring acceleration.

**Final Answer:** Tension $= 24$ N $\Rightarrow$ $\boxed{\text{A}}$

**Answer: (A)** Go Back to Q5

## Q6.

### Solution

**Concept — Power as rate of doing work:** Power is the work done per unit time; lifting water against gravity does work equal to its gain in potential energy.

**Step 1 — Work done in lifting the water:**

$$W = mgh = 600 \times 10 \times 10 = 60000 \text{ J}.$$

**Step 2 — Power as work per unit time:**

$$P = \frac{W}{t} = \frac{60000}{20} = 3000 \text{ W}.$$

**Why other options are wrong:**

- Option A (2000 W): divides by 30 instead of 20.
- Option B (1500 W): uses $g$ wrongly.
- Option D (6000 W): forgets to divide by time fully.

**Final Answer:** Power $= 3000$ W $\Rightarrow$ $\boxed{\text{C}}$

**Answer: (C)** Go Back to Q6

## Q7.

### Solution

**Concept — Moment of inertia of a solid sphere:** For a uniform solid sphere about a diameter, $I = \frac{2}{5}MR^2$.

**Step 1 — List the values:** Mass $M = 5$ kg.

Radius $R = 0.2$ m, so $R^2 = 0.04$ m$^2$.

**Step 2 — Substitute into the formula:**

$$I = \frac{2}{5}MR^2 = \frac{2}{5} \times 5 \times 0.04.$$

**Step 3 — Simplify:**

$$I = \frac{2}{5} \times 5 \times 0.04 = 2 \times 0.04 = 0.08 \text{ kg m}^2.$$

**Why other options are wrong:**

- Option A $(0.04)$: forgets the factor $\frac{2}{5} \times 5 = 2$.
- Option B $(0.16)$: doubles the correct value.
- Option C $(0.40)$: uses $MR^2$ without the $\frac{2}{5}$ factor.

**Final Answer:** Moment of inertia $= 0.08$ kg m$^2 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q7

## Q8.

**Solution**

**Concept — Variation of $g$ with height:** At height $h$ above the surface, $g' = g\left(\frac{R}{R+h}\right)^2$, where $R$ is the Earth's radius.

**Step 1 — Substitute $h = R$:**

$$g' = g\left(\frac{R}{R+R}\right)^2 = g\left(\frac{R}{2R}\right)^2.$$

**Step 2 — Simplify the fraction:**

$$g' = g\left(\frac{1}{2}\right)^2 = \frac{g}{4}.$$

**Step 3 — Put in the numerical value:**

$$g' = \frac{9.8}{4} = 2.45 \text{ m s}^{-2}.$$

**Why other options are wrong:**

- Option A $(9.8)$: assumes no change with height.
- Option B $(4.9)$: divides by $2$ instead of $4$.
- Option D $(1.225)$: divides by $8$.

**Final Answer:** $g' = 2.45$ m s$^{-2} \Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q8

## Q9.

### Solution

**Concept — Young's modulus and elongation:** For a wire under tension, $Y = \dfrac{FL}{A\,\Delta L}$, so the elongation is $\Delta L = \dfrac{FL}{AY}$.

**Step 1 — List the values:** Force $F = 100$ N.

Length $L = 2$ m.

Area $A = 1 \times 10^{-6}$ m$^2$.

Young's modulus $Y = 2 \times 10^{11}$ N m$^{-2}$.

**Step 2 — Write the elongation formula:**

$$\Delta L = \frac{FL}{AY}.$$

**Step 3 — Substitute the numbers:**

$$\Delta L = \frac{100 \times 2}{(1 \times 10^{-6}) \times (2 \times 10^{11})}.$$

$$\Delta L = \frac{200}{2 \times 10^5} = \frac{200}{200000}.$$

$$\Delta L = 1 \times 10^{-3} \text{ m} = 1 \text{ mm}.$$

**Why other options are wrong:**

- Option A ($0.5$ mm): halves the force or doubles the area.
- Option C ($2$ mm): doubles the result.
- Option D ($0.1$ mm): power-of-ten slip.

**Final Answer:** Elongation $= 1$ mm $\Rightarrow$ $\boxed{\text{B}}$

**Answer: (B)** Go Back to Q9

## Q10.

**Solution**

**Concept — Carnot efficiency:** The maximum efficiency of a heat engine working between a source at temperature $T_1$ and a sink at $T_2$ (in kelvin) is $\eta = 1 - \frac{T_2}{T_1}$.

