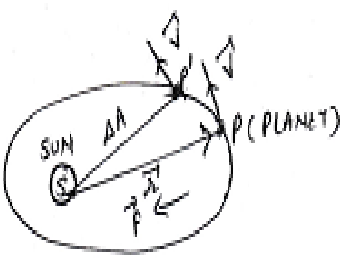
Class XI (2024-25)

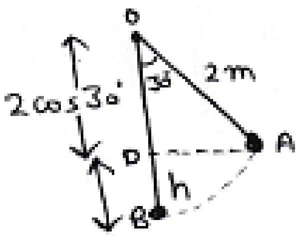
PHYSICS

SAMPLE PAPER MARKING SCHEME

Q.No.	Hints to the Answers	Value Point	Total Marks
	SECTION A		
1	d) 5	1	1
2	d) Figures A, B and C	1	1
3	d) in all options (A, B, C and D)	1	1
4	d) $\vec{r_4}$ = 3.0 t $\hat{\imath}$ - 4.0$t^3\hat{\jmath}$	1	1
5	c) – 300 W	1	1
6	b) $\frac{2MR^2}{5}$	1	1
7	c) $\frac{2}{3}$	1	1
8	b) 120 J/s	1	1
9	b) B only	1	1
10	b) $T_1<T_2<T_3$	1	1
11	d) + 10πm/s	1	1
12	d) y_4 (x,t) = - a sin (kx+ωt)	1	1
13	Option (a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion	1	1
14	Option : (C) Assertion is true but Reason is false	1	1
15	Option (a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion	1	1
16	Option : (b) Both Assertion and Reason are true but Reason is not the correct explanation of Assertions	1	1
	SECTION B		
17	L.H.S. = V = $[L^3 T^{-1}]$ R.H.S. = $\frac{\pi}{8}\frac{\rho r^4}{\eta l}$ = $\frac{[M^1L^{-1}T^{-2}]}{[M^1L^{-1}T^{-1}]}\frac{[L]^4}{[L]^1}$ = $[M^0L^3 T^{-1}]$ As LHS = RHS, dimensionally $\therefore$ The relation is correct	½ ½ ½ ½	2
18	Let after breaking, masses of two parts are $m_1 = \frac{2}{5}$m and $m_2 = \frac{3}{5}$m Acc. to law of conservation of linear momentum m (0) = $m_1\vec{v_1} + m_2\vec{v_2}$	½ ½	2

	$\therefore \frac{2}{5}m\,(8\hat{\imath} + 6\hat{\jmath}) + \frac{3}{5}m\overrightarrow{v_2} = 0$ $16\hat{\imath} + 12\,\hat{\jmath} + 3\,\overrightarrow{v_2} = 0$ $\overrightarrow{v_2} = (-\frac{16}{3}\,\hat{\imath} - 4\hat{\jmath})$ m/s	½ ½	
19	A projectile will have same horizontal range R for two angles of projection θ and $(90^0 - \theta)$. $R = \frac{u^2 sin\ 2\theta}{g}$ $t_1 = \frac{2u\ \sin\theta}{g}$, $t_2 \frac{2u\ \cos\theta}{g}$ $t_1\ t_2 = \left(\frac{2u\ \sin\theta}{g}\right)\left(\frac{2u\ \cos\theta}{g}\right)$ $t_1\ t_2 = \frac{2u^2 sin\ 2\theta}{g^2}$ $t_1\ t_2 = \frac{2R}{9}$ OR $(\vec{A} + \vec{B})$ and $(\vec{A} - \vec{B})$ are perpendicular to each so their dot product is Zero $(\vec{A} + \vec{B})\ .\ (\vec{A} - \vec{B}) = 0$ $\vec{A}.\vec{A} - \vec{A}.\vec{B} + \vec{B}.\vec{A} - \vec{B}.\vec{B} = 0$ $A^2 - \vec{A}.\vec{B} + \vec{A}.\overrightarrow{B} - B^2 = 0$ $A^2 - B^2 = O$ $A^2 = B^2$ $\therefore$ A = B	½ ½ ½ ½ ½ ½ ½ ½	2 2
20	$\frac{\Delta Q}{\Delta t} = KA\,\frac{\Delta T}{\Delta x}$ As , $\frac{\Delta Q_1}{\Delta t} = \frac{\Delta Q_2}{\Delta t}$ $K_1\ A_1 \frac{(T_1 - T_2)}{L} = \frac{K_2\ A_2\ (T_1 - T_2)}{L}$ $\therefore \frac{A_1}{A_2} = \frac{K_2}{K_1}$	½ ½ ½ ½	2
21	Pressure required to blow a hemispherical bubble at its end in water = $P_{outside} + \frac{2S}{R}$ $= 1.0 \times 10^5 + \frac{2x7.30x10^{-2}}{1x10^{-3}}$ $= 10^5 + 14.6 \times 10^1$ $= 10^5 + 0.00146 \times 10^5$ $= 1.00146 \times 10^5$Pa	½ ½ ½ ½	2

