SAAT Physics

Sample Paper – 7

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 universal gravitational constant G appears in $F = \dfrac{Gm_1m_2}{r^2}$. Its dimensional formula is

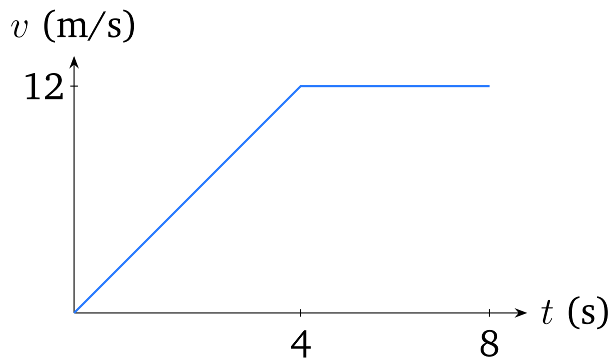
(A) $M^{-1}L^2T^{-2}$

(B) $M^{-1}L^3T^{-2}$

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

(D) $M^{-1}L^3T^{-1}$

Q2. The velocity–time graph of a particle moving in a straight line is shown below. The acceleration of the particle during the first 4 s is



(A) $3\ \text{m/s}^2$

(B) $4\ \text{m/s}^2$

(C) $12\ \text{m/s}^2$

(D) $1.5\ \text{m/s}^2$

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

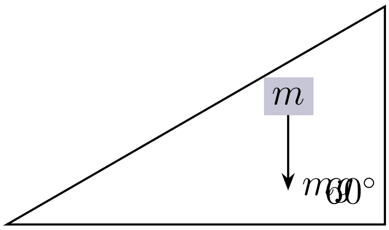
(A) 20 m

(B) 80 m

(C) 30 m

(D) 40 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 $(g = 10\ \text{m/s}^2)$



(A) 40 N

(B) 34.6 N

(C) 20 N

(D) 10 N

Q5. A gun of mass 2 kg fires a bullet of mass 20 g with a muzzle speed of $300\ \text{m/s}$. The recoil speed of the gun is

(A) $3\ \text{m/s}$

(B) $6\ \text{m/s}$

(C) $30\ \text{m/s}$

(D) 0.3 m/s

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

(A) 16 J

(B) 4 J

(C) 10 J

(D) -6 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 $(g = 10 \text{ m/s}^2)$

(A) 200 J

(B) 800 J

(C) 400 J

(D) 40 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

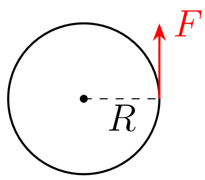
(A) MR^2

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

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

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

Q9. A tangential force of 20 N is applied 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) 2.5 N m

(D) 20 N m

Q10. The orbital speed of a satellite revolving close to the surface of a planet of radius R and surface gravity g is

(A) $\sqrt{2gR}$

(B) $\sqrt{gR}$

(C) gR

(D) $\sqrt{gR/2}$

Q11. A steel wire of length 4 m and cross-sectional area 2 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 of the wire is

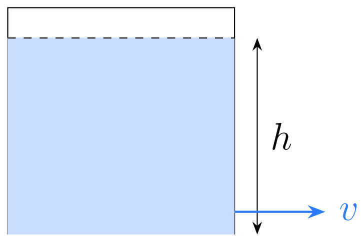
(A) 1 mm

(B) 4 mm

(C) 2 mm

(D) 0.5 mm

Q12. Water stands at a depth of 5 m above a small orifice in the side of a large tank, as shown. The speed of efflux of water through the orifice is $(g = 10 \text{ m/s}^2)$



(A) 5 m/s

(B) 50 m/s

(C) 100 m/s

(D) 10 m/s

Q13. In a process, 500 J of heat is supplied to a gas, and its internal energy increases by 350 J. The work done by the gas is

