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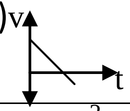
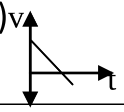
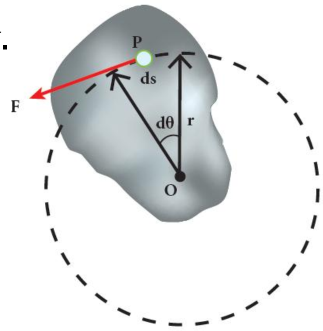
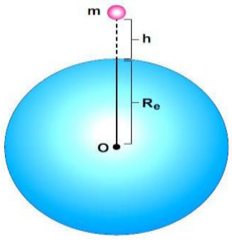
TENTATIVE ANSWER KEY

XI -PHYSICS **TOTAL MARKS : 70**

Q.N	PART – I		MARKS
	TYPE – A	TYPE – B	
1.	b) (250 ±5) Ω	b) increases	1
2.	b) increases	c) 6%	1
3.	d) zero	a) 	1
4.	a) 1.0m	d) $2ms^{-2}$	1
5.	c) 100Hz and 6m	b) pure rotation	1
6.	d) $2ms^{-2}$	a) 1.0m	1
7.	b) pure rotation	d) $\sqrt{\frac{k_B}{8k_A}}$	1
8.	c) Carbon-di-oxide	a) increase 4 times	1
9.	a) decrease and increase	d) zero	1
10.	a) 	a) decrease and increase	1
11.	c) 6%	c) Carbon-di-oxide	1
12.	a) $Jkg^{-1}K^{-1}$	c) 100Hz and 6m	1
13.	d) $\sqrt{\frac{k_B}{8k_A}}$	d) adiabatic	1
14.	d) adiabatic	b) (250 ±5) Ω	1
15.	a) increase 4 times	a) $Jkg^{-1}K^{-1}$	1
	PART – II		
16.	**Which one of these is more elastic, steel or rubber? Why?** ❖ Steel is more elastic than rubber. If an equal stress is applied to both steel and rubber, the steel produces less strain. So the Young's modulus is higher for steel than rubber. The object which has higher young's modulus is more elastic.		2

17.	**Vector Give examples:** It is a quantity which is described by both magnitude and direction. Eg: Force, velocity, displacement.	1 1
18.	Given: r = 10m, v = $50ms^{-1}$, m = 60kg. sol: F = $\frac{mv^2}{r}$ = $\frac{60\times50\times50}{10}$ = 15,000N (without unit reduce ½ mark)	½ ½ 1
19.	**Brownian motion** Brownian motion is due to the bombardment of suspended particles by molecules of the surrounding fluid.	2
20.	Given data: R= 1.5 m, ω =3 rad s^-1, V_{CM} = 5 ms^{-1} sol = V_{ROT} = Rω = 1.5x3 =4.5 ms^{-1} V_{CM} > Rω, it is not pure rolling but sliding	½ ½ ½ ½
21.	**Free oscillation:** When the oscillator is allowed to oscillate by displacing its positon from equilibrium positon, it oscillates with a frequency which is equal to the natural frequency of the oscillator. Such an oscillation or vibration is known as free oscillation or free vibration. In this case, the amplitude, frequency and the energy of the vibrating object remains constant.	2
22.	**Coefficient of restitution** ❖ It is defined as the ratio of velocity of separation (relative velocity) after collision to the velocity of approach (relative velocity) before collision, (or) $e = \frac{\text{velocity of separation (after collision)}}{\text{velocity of approach (before collision)}} = \frac{(v_2 - v_1)}{(u_1 - u_2)}$	2
23.	**The limitations of dimensional analysis** ❖ This method gives no information about the dimensionless constants in the formula like 1, 2,........π,e, etc. ❖ This method cannot decide whether the given quantity is a vector or a scalar. ❖ This method is not suitable to derive relations involving trigonometric, exponential and logarithmic functions. ❖ It cannot be applied to an equation involving more than three physical quantities. ❖ It can only check on whether a physical relation is dimensionally correct but not the correctness of the relation. For example using dimensional analysis, s = ut +$\frac{1}{3}at^2$ is dimensionally correct whereas the correct relation is s = ut +$\frac{1}{2}at^2$ **(Any 2 points)**	2
24.	Given data: W = -30 kJ = -30,000 J, Q = -5 k cal= -5 x 4184J = -20,920J ΔU= Q – W = -20,920J – (-30,000 J) = 9080J (without unit reduce ½ mark)	½ ½ 1

