SAAT Physics

Sample Paper – 2

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 Planck's constant h (where $E = h\nu$) is

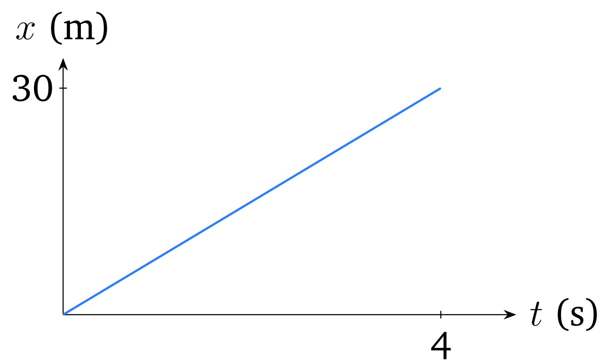
(A) ML^2T^{-3}

(B) ML^2T^{-1}

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

(D) MLT^{-1}

Q2. The position–time graph of a particle moving along a straight line is shown. The velocity of the particle during the motion is



(A) 7.5 m/s

(B) 6 m/s

(C) 30 m/s

(D) 4 m/s

Q3. A projectile is fired with a speed of $20\ \mathrm{m/s}$ at an angle of $45°$ to the horizontal. Its horizontal range is $(g = 10\ \mathrm{m/s^2})$

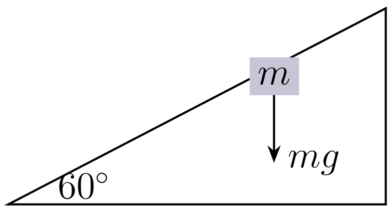
(A) 20 m

(B) 80 m

(C) 40 m

(D) 10 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 surface on the block is $(g = 10\ \mathrm{m/s^2})$



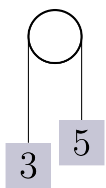
(A) 40 N

(B) 35 N

(C) 34.6 N

(D) 20 N

Q5. Two masses 3 kg and 5 kg are connected by a light inextensible string over a frictionless pulley, as shown. The acceleration of the system is $(g = 10\ \mathrm{m/s^2})$



(A) 1.5 m/s^2

(B) 2.5 m/s^2

(C) 5 m/s^2

(D) 2 m/s^2

Q6. A force $\vec{F} = (5\hat{i} + 2\hat{j})$ N acts on a body and displaces it through $\vec{d} = (4\hat{i} - 3\hat{j})$ m. The work done by the force is

(A) 14 J

(B) 26 J

(C) 20 J

(D) 6 J

Q7. A body of mass 2 kg is dropped from a height of 5 m. Using energy conservation, its speed just before it strikes the ground is $(g = 10 \text{ m/s}^2)$

(A) 5 m/s

(B) 100 m/s

(C) 10 m/s

(D) 50 m/s

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

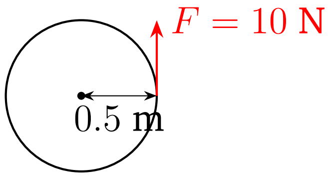
(A) $\frac{1}{2}MR^2$

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

(C) MR^2

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

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 in a circular orbit close to the Earth's surface ($R = 6.4 \times 10^6$ m, $g = 9.8$ m/s^2) is approximately

(A) 11.2 km/s

(B) 7.9 km/s

(C) 5.6 km/s

(D) 3.1 km/s

Q11. A wire of length 4 m and cross-sectional area 2 mm^2 is stretched by 2 mm under a load of 200 N. The Young's modulus of the material is

(A) 4×10^{11} N/m^2

(B) 1×10^{11} N/m^2

(C) 2×10^{11} N/m^2

(D) 5×10^{10} N/m^2

Q12. Water flows through a horizontal pipe whose cross-sectional area decreases from 6 cm^2 to 2 cm^2. If the speed in the wider section is 1.5 m/s, the speed in the narrower section is

(A) 0.5 m/s

(B) 3 m/s

(C) 6 m/s

(D) 4.5 m/s

Q13. A gas is supplied with 500 J of heat, and its internal energy increases by 300 J. The work done by the gas on its surroundings is

(A) 200 J

(B) 800 J

(C) 300 J

(D) 500 J

Q14. In an isothermal process carried out on an ideal gas, which one of the following quantities is always zero?