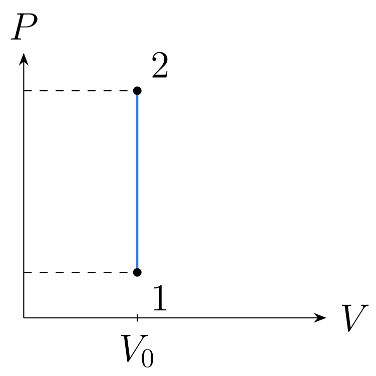
(A) 150 J

(B) 850 J

(C) 350 J

(D) 500 J

Q14. The P–V diagram below shows a thermodynamic process from state 1 to state 2. The process represented by the vertical line is



(A) Isobaric (constant pressure)

(B) Isochoric (constant volume)

(C) Isothermal (constant temperature)

(D) Adiabatic

Q15. For the molecules of an ideal gas at a given temperature, the correct order of the most probable speed v_{mp}, the mean speed $\bar{v}$, and the root-mean-square speed v_{rms} is

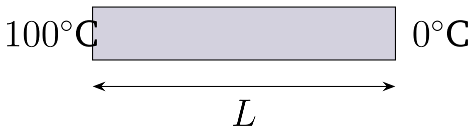
(A) $v_{rms} < \bar{v} < v_{mp}$

(B) $\bar{v} < v_{mp} < v_{rms}$

(C) $v_{mp} < \bar{v} < v_{rms}$

(D) $v_{mp} = \bar{v} = v_{rms}$

Q16. A metal rod of length 0.5 m and uniform cross-sectional area 4×10^{-4} m^2 has its ends maintained at $100°$C and $0°$C, as shown. If the thermal conductivity of the metal is $200\ \text{W}\,\text{m}^{-1}\text{K}^{-1}$, the rate of heat flow through the rod is



(A) 8 W

(B) 40 W

(C) 80 W

(D) 16 W

Q17. A particle executes SHM described by $x = 0.05\sin(10\,t)$ m, where t is in seconds. The maximum speed of the particle is

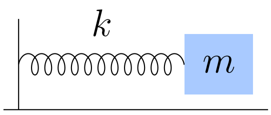
(A) 0.05 m/s

(B) 0.5 m/s

(C) 5 m/s

(D) 10 m/s

Q18. A spring of force constant 200 N/m carries a block of mass 2 kg and oscillates without friction, as shown. The time period of oscillation is (take $\pi^2 \approx 10$)



(A) 0.1π s

(B) π s

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

(D) 2π s

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

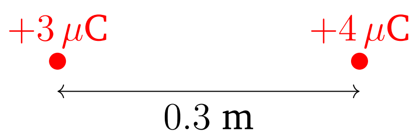
(A) 4

(B) 516

(C) 2

(D) 258

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



(A) 0.36 N

(B) 3.6 N

(C) 0.12 N

(D) 1.2 N

Q21. The electric field at a point 0.3 m from a point charge of $3\ \mu\text{C}$ is $\left(\dfrac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ \text{N}\right.$

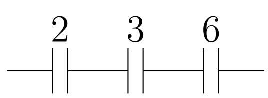
(A) $9 \times 10^4\ \text{N/C}$

(B) $3 \times 10^5\ \text{N/C}$

(C) $2.7 \times 10^5\ \text{N/C}$

(D) $9 \times 10^5\ \text{N/C}$

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



(A) $1\ \mu$F

(B) $11\ \mu$F

(C) $0.5\ \mu$F

(D) $2\ \mu$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 $\left(\dfrac{1}{4\pi\varepsilon_0} = 9 \times 10^9\ \mathrm{N\,m^2/C^2}\right)$

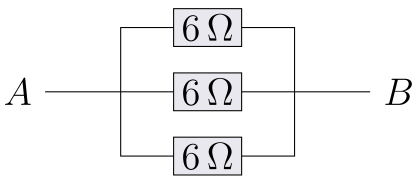
(A) -0.18 J

(B) $+0.09$ J

(C) -0.09 J

(D) $+0.18$ J

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



(A) $18\ \Omega$

(B) $6\ \Omega$

(C) $3\ \Omega$

(D) $2\ \Omega$

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 potential difference across the cell is

(A) 6 V

(B) 5 V

(C) 7 V

(D) 1 V

Q26. A heater of resistance $20\ \Omega$ is connected to a 200 V supply. The heat produced in 10 s is