	PART – III	
25.	Let us consider a rigid body rotating about a fixed axis. Figure 5.29 shows a point P on the body rotating about an axis perpendicular to the plane of the page. A tangential force F is applied on the body.  It produces a small displacement ‘ds ‘on the body. The work done (dw) by the force is, $dw = Fds$ As the distance ds, the angle of rotation dθ and radius r are related by the expression, $ds = r\, d\theta$ The expression for work done now becomes, $dw = F\, ds;\ dw = F\, r\, d\theta$ The term (Fr) is the torque τ produced by the force on the body. $dw = \tau d\theta$ This expression gives the work done by the external torque τ, which acts on the body rotating about a fixed axis through an angle dθ. The corresponding expression for work done in translational motion is, $dw = Fds$	1/2 1/2 1 1
26.	**The variation of g with altitude.** ❖ Consider an object of mass m at a height h from the surface of the Earth. Acceleration experienced by the object due to Earth is $$g' = \frac{GM}{(R_e + h)^2}$$	1



½

$$g' = \frac{GM}{R_e^2\left(1+\frac{h}{R_e}\right)^2} \qquad g' = \frac{GM}{R_e^2}\left(1+\frac{h}{R_e}\right)^{-2}$$

If h <<R e. We can use Binomial expansion. Taking the terms upto first order

$$g' = \frac{GM}{R_e^2}\left(1-2\frac{h}{R_e}\right)$$

$$g' = g\left(1-2\frac{h}{R_e}\right)$$

1

We find that g" < g. This means that as altitude h increases the acceleration due to gravity g decreases. ½

27.

The factors affecting the surface tension of a liquid:

- **Contamination or impurities :**
  The presence of any contamination or impurities considerably affects the force of surface tension depending upon the degree of contamination.
- **Dissolved substances :**
  The presence of dissolved substances can also affect the value of surface tension.
  Eg: A highly soluble substance like sodium chloride (*NaCl*) when dissolved in water (H_20) increases the surface tension of water.
- **Electrification:**
  When a liquid is electrified, surface tension decreases. Since external force acts on the liquid surface due to electrification, area of the liquid surface increases which acts against the contraction phenomenon of the surface tension. Hence, it decreases.
- **Temperature:**
  The surface tension decreases linearly with the rise of temperature. For a small range of temperature, the surface tension at T_t at t °C is

$$T_t = T_0(1-\alpha t)$$

Where, T_0 is the surface tension at temperature 0°C and α is the temperature coefficient of surface tension.

At critical temperature of water is 374°C, the surface tension is zero

$$T_t = T_0\left(1-\frac{t}{t_c}\right)^{\frac{3}{2}}$$

(Any 3 points) 3

28.	**The relation between the average kinetic energy and pressure:** ❖ The internal energy of the gas is given by $$U = \frac{3}{2}NkT$$ ❖ The above equation can also be written as $$U = \frac{3}{2}PV$$ since $PV = NkT$ $$P = \frac{2}{3}\frac{U}{V} = \frac{2}{3}u$$ **(upto)** ❖ From the equation, we can state that the pressure of the gas is equal to two thirds of internal energy per unit volume or internal energy density $$(u = \frac{U}{V})$$ • Writing pressure in terms of mean kinetic energy density using equation $$P = \frac{1}{3}nm\overline{v^2} = \frac{1}{3}\rho\overline{v^2}$$ where $\rho = nm$ = *mass density* (Note n is number density) • Multiply and divide R.H.S of equation by 2, we get $$P = \frac{2}{3}\left(\frac{\rho}{2}\overline{v^2}\right)$$ $$P = \frac{2}{3}\overline{KE}$$ • From the equation, pressure is equal to 2/3 of mean kinetic energy per unit volume.	1 ½ ½ 1
29.	**Forced oscillation:** Any oscillator driven by an external periodic agency to overcome the damping is known as forced oscillator or driven oscillator. In this type of vibration, the body executing vibration initially vibrates with its natural frequency and due to the presence of external periodic force , the body later vibrates with the frequency of the applied periodic force. Such vibrations are known as forced vibrations. Example: Sound boards of stringed instruments.	2 1
30	Given data: $y_1=5\sin(240\pi t)$, $y_2=4\sin(244\pi t)$ $2\pi f_1 = 240\pi$, $\therefore f_1 = 120$ Hz $2\pi f_2 = 244\pi$, $\therefore f_1 = 122$ Hz Number of beats produced per second = $\lvert f_1 - f_2 \rvert$ = $\lvert 120-122 \rvert$ = $\lvert -2 \rvert$ = 2(beats per second) (without unit reduce ½ mark)	1 1 1
31.	**Fundamental quantities:** Fundamental or base quantities are quantities which cannot be expressed in terms of any other physical quantities. **Example:** length, mass, time, electric current, temperature, luminous intensity and amount of substance.	1½

Derived quantities:

Quantities that can be expressed in terms of fundamental quantities are called derived quantities.

