# PGIMER BSc Nursing Physics

## Sample Paper – 2

**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.** Pressure is defined as force per unit area. The dimensional formula of pressure is:

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

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

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

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

**Q2.** A ball is thrown vertically upward with an initial speed of $20$ m s$^{-1}$. Taking $g = 10$ m s$^{-2}$ and neglecting air resistance, the total time for which the ball remains in the air before returning to the point of projection is:

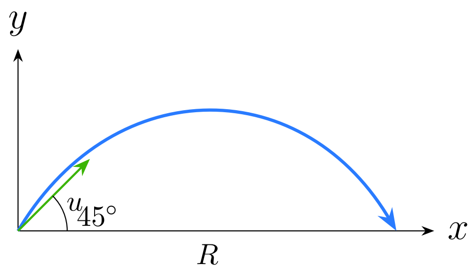
(A) $2$ s

(B) $4$ s

(C) $8$ s

(D) 1 s

**Q3.** A projectile is launched from the ground with a speed of $20 \text{ m s}^{-1}$ at an angle of $45^\circ$ to the horizontal, as shown. Taking $g = 10 \text{ m s}^{-2}$, its horizontal range is:




(A) 20 m

(B) 80 m

(C) 40 m

(D) 10 m

**Q4.** A block of mass 10 kg rests on a rough horizontal floor. The coefficient of static friction between the block and the floor is $\mu = 0.4$. Taking $g = 10 \text{ m s}^{-2}$, the minimum horizontal force required to just start moving the block is:

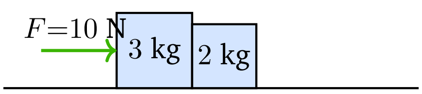
(A) 40 N

(B) 20 N

(C) 80 N

(D) 100 N

**Q5.** Two blocks of masses 3 kg and 2 kg are placed in contact on a smooth (frictionless) horizontal surface. A constant horizontal force of 10 N is applied to the 3 kg block so that the two move together, as shown. The contact force between the blocks is:



(A) 6 N

(B) 10 N

(C) 2 N

(D) 4 N

**Q6.** A constant force of 20 N acts on a body and displaces it through 5 m. The angle between the force and the displacement is $60^\circ$ ($\cos 60^\circ = 0.5$). The work done by the force is:

(A) 100 J

(B) 50 J

(C) 25 J

(D) 86.6 J

**Q7.** A torque of 10 N m acts on a rigid body whose moment of inertia about the axis of rotation is 2 kg $m^2$. The angular acceleration produced is:

(A) 2 rad $s^{-2}$

(B) 0.2 rad $s^{-2}$

(C) 20 rad $s^{-2}$

(D) 5 rad $s^{-2}$

**Q8.** The escape velocity from the surface of the Earth is given by $v_e = \sqrt{2gR}$. Taking $g = 9.8$ m $s^{-2}$ and the radius of the Earth $R = 6.4 \times 10^6$ m, the escape velocity is approximately:

(A) 7.9 km $s^{-1}$

(B) 9.8 km $s^{-1}$

(C) 11.2 km $s^{-1}$

(D) 22.4 km $s^{-1}$

**Q9.** Water stands at a height of 5 m above a small hole in the side wall of a large tank. Taking $g = 10$ m $s^{-2}$, the speed with which water flows out of the hole (Torricelli's law, $v = \sqrt{2gh}$) is:

(A) $10$ m s$^{-1}$

(B) $50$ m s$^{-1}$

(C) $5$ m s$^{-1}$

(D) $100$ m s$^{-1}$

**Q10.** A gas absorbs $100$ J of heat and does $40$ J of work on its surroundings. By the first law of thermodynamics, the change in the internal energy of the gas is:

(A) $40$ J

(B) $140$ J

(C) $60$ J

(D) $100$ J

**Q11.** The mean translational kinetic energy of a single molecule of an ideal gas is $\frac{3}{2}kT$. Taking the Boltzmann constant $k = 1.38 \times 10^{-23}$ J K$^{-1}$ and $T = 300$ K, this energy is:

(A) $6.21 \times 10^{-21}$ J

(B) $4.14 \times 10^{-21}$ J

(C) $1.38 \times 10^{-21}$ J

(D) $9.00 \times 10^{-21}$ J

**Q12.** A simple pendulum has a length of $1$ m. Taking $g = 9.8$ m s$^{-2}$ and $\pi = 3.14$, its time period of oscillation is approximately:

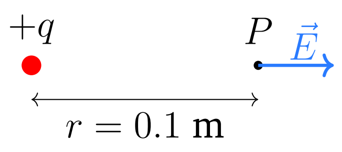
(A) $1$ s

(B) $4$ s

(C) $2$ s

(D) $0.5$ s

**Q13.** A point charge $q = +2\ \mu$C is placed in vacuum. The magnitude of the electric field it produces at a point $P$ located $0.1$ m from the charge, as shown, is $\left(\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ \text{N m}^2\,\text{C}^{-2}\right)$:




(A) $9 \times 10^5$ N C$^{-1}$

(B) $1.8 \times 10^6$ N C$^{-1}$

(C) $3.6 \times 10^6$ N C$^{-1}$

(D) $1.8 \times 10^5$ N C$^{-1}$

**Q14.** A parallel-plate capacitor has plates of area $2 \times 10^{-3}$ m$^2$ separated by a distance of $1 \times 10^{-3}$ m, with vacuum between the plates. Taking $\varepsilon_0 = 8.85 \times 10^{-12}$ F m$^{-1}$, its capacitance $\left(C = \frac{\varepsilon_0 A}{d}\right)$ is:

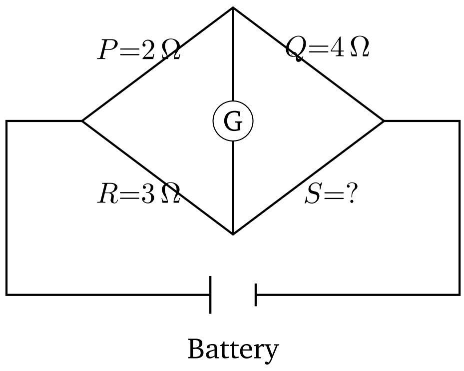
(A) $1.77$ pF

(B) $8.85$ pF

(C) $35.4$ pF

(D) $17.7$ pF

**Q15.** In the balanced Wheatstone bridge shown, the galvanometer G shows no deflection. With $P = 2\ \Omega$, $Q = 4\ \Omega$ and $R = 3\ \Omega$, the value of the unknown resistance $S$ is:




(A) $3\ \Omega$

(B) $6\ \Omega$

(C) $1.5\ \Omega$

(D) $12\ \Omega$

**Q16.** A metal wire has a resistance of $100\ \Omega$ at $20°$C. Its temperature coefficient of resistance is $\alpha = 0.004\ °\text{C}^{-1}$. Using $R = R_0(1 + \alpha\,\Delta T)$, its resistance at $70°$C is:

(A) $120\ \Omega$

(B) $140\ \Omega$

(C) $200\ \Omega$

(D) $100\ \Omega$

**Q17.** A charge of $2$ C moves with a speed of $4$ m s$^{-1}$ at right angles to a uniform magnetic field of $0.5$ T. The magnitude of the magnetic force acting on the charge ($F = qvB$) is:

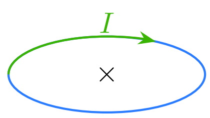
(A) $4$ N

(B) $8$ N

(C) $2$ N

(D) $1$ N

**Q18.** A circular coil of $100$ turns and radius $0.1$ m carries a current of $2$ A, as shown. Taking $\mu_0 = 4\pi \times 10^{-7}$ T m A$^{-1}$, the magnetic field at the centre of the coil $\left(B = \dfrac{\mu_0 n I}{2R}\right)$ is:




$n$=100 turns, $R$=0.1 m

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

(B) $1.26 \times 10^{-3}$ T

(C) $6.28 \times 10^{-4}$ T

(D) $4\pi \times 10^{-3}$ T

**Q19.** A conducting rod of length $0.4$ m moves with a uniform velocity of $10$ m s$^{-1}$ perpendicular to a uniform magnetic field of $0.5$ T. The motional emf induced across the ends of the rod ($\varepsilon = BLv$) is:

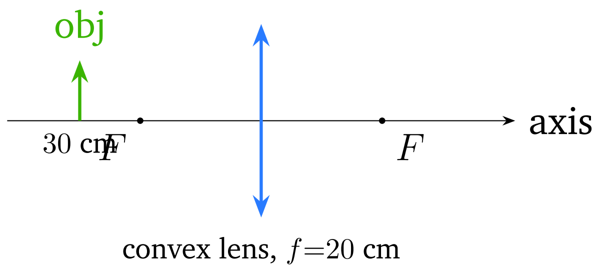
(A) $1$ V

(B) $4$ V

(C) $2$ V

(D) $0.5$ V

**Q20.** An object is placed $30$ cm in front of a thin convex lens of focal length $20$ cm, as shown. Using $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$, the distance of the image from the lens is:




(A) $60$ cm

(B) $20$ cm

(C) $30$ cm

(D) $12$ cm

**Q21.** In Young's double-slit experiment, constructive interference (a bright fringe) is observed at a point on the screen when the path difference between the two interfering waves is equal to:

(A) a half-integral multiple, $\left(n + \frac{1}{2}\right)\lambda$

(B) an integral multiple of the wavelength, $n\lambda$

(C) an odd multiple of half the wavelength, $(2n+1)\dfrac{\lambda}{2}$

(D) exactly half the wavelength, $\dfrac{\lambda}{2}$

**Q22.** A particle has a linear momentum of $6.6\times10^{-24}$ kg m s$^{-1}$. Taking Planck's constant $h = 6.6\times10^{-34}$ J s, its de Broglie wavelength $\left(\lambda = \dfrac{h}{p}\right)$ is:

(A) $6.6$ Å

(B) $0.1$ Å

(C) $10$ Å

(D) $1$ Å

**Q23.** In the Bohr model of the hydrogen atom, the radius of the $n$th orbit is $r_n = 0.529\,n^2$ Å. The radius of the second orbit $(n = 2)$ is:

(A) $0.529$ Å

(B) $2.12$ Å

(C) $1.06$ Å

(D) $4.76$ Å

**Q24.** The mass defect of a certain nucleus is $0.1$ u. Taking $1$ u $= 931.5$ MeV$/c^2$, the binding energy of the nucleus is:

(A) $9.315$ MeV

(B) $931.5$ MeV

(C) $18.63$ MeV

(D) $93.15$ MeV

**Q25.** Pure silicon is doped with a pentavalent impurity (such as phosphorus) to form an n-type semiconductor. The majority charge carriers in this material are:

(A) Holes

(B) Protons

(C) Negative ions

(D) Electrons

## Detailed Solutions

### Q1.

**Solution**

**Concept — Dimensions from a definition:** The dimensional formula of a quantity is found by substituting the dimensions of the quantities in its defining equation.

**Step 1 — Write pressure as force over area:**

$$P = \frac{F}{A}.$$

**Step 2 — Write the dimensions of force and area:** Force: $[F] = [MLT^{-2}]$.
Area: $[A] = [L^2]$.

**Step 3 — Substitute and simplify:**

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

**Why other options are wrong:**

- Option A $[MLT^{-2}]$: this is the dimension of force itself.
- Option B $[ML^2T^{-2}]$: this is the dimension of energy or work.
- Option D $[ML^{-1}T^{-1}]$: this is the dimension of coefficient of viscosity.

**Final Answer:** The dimensional formula of pressure is $[ML^{-1}T^{-2}] \Rightarrow \boxed{\text{C}}$

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

### Q2.

**Solution**

**Concept — Time of flight for vertical motion:** A body thrown straight up returns to the launch point after a total time $T = \frac{2u}{g}$, since the time to rise equals the time to fall.

**Step 1 — List the known values:** Initial speed $u = 20$ m s$^{-1}$.
Acceleration $g = 10$ m s$^{-2}$.

**Step 2 — Time to reach the highest point:** At the top, the velocity is zero, so

$t_{\text{up}} = \frac{u}{g} = \frac{20}{10} = 2$ s.

**Step 3 — Total time of flight:**

$$T = 2\,t_{\text{up}} = 2 \times 2 = 4 \text{ s.}$$

**Why other options are wrong:**

- Option A (2 s): this is only the time to reach the top, not the full flight.
- Option C (8 s): doubles the correct value.
- Option D (1 s): uses $g = 20$ by mistake.

**Final Answer:** Total time of flight $= 4$ s $\Rightarrow$ $\boxed{\text{B}}$

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

## Q3.

**Solution**

**Concept — Horizontal range of a projectile:** For a projectile launched with speed $u$ at angle $\theta$, the range on level ground is $R = \frac{u^2 \sin 2\theta}{g}$.

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

Angle $\theta = 45^\circ$, so $2\theta = 90^\circ$ and $\sin 90^\circ = 1$.

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

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

$$R = \frac{u^2 \sin 2\theta}{g} = \frac{(20)^2 \times 1}{10}.$$

**Step 3 — Simplify:**

$$R = \frac{400}{10} = 40 \text{ m.}$$

**Why other options are wrong:**

- Option A (20 m): uses $u$ instead of $u^2$.
- Option B (80 m): doubles the correct value.
- Option D (10 m): divides the speed instead of squaring it.