	SECTION C		
22	a) Node (N) is a point, where the amplitude of oscillation is zero and pressure is maximum i.e. antinode. Antinode (A) is a point where the amplitude of oscillation is maximum and pressure is minimum, hence node. b) Though the violin and sitar note have the same frequency, yet the overtones produced and their relative strengths are different in the two notes. c) Solids have both, the elasticity of volume and elasticity of shape, whereas gases have only the elasticity of volume.	½ ½ 1 1	1 1 1 =03
23	a) $\omega = \frac{2\pi}{T}$ $= 2 \times \frac{22}{7} \times \frac{7}{44}$ = 1 rad/s b) Since, direction of velocity changes continuously acceleration is not a constant vector. c) $a = \omega^2 R$ $= (1)^2 \times (10\text{ cm})$ $= 10 \text{ cm s}^{-2}$	½ ½ 1 ½ ½	1 1 1 = 03
24	a) The deformation between elastic limit and fracture point for material (Q) is more as compared to material (P). Hence (Q) is more ductile. b) $Y = \frac{\text{stress}}{\text{strain}}$ Slope of graph= $\frac{1}{Y}$ $(\text{slope})_P < (\text{slope})_Q$ $\therefore Y_P > Y_Q$ c) Material (Q) has higher tensile strength as it sustains more stress after elastic limit.	1 ½ ½ 1	1 1 1 =03
25	Law of areas- The radius vector drawn from the sun to a planet sweeps out equal areas in equal intervals of time, i.e., the areal velocity (area covered per unit time) of a planet around the sun is constant. Consider a planet moving in an elliptical orbit with the sun at focus S. Let $\vec{r}$ be the position vector of the planet w.r.t the sun and $\vec{F}$ be the gravitational force on the planet due to the sun. Torque exerted on the planet by this force about the sun is $\vec{\tau} = \vec{r} \times \vec{f}$ = 0(As $\vec{r}$ & $\vec{f}$ are oppositely directed)  But $\vec{\tau} = \frac{d\vec{L}}{dt}$		3

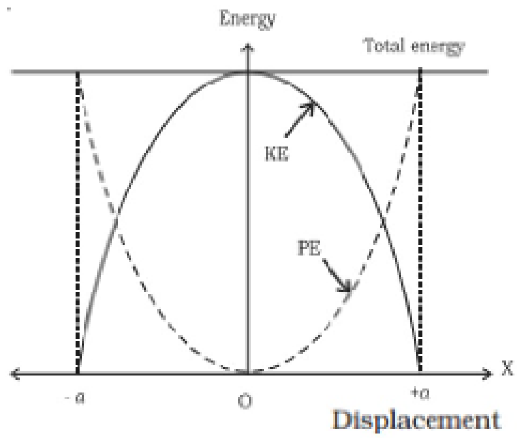
	$\therefore \frac{d\vec{L}}{dt}$ = 0 or $\vec{L}$ = constant Suppose the planet moves from position P to P$'$ in time Δt. The area swept by the radius vector $\vec{r}$ is $\overrightarrow{\Delta A} = \frac{1}{2}\vec{r} \times \overrightarrow{PP'}$ But $\overrightarrow{PP'} = \overrightarrow{\Delta r} = \vec{v}\Delta t = \frac{\vec{p}}{m}\Delta t$ $= \Delta\vec{A} = \frac{1}{2}\vec{r} \times \frac{\vec{p}}{m}\Delta t$ $= \frac{\Delta\vec{A}}{\Delta t} = \frac{1}{2m}(\vec{r} \times \vec{p}) = \frac{\vec{L}}{2m}$ or$\frac{\Delta A}{\Delta t}$ = constant (As $\vec{l}$ and $\vec{m}$ are constant)		
26	Ball A will not rise after collision.When two bodies of same mass undergo an elastic collision, their velocities are interchanged. After collision, ball A will come to rest and the ball B would move with the velocity of A.  Height BD = OB – OD = 2 - 2cos 30^0 = 2 -2 ($\sqrt{3}$/2) = 2 -1.73 = 0.27 m By law of conservation of energy $\frac{1}{2}$ mv^2 = mgh So, v =$\sqrt{2gh}$ = $\sqrt{2 \text{ x}0.27\text{x}10}$ v = $\sqrt{5.4}$ = 2.32 m/s	½ ½ ½ ½ ½ ½	3
27	MOI of hollow cylinder I_1= Mr^2 MOI of solid cylinder, $\mathrm{I}_2 = \frac{2}{5}$ Mr^2 For hollow sphere, $\tau = \mathrm{I}_1\propto_1$ For solid sphere, $\tau = \mathrm{I}_2\propto_2$ $\therefore \frac{\alpha_2}{\alpha_1} = \frac{I_1}{I_2} = \frac{Mr^2}{\frac{2}{5}Mr^2} = \frac{5}{2}$ As $\omega = \omega_o + \alpha t$and ω_o = o $\therefore \frac{\omega_2}{\omega_1} = \frac{\alpha_2}{\alpha_1} = \frac{5}{2}$	½ ½ ½ ½ ½ ½	3
28	We assume perfect contact between bodies A and B and the rigid portion	1	

