JCECE Physics Sample Paper – 7

Duration: 60 Minutes **Maximum Marks: 50**

Instructions

- This paper contains **50** Multiple Choice Questions (Single Correct Answer), modelled on the Physics portion of **JCECE** entrance.
- Each correct answer carries **+1 mark**. There is -0.25 **mark** for each incorrect answer; unattempted questions get 0.
- Only **one** option is correct. Choose carefully.
- Syllabus level: **Class 11 and Class 12 NCERT Physics (Jharkhand JAC / CBSE aligned).**
- Use of mobile phones, calculators, or electronic gadgets is strictly prohibited.

Q1. The dimensional formula of electric field strength E (force per unit charge) is:

(A) $[\mathrm{MLT^{-2}A^{-1}}]$

(B) $[\mathrm{ML^2T^{-3}A^{-1}}]$

(C) $[\mathrm{MLT^{-3}A^{-1}}]$

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

Q2. The radius of a sphere is measured with a relative (fractional) error of 2%. The relative error in the calculated surface area ($\propto r^2$) is:

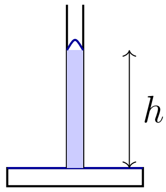
(A) 1%

(B) 2%

(C) 6%

(D) 4%

Q3. Water rises to a height of 4 cm in a clean glass capillary of radius r (contact angle $0°$). If the tube is replaced by one of radius $r/2$ of the same liquid, the new capillary rise is:



(A) 8 cm

(B) 2 cm

(C) 4 cm

(D) 16 cm

Q4. A wire of cross-sectional area 0.5 mm^2 breaks under a maximum load of 40 N. The breaking stress of the material is:

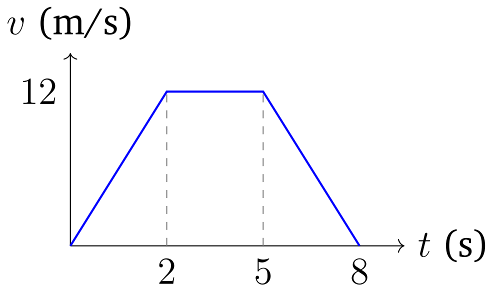
(A) 4×10^7 N/m^2

(B) 8×10^7 N/m^2

(C) 2×10^7 N/m^2

(D) 8×10^8 N/m^2

Q5. The velocity–time graph of a particle is shown. The distance covered only during the retardation (deceleration) phase is:



(A) 12 m

(B) 24 m

(C) 36 m

(D) 18 m

Q6. A projectile fired at 35° above the horizontal has a certain horizontal range. The other angle of projection (same speed) that gives the same range is:

(A) 55°

(B) 45°

(C) 65°

(D) 70°

Q7. An aeroplane flies due north at 80 m/s while a steady wind blows due east at 60 m/s. The magnitude of the aeroplane's resultant ground speed is:

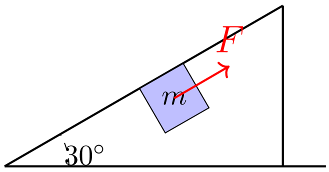
(A) 140 m/s

(B) 100 m/s

(C) 20 m/s

(D) 120 m/s

Q8. A block of mass 2 kg is pushed up a smooth incline of angle 30° at constant velocity, as shown ($g = 10$ m/s^2). The force applied along the incline is:



(A) 5 N

(B) 20 N

(C) 10 N

(D) 17.3 N

Q9. The coefficient of static friction between a block and an inclined surface is $\mu = \frac{1}{\sqrt{3}}$. The angle of repose is:

(A) $45°$

(B) $60°$

(C) $90°$

(D) $30°$

Q10. A circular road of radius 20 m is banked at angle θ with $\tan\theta = 0.5$, and the coefficient of friction between tyres and road is $\mu = 0.5$. The maximum safe speed ($g = 10$ m/s^2) is:

(A) 12 m/s

(B) $\sqrt{\frac{800}{3}}$ m/s

(C) $\sqrt{200}$ m/s

(D) 20 m/s

Q11. A constant force of 20 N acts at $60°$ to the direction of motion and moves a body through 5 m. The work done by the force is:

(A) 50 J

(B) 100 J

(C) 86.6 J

(D) 25 J

Q12. A car of mass 1000 kg moves up an incline of $\sin\theta = 0.1$ at a constant speed of 15 m/s (friction neglected, $g = 10$ m/s^2). The power delivered by the engine is:

(A) 1.0 kW

(B) 10 kW

(C) 1500 kW

(D) 15 kW

Q13. A stationary bomb of mass 5 kg explodes into two pieces of masses 2 kg and 3 kg. If the 2 kg piece flies off at 9 m/s, the speed of the 3 kg piece is:

(A) 9 m/s

(B) 4.5 m/s

(C) 6 m/s

(D) 13.5 m/s

Q14. A thin uniform rod of mass M and length L has moment of inertia $\frac{ML^2}{12}$ about its centre. Its moment of inertia about an axis through one end, perpendicular to the rod, is:

(A) $\frac{ML^2}{3}$

(B) $\frac{ML^2}{12}$

(C) $\frac{ML^2}{6}$

(D) $\frac{ML^2}{2}$

Q15. A satellite revolves around a planet in a circular orbit of radius r at orbital speed v. Its time period of revolution is:

(A) $\frac{\pi r}{v}$

(B) $\frac{2\pi r}{v}$

(C) $\frac{2\pi v}{r}$

(D) $\frac{\pi r}{2v}$

Q16. A Carnot engine operates between a source at 400 K and a sink at 300 K. If the sink temperature is lowered to 200 K (source unchanged), the efficiency becomes:

(A) 25%

(B) 40%

(C) 50%

(D) 75%

Q17. In an adiabatic process, a gas does work and its internal energy falls by 150 J. The work done by the gas is:

(A) 0 J

(B) -150 J

(C) 300 J

(D) 150 J

Q18. For one mole of an ideal diatomic gas (5 degrees of freedom) at temperature T, the internal energy is:

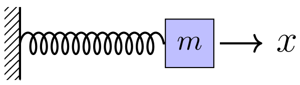
(A) $\frac{3}{2}RT$

(B) $\frac{5}{2}RT$

(C) $\frac{7}{2}RT$

(D) $3RT$

Q19. A particle executes SHM of amplitude 0.05 m and angular frequency 20 rad/s, on a spring as shown. Its maximum acceleration is:



(A) 1 m/s^2

(B) 10 m/s^2

(C) 20 m/s^2

(D) 40 m/s^2

Q20. For a particle in SHM of amplitude A, the ratio of its kinetic energy to potential energy when its displacement is $x = \frac{A}{\sqrt{2}}$ is:

(A) 1

(B) 2

(C) 3

(D) 1/2

Q21. A stretched string carries a wave of frequency f under a tension of 25 N. To double the frequency of the standing wave (length and mass density unchanged), the tension must be:

(A) 50 N

(B) 75 N

(C) 25 N

(D) 100 N

Q22. A stationary source emits sound of frequency 500 Hz. A wall moves towards the source at 33 m/s (speed of sound = 330 m/s). The frequency of the echo received back at the source is approximately:

(A) 556 Hz

(B) 611 Hz

(C) 550 Hz

(D) 500 Hz

Q23. Two point charges of $2\,\mu$C and $8\,\mu$C are placed 0.2 m apart in vacuum ($k = 9 \times 10^9$ N·m^2/C^2). The magnitude of the Coulomb force between them is:

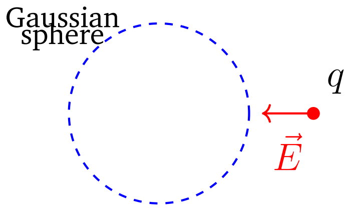
(A) 1.8 N

(B) 7.2 N

(C) 3.6 N

(D) 0.9 N

Q24. A point charge of $5\,\mu$C is placed just outside a closed Gaussian sphere as shown. The total electric flux through the surface is:



(A) 5.6×10^5 N·m^2/C

(B) 1.1×10^6 N·m^2/C

(C) 9×10^9 N·m^2/C

(D) 0

Q25. Two equal and opposite charges of magnitude $4\,\mu$C are separated by 5 mm. The electric dipole moment of the pair is:

(A) 2×10^{-8} C·m

(B) 2×10^{-5} C·m

(C) 4×10^{-8} C·m

(D) 8×10^{-8} C·m

Q26. A parallel-plate capacitor has capacitance $5\,\mu$F in air. When a dielectric slab completely fills the gap, the capacitance becomes $30\,\mu$F. The dielectric constant of the slab is:

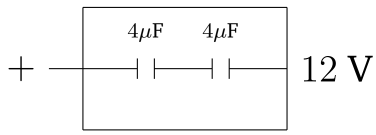
(A) 5

(B) 6

(C) 25

(D) 35

Q27. In the circuit shown, two $4\,\mu$F capacitors in series are connected across a 12 V battery. The charge stored on each capacitor is:



(A) 48 μC

(B) 12 μC

(C) 24 μC

(D) 96 μC

Q28. The drift speed of electrons in a conductor is 1.5×10^{-4} m/s when the electric field inside it is 5×10^{-2} V/m. The mobility of the electrons is:

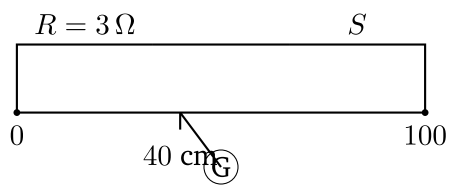
(A) 1.5×10^{-3} m^{2}V^{-1}s^{-1}

(B) 3×10^{-3} m^{2}V^{-1}s^{-1}

(C) 7.5×10^{-6} m^{2}V^{-1}s^{-1}

(D) 3×10^{-2} m^{2}V^{-1}s^{-1}

Q29. In a metre-bridge experiment, the balance point with a known resistance $R = 3\,\Omega$ in the left gap is found at 40 cm from the left end, as shown. The unknown resistance S in the right gap is:



(A) $4.5\,\Omega$

(B) $2\,\Omega$

(C) $6\,\Omega$

(D) $1.5\,\Omega$

Q30. A cell of EMF 6 V and internal resistance $3\,\Omega$ delivers maximum power to an external resistor. This maximum power is:

(A) 1 W

(B) 2 W

(C) 6 W

(D) 3 W

Q31. An electric bulb is rated 100 W at 200 V. Its resistance (when operating) is:

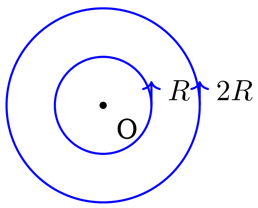
(A) $400\,\Omega$

(B) $200\,\Omega$

(C) $100\,\Omega$

(D) $40\,\Omega$

Q32. Two concentric circular loops of radii R and $2R$ carry equal currents I in the same sense, as shown. The net magnetic field at the common centre O is:



(A) $\frac{\mu_0 I}{2R}$

(B) $\frac{3\mu_0 I}{4R}$

(C) $\frac{\mu_0 I}{4R}$

(D) $\frac{\mu_0 I}{R}$

Q33. In a velocity selector, an electric field of 3×10^4 V/m and a magnetic field of 0.2 T are crossed at right angles. A charged particle passes undeflected if its speed is:

(A) 6×10^3 m/s

(B) 1.5×10^4 m/s

(C) 1.5×10^5 m/s

(D) 6×10^5 m/s

Q34. A solenoid of length 0.5 m has 500 turns and carries a current of 5 A ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A). The magnetic field inside it is:

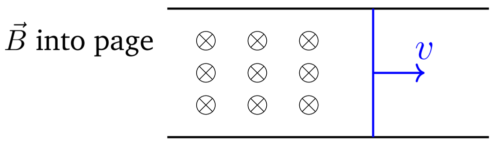
(A) 1.26×10^{-3} T

(B) 3.14×10^{-3} T

(C) 1.0×10^{-2} T

(D) 6.28×10^{-3} T

Q35. A conducting rod on rails encloses a circuit of resistance $2\,\Omega$ in a field $B = 0.5$ T directed into the page. When the rod moves so that the enclosed area decreases by 0.4 m^2, the charge that flows through the circuit is:



(A) 0.1 C

(B) 0.2 C

(C) 0.4 C

(D) 0.05 C

Q36. A series LCR circuit has $R = 6\,\Omega$, $X_L = 12\,\Omega$ and $X_C = 4\,\Omega$. If the peak voltage of the source is 100 V, the peak (amplitude) current is:

(A) 5 A

(B) 20 A

(C) 10 A

(D) 16.7 A

Q37. The rms value of an alternating voltage is 220 V. Its peak (maximum) value is approximately:

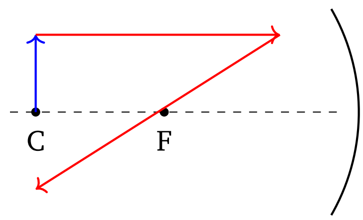
(A) 156 V

(B) 311 V

(C) 440 V

(D) 220 V

Q38. An object is placed at the centre of curvature of a concave mirror of focal length 20 cm, as shown. The image formed is:



(A) Virtual, erect, magnified

(B) Real, erect, same size

(C) Virtual, inverted, diminished

(D) Real, inverted, same size

Q39. The refractive index of diamond is 2.0. The critical angle for total internal reflection at a diamond–air interface is closest to:

(A) $45°$

(B) $24°$

(C) $30°$

(D) $60°$

Q40. A biconvex lens of glass ($n = 1.6$) has both radii of curvature equal to 24 cm in magnitude. Its focal length is:

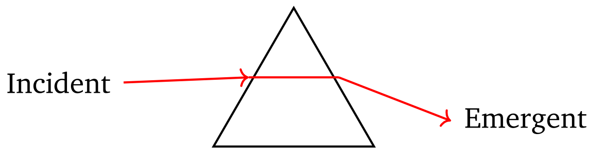
(A) 20 cm

(B) 24 cm

(C) 40 cm

(D) 15 cm

Q41. A ray passes symmetrically through a prism at minimum deviation, as shown. At minimum deviation the ray inside the prism travels:



(A) Along the base normally to one face

(B) Perpendicular to the incident ray

(C) Such that the angle of incidence is zero

(D) Parallel to the base of the prism

Q42. A Young's double-slit pattern has a fringe width of 0.6 mm in air. When the whole apparatus is immersed in water (refractive index $4/3$), the fringe width becomes:

(A) 0.8 mm

(B) 0.45 mm

(C) 0.6 mm

(D) 0.3 mm

Q43. To increase the resolving power of a telescope, one should:

(A) Decrease the diameter of its objective

(B) Increase the wavelength of light used

(C) Decrease the focal length of the eyepiece

(D) Increase the diameter of its objective

Q44. The energy of a photon of frequency 5×10^{14} Hz is ($h = 6.6 \times 10^{-34}$ J·s):

(A) 3.3×10^{-19} J

(B) 1.32×10^{-19} J

(C) 3.3×10^{-20} J

(D) 6.6×10^{-19} J

Q45. The de Broglie wavelength of a particle of mass m and kinetic energy K is given by:

(A) $\frac{h}{2mK}$

(B) $\frac{h}{\sqrt{mK}}$

(C) $\frac{h}{\sqrt{2mK}}$

(D) $\frac{2h}{\sqrt{mK}}$

Q46. For the hydrogen Lyman series, the wavelength of the transition from $n = 2$ to $n = 1$ (Rydberg constant $R = 1.1 \times 10^7$ m^{-1}) is approximately:

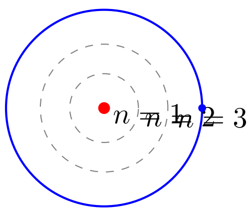
(A) 91 nm

(B) 121 nm

(C) 365 nm

(D) 656 nm

Q47. In Bohr's model of hydrogen, $r_n = n^2 a_0$ with $a_0 = 0.53$ Å. The radius of the third orbit ($n = 3$) is shown below. Its value is:



(A) 4.77 Å

(B) 1.59 Å

(C) 2.12 Å

(D) 9.54 Å

Q48. A radioactive sample has a half-life of 8 days. The time taken for 75% of the sample to decay is:

(A) 8 days

(B) 16 days

(C) 24 days

(D) 32 days

Q49. The mass defect of a deuteron is 0.0024 u. Taking 1 u $= 931$ MeV$/c^2$, its binding energy is approximately:

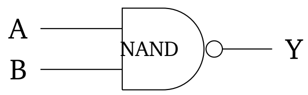
(A) 1.1 MeV

(B) 4.5 MeV

(C) 2.2 MeV

(D) 0.9 MeV

Q50. In the logic circuit shown, both inputs A and B of a two-input NAND gate are held HIGH (logic 1). The output Y is:



(A) Equal to A AND B (logic 1)

(B) Always HIGH regardless of inputs

(C) Undefined for equal inputs

(D) LOW (logic 0)

Detailed Solutions

Q1.

Solution

Concept — Dimensions of electric field: Electric field $E = \frac{F}{q} = \frac{\text{force}}{\text{charge}}$. Force has dimension $\mathrm{MLT^{-2}}$ and charge = current × time = AT.

Step 1 — Dimension of force: $[F] = \mathrm{MLT^{-2}}$.

Step 2 — Dimension of charge: $[q] = \mathrm{AT}$ (current × time).

Step 3 — Form the ratio: $[E] = \frac{\mathrm{MLT^{-2}}}{\mathrm{AT}}$.

Step 4 — Subtract exponents: $= \mathrm{MLT^{-2-1}A^{-1}} = \mathrm{MLT^{-3}A^{-1}}$.

Why other options are wrong:

- (A) is the dimension of force, not field.
- (B) is the dimension of electric potential.
- (D) is the dimension of resistance.

Final Answer: $[E] = \mathrm{MLT^{-3}A^{-1}} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q1

Q2.

Solution

Concept — Error in a power: If $A \propto r^n$, then the relative error $\frac{\Delta A}{A} = n\frac{\Delta r}{r}$.

Step 1 — Identify the power: Surface area $A \propto r^2$, so $n = 2$.

Step 2 — Write the relative error: $\frac{\Delta A}{A} = 2 \times \frac{\Delta r}{r}$.

Step 3 — Insert the radius error: $\frac{\Delta r}{r} = 2\%$.

Step 4 — Multiply: $\frac{\Delta A}{A} = 2 \times 2\% = 4\%$.

Why other options are wrong:

- (A) halves rather than doubles.
- (B) forgets the power of 2.
- (C) corresponds to a cube (r^3).

Final Answer: Relative error $= 4\% \Rightarrow \boxed{D}$

Answer: (D) Go Back to Q2

Q3.

Solution

Concept — Capillary rise and radius: $h = \dfrac{2T\cos\theta}{r\rho g}$, so for a fixed liquid and tube material $h \propto \dfrac{1}{r}$.

Step 1 — State the proportionality: $h_1 r_1 = h_2 r_2$ (since $h \propto 1/r$).

Step 2 — Insert known values: $h_1 = 4$ cm, $r_1 = r$, $r_2 = r/2$.

Step 3 — Solve for h_2: $h_2 = h_1 \dfrac{r_1}{r_2} = 4 \times \dfrac{r}{r/2}$.

Step 4 — Simplify the ratio: $\dfrac{r}{r/2} = 2$.

Step 5 — Evaluate: $h_2 = 4 \times 2 = 8$ cm.

Why other options are wrong:

- (B) halves instead of doubling.
- (C) ignores the change in radius.
- (D) squares the factor instead of using $1/r$.

Final Answer: $h_2 = 8 \text{ cm} \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q3

Q4.

Solution

Concept — Breaking stress: Breaking stress $= \dfrac{\text{maximum force}}{\text{cross-sectional area}} = \dfrac{F}{A}$.

Step 1 — List data: $F = 40$ N, $A = 0.5 \text{ mm}^2 = 0.5 \times 10^{-6} \text{ m}^2 = 5 \times 10^{-7} \text{ m}^2$.

Step 2 — Form the ratio: $\sigma = \dfrac{40}{5 \times 10^{-7}}$.

Step 3 — Divide the mantissas: $\dfrac{40}{5} = 8$.

Step 4 — Handle the power of ten: $\dfrac{1}{10^{-7}} = 10^7$.

Step 5 — Combine: $\sigma = 8 \times 10^7$ N/m^2.

Why other options are wrong:

- (A) halves the result.
- (C) uses a wrong area.
- (D) carries a power-of-ten slip.

Final Answer: $\sigma = 8 \times 10^7$ N/m$^2 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q4

Q5.

Solution

Concept — Distance in a phase of a v–t graph: Distance in any interval equals the area under the curve in that interval. The deceleration phase is the falling part of the graph.

Step 1 — Identify the retardation phase: Velocity falls from 12 m/s to 0 between $t = 5$ s and $t = 8$ s.

Step 2 — Find the time interval: $\Delta t = 8 - 5 = 3$ s.

Step 3 — Shape of this part: A triangle of base 3 s and height 12 m/s.

Step 4 — Apply the triangle area: Distance $= \frac{1}{2} \times$ base $\times$ height $= \frac{1}{2} \times 3 \times 12$.

Step 5 — Evaluate: $= \frac{1}{2} \times 36 = 18$ m.

Why other options are wrong:

- (A) takes only the height as the answer.
- (B) uses the full base $\times$ height without the $\frac{1}{2}$.
- (C) corresponds to the constant-velocity phase area.

Final Answer: Distance $= 18$ m $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q5

Q6.

Solution

Concept — Complementary angles and range: Two angles of projection give the same range when they add up to 90°, i.e. θ and $(90^\circ - \theta)$.

