AME CET Physics

Sample Paper – 1

Duration: 20 Minutes **Maximum Marks: 80**

Instructions

- This paper contains **20** Multiple Choice Questions (Single Correct Answer), modelled on the Physics section of **AME CET** entrance.
- Each correct answer carries **+4 marks**. Each wrong answer carries -1 **mark**. Unattempted questions carry **0 marks**.
- Only **one** option is correct per question. Choose carefully.
- Syllabus level: **Class 11 and 12 NCERT Physics** (Units & Measurement to Communication Systems).
- Use of mobile phones, calculators, or any electronic gadget is strictly prohibited.

Q1. A battery has an EMF of 12 V and an internal resistance of 2 Ω. It is connected to an external resistance of 4 Ω. The terminal voltage of the battery across the external resistance is:

(A) 12 V

(B) 4 V

(C) 8 V

(D) 6 V

Q2. Three resistors of 2 Ω, 3 Ω, and 6 Ω are connected in parallel. The equivalent resistance of the combination is:

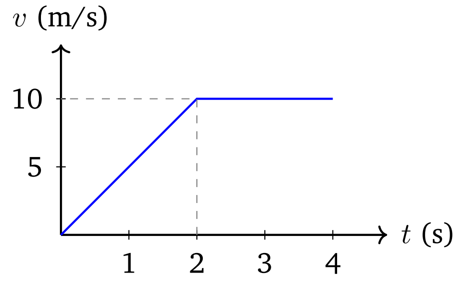
(A) 1 Ω

(B) 2 Ω

(C) 3 Ω

(D) 11 Ω

Q3. The velocity-time (v–t) graph of a particle is shown below. The displacement of the particle from $t = 0$ to $t = 4$ s is:



(A) 10 m

(B) 30 m

(C) 20 m

(D) 40 m

Q4. A ball is projected horizontally from a height of 80 m with a speed of 20 m/s. Taking $g = 10$ m/s^2, the horizontal range of the ball is:

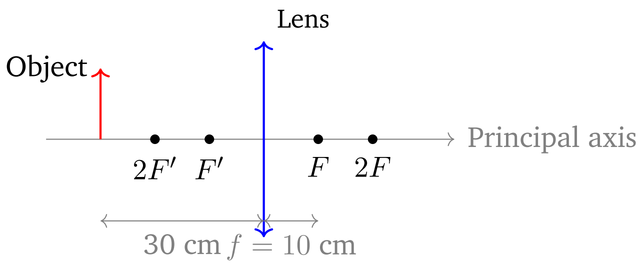
(A) 40 m

(B) 160 m

(C) 100 m

(D) 80 m

Q5. An object is placed 30 cm in front of a convex lens of focal length 10 cm, as shown in the figure. The image distance v is:



(A) 15 cm

(B) 20 cm

(C) 30 cm

(D) 10 cm

Q6. The critical angle for a glass-air interface is $42°$. The refractive index of glass is closest to: ($\sin 42° \approx 0.67$)

(A) 1.33

(B) 1.42

(C) 1.49

(D) 1.60

Q7. A coil of 200 turns has a magnetic flux of 0.05 Wb passing through it. The flux drops to zero in 0.1 s. The magnitude of the induced EMF is:

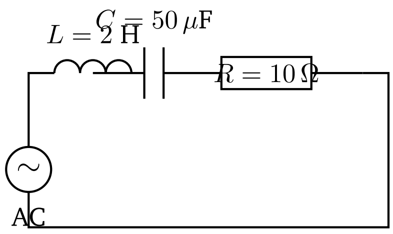
(A) 10 V

(B) 100 V

(C) 50 V

(D) 200 V

Q8. A series LCR circuit has inductance $L = 2$ H, capacitance $C = 50\ \mu$F and resistance $R = 10\ \Omega$, as shown. The angular resonant frequency ω_0 of the circuit is:



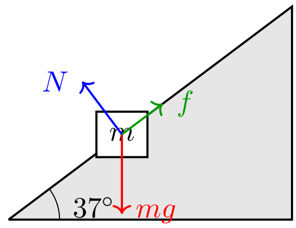
(A) 50 rad/s

(B) 25 rad/s

(C) 200 rad/s

(D) 100 rad/s

Q9. A block of mass 2 kg is placed on a rough inclined plane at 37° to the horizontal. The coefficient of kinetic friction is 0.5. The acceleration of the block as it slides down the incline is: ($g = 10$ m/s^2, $\sin 37^\circ = 0.6$, $\cos 37^\circ = 0.8$)



(A) 2 m/s^2

(B) 4 m/s^2

(C) 6 m/s^2

(D) 1 m/s^2

Q10. A ball of mass 2 kg moving at 4 m/s collides head-on with a stationary ball of the same mass 2 kg. If the collision is perfectly elastic, the speed of the first ball after collision is:

(A) 4 m/s

(B) 2 m/s

(C) 0 m/s

(D) -2 m/s

Q11. Two capacitors of capacitance 4 μF and 12 μF are connected in series and a potential difference of 120 V is applied across the combination. The charge on each capacitor is:

(A) 480 μC

(B) 360 μC

(C) 120 μC

(D) 240 μC

Q12. A straight conductor of length 0.5 m carries a current of 4 A and is placed perpendicular to a uniform magnetic field of 0.3 T. The magnetic force on the conductor is:

(A) 0.6 N

(B) 1.2 N

(C) 0.3 N

(D) 2.4 N

Q13. Light of frequency 1.5×10^{15} Hz falls on a metal surface with a work function of 4.2 eV. The maximum kinetic energy of the emitted photo-electrons is: ($h = 6.6 \times 10^{-34}$ J·s, 1 eV $= 1.6 \times 10^{-19}$ J)

(A) 4.2 eV

(B) 6.0 eV

(C) 1.0 eV

(D) 2.0 eV

Q14. An electron in a hydrogen atom transitions from the $n = 3$ energy level to the $n = 2$ energy level. The wavelength of the emitted photon is closest to: ($R_H = 1.097 \times 10^7$ m^{-1})

(A) 486 nm

(B) 122 nm

(C) 656 nm

(D) 410 nm

Q15. A Carnot engine operates between a hot reservoir at 800 K and a cold reservoir at 300 K. The efficiency of the engine is:

(A) 37.5%

(B) 62.5%

(C) 50.0%

(D) 75.0%

Q16. A particle executes simple harmonic motion (SHM) with amplitude $A = 0.1$ m and time period $T = 2\pi$ s. The maximum velocity of the particle is:

(A) 0.2π m/s

(B) π m/s

(C) 0.5 m/s

(D) 0.1 m/s

Q17. A uniform disc of mass 2 kg and radius 0.5 m rotates about an axis passing through its centre and perpendicular to its plane. The moment of inertia of the disc about this axis is:

(A) 0.5 kg·m^2

(B) 0.25 kg·m^2

(C) 1.0 kg·m^2

(D) 0.125 kg·m^2

Q18. A NAND gate and a NOT gate (inverter) are connected in series so that the output of the NAND gate is the input to the NOT gate. For inputs A and B, the Boolean expression for the final output Y is:

(A) $Y = A + B$

(B) $Y = \overline{A} \cdot \overline{B}$

(C) $Y = A \cdot B$

(D) $Y = \overline{A + B}$

Q19. A steel wire of length 2 m and cross-sectional area 1×10^{-6} m^2 is subjected to a tensile force of 200 N. If the Young's modulus of steel is 2×10^{11} Pa, the extension of the wire is:

(A) 2×10^{-3} m

(B) 1×10^{-3} m

(C) 4×10^{-3} m

(D) 5×10^{-4} m

Q20. A satellite orbits the Earth at a height equal to the Earth's radius $R = 6.4 \times 10^6$ m. Taking $g = 10$ m/s^2 at the Earth's surface, the orbital velocity of the satellite is:

(A) 8.0 km/s

(B) 4.0 km/s

(C) 6.4 km/s

(D) 5.66 km/s

Detailed Solutions

Q1.

