AIIMS B.Sc Nursing Physics

Sample Paper – 1

Duration: 36 Minutes **Maximum Marks: 30**

Instructions

- This paper contains **30 Multiple Choice Questions (single correct answer)**, modelled on the Physics section of the **AIIMS B.Sc Nursing** entrance.
- Each correct answer carries **+1 mark**. $\frac{1}{3}$ **mark is deducted** for every wrong answer, and an unattempted question gets **0 marks**.
- Only **one** option is correct. Choose carefully, since the questions are mostly numerical.
- Personal calculators, log tables, mobile phones, and other electronic gadgets are strictly prohibited.

Q1. Two point charges experience an electrostatic force F when held a distance r apart. If the distance between them is doubled, the force becomes:

(A) $F/4$

(B) $F/2$

(C) $2F$

(D) $4F$

Q2. The magnitude of the electric field at a distance of 0.3 m from a point charge of 9 nC is (take $k = 9 \times 10^9$ N m^{2}C^{-2}):

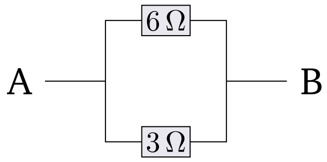
(A) 300 N/C

(B) 900 N/C

(C) 100 N/C

(D) 2700 N/C

Q3. In the circuit shown, two resistors are connected in parallel between A and B. The equivalent resistance between A and B is:



(A) $9\,\Omega$

(B) $4.5\,\Omega$

(C) $2\,\Omega$

(D) $18\,\Omega$

Q4. An electric bulb rated 60 W operates on a 120 V supply. The current drawn by the bulb is:

(A) 2 A

(B) 1 A

(C) 0.25 A

(D) 0.5 A

Q5. A parallel plate capacitor has capacitance C. If the separation between its plates is halved (with everything else unchanged), the new capacitance is:

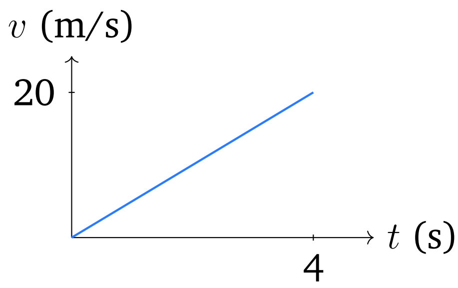
(A) $2C$

(B) $C/2$

(C) $4C$

(D) C

Q6. The velocity–time graph of a body starting from rest is shown. The acceleration of the body is:



(A) 2.5 m/s^2

(B) 5 m/s^2

(C) 10 m/s^2

(D) 20 m/s^2

Q7. The dimensional formula of force is:

(A) $[ML^2T^{-2}]$

(B) $[MLT^{-1}]$

(C) $[MLT^{-2}]$

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

Q8. A ball is thrown vertically upward with a speed of 30 m/s. The time taken to reach the highest point is (take $g = 10 \text{ m/s}^2$):

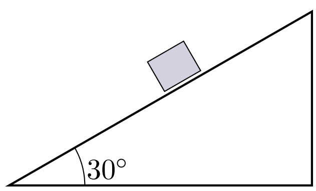
(A) 6 s

(B) 1.5 s

(C) 4.5 s

(D) 3 s

Q9. A block slides down a smooth (frictionless) inclined plane of inclination $30°$, as shown. Its acceleration along the incline is (take $g = 10 \text{ m/s}^2$):



(A) 5 m/s^2

(B) 10 m/s^2

(C) 2.5 m/s^2

(D) 7.5 m/s^2

Q10. A body of mass 2 kg moving at 5 m/s is brought to rest in 2 s by a constant force. The magnitude of the force is:

(A) 10 N

(B) 5 N

(C) 2.5 N

(D) 20 N

Q11. A body of mass 4 kg is moving with a speed of 3 m/s. Its kinetic energy is:

(A) 6 J

(B) 12 J

(C) 18 J

(D) 36 J

Q12. At the Earth's surface $g = 10 \text{ m/s}^2$. The acceleration due to gravity at a height equal to the radius of the Earth above the surface is:

(A) 10 m/s^2

(B) 5 m/s^2

(C) 1.25 m/s^2

(D) 2.5 m/s^2

Q13. The excess pressure inside a spherical liquid drop of radius r and surface tension T is:

(A) $\dfrac{2T}{r}$

(B) $\dfrac{4T}{r}$

(C) $\dfrac{T}{r}$

(D) $\dfrac{T}{2r}$

Q14. A wire of length 2 m and cross-sectional area 1 mm^2 stretches by 1 mm under a load. If the Young's modulus of the material is 2×10^{11} Pa, the load applied is:

(A) 50 N

(B) 100 N

(C) 200 N

(D) 400 N

Q15. A metal rod of length 1 m and linear expansion coefficient 1.2×10^{-5} °C^{-1} is heated through 50 °C. The increase in its length is:

(A) 0.2 mm

(B) 0.4 mm

(C) 0.6 mm

(D) 1.2 mm

Q16. The heat required to raise the temperature of 2 kg of water by 10 °C is (specific heat of water $= 4200$ J kg^{-1}°C^{-1}):

(A) 21000 J

(B) 42000 J

(C) 8400 J

(D) 84000 J

Q17. For an ideal gas undergoing an isothermal process, the change in internal energy is:

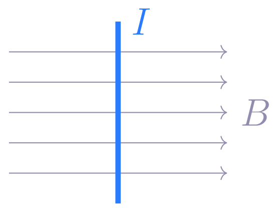
(A) zero

(B) equal to the work done by the gas

(C) equal to the heat supplied

(D) negative

Q18. A straight wire of length 0.5 m carrying a current of 4 A is placed perpendicular to a uniform magnetic field of 0.2 T, as shown. The force on the wire is:



(A) 0.2 N

(B) 0.4 N

(C) 0.8 N

(D) 4 N

Q19. According to Faraday's law of electromagnetic induction, the emf induced in a coil is large when:

(A) the magnetic flux through it stays constant

(B) the magnetic flux through it is large

(C) the magnetic flux through it changes rapidly

(D) the resistance of the coil is large

Q20. An alternating current has a peak (maximum) value I_0. Its root-mean-square (rms) value is:

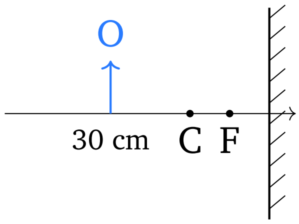
(A) I_0

(B) $2I_0$

(C) $I_0/2$

(D) $I_0/\sqrt{2}$

Q21. An object is placed 30 cm in front of a concave mirror of focal length 15 cm, as shown. The distance of the image from the mirror is:



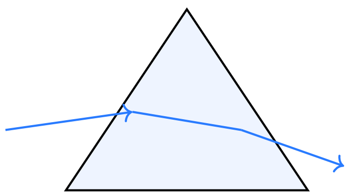
(A) 30 cm

(B) 15 cm

(C) 10 cm

(D) 60 cm

Q22. Light travels through a transparent medium at a speed of 2×10^8 m/s. Taking the speed of light in vacuum as 3×10^8 m/s, the refractive index of the medium is:



glass prism

(A) 1.0

(B) 1.5

(C) 2.0

(D) 0.67

Q23. Two thin lenses of power $+2$ D and $+3$ D are placed in contact with each other. The power of the combination is:

(A) $+1$ D

(B) $+2.5$ D

(C) $+5$ D

(D) $+6$ D

Q24. In the photoelectric effect, the work function of a metal is:

(A) the maximum kinetic energy of an emitted electron

(B) the energy of the incident photon

(C) the stopping potential of the metal

(D) the minimum energy needed to eject an electron from the metal surface

Q25. The energy of a photon of frequency 5×10^{14} Hz is (take $h = 6.6 \times 10^{-34}$ J s):

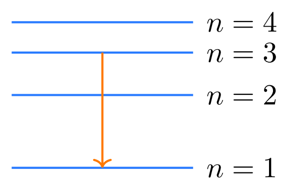
(A) 3.3×10^{-19} J

(B) 6.6×10^{-19} J

(C) 1.3×10^{-19} J

(D) 3.3×10^{-20} J

Q26. The energy levels of the hydrogen atom are shown. According to Bohr's model, the radius of the nth orbit is proportional to:



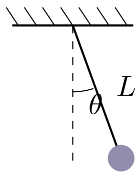
(A) n

(B) $1/n$

(C) n^2

(D) $1/n^2$

Q27. The time period of the simple pendulum shown, of length 1 m, is (take $g = 10$ m/s^2 and $\pi^2 \approx 10$):



(A) 1 s

(B) 2 s

(C) 3.14 s

(D) 4 s

Q28. A sound wave of frequency 500 Hz has a wavelength of 0.6 m in air. The speed of the wave is:

(A) 83 m/s

(B) 500 m/s

(C) 0.6 m/s

(D) 300 m/s

Q29. In a p-type semiconductor, the majority charge carriers are:

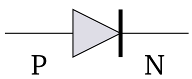
(A) holes

(B) electrons

(C) protons

(D) positive ions

Q30. The p-n junction diode shown conducts an appreciable current only when it is:



(A) reverse biased

(B) unbiased

(C) forward biased

(D) kept at a high frequency

Detailed Solutions

Q1.

Solution

Concept — Coulomb's law: The electrostatic force between two point charges acts along the line joining them and follows an inverse-square law. Coulomb's law states $F = \frac{k\,q_1 q_2}{r^2}$, where F is the force (N), $k = \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ N m^{2}C^{-2} is the Coulomb constant, q_1 and q_2 are the magnitudes of the two charges (C), and r is the separation between them (m). Since the charges are unchanged here, only r varies, so $F \propto \frac{1}{r^2}$.

Given: Initial separation $= r$ giving force F; new separation $= 2r$; charges q_1, q_2 held constant.

Step 1 — Write the proportionality: Keeping kq_1q_2 fixed, $F = \frac{\text{(constant)}}{r^2}$, so the force depends only on $\frac{1}{r^2}$.

Step 2 — Substitute the new distance: Replace r by $2r$. The new force is $F' = \frac{kq_1q_2}{(2r)^2} = \frac{kq_1q_2}{4r^2} = \frac{1}{4} \cdot \frac{kq_1q_2}{r^2}$.

Step 3 — Simplify: Since $\frac{kq_1q_2}{r^2} = F$, we get $F' = \frac{F}{4}$. Doubling the distance makes the force one-quarter of its original value.

Why each other option is wrong:

- (B) $F/2$ would follow only if $F \propto \frac{1}{r}$, which describes potential, not force.
- (C) $2F$ wrongly assumes the force increases when charges move apart.
- (D) $4F$ uses $F \propto r^2$, the exact inverse of the correct law.

Key point: For an inverse-square law, multiplying the distance by n divides the quantity by n^2; here $n = 2$ gives a factor of $\frac{1}{4}$.

Final Answer: $F/4 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q1

Q2.

Solution

Concept — Electric field of a point charge: A point charge sets up a radial electric field whose magnitude falls off as the inverse square of distance. The field is $E = \frac{kq}{r^2}$, where E is the field strength (N/C), $k = 9 \times 10^9$ N m^{2}C^{-2}, q is the charge (C), and r is the distance from the charge (m). The field points away from a positive charge and toward a negative one.

Given: $q = 9$ nC $= 9 \times 10^{-9}$ C; $r = 0.3$ m; $k = 9 \times 10^9$ N m^{2}C^{-2}.

Step 1 — Write the formula and substitute: $E = \frac{kq}{r^2} = \frac{(9 \times 10^9)(9 \times 10^{-9})}{(0.3)^2}$ N/C.

Step 2 — Simplify the numerator and denominator: Numerator $= 9 \times 10^9 \times 9 \times 10^{-9} = 81$ N m^{2}C^{-1}. Denominator $= (0.3)^2 = 0.09$ m^2.

Step 3 — Divide: $E = \frac{81}{0.09} = 900$ N/C.

Why each other option is wrong:

- (A) 300 N/C results from forgetting to square r (using r instead of r^2 gives $81/0.3 = 270$, a related slip).
- (C) 100 N/C drops part of the kq product.
- (D) 2700 N/C uses $r = 0.1$ m instead of 0.3 m.

Key point: Convert nanocoulombs to coulombs (1 nC $= 10^{-9}$ C) and always square the distance before dividing.

Final Answer: $E = 900$ N/C $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q2

Q3.

Solution

Concept — Resistors in parallel: When resistors are connected in parallel, the same potential difference appears across each, but the current divides between them. The reciprocal of the equivalent resistance equals the sum of the reciprocals: $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$, where R is the equivalent resistance (Ω) and R_1, R_2 are the branch resistances (Ω). The equivalent resistance of a parallel combination is always smaller than the smallest branch.

