R2024

No. of Printed Pages : 4

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11

PART – III

இயற்பியல் / PHYSICS

(English Version)

Time Allowed : 3.00 Hours] [Maximum Marks : 70

Instructions : (1) Check the question paper for fairness of printing. If there is any lack of fairness, inform the Hall Supervisor immediately

(2) Use **Blue** or **Black** ink to write and underline and pencil to draw diagrams.

PART – I

Note : (i) Answer **all** the questions. 15x1=15

(ii) Choose the most appropriate answer from the given **four** alternatives and write the option code and the corresponding answer.

1. The velocity of a particle v at an instant t is given by $v = at + bt^2$. The dimensions of b is

(a) [L] (b) $[LT^{-1}]$ (c) $[LT^{-2}]$ (d) $[LT^{-3}]$

2. An object is dropped in an unknown planet from height 50 m, it reaches the ground in 2 s. The acceleration due to gravity in this unknown planet is

(a) $g = 20\ m\ s^{-2}$ (b) $g = 25\ m\ s^{-2}$ (c) $g = 15\ m\ s^{-2}$ (d) $g = 30\ m\ s^{-2}$

3. The centre of mass of a system of particles does not depend upon,

(a) position of particles (b) relative distance between particles

(c) masses of particles (d) force acting on particle

4. Force acting on the particle moving with constant speed is

(a) always zero (b) need not be zero

(c) always non zero (d) cannot be concluded

5. Which of the following is not a scalar?

(a) viscosity (b) surface tension

(c) pressure (d) stress

6. An engine pumps water continuously through a hose. Water leaves the hose with a velocity v and m is the mass per unit length of the water of the jet. What is the rate at which kinetic energy is imparted to water?

(a) $\frac{1}{2}mv^3$ (b) mv^3 (c) $\frac{3}{2}mv^2$ (d) $\frac{5}{2}mv^2$

[Turn Over

7. The kinetic energy of the satellite orbiting around the Earth is
   (a) equal to potential energy (b) less than potential energy
   (c) greater than kinetic energy (d) zero
8. The torque about the axis will rotate the object about it and the torque perpendicular to the axis will turn the axis of rotation. When both exist simultaneously on a right body, the body will have,
   (a) precession (b) linear motion
   (c) circular motion (d) cannot predict
9. In an isochoric process, we have
   (a) W = 0 (b) Q = 0 (c) ΔU = 0 (d) ΔT = 0
10. The ratio $\gamma = \frac{C_p}{C_v}$ for a gas mixture consisting of 8 g of helium and 16 g of oxygen is
   (a) 23/15 (b) 15/23
   (c) 27/17 (d) 17/2
11. The unit of gravitational field is
   (a) m/s^2 (b) ms^2 (c) N/kg^{-1} (d) ms^{-1}
12. Example of diatomic molecule is
   (a) Neon (b) Nitrogen
   (c) Corbon di oxide (d) All three case
13. The Internal Energy of an ideal gas depends only
   (a) Absolute temperature (b) Mass
   (c) Number density (d) Pressure
14. A pendulum is hung in a very high building oscillates to and fro motion freely like a simple harmonic oscillator. If the acceleration of the bob is 16 ms^{-2} at a distance of 4 m from the mean position, then the time period is
   (a) 2 s (b) 1 s (c) 2πs (d) πs
15. Two particles with kinetic energies in the ratio of 4 : 1 are moving with equal linear momentum. The ratio of their masses is
   (a) 4 : 1 (b) 1 : 1 (c) 1 : 2 (c) 1 : 4

PART – II

Note : Answer **any six** questions. Question No. **16** is **compulsory.** **6x2=12**

16. Write the rules for determining significant figures.
17. Define – Co-efficient of Restitution.
18. Sate Newton's Second law.
19. Define displacement and distance.
20. What is the different between sliding and slipping?potential
21. Which one of these is more elastic steel (or) rupper ? Why?
22. What are the factors that affect the Brownian motion?
23. What is oscillatory or Vibratory motion?
24. What is gravitational (V_r)?

PART – III

Note : Answer **any six** questions. Question No. **33** is **compulsory.** **6x3=18**

25. Explain the triangulation method to measure larger distances.
26. Define Couple.
27. Define the term degrees of freedom.
28. Write a short note on the scalar product between two vectors and three properties.
29. What are the conditions for reversible process?
30. What is Reynold's number? Give its significant.
31. Distinguish between streamlined flow and turbulent flow.
32. Explain damped Oscillation. Give an example.
33. Consider two organ pipes of same length in which one organ pipe is closed and another organ pipe is open. If the fundamental frequency of closed pipe is 250 Hz. Calculate the fundamental frequency of the open pipe.