**Step 1 — Identify the temperatures:** Source $T_1 = 500$ K.

Sink $T_2 = 300$ K.

**Step 2 — Apply the efficiency formula:**

$$\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{300}{500}.$$

**Step 3 — Simplify:**

$$\eta = 1 - 0.6 = 0.4 = 40\%.$$

**Why other options are wrong:**

- Option B $(60\%)$: takes the ratio $T_2/T_1$ directly without subtracting.
- Option C $(20\%)$: arithmetic error.
- Option D $(30\%)$: uses wrong temperatures.

**Final Answer:** Maximum efficiency $= 40\% \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q10

## Q11.

**Solution**

**Concept — RMS speed of gas molecules:** The root-mean-square speed is $v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$, so for a fixed gas $v_{\text{rms}} \propto \sqrt{T}$.

**Step 1 — Write the proportionality:**

$$\frac{v_2}{v_1} = \sqrt{\frac{T_2}{T_1}}.$$

**Step 2 — Substitute the temperatures:**

$$\frac{v_2}{v_1} = \sqrt{\frac{600}{300}} = \sqrt{2}.$$

**Why other options are wrong:**

- Option A $(2)$: assumes $v_{\text{rms}} \propto T$ instead of $\sqrt{T}$.
- Option B $(4)$: squares the temperature ratio.
- Option C $(1.5)$: incorrect ratio.

**Final Answer:** The ratio of rms speeds is $\sqrt{2} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q11

## Q12.

**Solution**

**Concept — Time period of a spring–mass system:** A mass $m$ on a spring of force constant $k$ oscillates with period $T = 2\pi\sqrt{\frac{m}{k}}$.

**Step 1 — List the values:** Mass $m = 2$ kg.

Force constant $k = 200$ N m$^{-1}$.

**Step 2 — Compute the ratio inside the root:**

$$\frac{m}{k} = \frac{2}{200} = 0.01 \text{ s}^2.$$

$$\sqrt{\frac{m}{k}} = \sqrt{0.01} = 0.1 \text{ s}.$$

**Step 3 — Multiply by $2\pi$:**

$$T = 2\pi \times 0.1 = 2 \times 3.14 \times 0.1 = 0.628 \approx 0.63 \text{ s}.$$

**Why other options are wrong:**

- Option A $(0.31 \text{ s})$: uses $\pi$ instead of $2\pi$.
- Option C $(1.26 \text{ s})$: doubles the correct value.
- Option D $(0.10 \text{ s})$: forgets the $2\pi$ factor.

**Final Answer:** Time period $\approx 0.63$ s $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q12

## Q13.

**Solution**

**Concept — Coulomb's law:** The force between two point charges is $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$.

**Step 1 — List the values:** $q_1 = q_2 = 2\ \mu\text{C} = 2 \times 10^{-6}$ C.

Separation $r = 0.1$ m, so $r^2 = 0.01$ m$^2$.

**Step 2 — Substitute into Coulomb's law:**

$$F = 9 \times 10^9 \times \frac{(2 \times 10^{-6}) \times (2 \times 10^{-6})}{0.01}.$$

**Step 3 — Simplify the numerator:**

$$(2 \times 10^{-6}) \times (2 \times 10^{-6}) = 4 \times 10^{-12}\ \text{C}^2.$$

**Step 4 — Complete the calculation:**

$$F = 9 \times 10^9 \times \frac{4 \times 10^{-12}}{0.01} = \frac{36 \times 10^{-3}}{0.01} = 3.6\ \text{N}.$$

**Why other options are wrong:**

- Option A ($1.8$ N): halves the result.
- Option B ($7.2$ N): doubles the result.
- Option D ($0.36$ N): power-of-ten slip in $r^2$.

**Final Answer:** Force $= 3.6$ N $\Rightarrow$ C

**Answer: (C)** Go Back to Q13

## Q14.

**Solution**

**Concept — Energy stored in a capacitor:** A charged capacitor stores energy $U = \frac{1}{2}CV^2$.

**Step 1 — List the values:** Capacitance $C = 2\ \mu\text{F} = 2 \times 10^{-6}$ F.

Voltage $V = 100$ V, so $V^2 = 10^4$ V$^2$.

