GAT-B Physics

Sample Paper – 8

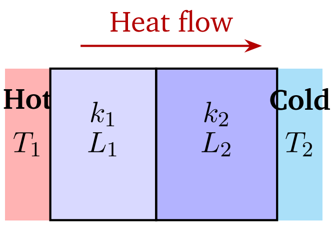
Duration: 23 Minutes | Maximum Marks: 15

Instructions

- This paper contains **15 Multiple Choice Questions (MCQs)** — Physics (Class 11 & 12, NCERT).
- Each question has **exactly one** correct answer from options (A)–(D).
- **Marking scheme:** Correct answer **+1**; Wrong answer -0.5; Unattempted **0**.
- Use of calculators is **not** permitted.
- Click/tap a question number in the answer key to jump to its solution.

Questions

Q1. Two slabs of equal cross-sectional area A are placed in series between two thermal reservoirs at temperatures $T_1 = 100\,°\text{C}$ and $T_2 = 0\,°\text{C}$. Slab 1 has thermal conductivity $k_1 = 2\,\text{W m}^{-1}\text{K}^{-1}$ and thickness $L_1 = 0.02\,\text{m}$; Slab 2 has $k_2 = 4\,\text{W m}^{-1}\text{K}^{-1}$ and $L_2 = 0.04\,\text{m}$. If $A = 1\,\text{m}^2$, what is the steady-state heat-flow rate $\dfrac{dQ}{dt}$?



(A) $5000\,\text{W}$

(B) $2000\,\text{W}$

(C) $4000\,\text{W}$

(D) $3333\,\text{W}$

Q2. Train A of length $120\,\text{m}$ moves east at $72\,\text{km h}^{-1}$ and Train B of length $60\,\text{m}$ moves west at $36\,\text{km h}^{-1}$ on parallel tracks. How long do they take to completely cross each other?

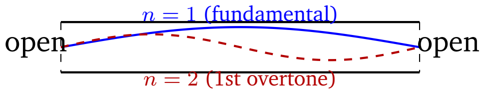
(A) $4\,\text{s}$

(B) 6 s

(C) 8 s

(D) 10 s

Q3. An open organ pipe of length $L = 0.85\,\mathrm{m}$ is set into resonance. Given the speed of sound $v = 340\,\mathrm{m\,s^{-1}}$, which of the following is **not** a resonant frequency of the open pipe?



(A) 200 Hz

(B) 400 Hz

(C) 500 Hz

(D) 600 Hz

Q4. The acceleration due to gravity on the Earth's surface is $g = 9.8\,\mathrm{m\,s^{-2}}$. What is the value of g' at an altitude $h = \dfrac{R}{2}$ above the Earth's surface, where R is the radius of the Earth?

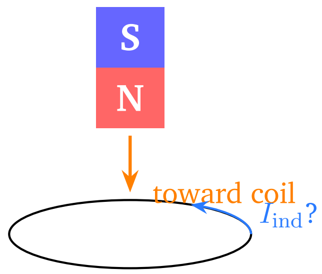
(A) $4.9\,\mathrm{m\,s^{-2}}$

(B) $\dfrac{4g}{9}$

(C) $\dfrac{g}{4}$

(D) $\dfrac{2g}{3}$

Q5. A bar magnet with its **north pole pointing downward** is moved **toward** a horizontal circular coil lying in the plane of the page, as shown. Which statement correctly describes the induced current in the coil (as seen from **above** the coil)?



(A) Clockwise (seen from above) — the coil acts as a south pole facing the magnet

(B) Anticlockwise (seen from above) — the coil acts as a north pole facing the magnet

(C) No current is induced because the coil is horizontal

(D) Clockwise (seen from above) — the coil acts as a north pole facing the magnet

Q6. A thin ring of radius $R = 0.10\,\text{m}$ carries a uniformly distributed charge $Q = 4 \times 10^{-9}\,\text{C}$. What is the magnitude of the electric field at a point on the axis of the ring at a distance $x = 0.10\,\text{m}$ from the centre? (Take $k = 9 \times 10^{9}\,\text{N}\,\text{m}^2\,\text{C}^{-2}$.)