Solution

Concept — Terminal Voltage: When current flows through a battery with internal resistance r, a voltage drop Ir occurs internally. The terminal voltage is the EMF minus this internal drop.

Step 1 — Find current I:

$$I = \frac{\varepsilon}{R + r} = \frac{12}{4 + 2} = \frac{12}{6} = 2\ \text{A}$$

Step 2 — Find terminal voltage V:

$$V = \varepsilon - Ir = 12 - (2)(2) = 12 - 4 = 8\ \text{V}$$

Why other options are wrong:

- Option A (12 V): This is the EMF, not the terminal voltage — ignores internal voltage drop.
- Option B (4 V): Equals the voltage drop across r alone, not the terminal voltage.
- Option D (6 V): Incorrect; arises from dividing EMF by 2, which has no physical basis here.

Final Answer: Terminal voltage $V = 8\ \text{V} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Parallel Resistance: For n resistors in parallel, the reciprocal of the equivalent resistance equals the sum of reciprocals of individual resistances.

Step 1 — Apply the parallel formula:

$$\frac{1}{R_{eq}} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6}$$

Step 2 — Find a common denominator (LCD = 6):

$$\frac{1}{R_{eq}} = \frac{3}{6} + \frac{2}{6} + \frac{1}{6} = \frac{6}{6} = 1$$

Step 3 — Solve for R_{eq}:

$$R_{eq} = 1\ \Omega$$

Why other options are wrong:

- Option B (2 Ω): Incorrect; parallel equivalent is always less than the smallest resistor (2 Ω).
- Option C (3 Ω): Exceeds smallest resistor — physically impossible for a parallel combination.
- Option D (11 Ω): This is the *series* sum $2 + 3 + 6 = 11\ \Omega$, not parallel.

Final Answer: $R_{eq} = 1\ \Omega \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q2

Q3.

Solution

Concept — Displacement from v–t Graph: The displacement equals the area enclosed between the v–t curve and the time axis.

Step 1 — Identify the two regions: From the graph: the velocity increases linearly from 0 to 10 m/s over $t = 0$ to $t = 2$ s (triangular region), then remains constant at 10 m/s from $t = 2$ s to $t = 4$ s (rectangular region).

Step 2 — Area of triangular region (0 to 2 s):

$$A_1 = \frac{1}{2} \times \text{base} \times \text{height} = \frac{1}{2} \times 2 \times 10 = 10 \text{ m}$$

Step 3 — Area of rectangular region (2 to 4 s):

$$A_2 = \text{base} \times \text{height} = 2 \times 10 = 20 \text{ m}$$

Step 4 — Total displacement:

$$s = A_1 + A_2 = 10 + 20 = 30 \text{ m}$$

Why other options are wrong:

- Option A (10 m): Only the triangular area — omits the rectangular portion.
- Option C (20 m): Only the rectangular area — omits the triangular portion.
- Option D (40 m): Would require constant velocity of 10 m/s for the full 4 s, but $v = 0$ at $t = 0$.

Final Answer: $s = 30$ m $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q3

Q4.

Solution

Concept — Horizontal Projectile: In horizontal projection, vertical and horizontal motions are independent. The ball falls under gravity vertically while moving horizontally at constant speed.

Step 1 — Time to fall height $h = 80$ m:

$$h = \frac{1}{2}gt^2 \implies t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \times 80}{10}} = \sqrt{16} = 4 \text{ s}$$

Step 2 — Horizontal range:

$$R = u_x \times t = 20 \times 4 = 80 \text{ m}$$

Why other options are wrong:

- Option A (40 m): Uses $t = 2$ s, which would correspond to a height of only 20 m.
- Option B (160 m): Uses $t = 8$ s, corresponding to a height of 320 m, not 80 m.
- Option C (100 m): Uses $t = 5$ s, corresponding to a height of 125 m, not 80 m.

