PGIMER BSc Nursing Physics

Sample Paper – 9

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 electric field at a point is defined as the force experienced per unit positive charge, $E = \frac{F}{q}$. The dimensional formula of electric field is:

(A) $[MLT^{-2}A^{-1}]$

(B) $[MLT^{-3}A^{-1}]$

(C) $[ML^2T^{-3}A^{-1}]$

(D) $[MLT^{-3}A^{-2}]$

Q2. A body starts moving with an initial velocity of 5 m s^{-1} and accelerates uniformly at 2 m s^{-2}. Its velocity after 10 s is:

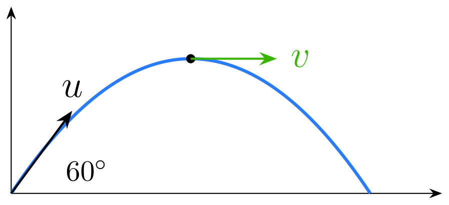
(A) 20 m s^{-1}

(B) 15 m s^{-1}

(C) 25 m s^{-1}

(D) 30 m s^{-1}

Q3. A projectile is launched with a speed of $20\ \text{m s}^{-1}$ at 60° above the horizontal, as shown. The speed of the projectile at the highest point of its path is:



(A) $20\ \text{m s}^{-1}$

(B) $10\ \text{m s}^{-1}$

(C) $17.3\ \text{m s}^{-1}$

(D) $0\ \text{m s}^{-1}$

Q4. A car travels around a flat (unbanked) circular track of radius 20 m. The coefficient of friction between the tyres and the road is $\mu = 0.5$ and $g = 10\ \text{m s}^{-2}$. The maximum speed with which the car can take the turn without skidding is:

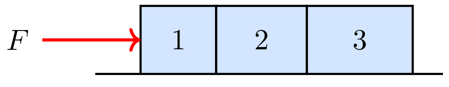
(A) $5\ \text{m s}^{-1}$

(B) $20\ \text{m s}^{-1}$

(C) $14.1\ \text{m s}^{-1}$

(D) $10\ \text{m s}^{-1}$

Q5. Three blocks of masses 1 kg, 2 kg and 3 kg are placed in contact in a row on a smooth horizontal surface. A horizontal force of 12 N is applied to the 1 kg block, as shown. The magnitude of the contact force between the 2 kg and 3 kg blocks is:



(A) 12 N

(B) 4 N

(C) 10 N

(D) 6 N

Q6. A body of mass 2 kg, initially at rest, is accelerated to a speed of 10 m s^{-1} in 5 s. The average power delivered to the body during this interval is:

(A) 20 W

(B) 10 W

(C) 40 W

(D) 100 W

Q7. A wheel rotates at 300 revolutions per minute. Its angular velocity is:

(A) 10π rad s^{-1}

(B) 5π rad s^{-1}

(C) 600π rad s^{-1}

(D) 2π rad s^{-1}

Q8. The time period of a satellite revolving in a circular orbit just above the Earth's surface is $T = 2\pi\sqrt{\frac{R}{g}}$. Taking $R = 6.4 \times 10^6$ m and $g = 10 \text{ m s}^{-2}$, the period is approximately:

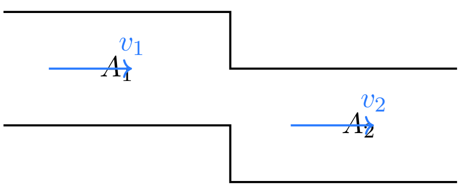
(A) 42 minutes

(B) 84 minutes

(C) 24 hours

(D) 168 minutes

Q9. Water flows steadily through a horizontal pipe whose cross-sectional area decreases from $A_1 = 10 \text{ cm}^2$ to $A_2 = 5 \text{ cm}^2$. If the speed in the wider part is $v_1 = 2 \text{ m s}^{-1}$, the speed in the narrower part is:



(A) 1 m s^{-1}

(B) 2 m s^{-1}

(C) 4 m s^{-1}

(D) 8 m s^{-1}

Q10. Two moles of an ideal monatomic gas ($C_v = \frac{3}{2}R$, $R = 8.3$ J mol^{-1}K^{-1}) are heated so that the temperature rises by 100 K. The change in internal energy of the gas is:

(A) 2490 J

(B) 1245 J

(C) 4150 J

(D) 0 J

Q11. The internal energy of n moles of a diatomic ideal gas at temperature T is $U = \dfrac{5}{2}nRT$. For 2 moles at 300 K (with $R = 8.3$ J mol^{-1}K^{-1}), the internal energy is:

(A) 7470 J

(B) 12450 J

(C) 4980 J

(D) 24900 J

Q12. A particle executes simple harmonic motion with amplitude 0.05 m and angular frequency 10 rad s^{-1}. The maximum acceleration of the particle is:

(A) 0.5 m s^{-2}

(B) 50 m s^{-2}

(C) 5 m s^{-2}

(D) 100 m s^{-2}

Q13. Two point charges separated by a fixed distance experience an electrostatic force of 18 N when placed in vacuum. When the same charges, at the same separation, are immersed in a medium of dielectric constant $K = 3$, the force between them becomes:

(A) 6 N

(B) 18 N

(C) 54 N

(D) 2 N

Q14. A capacitor $C_1 = 2\ \mu$F charged to $V_1 = 100$ V is connected in parallel (plate to like plate) with a capacitor $C_2 = 3\ \mu$F charged to $V_2 = 50$ V, as shown. The common potential after connection is:

(A) 75 V

(B) 70 V

(C) 150 V

(D) 50 V

Q15. A galvanometer of resistance $20\ \Omega$ gives a full-scale deflection for a current of 5 mA. To convert it into a voltmeter reading up to 5 V, the resistance that must be connected in series is:

(A) $1000\ \Omega$

(B) $1020\ \Omega$

(C) $980\ \Omega$

(D) $200\ \Omega$

Q16. A uniform wire has a resistance of $8\ \Omega$. It is folded exactly in half so that its length is halved and its cross-sectional area is doubled. The resistance of the folded wire is:

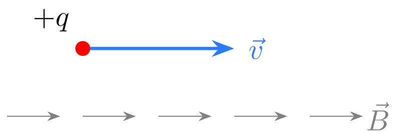
(A) $8\ \Omega$

(B) $4\ \Omega$

(C) $2\ \Omega$

(D) $16\ \Omega$

Q17. A positively charged particle moves with velocity $\vec{v}$ parallel to a uniform magnetic field $\vec{B}$, as shown. The magnetic force experienced by the particle is:



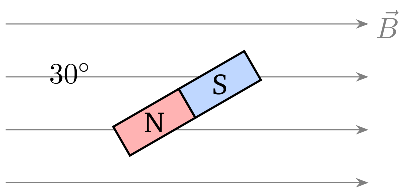
(A) zero

(B) qvB directed into the page

(C) qvB directed out of the page

(D) $\frac{1}{2}qvB$

Q18. A bar magnet of magnetic moment 0.4 A m^2 is placed in a uniform magnetic field of 0.5 T such that its axis makes an angle of 30° with the field, as shown. The torque acting on the magnet is:



(A) 0.2 N m

(B) 0.4 N m

(C) 0.05 N m

(D) 0.1 N m

Q19. Two coils have a mutual inductance of 0.5 H. If the current in one coil changes at the rate of 4 A s^{-1}, the magnitude of the emf induced in the other coil is:

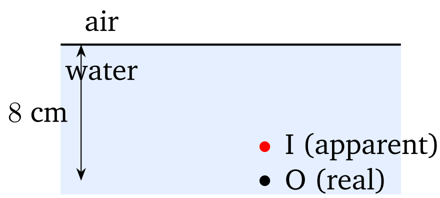
(A) 2 V

(B) 0.5 V

(C) 8 V

(D) 4 V

Q20. A small object lies at the bottom of a tank of water of real depth 8 cm. The refractive index of water is $\frac{4}{3}$. When viewed from directly above, the apparent depth of the object is:



(A) 8 cm

(B) 10.7 cm

(C) 4 cm

(D) 6 cm

Q21. In a Young's double-slit experiment, light of wavelength 600 nm illuminates slits separated by 0.3 mm, and the screen is 1 m away. The distance of the third bright fringe ($n = 3$) from the central maximum is:

(A) 2 mm

(B) 4 mm

(C) 6 mm

(D) 9 mm

Q22. Light of photon energy 4 eV falls on a metal of work function 3 eV. Taking the electron mass $m = 9.1 \times 10^{-31}$ kg and 1 eV $= 1.6 \times 10^{-19}$ J, the maximum speed of the emitted photoelectrons is approximately:

(A) 3×10^5 m s^{-1}

(B) 1.2×10^6 m s^{-1}

(C) 9×10^5 m s^{-1}

(D) 6×10^5 m s^{-1}

Q23. An electron in a hydrogen atom is excited to the $n = 5$ level. When it returns to the ground state, the maximum number of distinct spectral lines that can be emitted is:

(A) 4

(B) 5

(C) 6

(D) 10

Q24. A radioactive sample is allowed to decay for a time equal to 4 half-lives. The fraction of the original number of nuclei that remains undecayed is:

(A) $\frac{1}{4}$

(B) $\frac{1}{8}$

(C) $\frac{1}{16}$

(D) $\frac{1}{32}$

Q25. A light-emitting diode (LED) emits light because:

(A) it is reverse biased and incident light frees charge carriers

(B) under forward bias, electrons and holes recombine at the junction and release energy as photons

(C) it converts incident light directly into an electric current

(D) it stores electrical charge across its junction like a capacitor

Detailed Solutions

Q1.

Solution

Concept — Dimensions from a defining equation: The dimensions of a physical quantity are obtained by substituting the dimensions of the known quantities in its defining relation.

Step 1 — Write the defining relation:

$$E = \frac{F}{q}.$$

Step 2 — Dimensions of force:

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

Step 3 — Dimensions of charge: Charge = current × time, so

$$[q] = [AT].$$

Step 4 — Divide to get the electric field:

$$[E] = \frac{[MLT^{-2}]}{[AT]}.$$

$$[E] = [MLT^{-2-1}A^{-1}] = [MLT^{-3}A^{-1}].$$

Why other options are wrong:

- Option A $[MLT^{-2}A^{-1}]$: forgets that charge carries one power of time.
- Option C $[ML^2T^{-3}A^{-1}]$: an extra power of length; this is closer to potential × length.
- Option D $[MLT^{-3}A^{-2}]$: uses an extra power of current.

Final Answer: Dimensional formula of electric field = $[MLT^{-3}A^{-1}] \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept — First equation of motion: For uniform acceleration, the velocity after time t is $v = u + at$.

Step 1 — List the known values: Initial velocity $u = 5$ m s^{-1}.

Acceleration $a = 2$ m s^{-2}.

Time $t = 10$ s.

Step 2 — Apply $v = u + at$:

$$v = 5 + (2 \times 10).$$

Step 3 — Simplify:

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

Why other options are wrong:

- Option A (20): uses only at and drops the initial velocity.
- Option B (15): takes $a = 1$ instead of 2.
- Option D (30): adds an extra 5.

Final Answer: Velocity after 10 s $= 25$ m s^{-1} $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q2

Q3.

Solution

Concept — Velocity of a projectile at the top: The horizontal velocity of a projectile stays constant, while the vertical velocity becomes zero at the highest point. So at the top only the horizontal component survives.

Step 1 — Resolve the launch velocity: Horizontal component: $u_x = u\cos\theta$.

Vertical component: $u_y = u\sin\theta$.

Step 2 — Velocity at the top: At the highest point u_y has fallen to zero, so

$$v = u_x = u\cos\theta.$$

Step 3 — Substitute the values:

$$v = 20 \times \cos 60^\circ = 20 \times 0.5 = 10 \text{ m s}^{-1}.$$

Why other options are wrong:

- Option A (20): assumes the full launch speed is retained.
- Option C (17.3): uses the vertical component $u \sin 60^\circ$ instead of the horizontal one.
- Option D (0): wrongly assumes the whole velocity vanishes at the top.

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

Answer: (B) Go Back to Q3

Q4.