Step 1 — Use the complementary rule: The second angle $= 90^\circ - \theta$.

Step 2 — Insert $\theta = 35^\circ$: $90^\circ - 35^\circ$.

Step 3 — Evaluate: $= 55^\circ$.

Step 4 — Verify: $\sin(2 \times 35^\circ) = \sin 70^\circ = \sin(2 \times 55^\circ) = \sin 110^\circ$, so the ranges match.

Why other options are wrong:

- (B) is the angle of maximum range, not the complement.
- (C) and (D) do not add to 90° with 35°.

Final Answer: Second angle $= 55^\circ \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q6

Q7.

Solution

Concept — Resultant of perpendicular velocities: North and east are at right angles, so the ground speed is $\sqrt{v_N^2 + v_E^2}$.

Step 1 — List data: $v_N = 80$ m/s, $v_E = 60$ m/s.

Step 2 — Square each: $80^2 = 6400$, $60^2 = 3600$.

Step 3 — Add: $6400 + 3600 = 10000$.

Step 4 — Take square root: $\sqrt{10000} = 100$ m/s.

Why other options are wrong:

- (A) adds speeds arithmetically.
- (C) subtracts the speeds.
- (D) is an incorrect combination.

Final Answer: Ground speed $= 100$ m/s $\Rightarrow \boxed{B}$

Answer: (B) Go Back to Q7

Q8.

Solution

Concept — Pushing a block up a smooth incline: At constant velocity the net force is zero, so the applied force along the incline balances the gravity component: $F = mg\sin\theta$.

Step 1 — List data: $m = 2$ kg, $g = 10$ m/s^2, $\theta = 30°$.

Step 2 — Find $\sin\theta$**:** $\sin 30° = 0.5$.

Step 3 — Substitute: $F = 2 \times 10 \times 0.5$.

Step 4 — Evaluate: $F = 10$ N.

Why other options are wrong:

- (A) drops a factor of 2 in the mass.
- (B) uses the full weight mg.
- (D) uses $mg\cos\theta$ instead of $mg\sin\theta$.

Final Answer: $F = 10 \text{ N} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q8

Q9.

Solution

Concept — Angle of repose: $\mu = \tan\theta_r$, so $\theta_r = \tan^{-1}\mu$.

Step 1 — Insert μ**:** $\tan\theta_r = \frac{1}{\sqrt{3}}$.

Step 2 — Recognise the value: $\frac{1}{\sqrt{3}} = \tan 30°$.

Step 3 — Conclude: $\theta_r = 30°$.

Why other options are wrong:

- (A) is $\tan 45° = 1$.
- (B) is $\tan 60° = \sqrt{3}$, the reciprocal.
- (C) would require infinite friction.

Final Answer: $\theta_r = 30° \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q9

Q10.

Solution

Concept — Banked road with friction: The maximum safe speed is $v_{\max} = \sqrt{rg\,\dfrac{\tan\theta + \mu}{1 - \mu\tan\theta}}$.

Step 1 — List data: $r = 20$ m, $g = 10$ m/s^2, $\tan\theta = 0.5$, $\mu = 0.5$.

Step 2 — Numerator of the fraction: $\tan\theta + \mu = 0.5 + 0.5 = 1$.

Step 3 — Denominator of the fraction: $1 - \mu\tan\theta = 1 - 0.5 \times 0.5 = 1 - 0.25 = 0.75$.

Step 4 — Evaluate the fraction: $\dfrac{1}{0.75} = \dfrac{4}{3}$.

Step 5 — Multiply by rg: $rg \times \dfrac{4}{3} = 20 \times 10 \times \dfrac{4}{3} = \dfrac{800}{3}$.

Step 6 — Take square root: $v_{\max} = \sqrt{\dfrac{800}{3}} \approx 16.3$ m/s.

Why other options are wrong:

- (A) under-rounds the root.
- (C) uses only $\mu rg = 200$, ignoring the banking term.
- (D) ignores the fraction entirely.

Final Answer: $v_{\max} = \sqrt{\dfrac{800}{3}}$ m/s $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q10

Q11.

Solution

Concept — Work by a constant force at an angle: $W = Fs\cos\theta$.

Step 1 — List data: $F = 20$ N, $s = 5$ m, $\theta = 60^\circ$.

Step 2 — Find $\cos\theta$: $\cos 60^\circ = 0.5$.

Step 3 — Multiply F and s: $20 \times 5 = 100$.

Step 4 — Multiply by $\cos\theta$: $W = 100 \times 0.5 = 50$ J.

Why other options are wrong:

- (B) forgets the $\cos\theta$ factor.
- (C) uses $\sin 60^\circ$ instead of $\cos 60^\circ$.

- (D) halves the product incorrectly.

Final Answer: $W = 50\text{ J} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q11

Q12.

Solution

Concept — Power up an incline at constant speed: The engine balances the gravity component, so $P = Fv = (mg\sin\theta)v$.

Step 1 — List data: $m = 1000$ kg, $g = 10$ m/s^2, $\sin\theta = 0.1$, $v = 15$ m/s.

Step 2 — Find the resisting force: $F = mg\sin\theta = 1000 \times 10 \times 0.1 = 1000$ N.

Step 3 — Multiply by speed: $P = Fv = 1000 \times 15 = 15000$ W.

Step 4 — Convert to kilowatts: $15000\text{ W} = 15\text{ kW}$.

Why other options are wrong:

- (A) and (B) carry power-of-ten or factor slips.
- (C) forgets to apply $\sin\theta$.

Final Answer: $P = 15\text{ kW} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q12

Q13.

Solution

Concept — Conservation of momentum in an explosion: The bomb is at rest, so the total momentum stays zero; the two fragments carry equal and opposite momenta: $m_1v_1 = m_2v_2$.

Step 1 — List data: $m_1 = 2$ kg, $v_1 = 9$ m/s, $m_2 = 3$ kg.

Step 2 — Equate the magnitudes of momentum: $m_1v_1 = m_2v_2$.

Step 3 — Substitute: $2 \times 9 = 3 \times v_2$.

Step 4 — Solve for v_2: $v_2 = \dfrac{18}{3} = 6$ m/s.

Why other options are wrong:

- (A) sets the speeds equal, ignoring the mass ratio.

- (B) halves the first fragment's speed.
- (D) inverts the mass ratio.

Final Answer: $v_2 = 6$ m/s $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q13

Q14.

Solution

Concept — Parallel-axis theorem: $I_{end} = I_{cm} + Md^2$, where d is the shift of the axis.

Step 1 — Identify the shift: From centre to one end, $d = \frac{L}{2}$.

Step 2 — Compute Md^2: $M\left(\frac{L}{2}\right)^2 = \frac{ML^2}{4}$.

Step 3 — Add to I_{cm}: $I_{end} = \frac{ML^2}{12} + \frac{ML^2}{4}$.

Step 4 — Common denominator: $\frac{ML^2}{12} + \frac{3ML^2}{12} = \frac{4ML^2}{12}$.

Step 5 — Simplify: $\frac{4ML^2}{12} = \frac{ML^2}{3}$.

Why other options are wrong:

- (B) is the value about the centre.
- (C) and (D) use a wrong shift distance.

Final Answer: $I_{end} = \frac{ML^2}{3} \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q14

Q15.

