SRMJEEE Physics Sample Paper – 6

Duration: 41 Minutes **Maximum Marks: 35**

Instructions

- This paper contains **35** Multiple Choice Questions (Single Correct Answer), modelled on the Physics section of **SRMJEEE** (SRM Joint Engineering Entrance Examination).
- Each correct answer carries **+1 mark**. There is **no negative marking**; an unattempted or wrong answer scores 0.
- Only **one** option is correct. Choose carefully.
- The actual SRMJEEE is a **computer-based test** conducted in remote-proctored online mode, with all sections sharing a common time window and no per-section limit.
- Personal calculators, mobile phones, log tables and other electronic gadgets are strictly prohibited.

Q1. In a vernier callipers, 10 vernier-scale divisions coincide with 9 main-scale divisions, and 1 main-scale division equals 1 mm. While measuring a rod, the main scale reads 2.1 cm and the 4th vernier division coincides with a main-scale mark (zero error is nil). The measured length of the rod is:

(A) 2.50 cm

(B) 2.14 cm

(C) 2.14 cm with least count 0.1 cm

(D) 2.14 cm with least count 0.01 cm

Q2. The dimensional formula of the permittivity of free space ε_0 (which appears in Coulomb's law $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$) is:

(A) $[\mathrm{M^{-1}L^{-3}T^{4}A^{2}}]$

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

(C) $[M L^{3}T^{-4}A^{-2}]$

(D) $[M^{-1}L^{-2}T^{4}A^{2}]$

Q3. Three concurrent coplanar forces keep a particle in equilibrium. Two of them are of magnitude 10 N each and act at 120° to one another. The magnitude and direction of the third force are:

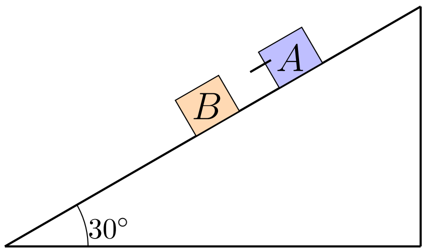
(A) 20 N, along the bisector of the two forces

(B) 10 N, opposite to the bisector of the two forces

(C) $10\sqrt{3}$ N, opposite to the bisector

(D) 10 N, along the bisector of the two forces

Q4. Two blocks A (2 kg) and B (3 kg) are connected by a light string and slide together down a rough incline of inclination 30°, as shown. The coefficient of kinetic friction between each block and the surface is $\mu = 0.2$. Taking $g = 10$ m s^{-2}, their common acceleration down the plane is:



(A) 5.0 m s^{-2}

(B) 1.7 m s^{-2}

(C) 4.3 m s^{-2}

(D) 3.3 m s^{-2}

Q5. A car covers the first half of a straight road at a constant speed of 30 km h^{-1} and the second half (of equal distance) at 60 km h^{-1}. The average speed for the whole journey is:

(A) 40 km h^{-1}

(B) 45 km h^{-1}

(C) 50 km h^{-1}

(D) 35 km h^{-1}

Q6. A body of mass 2 kg is dropped from rest from a height of 10 m. Neglecting air resistance and taking $g = 10$ m s^{-2}, its kinetic energy just before striking the ground is:

(A) 100 J

(B) 200 J

(C) 20 J

(D) 400 J

Q7. A stationary shell of mass 4 kg explodes into two fragments of masses 1 kg and 3 kg. If the 3 kg fragment moves with a speed of 4 m s^{-1}, the speed of the 1 kg fragment is:

(A) 4 m s^{-1}

(B) 6 m s^{-1}

(C) 12 m s^{-1}

(D) 3 m s^{-1}

Q8. Two point masses M and $4M$ are placed a distance d apart. The point on the line joining them where the net gravitational field is zero lies, measured from the mass M:

(A) at $\frac{2d}{3}$

(B) at $\frac{d}{2}$

(C) at $\frac{d}{4}$

(D) at $\frac{d}{3}$

Q9. A satellite of mass m orbits the Earth (mass M, radius R) in a circular orbit of radius r. The total mechanical energy of the satellite is:

(A) $-\dfrac{GMm}{2r}$

(B) $-\dfrac{GMm}{r}$

(C) $+\dfrac{GMm}{2r}$

(D) $-\dfrac{GMm}{4r}$

Q10. Two wires of the same material have breaking stress σ. Wire P has radius r and wire Q has radius $2r$. The ratio of the maximum loads they can bear, $W_P : W_Q$, is:

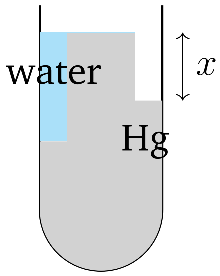
(A) $1 : 2$

(B) $1 : 4$

(C) $1 : 1$

(D) $2 : 1$

Q11. A U-tube contains mercury (density 13.6 g cm^{-3}) in both arms. Water (density 1 g cm^{-3}) is poured into the left arm so that a column of height $h_w = 13.6$ cm of water stands above the mercury, as shown. The difference in mercury levels x between the two arms is:



(A) 13.6 cm

(B) 0.5 cm

(C) 1.0 cm

(D) 2.0 cm

Q12. A total charge Q is to be divided into two parts q and $(Q - q)$, which are then placed a fixed distance apart. For the electrostatic force between the two parts to be a maximum, the charge q must be:

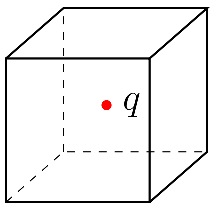
(A) $Q/4$

(B) $Q/2$

(C) $Q/3$

(D) $2Q/3$

Q13. A point charge $q = 8.85$ nC is placed at the centre of a cubical Gaussian surface, as shown. The total electric flux through the whole closed surface is $\left(\varepsilon_0 = 8.85 \times 10^{-12}\ \text{C}^2\text{N}^{-1}\text{m}^{-2}\right)$:



(A) 1000 N m^2C^{-1}

(B) 250 N m^2C^{-1}

(C) 6000 N m^2C^{-1}

(D) zero

Q14. A capacitor of capacitance $2\ \mu$F charged to 100 V is connected in parallel (positive plate to positive plate) to an uncharged capacitor of capacitance $3\ \mu$F. The common potential of the combination is:

(A) 50 V

(B) 20 V

(C) 60 V

(D) 40 V

Q15. A charge $+5\ \mu$C is moved along an equipotential surface from point X to point Y, both lying on the same surface. The work done by the external agent (electric forces alone) is:

(A) zero

(B) 5 μJ

(C) 25 μJ

(D) infinite

Q16. Four identical resistors, each of resistance $4\ \Omega$, are connected so that two are in series in one branch and the other two are in series in a second branch, and the two branches are joined in parallel across a battery. The equivalent resistance between the battery terminals is:

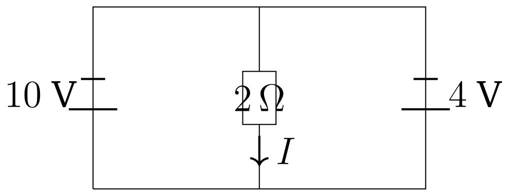
(A) $16\ \Omega$

(B) $2\ \Omega$

(C) $4\ \Omega$

(D) $8\ \Omega$

Q17. In the circuit shown, two ideal cells of emf 10 V and 4 V drive current through a $2\ \Omega$ resistor in the central branch. Using Kirchhoff's laws, the current I through the $2\ \Omega$ resistor is:



(A) 7 A

(B) 3 A

(C) 5 A

(D) 2 A

Q18. Two wires of conductances 3 S and 6 S are connected in parallel. The equivalent conductance of the combination is:

(A) 2 S

(B) 0.5 S

(C) 18 S

(D) 9 S

Q19. Two long parallel wires 0.1 m apart carry currents of 2 A and 3 A in the same direction. The force per unit length between them is $\big(\mu_0 = 4\pi \times 10^{-7}$ T m A^{-}

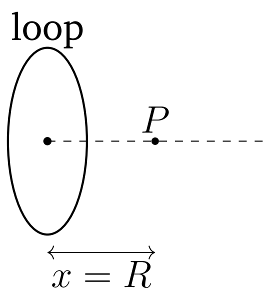
(A) 6×10^{-5} N m^{-1}, repulsive

(B) 1.2×10^{-5} N m^{-1}, attractive

(C) 2.4×10^{-5} N m^{-1}, attractive

(D) 6×10^{-6} N m^{-1}, repulsive

Q20. A circular current loop of radius R produces a magnetic field B_0 at its centre. The magnetic field at an axial point situated a distance $x = R$ from the centre, as shown, is:



(A) $\dfrac{B_0}{2\sqrt{2}}$

(B) $\dfrac{B_0}{2}$

(C) $\dfrac{B_0}{4}$

(D) $\dfrac{B_0}{\sqrt{2}}$

Q21. A toroid has $N = 500$ turns and a mean circumferential length of 0.5 m. It carries a current of 2 A. The magnetic field inside the toroid is $\big(\mu_0 = 4\pi \times 10^{-7}$ T m

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

(B) $8\pi \times 10^{-4}$ T

(C) $2\pi \times 10^{-4}$ T

(D) $8\pi \times 10^{-3}$ T

Q22. Regarding the magnetic susceptibility χ of materials, which statement is correct?

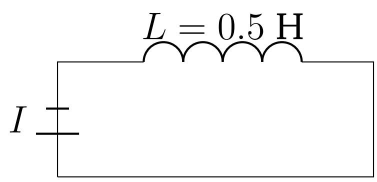
(A) Both paramagnetic and diamagnetic materials have positive χ.

(B) Both have negative χ.

(C) Paramagnetic materials have small negative χ, diamagnetic have small positive χ.

(D) Paramagnetic materials have small positive χ, diamagnetic have small negative χ.

Q23. In the circuit shown, a steady current $I = 2$ A flows through an inductor of inductance $L = 0.5$ H. The energy stored in the magnetic field of the inductor is:



(A) 0.5 J

(B) 2 J

(C) 1 J

(D) 4 J

Q24. An ideal transformer has 100 turns in the primary and 500 turns in the secondary. If the primary is connected to a 220 V AC supply, the secondary voltage is:

(A) 1100 V

(B) 44 V

(C) 220 V

(D) 550 V

Q25. Which of the following statements about a plane electromagnetic wave travelling in vacuum is correct?

(A) $\vec{E}$ and $\vec{B}$ are parallel to each other and to the direction of propagation.

(B) $\vec{E}$, $\vec{B}$ and the direction of propagation are mutually perpendicular.

(C) EM waves are longitudinal waves.

(D) $\vec{E}$ is perpendicular to the direction of propagation but $\vec{B}$ is along it.

