SAAT Physics

Sample Paper – 4

Duration: 40 Minutes **Maximum Marks: 40**

Instructions

- This paper contains **40** Multiple Choice Questions (Single Correct Answer), modelled on the Physics section of the **SAAT** (Siksha 'O' Anusandhan Admission Test).
- Each correct answer carries **+1 mark**. There is **no negative marking** for incorrect or unattempted answers.
- Only **one** option is correct. Attempt every question, since wrong answers are not penalised.
- Use of mobile phones, calculators, or other electronic gadgets is strictly prohibited.

Q1. The dimensional formula of the coefficient of viscosity η is

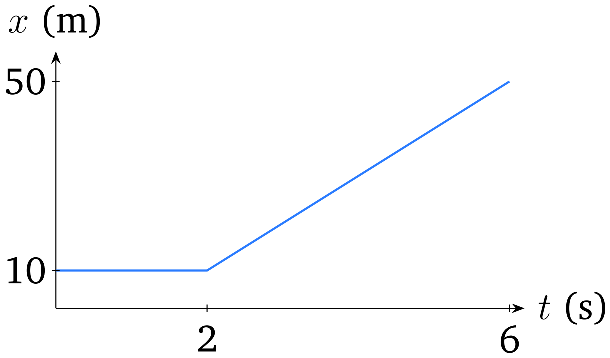
(A) $ML^{-1}T^{-1}$

(B) MLT^{-1}

(C) $ML^{-1}T^{-2}$

(D) $ML^{2}T^{-1}$

Q2. The position–time graph of a particle moving along a straight line is shown. The velocity of the particle during the interval from $t = 2$ s to $t = 6$ s is



(A) 5 m/s

(B) 10 m/s

(C) 20 m/s

(D) 8 m/s

Q3. A projectile is launched with a speed of $30\ \text{m/s}$ at an angle of 30° above the horizontal. Its horizontal range is $(g = 10\ \text{m/s}^2)$

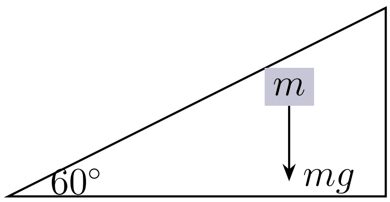
(A) 90 m

(B) 45 m

(C) 78 m

(D) 156 m

Q4. A block of mass 4 kg rests on a smooth inclined plane of inclination 60°, as shown. The normal reaction exerted by the incline on the block is $(g = 10\ \text{m/s}^2)$



(A) 40 N

(B) 34.6 N

(C) 30 N

(D) 20 N

Q5. A ball of mass 0.2 kg moving at $10\ \text{m/s}$ strikes a wall normally and rebounds with the same speed. The magnitude of the impulse imparted to the ball is

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

(B) $2\ \text{N s}$

(C) $1\ \mathrm{N\,s}$

(D) 0

Q6. A force of 20 N acts on a body and displaces it by 5 m in a direction making an angle of 60° with the force. The work done by the force is

(A) 100 J

(B) 50 J

(C) 86.6 J

(D) 25 J

Q7. A body of mass 2 kg is dropped from a height of 5 m. Its kinetic energy just before striking the ground is $(g = 10\ \mathrm{m/s^2})$

(A) 50 J

(B) 20 J

(C) 200 J

(D) 100 J

Q8. The moment of inertia of a uniform solid sphere of mass M and radius R about an axis passing through its centre is

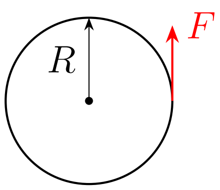
(A) $\frac{1}{2}MR^2$

(B) $\frac{2}{3}MR^2$

(C) $\frac{2}{5}MR^2$

(D) MR^2

Q9. A force of 10 N is applied tangentially at the rim of a wheel of radius 0.5 m, as shown. The torque produced about the axle is



(A) 5 N m

(B) 20 N m

(C) 10 N m

(D) 2.5 N m

Q10. The orbital speed of a satellite revolving close to the surface of the Earth (radius $R = 6.4 \times 10^6$ m, $g = 10 \text{ m/s}^2$) is approximately

(A) 11.2 km/s

(B) 8 km/s

(C) 5.6 km/s

(D) 16 km/s

Q11. A steel wire of length 3 m and cross-sectional area 2 mm^2 is stretched by a force of 200 N. If the Young's modulus of steel is $2 \times 10^{11} \text{ N/m}^2$, the elongation produced is