Solution

Concept — Maximum speed on a level circular road: Friction supplies the centripetal force. At the maximum speed, $\dfrac{mv^2}{r} = \mu mg$, which gives $v = \sqrt{\mu r g}$.

Step 1 — List the values: $\mu = 0.5$, $r = 20$ m, $g = 10$ m s^{-2}.

Step 2 — Write the formula:

$$v = \sqrt{\mu r g}.$$

Step 3 — Substitute:

$$v = \sqrt{0.5 \times 20 \times 10}.$$

Step 4 — Simplify:

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

Why other options are wrong:

- Option A (5): forgets to take the square root after halving.
- Option B (20): drops the friction coefficient.
- Option C (14.1): uses rg without μ ($\sqrt{200}$).

Final Answer: Maximum safe speed $= 10$ m s^{-1} $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — System of blocks in contact: First find the common acceleration of all blocks from the total force and total mass, then isolate the last block to find the contact force on it.

Step 1 — Common acceleration of the system:

$$a = \frac{F}{m_1 + m_2 + m_3} = \frac{12}{1+2+3} = \frac{12}{6} = 2\ \text{m s}^{-2}.$$

Step 2 — Isolate the last (3 kg) block: Only the contact force F_{23} from the 2 kg block pushes it, so

$$F_{23} = m_3\, a.$$

Step 3 — Substitute:

$$F_{23} = 3 \times 2 = 6\ \text{N}.$$

Why other options are wrong:

- Option A (12): equals the applied force, not the contact force.
- Option B (4): uses $m = 2$ kg.
- Option C (10): is the contact force between the 1 kg and 2 kg blocks $= (m_2 + m_3)a$.

Final Answer: Contact force between the 2 kg and 3 kg blocks $= 6\ \text{N} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q5

Q6.

Solution

Concept — Average power: Average power is the total work done divided by the time taken. The work equals the gain in kinetic energy.

Step 1 — Kinetic energy gained:

$$\Delta KE = \tfrac{1}{2}mv^2 - 0 = \tfrac{1}{2} \times 2 \times (10)^2.$$

$$\Delta KE = \tfrac{1}{2} \times 2 \times 100 = 100\ \text{J}.$$

Step 2 — Divide by the time:

$$P = \frac{\Delta KE}{t} = \frac{100}{5}.$$

Step 3 — Simplify:

$$P = 20 \text{ W}.$$

Why other options are wrong:

- Option B (10): divides by 10 instead of 5.
- Option C (40): drops the factor $\frac{1}{2}$ in kinetic energy.
- Option D (100): gives the work done, forgetting to divide by time.

Final Answer: Average power $= 20$ W $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q6

Q7.

Solution

Concept — Angular velocity from rpm: If a body makes N revolutions per minute, its angular velocity is $\omega = \dfrac{2\pi N}{60}$ rad per second.

Step 1 — List the value: $N = 300$ revolutions per minute.

Step 2 — Apply the formula:

$$\omega = \frac{2\pi N}{60} = \frac{2\pi \times 300}{60}.$$

Step 3 — Simplify:

$$\omega = \frac{600\pi}{60} = 10\pi \text{ rad s}^{-1} \approx 31.4 \text{ rad s}^{-1}.$$

Why other options are wrong:

- Option B (5π): divides by 120 instead of 60.
- Option C (600π): forgets to divide by 60.
- Option D (2π): uses $N = 1$ (one revolution per second wrongly).

Final Answer: Angular velocity $= 10\pi$ rad s^{-1} $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q7

Q8.

Solution

Concept — Period of a near-Earth satellite: A satellite orbiting just above the surface has $T = 2\pi\sqrt{\dfrac{R}{g}}$.

Step 1 — List the values: $R = 6.4 \times 10^6$ m, $g = 10$ m s^{-2}.

