PGIMER BSc Nursing Physics

Sample Paper – 3

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. When the number 0.0006032 is rounded off to **three** significant figures, the result is:

(A) 6.03×10^{-4}

(B) 6.0×10^{-4}

(C) 6.032×10^{-4}

(D) 6×10^{-4}

Q2. A body starts moving in a straight line with an initial velocity of 3 m s^{-1} and a uniform acceleration of 2 m s^{-2}. The distance travelled by the body during the 4th second of its motion is:

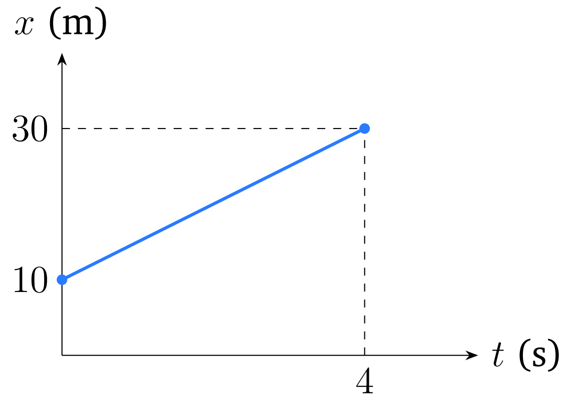
(A) 7 m

(B) 8 m

(C) 9 m

(D) 10 m

Q3. The position–time (x–t) graph of a body moving in a straight line is shown below. The velocity of the body is equal to the slope of this graph. The velocity of the body is:



(A) 4 m s^{-1}

(B) 5 m s^{-1}

(C) 10 m s^{-1}

(D) 2.5 m s^{-1}

Q4. A person of mass 60 kg stands on a weighing scale inside a lift. The lift accelerates **upward** at 2 m s^{-2}. Taking $g = 10 \text{ m s}^{-2}$, the apparent weight of the person (the reading of the scale) is:

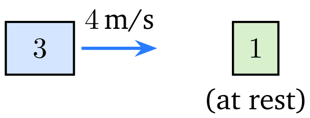
(A) 600 N

(B) 480 N

(C) 660 N

(D) 720 N

Q5. A block of mass 3 kg moving at 4 m s^{-1} collides head-on with a stationary block of mass 1 kg and the two stick together, as shown. The common velocity of the combined blocks after the collision is:



(A) 1 m s^{-1}

(B) 2 m s^{-1}

(C) 4 m s^{-1}

(D) 3 m s^{-1}

Q6. A body of mass 2 kg moving with a speed of 10 m s^{-1} is brought to rest by a constant retarding force of 20 N. Using the work–energy theorem, the distance travelled by the body before stopping is:

(A) 2.5 m

(B) 10 m

(C) 5 m

(D) 20 m

Q7. A figure skater spinning with her arms outstretched has a moment of inertia of 6 kg m^2 and an angular speed of 2 rad s^{-1}. When she pulls her arms in, her moment of inertia reduces to 2 kg m^2. Her new angular speed is:

(A) 3 rad s^{-1}

(B) 6 rad s^{-1}

(C) 2 rad s^{-1}

(D) 12 rad s^{-1}

Q8. A satellite moves in a circular orbit of radius $r = 1 \times 10^7$ m around a planet for which $GM = 6.4 \times 10^{14} \text{ N m}^2 \text{ kg}^{-1}$. The orbital velocity of the satellite $\left(v = \sqrt{\frac{GM}{r}}\right)$ is:

(A) 8 km s^{-1}

(B) 6.4 km s^{-1}

(C) 4 km s^{-1}

(D) 16 km s^{-1}

Q9. The excess pressure inside a spherical liquid drop of radius 2×10^{-3} m is to be found. The surface tension of the liquid is 0.05 N m^{-1}. The excess pressure inside the drop $\left(\Delta P = \frac{2T}{r}\right)$ is:

(A) 25 Pa

(B) 100 Pa

(C) 200 Pa

(D) 50 Pa

Q10. One mole of an ideal gas expands isothermally and reversibly at 300 K from volume V to $2V$. Taking $R = 8.314$ J mol^{-1}K^{-1} and $\ln 2 = 0.693$, the work done by the gas $\left(W = nRT \ln \frac{V_2}{V_1}\right)$ is approximately:

(A) 2079 J

(B) 1729 J

(C) 900 J

(D) 0 J

Q11. A rigid diatomic ideal gas molecule has 5 degrees of freedom. The ratio of specific heats $\gamma = \frac{C_P}{C_V} = 1 + \frac{2}{f}$ for this gas is:

(A) 1.33

(B) 1.40

(C) 1.67

(D) 1.50

Q12. A sound wave of frequency 500 Hz travels through a medium with a wavelength of 0.4 m. The speed of the wave $(v = f\lambda)$ is:

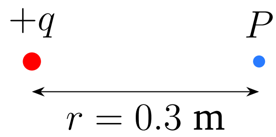
(A) 50 m s^{-1}

(B) 125 m s^{-1}

(C) 1250 m s^{-1}

(D) 200 m s^{-1}

Q13. An electric potential is set up by a point charge $q = +2$ nC. The potential at a point P located 0.3 m from the charge, as shown, is $\left(V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}, \frac{1}{4\pi\varepsilon_0} = 9 \times 1\right.$



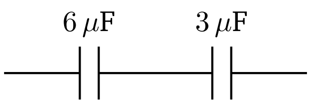
(A) 30 V

(B) 20 V

(C) 60 V

(D) 18 V

Q14. Two capacitors of capacitances $6\ \mu$F and $3\ \mu$F are connected in series, as shown. The equivalent capacitance of the combination is:



(A) $9\ \mu$F

(B) $4.5\ \mu$F

(C) $2\ \mu$F

(D) $18\ \mu$F

Q15. A current of 1.6 A flows through a conductor of cross-sectional area 1×10^{-6} m^2. The free-electron density is $n = 1 \times 10^{29}$ m^{-3} and $e = 1.6 \times 10^{-19}$ C. The drift velocity of the electrons $\left(v_d = \frac{I}{nAe}\right)$ is:

(A) $1 \times 10^{-4} \text{ m s}^{-1}$

(B) $2 \times 10^{-4} \text{ m s}^{-1}$

(C) $1.6 \times 10^{-3} \text{ m s}^{-1}$

(D) 1×10^{-3} m s^{-1}

Q16. A current of 2 A flows through a resistor of resistance $5\ \Omega$ for 10 s. The heat produced in the resistor $(H = I^2Rt)$ is:

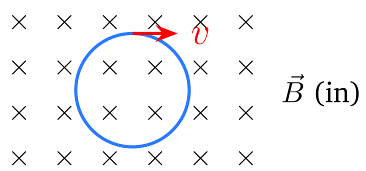
(A) 200 J

(B) 100 J

(C) 400 J

(D) 50 J

Q17. A charged particle of mass 1.6×10^{-27} kg and charge 1.6×10^{-19} C enters a uniform magnetic field of 0.2 T (into the page) with a speed of 3.2×10^6 m s^{-1} perpendicular to the field, as shown. The radius of its circular path $\left(r = \dfrac{mv}{qB}\right)$ is:



(A) 0.08 m

(B) 0.16 m

(C) 0.32 m

(D) 0.40 m

Q18. A circular coil of 100 turns, each of area 5×10^{-4} m^2, carries a current of 2 A. The magnetic dipole moment of the coil $(m = NIA)$ is:

(A) 0.05 A m^2

(B) 0.10 A m^2

(C) 0.20 A m^2

(D) 1.0 A m^2

Q19. A current of 3 A flows through an inductor of self-inductance 2 H. The energy stored in the magnetic field of the inductor $\left(U = \frac{1}{2}LI^2\right)$ is:

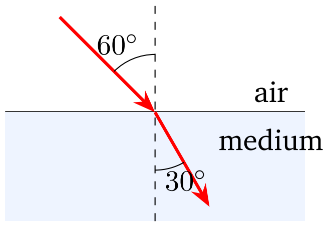
(A) 9 J

(B) 18 J

(C) 4.5 J

(D) 6 J

Q20. A ray of light passes from air into a transparent medium. The angle of incidence is 60° and the angle of refraction is 30°, as shown. The refractive index of the medium $\left(n = \frac{\sin i}{\sin r}\right)$ is:



(A) 0.58

(B) 1.0

(C) 2.0

(D) $\sqrt{3}$

Q21. In a single-slit diffraction experiment, monochromatic light of wavelength λ falls normally on a slit of width a. The condition for the **first** diffraction minimum (in terms of the diffraction angle θ) is:

(A) $a\sin\theta = \lambda$

(B) $a\sin\theta = \frac{\lambda}{2}$

(C) $a\sin\theta = 2\lambda$

(D) $a\sin\theta = \frac{3\lambda}{2}$

Q22. The work function of a metal surface is 3.3×10^{-19} J. Taking Planck's constant $h = 6.6 \times 10^{-34}$ J s, the threshold frequency of the metal $\left(f_0 = \dfrac{\phi}{h}\right)$ is:

(A) 2×10^{14} Hz

(B) 1×10^{15} Hz

(C) 5×10^{14} Hz

(D) 3.3×10^{14} Hz

Q23. An electron in a hydrogen atom makes a transition from the level $n = 2$ to the level $n = 1$, emitting a photon of energy 10.2 eV. Taking $hc = 1240$ eV nm, the wavelength of the emitted photon $\left(\lambda = \dfrac{hc}{E}\right)$ is approximately:

(A) 91 nm

(B) 103 nm

(C) 122 nm

(D) 656 nm

Q24. A radioactive nuclide has a half-life of 6.93 s. The decay constant of the nuclide $\left(\lambda = \dfrac{0.693}{T_{1/2}}\right)$ is:

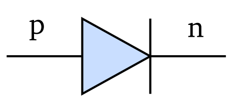
(A) 0.693 s^{-1}

(B) 6.93 s^{-1}

(C) 0.05 s^{-1}

(D) 0.1 s^{-1}

Q25. The circuit symbol of a p-n junction diode is shown below. Which one of the following statements about the **forward biasing** of the diode is correct?



(A) In reverse bias the depletion region narrows and the current is large.

(B) In forward bias the p-side is connected to the negative terminal of the battery.

(C) In forward bias the depletion region narrows and the diode conducts appreciable current.

(D) In forward bias the diode offers infinite resistance and blocks the current completely.

Detailed Solutions

Q1.

Solution

Concept — Rounding to significant figures: To keep a fixed number of significant figures, count significant digits from the first non-zero digit and round the remaining part using the standard rounding rule.

Step 1 — Identify the significant figures: In 0.0006032 the leading zeros are not significant. The significant digits, in order, are 6, 0, 3, 2.

Step 2 — Keep the first three significant digits: The first three significant digits are 6, 0, 3, which give 0.000603.

Step 3 — Apply the rounding rule: The next digit (the fourth significant digit) is 2, which is less than 5, so the digit 3 is left unchanged.

$$0.0006032 \to 0.000603 = 6.03 \times 10^{-4}.$$

Why other options are wrong:

- Option B (6.0×10^{-4}): keeps only two significant figures.
- Option C (6.032×10^{-4}): keeps four significant figures.
- Option D (6×10^{-4}): keeps only one significant figure.

Final Answer: The rounded value is $6.03 \times 10^{-4} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q1

Q2.

Solution

Concept — Distance in the nth second: For uniform acceleration, the distance travelled during the nth second is $s_n = u + \frac{a}{2}(2n - 1)$.

Step 1 — List the values: Initial velocity $u = 3$ m s^{-1}.

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

The nth second is the 4th second, so $n = 4$.

Step 2 — Substitute into the formula:

$$s_n = u + \frac{a}{2}(2n - 1) = 3 + \frac{2}{2}(2 \times 4 - 1).$$

Step 3 — Simplify the bracket:

$$2 \times 4 - 1 = 8 - 1 = 7.$$

Step 4 — Complete the calculation:

$$s_n = 3 + 1 \times 7 = 3 + 7 = 10 \text{ m}.$$

Why other options are wrong:

- Option A (7 m): uses only the $\frac{a}{2}(2n - 1)$ term and drops u.
- Option B (8 m): uses $n = 3$ instead of $n = 4$.
- Option C (9 m): arithmetic slip in the bracket.

Final Answer: Distance in the 4th second $= 10$ m $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q2

Q3.

Solution

Concept — Slope of a position–time graph: The velocity of a body equals the slope of its x–t graph, $v = \frac{\Delta x}{\Delta t}$.

Step 1 — Read two points off the straight line: At $t = 0$ s, the position is $x = 10$ m.

At $t = 4$ s, the position is $x = 30$ m.

Step 2 — Find the change in position and time:

$$\Delta x = 30 - 10 = 20 \text{ m}.$$

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

Step 3 — Compute the slope:

$$v = \frac{\Delta x}{\Delta t} = \frac{20}{4} = 5 \text{ m s}^{-1}.$$

Why other options are wrong:

- Option A (4 m s^{-1}): divides the time by the position.
- Option C (10 m s^{-1}): uses the initial position as the velocity.