[Turn Over

PART – IV

Note : Answer **all** the questions. **5x5=25**

34. (a) Write note on triangulation method and Radar method to measure larger distances.

(OR)

(b) Derive the kinetic equation of motion for constant acceleration.

35. (a) Using free body diagram, show that it is easy to pull an object than to push it.

(OR)

(b) Define the following: i) Power ii) Law of conservation of Energy
iii) Loss of Kinetic energy in inelastic collision.

36. (a) State and prove Parallel axis theorem.

(OR)

(b) Derive an expression for Escape Speed.

37. (a) Explain in detail Newton's law of Cooling.

(OR)

(b) Write down the postulates of Kinetic theory of gases.

38. (a) Write down the difference between simple harmonic motion and angular simple harmonic motion.

(OR)

(b) Explain how overtones are produced in:
1) Closed Organ Pipe 2) Open Organ Pipe

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HIGHER SECONDARY FIRST YEAR SECOND REVISION EXAMINATION – FEBRUARY 2024

PHYSICS KEY ANSWER

Note:

1. Answers written with **Blue** or **Black** ink only to be evaluated.
2. Choose the most suitable answer in Part A, from the given alternatives and write the option code and the corresponding answer.
3. For answers in Part-II, Part-III and Part-IV like reasoning, explanation, narration, description and listing of points, students may write in their own words but without changing the concepts and without skipping any point.
4. In numerical problems, if formula is not written, marks should be given for the remaining correct steps.
5. In graphical representation, physical variables for X-axis and Y-axis should be marked.

PART – I

Answer all the questions. 15x1=15

Q. No.	OPTION	ANSWER	Q. No.	OPTION	ANSWER
1	(d)	$[LT^{-3}]$	9	(a)	W=0
2	(b)	$g=25ms^2$	10	(c)	27/17
3	(d)	Force acting on particles	11	(a)	m/s^2
4	(b)	need not be zero	12	(b)	Nitrogen
5	(d)	Stress	13	(a)	Absolute temperature
6	(a)	$\frac{1}{2} mv^3$	14	(d)	πs
7	(b)	Less than potential energy	15	(d)	1 : 4
8	(a)	Precession			

PART – II

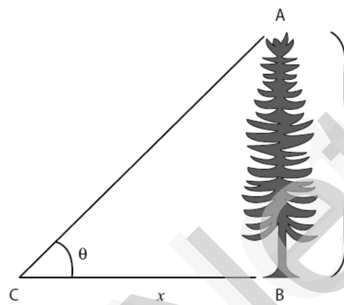
Answer any **six** questions. Question number **24** is compulsory. 6x2=12

16	1. All **non-zero digits** are significant. Ex.**1342** has **four** significant figures 2. All **zeros between two non-zero** digits are significant. Ex. **2008 has four** significant figures. 3. All **zeros to the right of a non-zero** digit but to the left of a decimal point are significant. Ex. **30700. has five** significant figures. 4. The **number without a decimal point**, the terminal or trailing zero(s) are not significant. Ex. **30700 has three** significant figures. 5. All zeros are significant if they come from a measurement Ex. **30700 m** has **five** significant figures. (Any 4)	4x½ =2	2

17	**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, i.e., e = $\frac{\text{Velocity of separation (after collision)}}{\text{Velocity of approach (before collision)}}$; $\frac{(v_2-v_1)}{(u_1-u_2)}$	2	2
18	**Newton's second law.** The force acting on an object is equal to **the rate of change of its momentum.** $\vec{F} = \frac{d\vec{p}}{dt}$	2	2
19	**Distance** is the **actual path length** travelled by an object in the given **interval of time during the motion.** It is a positive **scalar quantity.** **Displacement** the shortest **distance between these two positions** of the object and its direction is from the initial to final position of the object, during the given interval of time**.** It is a **vector quantity.**	1 1	2
20	**Sliding** is the case when $v_{CM} > R\omega$ (or $v_{TRANS} > v_{ROT}$). The translation is more than the rotation. **Slipping** is the case when $v_{CM} < R\omega$ (or $v_{TRANS} < v_{ROT}$). The rotation is more than the translation.	1 1	2
21	Steel is **more elastic than rubber because the steel has higher young's modulus than rubber**. That's why**, if equal stress is applied on both steel and rubber, the steel produces less strain.**	2	2
22	Brownian motion **increases with increasing temperature.** Brownian **motion decreases with bigger particle size, high viscosity and density of the liquid (or) gas.**		2
23	When an object or a particle moves back and forth repeatedly for some duration of time its motion is said to be oscillatory (or vibratory). Examples; our heart beat, swinging motion of the wings of an insect, grandfather's clock (pendulum clock), etc.	2	2
24	The gravitational potential at a distance r due to a mass is defined as the amount of work required to bring unit mass from infinity to the distance r.	2	2