Step 2 — Evaluate the ratio inside the root:

$$\frac{R}{g} = \frac{6.4 \times 10^6}{10} = 6.4 \times 10^5 \text{ s}^2.$$

Step 3 — Take the square root:

$$\sqrt{6.4 \times 10^5} = \sqrt{640000} = 800 \text{ s}.$$

Step 4 — Multiply by 2π:

$$T = 2\pi \times 800 = 1600\pi \approx 5027 \text{ s}.$$

Step 5 — Convert to minutes:

$$T = \frac{5027}{60} \approx 84 \text{ minutes}.$$

Why other options are wrong:

- Option A (42 min): halves the correct period.
- Option C (24 hr): is the period of a geostationary satellite, not a near-Earth one.
- Option D (168 min): doubles the correct period.

Final Answer: Period ≈ 84 minutes $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q8

Q9.

Solution

Concept — Equation of continuity: For an incompressible fluid in steady flow, the volume flow rate is constant: $A_1 v_1 = A_2 v_2$.

Step 1 — List the values: $A_1 = 10\ \text{cm}^2$, $v_1 = 2\ \text{m s}^{-1}$, $A_2 = 5\ \text{cm}^2$.

Step 2 — Rearrange the continuity equation:

$$v_2 = \frac{A_1 v_1}{A_2}.$$

Step 3 — Substitute (the area units cancel):

$$v_2 = \frac{10 \times 2}{5}.$$

Step 4 — Simplify:

$$v_2 = \frac{20}{5} = 4\ \text{m s}^{-1}.$$

Why other options are wrong:

- Option A (1): inverts the area ratio.
- Option B (2): assumes the speed does not change.
- Option D (8): uses an area ratio of 4 instead of 2.

Final Answer: Speed in the narrower part $= 4\ \text{m s}^{-1} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q9

Q10.

Solution

Concept — Internal energy of an ideal gas: The internal energy of an ideal gas depends only on its temperature, and its change is $\Delta U = nC_v\,\Delta T$, regardless of the process followed.

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

Molar heat capacity at constant volume $C_v = \frac{3}{2}R = \frac{3}{2} \times 8.3 = 12.45\ \text{J mol}^{-1}\text{K}^{-1}$.

Temperature rise $\Delta T = 100\ \text{K}$.

Step 2 — Apply the formula:

$$\Delta U = nC_v\,\Delta T = 2 \times 12.45 \times 100.$$

Step 3 — Simplify:

$$\Delta U = 2 \times 1245 = 2490 \text{ J}.$$

Why other options are wrong:

- Option B (1245): uses $n = 1$ instead of 2.
- Option C (4150): uses $C_v = \frac{5}{2}R$ (a diatomic value).
- Option D (0): wrongly assumes no change in internal energy.

Final Answer: Change in internal energy $= 2490$ J $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q10

Q11.

Solution

Concept — Internal energy of a diatomic gas: A diatomic gas has 5 degrees of freedom, so its internal energy is $U = \frac{5}{2}nRT$.

Step 1 — List the values: $n = 2$ mol, $T = 300$ K, $R = 8.3$ J mol^{-1}K^{-1}.

Step 2 — Apply the formula:

$$U = \frac{5}{2}nRT = \frac{5}{2} \times 2 \times 8.3 \times 300.$$

Step 3 — Simplify step by step:

$$\frac{5}{2} \times 2 = 5.$$

$$5 \times 8.3 = 41.5.$$

$$41.5 \times 300 = 12450 \text{ J}.$$

Why other options are wrong:

- Option A (7470): uses $\frac{3}{2}nRT$ (a monatomic value).
- Option C (4980): uses $n = 1$ and $\frac{5}{2}$ wrongly.
- Option D (24900): doubles the correct value.

Final Answer: Internal energy $= 12450$ J $\Rightarrow$ B

Answer: (B) Go Back to Q11

Q12.

Solution

Concept — Maximum acceleration in SHM: In simple harmonic motion the acceleration is largest at the extreme position, where $a_{\text{max}} = \omega^2 A$.

Step 1 — List the values: Amplitude $A = 0.05$ m.

Angular frequency $\omega = 10$ rad s^{-1}.

Step 2 — Apply the formula:

$$a_{\text{max}} = \omega^2 A = (10)^2 \times 0.05.$$

Step 3 — Simplify:

$$a_{\text{max}} = 100 \times 0.05 = 5 \text{ m s}^{-2}.$$

Why other options are wrong:

- Option A (0.5): uses ωA (the maximum velocity) instead of $\omega^2 A$.
- Option B (50): forgets to multiply by the amplitude correctly.
- Option D (100): equals ω^2 alone, dropping the amplitude.