Given: $R_1 = 6\,\Omega$ and $R_2 = 3\,\Omega$ connected in parallel between A and B.

Step 1 — Write the reciprocal relation: $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{6} + \frac{1}{3}$.

Step 2 — Take a common denominator: $\frac{1}{R} = \frac{1}{6} + \frac{2}{6} = \frac{1+2}{6} = \frac{3}{6} = \frac{1}{2}\,\Omega^{-1}$.

Step 3 — Invert: $R = 2\,\Omega$. As a check, $\frac{R_1 R_2}{R_1 + R_2} = \frac{6 \times 3}{6+3} = \frac{18}{9} = 2\,\Omega$, and indeed $2\,\Omega < 3\,\Omega$ (the smaller branch).

Why each other option is wrong:

- (A) $9\,\Omega$ is the series sum $6 + 3$, valid only if the resistors were in series.
- (B) $4.5\,\Omega$ is the simple average of 6 and 3, which is not how parallel resistors combine.
- (D) $18\,\Omega$ is the product 6×3 without dividing by the sum.

Key point: For two resistors in parallel the shortcut $R = \frac{R_1 R_2}{R_1 + R_2}$ (product over sum) is fast and the result must be less than the smallest branch.

Final Answer: $R = 2\,\Omega \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q3

Q4.

Solution

Concept — Electric power: The power dissipated by an electrical device equals the product of the voltage across it and the current through it: $P = VI$, where P is the power (W), V is the potential difference (V), and I is the current (A). Rearranging gives the current $I = \frac{P}{V}$. The rating of a bulb tells us the power it consumes at its rated voltage.

Given: Rated power $P = 60$ W; supply voltage $V = 120$ V.

Step 1 — Rearrange the power formula: From $P = VI$, the current is $I = \frac{P}{V}$.

Step 2 — Substitute with units: $I = \frac{60\text{ W}}{120\text{ V}} = \frac{60}{120}$ A.

Step 3 — Evaluate: $I = 0.5$ A.

Why each other option is wrong:

- (A) 2 A comes from inverting the ratio as $\frac{V}{P} = \frac{120}{60}$.
- (B) 1 A uses $V = 60$ V instead of 120 V.
- (C) 0.25 A uses a 240 V supply rather than the given 120 V.

Key point: Current equals power divided by voltage; keep the rated voltage that matches the supply, and watch the units (W/V = A).

Final Answer: $I = 0.5\text{ A} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q4

Q5.

Solution

Concept — Parallel plate capacitor: The capacitance of a parallel plate capacitor measures how much charge it stores per unit voltage. It is given by $C = \frac{\varepsilon_0 A}{d}$, where C is the capacitance (F), ε_0 is the permittivity of free space, A is the plate area (m^2), and d is the plate separation (m). With A and the dielectric unchanged, $C \propto \frac{1}{d}$: bringing the plates closer raises the capacitance.

Given: Original capacitance $= C$; new separation $= \frac{d}{2}$; area A and dielectric unchanged.

Step 1 — Write the proportionality: Holding $\varepsilon_0 A$ fixed, $C = \frac{\text{(constant)}}{d}$.

Step 2 — Substitute the new separation: $C' = \frac{\varepsilon_0 A}{d/2} = \frac{2\,\varepsilon_0 A}{d} = 2\left(\frac{\varepsilon_0 A}{d}\right)$.

Step 3 — Simplify: Since $\frac{\varepsilon_0 A}{d} = C$, the new capacitance is $C' = 2C$.

Why each other option is wrong:

- (B) $C/2$ assumes $C \propto d$, the inverse of the true relation.
- (C) $4C$ would require $C \propto \frac{1}{d^2}$, which is not how capacitance depends on d.
- (D) C ignores the change in separation entirely.

Key point: Capacitance is inversely proportional to plate separation, so halving d doubles C.

Final Answer: $2C \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q5

Q6.

Solution

Concept — Acceleration from a v–t graph: On a velocity–time graph, the slope of the line at any instant equals the acceleration. For uniform acceleration the graph is a straight line, and the slope is $a = \dfrac{\Delta v}{\Delta t}$, where Δv is the change in velocity (m/s) and Δt is the corresponding time interval (s). A straight line through the origin means the body starts from rest and accelerates uniformly.

Given: The body starts from rest ($v = 0$ at $t = 0$) and the velocity reaches 20 m/s at $t = 4$ s.

Step 1 — Identify the two points on the line: Initial point $(0 \text{ s}, 0 \text{ m/s})$ and final point $(4 \text{ s}, 20 \text{ m/s})$.

Step 2 — Compute the changes: $\Delta v = 20 - 0 = 20$ m/s and $\Delta t = 4 - 0 = 4$ s.

Step 3 — Take the slope: $a = \dfrac{\Delta v}{\Delta t} = \dfrac{20 \text{ m/s}}{4 \text{ s}} = 5 \text{ m/s}^2$.

Why each other option is wrong:

- (A) 2.5 m/s^2 halves the slope, as if $\Delta v = 10$ m/s.
- (C) 10 m/s^2 misreads the time as 2 s.
- (D) 20 m/s^2 takes Δv as the slope and ignores the 4 s interval.

Key point: The slope of a v–t line is acceleration; read both axes carefully and divide Δv by Δt.

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

Answer: (B) Go Back to Q6

Q7.

Solution

Concept — Dimensional formula of force: The dimensional formula expresses a physical quantity in terms of the base quantities mass $[M]$, length $[L]$, and time $[T]$. Force is defined by Newton's second law as $F = ma$, where m is mass and a is acceleration. Acceleration is the rate of change of velocity, so its dimensions are length per time squared, $[LT^{-2}]$.

Step 1 — Write the dimensions of each factor: Mass has dimensions $[M]$. Velocity is length/time $= [LT^{-1}]$, so acceleration (velocity/time) is $[LT^{-2}]$.

Step 2 — Multiply for force: $[F] = [m][a] = [M]\,[LT^{-2}]$.

Step 3 — Combine the symbols: $[F] = [MLT^{-2}]$. (In SI this corresponds to kg m s^{-2} = newton.)

Why each other option is wrong:

- (A) $[ML^2T^{-2}]$ is the dimension of energy or work ($F\times$ distance).
- (B) $[MLT^{-1}]$ is the dimension of linear momentum (mv).
- (D) $[ML^{-1}T^{-2}]$ is the dimension of pressure or stress (force per area).