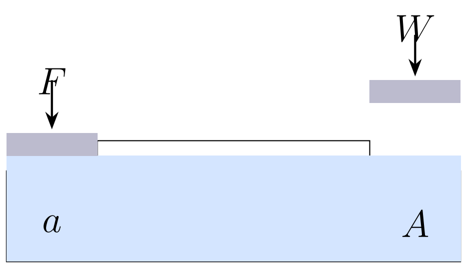
(A) 3×10^{-3} m

(B) 0.5×10^{-3} m

(C) 1.5×10^{-3} m

(D) 2×10^{-3} m

Q12. In a hydraulic lift the cross-sectional areas of the small and large pistons are 5 cm^2 and 200 cm^2. A force of 25 N applied on the small piston can lift a maximum load of



(A) 250 N

(B) 500 N

(C) 625 N

(D) 1000 N

Q13. 150 J of heat is supplied to a gas which then does 90 J of work on its surroundings. The increase in the internal energy of the gas is

(A) 240 J

(B) 60 J

(C) 90 J

(D) 150 J

Q14. A gas is taken through a complete cyclic process and returns to its initial state. For one full cycle, which one of the following is necessarily zero?

(A) Change in internal energy

(B) Heat absorbed by the gas

(C) Work done by the gas

(D) Change in pressure during each step

Q15. For an ideal diatomic gas (rigid molecules) at ordinary temperature, the number of degrees of freedom and the ratio of specific heats $\gamma = C_P/C_V$ are respectively

(A) 3 and $5/3$

(B) 6 and $4/3$

(C) 7 and $9/7$

(D) 5 and $7/5$

Q16. 100 g of water at $80°C$ is mixed with 300 g of water at $20°C$. Assuming no heat loss, the final temperature of the mixture is

(A) $50°C$

(B) $40°C$

(C) 35°C

(D) 30°C

Q17. A particle executes simple harmonic motion of amplitude 0.05 m and angular frequency 20 rad/s. The maximum speed of the particle is

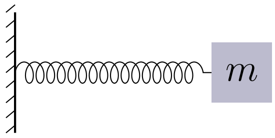
(A) 1 m/s

(B) 0.5 m/s

(C) 2 m/s

(D) 20 m/s

Q18. A mass of 2 kg attached to a spring of force constant 200 N/m executes simple harmonic motion, as shown. Its time period is



(A) $\frac{\pi}{10}$ s

(B) $\frac{\pi}{5}$ s

(C) π s

(D) $\frac{2\pi}{5}$ s

Q19. Two tuning forks of frequencies 256 Hz and 260 Hz are sounded together. The number of beats heard per second is

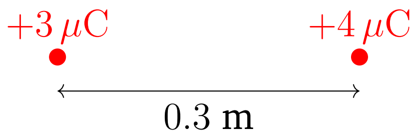
(A) 516

(B) 2

(C) 4

(D) 8

Q20. Two point charges of $+3\ \mu$C and $+4\ \mu$C are placed 0.3 m apart, as shown. The magnitude of the electrostatic force between them is $\left(\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ \mathrm{N\,m^2/C^2}\right.$



(A) 0.6 N

(B) 3.6 N

(C) 0.36 N

(D) 1.2 N

Q21. A uniform electric field of 500 N/C acts on a charge of $4\ \mu$C. The force experienced by the charge is

(A) 2×10^{-3} N

(B) 1.25×10^{8} N

(C) 2×10^{-2} N

(D) 5×10^{-4} N

Q22. Three capacitors of $2\ \mu$F, $3\ \mu$F and $6\ \mu$F are connected in series. The equivalent capacitance of the combination is

(A) $11\ \mu$F

(B) $1\ \mu$F

(C) $3\ \mu$F

(D) $0.5\ \mu$F

Q23. The electrostatic potential energy of a system of two point charges $+2\ \mu$C and $-3\ \mu$C separated by 0.6 m is $\left(\dfrac{1}{4\pi\varepsilon_0} = 9 \times 10^{9}\right)$

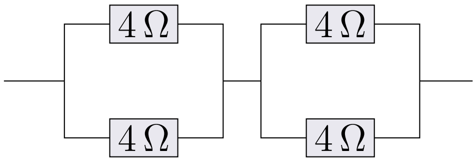
(A) $+0.09$ J

(B) $+0.18$ J

(C) -0.09 J

(D) -0.18 J

Q24. Four resistors, each of $4\ \Omega$, are connected so that two parallel pairs are joined in series, as shown. The equivalent resistance between the terminals is