**Final Answer:** Horizontal range $= 40$ m $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q3

## Q4.

**Solution**

**Concept — Limiting static friction:** A block on a horizontal floor just begins to move when the applied horizontal force equals the maximum (limiting) static friction, $f_{\text{max}} = \mu N$.

**Step 1 — Find the normal force:** On a horizontal floor the normal force balances the weight:

$$N = mg = 10 \times 10 = 100 \text{ N}.$$

**Step 2 — Compute the limiting friction:**

$$f_{\text{max}} = \mu N = 0.4 \times 100 = 40 \text{ N}.$$

**Step 3 — Minimum force to start motion:** The block just starts to move when the applied force equals $f_{\text{max}}$:

$$F_{\text{min}} = 40 \text{ N}.$$

**Why other options are wrong:**

- Option B (20 N): uses half the coefficient.
- Option C (80 N): doubles the correct value.
- Option D (100 N): equals the normal force, not the friction.

**Final Answer:** Minimum force $= 40$ N $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q4

## Q5.

**Solution**

**Concept — Two blocks in contact:** Treat the two blocks as one system to find the common acceleration, then isolate the rear block to find the contact (normal) force that pushes it.

**Step 1 — Common acceleration of the system:**

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

**Step 2 — Isolate the second block (2 kg):** The only horizontal force on the 2 kg block is the contact force $N$ from the first block, so:

$$N = m_2 \, a.$$

**Step 3 — Substitute the numbers:**

$$N = 2 \times 2 = 4 \text{ N}.$$

**Why other options are wrong:**

- Option A (6 N): uses the 3 kg mass instead of the 2 kg mass.
- Option B (10 N): equals the full applied force.
- Option C (2 N): uses the acceleration value as the force.

**Final Answer:** Contact force $= 4$ N $\Rightarrow$ D

Answer: (D) Go Back to Q5

## Q6.

Solution

**Concept — Work done by a constant force:** The work done is $W = Fd\cos\theta$, where $\theta$ is the angle between the force and the displacement.

**Step 1 — List the values:** Force $F = 20$ N.

Displacement $d = 5$ m.

Angle $\theta = 60^\circ$, so $\cos 60^\circ = 0.5$.

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

$$W = Fd\cos\theta = 20 \times 5 \times 0.5.$$

**Step 3 — Simplify:**

$$W = 100 \times 0.5 = 50 \text{ J}.$$

**Why other options are wrong:**

- Option A (100 J): forgets the $\cos 60^\circ$ factor.
- Option C (25 J): uses $\cos 60^\circ = 0.25$ by mistake.
- Option D (86.6 J): uses $\cos 30^\circ$ instead of $\cos 60^\circ$.

**Final Answer:** Work done $= 50$ J $\Rightarrow \boxed{\text{B}}$

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

## Q7.

### Solution

**Concept — Rotational form of Newton's second law:** The angular acceleration of a rigid body is related to the torque by $\tau = I\alpha$, so $\alpha = \frac{\tau}{I}$.

**Step 1 — List the values:** Torque $\tau = 10$ N m.

Moment of inertia $I = 2$ kg m$^2$.

**Step 2 — Rearrange and substitute:**

$$\alpha = \frac{\tau}{I} = \frac{10}{2}.$$

**Step 3 — Simplify:**

$$\alpha = 5 \text{ rad s}^{-2}.$$

**Why other options are wrong:**

- Option A (2 rad s$^{-2}$): equals the moment of inertia, not the acceleration.
- Option B (0.2 rad s$^{-2}$): inverts the ratio.
- Option C (20 rad s$^{-2}$): multiplies instead of dividing.

**Final Answer:** Angular acceleration $= 5$ rad s$^{-2}$ $\Rightarrow \boxed{\text{D}}$

**Answer: (D)** Go Back to Q7

## Q8.

### Solution

**Concept — Escape velocity:** The minimum speed needed to escape the Earth's gravity from its surface is $v_e = \sqrt{2gR}$.

**Step 1 — List the values:** $g = 9.8$ m s$^{-2}$.

$R = 6.4 \times 10^6$ m.

**Step 2 — Compute the product $2gR$:**

$$2gR = 2 \times 9.8 \times 6.4 \times 10^6 = 1.2544 \times 10^8 \text{ m}^2\,\text{s}^{-2}.$$

**Step 3 — Take the square root:**

$$v_e = \sqrt{1.2544 \times 10^8} = 1.12 \times 10^4 \text{ m s}^{-1}.$$

$$v_e = 11.2 \text{ km s}^{-1}.$$

**Why other options are wrong:**

- Option A ($7.9$ km s$^{-1}$): this is the orbital speed $\sqrt{gR}$, not the escape speed.
- Option B ($9.8$ km s$^{-1}$): mistakes $g$ for a speed.
- Option D ($22.4$ km s$^{-1}$): doubles the correct value.