Solution

Concept — Period of circular motion: The period equals the circumference divided by the speed: $T = \frac{\text{distance per revolution}}{\text{speed}} = \frac{2\pi r}{v}$.

Step 1 — Circumference of the orbit: $C = 2\pi r$.

Step 2 — Divide by orbital speed: $T = \frac{2\pi r}{v}$.

Why other options are wrong:

- (A) uses half the circumference.
- (C) inverts r and v.
- (D) is a quarter of the correct period.

Final Answer: $T = \dfrac{2\pi r}{v} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q15

Q16.

Solution

Concept — Carnot efficiency: $\eta = 1 - \dfrac{T_C}{T_H}$ in kelvin.

Step 1 — New sink and same source: $T_C = 200$ K, $T_H = 400$ K.

Step 2 — Form the ratio: $\dfrac{T_C}{T_H} = \dfrac{200}{400} = 0.5$.

Step 3 — Subtract from 1**:** $\eta = 1 - 0.5 = 0.5$.

Step 4 — Convert to percent: $0.5 = 50\%$.

Why other options are wrong:

- (A) is the original efficiency $(1 - 300/400)$.
- (B) uses a wrong ratio.
- (D) over-subtracts.

Final Answer: $\eta = 50\% \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q16

Q17.

Solution

Concept — First law in an adiabatic process: For an adiabatic change $Q = 0$, so $\Delta U = -W$, i.e. the work done by the gas equals the drop in internal energy.

Step 1 — Apply the first law: $Q = \Delta U + W$ with $Q = 0$.

Step 2 — Rearrange: $W = -\Delta U$.

Step 3 — Insert $\Delta U = -150$ J (internal energy falls): $W = -(-150)$.

Step 4 — Evaluate: $W = +150$ J.

Why other options are wrong:

- (A) would hold only if $\Delta U = 0$.
- (B) has the wrong sign.
- (C) doubles the magnitude.

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

Answer: (D) Go Back to Q17

Q18.

Solution

Concept — Internal energy from degrees of freedom: For n moles with f degrees of freedom, $U = \frac{f}{2}nRT$.

Step 1 — List data: $n = 1$ mole, $f = 5$ (diatomic).

Step 2 — Substitute: $U = \frac{5}{2} \times 1 \times RT$.

Step 3 — Simplify: $U = \frac{5}{2}RT$.

Why other options are wrong:

- (A) is the monatomic value ($f = 3$).
- (C) corresponds to $f = 7$ (with vibration).
- (D) is an incorrect coefficient.

Final Answer: $U = \frac{5}{2}RT \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q18

Q19.

Solution

Concept — Maximum acceleration in SHM: $a_{\max} = \omega^2 A$.

Step 1 — List data: $\omega = 20$ rad/s, $A = 0.05$ m.

Step 2 — Square the angular frequency: $\omega^2 = 20^2 = 400$.

Step 3 — Multiply by amplitude: $a_{\max} = 400 \times 0.05$.

Step 4 — Evaluate: $a_{\text{max}} = 20\ \text{m/s}^2$.

Why other options are wrong:

- (A) uses ωA without squaring ω fully.
- (B) carries an arithmetic slip.
- (D) doubles the result.

Final Answer: $a_{\text{max}} = 20\ \text{m/s}^2 \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q19

Q20.

Solution

Concept — SHM energy split: Total energy $E = \frac{1}{2}kA^2$; potential energy $U = \frac{1}{2}kx^2$; kinetic energy $K = E - U$.

Step 1 — Find U/E at $x = A/\sqrt{2}$: $\dfrac{U}{E} = \dfrac{x^2}{A^2} = \dfrac{(A/\sqrt{2})^2}{A^2} = \dfrac{A^2/2}{A^2} = \dfrac{1}{2}$.

Step 2 — Find K/E: $\dfrac{K}{E} = 1 - \dfrac{1}{2} = \dfrac{1}{2}$.

Step 3 — Form the ratio K/U: $\dfrac{K}{U} = \dfrac{1/2}{1/2} = 1$.

Why other options are wrong:

- (B) and (C) would hold at $x = A/\sqrt{3}$ or $x = A/2$ type points, not here.
- (D) inverts the equal split.

Final Answer: $K : U = 1 \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q20

Q21.

Solution

Concept — Frequency and tension on a string: The fundamental frequency $f = \dfrac{1}{2L}\sqrt{\dfrac{T}{\mu}}$, so $f \propto \sqrt{T}$ for fixed L and μ.

Step 1 — Set up the ratio: $\dfrac{f_2}{f_1} = \sqrt{\dfrac{T_2}{T_1}}$.

Step 2 — Insert the doubling condition: $\frac{f_2}{f_1} = 2$, so $2 = \sqrt{\frac{T_2}{T_1}}$.

Step 3 — Square both sides: $4 = \frac{T_2}{T_1}$.

Step 4 — Solve for T_2: $T_2 = 4T_1 = 4 \times 25 = 100$ N.

Why other options are wrong:

- (A) doubles the tension only.
- (B) triples it.
- (C) leaves it unchanged.

Final Answer: $T_2 = 100 \text{ N} \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q21

Q22.

Solution

Concept — Echo from a moving reflector: The wall first acts as a moving observer receiving the sound, then re-emits it as a moving source. The two Doppler steps multiply, giving $f' = f\frac{v + v_w}{v - v_w}$ for a wall approaching the source.

Step 1 — List data: $f = 500$ Hz, $v = 330$ m/s, $v_w = 33$ m/s.

Step 2 — Numerator: $v + v_w = 330 + 33 = 363$.

Step 3 — Denominator: $v - v_w = 330 - 33 = 297$.

Step 4 — Form the ratio: $\frac{363}{297} = \frac{11}{9}$.

Step 5 — Multiply by f: $f' = 500 \times \frac{11}{9} = \frac{5500}{9} \approx 611$ Hz.

Why other options are wrong:

- (A) applies only one Doppler step.
- (C) inverts the shift direction.
- (D) ignores the wall's motion.

Final Answer: $f' \approx 611 \text{ Hz} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q22

Q23.

Solution

Concept — Coulomb's law: $F = \dfrac{kq_1q_2}{r^2}$.

Step 1 — List data: $q_1 = 2 \times 10^{-6}$ C, $q_2 = 8 \times 10^{-6}$ C, $r = 0.2$ m, $k = 9 \times 10^9$.

Step 2 — Product of charges: $q_1q_2 = 2 \times 10^{-6} \times 8 \times 10^{-6} = 16 \times 10^{-12}$ C^2.

Step 3 — Square the distance: $r^2 = (0.2)^2 = 0.04$ m^2.

Step 4 — Numerator: $kq_1q_2 = 9 \times 10^9 \times 16 \times 10^{-12} = 144 \times 10^{-3} = 0.144$.

Step 5 — Divide by r^2: $F = \dfrac{0.144}{0.04} = 3.6$ N.

Why other options are wrong:

- (A) halves the correct result.
- (B) drops a power of ten in the distance.
- (D) uses a quarter of the correct value.

Final Answer: $F = 3.6 \text{ N} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q23

Q24.

Solution

Concept — Gauss's law with charge outside: The flux through a closed surface depends only on the charge enclosed. A charge lying outside the surface contributes zero net flux, because every field line that enters also leaves.