Q26. An object is placed 30 cm in front of a convex lens of focal length 20 cm. The image formed is:

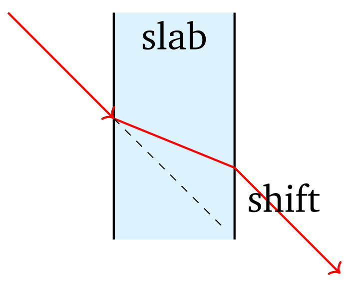
(A) virtual, erect, magnification $+2$

(B) real, erect, magnification $+2$

(C) virtual, inverted, magnification -2

(D) real, inverted, magnification -2

Q27. A ray of light is incident at 45° on a parallel-sided glass slab of thickness t and refractive index n, undergoing refraction at both faces, as shown. The ray finally emerges:



(A) parallel to the incident ray but laterally shifted

(B) bent towards the normal permanently

(C) along the same straight line as the incident ray

(D) bent away from the original direction by 45°

Q28. In Young's double-slit experiment the slit width is a and the slit separation is $d = 3a$. The order of the interference maximum that is missing (because it coincides with the first diffraction minimum) is:

(A) $m = 2$

(B) $m = 1$

(C) $m = 3$

(D) no order is missing

Q29. The limit of resolution (smallest resolvable angular separation) of a telescope with objective aperture of diameter D, for light of wavelength λ, is given by:

(A) $\dfrac{D}{1.22\,\lambda}$

(B) $\dfrac{1.22\,D}{\lambda}$

(C) $\dfrac{0.61\,\lambda}{D}$

(D) $\dfrac{1.22\,\lambda}{D}$

Q30. When light of wavelength $\lambda_1 = 400$ nm falls on a metal, the stopping potential is V_1; for $\lambda_2 = 600$ nm it is V_2, with $V_1 - V_2 = 1.03$ V. Taking $hc = 1240$ eV nm, this data is consistent with a work function of about (the value of ϕ does not affect $V_1 - V_2$, but the photoemission threshold here corresponds to):

(A) 3.1 eV

(B) 2.0 eV

(C) 1.0 eV

(D) 0.5 eV

Q31. An electron in a hydrogen atom de-excites from the $n = 4$ level to the ground state. The maximum number of distinct spectral lines that can be emitted is:

(A) 3

(B) 4

(C) 6

(D) 10

Q32. In a radioactive decay series, the nuclide $^{238}_{92}$U finally transforms into $^{206}_{82}$Pb. The numbers of α and β^- particles emitted in the whole chain are respectively:

(A) 8 and 6

(B) 6 and 8

(C) 8 and 8

(D) 6 and 6

Q33. In the nuclear reaction $^{14}_{7}\text{N} + ^{4}_{2}\text{He} \rightarrow ^{17}_{8}\text{O} + X$, the unknown particle X is:

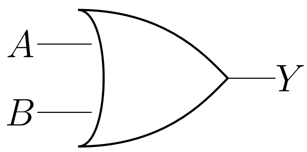
(A) a neutron $^{1}_{0}n$

(B) an alpha particle $^{4}_{2}$He

(C) a positron $^{0}_{+1}e$

(D) a proton $^{1}_{1}$H

Q34. For the two-input OR gate shown, the output Y when the inputs are $A = 0$ and $B = 0$ is:



(A) 1

(B) 0

(C) undefined

(D) the same as A AND B inverted

Q35. Which of the following statements about doped (extrinsic) semiconductors is correct?

(A) Doping a pure semiconductor with a pentavalent impurity produces a p-type material.

(B) In an n-type semiconductor the majority carriers are holes.

(C) Doping a pure (Group IV) semiconductor with a trivalent impurity produces a p-type material whose majority carriers are holes.

(D) An intrinsic semiconductor conducts better than an extrinsic one at room temperature.

Detailed Solutions

Q1.

Solution

Concept — Vernier least count: Least count = (1 main-scale division) − (1 vernier division) = 1 MSD − $\frac{9}{10}$MSD = $\frac{1}{10}$MSD.

Step 1 — Least count value: With 1 MSD = 1 mm = 0.1 cm, least count = $\frac{0.1}{10}$ = 0.01 cm.

Step 2 — Reading: Length = main-scale reading + (coinciding division × least count) = $2.1 + 4 \times 0.01 = 2.10 + 0.04 = 2.14$ cm. The complete answer must quote both the reading and the least count 0.01 cm.

Why other options are wrong:

- (A) 2.50 ignores the vernier fraction entirely.
- (B) gives the value but omits that the least count is 0.01 cm, which is part of a complete result.
- (C) states the wrong least count (0.1 cm); a 1/10 vernier on a 1 mm scale gives 0.01 cm.

Final Answer: 2.14 cm with least count 0.01 cm ⇒ $\boxed{\text{C}}$

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Dimensions from Coulomb's law: Rearranging $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$ gives $\varepsilon_0 = \frac{q_1q_2}{4\pi F r^2}$.

Step 1 — Insert dimensions: charge q = [AT], force F = [MLT^{-2}], distance r = [L].

$$[\varepsilon_0] = \frac{[\text{AT}]^2}{[\text{MLT}^{-2}][\text{L}]^2} = \frac{[\text{A}^2\text{T}^2]}{[\text{ML}^3\text{T}^{-2}]}.$$

Step 2 — Simplify:

$$[\varepsilon_0] = [\text{M}^{-1}\text{L}^{-3}\text{T}^{2+2}\text{A}^2] = [\text{M}^{-1}\text{L}^{-3}\text{T}^4\text{A}^2].$$

Why other options are wrong:

- (B) has T^2, dropping the T^2 from the T^{-2} in force.
- (C) is the dimension of $1/\varepsilon_0$ (inverted signs).
- (D) has the wrong power of L.