(A) 2×10^4 J

(B) 2×10^3 J

(C) 1×10^4 J

(D) 4×10^4 J

Q27. A wire of length 2 m and cross-sectional area $0.5\ \text{mm}^2$ has a resistance of $4\ \Omega$. The resistivity of the material of the wire is

(A) $2 \times 10^{-6}\ \Omega\,\text{m}$

(B) $4 \times 10^{-6}\ \Omega\,\text{m}$

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

(D) $8 \times 10^{-6}\ \Omega\,\text{m}$

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

(A) 1.0×10^{-3} T

(B) 6.28×10^{-4} T

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

(D) 2.51×10^{-3} T

Q29. A straight conductor of length 0.5 m carrying a current of 3 A is placed perpendicular to a uniform magnetic field of 0.4 T. The force on the conductor is

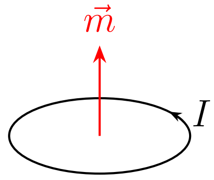
(A) 0.6 N

(B) 1.2 N

(C) 0.3 N

(D) 6 N

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



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

(B) $\pi\ \mathrm{A\,m^2}\ \ (= 3.14)$

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

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

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

(A) 10 V

(B) 40 V

(C) 20 V

(D) 0.1 V

Q32. A capacitor of capacitance $50\ \mu$F is connected to an AC source of angular frequency $200\ \mathrm{rad/s}$. The capacitive reactance is

(A) $50\ \Omega$

(B) $200\ \Omega$

(C) $25\ \Omega$

(D) $100\ \Omega$

Q33. An electromagnetic wave in vacuum has a frequency of 6×10^{14} Hz. Its wavelength is $(c = 3 \times 10^{8}\ \mathrm{m/s})$

(A) 5×10^{-7} m

(B) 2×10^{-7} m

(C) 5×10^{-6} m

(D) 1.8×10^{23} m

Q34. A carrier wave of frequency 1000 kHz is amplitude-modulated by a message signal of frequency 5 kHz. The frequencies of the upper and lower sidebands are

(A) 1000 kHz and 5 kHz

(B) 1005 kHz and 995 kHz

(C) 2000 kHz and 10 kHz

(D) 1010 kHz and 990 kHz

Q35. The threshold wavelength for a metal is 600 nm. The work function of the metal is $(hc = 1240 \text{ eV nm})$

(A) 1.0 eV

(B) 3.1 eV

(C) 2.5 eV

(D) 2.07 eV

Q36. If the speed of an electron is doubled, its de Broglie wavelength becomes

(A) doubled

(B) four times

(C) halved

(D) unchanged

Q37. In a hydrogen atom, an electron makes a transition from $n = 3$ to $n = 2$. The energy of the emitted photon is $(E_n = -13.6/n^2 \text{ eV})$

(A) 1.89 eV

(B) 3.4 eV

(C) 1.51 eV

(D) 12.09 eV

Q38. The mass defect of a nucleus is 0.05 u. The binding energy of the nucleus is $(1 \text{ u} = 931 \text{ MeV})$

(A) 9.31 MeV

(B) 46.55 MeV

(C) 93.1 MeV

(D) 18.62 MeV

Q39. A photodiode used to detect optical signals is always operated in

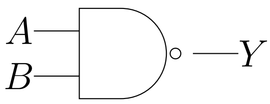
(A) forward bias, where current increases with light

(B) zero bias only

(C) reverse bias, where the reverse current depends on illumination

(D) breakdown region to regulate voltage

Q40. Which one of the following statements about logic gates is correct?



(A) An OR gate alone can generate any other gate.

(B) An AND gate alone is a universal gate.

(C) A NOT gate alone is a universal gate.

(D) A NAND gate alone is a universal gate (any gate can be built from NANDs).

Detailed Solutions

Q1.

Solution

Concept — Dimensions of G: Rearrange $F = \frac{Gm_1m_2}{r^2}$ to isolate $G = \frac{Fr^2}{m_1m_2}$.