(A) $18\,\text{N}\,\text{C}^{-1}$

(B) $900\,\text{N}\,\text{C}^{-1}$

(C) $1273\,\text{N}\,\text{C}^{-1}$

(D) $636\,\text{N}\,\text{C}^{-1}$

Q7. A uniformly charged thin spherical shell of radius R carries a total charge Q. A point P is located **inside** the shell at a distance $r < R$ from the centre. By Gauss's law, the electric field at P is:

(A) $\dfrac{kQ}{r^2}$, directed radially outward

(B) $\dfrac{kQ}{R^2}$, directed radially outward

(C) Zero

(D) $\dfrac{kQr}{R^3}$, directed radially outward

Q8. A viscous liquid flows through a cylindrical tube of radius r, length L, under a pressure difference ΔP. The volume flow rate is Q_0. If the radius of the tube is **doubled** (all other quantities unchanged), the new flow rate Q' is:

(A) $2Q_0$

(B) $4Q_0$

(C) $8Q_0$

(D) $16Q_0$

Q9. Light of frequency $f = 1.2 \times 10^{15}\,\mathrm{Hz}$ is incident on a metal surface whose work function is $\phi = 2.0\,\mathrm{eV}$. What is the stopping potential V_0? (Take $h = 6.63 \times 10^{-34}\,\mathrm{J\,s}$, $e = 1.6 \times 10^{-19}\,\mathrm{C}$.)

(A) $1.97\,\mathrm{V}$

(B) $3.00\,\mathrm{V}$

(C) $2.97\,\mathrm{V}$

(D) $4.97\,\mathrm{V}$

Q10. The nuclear radius is given by $R = R_0 A^{1/3}$. If nucleus X has mass number $A_X = 27$ and nucleus Y has mass number $A_Y = 125$, what is the ratio $R_X : R_Y$?

(A) $3 : 5$

(B) $9 : 25$

(C) $27 : 125$

(D) $1 : 5$

Q11. Which of the following correctly matches the electromagnetic radiation type with its approximate frequency range?

(A) Microwaves: 10^{14}–$10^{15}\,\mathrm{Hz}$

(B) X-rays: 10^8–10^{10} Hz

(C) Ultraviolet: 10^{15}–10^{17} Hz

(D) Infrared: 10^{11}–10^{14} Hz

Q12. A biconvex lens is made of glass with refractive index $n = 1.5$. Both surfaces have equal radii of curvature $R_1 = R_2 = 20\,\text{cm}$ (with appropriate sign convention: $R_1 = +20\,\text{cm}$, $R_2 = -20\,\text{cm}$). What is the focal length of the lens?

(A) $10\,\text{cm}$

(B) $20\,\text{cm}$

(C) $40\,\text{cm}$

(D) $5\,\text{cm}$

Q13. An electric dipole of moment $p = 2 \times 10^{-9}\,\text{C m}$ is placed in a uniform electric field $E = 5 \times 10^4\,\text{N C}^{-1}$. The dipole makes an angle $\theta = 60^\circ$ with the field direction. What is the torque acting on the dipole?

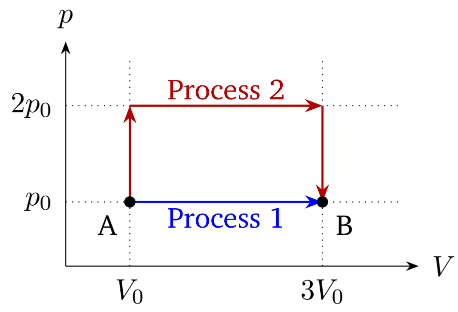
(A) $5 \times 10^{-5}\,\text{N m}$

(B) $8.66 \times 10^{-5}\,\text{N m}$

(C) $1.0 \times 10^{-4}\,\text{N m}$

(D) $1.73 \times 10^{-4}\,\text{N m}$

Q14. The p-V diagram below shows two processes taking a gas from state A (p_0, V_0) to state B $(p_0, 3V_0)$: Process 1 is **isobaric** (straight horizontal line); Process 2 goes from A **first** isochorically to $(2p_0, V_0)$ **then** isobarically to $(2p_0, 3V_0)$ and **then** isochorically to B — i.e., an indirect three-step path. Which process involves greater work done **by** the gas?