**Final Answer:** Escape velocity $\approx 11.2$ km s$^{-1}$ $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q8

## Q9.

**Solution**

**Concept — Torricelli's law:** The speed of liquid flowing out of a small hole at depth $h$ below the free surface is $v = \sqrt{2gh}$, the same as a body falling freely through height $h$.

**Step 1 — List the values:** Depth of water above the hole $h = 5$ m.

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

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

$$v = \sqrt{2gh} = \sqrt{2 \times 10 \times 5}.$$

**Step 3 — Simplify:**

$$v = \sqrt{100} = 10 \text{ m s}^{-1}.$$

**Why other options are wrong:**

- Option B ($50$ m s$^{-1}$): forgets to take the square root.
- Option C ($5$ m s$^{-1}$): equals $h$, not the speed.
- Option D ($100$ m s$^{-1}$): equals $2gh$ without the root.

**Final Answer:** Speed of efflux $= 10$ m s$^{-1}$ $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

## Q10.

**Solution**

**Concept — First law of thermodynamics:** The change in internal energy is $\Delta U = Q - W$, where $Q$ is the heat added to the gas and $W$ is the work done by the gas.

**Step 1 — List the values:** Heat absorbed $Q = 100$ J.

Work done by the gas $W = 40$ J.

**Step 2 — Apply the first law:**

$$\Delta U = Q - W = 100 - 40.$$

**Step 3 — Simplify:**

$$\Delta U = 60 \text{ J}.$$

**Why other options are wrong:**

- Option A (40 J): equals the work done, not the change in internal energy.
- Option B (140 J): adds the work instead of subtracting it.
- Option D (100 J): equals the heat added, ignoring the work.

**Final Answer:** Change in internal energy $= 60$ J $\Rightarrow$ $\boxed{\text{C}}$

**Answer: (C)** Go Back to Q10

## Q11.

**Solution**

**Concept — Mean translational kinetic energy:** The average translational kinetic energy of one molecule of an ideal gas is $\overline{KE} = \frac{3}{2}kT$, depending only on the absolute temperature.

**Step 1 — List the values:** Boltzmann constant $k = 1.38 \times 10^{-23}$ J K$^{-1}$.

Temperature $T = 300$ K.

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

$$\overline{KE} = \frac{3}{2} \times (1.38 \times 10^{-23}) \times 300.$$

**Step 3 — Simplify step by step:**

$$\overline{KE} = 1.5 \times 1.38 \times 300 \times 10^{-23}.$$

$$1.5 \times 1.38 = 2.07.$$

$$2.07 \times 300 = 621.$$

$$\overline{KE} = 621 \times 10^{-23} = 6.21 \times 10^{-21} \text{ J}.$$

**Why other options are wrong:**

- Option B ($4.14 \times 10^{-21}$ J): uses a factor of $1$ instead of $\frac{3}{2}$.
- Option C ($1.38 \times 10^{-21}$ J): drops the temperature and the $\frac{3}{2}$ factor.
- Option D ($9.00 \times 10^{-21}$ J): incorrect arithmetic.

**Final Answer:** Mean translational KE $= 6.21 \times 10^{-21}$ J $\Rightarrow \boxed{\text{A}}$

**Answer: (A)** Go Back to Q11

## Q12.

**Solution**

**Concept — Time period of a simple pendulum:** A simple pendulum of length $L$ oscillates with period $T = 2\pi\sqrt{\frac{L}{g}}$.

**Step 1 — List the values:** Length $L = 1$ m.

Acceleration $g = 9.8$ m s$^{-2}$.

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

$$\frac{L}{g} = \frac{1}{9.8} = 0.102 \text{ s}^2.$$

$$\sqrt{\frac{L}{g}} = \sqrt{0.102} = 0.319 \text{ s}.$$

**Step 3 — Multiply by $2\pi$:**

$$T = 2\pi \times 0.319 = 2 \times 3.14 \times 0.319.$$

$$T = 6.28 \times 0.319 = 2.0 \text{ s}.$$

**Why other options are wrong:**

- Option A ($1$ s): uses $\pi$ instead of $2\pi$.
- Option B ($4$ s): doubles the correct value.
- Option D ($0.5$ s): forgets the $2\pi$ factor.