Step 1 — Substitute dimensions: $[G] = \frac{[\text{Force}][\text{Length}]^2}{[\text{Mass}]^2} = \frac{(MLT^{-2})(L^2)}{M^2}$.

Step 2 — Simplify: $[G] = \frac{ML^3T^{-2}}{M^2} = M^{-1}L^3T^{-2}$.

Why other options are wrong: $M^{-1}L^2T^{-2}$ drops one power of length; ML^3T^{-2} has the wrong mass power; $M^{-1}L^3T^{-1}$ has the wrong time power.

Final Answer: $[G] = M^{-1}L^3T^{-2} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q1

Q2.

Solution

Concept — Slope of a v–t graph: The acceleration equals the slope of the velocity–time line.

Step 1 — Read the rising segment: Velocity goes from 0 to 12 m/s over the first 4 s.

Step 2 — Compute the slope: $a = \frac{12-0}{4-0} = 3\ \text{m/s}^2$.

Why other options are wrong: 4 uses the wrong time; 12 reports the velocity, not the slope; 1.5 halves the answer.

Final Answer: $a = 3\ \text{m/s}^2 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q2

Q3.

Solution

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

Step 1 — Put $\theta = 45°$: $\sin 2\theta = \sin 90° = 1$, so $R = \frac{u^2}{g}$.

Step 2 — Substitute: $R = \dfrac{(20)^2}{10} = \dfrac{400}{10} = 40$ m.

Why other options are wrong: 20 and 30 have no consistent basis; 80 doubles the range incorrectly.

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

Answer: (D) 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: $N = 4 \times 10 \times \cos 60° = 40 \times 0.5$.

Step 2 — Compute: $N = 20$ N.

Why other options are wrong: 40 N is the full weight mg; 34.6 N uses $\cos 30°$; 10 N has no basis.

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

Answer: (C) Go Back to Q4

Q5.

Solution

Concept — Conservation of momentum: The gun and bullet start at rest, so $m_g v_g = m_b v_b$.

Step 1 — Substitute: $2 \times v_g = 0.02 \times 300$.

Step 2 — Solve: $v_g = \dfrac{6}{2} = 3$ m/s.

Why other options are wrong: 6 forgets to divide by the gun mass; 30 and 0.3 mis-place a power of ten in the bullet mass.

Final Answer: $v_g = 3$ m/s $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) 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: $W = (5)(2) + (2)(-3) = 10 - 6$.

Step 2 — Add: $W = 4$ J.

Why other options are wrong: 16 adds magnitudes wrongly; 10 keeps only the first term; -6 keeps only the second term.

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

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Conservation of energy: For a freely falling body, the kinetic energy at the ground equals the lost potential energy, $KE = mgh$.

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

Step 2 — Compute: $KE = 400$ J.

Why other options are wrong: 200 drops a factor of 2; 800 doubles incorrectly; 40 omits the height.

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

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 the sphere gives $\frac{2}{5}MR^2$.

Why other options are wrong: MR^2 is a ring; $\frac{1}{2}MR^2$ is a disc; $\frac{2}{3}MR^2$ 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 of a tangential force: $\tau = F \times R$ for a force applied tangentially at the rim.

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

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

Why other options are wrong: 80 divides instead of multiplying by R; 2.5 halves the answer; 20 ignores the radius.

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

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Orbital speed near the surface: The gravitational pull provides the centripetal force, $\frac{mv^2}{R} = mg$.

Step 1 — Solve for v: $v^2 = gR$.

Step 2 — Take the root: $v = \sqrt{gR}$.

Why other options are wrong: $\sqrt{2gR}$ is the escape speed; gR has the wrong dimensions; $\sqrt{gR/2}$ has a spurious factor.

Final Answer: $v = \sqrt{gR} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q10

Q11.

Solution

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

Step 1 — Substitute SI values: $F = 200$ N, $L = 4$ m, $A = 2 \times 10^{-6}$ m^2, $Y = 2 \times 10^{11}$ N/m^2.

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

Why other options are wrong: 1 mm and 0.5 mm drop a factor; 4 mm doubles the result.

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

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Torricelli's law of efflux: The speed of liquid escaping through an orifice at depth h is $v = \sqrt{2gh}$.