(A) Process 1, with work $W_1 = 2p_0V_0$

(B) Process 2, with work $W_2 = 4p_0V_0$

(C) Both processes involve equal work because A and B are the same

(D) Process 2, with work $W_2 = 2p_0V_0$

Q15. Gallium arsenide (GaAs) has a band gap of $E_g = 1.43\,\mathrm{eV}$. A photon must have energy **at least** equal to E_g to create an electron-hole pair. What is the **maximum** wavelength of light that can be detected by a GaAs photodiode? (Take $hc = 1240\,\mathrm{eV\,nm}$.)

(A) $868\,\mathrm{nm}$

(B) $620\,\mathrm{nm}$

(C) $1100\,\mathrm{nm}$

(D) $400\,\mathrm{nm}$

Detailed Solutions

Q1.

Solution

Concept — Heat conduction through slabs in series (thermal resistance)

For slabs in series the total thermal resistance is $R_{th} = R_1 + R_2$ where $R_i = L_i/(k_i A)$.

Step 1 — Compute individual thermal resistances:

$$R_1 = \frac{L_1}{k_1 A} = \frac{0.02}{2 \times 1} = 0.01\,\mathrm{K\,W^{-1}}$$

$$R_2 = \frac{L_2}{k_2 A} = \frac{0.04}{4 \times 1} = 0.01\,\mathrm{K\,W^{-1}}$$

Step 2 — Total resistance and heat flow rate:

$$R_{\text{total}} = R_1 + R_2 = 0.02\,\mathrm{K\,W^{-1}}$$

$$\frac{dQ}{dt} = \frac{\Delta T}{R_{\text{total}}} = \frac{100 - 0}{0.02} = \boxed{5000\,\mathrm{W}}$$

Why other options are wrong:

- **(B) 2000 W** — Results from adding conductivities instead of resistances.
- **(C) 4000 W** — Arises from using an incorrect effective $k = k_1 + k_2$.
- **(D) 3333 W** — Corresponds to using a harmonic mean of conductivities without weighting by thickness.

Final Answer: (A) 5000 W

Answer: (A) **Go Back to Q 1**

Q2.

Solution

Concept — Relative motion; time to cross oncoming trains

When two objects move toward each other, their relative speed is the sum of their speeds. The total distance covered equals the sum of their lengths.

Step 1 — Convert speeds to m/s:

$$v_A = 72\,\text{km}\,\text{h}^{-1} = \frac{72 \times 1000}{3600} = 20\,\text{m}\,\text{s}^{-1}$$

$$v_B = 36\,\text{km}\,\text{h}^{-1} = \frac{36 \times 1000}{3600} = 10\,\text{m}\,\text{s}^{-1}$$

Step 2 — Relative speed (opposite directions):

$$v_{\text{rel}} = v_A + v_B = 20 + 10 = 30\,\text{m}\,\text{s}^{-1}$$

Step 3 — Total distance to be covered:

$$d = L_A + L_B = 120 + 60 = 180\,\text{m}$$

Step 4 — Time:

$$t = \frac{d}{v_{\text{rel}}} = \frac{180}{30} = 6\,\text{s}$$

Why other options are wrong:

- **(A) 4 s** — Obtained by using only one speed ($20\,\text{m}\,\text{s}^{-1}$) or incorrect total length.
- **(C) 8 s** — Would require $v_{\text{rel}} \approx 22.5\,\text{m}\,\text{s}^{-1}$; relative speed of opposing trains is always summed, not averaged.
- **(D) 10 s** — Arises from treating only one train's speed as $18\,\text{m}\,\text{s}^{-1}$; both contributions must be added.

Final Answer: (B) 6 s

Answer: (B) **Go Back to Q 2**

Q3.

Solution

Concept — Resonant frequencies of an open pipe

For a pipe open at both ends the resonant frequencies are:

$$f_n = \frac{nv}{2L}, \quad n = 1, 2, 3, \ldots$$

All harmonics (integer multiples of the fundamental) are present.