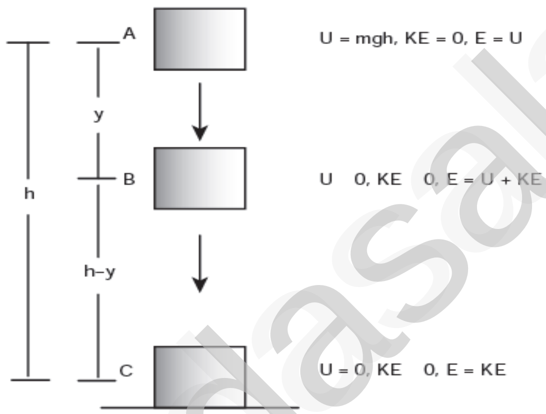
Example: area, volume, velocity, acceleration, force. 1½

32.

Law of conservation of energy: 2

- The law of conservation of energy states that energy can neither be created nor destroyed. It may be transformed from one form to another but the total energy of an isolated system remains constant.

- When an object is thrown upwards its kinetic energy goes on decreasing and consequently its potential energy keeps increasing (neglecting air resistance). When it reaches the highest point its energy is completely potential. Similarly, when the object falls back from a height its kinetic energy increases whereas its potential energy decreases. When it touches the ground its energy is completely kinetic. At the intermediate points the energy is both kinetic and potential as shown in Figure .When the body reaches the ground the kinetic energy is completely dissipated into some other form of energy like sound, heat, light and deformation of the body ½



½

- The energy transformation takes place at every point. The sum of kinetic energy and potential energy i.e., the total mechanical energy always remains constant, implying that the total energy is conserved. This is stated as the law of conservation of energy.

33.

Given: $u = 5ms^{-1}$, $\theta = 30^0$

sol: $h_{max} = \frac{u^2 sin^2\theta}{2g}$

$= \frac{5\times5\times sin^2 30^0}{2\times9.8}$

$= 0.318m$ 11/2

Range $= \frac{u^2 sin2\theta}{g}$

$= \frac{5\times5\ sin2\times30^0}{9.8} = \frac{5\times5\ sin60^0}{9.8}$ 11/2

$= 2.209 = 2.21m$

PART – IV

34. a)

Given

Frequency of vibrating string γ depends on applied force F, length l,

and mass per unit length $\frac{m}{l}$. prove that $\gamma \ \alpha \ \frac{1}{l}\sqrt{\frac{F}{m}}$

$\gamma \ \alpha \ l^a F^b m^c$ ----------------- (1) (1 mark)

Substituting dimensions on both sides

$[M^0L^0T^{-1}] = [L]^a [MLT^{-2}]^b [ML^{-1}]^c = [L^a M^b L^b T^{-2b} M^c L^{-c}]$

$= [M^{b+c} L^{a+b-c} T^{-2b}]$ (1 mark)

Equating powers on both sides

$b + c = 0, \ a + b – c = 0, \ - 2b = - 1$

This implies b = ½ , c = - ½ and a = -1 (1 mark)

Subs. a, b and c in equations (1) we get

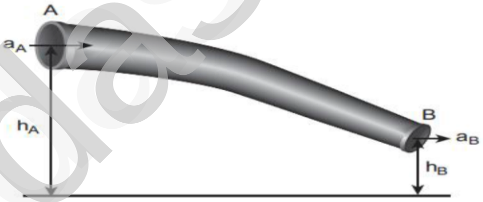
$\gamma \ \alpha \ l^{-1} F^{1/2} m^{-1/2}$ (1 mark)

$\gamma \ \alpha \ \frac{1}{l}\sqrt{\frac{F}{m}}$ [hence proved] (1 mark)

or 34. (b)

Bernoulli's theorem for a flow of incompressible, non-viscous, and streamlined flow of fluid.

- According to Bernoulli's theorem, the sum of pressure energy, kinetic energy, and potential energy per unit mass of an incompressible, non-viscous fluid in a streamlined flow remains a constant. Mathematically (1 mark)
- $\frac{P}{\rho} + \frac{1}{2}v^2 + gh = \text{constant}$



(½ mark)

- Let us consider a flow of liquid through a pipe AB as shown in Figure Let V be the volume of the liquid when it enters A and a time r which is equal to the volume of the liquid leaving B in the same time.
- Let a_A, v_A and P_A be the area of cross section of the tube, velocity of the liquid and pressure exerted by the liquid at A respectively.
- Let the force exerted by the liquid at A is
  $FA = P_A a_A$
- Distance travelled by the liquid in time t is
  $d = v_A t$
- Therefore, the work done is
- $W = F_A d = P_A a_A v_A t$ But $aAvAt = a_A d = V$, volume of the liquid entering at A. Thus, the work done is the pressure energy (at A), $W = F_A d = P_A V$ (½ mark)