- Option D (2.5 m s^{-1}): halves the correct slope.

Final Answer: Velocity $= 5$ m s^{-1} $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q3

Q4.

Solution

Concept — Apparent weight in a lift: When a lift accelerates upward with acceleration a, the normal force (scale reading) is $N = m(g + a)$.

Step 1 — List the values: Mass $m = 60$ kg.

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

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

Step 2 — Write the apparent weight formula:

$$N = m(g + a).$$

Step 3 — Substitute the numbers:

$$N = 60 \times (10 + 2) = 60 \times 12.$$

Step 4 — Simplify:

$$N = 720 \text{ N}.$$

Why other options are wrong:

- Option A (600 N): is the true weight mg, ignoring the acceleration.
- Option B (480 N): uses $m(g - a)$, which applies to downward acceleration.
- Option C (660 N): adds only 1 m s^{-2} instead of 2.

Final Answer: Apparent weight $= 720$ N $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Conservation of linear momentum: In the absence of external forces, the total momentum before a collision equals the total momentum after it. For a perfectly inelastic (sticking) collision the two bodies move together with a common velocity.

Step 1 — List the values: Mass $m_1 = 3$ kg, initial velocity $u_1 = 4$ m s^{-1}.

Mass $m_2 = 1$ kg, initial velocity $u_2 = 0$.

Step 2 — Write the momentum conservation equation:

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v.$$

Step 3 — Substitute the numbers:

$$3 \times 4 + 1 \times 0 = (3 + 1)v.$$

$$12 = 4v.$$

Step 4 — Solve for v:

$$v = \frac{12}{4} = 3 \text{ m s}^{-1}.$$

Why other options are wrong:

- Option A (1 m s^{-1}): divides by the wrong total mass.
- Option B (2 m s^{-1}): uses equal masses by mistake.
- Option C (4 m s^{-1}): assumes the velocity is unchanged, ignoring the added mass.

Final Answer: Common velocity = 3 m s^{-1} $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q5

Q6.

Solution

Concept — Work–energy theorem: The work done by the net force equals the change in kinetic energy. When a body stops, the retarding force does negative work equal in magnitude to the body's initial kinetic energy.

Step 1 — Find the initial kinetic energy:

$$K = \frac{1}{2}mv^2 = \frac{1}{2} \times 2 \times (10)^2.$$

$$K = \frac{1}{2} \times 2 \times 100 = 100 \text{ J}.$$

Step 2 — Equate the work done by the retarding force to the kinetic energy:

$$F\,d = K.$$

$$20 \times d = 100.$$

Step 3 — Solve for the distance:

$$d = \frac{100}{20} = 5 \text{ m}.$$

Why other options are wrong:

- Option A (2.5 m): forgets the factor $\frac{1}{2}$ in the kinetic energy.
- Option B (10 m): uses momentum instead of energy.
- Option D (20 m): divides by the wrong quantity.

Final Answer: Stopping distance $= 5 \text{ m} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q6

Q7.

Solution

Concept — Conservation of angular momentum: When no external torque acts, the angular momentum $L = I\omega$ stays constant, so $I_1\omega_1 = I_2\omega_2$.

Step 1 — List the values: Initial moment of inertia $I_1 = 6$ kg m^2, initial angular speed $\omega_1 = 2$ rad s^{-1}.

Final moment of inertia $I_2 = 2$ kg m^2.

Step 2 — Apply conservation of angular momentum:

$$I_1\omega_1 = I_2\omega_2.$$

$$6 \times 2 = 2 \times \omega_2.$$

Step 3 — Solve for ω_2:

$$\omega_2 = \frac{12}{2} = 6 \text{ rad s}^{-1}.$$

Why other options are wrong:

- Option A (3 rad s^{-1}): multiplies the angular speed by the ratio in the wrong sense.
- Option C (2 rad s^{-1}): assumes no change in angular speed.
- Option D (12 rad s^{-1}): forgets to divide by the new moment of inertia.

Final Answer: New angular speed $= 6$ rad s^{-1} $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q7

Q8.

Solution

Concept — Orbital velocity of a satellite: A satellite in a circular orbit of radius r has orbital speed $v = \sqrt{\dfrac{GM}{r}}$.