(A) $16\ \Omega$

(B) $8\ \Omega$

(C) $2\ \Omega$

(D) $4\ \Omega$

Q25. A cell of emf 6 V and internal resistance $0.5\ \Omega$ delivers a current of 2 A to an external circuit. The terminal voltage of the cell is

(A) 5 V

(B) 6 V

(C) 7 V

(D) 4 V

Q26. An electric heater draws a current of 5 A from a 220 V supply. The heat energy produced in 2 minutes is

(A) 66 kJ

(B) 132 kJ

(C) 1100 J

(D) 264 kJ

Q27. A wire of length 10 m and cross-sectional area $2\times10^{-6}\ \mathrm{m}^2$ has a resistance of $5\ \Omega$. The resistivity of the material is

(A) $2.5 \times 10^{-6}\ \Omega\,\mathrm{m}$

(B) $2 \times 10^{-6}\ \Omega\,\mathrm{m}$

(C) $1 \times 10^{-6}\ \Omega\,\mathrm{m}$

(D) $5 \times 10^{-7}\ \Omega\,\mathrm{m}$

Q28. A long solenoid has 500 turns per metre and carries a current of 4 A. The magnetic field inside the solenoid is $(\mu_0 = 4\pi \times 10^{-7}\ \mathrm{T\,m/A})$

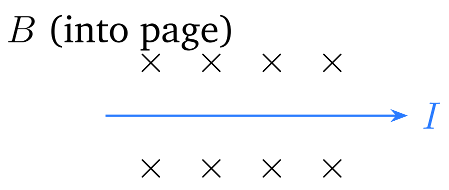
(A) 1.0×10^{-3} T

(B) $4\pi \times 10^{-3}$ T

(C) 6.28×10^{-4} T

(D) 2.51×10^{-3} T

Q29. A straight conductor of length 0.5 m carrying a current of 4 A is placed perpendicular to a uniform magnetic field of 0.2 T, as shown. The force on the conductor is



(A) 0.8 N

(B) 0.4 N

(C) 0.2 N

(D) 1.6 N

Q30. A circular coil of 50 turns and radius 0.1 m carries a current of 2 A. The magnetic moment of the coil is

(A) $0.5\pi\ \mathrm{A\,m^2}$

(B) $2\pi\ \mathrm{A\,m^2}$

(C) $\pi\ \mathrm{A\,m^2}$

(D) $10\pi\ \mathrm{A\,m^2}$

Q31. The magnetic flux through a coil changes from 0.04 Wb to 0.10 Wb in 0.3 s. The magnitude of the average emf induced in the coil is

(A) 0.2 V

(B) 0.6 V

(C) 0.06 V

(D) 0.02 V

Q32. An inductor of 0.5 H is connected to an AC source of angular frequency $100\ \mathrm{rad/s}$. The inductive reactance is

(A) $200\ \Omega$

(B) $25\ \Omega$

(C) $100\ \Omega$

(D) $50\ \Omega$

Q33. The speed of electromagnetic waves in vacuum is determined by the permeability μ_0 and permittivity ε_0 of free space through the relation

(A) $c = \sqrt{\mu_0 \varepsilon_0}$

(B) $c = \dfrac{1}{\sqrt{\mu_0 \varepsilon_0}}$

(C) $c = \dfrac{\mu_0}{\varepsilon_0}$

(D) $c = \dfrac{1}{\mu_0 \varepsilon_0}$

Q34. Electromagnetic waves that travel from the transmitting antenna to the receiving antenna after reflection from the ionosphere are propagated as

(A) sky waves

(B) ground waves

(C) space waves

(D) surface waves

Q35. The work function of a metal is 2.5 eV. When light of photon energy 6.5 eV is incident on it, the stopping potential required to stop the fastest photoelectrons is

(A) 9 V

(B) 2.5 V

(C) 4 V

(D) 6.5 V

Q36. The de Broglie wavelength of an electron (mass 9×10^{-31} kg) moving with a speed of 3.3×10^6 m/s is approximately $(h = 6.6 \times 10^{-34}\ \mathrm{J\,s})$

(A) 1.1×10^{-10} m

(B) 6.6×10^{-10} m

(C) 3.3×10^{-10} m

(D) 2.2×10^{-10} m

Q37. In the Bohr model of the hydrogen atom, the radius of the first orbit is 0.53 Å. The radius of the third orbit $(n = 3)$ is

