## General Instructions:

(1) There are 35 questions in all. All questions are compulsory.
(2) This question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.
(3) Section A contains eighteen MCQ of 1 mark each, Section B contains seven questions of two marks each, Section C contains five questions of three marks each, section $D$ contains three long questions of five marks each and Section $E$ contains two case study based questions of 4 marks each.
(4) There is no overall choice. However, an internal choice has been provided in section B, C, D and E. You have to attempt only one of the choices in such questions.
(5) Use of calculators is not allowed.
(6) $\mathbf{i}, \mathbf{j}$ and $\mathbf{k}$ represent unit vectors along the $x, y$ and $z$ axis respectively.

## SECTION - A

Q1.The number of significant figures in 0.0020 kg is
a) 1
b) 2
c) 3
d) 4

Q 2. Four $x$-t graphs for particles moving along $x$ - axis are shown in the figure. For which one average velocity over the time interval ( $0, \mathrm{~T}$ ) can vanish for a suitably chosen T?

a) i)
b) ii)
c) iii)
d) iv)

Q 3 The angle between vector $\mathbf{A = ( i + j )}$ and vector $\mathbf{B = ( i}-\mathbf{j})$ is
a) $30^{\circ}$
b) $45^{\circ}$
c) $90^{\circ}$
d) $180^{\circ}$
.Q 4 Vikas is driving a car of mass $m$ along a circular path of radius $R$. The coefficient of static friction between the path and tyres of the car is $\mu s$.The maximum speed with which he can drive the car without slipping is ( g is acceleration due to gravity )
a) $\sqrt{(\mu s g / R)}$
b) $\sqrt{(\mu s / R g)}$
c) $\sqrt{(\mu s g R)}$
d) $\sqrt{(R g / \mu s}$

Q 5 The maximum heights reached by a ball projected with speed $u$ are $h_{1}$ and $h_{2}$ when it makes an angle of $30^{\circ}$ and $60^{\circ}$ with the horizontal respectively. The ratio $\left(\frac{h_{1}}{h_{2}}\right)$ is
a) $\frac{1}{3}$
b) $\frac{1}{2}$
C) $\frac{1}{4}$
d) $\frac{1}{8}$

Q 6 Three blocks A ( 3 kg ), B (2 kg ) and C (1 kg) are placed in contact with each other on a smooth horizontal surface as shown in figure. A force of 12 N is applied on block $A$. The net force acting on block $B$ is

## 12N 

a) 4 N
b) 6 N
c) 8 N
d) 12 N

Q 7 A particle of mass $m$ is moving in a vertical circle of radius $R$. Let $K_{1}$ and $K_{2}$ be the minimum kinetic energies of the particle at the lowest point and the highest point of the circle respectively. The ratio of $\mathrm{K}_{1}$ and $\mathrm{K}_{2},\left(\frac{K_{1}}{K_{2}}\right)$ is
a) $\frac{1}{5}$
b) $\frac{2}{5}$
c) 2
d) 5
Q. 8 A ball of mass 100 g is thrown vertically upward from $\mathrm{x}=0, \mathrm{y}=0$ with energy of 20 J . It reaches the height of 20 m and falls back into a pit of 20 m depth. After striking the bottom of the pit, the ball comes to rest.The total energy of the ball at its highest point and at the bottom of the pit are respectively $\left(g=10 \mathrm{~m} / \mathrm{s}^{2}\right)$
a) $20 \mathrm{~J}, 0 \mathrm{~J}$
b) $20 \mathrm{~J}, 20 \mathrm{~J}$
c) $20 \mathrm{~J},-20 \mathrm{~J}$
d) $0 \mathrm{~J},-20 \mathrm{~J}$

Q9. Beats are produced by two waves
$Y_{1}=a \sin (2000 \pi t)$
$Y_{2}=a \sin (2008 \mathrm{mt})$
The number of beats heard per second is
a) zero
b) one
c) four
d) eight

Q10. The radius of one arm of a hydraulic lift is four times the radius of the other arm. What force should be applied on the narrow arm to lift a body of 200 kg ?
a) 100 N
b) 125 N
c) 115 N
d) 120 N

Q11. The total energy of a particle executing SHM ( $x=a \sin \omega t$ ) is
a) independent of $x$
b) proportional to $x^{2}$
c) proportional to $x$
d) proportional to $\sqrt{x}$

Q12. A thermodynamic system is taken through a cycle ABCD as shown in the figure. Heat rejected by the gas during the cycle is

a) 2 PV
b) 4 PV
c) $\frac{1}{2} \mathrm{PV}$
d) PV

Q13. A pressure cooker reduces cooking time for food because
a) heat is more evenly distributed in the cooking vessel.
b) the boiling point of water involved in cooking is increased.
c) cooking involves mainly chemical changes helped by rise in temperature.
d) the boiling point of water involved in cooking is decreased.