(A) Heat absorbed by the gas

(B) Change in internal energy

(C) Work done by the gas

(D) Pressure of the gas

Q15. The average translational kinetic energy of a molecule of an ideal gas at a temperature of 300 K is ($k_B = 1.38 \times 10^{-23}$ J/K)

(A) 4.14×10^{-21} J

(B) 2.07×10^{-21} J

(C) 1.38×10^{-21} J

(D) 6.21×10^{-21} J

Q16. A refrigerator extracts 200 J of heat from its interior while the compressor does 50 J of work in each cycle. The coefficient of performance of the refrigerator is

(A) 0.25

(B) 5

(C) 4

(D) 2

Q17. A particle executes SHM with amplitude 0.05 m and angular frequency 4 rad/s. Its maximum speed is

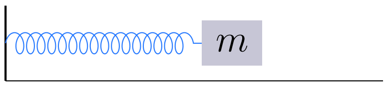
(A) 0.2 m/s

(B) 0.05 m/s

(C) 0.8 m/s

(D) 0.4 m/s

Q18. A mass of 0.5 kg attached to a spring of force constant $200\ \mathrm{N/m}$ oscillates on a smooth horizontal surface, as shown. Its time period is



(A) $\frac{\pi}{20}$ s

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

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

(D) π s

Q19. A string of linear mass density $0.01\ \mathrm{kg/m}$ is held under a tension of 400 N. The speed of a transverse wave on the string is

(A) 100 m/s

(B) 400 m/s

(C) 200 m/s

(D) 50 m/s

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 $\left(\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ \mathrm{N\,m^2/C^2}\right.$

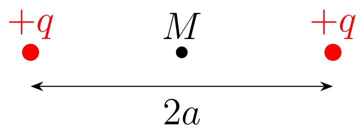
(A) 0.6 N

(B) 1.8 N

(C) 0.36 N

(D) 1.2 N

Q21. Two equal positive point charges $+q$ are placed at points A and B separated by a distance $2a$, as shown. The electric field at the midpoint M of the line joining them is



(A) $\dfrac{kq}{a^2}$

(B) zero

(C) $\dfrac{2kq}{a^2}$

(D) $\dfrac{kq}{2a^2}$

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) $1\ \mu$F

(B) $11\ \mu$F

(C) $6\ \mu$F

(D) $3\ \mu$F

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

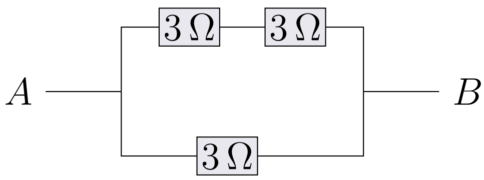
(A) $+0.09$ J

(B) $+0.18$ J

(C) -0.18 J

(D) -0.09 J

Q24. In the network shown, each resistor has a resistance of $3\ \Omega$. The equivalent resistance between points A and B is



(A) $9\ \Omega$

(B) $3\ \Omega$

(C) $2\ \Omega$

(D) $6\ \Omega$

Q25. A cell of emf 6 V and internal resistance $0.5\ \Omega$ supplies 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. A heating coil of resistance $20\ \Omega$ carries a current of 5 A for 2 minutes. The heat produced in the coil is

(A) $30{,}000$ J

(B) $60{,}000$ J

(C) $1{,}000$ J

(D) 500 J

Q27. A wire of resistivity ρ has length L and area of cross-section A, giving resistance R. If the wire is stretched so that its length doubles (volume constant), its new resistance becomes

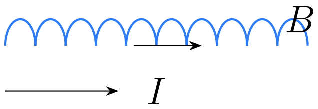
(A) $2R$

(B) $R/2$

(C) $4R$

(D) $R/4$

Q28. A long solenoid has 2000 turns per metre and carries a current of 3 A. The magnetic field at its centre is $(\mu_0 = 4\pi \times 10^{-7}\ \mathrm{T\,m/A})$



(A) 1.5×10^{-3} T

(B) 6×10^{-3} T

(C) 3×10^{-3} T

(D) 7.54×10^{-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. The force on the conductor is

(A) 0.4 N

(B) 0.8 N

(C) 0.2 N

(D) 1.6 N

Q30. A circular coil of 50 turns and area $4 \times 10^{-2}\ \mathrm{m}^2$ carries a current of 3 A. It is placed in a uniform magnetic field of 0.5 T with its plane parallel to the field. The torque on the coil is