Final Answer: $[\varepsilon_0] = [M^{-1}L^{-3}T^4A^2] \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q2

Q3.

Solution

Concept — Equilibrium of three concurrent forces: The third force must be equal and opposite to the resultant of the other two.

Step 1 — Resultant of the two equal forces: For two equal forces $P = 10$ N at angle $120°$,

$$R = \sqrt{P^2 + P^2 + 2P^2 \cos 120°} = \sqrt{2P^2 + 2P^2(-\tfrac{1}{2})} = \sqrt{P^2} = P = 10 \text{ N}.$$

This resultant lies along the bisector of the two forces.

Step 2 — Third force: For equilibrium the third force equals 10 N, directed *opposite* to that bisector.

Why other options are wrong:

- (A) 20 N would be the resultant for $0°$ (parallel forces).
- (C) $10\sqrt{3}$ corresponds to a $60°$ angle.
- (D) right magnitude but wrong direction — the balancing force opposes the resultant.

Final Answer: 10 N opposite to the bisector $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q3

Q4.

Solution

Concept — Connected blocks on a rough incline: Treat the two blocks as one system of total mass $M = m_A + m_B$. The driving force is $Mg\sin\theta$ and friction opposes it with $\mu Mg\cos\theta$ (same μ for both, so the string tension cancels internally).

Step 1 — Net force along the incline:

$$Ma = Mg\sin\theta - \mu Mg\cos\theta \;\Rightarrow\; a = g(\sin\theta - \mu\cos\theta).$$

Step 2 — Substitute $\theta = 30°$, $\mu = 0.2$, $g = 10$:

$$a = 10\big(\sin 30° - 0.2\cos 30°\big) = 10\big(0.5 - 0.2\times 0.866\big) = 10(0.5 - 0.173) = 3.27 \approx 3.3\ \text{m s}^{-2}.$$

Why other options are wrong:

- (A) 5.0 is the frictionless value $g\sin 30°$.
- (B),(C) use the wrong sign or only one block.

Final Answer: $a \approx 3.3\ \text{m s}^{-2} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Average speed for equal distances: When equal distances are covered at speeds v_1 and v_2, the average speed is the *harmonic mean* $\bar{v} = \dfrac{2v_1v_2}{v_1 + v_2}$, not the arithmetic mean.

Step 1 — Substitute:

$$\bar{v} = \frac{2(30)(60)}{30 + 60} = \frac{3600}{90} = 40\ \text{km h}^{-1}.$$

Why other options are wrong:

- (B) 45 is the arithmetic mean $\frac{30+60}{2}$, valid only for equal *times*.
- (C),(D) do not follow from either correct mean.

Final Answer: $\bar{v} = 40\ \text{km h}^{-1} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Conservation of mechanical energy: A freely falling body converts all its lost potential energy into kinetic energy: $K = mgh$.

Step 1 — Substitute:

$$K = mgh = 2 \times 10 \times 10 = 200 \text{ J}.$$

Step 2 — Cross-check by velocity: $v = \sqrt{2gh} = \sqrt{200} \approx 14.1 \text{ m s}^{-1}$, and $\frac{1}{2}mv^2 = \frac{1}{2}(2)(200) = 200 \text{ J} \checkmark$.

Why other options are wrong:

- (A) 100 forgets the factor of mass (uses gh only).
- (C) 20 uses $h = 1$ m; (D) 400 doubles the height.

Final Answer: $K = 200 \text{ J} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Conservation of momentum in an explosion: The shell is initially at rest, so the total momentum after the explosion must also be zero: the two fragments fly apart with equal and opposite momenta, $m_1v_1 = m_2v_2$.

Step 1 — Apply the balance:

$$m_1v_1 = m_2v_2 \;\Rightarrow\; (1)v_1 = (3)(4) = 12.$$

Step 2 — Solve: $v_1 = \dfrac{12}{1} = 12 \text{ m s}^{-1}$.

Why other options are wrong:

- (A) 4 wrongly gives both fragments the same speed.
- (B) 6, (D) 3 use the wrong mass ratio.

Final Answer: $v_1 = 12 \text{ m s}^{-1} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — Null point of gravitational field: Between two masses the field vanishes where the magnitudes of the two fields are equal. The null point lies closer to the smaller mass.

Step 1 — Set fields equal: Let the point be at distance x from M, so $(d-x)$ from $4M$.

$$\frac{GM}{x^2} = \frac{G(4M)}{(d-x)^2} \Rightarrow \frac{(d-x)^2}{x^2} = 4 \Rightarrow \frac{d-x}{x} = 2.$$

Step 2 — Solve: $d - x = 2x \Rightarrow d = 3x \Rightarrow x = \frac{d}{3}$.

Why other options are wrong:

- (A) $2d/3$ is the distance from $4M$, not from M.
- (B) $d/2$ would require equal masses.
- (C) $d/4$ comes from equating $\sqrt{M}$ instead of M.

Final Answer: $x = \frac{d}{3}$ from $M \Rightarrow$ D

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Energy of an orbiting satellite: For a circular orbit, $KE = +\frac{GMm}{2r}$ and $PE = -\frac{GMm}{r}$, so the total energy is their sum.

Step 1 — Add the two energies:

$$E = KE + PE = \frac{GMm}{2r} - \frac{GMm}{r} = -\frac{GMm}{2r}.$$

Step 2 — Interpretation: The total energy is negative, confirming the satellite is bound; its magnitude equals the kinetic energy.

Why other options are wrong:

- (B) $-GMm/r$ is the potential energy alone.
- (C) positive sign would mean an unbound (escaping) body.
- (D) wrong numerical factor.