(A) 1.59 Å

(B) 4.77 Å

(C) 0.53 Å

(D) 9.0 Å

Q38. The mass defect in the formation of a nucleus is 0.0303 u. The corresponding binding energy is (take $1\ \mathrm{u} = 931\ \mathrm{MeV/c^2}$)

(A) 28.2 MeV

(B) 2.82 MeV

(C) 93.1 MeV

(D) 282 MeV

Q39. A single p–n junction diode is used in a half-wave rectifier circuit. During one full cycle of the input AC, the output across the load conducts

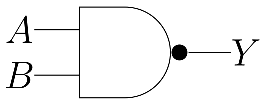
(A) during both halves of the cycle

(B) during neither half of the cycle

(C) only during one half of the cycle

(D) at a doubled frequency

Q40. For the two-input logic gate shown, the output Y is 0 *only* when both inputs A and B are 1; for every other input combination $Y = 1$. This gate is



(A) AND gate

(B) OR gate

(C) NOR gate

(D) NAND gate

Detailed Solutions

Q1.

Solution

Concept — Dimensions of viscosity: From $F = \eta A\frac{dv}{dx}$, $\eta = \frac{F}{A(dv/dx)}$.

Step 1 — Build the formula: $[\eta] = \frac{[MLT^{-2}]}{[L^2]\,[T^{-1}]} = \frac{MLT^{-2}}{L^2T^{-1}}$.

Step 2 — Simplify: $[\eta] = ML^{-1}T^{-1}$.

Why other options are wrong: MLT^{-1} is momentum-like; $ML^{-1}T^{-2}$ is pressure; ML^2T^{-1} is angular momentum.

Final Answer: $[\eta] = ML^{-1}T^{-1} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q1

Q2.

Solution

Concept — Velocity from an x–t graph: The velocity equals the slope of the position–time graph.

Step 1 — Read the change: Between $t = 2$ s and $t = 6$ s, x rises from 10 m to 50 m.

Step 2 — Compute the slope: $v = \frac{50 - 10}{6 - 2} = \frac{40}{4} = 10$ m/s.

Why other options are wrong: 5 and 8 misread the coordinates; 20 ignores the 4 s interval.

Final Answer: $v = 10$ m/s $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q2

Q3.

Solution

Concept — Projectile range: $R = \frac{u^2 \sin 2\theta}{g}$.

Step 1 — Substitute: $R = \frac{(30)^2 \sin 60^\circ}{10} = \frac{900 \times (\sqrt{3}/2)}{10}$.

Step 2 — Compute: $R = 45\sqrt{3} \approx 78$ m.

Why other options are wrong: 90 m uses $\sin 2\theta = 1$; 45 m halves; 156 m doubles the correct range.

Final Answer: $R = 45\sqrt{3} \approx 78$ m $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q3

Q4.

Solution

Concept — Normal reaction on an incline: On a smooth incline $N = mg\cos\theta$.

Step 1 — Substitute: $N = 4 \times 10 \times \cos 60° = 40 \times 0.5$.

Step 2 — Compute: $N = 20$ N.

Why other options are wrong: 40 N is mg; 34.6 N uses $\cos 30°$; 30 N has no basis.

Final Answer: $N = 20$ N $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Impulse = change in momentum: $J = \Delta p = m(v_f - v_i)$, taking the rebound direction as positive.

Step 1 — Momenta: Initial $= -mv = -0.2 \times 10 = -2$; final $= +2$ (in N s).

Step 2 — Change: $J = 2 - (-2) = 4$ N s.

Why other options are wrong: 2 ignores the reversal; 1 halves; 0 would hold only if it stuck with no rebound.

Final Answer: $J = 4$ N s $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Work with an angle: $W = Fd\cos\theta$.

Step 1 — Substitute: $W = 20 \times 5 \times \cos 60° = 100 \times 0.5$.

Step 2 — Compute: $W = 50$ J.

Why other options are wrong: 100 uses $\cos 0°$; 86.6 uses $\cos 30°$; 25 halves twice.

Final Answer: $W = 50\text{ J} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Energy conservation: All the lost potential energy becomes kinetic energy: $KE = mgh$.

Step 1 — Substitute: $KE = 2 \times 10 \times 5$.

Step 2 — Compute: $KE = 100$ J.

Why other options are wrong: 50 drops the mass factor; 20 uses $h = 1$; 200 doubles incorrectly.

Final Answer: $KE = 100\text{ J} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q7

Q8.