**Final Answer:** Time period $\approx 2$ s $\Rightarrow \boxed{\text{C}}$

**Answer: (C)** Go Back to Q12

## Q13.

### Solution

**Concept — Field of a point charge:** The electric field a distance $r$ from a point charge $q$ has magnitude $E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$.

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

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

$\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m$^2$ C$^{-2}$.

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

$$E = 9 \times 10^9 \times \frac{2 \times 10^{-6}}{0.01}.$$

**Step 3 — Simplify step by step:**

$$\frac{2 \times 10^{-6}}{0.01} = 2 \times 10^{-4}.$$

$$E = 9 \times 10^9 \times 2 \times 10^{-4} = 18 \times 10^5 = 1.8 \times 10^6 \text{ N C}^{-1}.$$

**Why other options are wrong:**

- Option A ($9 \times 10^5$): uses $q = 1\ \mu$C.
- Option C ($3.6 \times 10^6$): doubles the correct value.
- Option D ($1.8 \times 10^5$): a power-of-ten slip in $r^2$.

**Final Answer:** Electric field $= 1.8 \times 10^6$ N C$^{-1}$ $\Rightarrow \boxed{\text{B}}$

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

## Q14.

**Solution**

**Concept — Parallel-plate capacitance:** A parallel-plate capacitor with vacuum between its plates has capacitance $C = \dfrac{\varepsilon_0 A}{d}$.

**Step 1 — List the values:** Plate area $A = 2 \times 10^{-3}$ m$^2$.

Plate separation $d = 1 \times 10^{-3}$ m.

$\varepsilon_0 = 8.85 \times 10^{-12}$ F m$^{-1}$.

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

$$C = \frac{(8.85 \times 10^{-12}) \times (2 \times 10^{-3})}{1 \times 10^{-3}}.$$

**Step 3 — Simplify step by step:**

$$\frac{2 \times 10^{-3}}{1 \times 10^{-3}} = 2.$$

$$C = 8.85 \times 10^{-12} \times 2 = 1.77 \times 10^{-11} \text{ F} = 17.7 \text{ pF}.$$

**Why other options are wrong:**

- Option A ($1.77$ pF): a power-of-ten slip.
- Option B ($8.85$ pF): forgets the factor of $2$ from the area.
- Option C ($35.4$ pF): doubles the correct value.

**Final Answer:** Capacitance $= 17.7$ pF $\Rightarrow$ $\boxed{\text{D}}$

**Answer: (D)** Go Back to Q14

## Q15.

**Solution**

**Concept — Balanced Wheatstone bridge:** When the galvanometer shows no deflection, the bridge is balanced and the ratio condition $\dfrac{P}{Q} = \dfrac{R}{S}$ holds.

**Step 1 — Write the balance condition:**

$$\frac{P}{Q} = \frac{R}{S}.$$

**Step 2 — Rearrange for the unknown $S$:**

$$S = \frac{Q\,R}{P}.$$

**Step 3 — Substitute the values $P = 2$, $Q = 4$, $R = 3$:**

$$S = \frac{4 \times 3}{2} = \frac{12}{2} = 6\ \Omega.$$

**Why other options are wrong:**

- Option A ($3\ \Omega$): equals $R$, ignoring the $Q/P$ ratio.
- Option C ($1.5\ \Omega$): inverts the ratio.
- Option D ($12\ \Omega$): forgets to divide by $P$.

**Final Answer:** Unknown resistance $S = 6\ \Omega \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q15

## Q16.

### Solution

**Concept — Temperature dependence of resistance:** A metal's resistance varies with temperature as $R = R_0(1 + \alpha\,\Delta T)$, where $\Delta T$ is the rise in temperature.

**Step 1 — List the values:** Initial resistance $R_0 = 100\ \Omega$.

Temperature coefficient $\alpha = 0.004\ °\text{C}^{-1}$.

Temperature rise $\Delta T = 70 - 20 = 50\ °\text{C}$.

**Step 2 — Compute the factor $\alpha\,\Delta T$:**

$$\alpha\,\Delta T = 0.004 \times 50 = 0.2.$$

**Step 3 — Substitute into the formula:**

$$R = 100 \times (1 + 0.2) = 100 \times 1.2 = 120\ \Omega.$$

**Why other options are wrong:**

- Option B ($140\ \Omega$): uses $\Delta T = 100$ by mistake.
- Option C ($200\ \Omega$): doubles the resistance incorrectly.
- Option D ($100\ \Omega$): ignores the temperature change.