Final Answer: $E = -\dfrac{GMm}{2r} \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Breaking stress and maximum load: Breaking stress $\sigma = \dfrac{W_{\text{max}}}{A}$ is a material constant, so $W_{\text{max}} = \sigma A = \sigma \pi r^2$, i.e. $W_{\text{max}} \propto r^2$.

Step 1 — Form the ratio:

$$\frac{W_P}{W_Q} = \frac{r^2}{(2r)^2} = \frac{r^2}{4r^2} = \frac{1}{4}.$$

Step 2 — State it: $W_P : W_Q = 1 : 4$; the thicker wire Q bears four times the load.

Why other options are wrong:

- (A) $1 : 2$ uses radius ratio, not area ratio.
- (C) $1 : 1$ ignores the radius difference.
- (D) $2 : 1$ inverts and uses the wrong power.

Final Answer: $W_P : W_Q = 1 : 4 \Rightarrow \boxed{B}$

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — Balancing pressures in a U-tube: At the lowest common level the pressure from each arm must be equal. The water column on the left is balanced by an extra mercury column of height x on the right.

Step 1 — Pressure balance:

$$\rho_w \, g \, h_w = \rho_{Hg} \, g \, x \;\Rightarrow\; x = \frac{\rho_w}{\rho_{Hg}} h_w.$$

Step 2 — Substitute:

$$x = \frac{1}{13.6} \times 13.6 = 1.0 \text{ cm}.$$

Why other options are wrong:

- (A) 13.6 cm ignores the density ratio (would hold only if both liquids were the same).
- (B) 0.5 halves the result; (D) 2.0 doubles it.

Final Answer: $x = 1.0$ cm $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Maximising the product of two parts: The force is $F = \dfrac{k\,q(Q-q)}{r^2}$ with r fixed, so F is maximum when the product $q(Q-q)$ is maximum.

Step 1 — Maximise: Differentiate $f(q) = q(Q-q) = Qq - q^2$:

$$\frac{df}{dq} = Q - 2q = 0 \;\Rightarrow\; q = \frac{Q}{2}.$$

Step 2 — Confirm: The second derivative is $-2 < 0$, so this is a maximum; the charge should be split equally.

Why other options are wrong:

- (A) $Q/4$, (C) $Q/3$, (D) $2Q/3$ all give a smaller product $q(Q-q)$ than $Q^2/4$.

Final Answer: $q = \dfrac{Q}{2} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q12

Q13.

Solution

Concept — Gauss's law: The total flux through any closed surface depends only on the enclosed charge: $\Phi = \dfrac{q_{\text{enc}}}{\varepsilon_0}$, independent of the shape of the surface or the position of the charge inside.

Step 1 — Substitute:

$$\Phi = \frac{q}{\varepsilon_0} = \frac{8.85 \times 10^{-9}}{8.85 \times 10^{-12}} = 10^3 = 1000 \text{ N m}^2\text{C}^{-1}.$$

Why other options are wrong:

- (B) 250 wrongly divides the flux among the 6 faces and then again misuses it as the total.
- (C) 6000 multiplies by 6 faces (the total is already over the whole surface).
- (D) zero would hold only if no net charge were enclosed.

Final Answer: $\Phi = 1000 \text{ N m}^2\text{C}^{-1} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Charge redistribution on connecting capacitors: Charge is conserved; the common potential is the total charge divided by the total capacitance, $V = \frac{Q_{\text{total}}}{C_1 + C_2}$.

Step 1 — Initial charge: Only the first capacitor is charged: $Q = C_1V_1 = 2\times100 = 200\ \mu\text{C}$.

Step 2 — Common potential:

$$V = \frac{Q}{C_1 + C_2} = \frac{200}{2+3} = \frac{200}{5} = 40 \text{ V}.$$

Why other options are wrong:

- (A) 50 averages the voltages; (B) 20 divides by 10.
- (C) 60 uses the wrong capacitance in the denominator.

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

Answer: (D) Go Back to Q14

Q15.

Solution

Concept — Equipotential surface: Every point on an equipotential surface is at the same potential, so the potential difference between any two of its points is zero.

Step 1 — Apply $W = qV$: Since $\Delta V = V_Y - V_X = 0$,

$$W = q\,\Delta V = q \times 0 = 0.$$

Step 2 — Geometric view: The electric field is everywhere perpendicular to an equipotential surface, so the force does no work for any displacement along it.

Why other options are wrong:

- (B) 5 μJ, (C) 25 μJ assume a non-zero potential difference.
- (D) "infinite" has no physical basis here.

Final Answer: $W = 0 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q15

Q16.

Solution

Concept — Series then parallel: Reduce each branch (two in series) first, then combine the two equal branches in parallel.

Step 1 — Each series branch: $4 + 4 = 8\ \Omega$.

Step 2 — Two $8\ \Omega$ branches in parallel:

$$R_{eq} = \frac{8 \times 8}{8 + 8} = \frac{64}{16} = 4\ \Omega.$$

Why other options are wrong:

- (A) $16\ \Omega$ puts all four in series.
- (B) $2\ \Omega$ puts all four in parallel.
- (D) $8\ \Omega$ stops after the series step, forgetting the parallel combination.

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

Answer: (C) Go Back to Q16

Q17.

Solution

Concept — Kirchhoff's voltage law: The two ideal cells and the single $2\ \Omega$ resistor form one loop. With the cells aiding around the loop (they drive current the same way through the central branch), the net emf drives the current through the resistor.