PART – II

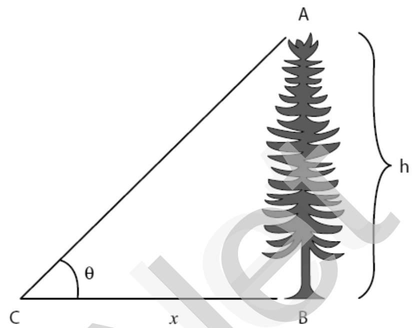
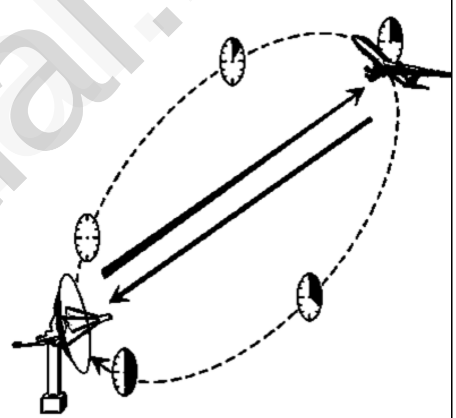
Answer **any six** questions. Question number **33 is compulsory.** 6x3=18

25	**Measurement of large distances:** For measuring larger distances such as the height of a tree, distance of the **Moon or a planet from the Earth,** some special methods are adopted. **Triangulation method, parallax method and radar method are used to determine very large distances.** Triangulation method for the height of an accessible object: Let **AB = h be the height of the tree** or tower to be measured. Let C be the point of observation at distance x from B. Place a range finder at C and measure the angle of elevation, ∠ACB = θ as shown in Figure. From right angled triangle **ABC,** $\tan\theta = \frac{AB}{BC} = \frac{h}{x}$ (or) height $h = x \tan\theta$ Knowing the distance *x*, the height h can be determined. 	1 1 1	3
26	**Couple.** Pair of forces which are equal in magnitude but **opposite in direction** and separated by a **perpendicular distance** so that **their lines of action do not coincide** that causes a turning effect is called a couple.	3	3
27	The minimum number of independent coordinates needed to specify **the position and configuration of a thermo-dynamical system in space** is called the degree of freedom of the system.	3	3
28	The scalar product (or dot product) of two vectors is defined **as the product of the magnitudes of both the vectors and the cosine of the angle** between them. $\vec{A}.\vec{B}$ = ABcosθ. Here, A and B are magnitudes of $\vec{A}$ and $\vec{B}$. **Properties:** The product quantity $\vec{A}$ and $\vec{B}$ is always a scalar. The **scalar product** is **commutative.** The **vectors obey distributive law** i.e. $\vec{A}.(\vec{B}+\vec{C}) = \vec{A}.\vec{B} + \vec{A}.\vec{C}$ The angle between the vectors $\theta = \cos{-1}\left[\frac{\vec{A}.\vec{B}}{AB}\right]$ The **scalar product of two vectors will be maximum** when Cos θ = 1, i.e. θ = 0^0, i.e., when the vectors are parallel; $(\vec{A}.\vec{B})_{max}$ = AB The **scalar product of two vectors will be minimum**, when Cos θ = –1, i.e. θ = 180^0 $(\vec{A}.\vec{B})_{min}$ = – AB when the vectors are anti-parallel.	1½ 1½	3
29	**Reversible process:** A thermodynamic process can be considered **reversible only if it possible to retrace the path in the opposite direction in such a way that the system and surroundings pass through the same states** as in the initial, direct process. Example: **A quasi–static isothermal expansion of gas, slow compression and expansion of a spring.**	3	3

30	Reynold's number (R_C) is **a dimensionless number, which is used to find out the nature of flow of the liquid. $R_C = \frac{\rho v D}{\eta}$** Where, ρ- density of the liquid, v –The velocity of flow of liquid. D- Diameter of the pipe, η - The coefficient of viscosity of the fluid.	2 1	3
31	**Streamlined flow: When a liquid flows such that each particle of the liquid passing through a point moves along the same path with the same velocity** as its predecessor then the flow of liquid is said to be a streamlined flow. The velocity of the particle at any point is constant. It is also referred to as steady or laminar flow. **The actual path taken by the particle of the moving fluid is called a streamline**, which is a curve, the tangent to which at any point gives the direction of the flow of the fluid at that point. **Turbulent flow: When the speed of the moving fluid exceeds the critical speed, v_c the motion becomes turbulent.** The velocity changes both in magnitude and direction from particle to particle. The path taken by the particles in turbulent flow becomes erratic and whirlpool-like circles called eddy current or eddies.	1½ 1½	3
32	Due to the presence of friction and air drag, **the amplitude of oscillation decreases as time progresses.** It implies that the oscillation is not sustained and the energy of the SHM decreases gradually indicating the loss of energy. **The energy lost is absorbed by the surrounding medium. This type of oscillatory motion** is known as damped oscillation. **Examples (i) The oscillations of a pendulum (including air friction) or pendulum oscillating inside an oil filled container. (ii) Electromagnetic oscillations in a tank circuit. (iii) Oscillations** in a dead beat and ballistic galvanometers.	2 1	3
33	The third harmonic of a closed organ pipe $f_c = \frac{v}{4L}$ ------------1 The fundamental frequency of open organ pipe is $f_0 = \frac{v}{2L}$ ----------2 Divide equation 2 by 1 $\frac{f_0}{f_c} = \frac{\left[\frac{v}{2L}\right]}{\left[\frac{v}{4L}\right]}$ = 2 $f_0 = 2f_c$ = 2 x 250 = 500Hz	1 1 1	3