- ❖ Since m is the mass of the liquid entering at A in a given time, therefore, pressure energy of the liquid at A is

$$E_{PA} = P_A V = P_A V \times \left(\frac{m}{m}\right) = m\frac{P_A}{\rho}$$

- Potential energy of the liquid at A,

$$PE_A = mg\,h_A,$$

- Due to the flow of liquid, the kinetic energy of the liquid at A,

$$KE_A = \tfrac{1}{2} mV_A^2$$

- Therefore, the total energy due to the flow of liquid at A, $E_A = EP_A + KE_A + PE_A$

$$E_A = m\frac{P_A}{\rho} + \frac{1}{2} mv_A^2 + mg\,h_A$$

1

- Similarly, let a_B, v_B, and P_B be the area of cross section of the tube, velocity of the liquid, and pressure exerted by the liquid at *B*. Calculating the total energy at E_B, we get

$$E_B = m\frac{P_B}{\rho} + \frac{1}{2} mv_B^2 + mg\,h_B$$

½

- From the law of conservation of energy,

$$E_A = E_B$$

½

$$m\frac{P_A}{\rho} + \frac{1}{2} mv_A^2 + mgh_A = m\frac{P_B}{\rho} + \frac{1}{2} mv_B^2 + mgh_B$$

$$\frac{P_A}{\rho} + \frac{1}{2} v_A^2 + gh_A = \frac{P_B}{\rho} + \frac{1}{2} v_B^2 + gh_B = \text{constant}$$

- ❖ $\frac{P}{\rho} + \frac{1}{2} v^2 + gh = \text{constant}$

  When, h=0 1

- ❖ $\frac{P}{\rho g} + \frac{1}{2g} v^2 = \text{constant}$

35. a) State and Explain Work energy principle. Mention any three examples for it.

- ❖ The work done by the force on the body changes the kinetic energy of the body. This is called work-kinetic energy theorem. 1
- ❖ The work (W) done by the constant force (F) for a displacement (s) in the same direction is,

  W = Fs--------(1)

  The constant force is given by the equation, 1

  F = ma-------(2)

  The third equation of motion can be written as,

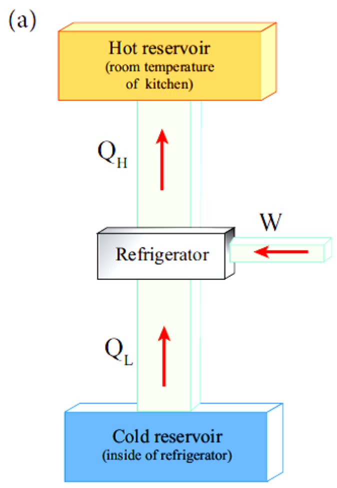
  $v^2 = u^2 + 2as$

  $a = \frac{v^2 u^2}{2s}$

  Substituting for a in equation (2)

	$F=m\left(\frac{v^2u^2}{2s}\right)$. . . .(3) Substituting equation(3) in (1) $W=m\left(\frac{v^2}{2s}s\right)-\left(\frac{u^2}{2s}s\right)$ $W=\frac{1}{2}mv^2-\frac{1}{2}mu^2$ ***The expression for kinetic energy**:* ❖ *The term ½ mv2 in the above equation is the kinetic energy of the body of mass (m) moving with velocity (v).* ❖ *$KE=\frac{1}{2}mv^2$* ❖ *Kinetic energy of the body is always positive. From equations (4) and (5)* ❖ $\Delta KE=\frac{1}{2}mv^2-\frac{1}{2}mu^2$ Thus, W=ΔKE The expression on the right hand side (RHS) of equation (6) is the change in kinetic energy (ΔKE) of the body. **The work-kinetic energy theorem implies the following.** 1. If the work done by the force on the body is positive then its kinetic energy increases. 2. If the work done by the force on the body is negative then its kinetic energy decreases. 3. If there is no work done by the force on the body then there is no change in its kinetic energy, which means that the body has moved at constant speed provided its mass remains constant.	1 1 1
35. (OR) b)	COP: COP is a measure of the efficiency of a refrigerator. It is defined as the ratio of heat extracted from the cold body (sink) to the external work done by the compressor W. $COP=\beta=\frac{Q}{W}$ The working of a refrigerator: **A refrigerator is a Carnot's engine working in the reverse order.** The working substance (gas) absorbs a quantity of heat Q_L from the cold body (sink) at a lower temperature T_L. A certain amount of work W is done on the working substance by the compressor and a quantity of heat Q_H is rejected to the hot body (source) i.e, the atmosphere at T_H.	1 1 ½

Working Principle:



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When you stand beneath of refrigerator, you can feel warmth air. From the first law of thermodynamics , we have

$$Q_L + W = Q_H$$

1

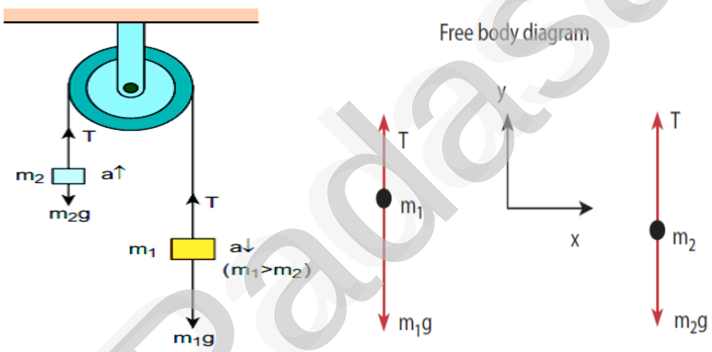
As a result the cold reservoir (refrigerator) further cools down and the surroundings (kitchen or atmosphere) gets hotter.

