PGIMER BSc Nursing Physics

Sample Paper – 7

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 density of a small body is found from the relation $\rho = \frac{m}{V}$. The mass m is measured with an error of 2% and the volume V is measured with an error of 1%. The maximum percentage error in the calculated density is:

(A) 1%

(B) 2%

(C) 3%

(D) 4%

Q2. A car moving at 20 m s^{-1} applies its brakes and comes to rest with a uniform retardation of 4 m s^{-2}. Using $v^2 = u^2 - 2as$, the distance travelled by the car before stopping is:

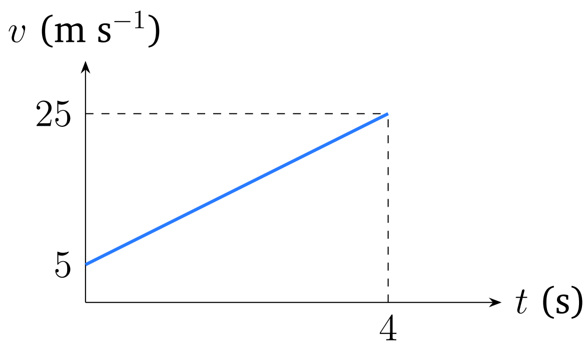
(A) 50 m

(B) 40 m

(C) 25 m

(D) 100 m

Q3. The velocity–time graph of a particle moving in a straight line is the single sloping straight line shown below. The acceleration of the particle during this interval is:



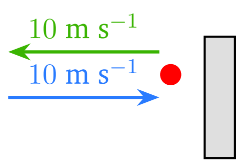
(A) 2 m s^{-2}

(B) 10 m s^{-2}

(C) 4 m s^{-2}

(D) 5 m s^{-2}

Q4. A ball of mass 0.2 kg moving horizontally at 10 m s^{-1} strikes a rigid wall normally and rebounds with the same speed, as shown. The magnitude of the impulse imparted to the ball by the wall is:



(A) 2 N s

(B) 4 N s

(C) 0 N s

(D) 8 N s

Q5. A gun of mass 4 kg fires a bullet of mass 20 g with a muzzle speed of 200 m s^{-1}. By conservation of momentum, the recoil speed of the gun is:

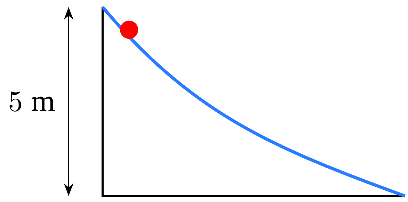
(A) 4 m s^{-1}

(B) 2 m s^{-1}

(C) 1 m s^{-1}

(D) 0.5 m s^{-1}

Q6. A child slides from rest down a smooth (frictionless) slide whose top is 5 m above the bottom, as shown. Taking $g = 10 \text{ m s}^{-2}$, the speed of the child at the bottom of the slide is:



(A) 5 m s^{-1}

(B) 10 m s^{-1}

(C) 20 m s^{-1}

(D) 7.5 m s^{-1}

Q7. Two point masses, 2 kg at $x = 0$ and 3 kg at $x = 5$ m, lie on the x-axis as shown. The x-coordinate of the centre of mass of the system is:

(A) 2 m

(B) 2.5 m

(C) 3 m

(D) 1.5 m

Q8. A satellite revolving around the Earth in a circular orbit has a kinetic energy of 5×10^9 J. For a satellite in a bound circular orbit, the total mechanical energy equals the negative of the kinetic energy. The total energy of the satellite is:

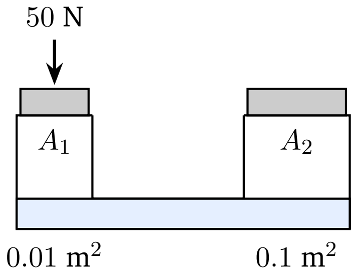
(A) $+5 \times 10^9$ J

(B) -1.0×10^{10} J

(C) $+2.5 \times 10^9$ J

(D) -5×10^9 J

Q9. In the hydraulic lift shown, a force of 50 N is applied on the small piston of area 0.01 m^2. The large piston has an area of 0.1 m^2. By Pascal's law, the force available on the large piston is:



(A) 500 N

(B) 50 N

(C) 5000 N

(D) 250 N

Q10. A refrigerator extracts 300 J of heat from the cold compartment for every 100 J of electrical work supplied to it. The coefficient of performance (COP $= Q_2/W$) of the refrigerator is:

(A) 3

(B) 4

(C) 0.33

(D) 1

Q11. The internal energy of n moles of an ideal monatomic gas is $U = \frac{3}{2}nRT$. For 2 moles of such a gas at a temperature of 300 K (take $R = 8.31$ J mol^{-1} K^{-1}), the internal energy is approximately:

(A) 4986 J

(B) 2493 J

(C) 7479 J

(D) 9972 J

Q12. Two tuning forks of frequencies 256 Hz and 260 Hz are sounded together. The number of beats heard per second is:

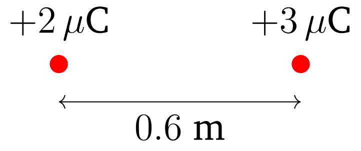
(A) 4

(B) 2

(C) 8

(D) 516

Q13. Two point charges, $q_1 = +2\ \mu$C and $q_2 = +3\ \mu$C, are separated by 0.6 m in vacuum, as shown. Taking $\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^2 C^{-2}, the electrostatic potential energy of the system is:



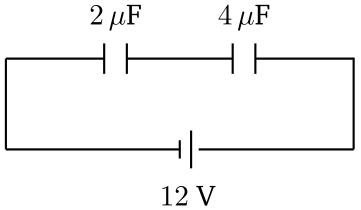
(A) 0.9 J

(B) 0.045 J

(C) 0.18 J

(D) 0.09 J

Q14. Two capacitors of capacitances 2 μF and 4 μF are joined in series across a 12 V battery, as shown. The charge on each capacitor is:



(A) 16 μC

(B) 24 μC

(C) 32 μC

(D) 8 μC

Q15. In a meter bridge, an unknown resistance X is in the left gap and a known resistance of $6\ \Omega$ is in the right gap. The bridge balances when the jockey is at 40 cm from the left end, so that $\frac{X}{6} = \frac{40}{60}$. The value of X is:

(A) $6\ \Omega$

(B) $4\ \Omega$

(C) $9\ \Omega$

(D) $2.4\ \Omega$

Q16. A uniform wire of resistance $10\ \Omega$ is cut into 5 equal parts, and these parts are then connected in parallel. The equivalent resistance of the combination is:

(A) $0.4\ \Omega$

(B) $2\ \Omega$

(C) $50\ \Omega$

(D) $10\ \Omega$

Q17. In a velocity selector, a charged particle passes undeviated through mutually perpendicular electric and magnetic fields when $qE = qvB$, i.e. $v = E/B$. If $E = 2 \times 10^4$ V m^{-1} and $B = 0.5$ T, the selected speed of the particle is:

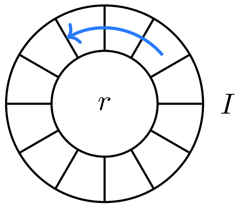
(A) 1×10^4 m s^{-1}

(B) 2×10^4 m s^{-1}

(C) 1×10^5 m s^{-1}

(D) 4×10^4 m s^{-1}

Q18. A toroid of mean radius $r = 0.1$ m has $N = 1000$ turns and carries a current $I = 2$ A, as shown. Taking $\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1}, the magnetic field inside the toroid, $B = \frac{\mu_0 NI}{2\pi r}$, is:



(A) 1×10^{-3} T

(B) 2×10^{-3} T

(C) 8×10^{-3} T

(D) 4×10^{-3} T

Q19. An alternating current has a peak (maximum) value of 4 A. The root-mean-square (rms) value of the current, $I_{\text{rms}} = \frac{I_0}{\sqrt{2}}$, is approximately:

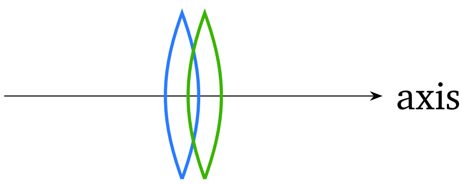
(A) 4 A

(B) 2 A

(C) 2.83 A

(D) 5.66 A

Q20. Two thin convex lenses of focal lengths 10 cm and 15 cm are placed in contact with each other, as shown. The focal length of the combination, given by $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$, is:



$f_1 = 10 f_2 = 15$

(A) 25 cm

(B) 12.5 cm

(C) 5 cm

(D) 6 cm

Q21. The objective of a telescope has an aperture (diameter) of 0.1 m and is used with light of wavelength 500 nm. The limit of angular resolution of the telescope, $\Delta\theta = \dfrac{1.22\,\lambda}{D}$, is:

(A) 1.22×10^{-6} rad

(B) 3.05×10^{-6} rad

(C) 6.1×10^{-6} rad

(D) 1.22×10^{-5} rad

Q22. The threshold wavelength for photoelectric emission from a metal is 600 nm. The work function of the metal, $\phi = \dfrac{hc}{\lambda_0}$ (take $hc = 1240$ eV nm), is:

(A) 1.24 eV

(B) 2.07 eV

(C) 3.1 eV

(D) 4.13 eV

Q23. In Bohr's model, the angular momentum of the electron in the nth orbit of hydrogen is $L = \dfrac{nh}{2\pi}$. For the second orbit ($n = 2$), taking $h = 6.6 \times 10^{-34}$ J s, the angular momentum is:

(A) 1.05×10^{-34} J s

(B) 2.1×10^{-34} J s

(C) 3.15×10^{-34} J s

(D) 4.2×10^{-34} J s

Q24. The radius of a nucleus is given by $R = R_0 A^{1/3}$, with $R_0 = 1.2$ fm. For a nucleus of mass number $A = 125$, the nuclear radius is:

(A) 6 fm

(B) 1.2 fm

(C) 5 fm

(D) 150 fm

Q25. A sinusoidal alternating voltage of frequency 50 Hz is applied to a full-wave rectifier. The fundamental ripple frequency of the rectified output is:

(A) 50 Hz

(B) 100 Hz

(C) 25 Hz

(D) 150 Hz

Detailed Solutions

Q1.

Solution

Concept — Combination of errors: For a quantity formed by multiplication or division of measured quantities, the maximum fractional (or percentage) errors add up.

Step 1 — Write the dependence of density:

$$\rho = \frac{m}{V}.$$

Mass is in the numerator (power $+1$) and volume is in the denominator (power -1).

Step 2 — Rule for the percentage error:

$$\frac{\Delta\rho}{\rho} \times 100 = \frac{\Delta m}{m} \times 100 + \frac{\Delta V}{V} \times 100.$$

Step 3 — Substitute the given errors: The error in mass is 2% and the error in volume is 1%.

$$\frac{\Delta\rho}{\rho} \times 100 = 2\% + 1\% = 3\%.$$

Why other options are wrong:

- Option A (1%): uses only the volume error.
- Option B (2%): uses only the mass error.
- Option D (4%): doubles the mass error by mistake.

Final Answer: Maximum percentage error in density $= 3\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Stopping distance under uniform retardation: When a body decelerating uniformly comes to rest, $v^2 = u^2 - 2as$ with final velocity $v = 0$.

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

Final speed $v = 0$.

Retardation $a = 4$ m s^{-2}.

Step 2 — Apply the equation of motion:

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

Put $v = 0$:

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

$$s = \frac{u^2}{2a}.$$

Step 3 — Substitute the numbers:

$$s = \frac{(20)^2}{2 \times 4} = \frac{400}{8} = 50 \text{ m}.$$

Why other options are wrong:

- Option B (40 m): uses $a = 5$ instead of 4.
- Option C (25 m): forgets to square the speed correctly.
- Option D (100 m): omits the factor of 2 in $2a$.

Final Answer: Stopping distance $= 50$ m $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q2

Q3.

Solution

Concept — Acceleration from a velocity–time graph: The acceleration equals the slope of the v–t graph, i.e. the change in velocity divided by the change in time.

Step 1 — Read the endpoints of the line: At $t = 0$ the velocity is 5 m s^{-1}.

At $t = 4$ s the velocity is 25 m s^{-1}.

Step 2 — Find the change in velocity:

$$\Delta v = 25 - 5 = 20 \text{ m s}^{-1}.$$

Step 3 — Find the change in time:

$$\Delta t = 4 - 0 = 4 \text{ s}.$$

Step 4 — Compute the slope:

$$a = \frac{\Delta v}{\Delta t} = \frac{20}{4} = 5 \text{ m s}^{-2}.$$

Why other options are wrong:

- Option A (2 m s^{-2}): divides 20 by an incorrect time.
- Option B (10 m s^{-2}): uses the final velocity instead of Δv.
- Option C (4 m s^{-2}): swaps numerator and denominator partially.

Final Answer: Acceleration $= 5 \text{ m s}^{-2} \Rightarrow \boxed{\text{D}}$

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

Q4.

Solution

Concept — Impulse–momentum theorem: The impulse delivered to a body equals its change in momentum, $J = \Delta p = m(v - u)$, taking the directions into account.