Step 1 — List the values: $GM = 6.4 \times 10^{14}$ N m^2 kg^{-1}.

$r = 1 \times 10^7$ m.

Step 2 — Form the ratio inside the root:

$$\frac{GM}{r} = \frac{6.4 \times 10^{14}}{1 \times 10^7} = 6.4 \times 10^7 \text{ m}^2\,\text{s}^{-2}.$$

Step 3 — Take the square root:

$$v = \sqrt{6.4 \times 10^7} = \sqrt{64 \times 10^6} = 8 \times 10^3 \text{ m s}^{-1}.$$

$$v = 8000 \text{ m s}^{-1} = 8 \text{ km s}^{-1}.$$

Why other options are wrong:

- Option B (6.4 km s^{-1}): quotes the ratio digits without taking the square root.

- Option C ($4\ \text{km s}^{-1}$): halves the correct value.
- Option D ($16\ \text{km s}^{-1}$): doubles the correct value.

Final Answer: Orbital velocity $= 8\ \text{km s}^{-1} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q8

Q9.

Solution

Concept — Excess pressure inside a drop: A spherical liquid drop has a single surface, so the excess (gauge) pressure inside it is $\Delta P = \dfrac{2T}{r}$.

Step 1 — List the values: Surface tension $T = 0.05\ \text{N m}^{-1}$.

Radius $r = 2 \times 10^{-3}$ m.

Step 2 — Substitute into the formula:

$$\Delta P = \frac{2T}{r} = \frac{2 \times 0.05}{2 \times 10^{-3}}.$$

Step 3 — Simplify the numerator and divide:

$$\Delta P = \frac{0.10}{2 \times 10^{-3}} = \frac{0.10}{0.002} = 50\ \text{Pa}.$$

Why other options are wrong:

- Option A (25 Pa): uses $\dfrac{T}{r}$, dropping the factor of 2.
- Option B (100 Pa): uses $\dfrac{4T}{r}$, which is the soap-bubble (two-surface) formula.
- Option C (200 Pa): uses an even larger incorrect factor.

Final Answer: Excess pressure $= 50$ Pa $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q9

Q10.

Solution

Concept — Work in an isothermal process: For the reversible isothermal expansion of an ideal gas, the work done by the gas is $W = nRT\ln\frac{V_2}{V_1}$. (In an adiabatic process there is no heat exchange and the relation PV^γ = constant applies instead.)

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

Temperature $T = 300$ K.

$R = 8.314$ J mol^{-1}K^{-1}.

Volume ratio $\frac{V_2}{V_1} = \frac{2V}{V} = 2$, so $\ln 2 = 0.693$.

Step 2 — Substitute into the work formula:

$$W = nRT\ln\frac{V_2}{V_1} = 1 \times 8.314 \times 300 \times 0.693.$$

Step 3 — Multiply step by step:

$$8.314 \times 300 = 2494.2.$$

$$W = 2494.2 \times 0.693 \approx 1729 \text{ J}.$$

Why other options are wrong:

- Option A (2079 J): uses $\ln$ of the wrong ratio.
- Option C (900 J): uses an incorrect temperature.
- Option D (0 J): would only be true if there were no volume change.

Final Answer: Work done ≈ 1729 J $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — Specific-heat ratio from degrees of freedom: For an ideal gas whose molecules have f degrees of freedom, the ratio of specific heats is $\gamma = 1 + \frac{2}{f}$.

Step 1 — Identify the degrees of freedom: For a rigid diatomic molecule, $f = 5$ (three translational and two rotational).

Step 2 — Substitute into the formula:

$$\gamma = 1 + \frac{2}{f} = 1 + \frac{2}{5}.$$

Step 3 — Simplify:

$$\gamma = 1 + 0.4 = 1.4 = \frac{7}{5}.$$

Why other options are wrong:

- Option A (1.33): is γ for a polyatomic gas with $f = 6$.
- Option C (1.67): is γ for a monatomic gas with $f = 3$.
- Option D (1.50): does not correspond to any standard value.

Final Answer: $\gamma = 1.4 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q11

Q12.

Solution

Concept — Wave speed relation: The speed of a wave is the product of its frequency and wavelength, $v = f\lambda$.

Step 1 — List the values: Frequency $f = 500$ Hz.

Wavelength $\lambda = 0.4$ m.