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

Step 2 — Compute: $v = 10 \text{ m/s}$.

Why other options are wrong: 5 forgets the $2g$ factor; 50 skips the square root; 100 is v^2, not v.

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

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: $W = 500 - 350 = 150 \text{ J}$.

Why other options are wrong: 850 adds instead of subtracting; 350 and 500 report ΔU or Q directly.

Final Answer: $W = 150 \text{ J} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Reading a P–V graph: A vertical line means the volume stays fixed while the pressure changes, which is an isochoric (constant-volume) process.

Step 1 — Identify the constant variable: Both endpoints sit at $V = V_0$, so $\Delta V = 0$.

Why other options are wrong: Isobaric is a horizontal line (constant P); isothermal is a hyperbola $PV = \text{const}$; adiabatic is a steeper curve, not a vertical line.

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

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Speeds of gas molecules: $v_{mp} = \sqrt{\frac{2RT}{M}}$, $\bar{v} = \sqrt{\frac{8RT}{\pi M}}$, $v_{rms} = \sqrt{\frac{3RT}{M}}$.

Step 1 — Compare the coefficients: $\sqrt{2} \approx 1.41$, $\sqrt{8/\pi} \approx 1.60$, $\sqrt{3} \approx 1.73$.

Step 2 — Order them: $v_{mp} < \bar{v} < v_{rms}$.

Why other options are wrong: The reversed orders contradict the coefficients; the speeds are not equal.

Final Answer: $v_{mp} < \bar{v} < v_{rms} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Steady-state conduction: $\frac{Q}{t} = \frac{kA\,\Delta T}{L}$.

Step 1 — Substitute: $\frac{Q}{t} = \frac{200 \times 4 \times 10^{-4} \times 100}{0.5}$.

Step 2 — Compute: $\frac{Q}{t} = \frac{8}{0.5} = 16$ W.

Why other options are wrong: 8 omits the length divisor; 40 and 80 mis-handle the area or length factor.

Final Answer: $\frac{Q}{t} = 16 \text{ W} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Maximum speed in SHM: For $x = A\sin(\omega t)$, the maximum speed is $v_{max} = A\omega$.

Step 1 — Read amplitude and angular frequency: $A = 0.05$ m, $\omega = 10$ rad/s.

Step 2 — Compute: $v_{max} = 0.05 \times 10 = 0.5$ m/s.

Why other options are wrong: 0.05 reports the amplitude; 5 and 10 mis-place a factor of ten.

Final Answer: $v_{max} = 0.5$ m/s $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q17

Q18.

Solution

Concept — Time 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: $T = 2\pi \times 0.1 = 0.2\pi = \dfrac{\pi}{5}$ s.

Why other options are wrong: 0.1π halves the answer; π and 2π mis-handle the square root.

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

Answer: (C) Go Back to Q18

Q19.

Solution

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

Step 1 — Subtract: $f_{beat} = |260 - 256|$.

Step 2 — Compute: $f_{beat} = 4$ Hz, so 4 beats per second.

Why other options are wrong: 516 adds the frequencies; 258 is the average; 2 halves the difference.

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

Answer: (A) 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: 0.36 N forgets to divide by r^2; 3.6 N and 0.12 N mis-place the power of ten.

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

Answer: (D) Go Back to Q20

Q21.

Solution

Concept — Field of a point charge: $E = \dfrac{1}{4\pi\varepsilon_0}\dfrac{Q}{r^2}$.

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

Step 2 — Compute: $E = \dfrac{2.7 \times 10^4}{0.09} = 3 \times 10^5$ N/C.

Why other options are wrong: 9×10^4 uses r instead of r^2; 2.7×10^5 drops the 0.09 divisor; 9×10^5 triples it.

Final Answer: $E = 3 \times 10^5$ N/C $\Rightarrow$ $\boxed{\text{B}}$

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: $C_{eq} = 1\ \mu\text{F}$.

Why other options are wrong: $11\ \mu$F adds them as if in parallel; $0.5\ \mu$F and $2\ \mu$F come from arithmetic slips.

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 charges: $U = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r}$, keeping the signs of the charges.