Step 1 — Identify enclosed charge: The 5 μC charge is outside the sphere, so $q_{enc} = 0$.

Step 2 — Apply Gauss's law: $\Phi = \dfrac{q_{enc}}{\varepsilon_0} = \dfrac{0}{\varepsilon_0}$.

Step 3 — Evaluate: $\Phi = 0$.

Why other options are wrong:

- (A) and (B) wrongly treat the charge as enclosed.
- (C) quotes the constant k, not a flux.

Final Answer: $\Phi = 0 \Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q24

Q25.

Solution

Concept — Electric dipole moment: $p = q \times (2a)$, where q is the magnitude of either charge and $2a$ is their separation.

Step 1 — List data: $q = 4 \times 10^{-6}$ C, $2a = 5$ mm $= 5 \times 10^{-3}$ m.

Step 2 — Multiply: $p = 4 \times 10^{-6} \times 5 \times 10^{-3}$.

Step 3 — Multiply the mantissas: $4 \times 5 = 20$.

Step 4 — Add the exponents: $10^{-6-3} = 10^{-9}$, so $p = 20 \times 10^{-9}$.

Step 5 — Standard form: $p = 2 \times 10^{-8}$ C·m.

Why other options are wrong:

- (B) carries a power-of-ten error.
- (C) doubles the value.
- (D) quadruples the value.

Final Answer: $p = 2 \times 10^{-8}$ C·m $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q25

Q26.

Solution

Concept — Dielectric constant from capacitances: Filling a capacitor with a dielectric multiplies its capacitance: $C' = KC_0$, so $K = \dfrac{C'}{C_0}$.

Step 1 — List data: $C_0 = 5\,\mu$F, $C' = 30\,\mu$F.

Step 2 — Form the ratio: $K = \dfrac{30}{5}$.

Step 3 — Evaluate: $K = 6$.

Why other options are wrong:

- (A) quotes the air capacitance.
- (C) and (D) come from wrong ratios.

Final Answer: $K = 6 \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q26

Q27.

Solution

Concept — Charge on series capacitors: Capacitors in series carry the same charge $Q = C_{eq}V$, where C_{eq} is the series combination.

Step 1 — Series capacitance of two $4\ \mu$F: $\dfrac{1}{C_{eq}} = \dfrac{1}{4} + \dfrac{1}{4} = \dfrac{1}{2}$, so $C_{eq} = 2\ \mu$F.

Step 2 — Apply $Q = C_{eq}V$: $Q = 2\ \mu\text{F} \times 12\ \text{V}$.

Step 3 — Evaluate: $Q = 24\ \mu$C.

Step 4 — Note: In series both capacitors carry this same charge of $24\ \mu$C.

Why other options are wrong:

- (A) uses a single $4\ \mu$F at 12 V.
- (B) uses $1\ \mu$F.
- (D) adds the capacitances in parallel.

Final Answer: $Q = 24\ \mu\text{C} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q27

Q28.

Solution

Concept — Mobility of charge carriers: Mobility $\mu = \dfrac{v_d}{E}$, the drift speed per unit electric field.

Step 1 — List data: $v_d = 1.5 \times 10^{-4}$ m/s, $E = 5 \times 10^{-2}$ V/m.

Step 2 — Form the ratio: $\mu = \dfrac{1.5 \times 10^{-4}}{5 \times 10^{-2}}$.

Step 3 — Divide the mantissas: $\dfrac{1.5}{5} = 0.3$.

Step 4 — Subtract exponents: $10^{-4-(-2)} = 10^{-2}$.

Step 5 — Combine: $\mu = 0.3 \times 10^{-2} = 3 \times 10^{-3}\ \text{m}^2\text{V}^{-1}\text{s}^{-1}$.

Why other options are wrong:

- (A) halves the mantissa.
- (C) multiplies instead of dividing.
- (D) carries a power-of-ten error.

Final Answer: $\mu = 3 \times 10^{-3}\ \text{m}^2\text{V}^{-1}\text{s}^{-1} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q28

Q29.

Solution

Concept — Metre bridge balance: At balance $\dfrac{R}{S} = \dfrac{\ell}{100-\ell}$, where ℓ is the balancing length from the end nearest R.

Step 1 — List data: $R = 3\,\Omega$, $\ell = 40$ cm.

Step 2 — Length ratio: $\dfrac{\ell}{100-\ell} = \dfrac{40}{60} = \dfrac{2}{3}$.

Step 3 — Apply the balance relation: $\dfrac{R}{S} = \dfrac{2}{3}$, so $S = R \times \dfrac{3}{2}$.

Step 4 — Substitute $R = 3$: $S = 3 \times \dfrac{3}{2} = \dfrac{9}{2} = 4.5\,\Omega$.

Why other options are wrong:

- (B) inverts the length ratio.
- (C) and (D) use wrong ratios.

Final Answer: $S = 4.5\,\Omega \Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q29

Q30.

Solution

Concept — Maximum power transfer: Maximum power is delivered when the load equals the internal resistance, $R = r$, and then $P_{\text{max}} = \dfrac{E^2}{4r}$.

Step 1 — List data: $E = 6$ V, $r = 3\,\Omega$.

Step 2 — Square the EMF: $E^2 = 6^2 = 36$.

Step 3 — Compute $4r$: $4 \times 3 = 12$.

Step 4 — Divide: $P_{\text{max}} = \dfrac{36}{12} = 3$ W.

Why other options are wrong:

- (A) and (B) carry arithmetic slips.

- (C) divides by r instead of $4r$.

Final Answer: $P_{max} = 3$ W $\Rightarrow \boxed{D}$

Answer: (D) Go Back to Q30

Q31.

Solution

Concept — Resistance from power rating: $P = \frac{V^2}{R}$, so $R = \frac{V^2}{P}$.

Step 1 — List data: $V = 200$ V, $P = 100$ W.

Step 2 — Square the voltage: $V^2 = 200^2 = 40000$.

Step 3 — Divide by power: $R = \frac{40000}{100} = 400\,\Omega$.

Why other options are wrong:

- (B) halves the result.
- (C) and (D) carry arithmetic slips.

Final Answer: $R = 400\,\Omega \Rightarrow \boxed{A}$

Answer: (A) Go Back to Q31

Q32.

Solution

Concept — Field of concentric loops: Each loop gives $B = \frac{\mu_0 I}{2R}$ at its centre. With both currents in the same sense the fields add.

Step 1 — Field of inner loop (radius R): $B_1 = \frac{\mu_0 I}{2R}$.

Step 2 — Field of outer loop (radius $2R$): $B_2 = \frac{\mu_0 I}{2(2R)} = \frac{\mu_0 I}{4R}$.

Step 3 — Add (same direction): $B = B_1 + B_2 = \frac{\mu_0 I}{2R} + \frac{\mu_0 I}{4R}$.

Step 4 — Common denominator: $= \frac{2\mu_0 I}{4R} + \frac{\mu_0 I}{4R} = \frac{3\mu_0 I}{4R}$.

Why other options are wrong:

- (A) counts only the inner loop.

- (C) counts only the outer loop.
- (D) doubles the inner-loop field.

Final Answer: $B = \frac{3\mu_0 I}{4R} \Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q32

Q33.

Solution

Concept — Velocity selector: A charge moves undeflected when the electric and magnetic forces balance: $qE = qvB$, giving $v = \frac{E}{B}$.