Q14. Oxygen and hydrogen gases are at the same temperature T . The average kinetic energy of an oxygen molecule will be ------ the average kinetic energy of a hydrogen molecule.
a) 16 times
b) 4 times
c) Equal to
d) $\frac{1}{4}$ times

Q15. $V$ versus $T$ curves of an ideal gas for three pressures $P_{1}, P_{2}$ and $P_{3}$ are shown in figure. Which of the following relations between $P_{1}, P_{2}$ and $P_{3}$ is correct?

a) $\mathrm{P}_{1}>\mathrm{P}_{2}>\mathrm{P}_{3}$
b) $P_{1}<P_{2}<P_{3}$
c) $\mathrm{P}_{3}>\mathrm{P}_{1}>\mathrm{P}_{2}$
d) $\mathrm{P}_{2}>\mathrm{P}_{1}>\mathrm{P}_{3}$

## Q16 to 18 are Assertion Reason Questions

Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:
a) Both $A$ and $R$ are true and $R$ is the correct explanation of $A$.
$b$ Both $A$ and $R$ are true and $R$ is NOT the correct explanation of $A$.
c) $A$ is true but $R$ is false.
d) $A$ is false and $R$ is also false.

Q16. Assertion (A): Work done by a conservative force around a closed path is zero.

Reason (R): Work done by a conservative force depends only on initial position and final position.

Q17. Assertion (A): In a pure translational motion all particles of the body move with the same velocity at any instant of time.

Reason (R): In a rotating rigid body all particles have the same angular velocity at any instant of time.

Q18. Assertion (A) : Heat transfer always involves temperature difference between two systems or parts of the same system.
Reason ( R ): Any energy transfer that does not involve temperature difference in some way is not heat.

## SECTION - B

Q19. Consider the following equation

$$
\mathrm{X}=\frac{E}{(b+t)}
$$

where $E$ denotes energy and $t$ time. Find the dimensions of $X$ and $b$. Also identify X .

Q20. Explain the following statements for objects moving along a straight line.
a)The zero velocity of a particle at any instant does not necessarily imply zero acceleration at that instant.
b)The average speed of an object is greater than or equal to the magnitude of the average velocity over a given time interval.

Q21. A ball is thrown vertically upward with a speed of $30 \mathrm{~m} / \mathrm{s}$. What is its distance and magnitude of displacement after 4 s ? ( $\mathrm{g}=10 \mathrm{~m} / \mathrm{s}^{2}$ )

OR
A particle starts from the origin at $\mathrm{t}=0 \mathrm{~s}$ with the velocity of $4 \mathrm{j} \mathrm{m} / \mathrm{s}$ and moves in $x$ - $y$ plane with a constant acceleration of $(2 \mathbf{i}+6 \mathbf{j}) \mathrm{m} / \mathrm{s}^{2}$. At what time is the $x$-coordinate of the particle 32 m ?

Q22 An object is thrown vertically upward with speed $v$ from the surface of earth. Find the minimum value of $v$ for which the object will not return to earth.

Q23.A body of mass 100 g moves along a straight line and experiences a frictional force given by
$F_{r}=-\frac{1}{x}, \quad\left(x\right.$ is in metre and $F$ is in newton) between $\mathrm{X}_{1}=1.0 \mathrm{~m}$ to $\mathrm{X}_{2}=2.0$ m . Find the change in kinetic energy of the body.

Q24. The velocity of a small ball of mass $M$ and density $d_{1}$ when dropped in a container filled with glycerine becomes constant after sometime. The density of glycerine is $d_{2}$. Find the expression of the viscous force acting on the ball.

## OR

A spinning ball deviates from its parabolic trajectory as it moves through air. Explain.

Q25. Two wires of length 1 m each and diameter 0.2 cm , one made of steel and other made of copper are loaded as shown in figure. Calculate the ratio of the elongation of the steel and copper wires. Young's modulus of steel $=200$ $\times 10^{9} \mathrm{~N} / \mathrm{m}^{2}$, Young's modulus of copper $=120 \times 10^{9} \mathrm{~N} / \mathrm{m}^{2}$.


## SECTION - C

Q26.Three particles of masses $m, 2 m$ and $m$ are kept at the vertices of an equilateral triangle of side L . Calculate the potential energy of the system.

OR
A satellite of mass $m$ is moving in a circular orbit of radius $R$. The satellite is made to transfer in another orbit of radius (3R/4). Find the change in its kinetic energy and its potential energy.