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

Step 2 — Compute: $U = \frac{-54\times10^{-3}}{0.6} = -0.09$ J.

Why other options are wrong: The positive options ignore the unlike-charge (negative) sign; -0.18 J drops the 0.6 divisor.

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

Answer: (C) Go Back to Q23

Q24.

Solution

Concept — Three equal resistors in parallel: $\frac{1}{R_{eq}} = \frac{3}{R}$, so $R_{eq} = \frac{R}{3}$.

Step 1 — Apply the rule: With $R = 6\ \Omega$, $R_{eq} = \frac{6}{3}$.

Step 2 — Compute: $R_{eq} = 2\ \Omega$.

Why other options are wrong: $18\ \Omega$ adds them in series; $6\ \Omega$ keeps a single resistor; $3\ \Omega$ uses only two in parallel.

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

Answer: (D) Go Back to Q24

Q25.

Solution

Concept — Terminal voltage: $V = \varepsilon - Ir$, the emf less the drop across 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 it; 1 V reports only the drop.

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

Answer: (B) Go Back to Q25

Q26.

Solution

Concept — Joule heating: $H = \dfrac{V^2}{R}t$.

Step 1 — Substitute: $H = \dfrac{(200)^2}{20} \times 10 = \dfrac{40000}{20} \times 10$.

Step 2 — Compute: $H = 2000 \times 10 = 2 \times 10^4$ J.

Why other options are wrong: 2×10^3 omits the time; 1×10^4 halves the power; 4×10^4 doubles it.

Final Answer: $H = 2 \times 10^4$ J $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q26

Q27.

Solution

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

Step 1 — Substitute: $\rho = \dfrac{4 \times 0.5 \times 10^{-6}}{2}$, with $A = 0.5\ \text{mm}^2 = 0.5 \times 10^{-6}\ \text{m}^2$.

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

Why other options are wrong: 2×10^{-6} omits the length divisor; 4×10^{-6} and 8×10^{-6} mis-handle the area.

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 the number of turns per metre.

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

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

Why other options are wrong: 1.0×10^{-3}, 6.28×10^{-4}, and $4\pi \times 10^{-4}$ each drop a factor of the turns or the current.

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

Answer: (D) Go Back to Q28

Q29.

Solution

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

Step 1 — Substitute: $F = (0.4)(3)(0.5)$.

Step 2 — Compute: $F = 0.6$ N.

Why other options are wrong: 1.2 N drops the length factor; 0.3 N halves it; 6 N mis-places a power of ten.

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

Answer: (A) Go Back to Q29

Q30.

Solution

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

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

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

Why other options are wrong: 10π uses r instead of r^2; 2π doubles the result; 0.5π halves it.

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

Answer: (B) Go Back to Q30

Q31.

Solution

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

Step 1 — Substitute: $|\varepsilon| = 200 \times \dfrac{|0.01 - 0.04|}{0.3} = 200 \times \dfrac{0.03}{0.3}$.

Step 2 — Compute: $|\varepsilon| = 200 \times 0.1 = 20$ V.

Why other options are wrong: 10 V halves the result; 40 V doubles the flux change; 0.1 V omits the number of turns.

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

Answer: (C) Go Back to Q31

Q32.

Solution

Concept — Capacitive reactance: $X_C = \dfrac{1}{\omega C}$.

Step 1 — Substitute: $X_C = \dfrac{1}{(200)(50 \times 10^{-6})}$.

Step 2 — Compute: $X_C = \dfrac{1}{0.01} = 100\ \Omega$.

Why other options are wrong: 50, 200, and 25 Ω result from mis-handling the product $\omega C = 0.01$.

Final Answer: $X_C = 100\ \Omega \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q32

Q33.

Solution

Concept — Wave relation: $c = f\lambda \Rightarrow \lambda = \frac{c}{f}$.

Step 1 — Substitute: $\lambda = \frac{3 \times 10^8}{6 \times 10^{14}}$.

Step 2 — Compute: $\lambda = 0.5 \times 10^{-6} = 5 \times 10^{-7}$ m.