PART – IV

Answer **all** the questions. 5x5=25

34 (a)	**Measurement of large distances:** For measuring larger distances such as the height of a tree, distance of the **Moon or a planet from the Earth,** some special methods are adopted. **Triangulation method, parallax method and radar method are used to determine very large distances.** **Triangulation method for the height of an accessible object:** Let **AB = h be the height of the tree** or tower to be measured. Let C be the point of observation at distance *x* from B. Place a range finder at C and measure the angle of elevation, ∠ACB = θ as shown in Figure. From right angled triangle **ABC,** **tanθ =** $\frac{AB}{BC} = \frac{h}{x}$ (or) **height h = *x* tan θ** Knowing the distance *x*, the height h can be determined.  **RADAR method:** The word RADAR stands for **Radio Detection and Ranging.** Radar can be used **to measure accurately the distance of a nearby planet** such as Mars. In this method, **radio waves are sent from transmitters which, after reflection from the planet, are detected by the receiver.** By measuring, the time interval (t) between the instants the radio waves are sent and received, the distance of the planet can be determined as d= $\frac{v \times t}{2}$.  where **v is the speed of the radio wave.** As the time taken (t) is for the distance covered during the forward and backward path of the radio waves, it is divided by 2 to get the actual distance of the object. This method can also be **used to determine the height, at which an aero-plane flies from the ground.**	2 ½ 2 ½	5

34 (b)

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 later time t.

Velocity - time relation:

1) 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,

$$\int_u^v dv = \int_0^t a dt$$

$$= a \int_u^v dt \implies [v]_u^v = a\,[t]_0^t \quad \text{-------(1)}$$

v – u = at (or) v = u + at

Displacement – time relation:

2) The velocity of the body is given by **the first derivative of the displacement with respect to time**. $v = \frac{ds}{dt}$ or ds = v dt 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 $\int_0^s ds$

$$= \int_0^t u dt + \int_0^t a t dt \quad \text{or } s = ut + \tfrac{1}{2} at^2 \quad \text{------------(2)}$$

Velocity – displacement relation:

3) 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 distance traversed]

This is rewritten as $a = \frac{1}{2}\frac{dv^2}{ds}$ or $ds = \frac{1}{2a} d(v^2)$

4) 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 $\int_0^s ds$

$$= \int_u^v \frac{1}{2a} d(v^2) \;;\; s = \frac{1}{2a}(v^2 - u^2) \;;\; v^2 = u^2 + 2as \quad \text{-----------(3)}$$

5) We can also derive the displacement s in terms of initial velocity u and final velocity v. From the equation (1) we can write, at = v – u

Substitute this in equation (2), we get s = ut + ½ (v – u)t

$$s = \frac{(u+v)t}{2} \quad \text{---------------(4)}$$

The equations (1), (2), (3) and (4) are called kinematic equations of motion, and have a wide variety of practical applications.

Kinematic equations:

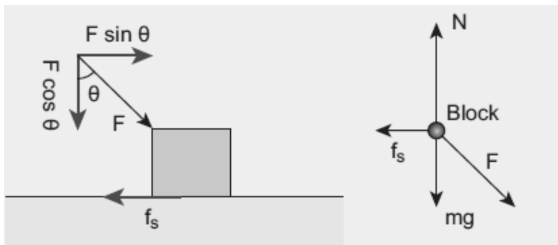
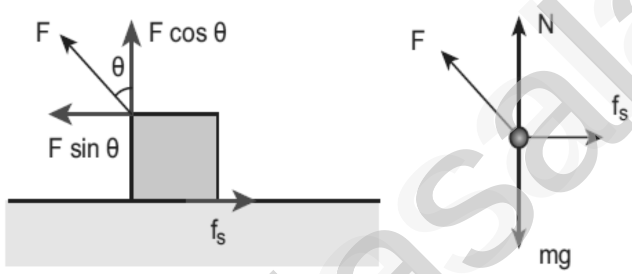
$v = u + at$;