Final Answer: Maximum acceleration $= 5$ m s^{-2} $\Rightarrow$ C

Answer: (C) Go Back to Q12

Q13.

Solution

Concept — Coulomb force in a medium: Placing charges in a medium of dielectric constant K reduces the force by a factor of K: $F_{\text{medium}} = \dfrac{F_{\text{vacuum}}}{K}$.

Step 1 — List the values: Force in vacuum $F_{\text{vacuum}} = 18$ N.

Dielectric constant $K = 3$.

Step 2 — Apply the formula:

$$F_{\text{medium}} = \frac{F_{\text{vacuum}}}{K} = \frac{18}{3}.$$

Step 3 — Simplify:

$$F_{\text{medium}} = 6 \text{ N}.$$

Why other options are wrong:

- Option B (18): assumes no change when the medium is introduced.
- Option C (54): multiplies by K instead of dividing.
- Option D (2): divides by 9 instead of 3.

Final Answer: Force in the medium $= 6$ N $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Common potential of two connected capacitors: When two charged capacitors are joined, charge is conserved and they reach a common potential $V = \dfrac{C_1V_1 + C_2V_2}{C_1 + C_2}$.

Step 1 — List the values: $C_1 = 2\ \mu$F, $V_1 = 100$ V.

$C_2 = 3\ \mu$F, $V_2 = 50$ V.

Step 2 — Find the total charge (numerator):

$$C_1V_1 + C_2V_2 = (2 \times 100) + (3 \times 50) = 200 + 150 = 350\ \mu\text{C}.$$

Step 3 — Find the total capacitance (denominator):

$$C_1 + C_2 = 2 + 3 = 5\ \mu\text{F}.$$

Step 4 — Divide:

$$V = \frac{350}{5} = 70 \text{ V}.$$

Why other options are wrong:

- Option A (75): takes the plain average of the two voltages.
- Option C (150): adds the two voltages.
- Option D (50): just picks the smaller voltage.

Final Answer: Common potential $= 70$ V $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Converting a galvanometer into a voltmeter: A high resistance R is placed in series so that the full-scale current i_g flows when the desired voltage V is applied: $R = \frac{V}{i_g} - G$.

Step 1 — List the values: $G = 20\ \Omega$, $i_g = 5$ mA $= 0.005$ A, $V = 5$ V.

Step 2 — Compute $\frac{V}{i_g}$:

$$\frac{V}{i_g} = \frac{5}{0.005} = 1000\ \Omega.$$

Step 3 — Subtract the galvanometer resistance:

$$R = 1000 - 20 = 980\ \Omega.$$

Why other options are wrong:

- Option A (1000): forgets to subtract G.
- Option B (1020): adds G instead of subtracting it.
- Option D (200): uses $i_g = 25$ mA wrongly.

Final Answer: Series resistance $= 980\ \Omega \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Resistance of a folded wire: For $R = \rho\frac{L}{A}$, folding in half halves the length and doubles the area, so the resistance falls to one quarter.

Step 1 — Effect of folding: New length $L' = \frac{L}{2}$.

New area $A' = 2A$ (two strands side by side).

Step 2 — New resistance:

$$R' = \rho\frac{L'}{A'} = \rho\frac{L/2}{2A} = \frac{1}{4}\rho\frac{L}{A} = \frac{R}{4}.$$

Step 3 — Substitute the value:

$$R' = \frac{8}{4} = 2\ \Omega.$$

Why other options are wrong:

- Option A (8): assumes no change.
- Option B (4): halves only once, ignoring the area change.
- Option D (16): doubles instead of quartering.

Final Answer: Resistance of the folded wire $= 2\ \Omega \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q16

Q17.

Solution

Concept — Magnetic force on a moving charge: The force is $F = qvB\sin\theta$, where θ is the angle between the velocity and the field.

Step 1 — Identify the angle: The velocity $\vec{v}$ is parallel to the field $\vec{B}$, so $\theta = 0°$.