Step 1 — List data: $E = 3 \times 10^4$ V/m, $B = 0.2$ T.

Step 2 — Form the ratio: $v = \frac{3 \times 10^4}{0.2}$.

Step 3 — Divide: $\frac{3 \times 10^4}{0.2} = 15 \times 10^4 = 1.5 \times 10^5$ m/s.

Why other options are wrong:

- (A) and (B) carry power-of-ten errors.
- (D) multiplies E by B rather than dividing.

Final Answer: $v = 1.5 \times 10^5$ m/s $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q33

Q34.

Solution

Concept — Field of a solenoid: $B = \mu_0 n I$ where $n = \frac{N}{L}$ is turns per metre.

Step 1 — Turns per metre: $n = \frac{500}{0.5} = 1000\ \text{m}^{-1}$.

Step 2 — Compute nI: $nI = 1000 \times 5 = 5000$.

Step 3 — Multiply by μ_0: $B = 4\pi \times 10^{-7} \times 5000 = 2 \times 10^4 \pi \times 10^{-7}$.

Step 4 — Simplify: $= 2\pi \times 10^{-3}$.

Step 5 — Evaluate: $2\pi \times 10^{-3} \approx 6.28 \times 10^{-3}$ T.

Why other options are wrong:

- (A) uses a wrong n (factor of 5).
- (B) halves the result.
- (C) over-rounds π.

Final Answer: $B \approx 6.28 \times 10^{-3}$ T $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q34

Q35.

Solution

Concept — Charge from flux change: The charge that flows is $q = \frac{\Delta\Phi}{R} = \frac{B\,\Delta A}{R}$, independent of how fast the change happens.

Step 1 — List data: $B = 0.5$ T, $\Delta A = 0.4$ m^2, $R = 2\,\Omega$.

Step 2 — Flux change: $\Delta\Phi = B\,\Delta A = 0.5 \times 0.4 = 0.2$ Wb.

Step 3 — Divide by resistance: $q = \frac{0.2}{2}$.

Step 4 — Evaluate: $q = 0.1$ C.

Why other options are wrong:

- (B) forgets to divide by R.
- (C) uses $\Delta\Phi$ as the charge.
- (D) halves the correct value.

Final Answer: $q = 0.1$ C $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q35

Q36.

Solution

Concept — Peak current in series LCR: First find the impedance $Z = \sqrt{R^2 + (X_L - X_C)^2}$, then $I_0 = \frac{V_0}{Z}$.

Step 1 — Net reactance: $X_L - X_C = 12 - 4 = 8\,\Omega$.

Step 2 — Square the terms: $R^2 = 6^2 = 36$; $(X_L - X_C)^2 = 8^2 = 64$.

Step 3 — Add and root: $Z = \sqrt{36 + 64} = \sqrt{100} = 10\,\Omega$.

Step 4 — Peak current: $I_0 = \frac{V_0}{Z} = \frac{100}{10} = 10$ A.

Why other options are wrong:

- (A) uses $Z = 20\,\Omega$.
- (B) uses only R as the impedance.
- (D) uses $Z = 6\,\Omega$.

Final Answer: $I_0 = 10$ A $\Rightarrow$ $\boxed{\text{C}}$

Answer: (C) Go Back to Q36

Q37.

Solution

Concept — Peak from rms: For a sinusoidal AC, $V_0 = \sqrt{2}\,V_{rms}$.

Step 1 — List data: $V_{rms} = 220$ V.

Step 2 — Multiply by $\sqrt{2}$: $V_0 = 1.414 \times 220$.

Step 3 — Evaluate: $V_0 \approx 311$ V.

Why other options are wrong:

- (A) divides by $\sqrt{2}$ instead of multiplying.
- (C) doubles the rms value.
- (D) leaves it unchanged.

Final Answer: $V_0 \approx 311$ V $\Rightarrow$ $\boxed{\text{B}}$

Answer: (B) Go Back to Q37

Q38.

Solution

Concept — Object at centre of curvature: For a concave mirror, C is at $R = 2f$. An object at C forms its image at C itself, real, inverted, and the same size as the object ($m = -1$).

Step 1 — Locate C: $R = 2f = 2 \times 20 = 40$ cm, so $u = -40$ cm.

Step 2 — Mirror formula: $\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{-20} - \frac{1}{-40} = -\frac{2}{40} + \frac{1}{40} = -\frac{1}{40}$.

Step 3 — Image distance: $v = -40$ cm (at C, real).

Step 4 — Magnification: $m = -\frac{v}{u} = -\frac{-40}{-40} = -1$, so same size and inverted.

Why other options are wrong:

- (A) and (C) describe virtual images, impossible here.
- (B) wrongly calls a real image erect.

Final Answer: Real, inverted, same size $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q38

Q39.

Solution

Concept — Critical angle: $\sin\theta_c = \dfrac{1}{n}$.

Step 1 — Insert $n = 2$**:** $\sin\theta_c = \dfrac{1}{2} = 0.5$.

Step 2 — Take the inverse sine: $\theta_c = \sin^{-1}(0.5)$.

Step 3 — Evaluate: $\theta_c = 30°$.

Why other options are wrong:

- (A) corresponds to $\sin\theta_c = 1/\sqrt{2}$.
- (B) corresponds to a higher index (≈ 2.42 for real diamond).
- (D) corresponds to $\sin\theta_c = \sqrt{3}/2$.

Final Answer: $\theta_c = 30° \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q39

Q40.

Solution

Concept — Lens maker's formula: $\dfrac{1}{f} = (n-1)\left(\dfrac{1}{R_1} - \dfrac{1}{R_2}\right)$; for a biconvex lens $R_1 = +R$, $R_2 = -R$, giving $\dfrac{1}{f} = (n-1)\dfrac{2}{R}$.

Step 1 — Insert radii: $\dfrac{1}{R_1} - \dfrac{1}{R_2} = \dfrac{2}{R} = \dfrac{2}{24}$.

Step 2 — Simplify $(n-1)$**:** $n - 1 = 1.6 - 1 = 0.6$.

Step 3 — Multiply: $\dfrac{1}{f} = 0.6 \times \dfrac{2}{24} = \dfrac{1.2}{24} = \dfrac{1}{20}$.

Step 4 — Invert: $f = 20$ cm.

Why other options are wrong:

- (B) drops the factor $(n-1)$ effect.
- (C) drops the factor of 2 from two surfaces.
- (D) carries an arithmetic slip.

Final Answer: $f = 20$ cm $\Rightarrow \boxed{\text{A}}$

Answer: (A) Go Back to Q40

Q41.

Solution

Concept — Symmetry at minimum deviation: At minimum deviation the ray passes symmetrically through the prism; inside the prism the refracted ray runs parallel to the base, and the angles of incidence and emergence are equal.

Step 1 — Recall the condition: $i_1 = i_2$ and $r_1 = r_2$ at minimum deviation.

Step 2 — Geometric consequence: Equal internal angles make the internal ray parallel to the base of the prism.

Step 3 — Conclude: The ray inside travels parallel to the base.

Why other options are wrong:

- (A) misstates the geometry of the internal ray.
- (B) and (C) are not implied by minimum-deviation symmetry.

Final Answer: Internal ray parallel to the base $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q41

Q42.