Why other options are wrong: 2×10^{-7} inverts the ratio of mantissas; 5×10^{-6} mis-places a power of ten; 1.8×10^{23} multiplies instead of dividing.

Final Answer: $\lambda = 5 \times 10^{-7}$ m $\Rightarrow$ A

Answer: (A) Go Back to Q33

Q34.

Solution

Concept — AM sidebands: Amplitude modulation produces an upper sideband at $f_c + f_m$ and a lower sideband at $f_c - f_m$.

Step 1 — Upper sideband: $1000 + 5 = 1005$ kHz.

Step 2 — Lower sideband: $1000 - 5 = 995$ kHz.

Why other options are wrong: $1010/990$ uses $2f_m$; $2000/10$ doubles or mixes the frequencies; $1000/5$ just lists the carrier and message.

Final Answer: Sidebands at 1005 kHz and 995 kHz $\Rightarrow$ B

Answer: (B) Go Back to Q34

Q35.

Solution

Concept — Work function from threshold wavelength: $\phi = \frac{hc}{\lambda_0}$.

Step 1 — Substitute: $\phi = \frac{1240 \text{ eV nm}}{600 \text{ nm}}$.

Step 2 — Compute: $\phi = 2.07$ eV.

Why other options are wrong: 1.0 eV and 3.1 eV use wrong wavelengths; 2.5 eV rounds incorrectly.

Final Answer: $\phi = 2.07$ eV $\Rightarrow$ $\boxed{\text{D}}$

Answer: (D) Go Back to Q35

Q36.

Solution

Concept — de Broglie wavelength: $\lambda = \frac{h}{mv}$, so $\lambda \propto \frac{1}{v}$ for a fixed mass.

Step 1 — Double the speed: Replacing v by $2v$ divides the wavelength by 2.

Step 2 — Result: λ becomes half its original value.

Why other options are wrong: "Doubled" and "four times" assume a direct dependence; "unchanged" ignores the speed entirely.

Final Answer: λ is halved $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q36

Q37.

Solution

Concept — Bohr transition energy: The emitted photon energy is $E = E_3 - E_2$ in magnitude, with $E_n = -13.6/n^2$ eV.

Step 1 — Level energies: $E_2 = -3.4$ eV, $E_3 = -1.51$ eV.

Step 2 — Compute: $E = E_3 - E_2 = -1.51 - (-3.4) = 1.89$ eV.

Why other options are wrong: 3.4 and 1.51 eV are level energies, not the difference; 12.09 eV is the $n = 1$ to $n = 3$ jump.

Final Answer: $E = 1.89$ eV $\Rightarrow$ $\boxed{\text{A}}$

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: $BE = 0.05 \times 931$.

Step 2 — Compute: $BE = 46.55$ MeV.

Why other options are wrong: 9.31 and 93.1 MeV mis-place a factor of ten; 18.62 MeV doubles a wrong mass.

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

Answer: (B) **Go Back to Q38**

Q39.

Solution

Concept — Photodiode operation: A photodiode is operated in reverse bias; incident light generates electron–hole pairs, and the reverse (saturation) current increases with the intensity of illumination.

Step 1 — Why reverse bias: The fractional change in current with light is much larger in reverse bias, making detection more sensitive.

Why other options are wrong: Forward bias is used for LEDs, not detection; zero bias is not the standard mode; the breakdown region describes a Zener regulator.

Final Answer: Reverse bias, current depends on illumination $\Rightarrow \boxed{\text{C}}$

Answer: (C) **Go Back to Q39**

Q40.

Solution

Concept — Universal gate: A gate is universal if every other logic function can be built from it alone. The NAND gate (and the NOR gate) has this property.

Step 1 — Build NOT from NAND: Tying both inputs together gives $\overline{A \cdot A} = \bar{A}$.

Step 2 — Build AND and OR: A NAND followed by a NAND-inverter gives AND; using De Morgan, OR also follows, so all gates are reachable.

Why other options are wrong: Standalone OR, AND, and NOT gates cannot generate every other gate; only NAND and NOR are universal.

Final Answer: A NAND gate alone is universal $\Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q40**

Answer Key

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