Final Answer: $R = 80$ m $\Rightarrow \boxed{D}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Thin Lens Formula: $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$, where u is negative for object on the left of the lens (sign convention: distances measured from optical centre).

Step 1 — Assign values with sign convention:

$$u = -30 \text{ cm}, \quad f = +10 \text{ cm (convex lens)}$$

Step 2 — Apply the lens formula:

$$\frac{1}{v} = \frac{1}{f} + \frac{1}{u} = \frac{1}{10} + \frac{1}{-30}$$

Step 3 — Find a common denominator (LCD = 30):

$$\frac{1}{v} = \frac{3}{30} - \frac{1}{30} = \frac{2}{30} = \frac{1}{15}$$

Step 4 — Solve for v:

$$v = +15 \text{ cm}$$

The positive sign confirms a real image on the opposite side of the object.

Why other options are wrong:

- Option B (20 cm): Arises from incorrectly applying $1/v = 1/f - 1/|u|$ with wrong sign.
- Option C (30 cm): Equal to object distance; only happens when object is at $2F$, but here $u = 3f$.
- Option D (10 cm): Equal to f; image at f only when object is at infinity.

Final Answer: $v = 15 \text{ cm} \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Critical Angle and Refractive Index: At the critical angle C, light travels along the interface. By Snell's law at the glass-air boundary: $\mu \sin C = 1 \times \sin 90° = 1$, so $\mu = 1/\sin C$.

Step 1 — Apply the formula:

$$\mu = \frac{1}{\sin C} = \frac{1}{\sin 42°}$$

Step 2 — Substitute $\sin 42° \approx 0.67$:

$$\mu = \frac{1}{0.67} \approx 1.49$$

Why other options are wrong:

- Option A (1.33): Refractive index of water, not this glass; critical angle of water is $\approx 49°$.
- Option B (1.42): Corresponds to $\sin C \approx 0.704$, i.e. $C \approx 44.7°$, not $42°$.
- Option D (1.60): Corresponds to $\sin C \approx 0.625$, i.e. $C \approx 38.7°$, not $42°$.

Final Answer: $\mu \approx 1.49 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q6

Q7.

Solution

Concept — Faraday's Law of Electromagnetic Induction: The induced EMF equals the number of turns times the rate of change of flux: $\varepsilon = -N\dfrac{\Delta\Phi}{\Delta t}$ (magnitude taken positive).

Step 1 — Identify given values:

$$N = 200, \quad \Delta\Phi = \Phi_i - \Phi_f = 0.05 - 0 = 0.05 \text{ Wb}, \quad \Delta t = 0.1 \text{ s}$$

Step 2 — Apply Faraday's Law:

$$|\varepsilon| = N \cdot \frac{\Delta\Phi}{\Delta t} = 200 \times \frac{0.05}{0.1}$$

Step 3 — Compute:

$$|\varepsilon| = 200 \times 0.5 = 100 \text{ V}$$

Why other options are wrong:

- Option A (10 V): Ignores the number of turns N; gives $\Delta\Phi/\Delta t$ only.
- Option C (50 V): Uses $N = 100$ (half the actual turns) or $\Delta\Phi/\Delta t = 0.25$.
- Option D (200 V): Uses N but forgets to divide by Δt (i.e. uses $N \times \Delta\Phi$).

Final Answer: $|\varepsilon| = 100 \text{ V} \Rightarrow \boxed{\text{B}}$

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

Q8.

Solution

Concept — LCR Resonance Frequency: At resonance in a series LCR circuit, the inductive reactance equals the capacitive reactance. The angular resonant frequency is $\omega_0 = \dfrac{1}{\sqrt{LC}}$.