Key point: Build force from $F = ma$; the single power of L and the T^{-2} distinguish it from energy, momentum, and pressure.

Final Answer: $[MLT^{-2}] \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q7

Q8.

Solution

Concept — Vertical motion under gravity: A ball thrown straight up decelerates uniformly at g until, at the highest point, its velocity momentarily becomes zero. Using $v = u - gt$ with $v = 0$ at the top gives the time to reach maximum height as $t = \frac{u}{g}$, where u is the initial upward speed (m/s) and g is the acceleration due to gravity (m/s^2).

Given: Initial speed $u = 30$ m/s (upward); $g = 10$ m/s^2; velocity at top $v = 0$.

Step 1 — Apply the equation of motion: $v = u - gt \Rightarrow 0 = 30 - 10\,t$.

Step 2 — Solve for t: $10\,t = 30 \Rightarrow t = \dfrac{30 \text{ m/s}}{10 \text{ m/s}^2}$.

Step 3 — Evaluate: $t = 3$ s. This is the time to rise to the top only.

Why each other option is wrong:

- (A) 6 s is the total time of flight (up and back down), which is twice the time to the top.
- (B) 1.5 s uses $g = 20$ m/s^2.
- (C) 4.5 s uses an incorrect value of g (about 6.7 m/s^2).

Key point: Time to the highest point is u/g; the full up-and-down flight takes twice as long ($2u/g$).

Final Answer: $t = 3 \text{ s} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q8

Q9.

Solution

Concept — Block on a smooth incline: On a frictionless inclined plane, the only force driving the block along the surface is the component of gravity parallel to the incline, $mg\sin\theta$. The normal force balances the perpendicular component $mg\cos\theta$. Applying Newton's second law along the incline, $ma = mg\sin\theta$, so $a = g\sin\theta$; the mass cancels, where θ is the angle of inclination and g the gravitational acceleration.

Given: Incline angle $\theta = 30°$; surface frictionless; $g = 10$ m/s^2.

Step 1 — Write the formula: $a = g\sin\theta$.

Step 2 — Substitute the values: $a = 10$ m/s$^2 \times \sin 30° = 10 \times 0.5$ m/s^2.

Step 3 — Evaluate: $a = 5$ m/s^2, directed down the incline.

Why each other option is wrong:

- (B) 10 m/s^2 is the free-fall value, valid only for a vertical drop ($\theta = 90°$).
- (C) 2.5 m/s^2 corresponds to $g\sin^2\theta$ or a wrong factor, not $\sin 30°$.
- (D) 7.5 m/s^2 would need $\sin\theta = 0.75$, which does not match $30°$.

Key point: On a smooth incline the acceleration is $g\sin\theta$, independent of mass; $\sin 30° = 0.5$ halves g.

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

Answer: (A) Go Back to Q9

Q10.

Solution

Concept — Force from change in momentum: Newton's second law in its general form states that force equals the rate of change of momentum: $F = \dfrac{\Delta p}{\Delta t} = \dfrac{m\,\Delta v}{\Delta t}$, where Δp is the change in momentum (kg m/s), m is the mass (kg), Δv is the change in velocity (m/s), and Δt is the time over which it occurs (s). Bringing a body to rest reverses its momentum to zero, so Δv equals the initial speed in magnitude.

Given: $m = 2$ kg; initial speed $= 5$ m/s; final speed $= 0$; $\Delta t = 2$ s.

Step 1 — Find the change in momentum: $\Delta p = m\,\Delta v = 2$ kg $\times (5 - 0)$ m/s $=$ 10 kg m/s.

Step 2 — Divide by the time: $F = \dfrac{\Delta p}{\Delta t} = \dfrac{10 \text{ kg m/s}}{2 \text{ s}}$.

Step 3 — Evaluate: $F = 5$ N (a retarding force, opposite to the motion).

Why each other option is wrong:

- (A) 10 N forgets to divide the momentum change by the 2 s interval.
- (C) 2.5 N divides by an incorrect time of 4 s.
- (D) 20 N multiplies instead of dividing by time.

Key point: Force = change in momentum ÷ time; equivalently $F = ma$ with $a = \Delta v/\Delta t = 5/2 = 2.5$ m/s^2 gives the same 5 N.

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

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — Kinetic energy: The kinetic energy of a moving body is the energy it possesses due to its motion. It is given by $KE = \frac{1}{2}mv^2$, where KE is in joules (J), m is the mass (kg), and v is the speed (m/s). Note the dependence on the *square* of the speed, so doubling the speed quadruples the kinetic energy.

Given: $m = 4$ kg; $v = 3$ m/s.

Step 1 — Write the formula and substitute: $KE = \frac{1}{2}mv^2 = \frac{1}{2}(4 \text{ kg})(3 \text{ m/s})^2$.

Step 2 — Square the speed: $(3 \text{ m/s})^2 = 9 \text{ m}^2/\text{s}^2$, so $KE = \frac{1}{2}(4)(9)$ J.

Step 3 — Evaluate: $KE = \frac{1}{2} \times 36 = 18$ J.

Why each other option is wrong:

- (A) 6 J drops the square, using $\frac{1}{2}mv = \frac{1}{2}(4)(3)$.
- (B) 12 J uses $\frac{1}{2}mv$ with the wrong arithmetic or forgets a factor.
- (D) 36 J omits the factor $\frac{1}{2}$ $(mv^2 = 4 \times 9)$.

Key point: Square the speed first, then apply the $\frac{1}{2}$ factor; energy scales with v^2, not v.

Final Answer: $KE = 18 \text{ J} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q11

Q12.

Solution

Concept — Variation of g with height: The acceleration due to gravity decreases with height because the distance from the Earth's centre increases. At a height h above the surface, $g' = g\left(\frac{R}{R+h}\right)^2$, where g is the surface value, R is the Earth's radius, and h is the height. This follows directly from Newton's law of gravitation, $g \propto \frac{1}{(\text{distance from centre})^2}$.

Given: Surface value $g = 10 \text{ m/s}^2$; height $h = R$ (equal to the Earth's radius).

Step 1 — Substitute $h = R$: $g' = g\left(\frac{R}{R+R}\right)^2 = g\left(\frac{R}{2R}\right)^2$.

Step 2 — Simplify the ratio: $\left(\frac{R}{2R}\right)^2 = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$, so $g' = \frac{g}{4}$.