(A) $1.5\ \mathrm{N\,m}$

(B) $3\ \mathrm{N\,m}$

(C) $6\ \mathrm{N\,m}$

(D) $0.3\ \mathrm{N\,m}$

Q31. The magnetic flux linked with a coil of 200 turns changes uniformly from 0.04 Wb to 0.01 Wb in 0.3 s. The magnitude of the induced emf is

(A) 40 V

(B) 10 V

(C) 20 V

(D) 60 V

Q32. An inductor of inductance 0.5 H is connected to an AC source of frequency $50/\pi$ Hz. The inductive reactance is

(A) $25\ \Omega$

(B) $100\ \Omega$

(C) $157\ \Omega$

(D) $50\ \Omega$

Q33. In a plane electromagnetic wave travelling through vacuum, the directions of the electric field $\vec{E}$, the magnetic field $\vec{B}$, and the direction of propagation are

(A) mutually perpendicular to one another

(B) all parallel to one another

(C) $\vec{E}$ and $\vec{B}$ parallel, both perpendicular to propagation

(D) $\vec{E}$ along the direction of propagation

Q34. The process of retrieving the original low-frequency message signal from a modulated carrier wave at the receiver is called

(A) Modulation

(B) Demodulation

(C) Transmission

(D) Attenuation

Q35. The work function of a metal is 3.2×10^{-19} J. The threshold frequency of light required to eject photoelectrons from it is $(h = 6.4 \times 10^{-34}\ \mathrm{J\,s})$

(A) 2×10^{14} Hz

(B) 1×10^{15} Hz

(C) 5×10^{14} Hz

(D) 8×10^{14} Hz

Q36. An electron is accelerated through a potential difference of 100 V. Its de Broglie wavelength is approximately $\left(\lambda = \frac{12.27}{\sqrt{V}}\ \text{Å}\right)$

(A) 12.27 Å

(B) 0.123 Å

(C) 1.0 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 $(n = 1)$ 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. In a nuclear reaction the total mass defect is 0.05 u. The energy released is approximately $(1\ \mathrm{u} \approx 931\ \mathrm{MeV})$

(A) 9.31 MeV

(B) 18.62 MeV

(C) 46.55 MeV

(D) 93.1 MeV

Q39. When a p–n junction diode is reverse biased, the width of the depletion region and the resistance of the junction respectively

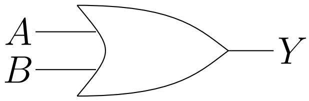
(A) increase and increase

(B) decrease and decrease

(C) increase and decrease

(D) decrease and increase

Q40. The logic gate whose output Y is 1 when at least one of the inputs A or B is 1, represented by $Y = A + B$, is



(A) AND gate

(B) NAND gate

(C) NOT gate

(D) OR gate

Detailed Solutions

Q1.

Solution

Concept — Dimensional formula of Planck's constant: From $E = h\nu$, $h = E/\nu$, where E is energy and ν is frequency.

Step 1 — Dimensions: $[E] = ML^2T^{-2}$ and $[\nu] = T^{-1}$.

Step 2 — Divide: $[h] = \frac{ML^2T^{-2}}{T^{-1}} = ML^2T^{-1}$.

Why other options are wrong: ML^2T^{-2} is energy/torque; MLT^{-1} is linear momentum. Planck's constant has the dimensions of angular momentum, ML^2T^{-1}.

Final Answer: $[h] = ML^2T^{-1} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept — Slope of an x–t graph: The velocity equals the slope of the position–time graph, $v = \Delta x/\Delta t$.

Step 1 — Read the endpoints: The line goes from $(0, 0)$ to $(4\ \text{s}, 30\ \text{m})$.

Step 2 — Compute the slope: $v = \frac{30}{4} = 7.5\ \text{m/s}$.

Why other options are wrong: 30 m/s reads off the final position; 6 and 4 m/s use a wrong time interval.

Final Answer: $v = 7.5\ \text{m/s} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q2

Q3.

Solution

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

Step 1 — Substitute: $u = 20\ \text{m/s}$, $\theta = 45°$, so $\sin 90° = 1$.

Step 2 — Compute: $R = \frac{(20)^2(1)}{10} = \frac{400}{10} = 40\ \text{m}$.

Why other options are wrong: 80 m uses $u^2/5$; 20 m halves the result; 10 m drops a factor.

Final Answer: $R = 40$ m $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q3

Q4.