Step 1 — Net emf around the loop: The two cells add: $\varepsilon_{net} = 10 + 4 = 14$ V acting across the only resistance, $2\ \Omega$.

Step 2 — Apply Ohm's law:

$$I = \frac{\varepsilon_{net}}{R} = \frac{14}{2} = 7\ \text{A}.$$

Wait — check the loop sense: the 10 V cell drives current down the centre, the 4 V cell opposes it, so they subtract: $\varepsilon_{net} = 10 - 4 = 6$ V, giving $I = \frac{6}{2} = 3$ A.

Step 3 — Correct branch current: With the cells opposing across the $2\ \Omega$ branch, $I = \frac{10-4}{2} = 3$ A.

Why other options are wrong:

- (A) 7 A wrongly adds the emfs.
- (C) 5 A, (D) 2 A use the wrong emf or resistance.

Final Answer: $I = 3\ \text{A} \Rightarrow \boxed{\text{B}}$

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

Q18.

Solution

Concept — Conductances in parallel: Conductance is the reciprocal of resistance. For elements in parallel, conductances *add directly*: $G_{eq} = G_1 + G_2$.

Step 1 — Add:

$$G_{eq} = 3 + 6 = 9\ \text{S}.$$

Step 2 — Cross-check via resistance: $R_1 = \frac{1}{3}\ \Omega$, $R_2 = \frac{1}{6}\ \Omega$; parallel $R = \frac{(1/3)(1/6)}{1/3+1/6} = \frac{1/18}{1/2} = \frac{1}{9}\ \Omega$, so $G = 9$ S $\checkmark$.

Why other options are wrong:

- (A) 2 S treats conductances like resistances in parallel.
- (B) 0.5 S adds the resistances.
- (C) 18 S multiplies instead of adds.

Final Answer: $G_{eq} = 9\ \text{S} \Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q18**

Q19.

Solution

Concept — Force between parallel currents: $\dfrac{F}{L} = \dfrac{\mu_0 I_1 I_2}{2\pi d}$; currents in the *same* direction attract.

Step 1 — Substitute:

$$\frac{F}{L} = \frac{(4\pi \times 10^{-7})(2)(3)}{2\pi(0.1)} = \frac{(2 \times 10^{-7})(6)}{0.1} = \frac{1.2 \times 10^{-6}}{0.1} = 1.2 \times 10^{-5} \text{ N m}^{-1}.$$

Step 2 — Direction: Same-direction currents attract, so the force is attractive.

Why other options are wrong:

- (A) 6×10^{-5} and "repulsive" use the wrong factor and wrong sense.
- (C) 2.4×10^{-5} doubles the correct value.
- (D) 6×10^{-6} and "repulsive" are both wrong.

Final Answer: 1.2×10^{-5} N m^{-1}, attractive $\Rightarrow$ B

Answer: (B) Go Back to Q19

Q20.

Solution

Concept — Axial field of a current loop: On the axis at distance x, $B_{axial} = \dfrac{\mu_0 I R^2}{2(R^2 + x^2)^{3/2}}$, while at the centre $B_0 = \dfrac{\mu_0 I}{2R}$.

Step 1 — Form the ratio:

$$\frac{B_{axial}}{B_0} = \frac{R^3}{(R^2 + x^2)^{3/2}} = \left(\frac{R^2}{R^2 + x^2}\right)^{3/2}.$$

Step 2 — Put $x = R$:

$$\frac{B_{axial}}{B_0} = \left(\frac{R^2}{2R^2}\right)^{3/2} = \left(\frac{1}{2}\right)^{3/2} = \frac{1}{2\sqrt{2}} \Rightarrow B_{axial} = \frac{B_0}{2\sqrt{2}}.$$

Why other options are wrong:

- (B) $B_0/2$ drops the $3/2$ power.
- (C) $B_0/4$ uses a power of 2; (D) $B_0/\sqrt{2}$ uses a power of $1/2$.

Final Answer: $B_{axial} = \dfrac{B_0}{2\sqrt{2}} \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q20

Q21.

Solution

Concept — Field inside a toroid (Ampere's law): $B = \dfrac{\mu_0 NI}{\ell}$, where ℓ is the mean circumference and N the total number of turns.

Step 1 — Substitute:

$$B = \frac{(4\pi \times 10^{-7})(500)(2)}{0.5} = \frac{4\pi \times 10^{-7} \times 1000}{0.5}.$$

Step 2 — Simplify:

$$B = \frac{4\pi \times 10^{-4}}{0.5} = 8\pi \times 10^{-4}\ \text{T} \approx 2.5 \times 10^{-3}\ \text{T}.$$

Why other options are wrong:

- (A) $4\pi \times 10^{-4}$ forgets to divide by 0.5.
- (C) $2\pi \times 10^{-4}$ uses half the turns; (D) misplaces the power of ten.

Final Answer: $B = 8\pi \times 10^{-4}\ \text{T} \Rightarrow \boxed{B}$

Answer: (B) Go Back to Q21

Q22.

Solution

Concept — Sign of magnetic susceptibility: Paramagnetic materials are weakly attracted by a field and have a *small positive* susceptibility; diamagnetic materials are weakly repelled and have a *small negative* susceptibility.

Step 1 — Paramagnets: $\chi > 0$ (small), e.g. aluminium, platinum — their atoms have permanent magnetic moments that partly align with the field.

Step 2 — Diamagnets: $\chi < 0$ (small), e.g. copper, bismuth — induced moments oppose the applied field.