**Step 2 — Substitute into the energy formula:**

$$U = \frac{1}{2} \times (2 \times 10^{-6}) \times (10^4).$$

**Step 3 — Simplify:**

$$U = \frac{1}{2} \times 2 \times 10^{-6+4} = 1 \times 10^{-2} = 0.01 \text{ J}.$$

**Why other options are wrong:**

- Option B ($0.02$ J): forgets the factor $\frac{1}{2}$.
- Option C ($0.10$ J): power-of-ten slip.
- Option D ($0.005$ J): halves the correct value again.

**Final Answer:** Energy stored $= 0.01$ J $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q14

## Q15.

### Solution

**Concept — Series and parallel resistors:** Resistors in parallel combine as $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$; resistors in series simply add.

**Step 1 — Combine the two parallel $6\ \Omega$ resistors:**

$$\frac{1}{R_p} = \frac{1}{6} + \frac{1}{6} = \frac{2}{6} = \frac{1}{3}.$$

$$R_p = 3\ \Omega.$$

**Step 2 — Add the series $2\ \Omega$ resistor:**

$$R_{\text{total}} = R_p + 2 = 3 + 2 = 5\ \Omega.$$

**Step 3 — Apply Ohm's law for the battery current:**

$$I = \frac{V}{R_{\text{total}}} = \frac{10}{5} = 2 \text{ A}.$$

**Why other options are wrong:**

- Option A ($1$ A): treats the two $6\ \Omega$ as in series ($12 + 2 = 14$, wrong setup).
- Option C ($5$ A): ignores the series resistor.
- Option D ($0.5$ A): inverts the calculation.

**Final Answer:** Current $= 2$ A $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q15

## Q16.

### Solution

**Concept — Resistance of a stretched wire:** When a wire is stretched at constant volume, both its length and area change. Since $R = \rho\dfrac{L}{A}$ and volume $V = AL$ is constant, $R \propto L^2$.

**Step 1 — Effect of doubling the length:** If length becomes $2L$ and volume stays constant, the new area becomes $A/2$ (because $A'L' = AL$ gives $A' = A/2$).

**Step 2 — New resistance from $R = \rho L/A$:**

$$R' = \rho\frac{2L}{A/2} = \rho\frac{2L \times 2}{A} = 4\,\rho\frac{L}{A} = 4R.$$

**Step 3 — Put in the value:**

$$R' = 4 \times 2 = 8\ \Omega.$$

**Why other options are wrong:**

- Option A ($4\ \Omega$): assumes $R \propto L$ only, ignoring the area change.
- Option B ($2\ \Omega$): assumes no change.
- Option C ($16\ \Omega$): uses $R \propto L^4$.

**Final Answer:** New resistance $= 8\ \Omega \Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q16

## Q17.

**Solution**

**Concept — Force on a current-carrying conductor:** A straight wire of length $L$ carrying current $I$ in a magnetic field $B$ experiences a force $F = BIL\sin\theta$. When the wire is perpendicular to the field, $\theta = 90^\circ$ and $\sin\theta = 1$.

**Step 1 — List the values:** Magnetic field $B = 0.5$ T.

Current $I = 2$ A.

Length $L = 0.5$ m.

Angle $\theta = 90^\circ$, so $\sin\theta = 1$.

**Step 2 — Substitute into the formula:**

$$F = BIL\sin\theta = 0.5 \times 2 \times 0.5 \times 1.$$

**Step 3 — Simplify:**

$$F = 0.5 \times 2 \times 0.5 = 0.5 \text{ N}.$$

**Why other options are wrong:**

- Option B (1.0 N): forgets to multiply by the length 0.5.
- Option C (2.0 N): drops the field value.
- Option D (0.25 N): squares the length factor.

**Final Answer:** Force on the wire $= 0.5$ N $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q17

## Q18.

**Solution**

**Concept — Magnetic field of a long solenoid:** Inside a long solenoid the field is uniform and given by $B = \mu_0 nI$, where $n$ is the number of turns per metre.

**Step 1 — List the values:** Turns per metre $n = 1000$ m$^{-1}$.

Current $I = 2$ A.

$\mu_0 = 4\pi \times 10^{-7}$ T m A$^{-1}$.