Q27. An object of mass 200 g changes its position from rest at $\mathbf{r}_{\mathbf{1}}=(\mathbf{i}+2 \mathbf{j}+\mathbf{k})$ $m$ to $\mathbf{r}_{2}=(2 \mathbf{i}+5 \mathbf{j}+3 \mathbf{k}) \mathrm{m}$ under the action of a force $\mathbf{F}=(2 \mathbf{i}+2 \mathbf{j}-\mathbf{k}) \mathrm{N}$. Calculate work done by the force and the final velocity of the object.

Q28.The displacement of a particle executing SHM is given by the equation $x=a \sin \omega t$. The following figure shows three plots $A, B$ and $C$ of the particle. Identify $x-t, v-t$, and $a-t$ plots and give reason. Mention the phase difference between displacement and acceleration.


Q29. a) State first law of thermodynamics. Write its mathematical form.
b) show that
i) in a cyclic process, the total heat absorbed by the system is equal to the work done by the system.
ii) in an isochoric process, the entire heat given to the system goes in increasing the temperature of the system

OR
Using kinetic theory of gases, prove that the pressure exerted on the wall of a container by an ideal gas is directly proportional to the square of the root mean square speed of the molecules of the gas.

Q30. Three identical rods A, B and C of equal lengths and equal diameters are joined as shown in the figure. Their thermal conductivities are $2 \mathrm{~K}, \mathrm{~K}$ and $2 K$ respectively. Calculate the temperatures at the junction of $A$ and $B\left(T_{1}\right)$ and at the junction of $B$ and $C\left(T_{2}\right)$.


## SECTION - D

Q31. a) A ball is projected in the $x$ - $y$ plane from position $(0,0)$ at $t=0$ with speed $v$ making an angle $\theta$ with $x$ axis under earth's gravity. Derive an expression for its trajectory. Also write the nature of the trajectory.
b) A ball is projected at time $t=0$ from point $x=0, y=0$ in $x-y$ plane with velocity ( $\mathbf{U}=\mathbf{U x i}+\mathbf{U y}$ ) $\mathrm{m} / \mathrm{s}$. Show that the angle $\theta(\mathrm{t})$ the ball makes with x axis at any time $t$ is given by

$$
\theta(\mathrm{t})=\tan ^{-1} \frac{(U y-g t)}{U x}
$$

## OR

a) An object is moving along a circular path of radius $r$ with uniform speed v. Derive an expression for centripetal acceleration of the object.
b) A small steel ball trapped in a circular groove of radius 25 cm moves along the groove steadily and completes $\frac{20}{\pi}$ revolutions in 50 seconds. Calculate angular speed and centripetal acceleration of the ball.

Q32. a) i) State law of conservation of angular momentum.
ii) Establish the relation between angular momentum (L) and angular velocity $(\omega)$ for a body of moment of inertia I.
b) Two bodies, a ring of radius R and a solid cylinder of radius $\left(\frac{R}{2}\right)$ start rolling down from rest from the top of an inclined plane at the same time. Which of the bodies reaches the ground with maximum velocity?

## OR

a) i) Three particles of masses $m_{1}, m_{2}$ and $m_{3}$ are lying at points ( $x_{1}, y_{1}$ ), $\left(x_{2}, y_{2}\right)$ and ( $x_{3}, y_{3}$ ) respectively. Determine centre of mass of the system. If the masses are equal, what is the centre of mass of the system?
ii) Consider a hollow sphere of radius $R$. It is now half filled with water. Explain qualitatively how the centre of mass shifts?
b) Two spheres of mass $m_{1}=10 \mathrm{~kg}$ and $\mathrm{m}_{2}=20 \mathrm{~kg}$ have position vectors
$\mathbf{r}_{1}=2 \mathbf{t i}+\mathrm{t}^{2} \mathbf{j}+2 \mathbf{k}, \mathbf{r}_{2}=\mathbf{i}+2 \mathrm{t}^{2} \mathbf{j}+5 \mathrm{tk}$ respectively, where $\mathbf{r}_{1}$ and $\mathbf{r}_{2}$ are in metres, time is in second.Calculate velocity of the centre of mass of this two particle system.

Q33. A transverse wave moving in a string along the positive $x$ axis is described by the equation
$y(x, t)=A \sin (\omega t-k x)$
The wave gets reflected by a rigid boundary. Then incident and the reflected wave gets superimposed.
a) Show that the resultant wave formed does not travel on either side of the string.
b) Prove that the distance between any two consecutive antinodes is $\frac{\lambda}{2}$.
c) An organ pipe open at one end is vibrating in first overtone (third harmonic ) and is in resonance with another pipe open at both ends and vibrating in third harmonic. Find the ratio of the lengths of the two pipes.

OR

Two identical springs of spring constant K are attached to a block of mass M and two fixed supports as shown in figure.

a) Show that when the mass is displaced from its equilibrium position on either side, it executes SHM. Find the frequency of oscillations.
b) The displacement of a particle varies according to the relation
$x=4(\cos \pi t+\sin \pi t)$
where $x$ is in metres and $t$ is in seconds.
What is the amplitude of the particle?