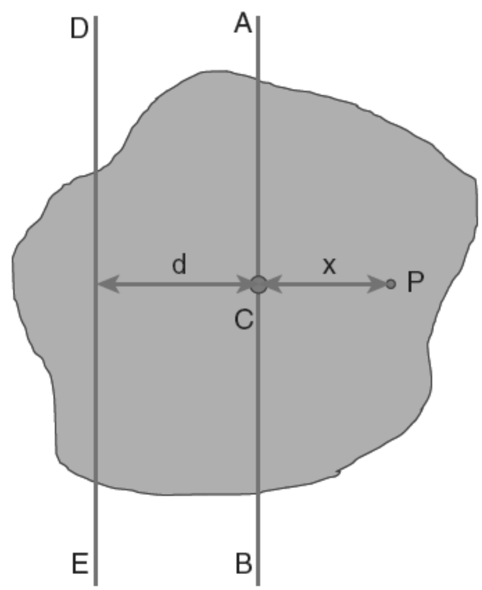
$s = ut + \frac{1}{2}at^2$;

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

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

5

35 (a)	When a body is pushed at an arbitrary angle θ. 0 to $\frac{\pi}{2}$, the applied force F can be resolved into two components as F sinθ parallel to the surface and F cosθ perpendicular to the surface as shown in Figure. The total downward force acting on the body is mg + Fcosθ. It implies that the normal force acting on the body increases. Since there is no acceleration along the vertical direction the normal force N is equal to **N_{push} = mg + F cos**θ **------------1**	1	5
	As a result, the maximal static friction also increases and is equal to $f_s^{max} = \mu_s N_{Push} = \mu_s(mg + F\cos\theta)$ **------------2** Equation (2) shows that a greater force needs to be applied to push the object into motion.	1	
			
	When an object is pulled at an angle θ, the applied force is resolved into two components as shown in Figure. The total downward force acting on the object is **N_{Pull} = mg - F cos**θ **------------3**	1	
		1	
	Equation (3) shows that the normal force is less than N_{push}. From equations (1) and (3), **it is easier to pull an object than to push to make it move.**	1	

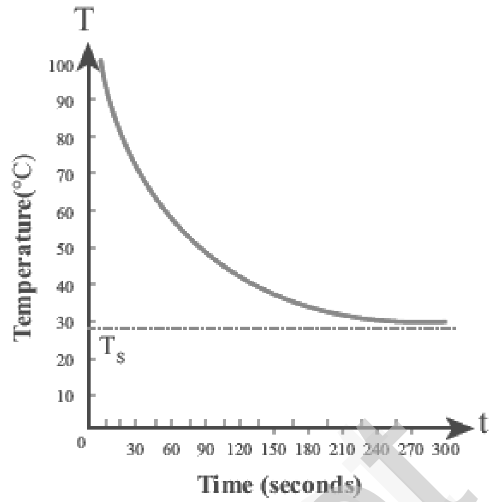
35 (b)	**b) Power:** The rate of work done or energy delivered. Power (P) = $\frac{\text{Workdone (W)}}{\text{Time taken (t)}}$ **c) Law of conservation of energy:** **Energy can neither be created nor destroyed**. It may be **transformed** from **one form to another but the total energy** of an isolated system remains constant. **d) Loss of kinetic energy in inelastic collision:** **In perfectly inelastic collision, the loss in kinetic energy during collision is transformed to another form of energy like sound, thermal, heat, light** etc. Let KE_i be the total kinetic energy before collision and KE_f be the total kinetic energy after collision. Total kinetic energy before collision, $KE_i = \frac{1}{2} m_1 u_1^2 + \frac{1}{2} m_2 u_2^2$ ----------(1) Total kinetic energy after collision, $KE_f = \frac{1}{2}(m_1 + m_2)v^2$ ----------- (2) Then the loss of kinetic energy is Loss of KE, $\Delta Q = KE_f - KE_i$ $= \frac{1}{2}(m_1 + m_2)v^2 - \frac{1}{2} m_1 u_1^2 + \frac{1}{2} m_2 u_2^2$ -------- (3) Substituting equation $v = \frac{\mathbf{m_1 u_1 + m_2 u_2}}{\mathbf{(m_1 + m_2)}}$ in equation (3), and on simplifying (expand v by using the algebra $(a+b)^2 = a^2 + b^2 + 2ab$, we get **Loss of KE,** $\Delta Q = \frac{1}{2}\left(\frac{m_1 m_2}{m_1 + m_2}\right)(u_1 - u_2)^2$	1 1 1 1 1	5
36 (a)	**Parallel axis theorem.** i) Parallel axis theorem states that **the moment of inertia of a body about any axis is equal to the sum of its moment of inertia about a parallel axis through its center of mass and the product of the mass of the body and the square of the perpendicular distance between the two axes.**  ii) If IC is the moment of inertia of the body of mass M about an axis passing through the center of mass, then the moment of inertia I about a parallel axis at a distance d from it is given by the relation, $I = I_C + Md^2$ iii) let us consider a rigid body as shown in Figure. Its **moment of inertia about an axis AB passing through the center of mass is I_C.** DE is another axis parallel to AB at a perpendicular distance d from AB. The moment of inertia of the body about DE	1 1	5