Step 3 — Evaluate: $g' = \frac{10 \text{ m/s}^2}{4} = 2.5 \text{ m/s}^2$.

Why each other option is wrong:

- (A) 10 m/s^2 ignores the height altogether.
- (B) 5 m/s^2 uses $g/2$, forgetting to square the distance ratio.
- (C) 1.25 m/s^2 uses $g/8$, an over-correction.

Key point: At height $h = R$ the distance from the centre doubles, so g falls to one-quarter, not one-half.

Final Answer: $g' = 2.5 \text{ m/s}^2 \Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q12**

Q13.

Solution

Concept — Excess pressure in a liquid drop: Surface tension makes the curved surface of a liquid drop behave like a stretched membrane, so the pressure just inside the drop is greater than outside. For a spherical drop, which has a single liquid–air surface, the excess (gauge) pressure is $\Delta P = \frac{2T}{r}$, where T is the surface tension (N/m) and r is the radius of the drop (m). The smaller the drop, the larger the excess pressure.

Step 1 — Count the surfaces: A liquid drop has only *one* surface separating liquid from air, unlike a soap bubble which has two (inner and outer).

Step 2 — Apply the surface-tension result: For each surface the contribution is $\frac{2T}{r}$; with one surface the drop gives $\Delta P = \frac{2T}{r}$.

Step 3 — Contrast with a bubble: A soap bubble with two surfaces would give $\Delta P = \frac{4T}{r}$, double the drop's value, confirming the factor for a single-surface drop is 2.

Why each other option is wrong:

- (B) $\frac{4T}{r}$ applies to a soap bubble (two surfaces), not a drop.
- (C) $\frac{T}{r}$ omits the factor of 2 from surface curvature.
- (D) $\frac{T}{2r}$ halves the result instead of doubling it.

Key point: Drop (one surface) $\Rightarrow \frac{2T}{r}$; soap bubble (two surfaces) $\Rightarrow \frac{4T}{r}$.

Final Answer: $\Delta P = \frac{2T}{r} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q13

Q14.

Solution

Concept — Young's modulus: Young's modulus measures the stiffness of a material under tension. It is the ratio of tensile stress to longitudinal strain: $Y = \frac{\text{stress}}{\text{strain}} = \frac{F/A}{\Delta L/L} = \frac{FL}{A\,\Delta L}$, where F is the load (N), L is the original length (m), A is the cross-sectional area (m^2), and ΔL is the extension (m). Rearranging gives the load $F = \frac{YA\,\Delta L}{L}$.

Given: $L = 2$ m; $A = 1\ \text{mm}^2 = 1 \times 10^{-6}\ \text{m}^2$; $\Delta L = 1\ \text{mm} = 1 \times 10^{-3}$ m; $Y = 2 \times 10^{11}$ Pa.

Step 1 — Write the load formula: $F = \frac{YA\,\Delta L}{L}$.

Step 2 — Substitute with units: $F = \frac{(2 \times 10^{11}\ \text{Pa})(1 \times 10^{-6}\ \text{m}^2)(1 \times 10^{-3}\ \text{m})}{2\ \text{m}}$.

Step 3 — Evaluate: Numerator $= 2 \times 10^{11} \times 10^{-6} \times 10^{-3} = 2 \times 10^{2} = 200$ N m; dividing by $L = 2$ m gives $F = \frac{200}{2} = 100$ N.

Why each other option is wrong:

- (A) 50 N divides by an extra factor (e.g. uses $A = 0.5\ \text{mm}^2$).

- (C) 200 N forgets to divide by the length $L = 2$ m.
- (D) 400 N uses a wrong area or doubles the load.

Key point: Convert mm^2 to m^2 (10^{-6}) and mm to m (10^{-3}) before substituting, and remember to divide by the original length.

Final Answer: $F = 100$ N $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q14

Q15.

Solution

Concept — Linear thermal expansion: When a solid rod is heated, it expands in length in proportion to its original length, the temperature rise, and the material's coefficient of linear expansion. The increase in length is $\Delta L = L\,\alpha\,\Delta T$, where L is the original length (m), α is the coefficient of linear expansion (°C^{-1}), and ΔT is the temperature change (°C).

Given: $L = 1$ m; $\alpha = 1.2 \times 10^{-5}$ °C^{-1}; $\Delta T = 50$ °C.

Step 1 — Write the formula and substitute: $\Delta L = L\,\alpha\,\Delta T = (1 \text{ m})(1.2 \times 10^{-5}$ °C$^{-1})(50$ °C$)$.

Step 2 — Multiply the numbers: $1.2 \times 10^{-5} \times 50 = 60 \times 10^{-5} = 6 \times 10^{-4}$, so $\Delta L = 6 \times 10^{-4}$ m.

Step 3 — Convert to millimetres: 6×10^{-4} m $= 0.6 \times 10^{-3}$ m $= 0.6$ mm.

Why each other option is wrong:

- (A) 0.2 mm uses $\Delta T \approx 17$°C or a wrong α.
- (B) 0.4 mm uses $\Delta T \approx 33$°C instead of 50°C.
- (D) 1.2 mm doubles the correct result (e.g. uses $\Delta T = 100$°C).

Key point: Keep the units of α and ΔT consistent (both per °C) and convert the final answer from metres to millimetres.

Final Answer: $\Delta L = 0.6$ mm $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q15

Q16.

Solution

Concept — Heat and specific heat (calorimetry): The heat needed to change the temperature of a substance without a change of state is $Q = mc\,\Delta T$, where Q is the heat (J), m is the mass (kg), c is the specific heat capacity (J kg^{-1} °C^{-1}), and ΔT is the temperature change (°C). Specific heat is the heat needed to raise 1 kg of the substance by 1°C.

Given: $m = 2$ kg; $\Delta T = 10$ °C; $c = 4200$ J kg^{-1}°C^{-1}.

Step 1 — Write the formula and substitute: $Q = mc\,\Delta T = (2 \text{ kg})(4200 \text{ J kg}^{-1}°\text{C}^{-1})(10 \text{ °C})$.

Step 2 — Multiply step by step: $2 \times 4200 = 8400$ J/°C; then $8400 \times 10 = 84000$ J.

Step 3 — State the result: $Q = 84000$ J $= 84$ kJ.

Why each other option is wrong:

- (A) 21000 J halves the mass and the temperature rise.
- (B) 42000 J uses $m = 1$ kg instead of 2 kg.
- (C) 8400 J uses $\Delta T = 1$°C instead of 10°C.