**Final Answer:** Resistance at $70°\text{C} = 120\ \Omega \Rightarrow \boxed{\text{A}}$

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

## Q17.

**Solution**

**Concept — Magnetic force on a moving charge:** A charge $q$ moving with speed $v$ at angle $\theta$ to a magnetic field $B$ feels a force $F = qvB\sin\theta$. When the motion is perpendicular to the field, $\theta = 90°$ and $\sin\theta = 1$.

**Step 1 — List the values:** Charge $q = 2$ C.

Speed $v = 4$ m s$^{-1}$.

Field $B = 0.5$ T.

Angle $\theta = 90°$, so $\sin\theta = 1$.

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

$$F = qvB\sin\theta = 2 \times 4 \times 0.5 \times 1.$$

**Step 3 — Simplify:**

$$F = 8 \times 0.5 = 4\ \text{N}.$$

**Why other options are wrong:**

- Option B (8 N): forgets the field value of 0.5 T.
- Option C (2 N): drops the speed factor.
- Option D (1 N): uses only the charge and field.

**Final Answer:** Magnetic force $= 4\ \text{N} \Rightarrow \boxed{\text{A}}$

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

## Q18.

**Solution**

**Concept — Field at the centre of a circular coil:** A flat circular coil of $n$ turns and radius $R$ carrying current $I$ produces a field at its centre of $B = \frac{\mu_0 n I}{2R}$.

**Step 1 — List the values:** Turns $n = 100$.

Current $I = 2$ A.

Radius $R = 0.1$ m.

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

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

$$B = \frac{(4\pi \times 10^{-7}) \times 100 \times 2}{2 \times 0.1}.$$

**Step 3 — Simplify step by step:**

$$\text{Numerator} = 4\pi \times 10^{-7} \times 200 = 800\pi \times 10^{-7}.$$

$$\text{Denominator} = 0.2.$$

$$B = \frac{800\pi \times 10^{-7}}{0.2} = 4000\pi \times 10^{-7} = 4\pi \times 10^{-4}\ \text{T}.$$

$$B = 4 \times 3.14 \times 10^{-4} = 12.56 \times 10^{-4} = 1.26 \times 10^{-3}\ \text{T}.$$

**Why other options are wrong:**

- Option A ($2.51 \times 10^{-3}$ T): doubles the correct value.
- Option C ($6.28 \times 10^{-4}$ T): halves the correct value.
- Option D ($4\pi \times 10^{-3}$ T): a power-of-ten error.

**Final Answer:** Field at the centre $\approx 1.26 \times 10^{-3}$ T $\Rightarrow$ $\boxed{\text{B}}$

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

## Q19.

**Solution**

**Concept — Motional emf:** A conducting rod of length $L$ moving with speed $v$ perpendicular to a magnetic field $B$ develops an emf $\varepsilon = BLv$ across its ends.

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

Length $L = 0.4$ m.

Speed $v = 10$ m s$^{-1}$.

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

$$\varepsilon = BLv = 0.5 \times 0.4 \times 10.$$

**Step 3 — Simplify:**

$$\varepsilon = 0.5 \times 4 = 2 \text{ V}.$$

**Why other options are wrong:**

- Option A ($1$ V): uses half the length.
- Option B ($4$ V): drops the field value of $0.5$ T.
- Option D ($0.5$ V): uses only the field as the answer.

**Final Answer:** Motional emf $= 2$ V $\Rightarrow \boxed{\text{C}}$

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

## Q20.

**Solution**

**Concept — Thin lens formula:** For a thin lens, $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$, 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 convex lens $f = +20$ cm.

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

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{20} + \frac{1}{-30}.$$

**Step 3 — Combine the fractions:**

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{30} = \frac{3-2}{60} = \frac{1}{60}.$$

**Step 4 — Invert to find $v$:**

$$v = +60 \text{ cm}.$$

The positive sign shows the image is real and forms 60 cm on the far side of the lens.

**Why other options are wrong:**

- Option B (20 cm): equals the focal length.
- Option C (30 cm): equals the object distance.
- Option D (12 cm): comes from adding the reciprocals wrongly.

**Final Answer:** Image distance = 60 cm $\Rightarrow$ $\boxed{\text{A}}$

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

## Q21.

**Solution**

**Concept — Condition for a bright fringe:** In double-slit interference, a bright fringe (constructive interference) occurs where the two waves arrive in phase, that is where the path difference is a whole number of wavelengths.

