JEE MAIN Physics Sample Paper 01

Subject: Physics

Structure: 20 MCQs + 5 Numerical Type Questions

Marking Scheme: Correct (+4) | Incorrect MCQ (-1) | Incorrect NVT (0)

Section A: Multiple Choice Questions (1-20)

1. The workdone by a gas molecule is $W = \alpha\beta^2 e^{-x^2/\alpha kT}$. The dimension of β is:

A. $[ML^2T^{-2}]$

B. $[MLT^{-2}]$

C. $[M^2LT^2]$

D. $[M^0LT^0]$

2. A stone falls from a building. 5m down, another stone starts to fall from a point 25m below the top. Both reach the bottom simultaneously. Building height:

A. 35 m

B. 45 m

C. 50 m

D. 25 m

3. If |P+Q| = n|P-Q|, and both have equal magnitude, the angle between them is:

A. $\sin^{-1}((n-1)/(n+1))$

B. $\cos^{-1}((n-1)/(n+1))$

C. $\sin^{-1}((n^2-1)/(n^2+1))$

D. $\cos^{-1}((n^2-1)/(n^2+1))$

4. Velocity of a bullet becomes 1/3rd after penetrating 4 cm. Assuming constant resistance, total distance travelled before stopping is:

A. 4.5 cm

B. 5.0 cm

C. 5.5 cm

D. 6.0 cm

5. Range R and Max height H are equal. Then tan θ will be:

A. 1

B. 2

C. 3

D. 4

6. A particle moves with constant speed π m/s. For motion from A to B (120° arc), magnitude of average velocity is:

A. π

B. √3

C. 2√3

D. 1.5√3

7. Escape velocity for a planet with $9M_e$ and $4R_e$ (Earth V_e = 11.2 km/s):

A. 16.8 km/s

B. 33.6 km/s

C. 22.4 km/s

D. 44.8 km/s

8. In an LCR circuit, V_R = 10, V_L = 20, V_C = 20. The power factor is:

A. 0.5

B. 1.0

C. 0.707

D. 0.8

9. Ratio of max to min wavelength of Lyman series:

A. 4/3

B. 9/8

C. 3/2

D. 2/1

10. A biconvex lens of index 1.5 has 40cm focal length in air. In water (n=4/3) it is:

A. 80 cm

B. 120 cm

C. 160 cm

D. 100 cm

11. Potential across C is V. Battery removed, plate distance doubled. Work done is:

A. CV^2

B. $0.5CV^2$

C. $2CV^2$

D. Zero

12. A monoatomic gas expands adiabatically from T_1 to T_2. If lengths are L_1, L_2, then T_1/T_2:

A. $(L_2/L_1)^{2/3}$

B. $(L_1/L_2)^{2/3}$

C. L_2/L_1

D. L_1/L_2

13. Two bulbs 24W and 36W in series to 24V. When switch closed, bulb B (36W):

A. Brighter than A

B. Dimmer than A

C. Same as A

D. Fuses

14. Intensity in front of one slit in YDSE if d = 5λ, D = 10d:

A. I_0

B. $I_0/2$

C. $I_0/4$

D. $3I_0/4$

15. A particle of mass m, charge q enters B field at 30° to boundary. Time spent is:

A. πm/3qB

B. πm/6qB

C. 2πm/qB

D. 5πm/3qB

16. For a projectile, max range is 100m. Max height it can be thrown straight up is:

A. 100 m

B. 25 m

C. 50 m

D. 75 m

17. Percentage increase in pressure at 2h depth if at depth h pressure is $3x10^5$ Pa:

A. 66.7%

B. 100%

C. 50%

D. 33.3%

18. Species with highest bond order:

A. O_2

B. O_2^+

C. O_2^-

D. O_2^{2-}

19. Stability of carbocations:

A. Ethyl > Propyl

B. t-butyl > Isopropyl

C. Allyl > Ethyl

D. Both B and C

20. Prussian blue formula in Nitrogen test:

A. $Fe_4[Fe(CN)_6]_3$

B. $Fe_3[Fe(CN)_6]_4$

C. $Na_4[Fe(CN)_6]$

D. $Fe(SCN)_3$

Section B: Numerical Value Questions (21-25)