## SECTION - E

Q34.


Friction plays an important role in many daily- life situations. Consider the case of a block being held against a wall. It would be impossible to hold the block, if there were no friction between the wall and the block, even if we push the block against the wall with a larger force. Now do the physics of the following case.

A block of mass ( m ) is held against a vertical wall by pressing it with force ( F ) as shown in the figure. The coefficient of static friction and kinetic friction
between the block and the wall are $\mu s$ and $\mu k$ respectively and acceleration due to gravity is g .
a)What is the normal force acting on the block, if the block is not sliding?
b)What is the value of force of friction acting on the block when the block is not sliding? Give reason.
c)Explain the condition under which the given block does not slide down.

OR
c) Find the magnitude of the net force exerted on the block by the wall, when the block is stationary.

Q35. The property of surface tension of liquids is exhibited in many situations, like capillary action, formation of spherical drops and bubbles, etc.

Consider a liquid of density $0.8 \times 10^{3} \mathrm{~kg} / \mathrm{m}^{3}$ and surface tension $2.8 \times 10^{-2} \mathrm{~N} / \mathrm{m}$.
a) A capillary tube of radius 0.1 mm is dipped in a vessel filled with the above liquid. The angle of contact between the liquid and the surface of the tube is zero.Find out the height up to which the liquid will rise in the capillary.
b) If some detergent is added to the above liquid and the same capillary is dipped in the solution, what change will you observe in the height?
c) A drop of the above liquid of diameter 4 mm breaks into 1000 droplets of equal size. Calculate the resultant change in its surface energy.

## OR

c) Calculate the work done in blowing a bubble of the given liquid from diameter 4 mm to 6 mm .

Class: XI SESSION : 2022-2023
MARKING SCHEME PHYSICS
DAV SAMPLE QUESTION PAPER (THEORY)


| 18 | b | 1 | 1 |
| :---: | :---: | :---: | :---: |
|  | SECTION - B |  |  |
| 19 | $\begin{aligned} & \mathrm{b}=\mathrm{t}=[\mathrm{T}] \\ & \mathrm{X}=\frac{\omega}{T}=\mathrm{ML}^{2} \mathrm{~T}^{-3} \\ & \mathrm{X}=\text { Power } \end{aligned}$ | $\begin{aligned} & 1 / 2+1 / 2 \\ & 1 / 2 \\ & 1 / 2 \end{aligned}$ | 2 |
| 20 | (i) Consider, for example, a ball thrown upward under gravity. At its highest point the velocity becomes zero but acceleration remains the same that is, acceleration due to gravity g. <br> ( ii) The magnitude of displacement of an object is always equal to or less than the distance travelled by the object in given time interval. Therefor the magnitude of average velocity is equal to or less than the average speed. | $1$ $1$ | 2 |
| 21 | $\text { Distance }=50 \mathrm{~m}$ <br> Magnitude of displacement $=40 \mathrm{~m}$ <br> OR $\begin{aligned} & \mathbf{r}=\mathbf{u t}+(1 / 2) \mathbf{a} \mathrm{t}^{2} \\ & \mathbf{r}=4 \mathbf{i} t+(1 / 2)(2 \mathbf{i}+6 \mathbf{j}) \mathrm{t}^{2} \\ & x \mathbf{i}+y \mathbf{j}=4 \mathbf{i} t+(1 / 2)(2 \mathbf{i}+6 \mathbf{j}) \mathrm{t}^{2} \\ & x=4 t+t^{2}=36 \\ & t=-8 s, t=4 s \end{aligned}$ | $1$ <br> 1 <br> $1 / 2$ <br> $1 / 2$ <br> $1 / 2$ <br> $1 / 2$ | 2 |
| 22 | NCERT page 193 <br> Equation (8.29) <br> Equation (8.30) <br> Equation (8.31) | $\begin{aligned} & 1 / 2 \\ & 1 / 2 \\ & 1 / 2 \\ & 1 / 2 \end{aligned}$ | 2 |