**Step 1 — Constructive interference condition:** For the waves to add in phase, the path difference must be:

$$\Delta x = n\lambda, \qquad n = 0, 1, 2, \ldots$$

**Step 2 — Contrast with the dark-fringe condition:** A dark fringe (destructive interference) instead requires a half-integral path difference:

$$\Delta x = \left(n + \tfrac{1}{2}\right)\lambda.$$

**Why other options are wrong:**

- Option A $\left(n + \frac{1}{2}\right)\lambda$: this is the condition for a dark fringe.
- Option C $(2n+1)\frac{\lambda}{2}$: this is another form of the dark-fringe (destructive) condition.

- Option D $\frac{\lambda}{2}$: this gives only the first dark fringe, not the general bright condition.

**Final Answer:** A bright fringe needs a path difference of $n\lambda \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q21

## Q22.

### Solution

**Concept — de Broglie wavelength:** A particle of momentum $p$ has an associated wave of wavelength $\lambda = \dfrac{h}{p}$, where $h$ is Planck's constant.

**Step 1 — List the values:** Momentum $p = 6.6 \times 10^{-24}$ kg m s$^{-1}$.

Planck's constant $h = 6.6 \times 10^{-34}$ J s.

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

$$\lambda = \frac{h}{p} = \frac{6.6 \times 10^{-34}}{6.6 \times 10^{-24}}.$$

**Step 3 — Simplify:**

$$\lambda = 10^{-34-(-24)} = 10^{-10} \text{ m}.$$

$$\lambda = 1 \text{ Å} \quad (\text{since } 1 \text{ Å} = 10^{-10} \text{ m}).$$

**Why other options are wrong:**

- Option A ($6.6$ Å): keeps the numerical factor without cancelling.
- Option B ($0.1$ Å): a power-of-ten slip.
- Option C ($10$ Å): a power-of-ten slip in the other direction.

**Final Answer:** de Broglie wavelength $= 1$ Å $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q22

## Q23.

**Solution**

**Concept — Bohr orbit radius:** In the hydrogen atom the radius of the $n$th orbit grows as the square of $n$: $r_n = 0.529\, n^2$ Å.

**Step 1 — Substitute $n = 2$:**

$$r_2 = 0.529 \times (2)^2.$$

**Step 2 — Evaluate the square:**

$$(2)^2 = 4.$$

**Step 3 — Multiply:**

$$r_2 = 0.529 \times 4 = 2.12 \text{ Å}.$$

**Why other options are wrong:**

- Option A ($0.529$ Å): is the first-orbit radius ($n = 1$).
- Option C ($1.06$ Å): uses $n$ instead of $n^2$ (a factor of $2$).
- Option D ($4.76$ Å): uses $n = 3$.

**Final Answer:** Radius of the second orbit $= 2.12$ Å $\Rightarrow \boxed{\text{B}}$

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

## Q24.

**Solution**

**Concept — Mass–energy equivalence:** The binding energy of a nucleus equals its mass defect converted to energy. Using $1$ u $= 931.5$ MeV, the binding energy is $E = \Delta m \times 931.5$ MeV.

**Step 1 — List the values:** Mass defect $\Delta m = 0.1$ u.

Conversion: $1$ u $= 931.5$ MeV.

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

$$E = \Delta m \times 931.5 = 0.1 \times 931.5.$$

**Step 3 — Simplify:**

$$E = 93.15 \text{ MeV}.$$

**Why other options are wrong:**

- Option A ($9.315$ MeV): uses $\Delta m = 0.01$ u.
- Option B ($931.5$ MeV): uses $\Delta m = 1$ u.
- Option C ($18.63$ MeV): doubles using $\Delta m = 0.02$ u.

**Final Answer:** Binding energy $= 93.15$ MeV $\Rightarrow$ $\boxed{\text{D}}$

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

## Q25.

**Solution**

**Concept — n-type semiconductors:** Doping pure silicon (a tetravalent element) with a pentavalent impurity (such as phosphorus) adds an extra electron per dopant atom, and these free electrons become the majority carriers.

**Step 1 — Effect of pentavalent doping:** A pentavalent atom has five valence electrons. Four form covalent bonds with the neighbouring silicon atoms, leaving one electron loosely bound and free to move.

**Step 2 — Identify the majority carriers:** These donated free electrons greatly outnumber the thermally generated holes, so electrons are the majority charge carriers in an n-type semiconductor.

**Why other options are wrong:**

- Option A (Holes): holes are the minority carriers in n-type material; they dominate in p-type.
- Option B (Protons): protons are bound in the nuclei and do not move to carry current.
- Option C (Negative ions): the dopant ions are fixed in the lattice and do not act as mobile carriers.

**Final Answer:** The majority carriers in an n-type semiconductor are electrons $\Rightarrow$ $\boxed{\text{D}}$

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

## Answer Key

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