Step 2 — Substitute into the formula:

$$v = f\lambda = 500 \times 0.4.$$

Step 3 — Simplify:

$$v = 200 \text{ m s}^{-1}.$$

Why other options are wrong:

- Option A (50 m s^{-1}): divides instead of multiplying.
- Option B (125 m s^{-1}): divides frequency by wavelength.
- Option C (1250 m s^{-1}): misplaces a decimal in the wavelength.

Final Answer: Wave speed $= 200 \text{ m s}^{-1} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Potential due to a point charge: The electric potential at distance r from a point charge q is $V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$.

Step 1 — List the values: Charge $q = +2 \text{ nC} = 2 \times 10^{-9}$ C.

Distance $r = 0.3$ m.

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

Step 2 — Substitute into the formula:

$$V = 9 \times 10^9 \times \frac{2 \times 10^{-9}}{0.3}.$$

Step 3 — Simplify the numerator:

$$9 \times 10^9 \times 2 \times 10^{-9} = 18.$$

Step 4 — Divide by the distance:

$$V = \frac{18}{0.3} = 60 \text{ V}.$$

Why other options are wrong:

- Option A (30 V): divides by 0.6 instead of 0.3.
- Option B (20 V): uses a wrong power of ten.
- Option D (18 V): forgets to divide by the distance.

Final Answer: Potential at $P = 60 \text{ V} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q13

Q14.

Solution

Concept — Capacitors in series: For capacitors in series, the reciprocals of the capacitances add, $\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2}$.

Step 1 — List the values: $C_1 = 6\ \mu$F and $C_2 = 3\ \mu$F.

Step 2 — Add the reciprocals:

$$\frac{1}{C_{\text{eq}}} = \frac{1}{6} + \frac{1}{3} = \frac{1}{6} + \frac{2}{6} = \frac{3}{6} = \frac{1}{2}.$$

Step 3 — Invert to find the equivalent capacitance:

$$C_{\text{eq}} = 2\ \mu\text{F}.$$

Why other options are wrong:

- Option A ($9\ \mu$F): adds the capacitances as if in parallel.
- Option B ($4.5\ \mu$F): takes a simple average.
- Option D ($18\ \mu$F): multiplies the capacitances.

Final Answer: Equivalent capacitance $= 2\ \mu$F $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q14

Q15.

Solution

Concept — Drift velocity of electrons: The drift velocity of the charge carriers in a conductor is $v_d = \frac{I}{nAe}$, where n is the carrier density and A is the cross-sectional area.

Step 1 — List the values: Current $I = 1.6$ A.

Carrier density $n = 1 \times 10^{29}$ m^{-3}.

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

Electron charge $e = 1.6 \times 10^{-19}$ C.

Step 2 — Compute the denominator nAe:

$$nAe = (1 \times 10^{29}) \times (1 \times 10^{-6}) \times (1.6 \times 10^{-19}).$$

$$nAe = 1.6 \times 10^{29-6-19} = 1.6 \times 10^4.$$

Step 3 — Divide the current by the denominator:

$$v_d = \frac{I}{nAe} = \frac{1.6}{1.6 \times 10^4} = 1 \times 10^{-4} \text{ m s}^{-1}.$$

Why other options are wrong:

- Option B (2×10^{-4} m s^{-1}): doubles the correct value.
- Option C (1.6×10^{-3} m s^{-1}): drops a power of ten.
- Option D (1×10^{-3} m s^{-1}): mis-counts the powers of ten.

Final Answer: Drift velocity $= 1 \times 10^{-4}$ m s^{-1} $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q15

Q16.

Solution

Concept — Joule heating: The heat produced in a resistor carrying current I for a time t is $H = I^2Rt$.

Step 1 — List the values: Current $I = 2$ A, so $I^2 = 4$ A^2.

Resistance $R = 5\ \Omega$.

Time $t = 10$ s.

Step 2 — Substitute into the formula:

$$H = I^2Rt = 4 \times 5 \times 10.$$

Step 3 — Simplify:

$$H = 4 \times 5 \times 10 = 200 \text{ J}.$$

Why other options are wrong:

- Option B (100 J): uses I instead of I^2.
- Option C (400 J): squares the current twice.
- Option D (50 J): drops a factor in the time.

Final Answer: Heat produced $= 200$ J $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q16

Q17.

Solution

Concept — Circular motion in a magnetic field: A charged particle moving perpendicular to a uniform magnetic field follows a circle of radius $r = \frac{mv}{qB}$.