Step 1 — Compute LC:

$$LC = 2 \times 50 \times 10^{-6} = 100 \times 10^{-6} = 10^{-4} \text{ H·F}$$

Step 2 — Take the square root:

$$\sqrt{LC} = \sqrt{10^{-4}} = 10^{-2} = 0.01 \text{ s}$$

Step 3 — Find ω_0:

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{0.01} = 100 \text{ rad/s}$$

Note: The resistance R does not affect the resonant frequency.

Why other options are wrong:

- Option A (50 rad/s): Arises from taking $\omega_0 = 1/(2\sqrt{LC})$, which is incorrect.
- Option B (25 rad/s): Further off; no standard formula gives this result.
- Option C (200 rad/s): Arises from $\omega_0 = 2/\sqrt{LC}$, doubling the numerator erroneously.

Final Answer: $\omega_0 = 100 \text{ rad/s} \Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q8**

Q9.

Solution

Concept — Newton's Second Law on an Incline: For a block sliding down a rough inclined plane, net force = $mg\sin\theta - f_k$, where friction $f_k = \mu_k N = \mu_k mg\cos\theta$ acts up the slope.

Step 1 — Find normal force N:

$$N = mg\cos 37^\circ = 2 \times 10 \times 0.8 = 16 \text{ N}$$

Step 2 — Find kinetic friction f_k:

$$f_k = \mu_k N = 0.5 \times 16 = 8 \text{ N}$$

Step 3 — Find net force down the slope:

$$F_{net} = mg\sin 37^\circ - f_k = 2 \times 10 \times 0.6 - 8 = 12 - 8 = 4 \text{ N}$$

Step 4 — Find acceleration:

$$a = \frac{F_{net}}{m} = \frac{4}{2} = 2 \text{ m/s}^2$$

Why other options are wrong:

- Option B (4 m/s^2): Uses $a = g\sin 37^\circ = 6$ m/s^2 minus an extra incorrect term, or ignores friction.
- Option C (6 m/s^2): Uses $a = g\sin 37^\circ = 6$ m/s^2, neglecting friction entirely.
- Option D (1 m/s^2): Arises from dividing net force by total weight rather than mass.

Final Answer: $a = 2$ m/s^2 $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Elastic Collision between Equal Masses: In a perfectly elastic head-on collision between two objects of equal mass, the velocities are exchanged. The moving object comes to rest and the stationary one moves off with the original velocity.

Step 1 — Apply conservation of momentum:

$$mv_1 = mv_1' + mv_2' \implies v_1' + v_2' = 4 \quad \cdots(1)$$

Step 2 — Apply conservation of kinetic energy (elastic):

$$\frac{1}{2}mv_1^2 = \frac{1}{2}mv_1'^2 + \frac{1}{2}mv_2'^2 \implies v_1'^2 + v_2'^2 = 16 \quad \cdots(2)$$

Step 3 — Solve equations (1) and (2): From (1): $v_2' = 4 - v_1'$. Substitute into (2):

$$v_1'^2 + (4 - v_1')^2 = 16 \implies 2v_1'^2 - 8v_1' + 16 = 16 \implies 2v_1'(v_1' - 4) = 0$$

$$v_1' = 0 \text{ or } v_1' = 4$$

The solution $v_1' = 4$ means no collision occurred; the physical solution is $v_1' = 0$.

Why other options are wrong:

- Option A (4 m/s): Would mean the first ball continues at the same speed — violates energy exchange.
- Option B (2 m/s): Corresponds to a perfectly inelastic collision, not elastic.
- Option D (-2 m/s): A rebound in opposite direction only occurs if $m_1 < m_2$; here masses are equal.

Final Answer: Speed of first ball after collision = 0 m/s ⇒ $\boxed{\text{C}}$

Answer: (C) Go Back to Q10

Q11.