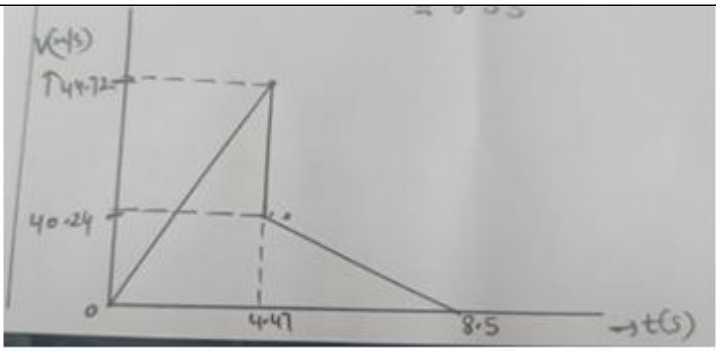
	(reaction) equals 200 N. There is no impending motion and no friction. The action-reaction forces between A and B are also 200 N. When the partition is removed, kinetic friction comes into play. Acceleration of A+B= $\frac{[200 \; -(150 \text{ x } 0.15)]}{15}$ = 11.8 m/s^2 Friction on A = 0.15 x 50 = 7.5N 200 – 7.5 – F_{AB} = 5x 11.8 F_{AB} = 1.3 x 10^2 N opposite to motion F_{BA} = 1.3 x 10^2 N in the direction of motion OR a) For t < 0 and t>6, the position of the particle is not changing hence no force is acting on the particle. For 0<t<6, position of the particle changes uniformly hence no force acts during this interval also. b) t=0 u=0 After t=0, v = slope of OA = $\frac{3}{6}$ m/s At t = 0, Impulse = change in momentum = m (v –u) = 8 ($\frac{3}{6}$-0) = 4 kgm/s At t = 6s, u = $\frac{3}{6}$, v = o Impulse = m (v –u) = 8 (0 - $\frac{3}{6}$) = - 4 kgm/s	½ ½ ½ ½ ½+½ 1 ½ ½	
	SECTION D (Case study)		
29	i) a) $x_0 f_0 \hat{k}$ ii) b) remains constant iii) d) $\frac{L}{4}$ OR iii) d) 3:1 iv) b) 24 kg m^2s^{-1}	1x4	4
30	i) c) At high temperature and low pressure ii) a) Ideal gas behavior iii) b) T_1>T_2 OR a) 8.31 J/K iv) a)	1x4	4
	SECTION E		
31(a)	Work done in an adiabatic change of an ideal gas from the state ($P_1V_1T_1$) to the state ($P_2V_2T_2$). W = $\int_{V_1}^{V_2} PdV$ - (1) Using PV^{γ} = constant 1) W = constant $\int_{V_1}^{V_2} \frac{dV}{V^{\gamma}}$	½ ½	

