SAAT Physics

Sample Paper – 6

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. In the equation $v = a + \frac{b}{t}$, where v is velocity and t is time, the equation is dimensionally consistent only if the constants a and b have the dimensions of

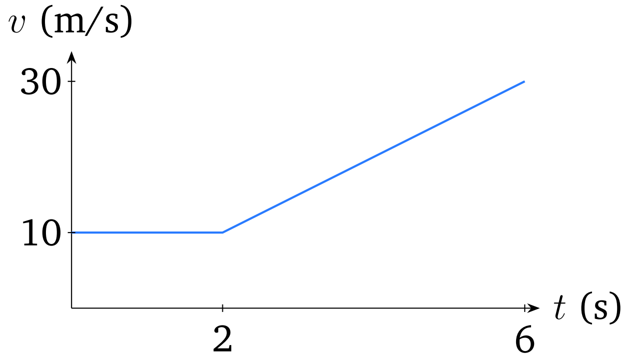
(A) velocity and length respectively

(B) length and velocity respectively

(C) velocity and time respectively

(D) acceleration and velocity respectively

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



(A) 2.5 m/s^2

(B) 5 m/s^2

(C) 10 m/s^2

(D) 20 m/s^2

Q3. A projectile is launched with a speed of 20 m/s at an angle of 30° to the horizontal. Its horizontal range is $(g = 10 \text{ m/s}^2)$

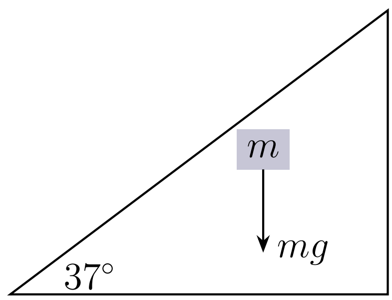
(A) $40\sqrt{3}$ m

(B) 40 m

(C) $20\sqrt{3}$ m

(D) 20 m

Q4. A block of mass 4 kg rests on a smooth inclined plane of inclination 37°, as shown. The normal reaction exerted by the surface on the block is $(g = 10 \text{ m/s}^2, \cos 37^\circ = 0.8)$



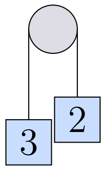
(A) 40 N

(B) 24 N

(C) 20 N

(D) 32 N

Q5. Two masses 3 kg and 2 kg are connected by a light string over a frictionless pulley, as shown. The acceleration of the system is ($g = 10\ \text{m/s}^2$)



(A) $1\ \text{m/s}^2$

(B) $2\ \text{m/s}^2$

(C) $2.5\ \text{m/s}^2$

(D) $5\ \text{m/s}^2$

Q6. A force $\vec{F} = (5\hat{i} + 2\hat{j} - \hat{k})$ N acts on a body and displaces it through $\vec{d} = (2\hat{i} - \hat{j} + 3\hat{k})$ m. The work done by the force is

(A) 5 J

(B) 9 J

(C) 11 J

(D) 13 J

Q7. A body of mass 2 kg is dropped from a height of 20 m. Its kinetic energy just before striking the ground is ($g = 10\ \text{m/s}^2$), neglecting air resistance

(A) 40 J

(B) 200 J

(C) 800 J

(D) 400 J

Q8. The moment of inertia of a uniform circular ring of mass M and radius R about a diameter is

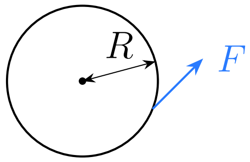
(A) MR^2

(B) $\frac{1}{4}MR^2$

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

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

Q9. A force of 20 N is applied tangentially at the rim of a wheel of radius 0.25 m, as shown. The torque produced about the axle is



(A) 5 N m

(B) 80 N m

(C) 10 N m

(D) 0.5 N m

Q10. A satellite revolves around the Earth in a circular orbit of radius r. If the radius of the orbit is increased to $4r$, the orbital speed of the satellite becomes (original speed v)

(A) $2v$

(B) $v/2$

(C) $v/4$

(D) $4v$

Q11. A steel wire of length 4 m and cross-sectional area $2\ \text{mm}^2$ is stretched by a force of 200 N. If Young's modulus of steel is $2 \times 10^{11}\ \text{N/m}^2$, the elongation produced is