Step 1 — Fundamental frequency:

$$f_1 = \frac{v}{2L} = \frac{340}{2 \times 0.85} = \frac{340}{1.70} = 200\,\text{Hz}$$

Step 2 — Check each option:

$$200\,\text{Hz} = 1 \times 200\,\text{Hz} \quad \checkmark \quad (n = 1)$$

$$400\,\text{Hz} = 2 \times 200\,\text{Hz} \quad \checkmark \quad (n = 2)$$

$$500\,\text{Hz}: \quad \frac{500}{200} = 2.5 \quad \text{— NOT an integer} \quad \times$$

$$600\,\text{Hz} = 3 \times 200\,\text{Hz} \quad \checkmark \quad (n = 3)$$

$500\,\text{Hz}$ is **not** a resonant frequency of this open pipe.

Why other options are wrong:

- **(A) 200 Hz** — This is the fundamental; it *is* a resonant frequency.
- **(B) 400 Hz** — First overtone ($n = 2$); it *is* present in an open pipe.
- **(D) 600 Hz** — Second overtone ($n = 3$); it *is* present in an open pipe.

Final Answer: (C) 500 Hz

Answer: (C) **Go Back to Q 3**

Q4.

Solution

Concept — Variation of g with altitude

The acceleration due to gravity at altitude h above Earth's surface is:

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

Step 1 — Substitute $h = R/2$:

$$g' = g\left(\frac{R}{R+\frac{R}{2}}\right)^2 = g\left(\frac{R}{\frac{3R}{2}}\right)^2 = g\left(\frac{2}{3}\right)^2 = \frac{4g}{9}$$

Step 2 — Numerical value:

$$g' = \frac{4 \times 9.8}{9} \approx 4.36\,\mathrm{m\,s^{-2}}$$

Why other options are wrong:

- **(A)** $4.9\,\mathrm{m\,s^{-2}}$ — This is $g/2$, which corresponds to h such that $(R/(R+h))^2 = 1/2$, i.e. $h = R(\sqrt{2}-1) \neq R/2$.
- **(C)** $g/4$ — Correct only if $(R/(R+h))^2 = 1/4$, requiring $R+h = 2R$, i.e. $h = R$, not $h = R/2$.
- **(D)** $2g/3$ — Corresponds to a linear approximation $g' \approx g(1-2h/R)$ at $h = R/3$, not $h = R/2$.

Final Answer: (B) $4g/9$

Answer: (B) **Go Back to Q 4**

Q5.

Solution

Concept — Lenz's law: direction of induced current

Lenz's law states that the induced current opposes the *change* in magnetic flux.

Step 1 — Determine the change in flux:

The north pole of the magnet faces *downward* and approaches the coil. Therefore the magnetic field lines point *downward* through the coil. As the magnet moves closer, the downward flux through the coil *increases*.

Step 2 — Apply Lenz's law:

To oppose the increase in downward flux, the induced current must create an *upward* magnetic field through the coil. By the right-hand rule, a current flowing **anticlockwise** when viewed from **above** produces a magnetic field directed *upward* through the coil.

Step 3 — Identify the coil's effective pole:

An anticlockwise current (seen from above) makes the top face of the coil a **north pole**, which repels the approaching north pole of the magnet — consistent with Lenz's law (opposition to motion).

Why other options are wrong:

- **(A)** — A clockwise current (seen from above) would make the top face a south pole, *attracting* the magnet, which would *accelerate* the flux change — violating Lenz's law.

- **(C)** — Current *is* induced; a changing flux always induces current by Faraday's law.
- **(D)** — A clockwise current cannot create a north pole facing the magnet when viewed from above.

Final Answer: (B) Anticlockwise (seen from above)

Answer: (B) **Go Back to Q 5**

Q6.

Solution

Concept — Electric field on the axis of a uniformly charged ring

$$E = \frac{kQx}{\left(R^2 + x^2\right)^{3/2}}$$

Step 1 — Identify values:

$$k = 9 \times 10^9\,\mathrm{N\,m^2\,C^{-2}}, \quad Q = 4 \times 10^{-9}\,\mathrm{C}, \quad R = x = 0.10\,\mathrm{m}$$

Step 2 — Compute denominator:

$$R^2 + x^2 = (0.10)^2 + (0.10)^2 = 0.01 + 0.01 = 0.02\,\mathrm{m^2}$$

$$\left(R^2 + x^2\right)^{3/2} = (0.02)^{3/2} = (0.02)\sqrt{0.02} = 0.02 \times 0.14142 = 2.828 \times 10^{-3}\,\mathrm{m^3}$$