Step 1 — List the values: Mass $m = 1.6 \times 10^{-27}$ kg.

Speed $v = 3.2 \times 10^{6}$ m s^{-1}.

Charge $q = 1.6 \times 10^{-19}$ C.

Field $B = 0.2$ T.

Step 2 — Compute the numerator mv:

$$mv = (1.6 \times 10^{-27}) \times (3.2 \times 10^{6}) = 5.12 \times 10^{-21}.$$

Step 3 — Compute the denominator qB:

$$qB = (1.6 \times 10^{-19}) \times 0.2 = 3.2 \times 10^{-20}.$$

Step 4 — Divide to find the radius:

$$r = \frac{5.12 \times 10^{-21}}{3.2 \times 10^{-20}} = 0.16 \text{ m}.$$

Why other options are wrong:

- Option A (0.08 m): halves the correct value.
- Option C (0.32 m): doubles the correct value.
- Option D (0.40 m): mis-handles the powers of ten.

Final Answer: Radius of the path $= 0.16$ m $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q17

Q18.

Solution

Concept — Magnetic dipole moment of a coil: A coil of N turns, each of area A, carrying current I has a magnetic dipole moment $m = NIA$.

Step 1 — List the values: Number of turns $N = 100$.

Current $I = 2$ A.

Area of each turn $A = 5 \times 10^{-4}$ m^2.

Step 2 — Substitute into the formula:

$$m = NIA = 100 \times 2 \times (5 \times 10^{-4}).$$

Step 3 — Simplify:

$$m = 200 \times 5 \times 10^{-4} = 1000 \times 10^{-4} = 0.10 \text{ A m}^2.$$

Why other options are wrong:

- Option A (0.05 A m^2): uses only one turn instead of the full current factor.
- Option C (0.20 A m^2): doubles the correct value.
- Option D (1.0 A m^2): drops a power of ten in the area.

Final Answer: Magnetic dipole moment $= 0.10$ A m^2 $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — Energy stored in an inductor: An inductor of self-inductance L carrying current I stores magnetic energy $U = \frac{1}{2}LI^2$.

Step 1 — List the values: Self-inductance $L = 2$ H.

Current $I = 3$ A, so $I^2 = 9$ A^2.

Step 2 — Substitute into the formula:

$$U = \frac{1}{2}LI^2 = \frac{1}{2} \times 2 \times 9.$$

Step 3 — Simplify:

$$U = \frac{1}{2} \times 2 \times 9 = 1 \times 9 = 9 \text{ J}.$$

Why other options are wrong:

- Option B (18 J): forgets the factor $\frac{1}{2}$.
- Option C (4.5 J): uses I instead of I^2.
- Option D (6 J): multiplies L and I linearly.

Final Answer: Energy stored $= 9$ J $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q19

Q20.

Solution

Concept — Snell's law: When light passes from air into a medium, the refractive index of the medium is $n = \frac{\sin i}{\sin r}$, where i is the angle of incidence and r is the angle of refraction.

Step 1 — List the values: Angle of incidence $i = 60°$, so $\sin 60° = \frac{\sqrt{3}}{2}$.

Angle of refraction $r = 30°$, so $\sin 30° = \frac{1}{2}$.

Step 2 — Substitute into Snell's law:

$$n = \frac{\sin i}{\sin r} = \frac{\sqrt{3}/2}{1/2}.$$

Step 3 — Simplify:

$$n = \frac{\sqrt{3}}{2} \times \frac{2}{1} = \sqrt{3} \approx 1.73.$$

Why other options are wrong:

- Option A (0.58): inverts the ratio, $\frac{\sin r}{\sin i}$.
- Option B (1.0): would mean no bending of the ray.
- Option C (2.0): uses a wrong value for one of the sines.

Final Answer: Refractive index $= \sqrt{3} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q20

Q21.

Solution

Concept — Single-slit diffraction minima: In single-slit diffraction, dark fringes (minima) occur where the path difference across the slit equals a whole number of wavelengths, $a \sin\theta = m\lambda$ with $m = 1, 2, 3, \ldots$

Step 1 — Identify the first minimum: The first minimum corresponds to $m = 1$.

Step 2 — Write the condition for $m = 1$:

$$a \sin\theta = 1 \times \lambda = \lambda.$$

Step 3 — Interpret the result: The first dark fringe forms at the angle θ for which $a \sin\theta = \lambda$.