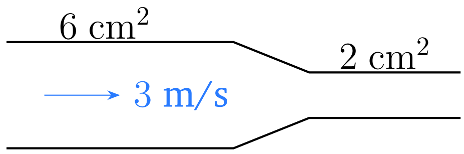
(A) 1 mm

(B) 4 mm

(C) 2 mm

(D) 0.5 mm

Q12. Water flows steadily through a horizontal pipe whose cross-sectional area narrows from $6\ \text{cm}^2$ to $2\ \text{cm}^2$. If the speed of water in the wider section is $3\ \text{m/s}$, its speed in the narrower section is



(A) 1 m/s

(B) 6 m/s

(C) 3 m/s

(D) 9 m/s

Q13. The internal energy of a gas increases by 120 J when it absorbs 300 J of heat. The work done by the gas during this process is

(A) 180 J

(B) 420 J

(C) 120 J

(D) 300 J

Q14. In an isothermal expansion of an ideal gas, which one of the following quantities remains zero?

(A) Heat absorbed by the gas

(B) Change in internal energy

(C) Work done by the gas

(D) Volume of the gas

Q15. Two gases, oxygen ($M = 32$) and hydrogen ($M = 2$), are kept at the same temperature. The ratio of the rms speed of hydrogen to that of oxygen is

(A) 1 : 4

(B) 16 : 1

(C) 4 : 1

(D) 1 : 16

Q16. A Carnot engine works between a source at 500 K and a sink at 400 K. Its efficiency is

(A) 80%

(B) 25%

(C) 44%

(D) 20%

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

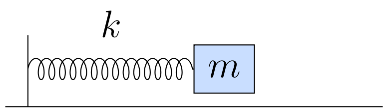
(A) 1 m/s

(B) 0.5 m/s

(C) 20 m/s

(D) 4 m/s

Q18. A mass of 0.5 kg attached to a spring of force constant 200 N/m oscillates on a frictionless surface, as shown. The time period of oscillation is



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

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

(C) $\frac{\pi}{20}$ 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) 2

(B) 8

(C) 4

(D) 516

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

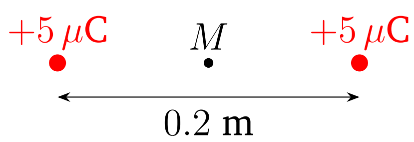
(A) 0.6 N

(B) 0.3 N

(C) 3.6 N

(D) 1.2 N

Q21. Two equal charges of $+5\ \mu\mathrm{C}$ each are placed 0.2 m apart, as shown. The magnitude of the resultant electric field at the midpoint M between them is



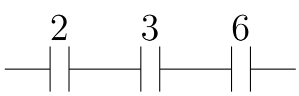
(A) 9×10^6 N/C

(B) 0

(C) 4.5×10^6 N/C

(D) 1.8×10^6 N/C

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



(A) $11\ \mu$F

(B) $3\ \mu$F

(C) $1\ \mu$F

(D) $2\ \mu$F

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

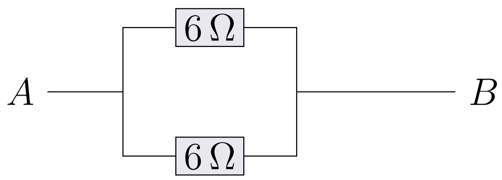
(A) -0.09 J

(B) $+0.09$ J

(C) -0.18 J

(D) -0.045 J

Q24. In the network shown, each resistor has a resistance of $6\ \Omega$. The equivalent resistance between points A and B is



(A) $12\ \Omega$

(B) $6\ \Omega$

(C) $9\ \Omega$

(D) $3\ \Omega$

Q25. A cell of emf 6 V and internal resistance $0.5\ \Omega$ delivers a current of 4 A to an external circuit. The terminal potential difference across the cell is

(A) 2 V

(B) 4 V

(C) 6 V

(D) 8 V

Q26. A heater of resistance $20\ \Omega$ carries a current of 5 A for 2 minutes. The heat produced is

(A) 60 kJ

(B) 500 J

(C) 1000 J

(D) 30 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 of the wire is

(A) $2.5\times10^{-6}\ \Omega\,\mathrm{m}$

(B) $4\times10^{-6}\ \Omega\,\mathrm{m}$

(C) $1\times10^{-6}\ \Omega\,\mathrm{m}$

(D) $1\times10^{-7}\ \Omega\,\mathrm{m}$

Q28. A long solenoid has 500 turns per metre and carries a current of 4 A. The magnetic field inside the solenoid is $(\mu_0 = 4\pi\times10^{-7}\ \mathrm{T\,m/A})$