	$= \text{constant}\left[\frac{V^{-\gamma+1}}{1-\gamma}\right]_{V_1}^{V_2}$ $= \frac{constant}{1-\gamma}\frac{1}{V_2^{\gamma-1}} - \frac{1}{V_1^{\gamma-1}}$ $= \frac{1}{1-\gamma}\frac{P_2V_2^{\gamma}}{V_2^{\gamma-1}} - \frac{P_1V_1^{\gamma}}{V_1^{\gamma-1}}$ (As $P_1V_1^{\gamma} = P_2V_2^{\gamma} = \text{constant}$) $= \frac{1}{1-\gamma}[P_2V_2 - P_1V_1]$ W.D. = $\frac{\mu R\ (T_1-T_2)}{\gamma-1}$	½ ½ 1	3
31(b) (i) (ii)	For adiabatic process $TV^{\gamma-1}$ = constant $T_2V_2^{\gamma-1} = T_1V_1^{\gamma-1}$ $\therefore T_2 = \left(\frac{V_1}{V_2}\right)^{\gamma-1} = 300\left(\frac{V}{2\sqrt{2}V}\right)^{\frac{5}{3}-1}$ $= 300 \times \frac{1}{(2^{3/2})^{2/3}}$ $= \frac{300}{2}$ K T_2 = 150 K $\Delta U = \mu\ C_V dt$ for all processes $= 2 \times \frac{3}{2}R \times (150-300)$ J = - 3 x 8.3 x 150 J = - 3735 J	½ ½ ½ ½	2 3 +2 = 5
31(a)	OR Let there be n drops (small) combine to form a big drop. Then, $n \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3$ or $n = \frac{R^3}{r^3}$ Mass of bigger drop of water $M = \frac{4}{3}\pi R^3 \times 1$ (ρ= 1 g/cc) Energy released = S.T x decrease in surface area $E = S \times 4\pi(nr^2 - R^2)$ $= S \times 4\pi\left(\frac{R^3}{r^3}r^2 - R^2\right)$ $= 4\pi SR^3\left(\frac{1}{r} - \frac{1}{R}\right)$ $= 3 \times \frac{4}{3}\pi R^3 S\left[\frac{R-r}{Rr}\right]$	1 ½ ½	

	$= 3\ MS\ [\frac{R-r}{Rr}]$ ∴ K.E. produced = E $\therefore \frac{1}{2} mv^2 = 3MS\ [\frac{R-r}{Rr}]$ $V = \sqrt{\frac{6S(R-r)}{Rr}}$	½ ½	3
31(b)	V_1 = 180 km/h = 50 m/s V_2 = 234 km/h = 65m/s A = 2 x 25 = 50m^2 ρ= 1 kg/m^3 $P_1 - P_2 = \frac{1}{2} \rho\ (V_2^2 - V_1^2)$ $= \frac{1}{2}$ x 1 x ($65^2 - 50^2$) ∴ Upward force = ($P_1 - P_2$) A $= \frac{1}{2}$ x ($65^2 - 50^2$) x 50 N As the plane is in level flight, so mg = ($P_1 - P_2$) A or, $m = \frac{(P_1 - P_2)A}{g}$ $= \frac{1 \text{ x } (65^2 - 50^2) \text{ x } 50}{2 \text{ x } 9.8}$ = 4.4 x 10^3 kg	½ ½ ½ ½	2 3 +2 = 5
32 (a)	Let the wave pulse moving from left to right (i.e. along +ve x –axis) be y_1 (x,t) = r sin (ωt – kx) As there is a phase change of π radian on reflection at the rigid boundary, ∴ Reflected wave pulse travelling from right to left is y_2 (x,t) = r sin (ωt +kx + π) y_2 (x,t)= - r sin (ωt + kx)  According to superposition principle, the resultant displacement y at time t and position x is given by y(x,t) = y_1 (x,t) + y_2 (x,t) y(x,t) = r sin (ωt – kx) – r sin (ωt + kx) y(x,t)= - r [sin (ωt + kx) – sin (ωt – kx)] Using the relation $\sin C - \sin D = 2 \cos\frac{C+D}{2} \sin \frac{C-D}{2}$ y(x,t) = - 2 r cosωt sin kx y(x,t) = - (2 r sin kx) cosωt	½ ½ ½ ½	2
32(b)	At the closed end of the pipe , x =0 sin kx = sin0^o = 0 ∴ y= 0 i.e. a node is formed. At the open end of the pipe of length L	½	