½

36. a)

Explain the motion of blocks connected by a string in Vertical motion

- Consider two blocks of masses m1 and m_2 ($m_1 > m_2$) connected by a light and inextensible string that passes over a pulley as shown in Figure



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- Let the tension in the string be *T* and acceleration *a*. When the system is released, both the blocks start moving, m2 vertically upward and m1 downward with same acceleration a. The gravitational force m1g on mass m1 is used in lifting the mass m2.
- The upward direction is chosen as y direction. The free body diagrams of both masses are shown in Figure

	❖ Applying Newton's second law for mass m2 $$T\hat{j} - m_2 g\hat{j} = m_2 a\hat{j}$$ ❖ The left hand side of the above equation is the total force that acts on *m*2 and the right hand side is the product of mass and acceleration of *m*2 in y direction. By comparing the components on both sides, we get $$T - m_2 g = m_2 a \quad \text{................ (1)}$$	1
	❖ Similarly, applying Newton's second law for mass m1 $$T\hat{j} - m_1 g\hat{j} = -m_1 a\hat{j}$$ ❖ As mass m1 moves downward (- *j*), its acceleration is along (- *j*) By comparing the components on both sides, we get $$T - m_1 g = -m_1 a$$ $$m_1 g - T = m_1 a \quad \text{................ (2)}$$	1
	❖ Adding equations (1) and (2), we get $$m_1 g - m_2 g = m_1 a + m_2 a$$ $$(m_1 - m_2) g = (m_1 + m_2) a \quad \text{................ (3)}$$ ❖ From equation (3), the acceleration of both the masses is $$a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) g$$	1
	❖ If both the masses are equal (m1 = m2), from equation *a* = 0 This shows that if the masses are equal, there is no acceleration and the system as a whole will be at rest. ❖ To find the tension acting on the string, substitute the acceleration from the equation (4) into the equation (1) $$T - m_2 g = m_2 \left(\frac{m_1 - m_2}{m_1 + m_2}\right)$$ $$T = m_2 g + m_2 \left(\frac{m_1 - m_2}{m_1 + m_2}\right) g$$ ❖ By taking m2g common in the RHS of equation (5)	

<table>
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$$T = m_2 g\left(1 + \frac{m_1 - m_2}{m_1 + m_2}\right)$$

$$T = m_2 g\left(\frac{m_1 + m_2 + m_1 - m_2}{m_1 + m_2}\right)$$

$$T = \left(\frac{2m_1 m_2}{m_1 + m_2}\right)g$$

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<tr><td>36
(OR)
b)</td><td>

State and explain Kepler's three Laws of Plantary motion

Law of orbits:

Each planet moves around the Sun in an elliptical orbit with the Sun at one of the foci.

The closest point of approach of the planet to the Sun 'P' is called perihelion and the farthest point 'A' is called aphelion (Figure 6.1). The semi-major axis is 'a' and semi-minor axis is 'b'.

Law of area: The radial vector (line joining the Sun to a planet) sweeps equal areas in equal intervals of time.

White shaded portion is the area DA swept in a small interval of time Dt, by a planet around the Sun.

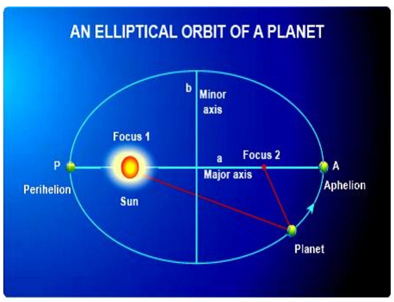
Since the Sun is not at the center of the ellipse, *the planets travel faster when they are nearer to the Sun and slower when they are farther from it, to cover equal area in equal intervals of time.*

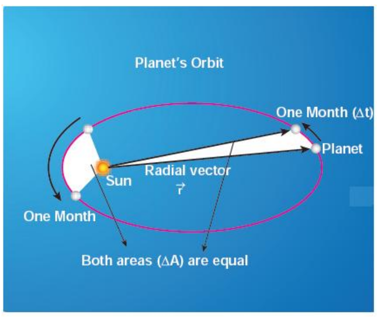
Law of period: The square of the time period of revolution of a planet around the Sun in its elliptical orbit is directly proportional to the cube of the semi-major axis of the ellipse.

$$T^2 \propto a^3$$

$$\frac{T^2}{a^3} = \text{constant}$$

T is the time period of revolution for a planet and *a* is the semi-major axis. Physically this law implies that as the distance of the planet from the Sun increases, the time period also increases but not at the same rate.