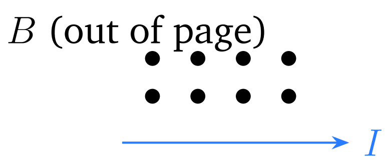
(A) $8\pi\times10^{-4}$ T

(B) $2\pi\times10^{-4}$ T

(C) $4\pi\times10^{-4}$ T

(D) $\pi\times10^{-3}$ T

Q29. A straight conductor of length 0.5 m carrying a current of 6 A is placed perpendicular to a uniform magnetic field of 0.4 T, as shown. The force experienced by the conductor is



(A) 2.4 N

(B) 1.2 N

(C) 0.6 N

(D) 4.8 N

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

(A) π A m^2

(B) 2π A m^2

(C) 0.5π A m^2

(D) 10π A m^2

Q31. The magnetic flux through a coil of 200 turns changes from 0.04 Wb to 0.01 Wb in 0.1 s. The magnitude of the emf induced in the coil is

(A) 6 V

(B) 0.3 V

(C) 60 V

(D) 30 V

Q32. An inductor of inductance 0.5 H is connected to an AC source of angular frequency 100 rad/s. The inductive reactance is

(A) 0.5 Ω

(B) 200 Ω

(C) 100 Ω

(D) 50 Ω

Q33. In vacuum, all electromagnetic waves, irrespective of their wavelength or frequency, travel with a speed of

(A) 3×10^8 m/s

(B) 3×10^5 m/s

(C) 1.5×10^8 m/s

(D) 9×10^{16} m/s

Q34. The process of recovering the original message signal from the received modulated carrier wave at the receiver is called

(A) Modulation

(B) Demodulation

(C) Transmission

(D) Attenuation

Q35. In a photoelectric experiment, the maximum kinetic energy of the emitted electrons is 1.5 eV. The stopping potential required to halt these electrons is

(A) 3 V

(B) 0.75 V

(C) 1.5 V

(D) 1.5×10^{-19} V

Q36. An electron is accelerated through a potential difference of V volts. The de Broglie wavelength associated with it is given by $\lambda = \dfrac{12.27}{\sqrt{V}}$ Å. For $V = 100$ V, the wavelength is

(A) 12.27 Å

(B) 0.122 Å

(C) 122.7 Å

(D) 1.227 Å

Q37. In the Bohr model of the hydrogen atom, the radius of the nth orbit is proportional to n^2. If the radius of the first orbit is 0.53 Å, the radius of the third orbit is

(A) 4.77 Å

(B) 1.59 Å

(C) 0.53 Å

(D) 9.0 Å

Q38. The mass defect in the formation of a certain nucleus is 0.05 u. The binding energy of the nucleus is (take $1\ \text{u} = 931\ \text{MeV}/c^2$)

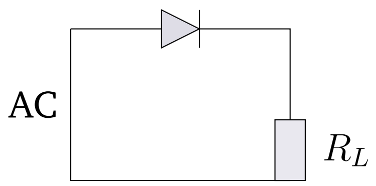
(A) 93.1 MeV

(B) 46.55 MeV

(C) 931 MeV

(D) 18.62 MeV

Q39. In the circuit shown, a single diode is used with an AC input. During one full cycle of the input, the output appears across the load only during



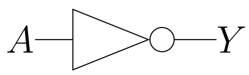
(A) both half-cycles

(B) neither half-cycle

(C) the negative half-cycle only

(D) one half-cycle only

Q40. The logic gate that has a single input and gives an output which is the complement of the input ($Y = \overline{A}$) is



(A) AND gate

(B) OR gate

(C) NOT gate

(D) NAND gate

Detailed Solutions

Q1.

Solution

Concept — Principle of homogeneity: Every term added or equated in a physical equation must have the same dimensions.

Step 1 — Term a: Since $v = a + b/t$, the constant a must have the dimension of velocity, $[a] = LT^{-1}$.

Step 2 — Term b: b/t must also be a velocity, so $[b] = [v][t] = (LT^{-1})(T) = L$, the dimension of length.

Why other options are wrong: Options swapping the two or assigning acceleration/time break homogeneity of one of the terms.

Final Answer: a is velocity and b is length $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q1

Q2.