	is I. We attempt to get an expression for I in terms of I_C. For this, let us consider a point mass m on the body at position x from its center of mass. iv) The moment of inertia of the point mass about the axis DE is, $m(x + d)^2$. The moment of inertia I of the whole body about DE is the summation of the above expression. $\mathbf{I = \Sigma m(x + d)^2}$ This equation could further be written as, $I = \Sigma m(x^2 + d^2 + 2xd)$ $I = \Sigma(mx^2 + md^2 + 2dmx)$ $\mathbf{I = \Sigma mx^2 + \Sigma md^2 + 2d\Sigma mx}$ v) Here, Σmx^2 is the moment of inertia of the body about the center of mass. Hence, $I_C = \Sigma mx^2$ The term, $\Sigma mx = 0$ because, x can take positive and negative values with respect to the axis AB. The summation (Σmx) will be zero Thus, $\mathbf{I = I_C + \Sigma md^2 \; ; I_C + (\Sigma m)d^2}$ vi) Here, Σm is the entire mass M of the object ($\Sigma m = M$) $\mathbf{I = I_C + Md^2}$ Hence, the parallel axis theorem is proved.	1 1 1	
36 (b)	**Escape speed.** 1) Consider an object of mass M on the surface of the Earth. **When it is thrown up with an initial speed v_i, the initial total energy of the object** is $E_i = \frac{1}{2} MV_i^2 - \frac{GMM_E}{R_E}$ ---------------- 1 Where M_E, is the mass of the Earth and R_E - the radius of the Earth. The term $-\frac{GMM_E}{R_E}$ is the potential energy of the mass M. 2) When the object reaches a height far away from Earth and hence treated as approaching infinity, **the gravitational potential energy becomes zero [$U(\infty) = 0$] and the kinetic energy becomes zero as well**. Therefore, **the final total energy of the object becomes zero. This is for minimum energy and for minimum speed to escape**. Otherwise Kinetic energy can be non-zero. $E_f = 0$, According to the law of energy conservation, $\mathbf{E_i = E_f}$ -------- 2 Substituting (1) in (2) we get, $\frac{1}{2} MV_i^2 - \frac{GMM_E}{R_E} = 0$; $\frac{1}{2} MV_i^2 = \frac{GMM_E}{R_E}$ ---------------- 3 3) The escape speed, the minimum speed required by an object to escape Earth's gravitational field, hence replace, V_i with V_e. i.e, $\frac{1}{2} MV_e^2 = \frac{GMM_E}{R_E}$; $V_e^2 = \frac{GMM_E}{R_E} \cdot \frac{2}{M}$; $V_e^2 = \frac{2GM_E}{R_E}$ ------------- 4 Using $g = \frac{GM_E}{R_e}$ ---------------- 5 $V_e^2 = 2gR_E$; $V_e = \sqrt{2gRE}$ ------------- 6 From equation (6) the escape speed depends on two factors: **acceleration due to gravity and radius of the Earth**. It is completely independent of the mass of the object.	1 1 1 1 1	5

37(a) **Newton's law of cooling:**

1) Newton's law of cooling states that the **rate of loss of heat of a body is directly proportional to the difference in the temperature between that body and its surroundings .** — 1

$\frac{dQ}{dt} \alpha\ -(T - T)$ ----------- 1



2) The **negative sign indicates that the quantity of heat lost by liquid goes on decreasing with time**. Where, — 1

T = Temperature of the object

T_s = Temperature of the surrounding.