Step 2 — Evaluate $\sin\theta$**:**

$$\sin 0° = 0.$$

Step 3 — Compute the force:

$$F = qvB\sin 0° = qvB \times 0 = 0.$$

A charge moving along the field direction feels no magnetic force.

Why other options are wrong:

- Options B and C (qvB): would hold only if the velocity were perpendicular to the field $(\theta = 90°)$.
- Option D $(\frac{1}{2}qvB)$: would correspond to $\theta = 30°$, not the parallel case.

Final Answer: The magnetic force is zero $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q17

Q18.

Solution

Concept — Torque on a magnetic dipole: A bar magnet of moment M in a field B at angle θ to the field experiences a torque $\tau = MB\sin\theta$.

Step 1 — List the values: $M = 0.4$ A m^2, $B = 0.5$ T, $\theta = 30°$.

Step 2 — Evaluate $\sin\theta$**:**

$$\sin 30° = 0.5.$$

Step 3 — Substitute into the formula:

$$\tau = MB\sin\theta = 0.4 \times 0.5 \times 0.5.$$

Step 4 — Simplify:

$$\tau = 0.4 \times 0.25 = 0.1 \text{ N m}.$$

Why other options are wrong:

- Option A (0.2): uses $\sin\theta = 1$ $(\theta = 90°)$.
- Option B (0.4): drops the field factor.
- Option C (0.05): uses an extra factor of $\frac{1}{2}$.

Final Answer: Torque $= 0.1$ N m $\Rightarrow$ $\boxed{\text{D}}$

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

Q19.

Solution

Concept — Mutual inductance: The emf induced in one coil due to a changing current in a neighbouring coil is $\varepsilon = M\dfrac{dI}{dt}$.

Step 1 — List the values: Mutual inductance $M = 0.5$ H.

Rate of change of current $\dfrac{dI}{dt} = 4$ A s^{-1}.

Step 2 — Apply the formula:

$$\varepsilon = M\frac{dI}{dt} = 0.5 \times 4.$$

Step 3 — Simplify:

$$\varepsilon = 2 \text{ V}.$$

Why other options are wrong:

- Option B (0.5): equals M alone, ignoring the current rate.
- Option C (8): multiplies by 4 twice.
- Option D (4): equals the current rate alone, ignoring M.

Final Answer: Induced emf $= 2$ V $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q19

Q20.

Solution

Concept — Apparent depth: When viewed from above, an object in a denser medium appears raised. The apparent depth is $\frac{\text{real depth}}{n}$.

Step 1 — List the values: Real depth $= 8$ cm.

Refractive index $n = \frac{4}{3}$.

Step 2 — Apply the formula:

$$\text{apparent depth} = \frac{\text{real depth}}{n} = \frac{8}{4/3}.$$

Step 3 — Simplify the division:

$$\frac{8}{4/3} = 8 \times \frac{3}{4} = 6 \text{ cm}.$$

Why other options are wrong:

- Option A (8): assumes no apparent shift.
- Option B (10.7): multiplies by n instead of dividing.
- Option C (4): divides by 2 instead of $\frac{4}{3}$.

Final Answer: Apparent depth $= 6$ cm $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q20

Q21.

Solution

Concept — Position of a bright fringe: In YDSE the nth bright fringe lies at $y_n = \frac{n\lambda D}{d}$ from the central maximum.

Step 1 — Convert to SI units: $\lambda = 600$ nm $= 600 \times 10^{-9}$ m.

$D = 1$ m.

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

$n = 3$.

Step 2 — Write the formula:

$$y_3 = \frac{n\lambda D}{d} = \frac{3 \times 600 \times 10^{-9} \times 1}{0.3 \times 10^{-3}}.$$

Step 3 — Simplify the fringe width first:

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

Step 4 — Multiply by $n = 3$:

$$y_3 = 3 \times 2 = 6 \text{ mm}.$$

Why other options are wrong:

- Option A (2 mm): is the fringe width, i.e. only the first fringe.
- Option B (4 mm): is the second fringe ($n = 2$).
- Option D (9 mm): uses a wrong fringe width of 3 mm.