Solution

Concept — Acceleration from a v–t graph: Acceleration equals the slope of the velocity–time line.

Step 1 — Read the segment: From $t = 2$ s to $t = 6$ s the velocity rises from 10 m/s to 30 m/s.

Step 2 — Slope: $a = \dfrac{30-10}{6-2} = \dfrac{20}{4} = 5\ \text{m/s}^2$.

Why other options are wrong: 2.5 doubles the time interval; 10 and 20 misread the velocity change.

Final Answer: $a = 5\ \text{m/s}^2 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q2

Q3.

Solution

Concept — Range of a projectile: $R = \dfrac{u^2 \sin 2\theta}{g}$.

Step 1 — Substitute: $R = \dfrac{(20)^2 \sin 60^\circ}{10} = \dfrac{400 \times (\sqrt{3}/2)}{10}$.

Step 2 — Compute: $R = \frac{200\sqrt{3}}{10} = 20\sqrt{3}$ m.

Why other options are wrong: $40\sqrt{3}$ and 40 use a wrong $\sin 2\theta$; 20 drops the $\sqrt{3}$ factor.

Final Answer: $R = 20\sqrt{3}$ m $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q3

Q4.

Solution

Concept — Block on a smooth incline: The normal reaction balances the perpendicular component of gravity, $N = mg\cos\theta$.

Step 1 — Substitute: $N = 4 \times 10 \times \cos 37° = 40 \times 0.8$.

Step 2 — Compute: $N = 32$ N.

Why other options are wrong: 40 N is full weight ($\theta = 0$); 24 N uses $\sin 37°$; 20 N has no consistent basis.

Final Answer: $N = 32$ N $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Atwood machine: $a = \frac{(m_1 - m_2)g}{m_1 + m_2}$.

Step 1 — Substitute: $a = \frac{(3-2) \times 10}{3+2} = \frac{10}{5}$.

Step 2 — Compute: $a = 2\ \text{m/s}^2$.

Why other options are wrong: 1 halves the net force wrongly; 2.5 and 5 use a wrong total mass.

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

Answer: (B) Go Back to Q5

Q6.

Solution

Concept — Work as a dot product: $W = \vec{F} \cdot \vec{d} = F_x d_x + F_y d_y + F_z d_z$.

Step 1 — Multiply components: $W = (5)(2) + (2)(-1) + (-1)(3) = 10 - 2 - 3$.

Step 2 — Add: $W = 5$ J.

Why other options are wrong: 9, 11, 13 result from dropping or mis-signing one of the three component products.

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

Answer: (A) Go Back to Q6

Q7.

Solution

Concept — Conservation of mechanical energy: The kinetic energy at the ground equals the loss in potential energy, $KE = mgh$.

Step 1 — Substitute: $KE = 2 \times 10 \times 20$.

Step 2 — Compute: $KE = 400$ J.

Why other options are wrong: 40 drops a factor of h; 200 uses half; 800 doubles the height.

Final Answer: $KE = 400$ J $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q7

Q8.

Solution

Concept — Moment of inertia of a ring about a diameter: For a thin ring, $I_{diameter} = \frac{1}{2}MR^2$.

Step 1 — Perpendicular-axis theorem: About the central axis $I_z = MR^2$; for a planar ring $I_x = I_y$ and $I_x + I_y = I_z$.

Step 2 — Solve: $2I_x = MR^2 \Rightarrow I_x = \frac{1}{2}MR^2$.

Why other options are wrong: MR^2 is about the central perpendicular axis; $\frac{1}{4}MR^2$ is a disc about a diameter; $\frac{2}{3}MR^2$ has no basis here.

Final Answer: $I = \frac{1}{2}MR^2 \Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q8

Q9.

Solution

Concept — Torque of a tangential force: $\tau = F \times R$ when the force acts tangentially at the rim.

Step 1 — Substitute: $\tau = 20 \times 0.25$.

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

Why other options are wrong: 80 divides by R; 10 doubles; 0.5 misplaces the decimal.

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

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Orbital speed: $v = \sqrt{\dfrac{GM}{r}}$, so $v \propto \dfrac{1}{\sqrt{r}}$.

Step 1 — Radius ratio: Increasing r to $4r$ divides the speed by $\sqrt{4} = 2$.

Step 2 — New speed: $v' = \dfrac{v}{2}$.