Solution

Concept — Moment of inertia of a solid sphere: About a central (diametric) axis, $I = \frac{2}{5}MR^2$.

Step 1 — Standard result: Integration of $r^2\,dm$ over the sphere gives $\frac{2}{5}MR^2$.

Why other options are wrong: $\frac{1}{2}MR^2$ is a disc; $\frac{2}{3}MR^2$ is a thin spherical shell; MR^2 is a ring.

Final Answer: $I = \frac{2}{5}MR^2 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q8

Q9.

Solution

Concept — Torque: For a force applied tangentially at the rim, $\tau = F \times R$.

Step 1 — Substitute: $\tau = 10 \times 0.5$.

Step 2 — Compute: $\tau = 5\,\text{N m}$.

Why other options are wrong: 20 and 10 use a wrong radius; 2.5 halves the answer.

Final Answer: $\tau = 5\,\mathrm{N\,m} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Orbital speed near the surface: $v_o = \sqrt{gR}$.

Step 1 — Substitute: $v_o = \sqrt{10 \times 6.4 \times 10^6} = \sqrt{6.4 \times 10^7}$.

Step 2 — Compute: $v_o = 8 \times 10^3$ m/s $= 8$ km/s.

Why other options are wrong: 11.2 km/s is the escape speed; 5.6 and 16 km/s mis-handle the square root.

Final Answer: $v_o = 8$ km/s $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — Young's modulus: $\Delta L = \dfrac{FL}{AY}$.

Step 1 — Substitute SI values: $F = 200\,\mathrm{N}$, $L = 3\,\mathrm{m}$, $A = 2\times10^{-6}\,\mathrm{m}^2$, $Y = 2\times10^{11}$.

Step 2 — Compute: $\Delta L = \dfrac{200 \times 3}{2 \times 10^{-6} \times 2 \times 10^{11}} = \dfrac{600}{4 \times 10^5} = 1.5 \times 10^{-3}$ m.

Why other options are wrong: 3×10^{-3} drops a factor of 2; 0.5×10^{-3} and 2×10^{-3} mishandle the arithmetic.

Final Answer: $\Delta L = 1.5 \times 10^{-3}$ m $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Pascal's law in a hydraulic lift: Pressure is transmitted equally, so $\dfrac{F}{a} = \dfrac{W}{A}$, giving $W = F\dfrac{A}{a}$.

Step 1 — Area ratio: $\dfrac{A}{a} = \dfrac{200}{5} = 40$.

Step 2 — Compute: $W = 25 \times 40 = 1000$ N.

Why other options are wrong: 250 uses a ratio of 10; 500 uses 20; 625 has no basis.

Final Answer: $W = 1000 \text{ N} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — First law of thermodynamics: $\Delta U = Q - W$, with W the work done by the gas.

Step 1 — Substitute: $\Delta U = 150 - 90$.

Step 2 — Compute: $\Delta U = 60$ J.

Why other options are wrong: 240 adds the terms; 90 and 150 confuse the work and heat.

Final Answer: $\Delta U = 60 \text{ J} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q13

Q14.

Solution

Concept — Cyclic process: Internal energy is a state function, so after one complete cycle the system returns to its initial state and $\Delta U = 0$.

Step 1 — Apply the first law over the cycle: $\oint dU = 0$, hence $Q_{net} = W_{net}$.

Why other options are wrong: The net heat and net work equal the enclosed area and are generally non-zero; pressure varies during the steps.

Final Answer: $\Delta U = 0$ for the cycle $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q14

Q15.

Solution

Concept — Degrees of freedom of a diatomic gas: A rigid diatomic molecule has 3 translational $+2$ rotational $= 5$ degrees of freedom.

Step 1 — Specific heats: $C_V = \frac{5}{2}R$, $C_P = \frac{7}{2}R$.

Step 2 — Ratio: $\gamma = \dfrac{C_P}{C_V} = \dfrac{7}{5}$.

Why other options are wrong: $3,\ 5/3$ is monatomic; $6,\ 4/3$ adds vibration; $7,\ 9/7$ has no standard basis at ordinary temperature.

Final Answer: 5 and $7/5 \Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q15**

Q16.

Solution

Concept — Calorimetry (no heat loss): Heat lost by hot water $=$ heat gained by cold water.

Step 1 — Equation: $100(80 - T) = 300(T - 20)$.

Step 2 — Solve: $8000 - 100T = 300T - 6000 \Rightarrow 14000 = 400T \Rightarrow T = 35°\text{C}$.