Key point: Multiply all three factors m, c, and ΔT together; the units (kg)(J kg^{-1}°C^{-1})(°C) cancel to leave joules.

Final Answer: $Q = 84000$ J $\Rightarrow$ D

Answer: (D) Go Back to Q16

Q17.

Solution

Concept — Isothermal process: For an ideal gas the internal energy depends *only* on its absolute temperature, $U = \frac{f}{2}nRT$, where f is the number of degrees of freedom, n the number of moles, R the gas constant, and T the temperature. An isothermal process is one carried out at constant temperature ($\Delta T = 0$), usually slowly while in contact with a heat reservoir.

Step 1 — Apply constant temperature: Since U depends only on T and $\Delta T = 0$, the change in internal energy is $\Delta U = 0$.

Step 2 — Check with the first law: The first law states $Q = \Delta U + W$. With $\Delta U = 0$, this becomes $Q = W$: all the heat supplied is converted into work done by the gas.

Step 3 — Interpret: The heat Q and the work W are individually non-zero and equal, but the quantity asked for, the change in internal energy, is exactly zero.

Why each other option is wrong:

- (B) "equal to the work done by the gas" describes Q, not ΔU.
- (C) "equal to the heat supplied" also describes Q $(= W)$, not the internal-energy change.
- (D) "negative" would require a temperature drop, but T is constant here.

Key point: For an ideal gas, no temperature change means no internal-energy change, regardless of heat and work flowing.

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

Answer: (A) Go Back to Q17

Q18.

Solution

Concept — Force on a current-carrying wire: A wire carrying current in a magnetic field experiences a force given by $F = BIL\sin\theta$, where B is the magnetic flux density (T), I is the current (A), L is the length of wire in the field (m), and θ is the angle between the wire and the field. When the wire is perpendicular to the field, $\theta = 90^\circ$, $\sin\theta = 1$, and the force is maximum: $F = BIL$.

Given: $B = 0.2$ T; $I = 4$ A; $L = 0.5$ m; wire perpendicular to B $(\theta = 90^\circ)$.

Step 1 — Use the perpendicular case: Since $\sin 90^\circ = 1$, $F = BIL$.

Step 2 — Substitute with units: $F = (0.2\text{ T})(4\text{ A})(0.5\text{ m})$.

Step 3 — Evaluate: $0.2 \times 4 = 0.8$; $0.8 \times 0.5 = 0.4$, so $F = 0.4$ N.

Why each other option is wrong:

- (A) 0.2 N drops the length factor L.
- (C) 0.8 N uses $L = 1$ m instead of 0.5 m (doubling the result).
- (D) 4 N keeps only the current and ignores B and L.

Key point: Use $F = BIL$ only when the wire is perpendicular to the field; otherwise include $\sin\theta$.

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

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — Faraday's law of electromagnetic induction: An emf is induced in a coil only when the magnetic flux linking it *changes*. The magnitude of the induced emf equals the rate of change of flux: $\varepsilon = -N\frac{d\Phi}{dt}$, where ε is the emf (V), N is the number of turns, Φ is the magnetic flux (Wb), and $\frac{d\Phi}{dt}$ is how fast the flux changes. The negative sign (Lenz's law) shows the emf opposes the change.

Step 1 — Identify what controls the emf: The emf depends on $\frac{d\Phi}{dt}$, the *rate* of change of flux, not on the flux value itself.

Step 2 — Decide what makes it large: A larger $\frac{d\Phi}{dt}$ gives a larger emf, so the flux must change rapidly.

Step 3 — Select the option: The induced emf is large when the magnetic flux through the coil changes rapidly.

Why each other option is wrong:

- (A) constant flux $\Rightarrow \frac{d\Phi}{dt} = 0 \Rightarrow$ zero emf, not large.
- (B) a large but steady flux still gives no emf, since nothing is changing.
- (D) resistance affects the induced *current* ($I = \varepsilon/R$), not the induced emf.

Key point: It is the speed of change of flux that induces emf; a steady flux, however large, induces none.

Final Answer: Flux changes rapidly $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q19

Q20.

Solution

Concept — RMS value of an alternating current: The root-mean-square (rms) value of an AC is the steady (DC) current that would dissipate the same average power in a resistor. For a sinusoidal current $i = I_0 \sin\omega t$, averaging i^2 over a cycle gives $\langle i^2 \rangle = \frac{I_0^2}{2}$, so the rms value is $I_{rms} = \sqrt{\langle i^2 \rangle} = \frac{I_0}{\sqrt{2}}$, where I_0 is the peak (maximum) current.

Step 1 — Square and average: The mean of $\sin^2 \omega t$ over a full cycle is $\frac{1}{2}$, so the mean of i^2 is $\dfrac{I_0^2}{2}$.

Step 2 — Take the square root: $I_{rms} = \sqrt{\dfrac{I_0^2}{2}} = \dfrac{I_0}{\sqrt{2}}$.

Step 3 — Numerical factor: $\dfrac{1}{\sqrt{2}} \approx 0.707$, so $I_{rms} \approx 0.707\, I_0$, which is less than the peak as expected.

Why each other option is wrong:

- (A) I_0 is the peak value, which is always larger than the rms value.
- (B) $2I_0$ is twice the peak and is physically impossible for the rms.
- (C) $I_0/2$ uses the wrong factor; it would correspond to averaging i, not i^2.

Key point: For a pure sine wave, $I_{rms} = \dfrac{I_0}{\sqrt{2}}$ and similarly $V_{rms} = \dfrac{V_0}{\sqrt{2}}$.

Final Answer: $I_{rms} = \dfrac{I_0}{\sqrt{2}} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q20

Q21.

Solution

Concept — Mirror formula: For a spherical mirror, the object distance u, image distance v, and focal length f are related by $\dfrac{1}{v} + \dfrac{1}{u} = \dfrac{1}{f}$. Here we use magnitudes for a concave mirror forming a real image of a real object, with the object placed beyond the focus. A concave mirror has a real focus, $f = 15$ cm, and a real image forms in front of the mirror.

Given: Object distance $u = 30$ cm; focal length $f = 15$ cm (concave).

Step 1 — Rearrange for $1/v$: $\dfrac{1}{v} = \dfrac{1}{f} - \dfrac{1}{u} = \dfrac{1}{15} - \dfrac{1}{30}$.