	y = L an antinode is formed i.e. y = Max. When sin kL = Max = ± 1 $= \sin (2n-1)\frac{\pi}{2}$ $\therefore kL = (2n-1)\frac{\pi}{2}$ where, n = 1,2 3 $\frac{2\pi}{\lambda} L = (2n-1)\frac{\pi}{2}$ $\therefore \lambda = \frac{4L}{(2n-1)}$ As $v = \nu\lambda$ $\therefore \nu = \frac{V}{\lambda} = \frac{(2n-1)V}{4L}$ $\therefore$ For frequency of n^{th} mode of vibration is $\nu_n = \frac{(2n-1)V}{4L}$	½ ½ ½	2
32(c)	For first mode of vibration n=1 $\nu_1 = \frac{V}{4L}$ For second mode of vibration n =2 $\therefore \nu_2 = \frac{(2\text{x}2-1)V}{4L} = \frac{3V}{4L} = 3\nu_1$ For third mode of vibration n = 3 $\nu_3 = \frac{(2\text{x}3-1)V}{4L} = \frac{5V}{4L} = 5\nu_1$ $\nu_1 : \nu_2 : \nu_3 = 1:3:5$ $\therefore$only odd harmonics are present in a closed end organ pipe.	½ ½	1 2+2+1 = 5
32	OR Kinetic Energy of the particle at the instant t, is $K = \frac{1}{2} mv^2 = \frac{1}{2} m (a\omega \cos\omega t)^2$ $K = \frac{1}{2} m\omega^2 a^2 \cos^2\omega t$ $K = \frac{1}{2} m\omega^2 a^2 (1-\sin^2\omega t)$ $K = \frac{1}{2} m\omega^2 (a^2-y^2)$ Potential Energy Work done for small displacement dy against the restoring force is dW = - Fdy = - (- ky) dy dW = kydy Total work done for displacing the particle from the mean position to a position of displacement y will be	½ ½ ½ ½ ½ ½	

	$W = \int_o^y ky\ dy = \frac{1}{2}ky^2$ This work done appears as PE. $U = \frac{1}{2}ky^2 = \frac{1}{2}m\omega^2 y^2$ 	½ ½ 1	5
33	u =0, a = 10 m /s^2, s = 100 m , t = ?, v = ? Using $v^2 – u^2 = 2as$ $v^2 – 0^2 = 2 \times 10 \times 100$ $v^2 = 2000$ v = $\sqrt{2000}$ = 44.72 m/s Using s = ut + $\frac{1}{2}$at ^{2} 100 = 0xt + $\frac{1}{2}$ x 10x t^2 100= 5t^2 $t^2 = \sqrt{20}$ ∴ t = 4.472 s Rebound velocity = $(1 - \frac{1}{10})$ x 44.72 = $\frac{9}{10}$ x 44.72 = 40.24 m/s Time taken to reach highest point v= u +at 0 = 40.24 – 10 xt t = $\frac{40-24}{10}$ = 4.024 s ∴ Total time = 4.472 + 4.024 = 8.496 s = 8.5 s	½ ½ ½ ½ ½ ½ ½ ½	5

		1	
33	OR Let the speed of ball 1 = u_1 = 2u m/s Then the speed of ball 2 = u_2 = um/s Let the height covered by ball 1 before coming to rest = h_1 Let the height covered by ball 2 before coming to rest = h_2 At the top their velocities becomes zero $u^2 = 2gh \Rightarrow h = \frac{u^2}{2g} \Rightarrow h_1 = \frac{{u_1}^2}{2g}$ $h_1 = \frac{4u^2}{2g}$ and $h_2 = \frac{u^2}{2g}$ A.T.Q $h_1 - h_2$ = 15 m (given) $\frac{4u^2}{2g} - \frac{u^2}{2g} = 15$ $\frac{u^2}{2g}[4-1] = 15$ $\Rightarrow u^2 = \frac{15 \text{ x } 2 \text{ x } 10}{3}$ $\Rightarrow u^2 = 100$ u = 10 m/s ∴ For ball 1, $v_1 = u_1 + gt$ $0 = 20 - 10\ t_1$ t_1 = 2s For ball 2, $v_2 = u2 + gt_2$ $0 = 10 - 10\ t_2$ t_2 = 1s ∴ Velocities of ball 1 and 2 are 20 m/s and 10m/s respectively. Time interval between two balls $= t_1 - t_2$ = (2-1) = 1 second	½ + ½ ½ 1 ½ ½ ½ 1	5