Why other options are wrong: 50 ignores the $1{:}3$ mass ratio; 40 and 30 come from a wrong balance.

Final Answer: $T = 35°\text{C} \Rightarrow \boxed{\text{C}}$

Answer: (C) **Go Back to Q16**

Q17.

Solution

Concept — Maximum speed in SHM: $v_{max} = A\omega$.

Step 1 — Substitute: $v_{max} = 0.05 \times 20$.

Step 2 — Compute: $v_{max} = 1$ m/s.

Why other options are wrong: 0.5 halves; 2 doubles; 20 is ω alone.

Final Answer: $v_{max} = 1$ m/s $\Rightarrow \boxed{\text{A}}$

Answer: (A) **Go Back to Q17**

Q18.

Solution

Concept — Period of a spring–mass system: $T = 2\pi\sqrt{\dfrac{m}{k}}$.

Step 1 — Substitute: $T = 2\pi\sqrt{\dfrac{2}{200}} = 2\pi\sqrt{0.01}$.

Step 2 — Compute: $T = 2\pi \times 0.1 = \dfrac{\pi}{5}$ s.

Why other options are wrong: $\pi/10$ and $2\pi/5$ mishandle the square root; π uses $m/k = 1/4$.

Final Answer: $T = \dfrac{\pi}{5}$ s $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — Beats: The beat frequency equals the difference of the two frequencies, $f_b = |f_1 - f_2|$.

Step 1 — Substitute: $f_b = |260 - 256|$.

Step 2 — Compute: $f_b = 4$ Hz.

Why other options are wrong: 516 adds the frequencies; 2 halves the difference; 8 doubles it.

Final Answer: $f_b = 4$ beats/s $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q19

Q20.

Solution

Concept — Coulomb's law: $F = \dfrac{1}{4\pi\varepsilon_0}\dfrac{q_1 q_2}{r^2}$.

Step 1 — Substitute: $F = \dfrac{9 \times 10^9 \times (3 \times 10^{-6})(4 \times 10^{-6})}{(0.3)^2}$.

Step 2 — Compute: $F = \dfrac{9 \times 10^9 \times 12 \times 10^{-12}}{0.09} = \dfrac{0.108}{0.09} = 1.2$ N.

Why other options are wrong: 0.6 drops a factor of 2; 3.6 ignores r^2; 0.36 misplaces a power of ten.

Final Answer: $F = 1.2\text{ N} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q20

Q21.

Solution

Concept — Force on a charge in a field: $F = qE$.

Step 1 — Substitute: $F = 4 \times 10^{-6} \times 500$.

Step 2 — Compute: $F = 2 \times 10^{-3}$ N.

Why other options are wrong: 1.25×10^{8} divides instead of multiplying; 2×10^{-2} and 5×10^{-4} misplace the power of ten.

Final Answer: $F = 2 \times 10^{-3}\text{ N} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q21

Q22.

Solution

Concept — Capacitors in series: $\dfrac{1}{C_s} = \dfrac{1}{C_1} + \dfrac{1}{C_2} + \dfrac{1}{C_3}$.

Step 1 — Add reciprocals: $\dfrac{1}{C_s} = \dfrac{1}{2} + \dfrac{1}{3} + \dfrac{1}{6} = \dfrac{3+2+1}{6} = 1$.

Step 2 — Compute: $C_s = 1\ \mu\text{F}$.

Why other options are wrong: $11\ \mu$F is the parallel sum; 3 and $0.5\ \mu$F come from arithmetic slips.

Final Answer: $C_s = 1\ \mu\text{F} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Potential energy of a pair of charges: $U = \dfrac{1}{4\pi\varepsilon_0}\dfrac{q_1 q_2}{r}$, including signs.

Step 1 — Substitute: $U = \dfrac{9 \times 10^{9} \times (2 \times 10^{-6})(-3 \times 10^{-6})}{0.6}$.

Step 2 — Compute: $U = \dfrac{-54 \times 10^{-3}}{0.6} = -0.09$ J.

Why other options are wrong: The product of opposite charges is negative, ruling out the positive entries; -0.18 drops the 0.6 factor.

Final Answer: $U = -0.09$ J $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q23

Q24.

Solution

Concept — Series of parallel pairs: Each parallel pair of equal $4\ \Omega$ resistors gives $2\ \Omega$; the two pairs add in series.

Step 1 — Each pair: $\dfrac{4 \times 4}{4 + 4} = 2\ \Omega$.