Solution

Concept — Capacitors in Series: In a series combination, all capacitors carry the same charge Q. The equivalent capacitance is found from $1/C_{eq} = \sum 1/C_i$.

Step 1 — Find equivalent capacitance:

$$\frac{1}{C_{eq}} = \frac{1}{4} + \frac{1}{12} = \frac{3}{12} + \frac{1}{12} = \frac{4}{12} = \frac{1}{3} \implies C_{eq} = 3\ \mu\text{F}$$

Step 2 — Find charge on the combination:

$$Q = C_{eq} \times V = 3 \times 120 = 360\ \mu\text{C}$$

Since capacitors in series carry the same charge, both capacitors have $Q = 360\ \mu$C.

Why other options are wrong:

- Option A (480 μC): Uses $Q = C_1 \times V = 4 \times 120$ — applies the voltage to one capacitor alone.
- Option C (120 μC): Uses $Q = C_{eq} \times V$ but with wrong $C_{eq} = 1\ \mu$F.
- Option D (240 μC): Uses the average capacitance $(4 + 12)/2 = 8\ \mu$F, not the series formula.

Final Answer: $Q = 360\ \mu$C on each capacitor $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q11

Q12.

Solution

Concept — Magnetic Force on a Current-Carrying Conductor: $F = BIL\sin\theta$. When the conductor is perpendicular to the field, $\theta = 90°$ and $\sin\theta = 1$, giving $F = BIL$.

Step 1 — Identify given values:

$$B = 0.3\ \text{T}, \quad I = 4\ \text{A}, \quad L = 0.5\ \text{m}, \quad \theta = 90°$$

Step 2 — Apply the force formula:

$$F = BIL = 0.3 \times 4 \times 0.5$$

Step 3 — Compute:

$$F = 0.3 \times 2 = 0.6 \text{ N}$$

Why other options are wrong:

- Option B (1.2 N): Uses $L = 1$ m instead of 0.5 m.
- Option C (0.3 N): Uses $I = 1$ A or $L = 0.25$ m — incorrect substitution.
- Option D (2.4 N): Uses $F = BIL$ but multiplies by 2 erroneously.

Final Answer: $F = 0.6 \text{ N} \Rightarrow \boxed{\text{A}}$

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

Q13.

Solution

Concept — Einstein's Photoelectric Equation: $KE_{max} = hf - \phi$, where hf is the photon energy and ϕ is the work function.

Step 1 — Calculate photon energy hf:

$$hf = 6.6 \times 10^{-34} \times 1.5 \times 10^{15} = 9.9 \times 10^{-19} \text{ J}$$

Step 2 — Convert to eV:

$$hf = \frac{9.9 \times 10^{-19}}{1.6 \times 10^{-19}} = 6.1875 \text{ eV} \approx 6.2 \text{ eV}$$

Step 3 — Apply Einstein's equation:

$$KE_{max} = hf - \phi = 6.2 - 4.2 = 2.0 \text{ eV}$$

Why other options are wrong:

- Option A (4.2 eV): This is the work function ϕ, not the kinetic energy.
- Option B (6.0 eV): Approximately the photon energy hf — forgets to subtract the work function.
- Option C (1.0 eV): Halves the correct answer, perhaps from an arithmetic error in unit conversion.

Final Answer: $KE_{max} = 2.0 \text{ eV} \Rightarrow \boxed{\text{D}}$

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

Q14.

Solution

Concept — Rydberg Formula for Hydrogen: $\frac{1}{\lambda} = R_H\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$, where $R_H = 1.097 \times 10^7\ \text{m}^{-1}$, $n_f = 2$, $n_i = 3$ (Balmer series transition).