**Step 2 — Substitute into the formula:**

$$B = \mu_0 nI = (4\pi \times 10^{-7}) \times 1000 \times 2.$$

**Step 3 — Simplify:**

$$B = 4\pi \times 10^{-7} \times 2000 = 8\pi \times 10^{-4}\ \text{T}.$$

$$B = 8 \times 3.14 \times 10^{-4} = 25.1 \times 10^{-4} = 2.51 \times 10^{-3}\ \text{T}.$$

**Why other options are wrong:**

- Option A ($1.25 \times 10^{-3}$ T): halves the result.
- Option B ($5.0 \times 10^{-3}$ T): doubles the result.
- Option D ($4\pi \times 10^{-4}$ T): forgets the factor of $2$ from the current.

**Final Answer:** Field $\approx 2.51 \times 10^{-3}$ T $\Rightarrow$ C

**Answer: (C)** Go Back to Q18

## Q19.

**Solution**

**Concept — Faraday's law of induction:** The magnitude of the average induced emf in a coil of $N$ turns is $\varepsilon = N\dfrac{|\Delta\Phi|}{\Delta t}$.

**Step 1 — Find the change in flux:**

$$|\Delta\Phi| = |0.01 - 0.04| = 0.03\ \text{Wb}.$$

**Step 2 — List the other values:** Number of turns $N = 100$.

Time interval $\Delta t = 0.03$ s.

**Step 3 — Substitute into Faraday's law:**

$$\varepsilon = N\frac{|\Delta\Phi|}{\Delta t} = 100 \times \frac{0.03}{0.03}.$$

**Step 4 — Simplify:**

$$\varepsilon = 100 \times 1 = 100\ \text{V}.$$

**Why other options are wrong:**

- Option A ($50$ V): uses half the turns.
- Option C ($150$ V): wrong flux change.
- Option D ($10$ V): drops a factor of ten.

**Final Answer:** Induced emf $= 100$ V $\Rightarrow \boxed{\text{B}}$

**Answer: (B)** Go Back to Q19

## Q20.

### Solution

**Concept — Mirror formula:** For a spherical mirror, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$, using the sign convention that distances measured against the incident light are negative.

**Step 1 — Assign signs to the data:** Object distance $u = -30$ cm.

Focal length of a concave mirror $f = -10$ cm.

**Step 2 — Rearrange the mirror formula for $\frac{1}{v}$:**

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{-10} - \frac{1}{-30}.$$

**Step 3 — Combine the fractions:**

$$\frac{1}{v} = -\frac{1}{10} + \frac{1}{30} = \frac{-3+1}{30} = \frac{-2}{30} = -\frac{1}{15}.$$

**Step 4 — Invert to find $v$:**

$$v = -15 \text{ cm}.$$

The negative sign shows the image is real and forms 15 cm in front of the mirror.

**Why other options are wrong:**

- Option A (10 cm): equals the focal length, not the image distance.
- Option B (30 cm): equals the object distance.
- Option C (7.5 cm): arithmetic error in combining fractions.

**Final Answer:** Image distance $= 15$ cm $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q20

## Q21.

**Solution**

**Concept — Fringe width in YDSE:** The spacing between consecutive bright (or dark) fringes is $\beta = \dfrac{\lambda D}{d}$, where $D$ is the slit-to-screen distance and $d$ is the slit separation.

**Step 1 — Convert all quantities to SI units:** Wavelength $\lambda = 600$ nm $= 600\times10^{-9}$ m.

Screen distance $D = 1$ m.

Slit separation $d = 0.3$ mm $= 0.3 \times 10^{-3}$ m.

**Step 2 — Substitute into the formula:**

$$\beta = \frac{\lambda D}{d} = \frac{600 \times 10^{-9} \times 1}{0.3 \times 10^{-3}}.$$

**Step 3 — Simplify:**

$$\beta = \frac{600 \times 10^{-9}}{0.3 \times 10^{-3}} = 2000 \times 10^{-6} = 2 \times 10^{-3} \text{ m} = 2 \text{ mm}.$$

**Why other options are wrong:**

- Option A (1 mm): uses double the slit separation.
- Option B (3 mm): wrong wavelength value.
- Option D (0.5 mm): inverts the ratio.