Solution

Concept — Normal reaction on an incline: On a smooth incline of angle θ, the normal reaction balances the perpendicular component of gravity, $N = mg\cos\theta$.

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

Step 2 — Compute: $N = 20$ N.

Why other options are wrong: 40 N ignores the angle; 34.6 N uses $\cos 30°$; 35 N has no basis.

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

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Atwood machine: For two masses over a frictionless pulley, $a = \dfrac{(m_2 - m_1)g}{m_1 + m_2}$.

Step 1 — Substitute: $a = \dfrac{(5-3)(10)}{5+3} = \dfrac{20}{8}$.

Step 2 — Compute: $a = 2.5$ m/s^2.

Why other options are wrong: 5 uses only the mass difference; 2 and 1.5 use a wrong total mass.

Final Answer: $a = 2.5$ m/s^2 $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q5

Q6.

Solution

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

Step 1 — Multiply components: $W = (5)(4) + (2)(-3) = 20 - 6$.

Step 2 — Add: $W = 14$ J.

Why other options are wrong: 26 J adds the two terms in magnitude; 20 J keeps only the first term; 6 J keeps only the second.

Final Answer: $W = 14$ J $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q6

Q7.

Solution

Concept — Conservation of energy: The loss in potential energy equals the gain in kinetic energy, $mgh = \frac{1}{2}mv^2$, so $v = \sqrt{2gh}$.

Step 1 — Substitute: $v = \sqrt{2(10)(5)} = \sqrt{100}$.

Step 2 — Compute: $v = 10$ m/s.

Why other options are wrong: 100 m/s forgets the square root; 50 m/s and 5 m/s mis-handle the factor of two or g.

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

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — Moment of inertia of a solid sphere: About a diameter through its centre, $I = \frac{2}{5}MR^2$.

Step 1 — Standard result: Integrating over thin spherical shells gives $\frac{2}{5}MR^2$.

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

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

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Torque: For a force applied tangentially at the rim, $\tau = rF$ since the force is perpendicular to the radius.

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

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

Why other options are wrong: 20 and $10\ \mathrm{N\,m}$ use a wrong radius (diameter); $2.5\ \mathrm{N\,m}$ 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: For a low orbit, $v = \sqrt{gR}$.

Step 1 — Substitute: $v = \sqrt{(9.8)(6.4 \times 10^6)} = \sqrt{6.27 \times 10^7}$.

Step 2 — Compute: $v \approx 7.9 \times 10^3$ m/s $= 7.9$ km/s.

Why other options are wrong: 11.2 km/s is the escape speed; 5.6 and 3.1 km/s use wrong factors.

Final Answer: $v \approx 7.9$ km/s $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q10

Q11.

Solution

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

Step 1 — Substitute SI values: $F = 200$ N, $L = 4$ m, $A = 2 \times 10^{-6}$ m^2, $\Delta L = 2 \times 10^{-3}$ m.

Step 2 — Compute: $Y = \dfrac{200 \times 4}{2 \times 10^{-6} \times 2 \times 10^{-3}} = \dfrac{800}{4 \times 10^{-9}} = 2 \times 10^{11}\ \mathrm{N/m^2}$.

Why other options are wrong: 4×10^{11} and 1×10^{11} mis-handle the area–extension product; 5×10^{10} drops a length factor.

Final Answer: $Y = 2 \times 10^{11}\ \mathrm{N/m^2} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Equation of continuity: For an incompressible fluid, $A_1v_1 = A_2v_2$.

Step 1 — Rearrange: $v_2 = \dfrac{A_1v_1}{A_2}$.

Step 2 — Substitute: $v_2 = \dfrac{6 \times 1.5}{2} = \dfrac{9}{2} = 4.5$ m/s.

Why other options are wrong: 0.5 m/s inverts the area ratio; 3 and 6 m/s use a wrong ratio.

Final Answer: $v_2 = 4.5$ m/s $\Rightarrow \boxed{D}$

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: $W = 500 - 300 = 200$ J.

Why other options are wrong: 800 J adds instead of subtracting; 300 and 500 J confuse ΔU and Q with the work.

Final Answer: $W = 200$ J $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Isothermal process: The internal energy of an ideal gas depends only on temperature. At constant temperature $\Delta U = 0$.

Step 1 — Apply the first law: With $\Delta U = 0$, $Q = W$, so heat absorbed equals the work done; neither is zero in general.