From the **graph** in Figure, it is clear that **the rate of cooling is high initially and decreases with falling temperature.**

3) Let us consider an object of mass m and specific heat capacity s at temperature T. Let **Ts be the temperature of the surroundings**. If the temperature falls by a small amount dT in time dt, then the amount of heat lost is, **dQ = msdT** -------------- 2 — 1

4) Dividing both sides of equation (2) by $\frac{dQ}{dt} = \frac{msdT}{dt}$ -----------3

From Newton's law of cooling $\frac{dQ}{dt} \alpha\ -(T - T_S)$

$\frac{dQ}{dt} = -a(T - T_S)$ --------- 4

Where a is some positive constant. From equation (2) and (4)

$-a(T - T_S) = ms\frac{dT}{dt}$ — 1

$\frac{dT}{(T - TS)} = -\frac{a}{ms}dt$ ------------------- 5

Integrating equation (5) on both sides,

$\int_0^\infty \frac{dT}{(T - TS)} = -\int_0^t \frac{a}{ms}dt$

$\ln(T - T_S) = \frac{a}{ms}t + b_1$ — 1

Where b_1 is the constant of integration. taking exponential both sides, we get, $T = T_S + b_{2}\, e\, \frac{a}{ms}t$. Here $b_2 = eb_1$ = Constant

Total: 5

37 (b)	**The postulates of kinetic theory of gases.** 1) All the molecules of a gas **are identical, elastic spheres**. 2) The molecules of **different gases are different.** 3) The number of molecules in a gas is **very large and the average** separation **between them is larger than size of the gas molecules**. 4) The molecules of a gas are in **a state of continuous random motion.** 5) The molecules collide with one another and also with the walls of the container. 6) These **collisions are perfectly elastic so that there is no loss of kinetic energy during collisions.** 7) Between two successive collisions, **a molecule moves with uniform velocity.** 8) The molecules do not exert any force of attraction or repulsion on each other except during collision. **The molecules do not possess any potential energy and the energy is wholly kinetic.** 9) The collisions are instantaneous. The time spent by a molecule in each collision is very small compared to the time elapsed between two consecutive collisions. 10) These **molecules obey Newton's laws of motion even though they move randomly.**	10x ½ =5	5

38 (a)

S. No.	Simple Harmonic Motion	Angular Harmonic Motion
1	The displacement of the particle is measured in terms of linear displacement $\vec{r}$	The displacement of the particle is measured in terms of angular displacement $\vec{\theta}$
2	Acceleration of the particle is $\vec{a} = -\omega^2\vec{r}$	Angular Acceleration of the particle is $\vec{\alpha} = -\omega^2\vec{\theta}$
3	Force , $\vec{F} = m\vec{a}$ where m is called mass of the particle.	Torque, $\vec{\tau} = I\vec{\alpha}$ where I is called moment of inertia of a body.
4	The restoring force $\vec{F} = -k\vec{r}$ where k is restoring force constant	The restoring torque $\vec{\tau} = -\kappa\vec{\theta}$ where k is restoring torsion constant. Note: k pronounced "kappa"
5	Angular frequency $\omega = \sqrt{\frac{k}{m}}$ rad^{-1}	Angular frequency $\omega = \sqrt{\frac{k}{I}}$ rad^{-1}

5x1=5 — 5

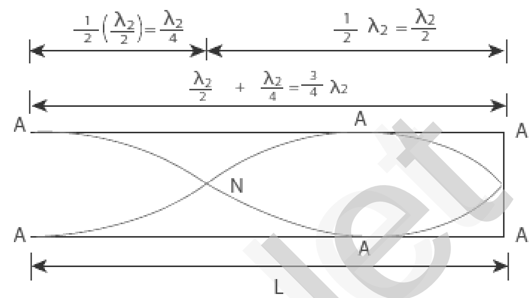
38 (b)

a) Closed organ pipes:

1) 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.

2) 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.**

3) 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 $\lambda_1 = 4L$;

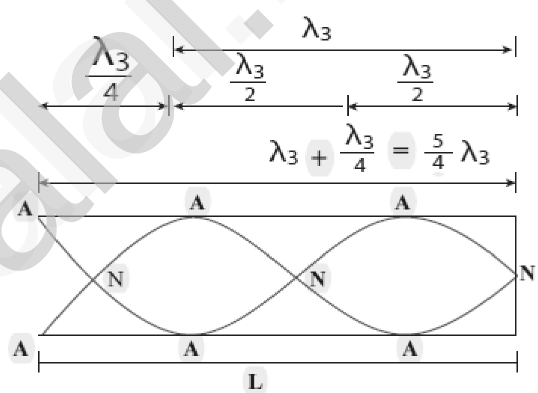
The frequency of the note emitted is

$f_1 = \frac{v}{\lambda_1} = \frac{v}{4L}$ **which is called the fundamental note.**

2 ½

4) The frequencies higher than fundamental frequency can be produced by blowing air strongly at open end. Such frequencies are called overtones.

The Figure 2 shows the second mode of vibration having two nodes and two anti-nodes. $4L = 3\lambda_2$ $L = \frac{3\lambda_2}{4}$ or $\lambda_2 = \frac{4L}{3}$



The frequency of this $f_2 = \frac{v}{\lambda_2} = \frac{3v}{4L} =$

5

$3f_1$ is called first over tone, since here, the frequency is three times the fundamental frequency it is called third harmonic.