Step 3 — Compute E:

$$E = \frac{9 \times 10^9 \times 4 \times 10^{-9} \times 0.10}{2.828 \times 10^{-3}} = \frac{9 \times 4 \times 0.10}{2.828 \times 10^{-3}} = \frac{3.6}{2.828 \times 10^{-3}} \approx 1273\,\mathrm{N\,C^{-1}}$$

Why other options are wrong:

- **(A)** $18\,\mathrm{N\,C^{-1}}$ — Results from forgetting to divide by $(R^2 + x^2)^{3/2}$ properly (treating it as a point charge at $r = 1\,\mathrm{m}$).
- **(B)** $900\,\mathrm{N\,C^{-1}}$ — Uses $(R^2 + x^2)^{1/2}$ instead of the correct $(R^2 + x^2)^{3/2}$.
- **(D)** $636\,\mathrm{N\,C^{-1}}$ — Off by a factor of 2; arises from using only R^2 in the denominator.

Final Answer: (C) 1273 N/C

Answer: (C) Go Back to Q 6

Q7.

Solution

Concept — Gauss's law applied to a uniformly charged spherical shell

For a Gaussian surface (sphere of radius $r < R$) inside the shell, the enclosed charge $Q_{\text{enc}} = 0$ because all charge resides on the shell surface.

Step 1 — Apply Gauss's law:

$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{\text{enc}}}{\varepsilon_0} = \frac{0}{\varepsilon_0} = 0$$

Step 2 — Conclude:

By symmetry, $\vec{E}$ is uniform over the Gaussian surface. Therefore:

$$E \cdot 4\pi r^2 = 0 \implies \boxed{E = 0}$$

Why other options are wrong:

- **(A)** kQ/r^2 — This is the field *outside* a uniformly charged sphere or shell ($r > R$), not inside.
- **(B)** kQ/R^2 — This is the field on the *surface* of the shell ($r = R$).
- **(D)** kQr/R^3 — This is the field inside a *uniformly charged solid sphere*, not a shell.

Final Answer: (C) Zero

Answer: (C) Go Back to Q 7

Q8.

Solution

Concept — Poiseuille's law for viscous flow

$$Q = \frac{\pi r^4 \Delta P}{8\eta L}$$

The flow rate varies as the *fourth power* of the radius.

Step 1 — Find ratio when $r \to 2r$:

$$\frac{Q'}{Q_0} = \frac{\pi(2r)^4 \Delta P/(8\eta L)}{\pi r^4 \Delta P/(8\eta L)} = \frac{(2r)^4}{r^4} = 2^4 = 16$$

Step 2 — New flow rate:

$$Q' = 16\,Q_0$$

Why other options are wrong:

- **(A)** $2Q_0$ — Assumes $Q \propto r$ (linear dependence); incorrect by Poiseuille's law.
- **(B)** $4Q_0$ — Assumes $Q \propto r^2$ (area dependence); misses the additional viscous factors.
- **(C)** $8Q_0$ — Assumes $Q \propto r^3$; the correct exponent is 4, not 3.

Final Answer: (D) $16Q_0$

$\boxed{\textbf{Answer: (D)}}$ **Go Back to Q 8**

Q9.

Solution

Concept — Photoelectric stopping potential

Einstein's photoelectric equation:

$$eV_0 = hf - \phi$$

Step 1 — Compute hf in eV:

$$hf = \frac{6.63 \times 10^{-34} \times 1.2 \times 10^{15}}{1.6 \times 10^{-19}} = \frac{7.956 \times 10^{-19}}{1.6 \times 10^{-19}} \approx 4.97\,\text{eV}$$

Step 2 — Find stopping potential:

$$V_0 = \frac{hf - \phi}{e} = \frac{4.97\,\text{eV} - 2.0\,\text{eV}}{e} = 2.97\,\text{V}$$

Why other options are wrong:

- **(A)** $1.97\,\text{V}$ — Subtracts an extra $1\,\text{eV}$; likely a rounding/arithmetic error.
- **(B)** $3.00\,\text{V}$ — Rounds hf to $5.0\,\text{eV}$, giving $V_0 = 3.0\,\text{V}$; slightly off from exact calculation.

- **(D)** $4.97\,\text{V}$ — Forgets to subtract the work function; gives hf/e directly.