Step 1 — Set up a sign convention: Take the initial direction (towards the wall) as positive.

Initial momentum: $p_i = mu = 0.2 \times 10 = +2 \text{ kg m s}^{-1}$.

Step 2 — Momentum after rebound: The ball rebounds with the same speed but in the opposite direction, so $v = -10 \text{ m s}^{-1}$.

$$p_f = mv = 0.2 \times (-10) = -2 \text{ kg m s}^{-1}.$$

Step 3 — Compute the change in momentum:

$$\Delta p = p_f - p_i = (-2) - (+2) = -4 \text{ kg m s}^{-1}.$$

Step 4 — Take the magnitude:

$$|J| = |\Delta p| = 4 \text{ N s}.$$

Why other options are wrong:

- Option A (2 N s): ignores the reversal of direction and uses only one momentum.
- Option C (0 N s): wrongly assumes the speeds cancel as scalars.
- Option D (8 N s): doubles the correct change in momentum.

Final Answer: Impulse on the ball $= 4$ N s $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q4

Q5.

Solution

Concept — Conservation of momentum (recoil): Before firing the system is at rest, so the total momentum is zero. After firing, the forward momentum of the bullet equals the backward momentum of the gun.

Step 1 — Convert the bullet mass to kilograms:

$$m_b = 20 \text{ g} = 0.02 \text{ kg}.$$

Step 2 — Write momentum conservation:

$$0 = m_b v_b + MV.$$

$$MV = -m_b v_b.$$

Step 3 — Solve for the recoil speed V:

$$V = \frac{m_b v_b}{M} = \frac{0.02 \times 200}{4}.$$

Step 4 — Simplify:

$$V = \frac{4}{4} = 1 \text{ m s}^{-1}.$$

The minus sign only shows the gun moves opposite to the bullet; its speed is 1 m s^{-1}.

Why other options are wrong:

- Option A (4 m s^{-1}): forgets to divide by the gun mass.
- Option B (2 m s^{-1}): uses half the gun mass.
- Option D (0.5 m s^{-1}): uses twice the gun mass.

Final Answer: Recoil speed of the gun $= 1$ m s^{-1} $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q5

Q6.

Solution

Concept — Conservation of mechanical energy: On a frictionless slide, the loss in gravitational potential energy equals the gain in kinetic energy.

Step 1 — Write the energy balance:

$$mgh = \frac{1}{2}mv^2.$$

Step 2 — Cancel the mass and solve for v:

$$gh = \frac{1}{2}v^2.$$

$$v = \sqrt{2gh}.$$

Step 3 — Substitute the numbers:

$$v = \sqrt{2 \times 10 \times 5} = \sqrt{100}.$$

Step 4 — Simplify:

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

Why other options are wrong:

- Option A (5 m s^{-1}): forgets the square root or the factor of 2.
- Option C (20 m s^{-1}): squares instead of taking the square root partially.
- Option D (7.5 m s^{-1}): arithmetic error under the root.

Final Answer: Speed at the bottom $= 10$ m s^{-1} $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Centre of mass of two particles: For two masses on a line, $x_{\text{cm}} = \dfrac{m_1 x_1 + m_2 x_2}{m_1 + m_2}$.

Step 1 — List the data: $m_1 = 2$ kg at $x_1 = 0$.

$m_2 = 3$ kg at $x_2 = 5$ m.

Step 2 — Substitute into the formula:

$$x_{\text{cm}} = \frac{(2 \times 0) + (3 \times 5)}{2 + 3}.$$

Step 3 — Simplify the numerator and denominator:

$$x_{\text{cm}} = \frac{0 + 15}{5} = \frac{15}{5}.$$

Step 4 — Final division:

$$x_{\text{cm}} = 3 \text{ m}.$$

Why other options are wrong:

- Option A (2 m): weights the position by the wrong mass.
- Option B (2.5 m): takes the simple midpoint, ignoring the masses.
- Option D (1.5 m): leans towards the lighter mass incorrectly.

Final Answer: Centre of mass at $x = 3$ m $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — Total energy of an orbiting satellite: For a satellite in a bound circular orbit, $E = -\dfrac{GMm}{2r}$, while the kinetic energy is $K = +\dfrac{GMm}{2r}$. Hence $E = -K$.

Step 1 — Relate total energy to kinetic energy:

$$K = \frac{GMm}{2r}, \qquad E = -\frac{GMm}{2r}.$$

$$\Rightarrow\ E = -K.$$

Step 2 — Substitute the given kinetic energy:

$$K = 5 \times 10^9 \text{ J}.$$

$$E = -K = -5 \times 10^9 \text{ J}.$$

Step 3 — Interpret the sign: The negative total energy shows the satellite is bound to the Earth.