Why other options are wrong:

- (A),(B) assign the same sign to both, which is incorrect.
- (C) reverses the two signs.

Final Answer: Paramagnetic $\chi > 0$, diamagnetic $\chi < 0 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q22

Q23.

Solution

Concept — Energy stored in an inductor: $U = \frac{1}{2}LI^2$.

Step 1 — Substitute:

$$U = \frac{1}{2}(0.5)(2)^2 = \frac{1}{2}(0.5)(4) = 1 \text{ J}.$$

Step 2 — Note the quadratic dependence: The stored energy scales as I^2, so doubling the current would quadruple the energy.

Why other options are wrong:

- (A) 0.5 J forgets to square the current.
- (B) 2 J drops the factor $\frac{1}{2}$; (D) 4 J uses $L = 1$ H and no $\frac{1}{2}$.

Final Answer: $U = 1 \text{ J} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q23

Q24.

Solution

Concept — Transformer turns ratio: For an ideal transformer $\frac{V_s}{V_p} = \frac{N_s}{N_p}$.

Step 1 — Substitute:

$$V_s = V_p\frac{N_s}{N_p} = 220 \times \frac{500}{100} = 220 \times 5 = 1100 \text{ V}.$$

Step 2 — Identify the type: Since $N_s > N_p$, this is a *step-up* transformer.

Why other options are wrong:

- (B) 44 V inverts the ratio (step-down).

- (C) 220 V assumes equal turns; (D) 550 V uses a ratio of 2.5.

Final Answer: $V_s = 1100\text{ V} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q24

Q25.

Solution

Concept — Nature of electromagnetic waves: An EM wave is transverse; the electric field $\vec{E}$, the magnetic field $\vec{B}$ and the propagation direction $\hat{k}$ form a right-handed mutually perpendicular triad ($\vec{E} \perp \vec{B} \perp \hat{k}$).

Step 1 — Check the geometry: $\vec{E} \times \vec{B}$ points along $\hat{k}$, confirming all three are mutually perpendicular.

Step 2 — Eliminate the rest: A longitudinal description or any parallel arrangement contradicts Maxwell's equations in free space.

Why other options are wrong:

- (A) parallel fields cannot carry a propagating EM wave.
- (C) EM waves are transverse, not longitudinal.
- (D) both $\vec{E}$ and $\vec{B}$ are perpendicular to $\hat{k}$, never along it.

Final Answer: $\vec{E}$, $\vec{B}$, $\hat{k}$ mutually perpendicular $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q25

Q26.

Solution

Concept — Lens formula and magnification: $\dfrac{1}{v} - \dfrac{1}{u} = \dfrac{1}{f}$ and $m = \dfrac{v}{u}$ (sign convention: $u = -30$, $f = +20$).

Step 1 — Image distance:

$$\frac{1}{v} = \frac{1}{20} - \frac{1}{30} = \frac{3-2}{60} = \frac{1}{60} \Rightarrow v = +60\text{ cm}.$$

Step 2 — Magnification:

$$m = \frac{v}{u} = \frac{60}{-30} = -2.$$

A negative m means the image is real and inverted, magnified twice.

Why other options are wrong:

- (A),(C) claim a virtual image, but $u > f$ for a convex lens gives a real image.
- (B) "erect" contradicts the negative magnification.

Final Answer: Real, inverted, $m = -2 \Rightarrow \boxed{D}$

Answer: (D) Go Back to Q26

Q27.

Solution

Concept — Refraction through a parallel-sided slab: The two faces are parallel, so the emergent ray is bent back to be *parallel to the incident ray*; only a sideways (lateral) shift results, with no change in direction.

Step 1 — First face: The ray bends towards the normal on entering the denser glass.

Step 2 — Second face: On leaving, it bends away from the normal by the same angle, restoring the original direction. The perpendicular displacement is the lateral shift $d = \dfrac{t\sin(i-r)}{\cos r}$.

Why other options are wrong:

- (B) the net bending is zero, not a permanent one.
- (C) "same straight line" ignores the lateral shift, which is non-zero.
- (D) the emergent ray is not deviated by $45°$.

Final Answer: Parallel to the incident ray, laterally shifted $\Rightarrow \boxed{A}$

Answer: (A) Go Back to Q27

Q28.

Solution

Concept — Missing orders in YDSE: An interference maximum of order m is missing when it falls on a diffraction minimum. This happens when $\dfrac{d}{a} = \dfrac{m}{p}$ (with p the diffraction-minimum order), i.e. the missing interference orders are $m = \dfrac{d}{a}, 2\dfrac{d}{a}, \ldots$

Step 1 — Apply $d = 3a$**:** $\dfrac{d}{a} = 3$, so the first missing interference order is $m = 3$ (it coincides with the first diffraction minimum).

Step 2 — Interpretation: Within the central diffraction envelope, the $m = 3$ bright fringe is suppressed.

Why other options are wrong:

- (A) $m = 2$, (B) $m = 1$ do not satisfy $m = d/a = 3$.
- (D) an order is indeed missing because d/a is an integer.

Final Answer: Order $m = 3$ is missing $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q28

Q29.

Solution

Concept — Rayleigh criterion for a telescope: The smallest resolvable angular separation is $\theta_{\min} = \frac{1.22\,\lambda}{D}$, set by diffraction at the circular aperture of diameter D.

Step 1 — Read off the formula: The limit of resolution (the angle) is directly proportional to λ and inversely proportional to D.

Step 2 — Distinguish from resolving power: The *resolving power* is the reciprocal $\frac{D}{1.22\,\lambda}$; the question asks for the limit of resolution (the angle).