Final Answer: (C) 2.97 V

Answer: (C) Go Back to Q 9

Q10.

Solution

Concept — Nuclear radius and mass number

$$R = R_0 A^{1/3}$$

Step 1 — Compute radii ratio:

$$\frac{R_X}{R_Y} = \frac{R_0 A_X^{1/3}}{R_0 A_Y^{1/3}} = \left(\frac{A_X}{A_Y}\right)^{1/3} = \left(\frac{27}{125}\right)^{1/3} = \frac{3}{5}$$

Step 2 — Express as ratio:

$$R_X : R_Y = 3 : 5$$

Why other options are wrong:

- **(B)** $9 : 25$ — This is $(A_X/A_Y)^{2/3}$; uses power $2/3$ instead of $1/3$.
- **(C)** $27 : 125$ — This is the ratio of mass numbers themselves $(A_X : A_Y)$; the cube root has not been taken.
- **(D)** $1 : 5$ — Incorrect; $27^{1/3} = 3$, not 1.

Final Answer: (A) 3 : 5

Answer: (A) Go Back to Q 10

Q11.

Solution

Concept — Electromagnetic spectrum frequency ranges

The approximate frequency ranges of different electromagnetic radiations:

Type	Frequency range (Hz)
Radio waves	10^4–10^8
Microwaves	10^8–10^{11} (up to $\sim 3 \times 10^{11}$)
Infrared	10^{11}–4×10^{14}
Visible	4×10^{14}–7×10^{14}
Ultraviolet	7×10^{14}–10^{17}
X-rays	10^{17}–10^{20}
Gamma rays	$> 10^{20}$

Step 1 — Check each option:

- **(A)** Microwaves at 10^{14}–10^{15} Hz — *Wrong*: this range is visible/UV.
- **(B)** X-rays at 10^8–10^{10} Hz — *Wrong*: this is the microwave range.
- **(C)** UV at 10^{15}–10^{17} Hz — **Correct**: UV spans roughly 7.5×10^{14} to 10^{17} Hz.
- **(D)** Infrared at 10^{11}–10^{14} Hz — *Partially correct* but not as precisely correct as (C) for UV.

Why other options are wrong:

- **(A)** — Microwaves lie at 10^8–10^{11} Hz, not 10^{14}–10^{15} Hz.
- **(B)** — X-rays have much higher frequencies (10^{17}–10^{20} Hz).
- **(D)** — Infrared spans approximately 10^{11}–4×10^{14} Hz; the upper bound is overstated.

Final Answer: (C) Ultraviolet: 10^{15}–10^{17} Hz

$\boxed{\text{Answer: (C)}}$ **Go Back to Q 11**

Q12.

Solution

Concept — Lens maker's equation

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

For a biconvex lens with $R_1 = +20\,\text{cm}$ and $R_2 = -20\,\text{cm}$ (standard sign convention):

Step 1 — Apply the formula:

$$\frac{1}{f} = (1.5 - 1)\left(\frac{1}{20} - \frac{1}{-20}\right) = 0.5 \times \left(\frac{1}{20} + \frac{1}{20}\right)$$

$$\frac{1}{f} = 0.5 \times \frac{2}{20} = 0.5 \times 0.1 = 0.05\,\text{cm}^{-1}$$

Step 2 — Focal length:

$$f = \frac{1}{0.05} = 20\,\text{cm}$$

Why other options are wrong:

- **(A) 10 cm** — Obtained by forgetting the factor $(n - 1) = 0.5$ and using $n = 1.5$ directly, giving $f = 20/1.5$.
- **(C) 40 cm** — Arises from using $1/f = (n - 1)/R$ with only one surface, i.e. not accounting for both surfaces.
- **(D) 5 cm** — Would require $n - 1 = 2$, i.e. $n = 3$, which is incorrect for glass.

Final Answer: (B) 20 cm

Answer: (B) **Go Back to Q 12**

Q13.