|  | Equation (8.32) |  |  |
| :---: | :---: | :---: | :---: |
| 23 | $\begin{aligned} & d W=F \cdot d x \\ & d W=(-1 / x) d x \end{aligned}$ <br> integrating it from $x=1 m$ to $x=2 m$, we get the work done by frictional force. $\begin{aligned} W & =\int_{1} \quad 2^{(-1 / x) d x} \\ & =-\ln 2=-0.693 \mathrm{~J} \end{aligned}$ | $1 / 2$ <br> $1 / 2$ <br> $1 / 2$ <br> $1 / 2$ | 2 |
| 24 | $\begin{aligned} & \mathrm{F}=6 \pi \eta r v \quad \text { - eq. } 1 \\ & \mathrm{v}=\frac{2 r^{2}\left(d_{1}-d_{2}\right) g}{9 \eta} \end{aligned}$ <br> Putting in eq. 1 $\begin{aligned} \mathrm{F} & =6 \pi \eta r\left(\frac{2 r^{2}\left(d_{1}-d_{2}\right) g}{9 \eta}\right) \\ \mathrm{F} & =\frac{4 \pi r^{3}\left(d_{1}-d_{2}\right) g}{3} \\ & =\mathrm{V}\left(\left(d_{1}-d_{2}\right) g=\mathrm{M} \frac{\left(d_{1}-d_{2}\right) g}{d_{1}}\right. \\ & =\mathrm{M}\left(1-\frac{d_{2}}{d_{1}}\right) \mathrm{g} \end{aligned}$ <br> OR <br> It is based on Bernouilli's Principle Explanation NCERT pg. 207 Diagram | $1 / 2$ <br> $1 / 2$ <br> $1 / 2$ <br> $1 / 2$ <br> $1 / 2$ <br> 1 <br> $1 / 2$ | 2 |
| 25 | Length $I_{1}=I_{2}=1 \mathrm{~m}$ <br> Diameter $\mathrm{d}_{1}=\mathrm{d}_{2}=0.2 \mathrm{~cm}$ $\mathrm{Y}=\frac{4 m g l}{\pi d^{2} \Delta l}$ <br> As I and d are same <br> $\Delta l \alpha \mathrm{~m} / \mathrm{Y}$ $\begin{aligned} & \frac{\Delta l s}{\Delta l c}=\frac{m s}{m c} \times \frac{Y c}{Y s} \\ & =\frac{10}{6} \times \frac{120 \times 10^{9}}{200 \times 10^{9}}=1: 1 \end{aligned}$ | $1 / 2$ <br> $1 / 2$ <br> $1 / 2$ <br> $1 / 2$ | 2 |
|  | SECTION - C |  |  |
| 26 | Diagram | $1 / 2$ |  |

\begin{tabular}{|c|c|c|c|}
\hline \& \begin{tabular}{l}
Gravitational potential energy between mass \(m_{1}\) and mass \(m_{2}=-\) \(\mathrm{Gm}_{1} \mathrm{~m}_{2} / \mathrm{l} \quad\) Gravitational potential energy between mass m and mass \(m=-G m m / l \quad\) Gravitational potential energy between mass \(m\) and mass \(2 m=-G 2 m m / l \quad\) Gravitational potential energy between mass \(m\) and mass \(2 \mathrm{~m}=-\mathrm{G} 2 \mathrm{~mm} / \mathrm{l} \quad\) Total Gravitational potential energy between mass m and mass \(2 \mathrm{~m}=\) \\
- \(5 \mathrm{Gmm} / \mathrm{l}\) \\
OR \\
For radius R : \\
Potential energy \(=-G M m / R\) \\
Kinetic energy \(=G M m / 2 R\) \\
For radius (3R/4): \\
Potential energy \(=-4 \mathrm{GMm} / 3 \mathrm{R}\) \\
Kinetic energy \(=2 \mathrm{GMm} / 3 \mathrm{R}\) \\
Change in potential energy \(=-G M m / 3 R\) \\
Change in kinetic energy \(=G M m / 6 R\)
\end{tabular} \& \(1 / 2\)
\(1 / 2\)
\(1 / 2\)
\(1 / 2\)
\(1 / 2\)
\(1 / 2\) \& 3

3 <br>

\hline 27 \& $$
W=F . s
$$

$$
\begin{aligned}
& \mathbf{S}=\mathbf{r}_{\mathbf{2}}-\mathbf{r}_{\mathbf{1}} \\
& \mathbf{S}=\mathbf{i}+3 \mathbf{j}+2 \mathbf{k} \\
& W=(2 \mathbf{i}+2 \mathbf{j}-\mathbf{k}) \cdot(\mathbf{i}+3 \mathbf{j}+2 \mathbf{k})
\end{aligned}
$$ \& $1 / 2$