Solution

Concept — Fringe width in a medium: The wavelength shrinks to λ/n inside a medium, so the fringe width also shrinks: $\beta_{medium} = \dfrac{\beta_{air}}{n}$.

Step 1 — List data: $\beta_{air} = 0.6$ mm, $n = 4/3$.

Step 2 — Divide by n: $\beta_{water} = \dfrac{0.6}{4/3} = 0.6 \times \dfrac{3}{4}$.

Step 3 — Evaluate: $0.6 \times 0.75 = 0.45$ mm.

Why other options are wrong:

- (A) multiplies by n instead of dividing.
- (C) leaves it unchanged.
- (D) halves the value.

Final Answer: $\beta_{water} = 0.45$ mm $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q42

Q43.

Solution

Concept — Resolving power of a telescope: Resolving power $\propto \dfrac{D}{\lambda}$, where D is the objective diameter. A larger objective gives finer resolution.

Step 1 — Identify the controlling quantity: The smallest resolvable angle is $\theta_{\min} = 1.22\dfrac{\lambda}{D}$, so resolving power $= \dfrac{1}{\theta_{\min}} \propto \dfrac{D}{\lambda}$.

Step 2 — To increase resolving power: Increase D (or decrease λ).

Step 3 — Choose the matching option: Increasing the diameter of the objective increases the resolving power.

Why other options are wrong:

- (A) reduces resolving power.
- (B) increasing λ reduces resolving power.
- (C) affects magnification, not resolving power.

Final Answer: Increase the objective diameter $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q43

Q44.

Solution

Concept — Photon energy: $E = h\nu$.

Step 1 — List data: $h = 6.6 \times 10^{-34}$ J·s, $\nu = 5 \times 10^{14}$ Hz.

Step 2 — Multiply the mantissas: $6.6 \times 5 = 33$.

Step 3 — Add the exponents: $10^{-34+14} = 10^{-20}$.

Step 4 — Combine: $E = 33 \times 10^{-20} = 3.3 \times 10^{-19}$ J.

Why other options are wrong:

- (B) carries a mantissa slip.
- (C) carries a power-of-ten error.
- (D) doubles the result.

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

Answer: (A) Go Back to Q44

Q45.

Solution

Concept — de Broglie wavelength from kinetic energy: For a particle, $p = \sqrt{2mK}$, and $\lambda = \dfrac{h}{p}$.

Step 1 — Relate momentum and KE: $K = \dfrac{p^2}{2m}$, so $p = \sqrt{2mK}$.

Step 2 — Substitute into de Broglie relation: $\lambda = \dfrac{h}{p} = \dfrac{h}{\sqrt{2mK}}$.

Why other options are wrong:

- (A) forgets the square root.
- (B) drops the factor of 2.
- (D) carries an extra factor of 2.

Final Answer: $\lambda = \dfrac{h}{\sqrt{2mK}} \Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q45

Q46.

Solution

Concept — Rydberg formula: $\dfrac{1}{\lambda} = R\left(\dfrac{1}{n_1^2} - \dfrac{1}{n_2^2}\right)$. For the Lyman α line, $n_1 = 1$, $n_2 = 2$.

Step 1 — Insert quantum numbers: $\dfrac{1}{\lambda} = R\left(\dfrac{1}{1^2} - \dfrac{1}{2^2}\right)$.

Step 2 — Evaluate the bracket: $1 - \dfrac{1}{4} = \dfrac{3}{4}$.

Step 3 — Multiply by R: $\frac{1}{\lambda} = 1.1 \times 10^7 \times \frac{3}{4} = 0.825 \times 10^7 \text{ m}^{-1}$.

Step 4 — Invert: $\lambda = \frac{1}{0.825 \times 10^7} \approx 1.21 \times 10^{-7}$ m.

Step 5 — Convert to nanometres: 1.21×10^{-7} m $= 121$ nm.

Why other options are wrong:

- (A) uses the series limit ($n_2 \to \infty$).
- (C) and (D) belong to the Balmer series.

Final Answer: $\lambda \approx 121$ nm $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q46

Q47.

Solution

Concept — Bohr orbit radius: $r_n = n^2 a_0$.

Step 1 — Insert $n = 3$: $r_3 = 3^2 a_0$.

Step 2 — Square: $3^2 = 9$.

Step 3 — Multiply by a_0: $r_3 = 9 \times 0.53$.

Step 4 — Evaluate: $r_3 = 4.77$ Å.

Why other options are wrong:

- (B) uses $n = 3$ but without squaring fully.
- (C) uses $n = 2$.
- (D) doubles the correct value.

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

Answer: (A) Go Back to Q47

Q48.

Solution

Concept — Decay by fraction: If 75% has decayed, 25% remains, i.e. $\frac{1}{4} = \left(\frac{1}{2}\right)^2$, which is 2 half-lives.

Step 1 — Fraction remaining: $100\% - 75\% = 25\% = \frac{1}{4}$.

Step 2 — Number of half-lives: $\frac{1}{4} = \left(\frac{1}{2}\right)^n \Rightarrow n = 2$.

Step 3 — Multiply by the half-life: $t = n \times T_{1/2} = 2 \times 8$.

Step 4 — Evaluate: $t = 16$ days.

Why other options are wrong:

- (A) is one half-life (50% decay).
- (C) is three half-lives (87.5% decay).
- (D) is four half-lives.

Final Answer: $t = 16$ days $\Rightarrow \boxed{\text{B}}$

Answer: (B) Go Back to Q48

Q49.

Solution

Concept — Binding energy from mass defect: $BE = \Delta m \times 931$ MeV when Δm is in u.

Step 1 — List data: $\Delta m = 0.0024$ u, 1 u $= 931$ MeV.

Step 2 — Multiply: $BE = 0.0024 \times 931$.

Step 3 — Evaluate: $0.0024 \times 931 = 2.23 \approx 2.2$ MeV.

Why other options are wrong:

- (A) and (D) carry arithmetic slips.
- (B) uses about twice the mass defect.

Final Answer: $BE \approx 2.2$ MeV $\Rightarrow \boxed{\text{C}}$

Answer: (C) Go Back to Q49

Q50.

Solution

Concept — NAND gate: A NAND gate gives the inverse of AND: $Y = \overline{A \cdot B}$. The output is LOW (0) only when both inputs are HIGH (1); otherwise it is HIGH.

Step 1 — Compute the AND of the inputs: $A \cdot B = 1 \cdot 1 = 1$.

Step 2 — Invert the result: $Y = \overline{1} = 0$.

Step 3 — Conclude: With both inputs HIGH, the NAND output is LOW (logic 0).

Why other options are wrong:

- (A) describes an AND gate, not NAND.
- (B) is false; the output depends on the inputs.
- (C) is false; the output is well defined for equal inputs.

Final Answer: $Y = 0$ (LOW) $\Rightarrow \boxed{\text{D}}$

Answer: (D) Go Back to Q50

Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	C	2	D	3	A	4	B	5	D
6	A	7	B	8	C	9	D	10	B
11	A	12	D	13	C	14	A	15	B
16	C	17	D	18	B	19	C	20	A
21	D	22	B	23	C	24	D	25	A
26	B	27	C	28	B	29	A	30	D
31	A	32	B	33	C	34	D	35	A
36	C	37	B	38	D	39	C	40	A
41	D	42	B	43	D	44	A	45	C
46	B	47	A	48	B	49	C	50	D