Solution

Concept — Torque on an electric dipole in a uniform field

$$\tau = pE\sin\theta$$

Step 1 — Substitute values:

$$p = 2 \times 10^{-9}\,\text{C m}, \quad E = 5 \times 10^{4}\,\text{N C}^{-1}, \quad \theta = 60^\circ$$

$$\tau = pE\sin 60^\circ = 2 \times 10^{-9} \times 5 \times 10^{4} \times \frac{\sqrt{3}}{2}$$

$$\tau = 1 \times 10^{-4} \times \frac{\sqrt{3}}{2} = \frac{\sqrt{3}}{2} \times 10^{-4}\,\text{N m}$$

$$\tau = \frac{1.732}{2} \times 10^{-4} = 0.866 \times 10^{-4} = 8.66 \times 10^{-5}\,\text{N m}$$

The torque is $\tau = pE\sin\theta = 2 \times 10^{-9} \times 5 \times 10^{4} \times \sin 60^\circ = 1 \times 10^{-4} \times \frac{\sqrt{3}}{2} = 8.66 \times 10^{-5}\,\text{N m}$.

Why other options are wrong:

- **(A)** 5×10^{-5} N m — Uses $\sin 30° = 0.5$ instead of $\sin 60°$.
- **(C)** 1.0×10^{-4} N m — Uses $\sin 90° = 1$ (maximum torque), but $\theta = 60°$ here.
- **(D)** 1.73×10^{-4} N m — Uses $\sin 90° = 1$ but with the wrong prefactor; a factor-of-2 error on the dipole moment.

Final Answer: (B) 8.66×10^{-5} **N m**

$\boxed{\text{Answer: (B)}}$ **Go Back to Q 13**

Q14.

Solution

Concept — Work done by gas equals area enclosed under p-V curve

Step 1 — Work for Process 1 (isobaric, $p = p_0$):

$$W_1 = p_0 \Delta V = p_0(3V_0 - V_0) = 2p_0V_0$$

Step 2 — Work for Process 2 (three-step path):

1. Isochoric A $\rightarrow (2p_0, V_0)$: $W = 0$ (no volume change)
2. Isobaric $(2p_0, V_0) \rightarrow (2p_0, 3V_0)$: $W = 2p_0(3V_0 - V_0) = 4p_0V_0$
3. Isochoric $(2p_0, 3V_0) \rightarrow$ B $(p_0, 3V_0)$: $W = 0$

$$W_2 = 0 + 4p_0V_0 + 0 = 4p_0V_0$$

Step 3 — Compare:

$$W_2 = 4p_0V_0 > W_1 = 2p_0V_0$$

Process 2 does more work because it operates at a *higher* average pressure.

Why other options are wrong:

- **(A)** — Process 1 work $2p_0V_0$ is correct but Process 2 does *more* work; this option incorrectly favours Process 1.
- **(C)** — Work done is *path-dependent* for a gas; same endpoints do not imply same work.
- **(D)** — States $W_2 = 2p_0V_0$, which is the work for Process 1, not Process 2.

Final Answer: (B) Process 2, $W_2 = 4p_0V_0$

$\boxed{\text{Answer: (B)}}$ **Go Back to Q 14**

Q15.

Solution

Concept — Photodiode threshold wavelength from band gap

A photon of energy $E = hc/\lambda$ must satisfy $E \geq E_g$ to generate an electron-hole pair. The maximum (threshold/cutoff) wavelength corresponds to $E = E_g$:

$$\lambda_{\text{max}} = \frac{hc}{E_g}$$

Step 1 — Substitute values:

$$\lambda_{\text{max}} = \frac{1240\,\text{eV nm}}{1.43\,\text{eV}} = 867.8\,\text{nm} \approx 868\,\text{nm}$$

This lies in the **near-infrared** region, making GaAs photodiodes useful for near-IR detection (e.g., optical fibre communications at $\sim 870\,\text{nm}$).

Why other options are wrong:

- **(B) 620 nm** — Corresponds to $E_g = 1240/620 = 2.0\,\text{eV}$, which is the band gap of GaP, not GaAs.
- **(C) 1100 nm** — Corresponds to silicon's band gap ($E_g \approx 1.12\,\text{eV}$), not GaAs.
- **(D) 400 nm** — Would require $E_g = 3.1\,\text{eV}$, characteristic of GaN, not GaAs.

Final Answer: (A) 868 nm

Answer: (A) **Go Back to Q 15**

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	B	3	C	4	B	5	B
6	C	7	C	8	D	9	C	10	A
11	C	12	B	13	B	14	B	15	A