Why other options are wrong:

- Option A ($+5 \times 10^9$ J): gives a positive (unbound) energy, which is wrong.
- Option B (-1.0×10^{10} J): uses $E = -2K$ instead of $E = -K$.
- Option C ($+2.5 \times 10^9$ J): halves the magnitude and keeps the wrong sign.

Final Answer: Total energy $= -5 \times 10^9$ J $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Pascal's law: A pressure applied to an enclosed fluid is transmitted equally, so $\frac{F_1}{A_1} = \frac{F_2}{A_2}$.

Step 1 — List the data: Input force $F_1 = 50$ N on area $A_1 = 0.01$ m^2.

Output area $A_2 = 0.1$ m^2.

Step 2 — Apply Pascal's law:

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}.$$

$$F_2 = F_1 \times \frac{A_2}{A_1}.$$

Step 3 — Substitute the numbers:

$$F_2 = 50 \times \frac{0.1}{0.01} = 50 \times 10.$$

Step 4 — Simplify:

$$F_2 = 500 \text{ N}.$$

Why other options are wrong:

- Option B (50 N): assumes the force is unchanged.
- Option C (5000 N): uses an area ratio of 100 instead of 10.
- Option D (250 N): uses an area ratio of 5.

Final Answer: Force on the large piston $= 500$ N $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Coefficient of performance (COP): For a refrigerator, COP is the heat extracted from the cold reservoir per unit of work input, COP $= \dfrac{Q_2}{W}$.

Step 1 — List the data: Heat extracted $Q_2 = 300$ J.

Work input $W = 100$ J.

Step 2 — Apply the definition:

$$\text{COP} = \frac{Q_2}{W} = \frac{300}{100}.$$

Step 3 — Simplify:

$$\text{COP} = 3.$$

Why other options are wrong:

- Option B (4): adds Q_2 and W then divides incorrectly.
- Option C (0.33): inverts the ratio to W/Q_2.
- Option D (1): wrongly equates W with Q_2.

Final Answer: Coefficient of performance $= 3 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q10

Q11.

Solution

Concept — Internal energy of a monatomic ideal gas: For n moles, $U = \frac{3}{2}nRT$, since each mole carries average translational energy $\frac{3}{2}RT$.

Step 1 — List the data: Number of moles $n = 2$.

Temperature $T = 300$ K.

Gas constant $R = 8.31$ J mol^{-1} K^{-1}.

Step 2 — Substitute into the formula:

$$U = \frac{3}{2} \times 2 \times 8.31 \times 300.$$

Step 3 — Multiply step by step:

$$\frac{3}{2} \times 2 = 3.$$

$$3 \times 8.31 = 24.93.$$

$$24.93 \times 300 = 7479 \text{ J}.$$

Why other options are wrong:

- Option A (4986 J): corresponds to the energy of 1 mole only.
- Option B (2493 J): drops the factor $\frac{3}{2}$.
- Option D (9972 J): uses a factor of 2 instead of $\frac{3}{2}$ per mole.

Final Answer: Internal energy ≈ 7479 J $\Rightarrow$ C

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Beats: When two sound waves of nearly equal frequencies superpose, the number of beats per second equals the difference of the two frequencies, $f_{\text{beat}} = |f_1 - f_2|$.

Step 1 — List the frequencies: $f_1 = 256$ Hz.

$f_2 = 260$ Hz.

Step 2 — Take the magnitude of the difference:

$$f_{\text{beat}} = |256 - 260| = |-4|.$$

Step 3 — Simplify:

$$f_{\text{beat}} = 4 \text{ Hz}.$$

So 4 beats are heard each second.

Why other options are wrong:

- Option B (2): halves the frequency difference.
- Option C (8): doubles the difference.
- Option D (516): adds the two frequencies instead of subtracting.

Final Answer: Beat frequency $= 4$ Hz $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q12

Q13.

Solution

Concept — Potential energy of two point charges: The electrostatic potential energy of a pair of point charges is $U = \dfrac{1}{4\pi\varepsilon_0}\dfrac{q_1 q_2}{r}$.

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

$q_2 = 3\ \mu\text{C} = 3 \times 10^{-6}$ C.

Separation $r = 0.6$ m.