$1 / 2$ \& <br>
\hline
\end{tabular}

|  | $=6 \mathrm{~J}$ <br> So, change in kinetic energy= work done $\begin{aligned} & =6 \mathrm{~J} \\ & \frac{1}{2} \mathrm{mv}^{2}=6 \\ & \mathrm{v}=\sqrt{60} \mathrm{~m} / \mathrm{s} \end{aligned}$ | $1 / 2$ <br> $1 / 2$ <br> $1 / 2$ <br> $1 / 2$ | 3 |
| :---: | :---: | :---: | :---: |
| 28 | $x=a \sin \omega t \quad \text { eq. } 1$ <br> Differentiating eq. 1 w.r.t time $\begin{aligned} & \frac{d x}{d t}=\omega \mathrm{a} \cos \omega t \\ & \mathrm{v}=\omega \mathrm{a} \cos \omega t \quad \text { eq. } 2 \end{aligned}$ <br> Differentiating eq. 2 w.r.t. time $\frac{d v}{d t}=-\omega^{2} \mathrm{a} \sin \omega t$ <br> acc. $=-\omega^{2} \mathrm{a} \sin \omega t \quad$ eq. 3 <br> Plot A represents v-t graph <br> Plot $B$ represents $x$-t graph <br> Plot C represents a-t graph <br> The phase between displacement and acceleration is $\pi$ | $\begin{aligned} & 1 / 2 \\ & 1 / 2 \\ & 1 / 2 \\ & 1 / 2 \\ & 1 / 2 \\ & 1 / 2 \end{aligned}$ | 3 |
| 29 | a) Correct Statement <br> NCERT pg. 202 $\Delta Q=\Delta U+\Delta W$ <br> b) i) In cyclic process $\underline{\mathrm{U}}=\text { constant }, \Delta \mathrm{U}=0$ <br> From first law of Thermodynamics $\Delta Q=\Delta W$ <br> ii) In isochoric process $V=\text { constant }$ $\Delta V=0$ <br> Work Done $=0$ <br> From first law $\Delta Q=\Delta U$ <br> As heat is given to the system $\Delta Q=+\mathrm{ve}$ <br> then $\Delta U=+\mathrm{ve}$ <br> Increase in internal energy means increase in temperature. <br> OR <br> Refer NCERT pg. 323 <br> calculation of total momentum transferred to the wall by molecules calculation of Pressure exerted on the wall calculation of Average Pressure | $1 / 2$ <br> $1 / 2$ <br> $1 / 2$ <br> $1 / 2$ <br> $1 / 2$ <br> $1 / 2$ <br> 1 1 1 | 3 3 |


| 30 | Under steady condition $\begin{aligned} & \frac{Q A}{t}=\frac{Q_{B}}{t}=\frac{Q^{\prime}}{t} \\ & \frac{2 k A\left(100-T_{1}\right)}{d}=\frac{\left.=k A T_{1}-T_{2}\right)}{d}=\frac{2 k A\left(T_{2}-0\right)}{d} \\ & 200-2 \mathrm{~T}_{1}=\mathrm{T}_{1}-\mathrm{T}_{2}=2 \mathrm{~T}_{2} \\ & 200=8 \mathrm{~T}_{2} \\ & \mathrm{~T}_{2}=25^{\circ} \mathrm{C} \\ & \mathrm{~T}_{1}=75^{\circ} \mathrm{C} \end{aligned}$ | $\begin{aligned} & 1 / 2 \\ & 1 / 2 \\ & 1 \\ & 1 / 2 \\ & 1 / 2 \end{aligned}$ | 3 |
| :---: | :---: | :---: | :---: |
|  | SECTION - D |  |  |
| 31 | (a) NCERT PAGE (75 ) <br> Diagram figure number (4.17) <br> Equation (4.36) <br> Equation (4.37) <br> Equation (4.38) <br> eliminating the time between the expression for x and y in above equation, we get the equation of the trajectory: <br> Equation (4.40) <br> (b) Diagram $\begin{aligned} & \tan _{\theta}=V y / V x \\ & \tan _{\theta}=(V y-g t) /(U x) \\ & \theta=\tan -1(V y-g t) /(U x) \end{aligned}$ <br> OR <br> (a) Diagram from ncert page 80 $\|\mathrm{a}\|=\lim _{\Delta t \rightarrow 0} \frac{I \Delta v I}{I \Delta t I}$ | $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $11 / 2+1 / 2$ $1 / 2$ $1 / 2$ | $(3+2=5)$ |