Step 2 — Series: $R_{eq} = 2 + 2 = 4\ \Omega$.

Why other options are wrong: 16 adds all four in series; 8 keeps two in series only; 2 stops at one parallel pair.

Final Answer: $R_{eq} = 4\ \Omega \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q24

Q25.

Solution

Concept — Terminal voltage: $V = \varepsilon - Ir$.

Step 1 — Substitute: $V = 6 - (2)(0.5)$.

Step 2 — Compute: $V = 6 - 1 = 5$ V.

Why other options are wrong: 6 ignores the internal drop; 7 adds it; 4 doubles the drop.

Final Answer: $V = 5$ V $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q25

Q26.

Solution

Concept — Electrical heating: $H = VIt$.

Step 1 — Substitute: $H = 220 \times 5 \times (2 \times 60)$.

Step 2 — Compute: $H = 220 \times 5 \times 120 = 132000$ J $= 132$ kJ.

Why other options are wrong: 66 kJ uses 1 minute; 1100 J omits time; 264 kJ doubles the time.

Final Answer: $H = 132$ kJ $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept — Resistivity: $R = \frac{\rho L}{A} \Rightarrow \rho = \frac{RA}{L}$.

Step 1 — Substitute: $\rho = \frac{5 \times 2 \times 10^{-6}}{10}$.

Step 2 — Compute: $\rho = \frac{10 \times 10^{-6}}{10} = 1 \times 10^{-6}\ \Omega\,\text{m}$.

Why other options are wrong: 2.5×10^{-6}, 2×10^{-6} and 5×10^{-7} all mishandle the RA/L arithmetic or the powers of ten.

Final Answer: $\rho = 1 \times 10^{-6}\ \Omega\,\text{m} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q27

Q28.

Solution

Concept — Field inside a solenoid: $B = \mu_0 n I$.

Step 1 — Substitute: $B = (4\pi \times 10^{-7})(500)(4)$.

Step 2 — Compute: $B = 4\pi \times 10^{-7} \times 2000 = 8\pi \times 10^{-4} \approx 2.51 \times 10^{-3}$ T.

Why other options are wrong: 1.0×10^{-3} and 6.28×10^{-4} drop a factor; $4\pi \times 10^{-3}$ overshoots by a power of ten.

Final Answer: $B \approx 2.51 \times 10^{-3}$ T $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q28

Q29.

Solution

Concept — Force on a current-carrying conductor: $F = BIL \sin\theta$, with $\theta = 90°$.

Step 1 — Substitute: $F = 0.2 \times 4 \times 0.5$.

Step 2 — Compute: $F = 0.4$ N.

Why other options are wrong: 0.8 doubles the length; 0.2 drops the current factor; 1.6 multiplies wrongly.

Final Answer: $F = 0.4 \text{ N} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q29

Q30.

Solution

Concept — Magnetic moment of a coil: $m = NIA = NI\pi R^2$.

Step 1 — Substitute: $m = 50 \times 2 \times \pi \times (0.1)^2 = 100\pi \times 0.01$.

Step 2 — Compute: $m = \pi \approx 3.14 \text{ A m}^2$.

Why other options are wrong: 2π doubles; 0.5π halves; 10π drops the R^2 factor.

Final Answer: $m = \pi \approx 3.14 \text{ A m}^2 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q30

Q31.

Solution

Concept — Faraday's law: $|\varepsilon| = \dfrac{\Delta\Phi}{\Delta t}$.

Step 1 — Change in flux: $\Delta\Phi = 0.10 - 0.04 = 0.06$ Wb.

Step 2 — Compute: $\varepsilon = \dfrac{0.06}{0.3} = 0.2$ V.

Why other options are wrong: 0.6 drops the time; 0.06 omits dividing by 0.3; 0.02 misplaces a power of ten.

Final Answer: $\varepsilon = 0.2 \text{ V} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q31

Q32.

Solution

Concept — Inductive reactance: $X_L = \omega L$.

Step 1 — Substitute: $X_L = 100 \times 0.5$.

Step 2 — Compute: $X_L = 50\ \Omega$.

Why other options are wrong: 200 and 25 mishandle the product; 100 uses $L = 1$.

Final Answer: $X_L = 50\ \Omega \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Speed of light from Maxwell's equations: The speed of electromagnetic waves in vacuum is $c = \dfrac{1}{\sqrt{\mu_0 \varepsilon_0}}$.