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37. (a)	**The kinematic equations of motion for constant acceleration.** ❖ Consider an object moving in a straight line with uniform or constant acceleration „a" Let u be the velocity of the object at time t = 0, and v be velocity of the body at a late time t. **Velocity - time relation** ❖ The acceleration of the body at any instant is given by the first derivative of the velocity with respect to time, $a = \frac{dv}{dt}$ or $dv = a\,dt$ Integrating both sides with the condition that as time changes from 0 to t, the velocity changes from u to v. For the constant acceleration, $\int_u^v dv = \int_0^t a\,dt = a\int_0^t dt \Rightarrow [v]_u^v = a[t]_0^t$ $v - u = at \quad (or) \quad v = u + at$ **Displacement – time relation** ❖ The velocity of the body is given by the first derivative of the displacement with respect to time. $v = \frac{ds}{dt}$ or $ds = vdt$ and since $v = u + at$, We get $ds = (u + at)dt$ Assume that initially at time t = 0, the particle started from the origin. At a later time t, the particle displacement is s. Further assuming that acceleration is time independent, we have $\int_0^s ds = \int_0^t u\,dt + \int_0^t at\,dt$ $s = ut + \frac{1}{2}at^2$ **Velocity – displacement relation** (iii) The acceleration is given by the first derivative of velocity with respect to time. $a = \frac{dv}{dt} = \frac{dv}{ds}\frac{ds}{dt} = \frac{dv}{ds}v$ [since ds/dt = v] where s is displacement traversed. This is rewritten as $a = \frac{1}{2}\frac{dv^2}{ds}$ or $ds = \frac{1}{2a}d(v^2)$ Integrating the above equation, using the fact when the velocity changes from u^2 to v^2, displacement changes from 0 to s, we get $\int_0^s ds = \int_u^v \frac{1}{2a}d(v^2)$ $\therefore s = \frac{1}{2a}(v^2 - u^2)$ $\therefore v^2 = u^2 + 2as$	1 11/2 2

We can also derive the displacement s in terms of initial velocity u and final velocity v. From the equation we can write,

$at = v - u$

Substitute this in equation, we get

$$s = ut + \frac{1}{2}(v - u)t$$

$$s = \frac{(u + v)t}{2}$$

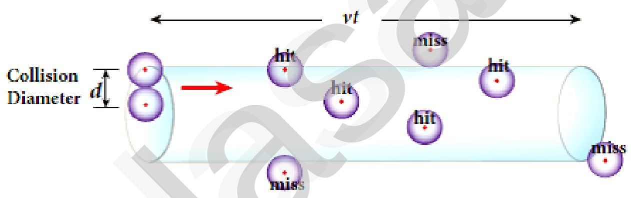
1/2

The expression for mean free path of the gas.

- ❖ Usually the average speed of gas molecules is several hundred meters per second even at room temperature (27 °C). Odor from an open perfume bottle takes some time to reach us even if we are closer to the room.
- ❖ The time delay is because the odor of the molecules cannot travel straight to us as it undergoes a lot of collisions with the nearby air molecules and moves in a zigzag path.

Expression for mean free path

- ❖ We know from postulates of kinetic theory that the molecules of a gas are in random motion and they collide with each other. Between two successive collisions, a molecule moves along a straight path with uniform velocity. This path is called mean free path. ½
- ❖ Consider a system of molecules each with diameter d. Let n be the number of molecules per unit volume. Assume that only one molecule is in motion and all others are at rest as shown in the Figure



½

- ❖ If a molecule moves with average speed *v* in a time t, the distance travelled is *vt.* In this time t, consider the molecule to move in an imaginary cylinder of volume π*d*2*vt.* It collides with any molecule whose center is within this cylinder.
- ❖ Therefore, the number of collisions is equal to the number of molecules in the volume of the imaginary cylinder. It is equal to π*d*2*vtn.* The total path length divided by the number of collisions in time t is the mean free path.
- ❖ This *average distance travelled by the molecule between collisions is called mean free path (λ). We can calculate the mean free path based on kinetic theory. (or)*

Mean free path $\lambda=\frac{distarce\ \ travelled}{Number\ \ of\ \ collisions}$

$$\lambda=\frac{v^t}{m\pi d^2 vt}\frac{1}{m\pi d^2}$$

1

- ❖ Tough we have assumed that only one molecule is moving at a time and other molecules are at rest, in actual practice all the molecules are in random motion