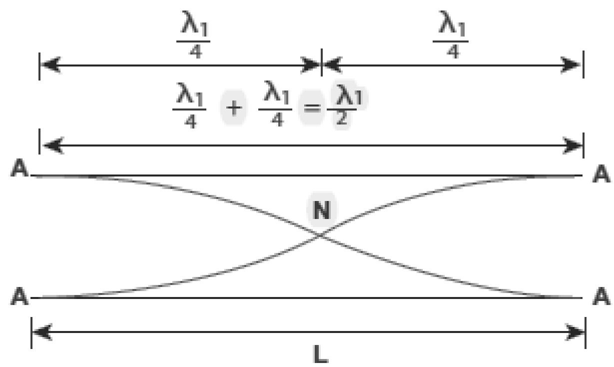
5) The Figure 3 shows third mode of vibration having three nodes and three anti-nodes. $4L = 5\lambda_3$ $L = \frac{5\lambda_3}{4}$ or $\lambda_3 = \frac{4L}{5}$

The frequency of this $f_3 = \frac{v}{\lambda_3} = \frac{5v}{4L} = 5f_1$ is called second over tone, and since n = 5 here, this is called fifth harmonic.

6) Hence, the closed organ pipe has only odd harmonics and frequency of the nth harmonic is **$f_n = (2n+1)f_1$. Therefore, the frequencies of harmonics are in the ratio $f_1 : f_2 : f_3 : f_4 : ... = 1 : 3 : 5 : 7 : ...$**

b) Open organ pipe:

1) **It is a pipe with both the ends open. At both open ends, anti-nodes are formed. Let us consider the simplest mode of vibration of the air column called fundamental mode. Since anti-nodes are formed at the open end,** a node is formed at the mid-point of the pipe.



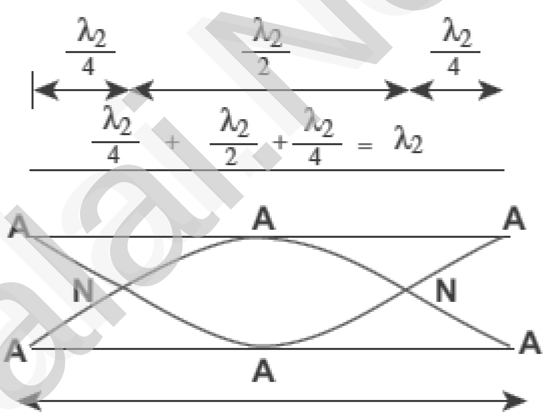
2) From Figure, if L be the length of the tube, the wavelength of the wave produced is given by

$L = \frac{\lambda_1}{2}$ or $\lambda_1 = 2L$

The frequency of the note emitted is $f_1 = \frac{v}{\lambda_1} = \frac{v}{2L}$

which is called the fundamental note.

3)The **frequencies higher than fundamental frequency can be produced by blowing** air strongly at one of the open ends. Such frequencies are called overtones.



4)The Figure shows the second mode of vibration in open pipes. It has two nodes and three anti-nodes, and therefore,

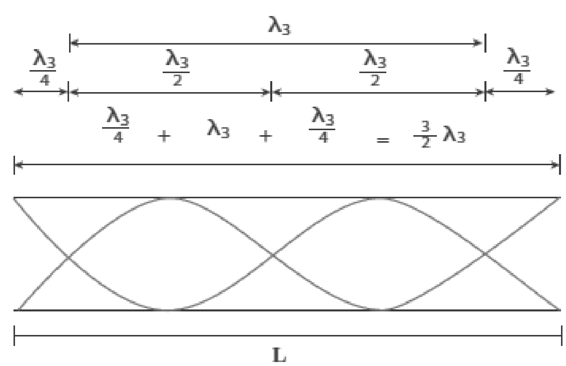
$L = \lambda_2$ or $\lambda_2 = L$

The frequency $f_2 = \frac{v}{\lambda_2} = \frac{v}{L} = 2 \times \frac{v}{2L} = 2f_1$ is called **first over tone**.

Since n = 2 here, it is called the **second harmonic.**

2 ½

5) The Figure shows the third mode of vibration having three nodes and four anti-nodes $L = \frac{3}{2}\lambda_3$ or $\lambda_3 = \frac{2L}{3}$;



$f_3 = \frac{v}{\lambda_3} = \frac{3v}{2L} = 3 \times \frac{v}{2L} = 3f_1$

is called second over tone. Since n = 3 here, it is called the third harmonic.

6)Hence, the open organ pipe has all the harmonics and frequency of n^{th} harmonic is fn = nf1. Therefore, **the frequencies of harmonics are in the ratio $f_1 : f_2 : f_3 : f_4 :... = 1 : 2 : 3 : 4 : ....$**