Why other options are wrong:

- Option B ($a \sin\theta = \lambda/2$): is the condition for the central region, not a minimum.
- Option C ($a \sin\theta = 2\lambda$): is the *second* minimum ($m = 2$).
- Option D ($a \sin\theta = 3\lambda/2$): corresponds to a secondary maximum, not the first minimum.

Final Answer: First minimum at $a \sin\theta = \lambda \Rightarrow \boxed{A}$

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

Q22.

Solution

Concept — Threshold frequency: The threshold frequency f_0 is the minimum frequency of incident light needed to eject electrons; it is related to the work function by $\phi = hf_0$, so $f_0 = \dfrac{\phi}{h}$.

Step 1 — List the values: Work function $\phi = 3.3 \times 10^{-19}$ J.

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

Step 2 — Substitute into the formula:

$$f_0 = \frac{\phi}{h} = \frac{3.3 \times 10^{-19}}{6.6 \times 10^{-34}}.$$

Step 3 — Simplify:

$$f_0 = \frac{3.3}{6.6} \times 10^{-19-(-34)} = 0.5 \times 10^{15} = 5 \times 10^{14} \text{ Hz}.$$

Why other options are wrong:

- Option A (2×10^{14} Hz): mis-divides the mantissas.
- Option B (1×10^{15} Hz): doubles the correct value.
- Option D (3.3×10^{14} Hz): quotes the work-function digits.

Final Answer: Threshold frequency $= 5 \times 10^{14}$ Hz $\Rightarrow \boxed{\text{C}}$

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

Q23.

Solution

Concept — Wavelength from photon energy: The wavelength of a photon of energy E is $\lambda = \frac{hc}{E}$. Using $hc = 1240$ eV nm gives λ directly in nanometres when E is in electronvolts.

Step 1 — List the values: Photon energy $E = 10.2$ eV.

$hc = 1240$ eV nm.

Step 2 — Substitute into the formula:

$$\lambda = \frac{hc}{E} = \frac{1240}{10.2}.$$

Step 3 — Simplify:

$$\lambda \approx 121.6 \text{ nm} \approx 122 \text{ nm}.$$

Why other options are wrong:

- Option A (91 nm): corresponds to the series limit (energy 13.6 eV).
- Option B (103 nm): corresponds to the $n = 3 \to 1$ transition.
- Option D (656 nm): is the $n = 3 \to 2$ (Balmer) line.

Final Answer: Wavelength ≈ 122 nm $\Rightarrow \boxed{\text{C}}$

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

Q24.

Solution

Concept — Decay constant and half-life: The decay constant is related to the half-life by $\lambda = \dfrac{0.693}{T_{1/2}}$.

Step 1 — List the values: Half-life $T_{1/2} = 6.93$ s.

Step 2 — Substitute into the formula:

$$\lambda = \frac{0.693}{T_{1/2}} = \frac{0.693}{6.93}.$$

Step 3 — Simplify:

$$\lambda = 0.1 \text{ s}^{-1}.$$

Why other options are wrong:

- Option A (0.693 s^{-1}): forgets to divide by the half-life.
- Option B (6.93 s^{-1}): quotes the half-life itself.
- Option C (0.05 s^{-1}): halves the correct value.

Final Answer: Decay constant $= 0.1$ s^{-1} $\Rightarrow \boxed{\text{D}}$

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

Q25.

Solution

Concept — Biasing of a p-n junction diode: In *forward* bias, the p-side is connected to the positive terminal and the n-side to the negative terminal of the battery. This reduces the width of the depletion region and its potential barrier, allowing a large forward current. In *reverse* bias the depletion region widens and the current is negligible.

Step 1 — Examine the depletion region in forward bias: The applied voltage opposes the built-in barrier, so the depletion layer narrows.

Step 2 — Examine the conduction in forward bias: With the barrier reduced, majority carriers cross the junction easily, so the diode conducts an appreciable current.

Step 3 — Match with the options: The statement that combines a narrowing depletion region with appreciable conduction in forward bias is option C.

Why other options are wrong:

- Option A: in reverse bias the depletion region *widens* and the current is very small, not large.
- Option B: in forward bias the p-side is connected to the *positive* terminal, not the negative one.
- Option D: a forward-biased diode offers low resistance and conducts; it does not block the current.

Final Answer: In forward bias the depletion region narrows and the diode conducts $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q25

Answer Key

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