Step 2 — Common denominator: $\dfrac{1}{v} = \dfrac{2}{30} - \dfrac{1}{30} = \dfrac{2-1}{30} = \dfrac{1}{30}\ \text{cm}^{-1}$.

Step 3 — Invert: $v = 30$ cm. The object sits at the centre of curvature ($R = 2f = 30$ cm), so the image forms at the same point, real, inverted, and the same size.

Why each other option is wrong:

- (B) 15 cm is just the focal length, not the image distance.

- (C) 10 cm does not satisfy the mirror formula with these values.
- (D) 60 cm would correspond to an object placed between F and the mirror, not at 30 cm.

Key point: When an object is at the centre of curvature ($u = 2f$), the image also forms at $2f$; here $v = 30$ cm.

Final Answer: $v = 30$ cm $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q21

Q22.

Solution

Concept — Refractive index: The (absolute) refractive index of a medium measures how much it slows down light compared with a vacuum. It is defined as $n = \frac{c}{v}$, where c is the speed of light in vacuum (3×10^8 m/s) and v is the speed of light in the medium (m/s). Since light always travels slower in a medium than in vacuum, $n \geq 1$.

Given: Speed in the medium $v = 2 \times 10^8$ m/s; speed in vacuum $c = 3 \times 10^8$ m/s.

Step 1 — Write the formula and substitute: $n = \frac{c}{v} = \frac{3 \times 10^8 \text{ m/s}}{2 \times 10^8 \text{ m/s}}$.

Step 2 — Cancel the powers of ten: The 10^8 and the units cancel, leaving $n = \frac{3}{2}$.

Step 3 — Evaluate: $n = 1.5$ (a typical value for glass).

Why each other option is wrong:

- (A) 1.0 would mean light is not slowed at all (vacuum), contradicting $v < c$.
- (C) 2.0 uses a wrong ratio (e.g. $c/(1.5 \times 10^8)$).
- (D) 0.67 is $\frac{v}{c}$, the reciprocal, which can never be the refractive index ($n \geq 1$).

Key point: Refractive index is c/v (vacuum speed over medium speed) and is always at least 1.

Final Answer: $n = 1.5 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Thin lenses in contact: When two thin lenses are placed in contact, the combination behaves like a single lens whose power is the algebraic sum of the individual powers: $P = P_1 + P_2$, where power $P = \dfrac{1}{f}$ is measured in dioptres (D) with f in metres. Converging (convex) lenses have positive power; diverging (concave) lenses have negative power.

Given: $P_1 = +2$ D and $P_2 = +3$ D, both lenses in contact.

Step 1 — Write the addition rule: $P = P_1 + P_2$.

Step 2 — Substitute the values: $P = (+2\text{ D}) + (+3\text{ D})$.

Step 3 — Evaluate: $P = +5$ D (the combination is more strongly converging, focal length $f = \frac{1}{5} = 0.2$ m).

Why each other option is wrong:

- (A) $+1$ D subtracts the powers instead of adding them.
- (B) $+2.5$ D averages the two powers, which is not the rule.
- (D) $+6$ D multiplies the powers, which has no physical basis here.

Key point: Powers of lenses in contact simply add (with correct signs); add reciprocals only when dealing with focal lengths in series.

Final Answer: $P = +5\text{ D} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q23

Q24.

Solution

Concept — Work function in the photoelectric effect: Electrons in a metal are bound by the attraction of the lattice. The work function ϕ is the *minimum* energy required to free the least tightly bound electron from the metal surface. It is related to the threshold frequency by $\phi = h\nu_0$, where h is Planck's constant and ν_0 is the lowest frequency of light that can just eject an electron.

Step 1 — Apply Einstein's photoelectric equation: $K_{\text{max}} = h\nu - \phi$, where $h\nu$ is the incident photon energy and K_{max} is the maximum kinetic energy of the emitted electron. Here ϕ is the energy barrier the photon must first overcome.

Step 2 — Interpret each term: A photon must supply at least ϕ to release an electron; any extra energy ($h\nu - \phi$) appears as the electron's kinetic energy.

Step 3 — Identify the work function: It is therefore the minimum energy needed to eject an electron from the metal surface.

Why each other option is wrong:

- (A) maximum kinetic energy $K_{\max}$ describes the emitted electron, not the binding energy.
- (B) the incident photon energy is $h\nu$, which can exceed ϕ.
- (C) stopping potential V_0 relates to $K_{\max}$ ($eV_0 = K_{\max}$), again a property of the emitted electron.

Key point: Work function = threshold energy $h\nu_0$ to liberate an electron; it is a fixed property of the metal, independent of the incident light.

Final Answer: Minimum energy to eject an electron $\Rightarrow \boxed{\text{D}}$

Answer: (D) **Go Back to Q24**

Q25.

Solution

Concept — Energy of a photon: Light is quantised into packets called photons. The energy of a single photon is $E = h\nu$, where E is the energy (J), $h = 6.6 \times 10^{-34}$ J s is Planck's constant, and ν is the frequency of the light (Hz). Higher-frequency light carries more energy per photon.

Given: $\nu = 5 \times 10^{14}$ Hz; $h = 6.6 \times 10^{-34}$ J s.

Step 1 — Write the formula and substitute: $E = h\nu = (6.6 \times 10^{-34}\text{ J s})(5 \times 10^{14}\text{ Hz})$.

Step 2 — Multiply the mantissas and add the exponents: $6.6 \times 5 = 33$ and $10^{-34} \times 10^{14} = 10^{-20}$, so $E = 33 \times 10^{-20}$ J.

Step 3 — Write in standard form: $E = 3.3 \times 10^{-19}$ J.

Why each other option is wrong:

- (B) 6.6×10^{-19} J doubles the result (uses $\nu = 10^{15}$ Hz).
- (C) 1.3×10^{-19} J comes from wrong multiplication of the mantissas.
- (D) 3.3×10^{-20} J keeps the wrong power of ten (off by a factor of 10).

Key point: Multiply the decimal parts and add the powers of ten separately, then convert 33×10^{-20} to 3.3×10^{-19}.

Final Answer: $E = 3.3 \times 10^{-19}$ J $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q25

Q26.

Solution

Concept — Bohr model of the hydrogen atom: In Bohr's model the electron moves in fixed circular orbits in which its angular momentum is quantised, $mvr = \frac{nh}{2\pi}$. Solving the dynamics gives the radius of the nth orbit as $r_n = \frac{n^2h^2\varepsilon_0}{\pi me^2}$, where n is the principal quantum number and h, ε_0, m, e are physical constants. For hydrogen this gives $r_n = 0.53\, n^2$ Å.