**Final Answer:** Fringe width $= 2$ mm $\Rightarrow$ $\boxed{\text{C}}$

**Answer: (C)** Go Back to Q21

## Q22.

**Solution**

**Concept — Einstein's photoelectric equation:** The maximum kinetic energy of an emitted photoelectron is $K_{\text{max}} = E_{\text{photon}} - \phi$, where $\phi$ is the work function.

**Step 1 — List the values:** Photon energy $E_{\text{photon}} = 5$ eV.

Work function $\phi = 2$ eV.

**Step 2 — Apply the photoelectric equation:**

$$K_{\text{max}} = E_{\text{photon}} - \phi = 5 - 2.$$

**Step 3 — Simplify:**

$$K_{max} = 3 \text{ eV}.$$

**Why other options are wrong:**

- Option B (2 eV): equals the work function, not the kinetic energy.
- Option C (5 eV): equals the photon energy, ignoring the work function.
- Option D (7 eV): adds instead of subtracting.

**Final Answer:** Maximum kinetic energy $= 3$ eV $\Rightarrow \boxed{A}$

**Answer: (A)** Go Back to Q22

## Q23.

### Solution

**Concept — Bohr energy levels:** In the hydrogen atom the energy of the $n$th level is $E_n = -\frac{13.6}{n^2}$ eV.

**Step 1 — Substitute $n = 2$:**

$$E_2 = -\frac{13.6}{2^2} = -\frac{13.6}{4}.$$

**Step 2 — Simplify:**

$$E_2 = -3.4 \text{ eV}.$$

**Why other options are wrong:**

- Option A ($-13.6$ eV): is the ground-state energy ($n = 1$).
- Option C ($-1.51$ eV): is the $n = 3$ level.
- Option D ($-0.85$ eV): is the $n = 4$ level.

**Final Answer:** Energy of the $n = 2$ level $= -3.4$ eV $\Rightarrow \boxed{B}$

**Answer: (B)** Go Back to Q23

## Q24.

**Solution**

**Concept — Radioactive half-life:** After $n$ half-lives, the remaining fraction of a sample is $\left(\frac{1}{2}\right)^n$.

**Step 1 — Find the number of half-lives for one-eighth:**

$$\frac{1}{8} = \left(\frac{1}{2}\right)^n.$$

Since $\frac{1}{8} = \left(\frac{1}{2}\right)^3$, we get $n = 3$.

**Step 2 — Multiply by the half-life:**

$$t = n \times T_{1/2} = 3 \times 2 = 6 \text{ days}.$$

**Why other options are wrong:**

- Option A (4 days): corresponds to 2 half-lives ($\frac{1}{4}$).
- Option B (8 days): corresponds to 4 half-lives ($\frac{1}{16}$).
- Option C (2 days): corresponds to 1 half-life ($\frac{1}{2}$).

**Final Answer:** Time required $= 6$ days $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q24

## Q25.

**Solution**

**Concept — p-type semiconductors:** Doping pure silicon (a tetravalent element) with a trivalent impurity (such as boron) creates vacancies called holes, which act as positive charge carriers.

**Step 1 — Effect of trivalent doping:** A trivalent atom has only three valence electrons, so one bond with the surrounding silicon atoms is left incomplete, creating a hole.

**Step 2 — Identify the majority carriers:** These holes are far more numerous than the thermally generated electrons, so holes are the majority charge carriers in a p-type semiconductor.

**Why other options are wrong:**

- Option A (Electrons): electrons are the minority carriers in p-type material; they are the majority carriers in n-type.
- Option C (Protons): protons are fixed in the nuclei and do not move to carry current.
- Option D (Positive ions): the dopant ions are fixed in the lattice and do not act as mobile carriers.

**Final Answer:** The majority carriers in a p-type semiconductor are holes $\Rightarrow \boxed{B}$

**Answer: (B)** Go Back to Q25

## Answer Key

| Q | Ans | Q | Ans | Q | Ans | Q | Ans | Q | Ans |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A | 2 | C | 3 | D | 4 | B | 5 | A |
| 6 | C | 7 | D | 8 | C | 9 | B | 10 | A |
| 11 | D | 12 | B | 13 | C | 14 | A | 15 | B |
| 16 | D | 17 | A | 18 | C | 19 | B | 20 | D |
| 21 | C | 22 | A | 23 | B | 24 | D | 25 | B |