21. Percentage error in R = V/I for V = 50 ± 2, I = 20 ± 0.2: _____

22. Ball dropped from 20m, e = 0.5. Rebound height (m): _____

23. Max range 100m. Max height thrown straight up (m): _____

24. Energy lost (nJ) sharing charge between two 60pF capacitors: _____

25. Max compression (cm) for 2kg block falling 40cm on k=1960: _____

ANSWER KEY & DETAILED EXPLANATION

1. [B] Dimension of exponent is dimensionless. Solving for α gives L^2/Energy. Substituting into $W=\alpha\beta^2$ gives dimensions of Force $[MLT^{-2}]$.

2. [B] Using $h=\frac{1}{2}gt^2$, calculate the time gap. Equating total displacement leads to building height 45 m.

3. [D] Squaring both sides and using $|P|=|Q|$ leads to the trigonometric identity $\cos\theta = (n^2-1)/(n^2+1)$.

4. [A] Using $v^2=u^2-2as$, deceleration $a = (4/9)u^2/4$. Total stopping distance $s = u^2/2a = 4.5$ cm.

5. [D] Equating Range and Max Height: $u^2\sin2\theta/g = u^2\sin^2\theta/2g$. Simplification yields $\tan\theta = 4$.

6. [D] Avg Velocity = Displacement / Time. Displacement = $R\sqrt{3}$. Time = $2R/3$. Ratio gives $1.5\sqrt{3}$.

7. [A] $V_e \propto \sqrt{(M/R)}$. New velocity = $11.2 * \sqrt{(9/4)} = 16.8$ km/s.

8. [B] Since $V_L = V_C$, the circuit is at resonance. $Z=R$, hence Power factor $\cos\varphi = 1.0$.

9. [A] Lyman series: Max λ $(2\rightarrow1) = 4/3R$, Min λ $(\infty\rightarrow1) = 1/R$. Ratio = 4/3.

10. [C] Using Lens Maker's formula in air vs water: f_water ≈ 4 * f_air = 160 cm.

11. [B] Work = ΔU. Charge is constant. U_final = 2 * U_initial. Work = $0.5CV^2$.

12. [A] Adiabatic process for monoatomic gas (γ=5/3) leads to $T \propto L^{-2}$. Ratio is (L2/L1)^(2/3).

13. [B] Power $P=V^2/R$. 36W bulb has lower resistance. In series, $P=I^2R$, so lower R consumes less power.

14. [B] Path difference $\Delta x = 1.25\lambda$. Intensity formula $I = I_0\cos^2(\Delta\varphi/2)$ yields $I_0/2$.

15. [D] Entering at 30° to boundary implies 120° deviation inside field. Time = $5\pi m/3qB$.

16. [C] Max range 100m means $u^2/g = 100$. Height $H = u^2/2g = 50$ m.

17. [D] Pressure at depth h is $P_0+\rho gh$. At 2h it is $P_0+2\rho gh$. Percentage increase is ~33.3%.

18. [B] O_2^+ has 15 electrons, resulting in Bond Order = 2.5.

19. [D] t-butyl (3°) and resonance-stabilized Allyl are both more stable than Ethyl.

20. [A] Prussian blue formula is $Fe_4[Fe(CN)_6]_3$.

21. [5] % Error = (2/50 + 0.2/20) * 100 = 4% + 1% = 5%.

22. [5] Rebound height $h' = e^2h = (0.5)^2 * 20 = 5$ m.

23. [50] $H = u^2/2g = R_{max} / 2 = 50$ m.

24. [120] Loss = $\frac{1}{2}[C1C2/(C1+C2)]V^2$. Calculation leads to 120 nJ.

25. [10] $mg(h+x) = \frac{1}{2}kx^2$. Solving for x gives 10 cm.