Step 1 — Separate the variable from the constants: Every factor except n^2 is a fixed constant, so $r_n \propto n^2$.

Step 2 — Verify with numbers: The first orbit ($n = 1$) has radius r_1; the second ($n = 2$) has $r_2 = 4r_1$ and the third ($n = 3$) has $r_3 = 9r_1$, exactly matching the n^2 pattern.

Step 3 — Conclusion: The orbit radius grows as the square of the quantum number, $r_n \propto n^2$.

Why each other option is wrong:

- (A) n underestimates the growth; the radius rises faster than linearly.
- (B) $1/n$ would mean orbits shrink with increasing n, the opposite of what happens.
- (D) $1/n^2$ describes the magnitude of the energy level ($E_n \propto -1/n^2$), not the radius.

Key point: In Bohr's model radius $\propto n^2$ (orbits spread out), while energy magnitude $\propto 1/n^2$ (levels crowd together).

Final Answer: $r_n \propto n^2 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q26

Q27.

Solution

Concept — Time period of a simple pendulum: For small oscillations a simple pendulum executes simple harmonic motion with time period $T = 2\pi\sqrt{\frac{L}{g}}$, where T is the period (s), L is the length of the pendulum (m), and g is the acceleration due to gravity (m/s^2). The period is independent of the mass of the bob and of the (small) amplitude.

Given: $L = 1$ m; $g = 10$ m/s^2; use $\pi^2 \approx 10$.

Step 1 — Substitute into the formula: $T = 2\pi\sqrt{\frac{L}{g}} = 2\pi\sqrt{\frac{1\text{ m}}{10\text{ m/s}^2}}$.

Step 2 — Simplify the surd: $T = 2\pi\sqrt{\frac{1}{10}} = \frac{2\pi}{\sqrt{10}}$ s.

Step 3 — Use $\pi^2 \approx 10$: Square the expression: $T^2 = \frac{4\pi^2}{10} = \frac{4\times 10}{10} = 4$, so $T = \sqrt{4} = 2$ s.

Why each other option is wrong:

- (A) 1 s halves the period (drops the factor 2).
- (C) 3.14 s keeps only π and ignores the $\sqrt{L/g}$ factor.
- (D) 4 s uses T^2 as if it were T, doubling the answer.

Key point: The approximation $\pi^2 \approx 10$ neatly cancels the $g = 10$, giving the clean result $T = 2$ s for a 1 m pendulum.

Final Answer: $T \approx 2$ s $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q27

Q28.

Solution

Concept — Wave speed relation: For any wave, the speed equals the product of frequency and wavelength: $v = f\lambda$, where v is the wave speed (m/s), f is the frequency (Hz, i.e. cycles per second), and λ is the wavelength (m, the distance covered in one cycle). This follows because the wave advances one wavelength every period $T = 1/f$.

Given: Frequency $f = 500$ Hz; wavelength $\lambda = 0.6$ m.

Step 1 — Write the formula and substitute: $v = f\lambda = (500\text{ Hz})(0.6\text{ m})$.

Step 2 — Multiply: $500 \times 0.6 = 300$, with units $\text{Hz} \cdot \text{m} = \text{s}^{-1} \cdot \text{m} = \text{m/s}$.

Step 3 — State the result: $v = 300$ m/s (a reasonable speed of sound in air).

Why each other option is wrong:

- (A) 83 m/s divides $\frac{500}{0.6}$ wrongly, or inverts the relation.
- (B) 500 m/s is just the frequency value, not the speed.
- (C) 0.6 m/s is just the wavelength value taken as a speed.

Key point: Speed is frequency times wavelength; check the units multiply to m/s.

Final Answer: $v = 300 \text{ m/s} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q28

Q29.

Solution

Concept — p-type semiconductor: A pure (intrinsic) semiconductor such as silicon has four valence electrons per atom. Doping it with a trivalent impurity (group-13 elements like boron, aluminium, or gallium) leaves one bond short of an electron at each impurity site. This vacancy, called a *hole*, behaves as a mobile positive charge carrier. Such doping produces a p-type (positive-type) semiconductor.

Step 1 — Effect of trivalent doping: Each trivalent atom accepts an electron from a neighbouring bond, creating a hole; the impurity is therefore called an acceptor.

Step 2 — Compare carrier numbers: The large number of acceptor atoms creates many holes, so holes greatly outnumber the thermally generated free electrons.

Step 3 — Identify the majority carriers: The majority charge carriers in a p-type semiconductor are holes (electrons are the minority carriers).

Why each other option is wrong:

- (B) electrons are the *minority* carriers in p-type material, not the majority.
- (C) protons are bound in atomic nuclei and never act as mobile charge carriers.
- (D) positive ions are part of the fixed crystal lattice and do not conduct current.

Key point: p-type $\Rightarrow$ trivalent (acceptor) dopant $\Rightarrow$ majority carriers are holes;

n-type would have electrons as majority carriers.

Final Answer: Holes ⇒ A

Answer: (A) Go Back to Q29

Q30.

Solution

Concept — p-n junction diode: A p-n junction has a depletion region at the boundary that sets up a potential barrier opposing the flow of majority carriers. A diode conducts an appreciable current only when this barrier is reduced, which happens when the p-side is connected to the positive terminal and the n-side to the negative terminal of the supply. This condition is called *forward bias*.

Step 1 — Forward bias: The external voltage opposes the built-in barrier, narrowing the depletion region. Once the applied voltage exceeds the knee voltage (about 0.7 V for silicon), a large forward current flows.

Step 2 — Reverse bias: If the p-side is made negative and the n-side positive, the barrier widens, the depletion region grows, and only a very small reverse saturation (leakage) current flows.

Step 3 — Conclusion: Appreciable current flows only in forward bias.

Why each other option is wrong:

- (A) reverse biased ⇒ wide barrier ⇒ negligible current (until breakdown).
- (B) unbiased ⇒ no net applied voltage ⇒ no steady current.
- (D) a high frequency by itself does not bias the junction or turn it on.

Key point: A diode is essentially a one-way valve: it conducts strongly only when forward biased (p to $+$, n to $-$).

Final Answer: Forward biased ⇒ C

Answer: (C) Go Back to Q30

Answer Key

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