Why other options are wrong: $2v$ and $4v$ would mean speed increases; $v/4$ uses $1/r$ instead of $1/\sqrt{r}$.

Final Answer: $v' = v/2 \Rightarrow \boxed{\mathrm{B}}$

Answer: (B) Go Back to Q10

Q11.

Solution

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

Step 1 — Substitute SI values: $F = 200\ \mathrm{N}$, $L = 4\ \mathrm{m}$, $A = 2\times10^{-6}\ \mathrm{m}^2$, $Y = 2\times10^{11}$.

Step 2 — Compute: $\Delta L = \dfrac{200 \times 4}{2 \times 10^{-6} \times 2 \times 10^{11}} = \dfrac{800}{4 \times 10^{5}} = 2 \times 10^{-3}\ \mathrm{m} = 2\ \mathrm{mm}$.

Why other options are wrong: 1 mm halves; 4 mm doubles; 0.5 mm divides by an extra factor.

Final Answer: $\Delta L = 2$ mm $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Equation of continuity: $A_1 v_1 = A_2 v_2$ for an incompressible fluid.

Step 1 — Substitute: $6 \times 3 = 2 \times v_2$.

Step 2 — Solve: $v_2 = \frac{18}{2} = 9$ m/s.

Why other options are wrong: 1 m/s inverts the ratio; 6 uses the wrong factor; 3 assumes no change in speed.

Final Answer: $v_2 = 9$ m/s $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — First law of thermodynamics: $Q = \Delta U + W$, where W is the work done *by* the gas.

Step 1 — Rearrange: $W = Q - \Delta U$.

Step 2 — Substitute: $W = 300 - 120 = 180$ J.

Why other options are wrong: 420 adds instead of subtracting; 120 and 300 confuse the heat and internal-energy terms.

Final Answer: $W = 180$ J $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Isothermal process: Temperature is constant, and for an ideal gas the internal energy depends only on temperature, so $\Delta U = 0$.

Step 1 — Apply the first law: With $\Delta U = 0$, $Q = W$; the gas absorbs heat and does an equal amount of work.

Why other options are wrong: Heat absorbed, work done, and volume all change in an isothermal expansion; only ΔU stays zero.

Final Answer: Change in internal energy is zero $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — RMS speed and molar mass: At the same temperature $v_{rms} \propto \frac{1}{\sqrt{M}}$.

Step 1 — Take the ratio: $\frac{v_{H_2}}{v_{O_2}} = \sqrt{\frac{M_{O_2}}{M_{H_2}}} = \sqrt{\frac{32}{2}}$.

Step 2 — Compute: $= \sqrt{16} = 4$, so the ratio is $4 : 1$.

Why other options are wrong: $1 : 4$ inverts it; $16 : 1$ and $1 : 16$ forget the square root.

Final Answer: $v_{H_2} : v_{O_2} = 4 : 1 \Rightarrow \boxed{C}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Carnot efficiency: $\eta = 1 - \frac{T_{sink}}{T_{source}}$ with temperatures in kelvin.

Step 1 — Substitute: $\eta = 1 - \frac{400}{500} = 1 - 0.8 = 0.2$.

Step 2 — As a percentage: $\eta = 20\%$.

Why other options are wrong: 80% uses the wrong ratio; 25% and 44% use wrong temperatures.

Final Answer: $\eta = 20\% \Rightarrow \boxed{D}$

Answer: (D) 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; 20 uses ω alone; 4 uses $A\omega^2$.

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

Answer: (A) Go Back to Q17

Q18.

Solution

Concept — Spring–mass period: $T = 2\pi\sqrt{\frac{m}{k}}$.

Step 1 — Substitute: $T = 2\pi\sqrt{\frac{0.5}{200}} = 2\pi\sqrt{2.5 \times 10^{-3}}$.

Step 2 — Compute: $\sqrt{2.5 \times 10^{-3}} = 0.05$, so $T = 2\pi(0.05) = \frac{\pi}{10}$ s.

Why other options are wrong: $\pi/5$ and $2\pi/5$ mis-evaluate the square root; $\pi/20$ halves the result.

Final Answer: $T = \frac{\pi}{10}$ s $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — Beat frequency: The number of beats per second equals the difference of the two frequencies, $f_b = |f_1 - f_2|$.

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

Step 2 — Compute: $f_b = 4$ beats per second.