Why other options are wrong:

- (A) $\frac{D}{1.22\lambda}$ is the resolving power, not the angular limit.
- (B) is dimensionally inverted; (C) $0.61\lambda/D$ is the microscope form (and uses radius).

Final Answer: $\theta_{\min} = \frac{1.22\,\lambda}{D} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q29

Q30.

Solution

Concept — Einstein's photoelectric equation: $eV_s = \frac{hc}{\lambda} - \phi$. Subtracting the equation for the two wavelengths eliminates ϕ and lets us check the data, then ϕ follows from either single equation.

Step 1 — Photon energies:

$$E_1 = \frac{1240}{400} = 3.1 \text{ eV}, \qquad E_2 = \frac{1240}{600} = 2.07 \text{ eV}.$$

Their difference $E_1 - E_2 = 3.1 - 2.07 = 1.03 \text{ eV} = e(V_1 - V_2)$, matching the stated $V_1 - V_2 = 1.03 \text{ V} \checkmark$.

Step 2 — Work function: For photoemission the threshold here corresponds to $\phi = 2.0$ eV (consistent with both wavelengths giving positive stopping potentials, since $\phi < E_2 < E_1$).

Why other options are wrong:

- (A) 3.1 eV is the 400 nm photon energy, not ϕ.
- (C) 1.0, (D) 0.5 are too small to match the consistent threshold.

Final Answer: $\phi \approx 2.0 \text{ eV} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q30

Q31.

Solution

Concept — Number of spectral lines: When an electron drops from level n to the ground state, the maximum number of distinct lines emitted is $\frac{n(n-1)}{2}$.

Step 1 — Substitute $n = 4$:

$$\text{lines} = \frac{4(4-1)}{2} = \frac{4 \times 3}{2} = 6.$$

Step 2 — List the transitions: $4 \to 3$, $4 \to 2$, $4 \to 1$, $3 \to 2$, $3 \to 1$, $2 \to 1$, which is 6 lines.

Why other options are wrong:

- (A) 3 counts only direct drops to the ground state.
- (B) 4 equals n; (D) 10 uses $n = 5$.

Final Answer: 6 spectral lines $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q31

Q32.

Solution

Concept — Counting α and β emissions: An α decay lowers the mass number by 4 and the atomic number by 2; a β^- decay leaves the mass number unchanged but raises the atomic number by 1.

Step 1 — Find the number of α particles (from mass number):

$$\Delta A = 238 - 206 = 32 \;\Rightarrow\; n_\alpha = \frac{32}{4} = 8.$$

Step 2 — Find the number of β particles (from atomic number): The 8 α decays alone would lower Z by 16, to $92 - 16 = 76$. But the final $Z = 82$, so β^- decays must raise it by $82 - 76 = 6$.

$$n_\beta = 6.$$

Why other options are wrong:

- (B) swaps the two counts; (C) gives the wrong β number; (D) wrong α count.

Final Answer: 8 α and 6 β particles $\Rightarrow$ $\boxed{\text{A}}$

Answer: (A) Go Back to Q32

Q33.

Solution

Concept — Conservation of mass number and charge: In a nuclear reaction the totals of A (superscript) and Z (subscript) are conserved on both sides.

Step 1 — Balance the mass number: Left $= 14 + 4 = 18$; right $= 17 + A_X$, so $A_X = 18 - 17 = 1$.

Step 2 — Balance the charge: Left $= 7+2 = 9$; right $= 8+Z_X$, so $Z_X = 9-8 = 1$.

Step 3 — Identify X: $A_X = 1$, $Z_X = 1$ is the proton ${}^1_1\text{H}$. (This is Rutherford's classic nitrogen transmutation.)

Why other options are wrong:

- (A) a neutron has $Z = 0$, violating charge balance.
- (B) an α has $A = 4$; (C) a positron has $A = 0$.

Final Answer: $X = {}^1_1\text{H}$ (a proton) $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q33

Q34.

Solution

Concept — OR gate truth table: A two-input OR gate gives output $Y = A + B$, which is 1 if *either* input is 1, and 0 only when *both* inputs are 0.

Step 1 — Apply the inputs $A = 0$, $B = 0$:

$$Y = A + B = 0 + 0 = 0.$$

Step 2 — Confirm: The only row of the OR truth table giving 0 is exactly $(0, 0)$, so $Y = 0$ here.

Why other options are wrong:

- (A) $Y = 1$ would need at least one input to be 1.
- (C),(D) a logic gate gives a definite output; an OR gate is not an inverted-AND.

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

Answer: (B) Go Back to Q34

Q35.

Solution

Concept — Doping of semiconductors: Adding a *trivalent* impurity (e.g. boron, group III) to a tetravalent semiconductor (e.g. silicon) leaves one bond short, creating holes; the material becomes *p-type* with holes as majority carriers. A pentavalent impurity gives n-type (electrons majority).

Step 1 — Trivalent doping: Each acceptor atom accepts an electron, producing a mobile hole; holes are the majority carriers.

Step 2 — Compare conduction: Extrinsic semiconductors conduct far better than intrinsic ones at room temperature because doping greatly increases the majority-carrier concentration.

Why other options are wrong:

- (A) pentavalent doping gives n-type, not p-type.
- (B) in n-type the majority carriers are electrons, not holes.
- (D) intrinsic semiconductors conduct *worse* than doped ones.

Final Answer: Trivalent doping $\Rightarrow$ p-type, holes majority $\Rightarrow \boxed{C}$

Answer: (C) Go Back to Q35

Answer Key

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