Why other options are wrong: Heat, work and pressure all change in an isothermal expansion or compression; only the change in internal energy is zero.

Final Answer: $\Delta U = 0 \Rightarrow \boxed{B}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Average translational kinetic energy: $\overline{KE} = \frac{3}{2}k_B T$ per molecule.

Step 1 — Substitute: $\overline{KE} = \frac{3}{2}(1.38 \times 10^{-23})(300)$.

Step 2 — Compute: $\overline{KE} = \frac{3}{2}(4.14 \times 10^{-21}) = 6.21 \times 10^{-21}$ J.

Why other options are wrong: 4.14×10^{-21} J omits the $3/2$; 2.07×10^{-21} uses $1/2$; 1.38×10^{-21} uses only $k_B T/10$.

Final Answer: $\overline{KE} = 6.21 \times 10^{-21}$ J $\Rightarrow \boxed{D}$

Answer: (D) Go Back to Q15

Q16.

Solution

Concept — Coefficient of performance of a refrigerator: $\text{COP} = \frac{Q_{\text{extracted}}}{W}$.

Step 1 — Substitute: $\text{COP} = \frac{200}{50}$.

Step 2 — Compute: $\text{COP} = 4$.

Why other options are wrong: 0.25 inverts the ratio; 5 uses $(Q+W)/W$ wrongly; 2 halves the answer.

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

Answer: (C) Go Back to Q16

Q17.

Solution

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

Step 1 — Substitute: $v_{max} = (4)(0.05)$.

Step 2 — Compute: $v_{max} = 0.2$ m/s.

Why other options are wrong: 0.05 m/s is the amplitude; 0.8 m/s uses $\omega^2 A$; 0.4 m/s doubles the answer.

Final Answer: $v_{max} = 0.2$ m/s $\Rightarrow$ $\boxed{A}$

Answer: (A) Go Back to Q17

Q18.

Solution

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

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 $T = 2\pi(0.05) = 0.1\pi = \frac{\pi}{10}$ s.

Why other options are wrong: $\frac{\pi}{20}$ s drops a factor of two; $\frac{\pi}{5}$ s doubles it; π s mis-handles the square root.

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

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — Speed of a transverse wave on a string: $v = \sqrt{\frac{T}{\mu}}$, where μ is the linear mass density.

Step 1 — Substitute: $v = \sqrt{\frac{400}{0.01}} = \sqrt{40000}$.

Step 2 — Compute: $v = 200$ m/s.

Why other options are wrong: 100 and 50 m/s mis-handle the square root; 400 m/s forgets it entirely.

Final Answer: $v = 200$ m/s $\Rightarrow$ $\boxed{C}$

Answer: (C) Go Back to Q19

Q20.

Solution

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

Step 1 — Substitute: $F = \frac{9\times10^9\times(3\times10^{-6})(4\times10^{-6})}{(0.3)^2}$.

Step 2 — Compute: $F = \frac{9\times10^9\times12\times10^{-12}}{0.09} = \frac{0.108}{0.09} = 1.2$ N.

Why other options are wrong: 0.36 N forgets to divide by r^2 correctly; 0.6 N and 1.8 N mis-handle the charge product or distance.

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

Answer: (D) Go Back to Q20

Q21.

Solution

Concept — Superposition of fields: The net field is the vector sum of the fields due to each charge.

Step 1 — Fields at the midpoint: Each charge produces a field of magnitude kq/a^2 at M, but the two point in *opposite* directions.

Step 2 — Add vectorially: The equal and opposite contributions cancel, giving zero.

Why other options are wrong: kq/a^2, $2kq/a^2$ and $kq/2a^2$ ignore the cancellation of the two opposing fields at the midpoint.

Final Answer: Net field at M is zero $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q21

Q22.

Solution

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

Step 1 — Add reciprocals: $\frac{1}{C_{eq}} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6} = \frac{3+2+1}{6} = \frac{6}{6} = 1$.

Step 2 — Invert: $C_{eq} = 1\ \mu$F.

Why other options are wrong: $11\ \mu$F adds the values (parallel); 6 and $3\ \mu$F stop part-way.

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

Answer: (A) Go Back to Q22

Q23.

Solution

Concept — Potential energy of two point 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 must be negative for unlike charges, ruling out the positive values; -0.18 J doubles the magnitude.

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

Answer: (D) Go Back to Q23

Q24.