Step 2 — Substitute into the formula:

$$U = 9 \times 10^9 \times \frac{(2 \times 10^{-6}) \times (3 \times 10^{-6})}{0.6}.$$

Step 3 — Multiply the charges:

$$(2 \times 10^{-6}) \times (3 \times 10^{-6}) = 6 \times 10^{-12}\ \text{C}^2.$$

Step 4 — Complete the calculation:

$$U = 9 \times 10^9 \times \frac{6 \times 10^{-12}}{0.6} = \frac{54 \times 10^{-3}}{0.6}.$$

$$U = 0.09 \text{ J}.$$

Why other options are wrong:

- Option A (0.9 J): omits the factor 0.6 (uses $r = 0.06$ m).
- Option B (0.045 J): halves the correct value.
- Option C (0.18 J): doubles the correct value.

Final Answer: Potential energy $= 0.09$ J $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q13

Q14.

Solution

Concept — Capacitors in series: In a series combination, the same charge sits on every capacitor, and the equivalent capacitance is given by $\frac{1}{C_s} = \frac{1}{C_1} + \frac{1}{C_2}$.

Step 1 — Find the equivalent capacitance:

$$\frac{1}{C_s} = \frac{1}{2} + \frac{1}{4} = \frac{2}{4} + \frac{1}{4} = \frac{3}{4}.$$

$$C_s = \frac{4}{3}\ \mu\text{F}.$$

Step 2 — Charge supplied by the battery:

$$Q = C_s V = \frac{4}{3} \times 10^{-6} \times 12.$$

Step 3 — Simplify:

$$Q = \frac{4 \times 12}{3} \times 10^{-6} = \frac{48}{3} \times 10^{-6} = 16 \times 10^{-6}\ \text{C}.$$

$$Q = 16\ \mu\text{C}.$$

Step 4 — Charge on each capacitor: In series the charge is the same on both, so each carries $16\ \mu$C.

Why other options are wrong:

- Option B ($24\ \mu$C): uses $C = 2\ \mu$F alone with 12 V.
- Option C ($32\ \mu$C): treats the capacitors as in parallel.
- Option D ($8\ \mu$C): halves the correct charge.

Final Answer: Charge on each capacitor $= 16\ \mu$C $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q14

Q15.

Solution

Concept — Meter bridge balance: At balance, the ratio of the gap resistances equals the ratio of the lengths on either side of the jockey, $\frac{X}{R} = \frac{l_1}{100 - l_1}$.

Step 1 — List the data: Known resistance $R = 6\ \Omega$.

Balance length from the left $l_1 = 40$ cm, so $100 - l_1 = 60$ cm.

Step 2 — Write the balance condition:

$$\frac{X}{6} = \frac{40}{60}.$$

Step 3 — Solve for X:

$$X = 6 \times \frac{40}{60} = 6 \times \frac{2}{3}.$$

Step 4 — Simplify:

$$X = \frac{12}{3} = 4\ \Omega.$$

Why other options are wrong:

- Option A ($6\ \Omega$): assumes the unknown equals the known resistance.
- Option C ($9\ \Omega$): inverts the length ratio.
- Option D ($2.4\ \Omega$): multiplies by $40/100$ instead of $40/60$.

Final Answer: Unknown resistance $X = 4\ \Omega \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q15

Q16.

Solution

Concept — Cutting and reconnecting a wire: Cutting a wire of resistance R into n equal parts gives each part resistance R/n; joining all n in parallel divides this further by n, giving R/n^2.

Step 1 — Resistance of one part:

$$R_{\text{part}} = \frac{R}{n} = \frac{10}{5} = 2\ \Omega.$$

Step 2 — Combine the 5 equal parts in parallel: For n equal resistors in parallel, $R_{\text{eq}} = \dfrac{R_{\text{part}}}{n}$.

$$R_{\text{eq}} = \frac{2}{5}.$$

Step 3 — Simplify:

$$R_{\text{eq}} = 0.4\ \Omega.$$

Equivalently, $R_{\text{eq}} = \dfrac{R}{n^2} = \dfrac{10}{25} = 0.4\ \Omega.$

Why other options are wrong:

- Option B $(2\ \Omega)$: gives just one cut piece, not the parallel combination.
- Option C $(50\ \Omega)$: multiplies by n^2 instead of dividing.
- Option D $(10\ \Omega)$: assumes no change from the original wire.

Final Answer: Equivalent resistance $= 0.4\ \Omega \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q16

Q17.

Solution

Concept — Velocity selector: A charged particle travels undeviated through crossed electric and magnetic fields when the electric force balances the magnetic force, $qE = qvB$, giving $v = \dfrac{E}{B}$.