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

Final Answer: 4 beats per second $\Rightarrow \boxed{\text{C}}$

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

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 and 0.3 mishandle the r^2 factor; 3.6 drops the r^2 denominator.

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

Answer: (D) Go Back to Q20

Q21.

Solution

Concept — Superposition of fields: At the midpoint, the two equal positive charges produce fields of equal magnitude but opposite direction.

Step 1 — Compare: Each field points away from its own charge, i.e. toward the centre from opposite sides, so they are anti-parallel and equal.

Step 2 — Resultant: The two fields cancel, giving net field $= 0$.

Why other options are wrong: The non-zero values ignore the cancellation by symmetry.

Final Answer: Net field $= 0 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q21

Q22.

Solution

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

Step 1 — Substitute: $\dfrac{1}{C_{eq}} = \dfrac{1}{2} + \dfrac{1}{3} + \dfrac{1}{6} = \dfrac{3+2+1}{6} = 1$.

Step 2 — Solve: $C_{eq} = 1\ \mu$F.

Why other options are wrong: 11 adds them (parallel); 3 and 2 stop at a partial sum.

Final Answer: $C_{eq} = 1\ \mu\text{F} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q22

Q23.

Solution

Concept — Potential energy of two charges: $U = \dfrac{1}{4\pi\varepsilon_0}\dfrac{q_1 q_2}{r}$.

Step 1 — Substitute: $U = \dfrac{9\times10^9\times(2\times10^{-6})(-3\times10^{-6})}{0.6}$.

Step 2 — Compute: $U = \dfrac{9\times10^9\times(-6\times10^{-12})}{0.6} = \dfrac{-0.054}{0.6} = -0.09$ J.

Why other options are wrong: The sign is negative for opposite charges; 0.18 and 0.045 misplace the distance factor.

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

Answer: (A) Go Back to Q23

Q24.

Solution

Concept — Two resistors in parallel: Two equal resistors of $6\ \Omega$ in parallel give half their value.

Step 1 — Parallel combination: $\dfrac{1}{R_{eq}} = \dfrac{1}{6} + \dfrac{1}{6} = \dfrac{2}{6}$.

Step 2 — Solve: $R_{eq} = 3\ \Omega$.

Why other options are wrong: 12 adds them in series; 6 keeps one resistor; 9 has no basis.

Final Answer: $R_{eq} = 3\ \Omega \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q24

Q25.

Solution

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

Step 1 — Substitute: $V = 6 - (4)(0.5)$.

Step 2 — Compute: $V = 6 - 2 = 4$ V.

Why other options are wrong: 6 ignores the internal drop; 2 is the drop itself; 8 adds instead of subtracting.

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

Answer: (B) Go Back to Q25

Q26.

Solution

Concept — Joule heating: $H = I^2Rt$.

Step 1 — Substitute: $H = (5)^2 \times 20 \times 120$ (with $t = 2$ min $= 120$ s).

Step 2 — Compute: $H = 25 \times 20 \times 120 = 60000$ J $= 60$ kJ.

Why other options are wrong: 500 and 1000 J forget the time in seconds; 30 kJ halves the time.

Final Answer: $H = 60\text{ kJ} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q26

Q27.

Solution

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

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

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

Why other options are wrong: 2.5×10^{-6} and 4×10^{-6} misplace factors; 1×10^{-7} slips a power 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: $B = \mu_0 n I$, where n is turns per metre.

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

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

Why other options are wrong: $2\pi \times 10^{-4}$ and $4\pi \times 10^{-4}$ drop a factor; $\pi \times 10^{-3}$ mis-multiplies.

Final Answer: $B = 8\pi \times 10^{-4}$ 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: $F = 0.4 \times 6 \times 0.5$.

Step 2 — Compute: $F = 1.2$ N.

Why other options are wrong: 2.4 doubles; 0.6 halves; 4.8 uses a wrong length.

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

Answer: (B) **Go Back to Q29**

Q30.

Solution

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

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

Step 2 — Compute: $m = 100 \times \pi \times 0.01 = \pi$ A m^2.

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

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

Answer: (A) **Go Back to Q30**

Q31.

Solution

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

Step 1 — Flux change: $\Delta\Phi = 0.04 - 0.01 = 0.03$ Wb.

Step 2 — Compute: $|\varepsilon| = 200 \times \dfrac{0.03}{0.1} = 200 \times 0.3 = 60$ V.