Solution

Concept — Series–parallel reduction: Two $3\ \Omega$ resistors in series form the top branch ($6\ \Omega$); this is in parallel with the single $3\ \Omega$ bottom branch.

Step 1 — Top branch: $3 + 3 = 6\ \Omega$.

Step 2 — Parallel combination: $R_{eq} = \dfrac{6\times3}{6+3} = \dfrac{18}{9} = 2\ \Omega$.

Why other options are wrong: $9\ \Omega$ adds everything in series; 3 and $6\ \Omega$ stop at an intermediate step.

Final Answer: $R_{eq} = 2\ \Omega \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q24

Q25.

Solution

Concept — Terminal voltage: $V = \varepsilon - Ir$, where r is the internal resistance.

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

Step 2 — Compute: $V = 6 - 1 = 5$ V.

Why other options are wrong: 6 V ignores the internal drop; 7 V adds instead of subtracting; 4 V uses a wrong drop.

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

Answer: (A) **Go Back to Q25**

Q26.

Solution

Concept — Joule heating: $H = I^2Rt$.

Step 1 — Substitute: $I = 5$ A, $R = 20\ \Omega$, $t = 2 \times 60 = 120$ s.

Step 2 — Compute: $H = (5)^2(20)(120) = 25 \times 20 \times 120 = 60{,}000$ J.

Why other options are wrong: 30,000 J uses $t = 60$ s; 1,000 J drops the time; 500 J uses I instead of I^2 with a wrong time.

Final Answer: $H = 60{,}000$ J $\Rightarrow \boxed{\text{B}}$

Answer: (B) **Go Back to Q26**

Q27.

Solution

Concept — Stretching a wire at constant volume: When the length doubles, the area halves (volume constant), and $R = \rho L/A$.

Step 1 — Track the change: $L \to 2L$ and $A \to A/2$.

Step 2 — New resistance: $R' = \rho\dfrac{2L}{A/2} = 4\rho\dfrac{L}{A} = 4R$. In general $R \propto L^2$ at constant volume.

Why other options are wrong: $2R$ ignores the area change; $R/2$ and $R/4$ have the dependence inverted.

Final Answer: $R' = 4R \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q27

Q28.

Solution

Concept — Field inside a long solenoid: $B = \mu_0 n I$, where n is turns per metre.

Step 1 — Substitute: $B = (4\pi \times 10^{-7})(2000)(3)$.

Step 2 — Compute: $B = (4\pi \times 10^{-7})(6000) = 24\pi \times 10^{-4} \approx 7.54 \times 10^{-3}$ T.

Why other options are wrong: 6×10^{-3} and 3×10^{-3} drop the factor π or part of n; 1.5×10^{-3} halves the current.

Final Answer: $B \approx 7.54 \times 10^{-3}\ \mathrm{T} \Rightarrow \boxed{\mathrm{D}}$

Answer: (D) Go Back to Q28

Q29.

Solution

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

Step 1 — Substitute: $F = (0.2)(4)(0.5)$.

Step 2 — Compute: $F = 0.4$ N.

Why other options are wrong: 0.8 N doubles the length; 0.2 N drops the length factor; 1.6 N uses a wrong current.

Final Answer: $F = 0.4\ \mathrm{N} \Rightarrow \boxed{\mathrm{A}}$

Answer: (A) Go Back to Q29

Q30.

Solution

Concept — Torque on a current loop: $\tau = NIAB \sin\theta$. When the plane is parallel to B, the normal is perpendicular to it, so $\theta = 90^\circ$ and $\sin\theta = 1$.

Step 1 — Substitute: $\tau = (50)(3)(4 \times 10^{-2})(0.5)$.

Step 2 — Compute: $\tau = 50 \times 3 \times 0.04 \times 0.5 = 3$ N m.

Why other options are wrong: 1.5 N m halves it; 6 N m doubles it; 0.3 N m drops a power of ten.

Final Answer: $\tau = 3\ \mathrm{N\,m} \Rightarrow \boxed{\mathrm{B}}$

Answer: (B) Go Back to Q30

Q31.

Solution

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

Step 1 — Change in flux: $|\Delta\phi| = 0.04 - 0.01 = 0.03$ Wb.

Step 2 — Compute: $|\varepsilon| = 200 \times \dfrac{0.03}{0.3} = 200 \times 0.1 = 20$ V.