- So, the average relative speed of one molecule with respect to other molecules has to be taken into account. After some detailed calculations (you will learn in higher classes) the correct expression for mean free path

$$\lambda = \frac{v^t}{n\pi d^2}$$

- The equation implies that the mean free path is inversely proportional to number density. When the number density increase the molecular collisions increases on it decreases the distance travelled by the molecule before collisions.
- Case l: Rearranging the equation using 'm' (mass of the molecule)

$$\lambda = \frac{m}{n\pi d^2, mm}$$

- But mn=mass per unit volume =p (density of the gas)

$$\therefore \lambda = \frac{m}{2\pi d^{2p}}$$ (upto) 1

- Also we know that PV=NKt

$$p = \frac{N}{V} kT = mkT$$

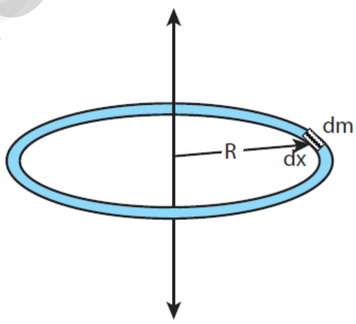
- Substituting $n = \frac{P}{kT}$ in equation

$$\lambda = \frac{kT}{\sqrt{2} n\pi d^{2p}}$$ 1

- The equation implies the following
  1. Mean free path increases with increasing temperature. As the temperature increases average speed of each molecule will increase. It is the reason why the smell of hot food reaches several meter away than smell of cold food. 1
  2. Mean free path increase with decreasing pressure of the gas and diameter of molecules.

38. (a) **The expression for moment of inertia of a uniform ring about an axis passing through the center and perpendicular to the plane.**

- Let us consider a uniform ring of mass M and radius R. To find the moment of inertia of the ring about an axis passing through its center and perpendicular to the plane, let us take an infinitesimally small mass (dm) of length (dx) of the ring. 1/2
- This (dm) is located at a distance R, which is the radius of the ring from the axis as shown in Figure



1

- The moment of inertia (dI) of this small mass (dm) is,

$$dI = (dm)R^2$$ ½

- The length of the ring is its circumference (2πR). As the mass is uniformly distributed, the mass per unit length (λ) is,

$$\lambda = \frac{\text{mass}}{\text{length}} = \frac{M}{2\pi R}$$

- The mass (dm) of the infinitesimally small length is,

$$dm = \lambda\, dx = \frac{M}{2\pi R} dx$$ 1

- Now, the moment of inertia (I) of the entire ring is,

$$I = \int dI = \int (dm) R^2 = \int \left(\frac{M}{2\pi R} dx \right) R^2$$

$$I = \frac{MR}{2\pi} \int dx$$ 1

- To cover the entire length of the ring, the limits of integration are taken from 0 to 2πR.

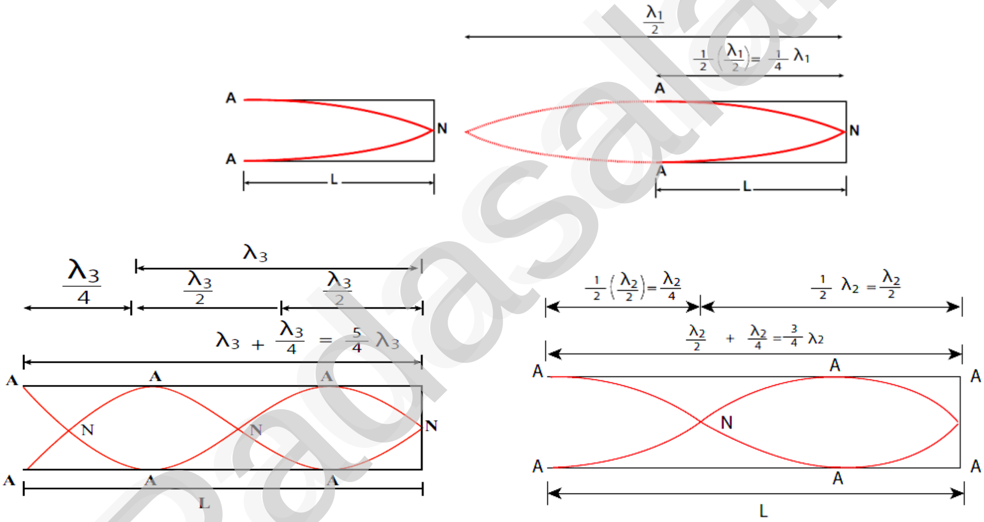
$$I = \frac{MR}{2\pi} \int_0^{2\pi R} dx$$

$$I = \frac{MR}{2\pi} [x]_0^{2\pi R} = \frac{MR}{2\pi} [2\pi R - 0]$$

$$I = MR^2$$ 1

38. (b) **Explain how overtones are produced in a closed organ pipe.**

Look at the picture of a clarinet, shown in Figure. It is a pipe with one end closed and the other end open. If one end of a pipe is closed, the wave reflected at this closed end is 180° out of phase with the incoming wave.



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❖ Thus there is no displacement of the particles at the closed end. Therefore, nodes are formed at the closed end and anti-nodes are formed at open end.

❖ Let us consider the simplest mode of vibration of the air column called the fundamental mode. Anti-node is formed at the open end and node at closed end. From the Figure, let *L* be the length of the tube and the wavelength of the wave produced.