Step 1 — List the data: Electric field $E = 2 \times 10^4$ V m^{-1}.

Magnetic field $B = 0.5$ T.

Step 2 — Apply the balance condition:

$$v = \frac{E}{B} = \frac{2 \times 10^4}{0.5}.$$

Step 3 — Simplify:

$$v = 4 \times 10^4 \text{ m s}^{-1}.$$

Why other options are wrong:

- Option A (1×10^4): divides by 2 instead of 0.5.
- Option B (2×10^4): forgets to divide by B.
- Option C (1×10^5): power-of-ten slip.

Final Answer: Selected speed $= 4 \times 10^4$ m s^{-1} $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q17

Q18.

Solution

Concept — Magnetic field inside a toroid: The field inside a toroid is $B = \dfrac{\mu_0 N I}{2\pi r}$, where N is the total number of turns and r is the mean radius.

Step 1 — List the data: $N = 1000$, $I = 2$ A, $r = 0.1$ m.

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

Step 2 — Substitute into the formula:

$$B = \frac{(4\pi \times 10^{-7}) \times 1000 \times 2}{2\pi \times 0.1}.$$

Step 3 — Simplify the numerator:

$$(4\pi \times 10^{-7}) \times 2000 = 8\pi \times 10^{-4}.$$

Step 4 — Simplify the denominator and divide:

$$2\pi \times 0.1 = 0.2\pi.$$

$$B = \frac{8\pi \times 10^{-4}}{0.2\pi} = \frac{8 \times 10^{-4}}{0.2} = 4 \times 10^{-3}\ \text{T}.$$

Why other options are wrong:

- Option A (1×10^{-3} T): drops a factor of 4.
- Option B (2×10^{-3} T): halves the result.
- Option C (8×10^{-3} T): omits the $2\pi r$ in the denominator partially.

Final Answer: Field inside the toroid $= 4 \times 10^{-3}$ T $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q18

Q19.

Solution

Concept — RMS value of an alternating current: For a sinusoidal current of peak value I_0, the root-mean-square value is $I_{\text{rms}} = \frac{I_0}{\sqrt{2}}$.

Step 1 — List the data: Peak current $I_0 = 4$ A.

Step 2 — Apply the formula:

$$I_{\text{rms}} = \frac{I_0}{\sqrt{2}} = \frac{4}{\sqrt{2}}.$$

Step 3 — Rationalise and simplify:

$$I_{\text{rms}} = \frac{4}{1.414} = 2\sqrt{2} \approx 2.83 \text{ A}.$$

Why other options are wrong:

- Option A (4 A): uses the peak value itself.
- Option B (2 A): divides by 2 instead of $\sqrt{2}$.
- Option D (5.66 A): multiplies by $\sqrt{2}$ instead of dividing.

Final Answer: RMS current ≈ 2.83 A $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q19

Q20.

Solution

Concept — Thin lenses in contact: When two thin lenses are placed in contact, their powers add, so $\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$.

Step 1 — List the data: $f_1 = 10$ cm and $f_2 = 15$ cm (both convex, so both positive).

Step 2 — Add the reciprocals:

$$\frac{1}{f} = \frac{1}{10} + \frac{1}{15}.$$

Step 3 — Take the common denominator (30):

$$\frac{1}{f} = \frac{3}{30} + \frac{2}{30} = \frac{5}{30} = \frac{1}{6}.$$

Step 4 — Invert to find f:

$$f = 6 \text{ cm}.$$

Why other options are wrong:

- Option A (25 cm): adds the focal lengths directly $(10 + 15)$.
- Option B (12.5 cm): takes the average of the focal lengths.
- Option C (5 cm): subtracts the reciprocals instead of adding.

Final Answer: Focal length of the combination $= 6$ cm $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q20

Q21.

Solution

Concept — Limit of resolution: The smallest angular separation a telescope can resolve is set by diffraction at its aperture, $\Delta\theta = \dfrac{1.22\,\lambda}{D}$.

Step 1 — List the data in SI units: Wavelength $\lambda = 500$ nm $= 5 \times 10^{-7}$ m. Aperture $D = 0.1$ m.

Step 2 — Substitute into the formula:

$$\Delta\theta = \frac{1.22 \times 5 \times 10^{-7}}{0.1}.$$

Step 3 — Simplify the numerator:

$$1.22 \times 5 \times 10^{-7} = 6.1 \times 10^{-7}.$$

Step 4 — Divide by the aperture:

$$\Delta\theta = \frac{6.1 \times 10^{-7}}{0.1} = 6.1 \times 10^{-6} \text{ rad}.$$

Why other options are wrong:

- Option A (1.22×10^{-6}): omits the wavelength factor of 5.