Step 1 — Substitute values:

$$\frac{1}{\lambda} = R_H\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = 1.097 \times 10^7 \times \left(\frac{1}{4} - \frac{1}{9}\right)$$

Step 2 — Compute the bracket:

$$\frac{1}{4} - \frac{1}{9} = \frac{9-4}{36} = \frac{5}{36}$$

Step 3 — Find $1/\lambda$:

$$\frac{1}{\lambda} = 1.097 \times 10^7 \times \frac{5}{36} = 1.524 \times 10^6\ \text{m}^{-1}$$

Step 4 — Find λ:

$$\lambda = \frac{1}{1.524 \times 10^6} = 6.56 \times 10^{-7}\ \text{m} = 656\ \text{nm}$$

This is the Hα line (red line) of the Balmer series.

Why other options are wrong:

- Option A (486 nm): Hβ line ($n = 4 \to n = 2$ transition), not $n = 3 \to n = 2$.
- Option B (122 nm): Lyman series ($n = 2 \to n = 1$), ultraviolet range.
- Option D (410 nm): Hδ line ($n = 6 \to n = 2$ transition).

Final Answer: $\lambda = 656\ \text{nm} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q14

Q15.

Solution

Concept — Carnot Efficiency: The efficiency of a Carnot engine depends only on the temperatures of the two reservoirs: $\eta = 1 - T_C/T_H$, where temperatures must be in Kelvin.

Step 1 — Identify temperatures:

$$T_H = 800\text{ K}, \quad T_C = 300\text{ K}$$

Step 2 — Apply the Carnot efficiency formula:

$$\eta = 1 - \frac{T_C}{T_H} = 1 - \frac{300}{800}$$

Step 3 — Compute:

$$\eta = 1 - 0.375 = 0.625 = 62.5\%$$

Why other options are wrong:

- Option A (37.5%): This is T_C/T_H, not $1 - T_C/T_H$ — inverts the formula.
- Option C (50%): Would require $T_C = T_H/2 = 400$ K, but $T_C = 300$ K here.
- Option D (75%): Would require $T_C = T_H/4 = 200$ K, not 300 K.

Final Answer: $\eta = 62.5\% \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q15

Q16.

Solution

Concept — Maximum Velocity in SHM: $v_{max} = A\omega$, where $\omega = 2\pi/T$ is the angular frequency.

Step 1 — Find angular frequency ω:

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{2\pi} = 1\text{ rad/s}$$

Step 2 — Find maximum velocity:

$$v_{max} = A\omega = 0.1 \times 1 = 0.1\text{ m/s}$$

The maximum velocity occurs at the equilibrium position (centre of oscillation).

Why other options are wrong:

- Option A (0.2π m/s): Uses $\omega = 2\pi$ rad/s, i.e., $T = 1$ s instead of $T = 2\pi$ s.
- Option B (π m/s): Uses $v_{max} = A \times 2\pi/T$ with $T = 1$ and $A = 0.5$, incorrect values.
- Option C (0.5 m/s): Amplitude taken as 0.5 m rather than 0.1 m.

Final Answer: $v_{max} = 0.1$ m/s $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Moment of Inertia of a Disc: For a uniform disc rotating about its central axis (perpendicular to the plane), $I = \frac{1}{2}MR^2$.

Step 1 — Identify given values:

$$M = 2 \text{ kg}, \quad R = 0.5 \text{ m}$$

Step 2 — Apply the formula:

$$I = \frac{1}{2}MR^2 = \frac{1}{2} \times 2 \times (0.5)^2$$

Step 3 — Compute:

$$I = \frac{1}{2} \times 2 \times 0.25 = 1 \times 0.25 = 0.25 \text{ kg·m}^2$$

Why other options are wrong:

- Option A (0.5 kg·m^2): Uses $I = MR^2$ (formula for a ring, not a disc — omits the $1/2$ factor).
- Option C (1.0 kg·m^2): Uses $I = MR^2$ with $R = \sqrt{0.5} \approx 0.707$ or some other error.
- Option D (0.125 kg·m^2): Uses $I = \frac{1}{4}MR^2$, which applies to a disc about a diameter, not the central axis.

Final Answer: $I = 0.25$ kg·m$^2 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q17

Q18.