|  | $\begin{aligned} & \frac{I \Delta v I}{I v I}=\frac{I \Delta r I}{I r I} \\ & \text { \| a } \mathrm{I}=\frac{v}{R} \lim _{\Delta t \rightarrow 0} \frac{I \Delta r I}{I \Delta t I} \\ & \text { a } \quad=\frac{v^{2}}{R} \text { and is directed towards the centre. } \\ & \Delta v^{\text {and }} \Delta r \text { represent vector quantities } \end{aligned}$ $\begin{aligned} & \text { (b) } \omega=2 \pi \nu \\ & \omega=4 / 5 \mathrm{rad} / \mathrm{s} \\ & \text { centripetal acceleration }=\omega_{\omega} . \mathrm{s} \\ & =0.16 \mathrm{~m} / \mathrm{s}{ }_{2} \end{aligned}$ |  | $(3+2=5)$ |
| :---: | :---: | :---: | :---: |
| 32 | (a) (i) Statement <br> Diagram NCERT pg. 153 Fig. 7.17(b) <br> (b) $\mathrm{V}^{2}=\frac{2 g h}{1+\frac{k^{2^{2}}}{R^{2}}}$ <br> For ring $k=R$ <br> Therefore $\mathrm{V}_{\text {ring }}=\sqrt{g h}$ <br> For solid cylinder $\mathrm{k}^{2}=\frac{R^{2}}{8}$ <br> $V_{\text {cylinder }}=\frac{4}{3} \sqrt{g h}$ <br> Therefore the velocity of the solid cylinder is more than the velocity of the ring. <br> OR <br> a) i) $\mathrm{X}=\frac{m_{1} x_{1}+m_{2} x_{2}+m_{3} x_{3}}{m_{1}+m_{2}+m_{3}}$ | $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ | $(3+2=5)$ |


|  | $\begin{aligned} & Y=\frac{m_{1} y_{1}+m_{2} y_{2}+m_{3} y_{3}}{m_{1}+m_{2}+m_{3}} \\ & X=\frac{x_{1}+x_{2}+x_{3}}{3} \\ & Y=\frac{y_{1}+y_{2}+y_{3}}{3} \end{aligned}$ <br> ii) Centre of mass of a hollow sphere lies at its geometrical centre. When it is half filled with water, the centre of mass shifts below the geometrical centre because of the mass of the water filled. $\begin{aligned} & \text { b) } \frac{d r_{1}}{d t}=\mathrm{v}_{1}=2 \mathbf{i}+2 \mathrm{t} \mathbf{j} \\ & \frac{d r_{2}}{d t}=\mathrm{v}_{2}=4 \mathrm{t} \mathbf{j}+5 \mathbf{k} \\ & \mathrm{~V} \mathrm{~cm}=\frac{m_{1} v_{1}+m_{2} v_{2}}{m_{1}+m_{2}} \\ & \mathrm{~V} \mathrm{~cm}=\left(\frac{2}{3} \mathbf{i}+\frac{10}{3} \mathrm{t} \mathbf{j}+\frac{10}{3} \mathbf{k}\right) \mathrm{m} / \mathrm{s} \end{aligned}$ | $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ | $(3+2=5)$ |
| :---: | :---: | :---: | :---: |
| 33 | a) Let the two waves be represented as <br> Incident wave $\mathrm{y}_{1}(\mathrm{x}, \mathrm{t})=\mathrm{A} \sin (\omega t-k x) \quad$ moving along +ve x axis <br> Reflected wave $\mathrm{y}_{2}(\mathrm{x}, \mathrm{t})=-\mathrm{A} \sin (\omega t+k x)$ moving along -ve x axis and is reflected from rigid support <br> By the principle of superposition, the resultant wave is given by $\begin{aligned} y & =y_{1}+y_{2} \\ & =A\left[\sin (\omega t-k x)-\sin \left(\omega_{6}+k x\right)\right] \end{aligned}$ <br> Using trigonometric identity <br> $\sin (A+B)-\sin (A-B)=2 \cos A \sin B$ <br> $y=-2 A \cos \omega_{6} \sin k x$ <br> This is not the equation of the travelling wave. Here amplitude varies from point to point. This is an equation of a standing wave which is neither moving to the right nor to the left. <br> b) For the positions of antinodes, (where the amplitude is maximum) $\begin{aligned} & \text { ISinkxI = 1 } \\ & \mathrm{Kx}=\left(\mathrm{n}+\frac{1}{2}\right) \pi \\ & \mathrm{x}=\frac{n \pi}{k} \end{aligned}$ <br> Since $k=\frac{2 \pi}{\lambda}$ $x=\left(n+\frac{1}{2}\right) \frac{\lambda}{2} \quad n=0,1,2,3 \ldots$ <br> Clearly the distance between two consecutive antinodes is $\frac{\lambda}{2}$ <br> c) For closed organ pipe <br> First overtone or Third harmonic $v_{1}=\frac{3 V}{4 l_{1}}$ <br> For open organ pipe <br> Third harmonic $v_{2}=\frac{3 V}{2 l_{2}}$ <br> At Resonance $v_{1}=v_{2}$ | $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ $1 / 2$ |  |