	❖ For the fundamental mode of vibration, we have, $$L = \frac{\lambda_1}{4} \; or \; \lambda_1 = 4L$$ $$f_1 = \frac{v}{\lambda_1} = \frac{v}{4L}$$ which is called the fundamental note. ❖ *The frequencies higher than fundamental frequency can be produced by blowing air strongly at open end. Such frequencies are called overtones.* ❖ The Figure shows the second mode of vibration $$L = \frac{3\lambda_2}{4} \quad or \quad \lambda_2 = \frac{4L}{3} \Rightarrow 4L = 3\lambda_2$$ The frequency for this is called *first over tone*, since here, the frequency is three times the fundamental frequency it is called *third harmonic*. $$f_2 = \frac{v}{\lambda_2} = \frac{3v}{4L} = 3f_1$$ The Figure shows third mode of vibration having three nodes and three anti-nodes. We have, $4L = 5\lambda_3$ $$L = \frac{5\lambda_3}{4} \; or \; \lambda_3 = \frac{4L}{5}$$ The frequency $$f_3 = \frac{v}{\lambda_3} = \frac{5v}{4L} = 5f_1$$ is called *second over tone*, and since *n* = 5 here, this is called *fifth harmonic*. Hence, *the closed organ pipe has only odd harmonics and frequency of the n*th *harmonic is fn* = (*2n+1*) f_1. Therefore, *the frequencies of harmonics are in the ratio* $$f_1 : f_2 : f_3 : f_4 : \ldots = 1 : 3 : 5 : 7 : \ldots$$	1 1 1 ½ ½

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2024 - 2025 ஆம் கல்வியாண்டிற்கான
KG முதல் XII வரை அட்மிஷன் நடைபெறுகிறது
பள்ளியின் சிறப்பம்சங்கள்:
❖ FOUNDATION, NEET, JEE, UPSC ,OLYMPIAD (For VI to XII)
❖ குழந்தைகளுக்கு விளையாட்டு மூலம் கற்றல் கற்பித்தல் (Play Way Method)
❖ Montessori தரத்தில் கற்றல் கற்பித்தல் நடைபெறுகிறது.
❖ KG குழந்தைகளுக்கு தரமாகவும், சுவையாகவும் மதிய உணவு வழங்கப்படுகிறது.
❖ KG - II Std வரை CBSE கற்பித்தல் முறை பின்பற்றப்படுகிறது.
❖ சிறந்த அழகிய கையெழுத்துப்பயிற்சி (தமிழ், ஆங்கிலம் மற்றும் ஹிந்தி) அளிக்கப்படுகிறது.
❖ சிறப்பாக ஆங்கிலத்தில் பேசும் பயிற்சி (Communicative English) அளிக்கப்படுகிறது.
❖ ஒவ்வொரு மாணவர் மீதும் கனிவான தனிகவனம் செலுத்தப்படுகிறது.
❖ கதை, கவிதை, கட்டுரை, ஓவியம் மற்றும் பேச்சாற்றலுக்கான சிறப்பு பயிற்சி அளிக்கப்படுகிறது
❖ தமிழ், ஆங்கிலம், ஹிந்தி வாசித்தல் திறனை மேம்படுத்தும் வகையில் பயிற்சிகள் அளிக்கப்படுகிறது.
❖ ஹிந்தி தேர்வுகளுக்கு (ப்ராத்மிக், மத்யமா, ராஷ்ட்ரபாஷா) தேர்வு மையமாக செயல்படுகிறது.
❖ ஒவ்வொரு வார இறுதியிலும் புரிதல் தேர்வு (Understanding Test) நடைபெறுகிறது.
❖ பாடவாரியாக Club அமைத்து Activity நடைபெறுகிறது .
❖ சிலம்பம், வில்வித்தை, கராத்தே, பரதம், மேற்கத்திய நடனம், துப்பாக்கிச்சுடுதல் ஆகிய Extracurricular Activity வகுப்புகள் சிறந்த முறையில் நடைபெறுகிறது.
❖ Education Oriented Field Trip அழைத்துச் செல்லப்படுகிறது.
❖ Computer பயிற்சி சிறந்த முறையில் அளிக்கப்டுகிறது.
❖ மன அமைதி மற்றும் ஞாபக சக்தியை மேம்படுத்துவதற்காக யோகா வகுப்புகள் நடத்தப்படுகிறது.
❖ மாணவர்கள் Chess ல் சிறந்து விளங்க Chess வகுப்புகள் சிறந்த முறையில் நடைபெறுகிறது.
❖ ஒவ்வொரு பருவத் தேர்வு இறுதியிலும் School Level Achievement Survey - Test நடத்தப்படுகிறது.
❖ மாணவர்களின் உடல் திறனை மேம்படுத்தும் வகையில் விளையாட்டுப் பயிற்சிகள் (Indoor And Outdoor Games) அளிக்கப்படுகிறது.
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