Why other options are wrong: 6 V drops the turns factor; 0.3 V drops it twice; 30 V halves the flux change.

Final Answer: $|\varepsilon| = 60$ V $\Rightarrow \boxed{\text{C}}$

Answer: (C) 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: 0.5 drops ω; 200 divides instead of multiplies; 100 ignores L.

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

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Speed of EM waves in vacuum: All electromagnetic waves travel at $c = \dfrac{1}{\sqrt{\mu_0\varepsilon_0}} = 3 \times 10^8$ m/s in free space.

Step 1 — Recall the constant: This speed is independent of frequency or wavelength.

Why other options are wrong: 3×10^5 is in km/s; 1.5×10^8 is half; 9×10^{16} is c^2.

Final Answer: $c = 3 \times 10^8$ m/s $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q33

Q34.

Solution

Concept — Demodulation: At the receiver, the message signal is extracted from the modulated carrier; this reverse of modulation is called demodulation.

Step 1 — Identify the stage: Modulation happens at the transmitter; recovery of the message at the receiver is demodulation.

Why other options are wrong: Modulation is the opposite process; transmission and attenuation describe sending and weakening of signals, not recovery.

Final Answer: The process is demodulation $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q34

Q35.

Solution

Concept — Stopping potential: $eV_0 = KE_{max}$, so $V_0 = \dfrac{KE_{max}}{e}$. In electron-volts this is numerically equal to the energy in eV.

Step 1 — Apply: $KE_{max} = 1.5$ eV corresponds to $V_0 = 1.5$ V.

Why other options are wrong: 3 V doubles; 0.75 V halves; 1.5×10^{-19} V wrongly divides the energy in joules by e twice.

Final Answer: $V_0 = 1.5$ V $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q35

Q36.

Solution

Concept — de Broglie wavelength of an accelerated electron: $\lambda = \dfrac{12.27}{\sqrt{V}}$ Å.

Step 1 — Substitute: $\lambda = \dfrac{12.27}{\sqrt{100}} = \dfrac{12.27}{10}$.

Step 2 — Compute: $\lambda = 1.227$ Å.

Why other options are wrong: 12.27 uses $\sqrt{V} = 1$; 0.122 and 122.7 slip a power of ten.

Final Answer: $\lambda = 1.227$ Å $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q36

Q37.

Solution

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

Step 1 — Put $n = 3$**:** $r_3 = 3^2 \times r_1 = 9 \times 0.53$ Å.

Step 2 — Compute: $r_3 = 4.77$ Å.

Why other options are wrong: 1.59 uses n instead of n^2; 0.53 ignores the orbit number; 9.0 multiplies the wrong base.

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

Answer: (A) Go Back to Q37

Q38.

Solution

Concept — Mass–energy equivalence: Binding energy $= \Delta m \times 931$ MeV when Δm is in atomic mass units.

Step 1 — Substitute: $E_B = 0.05 \times 931$.

Step 2 — Compute: $E_B = 46.55$ MeV.

Why other options are wrong: 93.1 doubles the mass defect; 931 uses $\Delta m = 1$; 18.62 uses a wrong factor.

Final Answer: $E_B = 46.55$ MeV $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) 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 — Conduction: During the half-cycle that forward-biases the diode, current flows and an output appears across R_L; during the other half the diode blocks current.

Why other options are wrong: "Both half-cycles" describes a full-wave rectifier; "neither" is wrong since the diode does conduct; specifying the negative half alone depends on diode orientation, but in general it conducts for exactly one half-cycle.

Final Answer: Output appears for one half-cycle only $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q39

Q40.

Solution

Concept — NOT gate (inverter): A NOT gate has a single input and produces the logical complement, $Y = \overline{A}$.

Step 1 — Match the rule: "Single input, output is the complement of the input" is precisely the inverter (NOT) function.

Why other options are wrong: AND, OR, and NAND each require two inputs and do not simply invert a single input.

Final Answer: The gate is a NOT gate $\Rightarrow \boxed{\text{C}}$

Answer: (C) 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	B
6	A	7	D	8	C	9	A	10	B
11	C	12	D	13	A	14	B	15	C
16	D	17	A	18	B	19	C	20	D
21	B	22	C	23	A	24	D	25	B
26	A	27	C	28	D	29	B	30	A
31	C	32	D	33	A	34	B	35	C
36	D	37	A	38	B	39	D	40	C