| $\begin{aligned} & \frac{3 V}{4 l_{1}}=\frac{3 V}{2 l_{2}} \\ & 4 l_{1}=2 I_{2} \\ & \frac{l_{1}}{l_{2}}=\frac{2}{4}=\frac{1}{2} \end{aligned}$ <br> OR <br> a)Let the mass be displaced by a small distance $x$ to the right side of the equilibrium position. <br> The forces acting on the mass are <br> $F_{1}=-k x \quad$ directed towards the mean position <br> $F_{2}=-k x \quad$ directed towards the mean position <br> The net force $F$, acting on the mass is given by $F=-2 k x$ <br> From Newton's second law, F = ma $\mathrm{a}=\frac{F}{m}=\frac{-2 k x}{m}$ <br> Comparing with standard SHM eq. $\mathrm{a}=-\omega^{2} x$ $\begin{aligned} & \omega=\sqrt{\frac{2 k}{m}} \\ & 2 \pi v=\sqrt{\frac{2 k}{m}} \\ & v=\frac{1}{2 \pi} \sqrt{\frac{2 k}{m}} \end{aligned}$ <br> b) $\mathrm{x}=4\left(\cos \pi_{6}+\sin \pi_{6}\right)$ $\begin{aligned} & =4 \sqrt{2}\left(\frac{\sin \pi t}{\sqrt{2}}+\frac{\cos \pi t}{\sqrt{2}}\right) \\ & =4 \sqrt{2}\left(\sin \pi_{6} \cos \frac{\pi}{4}+\cos \pi_{6} \sin \frac{\pi}{4}\right) \\ & =4 \sqrt{2} \sin \left(\pi_{6}+\frac{\pi}{4}\right) \end{aligned}$ <br> On comparing it with $x=A \sin \left(\omega_{6}+\phi\right)$ $A=4 \sqrt{2} \mathrm{~m}$ |  | $\begin{aligned} & (2+1+2 \\ & =5) \end{aligned}$ |
| :---: | :---: | :---: |
| SECTION - E |  |  |


| 34 | a)Using Newton's second law of motion along x axis, $\mathrm{N}-\mathrm{F}=\mathrm{O}$ Thjerefore $\mathrm{N}=\mathrm{F}$ <br> b)Using Newton's second law of motion along y axis, $\mathrm{f}-\mathrm{mg}=0$ Therefore $\mathrm{f}=\mathrm{mg}$ <br> c) Maximum frictional force between the wall and the block $=\mu{ }_{s} \mathrm{~N}=$ $\mu{ }_{s} \mathrm{~F}$ <br> The block will not slide if mg is less than the $\mu{ }_{s} \mathrm{~F}$. <br> OR <br> c) The wall exerts two forces on the block : <br> 1) The normal force $N=F$ <br> 2) The force of friction $f=m g$, when the block is not sliding. These forces are perpendicular to each other. Therefore the magnitude of the net force $=\sqrt{F^{2}+(m g)^{2}}$ | 1/2 <br> 1/2 <br> 1/2 <br> 1/2 <br> 1 <br> 1 <br> 1 <br> 1 | $\begin{aligned} & (1+1+2= \\ & 4) \end{aligned}$ |
| :---: | :---: | :---: | :---: |
| 35 | Given $\rho=0.8 \times 10^{3} \mathrm{Kg} / \mathrm{m}^{3}$ $\begin{aligned} & \mathrm{R}=0.1 \mathrm{~mm}=0.1 \times 10^{-3} \mathrm{~m} \\ & \mathrm{~T}=2.8 \times 10^{-2} \mathrm{~N} / \mathrm{m} \\ & \mathrm{~g}=10 \mathrm{~m} / \mathrm{s}^{2} \\ & \theta=0^{0} \end{aligned}$ $\text { a) } \begin{aligned} \mathrm{h} & =\frac{2 T \cos \theta}{R \rho g} \\ & =\frac{2 \times 2.8 \times 10^{-2} \times \cos 0}{0.1 \times 10^{-3} \times 0.8 \times 10^{3} \times 10} \\ =7 & \times 10^{-2} \mathrm{~m} \end{aligned}$ <br> b) As on adding impurity, surface Tension decreases and h $\alpha$ T <br> Therefore the height of the liquid will decrease. <br> c) Volume of 1000 droplets $=$ Volume of a big drop $\begin{aligned} & 1000 \frac{4}{3} \pi r^{3}=\frac{4}{3} \pi R^{3} \\ & 10 \mathrm{r}=\mathrm{R} \\ & \mathrm{r}=\frac{R}{10}=\frac{D}{20} \end{aligned}$ <br> Change in surface energy $=$ increase in surface area $\times$ surface Tension $\begin{aligned} & {\left[1000 \times 4 \pi\left(\frac{D}{20}\right)^{2}-4 \pi\left(\frac{D}{2}\right)^{2}\right] \times \mathrm{T}} \\ & =\pi \mathrm{D}^{2}\left(\frac{1000}{100}-1\right) \times \mathrm{T} \\ & =1.26 \times 10^{-5} \mathrm{~J} \end{aligned}$ | 1/2 |  |