Solution

Concept — Boolean Algebra (De Morgan's Theorem): A NAND gate gives output $\overline{A \cdot B}$. Passing this through a NOT gate inverts it again: $\overline{\overline{A \cdot B}} = A \cdot B$ (double negation cancels).

Step 1 — NAND gate output:

$$\text{NAND output} = \overline{A \cdot B}$$

Step 2 — NOT gate inverts the NAND output:

$$Y = \overline{\text{NAND output}} = \overline{\overline{A \cdot B}}$$

Step 3 — Apply double negation:

$$Y = A \cdot B$$

NAND + NOT = AND gate.

Why other options are wrong:

- Option A ($A + B$): This is the OR function, not obtained by NAND + NOT.
- Option B ($\overline{A} \cdot \overline{B}$): This is the NOR output (De Morgan equivalent of $\overline{A + B}$).
- Option D ($\overline{A + B}$): This is the NOR function, not the NAND + NOT combination.

Final Answer: $Y = A \cdot B \Rightarrow$ C

Answer: (C) Go Back to Q18

Q19.

Solution

Concept — Young's Modulus: $Y = \dfrac{FL}{A\,\Delta L}$, where F is tensile force, L is original length, A is cross-sectional area, and ΔL is extension. Rearranging: $\Delta L = \dfrac{FL}{AY}$.

Step 1 — Identify given values:

$$F = 200\text{ N},\quad L = 2\text{ m},\quad A = 1\times10^{-6}\text{ m}^2,\quad Y = 2\times10^{11}\text{ Pa}$$

Step 2 — Compute numerator FL:

$$FL = 200\times 2 = 400\text{ N·m}$$

Step 3 — Compute denominator AY:

$$AY = 1\times10^{-6}\times 2\times10^{11} = 2\times10^{5}\text{ N}$$

Step 4 — Find extension ΔL:

$$\Delta L = \frac{400}{2\times10^5} = \frac{400}{200000} = 2\times10^{-3}\text{ m}$$

Why other options are wrong:

- Option B (1×10^{-3} m): Halves the correct answer; might arise from using $L = 1$ m.
- Option C (4×10^{-3} m): Doubles the correct answer; perhaps from $F = 400$ N.
- Option D (5×10^{-4} m): Arises from a tenfold error in A or L.

Final Answer: $\Delta L = 2\times10^{-3}\text{ m} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q19

Q20.

Solution

Concept — Orbital Velocity of a Satellite: Using $GM = gR^2$, the orbital velocity at radius r from Earth's centre is $v = \sqrt{GM/r}$. At height $h = R$, the orbital radius is $r = R + h = 2R$.

Step 1 — Write orbital velocity at $r = 2R$:

$$v = \sqrt{\frac{GM}{2R}}$$

Step 2 — Substitute $GM = gR^2$:

$$v = \sqrt{\frac{gR^2}{2R}} = \sqrt{\frac{gR}{2}}$$

Step 3 — Substitute $g = 10$ m/s^2, $R = 6.4 \times 10^6$ m:

$$v = \sqrt{\frac{10 \times 6.4 \times 10^6}{2}} = \sqrt{3.2 \times 10^7}$$

Step 4 — Compute:

$$v = \sqrt{32 \times 10^6} = 4\sqrt{2} \times 10^3 \approx 4 \times 1.414 \times 10^3 = 5656 \text{ m/s} \approx 5.66 \text{ km/s}$$

Why other options are wrong:

- Option A (8.0 km/s): This is the first cosmic velocity at the Earth's surface ($h = 0$, $r = R$).
- Option B (4.0 km/s): Uses $v = \sqrt{gR/4}$ (orbital radius $4R$), not $2R$.
- Option C (6.4 km/s): Equals R in km — a dimensional coincidence, not a valid formula.

Final Answer: $v \approx 5.66$ km/s $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q20

Answer Key

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