Final Answer: Position of the third bright fringe $= 6$ mm $\Rightarrow$ $\boxed{C}$

Answer: (C) Go Back to Q21

Q22.

Solution

Concept — Photoelectric equation: The maximum kinetic energy of an emitted electron is $\frac{1}{2}mv_{\text{max}}^2 = E_{\text{photon}} - \phi$, from which the maximum speed is found.

Step 1 — Maximum kinetic energy:

$$K_{\text{max}} = E_{\text{photon}} - \phi = 4 - 3 = 1 \text{ eV}.$$

Step 2 — Convert to joules:

$$K_{\text{max}} = 1 \times 1.6 \times 10^{-19} = 1.6 \times 10^{-19} \text{ J}.$$

Step 3 — Use $\frac{1}{2}mv_{\text{max}}^2 = K_{\text{max}}$:

$$v_{\text{max}} = \sqrt{\frac{2K_{\text{max}}}{m}} = \sqrt{\frac{2 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}}.$$

Step 4 — Evaluate inside the root:

$$\frac{3.2 \times 10^{-19}}{9.1 \times 10^{-31}} = 3.5 \times 10^{11} \text{ m}^2\text{s}^{-2}.$$

Step 5 — Take the square root:

$$v_{\text{max}} = \sqrt{3.5 \times 10^{11}} \approx 5.9 \times 10^5 \approx 6 \times 10^5 \text{ m s}^{-1}.$$

Why other options are wrong:

- Option A (3×10^5): too small; corresponds to about 0.25 eV.
- Option B (1.2×10^6): doubles the speed (uses ≈ 4 eV).
- Option C (9×10^5): overestimates by using a larger kinetic energy.

Final Answer: Maximum speed $\approx 6 \times 10^5$ m s^{-1} $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q22

Q23.

Solution

Concept — Number of spectral lines: When an electron de-excites from the nth level, the maximum number of distinct lines emitted is $\frac{n(n-1)}{2}$.

Step 1 — Identify the level: $n = 5$.

Step 2 — Apply the formula:

$$\text{Number of lines} = \frac{n(n-1)}{2} = \frac{5 \times (5-1)}{2}.$$

Step 3 — Simplify:

$$= \frac{5 \times 4}{2} = \frac{20}{2} = 10.$$

Why other options are wrong:

- Option A (4): counts only transitions ending at the ground state ($n = 5 \to 1$ steps).
- Option B (5): off by using n directly.
- Option C (6): is the value for $n = 4$, namely $\frac{4 \times 3}{2}$.

Final Answer: Maximum number of spectral lines $= 10 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q23

Q24.

Solution

Concept — Radioactive decay over half-lives: After k half-lives the fraction of nuclei remaining is $\left(\frac{1}{2}\right)^k$.

Step 1 — Identify the number of half-lives: $k = 4$.

Step 2 — Apply the formula:

$$\text{fraction remaining} = \left(\frac{1}{2}\right)^4.$$

Step 3 — Simplify:

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

Why other options are wrong:

- Option A ($\frac{1}{4}$): corresponds to 2 half-lives.
- Option B ($\frac{1}{8}$): corresponds to 3 half-lives.
- Option D ($\frac{1}{32}$): corresponds to 5 half-lives.

Final Answer: Fraction remaining $= \dfrac{1}{16} \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q24

Q25.

Solution

Concept — Working of a light-emitting diode: An LED is a forward-biased p-n junction diode. Under forward bias, electrons from the n-side and holes from the p-side are pushed into the junction, where they recombine and release the energy difference as photons (light).

Step 1 — Bias condition: An LED operates under forward bias, which drives majority carriers across the junction.

Step 2 — Recombination releases light: At the junction an electron drops into a hole, and the energy released (close to the band gap) appears as a photon, so the diode emits light.

Why other options are wrong:

- Option A: a reverse-biased junction that responds to incident light describes a photodiode, not an LED.
- Option C: converting incident light into current describes a solar cell or photodiode, not an emitting device.
- Option D: storing charge across a junction describes a capacitor, not the emission process.

Final Answer: An LED emits light because electrons and holes recombine under forward bias, releasing photons $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q25

Answer Key

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