Why other options are wrong: 40 V doubles the flux change; 10 V halves the turns; 60 V drops the time factor.

Final Answer: $|\varepsilon| = 20$ V $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q31

Q32.

Solution

Concept — Inductive reactance: $X_L = \omega L = 2\pi f L$.

Step 1 — Substitute: $X_L = 2\pi\left(\dfrac{50}{\pi}\right)(0.5)$.

Step 2 — Compute: $X_L = 2 \times 50 \times 0.5 = 50\ \Omega$.

Why other options are wrong: 25 Ω halves it; 100 Ω doubles it; 157 Ω wrongly keeps a leftover π.

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

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Structure of an EM wave: In a plane electromagnetic wave the electric field, the magnetic field, and the direction of propagation form a mutually perpendicular right-handed set; the wave is transverse.

Step 1 — Apply the rule: $\vec{E} \perp \vec{B}$, and both are perpendicular to the propagation direction $\hat{k}$, with $\vec{E} \times \vec{B}$ along $\hat{k}$.

Why other options are wrong: The fields are not parallel to each other or to the propagation direction, and $\vec{E}$ is never along the direction of travel.

Final Answer: All three are mutually perpendicular $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q33

Q34.

Solution

Concept — Demodulation: Demodulation (detection) is the reverse of modulation; it recovers the original message signal from the modulated carrier at the receiver.

Step 1 — Match the definition: "Retrieving the message from the modulated carrier at the receiver" is precisely demodulation.

Why other options are wrong: Modulation impresses the message on the carrier at the transmitter; transmission and attenuation describe sending and weakening of the signal, not message recovery.

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

Answer: (B) Go Back to Q34

Q35.

Solution

Concept — Threshold frequency: At the threshold, the photon energy equals the work function, $\phi = h\nu_0$, so $\nu_0 = \phi/h$.

Step 1 — Substitute: $\nu_0 = \dfrac{3.2 \times 10^{-19}}{6.4 \times 10^{-34}}$.

Step 2 — Compute: $\nu_0 = 0.5 \times 10^{15} = 5 \times 10^{14}$ Hz.

Why other options are wrong: 1×10^{15} Hz doubles it; 2×10^{14} and 8×10^{14} Hz mis-handle the powers of ten.

Final Answer: $\nu_0 = 5 \times 10^{14}$ Hz $\Rightarrow$ $\boxed{\text{C}}$

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 Å forgets to divide by $\sqrt{V}$; 0.123 Å divides by V; 1.0 Å is only a rough rounding error.

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

Answer: (D) Go Back to Q36

Q37.

Solution

Concept — Radius of Bohr orbits: $r_n = n^2 r_1$, where $r_1 = 0.53$ Å.

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

Step 2 — Compute: $r_3 = 4.77$ Å.

Why other options are wrong: 1.59 Å uses n instead of n^2; 0.53 Å is the first orbit; 9.0 Å forgets to multiply by r_1.

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

Answer: (B) Go Back to Q37

Q38.

Solution

Concept — Mass–energy equivalence: The energy released equals the mass defect converted using $1\ \text{u} \approx 931\ \text{MeV}$.

Step 1 — Substitute: $E = (0.05)(931)$ MeV.

Step 2 — Compute: $E = 46.55$ MeV.

Why other options are wrong: 9.31 MeV uses 0.01 u; 18.62 MeV uses 0.02 u; 93.1 MeV uses 0.1 u.

Final Answer: $E = 46.55$ MeV $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q38

Q39.

Solution

Concept — Reverse-biased p–n junction: Reverse bias adds to the built-in field, so the depletion region widens and very little current flows, meaning a high junction resistance.

Step 1 — Effect of reverse bias: The external field pulls majority carriers away from the junction, increasing the depletion width.

Step 2 — Resistance: With the barrier raised, almost no current flows, so the resistance increases.

Why other options are wrong: Forward bias narrows the depletion region and lowers resistance; the two effects move together (both increase), so the mixed options are wrong.

Final Answer: Width increases and resistance increases $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q39

Q40.

Solution

Concept — Logic gates: The OR gate gives output 1 when *any* input is 1, with $Y = A + B$.

Step 1 — Match the rule: "Output 1 when at least one input is 1" is exactly the OR truth table.

Why other options are wrong: AND gives 1 only when both inputs are 1; NAND is the complement of AND; NOT inverts a single input.

Final Answer: The gate is an OR gate $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q40

Answer Key

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