Step 1 — Verify dimensionally: Substituting $\mu_0 = 4\pi \times 10^{-7}$ and $\varepsilon_0 = 8.85 \times 10^{-12}$ gives $c \approx 3 \times 10^8$ m/s.

Why other options are wrong: $\sqrt{\mu_0 \varepsilon_0}$ and $1/(\mu_0 \varepsilon_0)$ have the wrong dimensions; μ_0/ε_0 is an impedance-squared, not a speed.

Final Answer: $c = \dfrac{1}{\sqrt{\mu_0 \varepsilon_0}} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q33

Q34.

Solution

Concept — Sky-wave propagation: Waves in the range of a few MHz are reflected by the ionosphere back to Earth; this is sky-wave (ionospheric) propagation.

Step 1 — Match the description: Reflection from the ionosphere is the defining feature of sky waves.

Why other options are wrong: Ground/surface waves glide along the Earth's surface; space waves travel in a straight line of sight.

Final Answer: The mode is sky-wave propagation $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q34

Q35.

Solution

Concept — Stopping potential: $eV_0 = E_{photon} - \phi$, so $V_0 = E_{photon} - \phi$ in volts when energies are in eV.

Step 1 — Substitute: $V_0 = 6.5 - 2.5$.

Step 2 — Compute: $V_0 = 4$ V.

Why other options are wrong: 9 adds the two; 6.5 ignores the work function; 2.5 gives only the work function.

Final Answer: $V_0 = 4\text{ V} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q35

Q36.

Solution

Concept — de Broglie wavelength: $\lambda = \frac{h}{mv}$.

Step 1 — Substitute: $\lambda = \frac{6.6 \times 10^{-34}}{(9 \times 10^{-31})(3.3 \times 10^{6})}$.

Step 2 — Compute: Denominator $= 2.97 \times 10^{-24}$, so $\lambda \approx 2.2 \times 10^{-10}$ m.

Why other options are wrong: 1.1×10^{-10} halves; 6.6×10^{-10} and 3.3×10^{-10} mishandle the powers of ten.

Final Answer: $\lambda \approx 2.2 \times 10^{-10}\text{ m} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q36

Q37.

Solution

Concept — Bohr orbit radius: $r_n = n^2 r_1$.

Step 1 — Put $n = 3$: $r_3 = 9 \times r_1$.

Step 2 — Compute: $r_3 = 9 \times 0.53 = 4.77$ Å.

Why other options are wrong: 1.59 uses n instead of n^2; 0.53 is the first orbit; 9.0 drops the 0.53 factor.

Final Answer: $r_3 = 4.77\text{ Å} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q37

Q38.

Solution

Concept — Binding energy from mass defect: $BE = \Delta m \times 931$ MeV.

Step 1 — Substitute: $BE = 0.0303 \times 931$.

Step 2 — Compute: $BE \approx 28.2$ MeV.

Why other options are wrong: 2.82 and 282 misplace a power of ten; 93.1 uses a wrong mass defect.

Final Answer: $BE \approx 28.2$ MeV $\Rightarrow$ $\boxed{A}$

Answer: (A) Go Back to Q38

Q39.

Solution

Concept — Half-wave rectifier: A single diode conducts only when it is forward biased, i.e. during one half of each AC cycle.

Step 1 — Trace the cycle: During the half that forward-biases the diode, current flows to the load; during the other half the diode blocks it.

Why other options are wrong: Conduction in both halves is full-wave rectification; "neither half" would give no output; the output frequency equals the input for a half-wave rectifier.

Final Answer: Output conducts only during one half of the cycle $\Rightarrow$ $\boxed{C}$

Answer: (C) Go Back to Q39

Q40.

Solution

Concept — NAND gate: A NAND gate is an AND gate followed by an inverter; its output is 0 *only* when all inputs are 1, and 1 otherwise. The small circle (bubble) at the output marks the inversion.

Step 1 — Match the truth table: "$Y = 0$ only when $A = B = 1$" is exactly the NAND rule.

Why other options are wrong: AND gives 1 when both are 1; OR gives 1 if any is 1; NOR gives 1 only when both are 0.

Final Answer: The gate is a NAND gate $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q40

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	A	2	B	3	C	4	D	5	A
6	B	7	D	8	C	9	A	10	B
11	C	12	D	13	B	14	A	15	D
16	C	17	A	18	B	19	C	20	D
21	A	22	B	23	C	24	D	25	A
26	B	27	C	28	D	29	B	30	C
31	A	32	D	33	B	34	A	35	C
36	D	37	B	38	A	39	C	40	D