- Option B (3.05×10^{-6}): uses $\lambda = 250$ nm.
- Option D (1.22×10^{-5}): power-of-ten slip in the division.

Final Answer: Limit of resolution $= 6.1 \times 10^{-6}$ rad $\Rightarrow$ C

Answer: (C) Go Back to Q21

Q22.

Solution

Concept — Work function and threshold wavelength: The threshold wavelength λ_0 is the longest wavelength that can just eject an electron, with $\phi = \frac{hc}{\lambda_0}$.

Step 1 — List the data: Threshold wavelength $\lambda_0 = 600$ nm.

Use $hc = 1240$ eV nm.

Step 2 — Substitute into the formula:

$$\phi = \frac{hc}{\lambda_0} = \frac{1240}{600}.$$

Step 3 — Simplify:

$$\phi = 2.07 \text{ eV}.$$

Why other options are wrong:

- Option A (1.24 eV): uses $\lambda_0 = 1000$ nm.
- Option C (3.1 eV): uses $\lambda_0 = 400$ nm.
- Option D (4.13 eV): uses $\lambda_0 = 300$ nm.

Final Answer: Work function $= 2.07$ eV $\Rightarrow$ B

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Bohr's quantisation of angular momentum: The angular momentum of the electron in the nth orbit is an integer multiple of $\frac{h}{2\pi}$, i.e. $L = \frac{nh}{2\pi}$.

Step 1 — List the data: Orbit number $n = 2$.

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

Step 2 — Substitute into the formula:

$$L = \frac{2 \times 6.6 \times 10^{-34}}{2\pi}.$$

Step 3 — Compute $\frac{h}{2\pi}$ first:

$$\frac{h}{2\pi} = \frac{6.6 \times 10^{-34}}{6.28} = 1.05 \times 10^{-34} \text{ J s}.$$

Step 4 — Multiply by $n = 2$:

$$L = 2 \times 1.05 \times 10^{-34} = 2.1 \times 10^{-34} \text{ J s}.$$

Why other options are wrong:

- Option A (1.05×10^{-34}): is the value for $n = 1$.
- Option C (3.15×10^{-34}): is the value for $n = 3$.
- Option D (4.2×10^{-34}): is the value for $n = 4$.

Final Answer: Angular momentum $= 2.1 \times 10^{-34}$ J s $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q23

Q24.

Solution

Concept — Nuclear radius: The radius of a nucleus depends on its mass number through $R = R_0 A^{1/3}$, with $R_0 = 1.2$ fm.

Step 1 — List the data: $R_0 = 1.2$ fm, $A = 125$.

Step 2 — Evaluate the cube root of A:

$$A^{1/3} = 125^{1/3} = 5, \qquad \text{since } 5^3 = 125.$$

Step 3 — Substitute into the formula:

$$R = R_0 A^{1/3} = 1.2 \times 5.$$

Step 4 — Simplify:

$$R = 6 \text{ fm}.$$

Why other options are wrong:

- Option B (1.2 fm): forgets the $A^{1/3}$ factor (uses $A = 1$).
- Option C (5 fm): uses $A^{1/3}$ alone without R_0.
- Option D (150 fm): multiplies by A instead of $A^{1/3}$.

Final Answer: Nuclear radius $= 6$ fm $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q24

Q25.

Solution

Concept — Ripple frequency of a rectifier: A half-wave rectifier passes one half of each input cycle, so its ripple frequency equals the input frequency. A full-wave rectifier flips the negative half-cycles, producing two output pulses per input cycle, so its ripple frequency is twice the input frequency.

Step 1 — Identify the input frequency:

$$f_{\text{in}} = 50 \text{ Hz}.$$

Step 2 — Apply the full-wave rule:

$$f_{\text{ripple}} = 2 \times f_{\text{in}} = 2 \times 50.$$

Step 3 — Simplify:

$$f_{\text{ripple}} = 100 \text{ Hz}.$$

Why other options are wrong:

- Option A (50 Hz): is the half-wave (not full-wave) ripple frequency.
- Option C (25 Hz): halves the input frequency instead of doubling it.
- Option D (150 Hz): uses a factor of 3 with no physical basis.

Final Answer: Full-wave ripple frequency $= 100$ Hz $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q25

Answer Key

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