

CHAPTER 1 - PHYSICAL WORLD



1. Select the strongest force from the following list.

(Electromagnetic force, Gravitational force, Weak nuclear force)

(1) [Imp 2019]

2. "The weak nuclear force is stronger than gravitational force". State whether this statement is TRUE or FALSE.

(1) [March 2019]

3. State TRUE or FALSE. "Some conservation laws are true for one fundamental force, but not for the others".

(1) [Imp 2018]

4. The branch of Physics that was developed to understand and improve the working of heat engines is

a. Optics

b. Thermodynamics

c. Electronics

d. Electrodynamics

(1) [March 2018]

5. The gravitational force is always attractive whereas electro static force is attractive as well as repulsive. The ratio of electro static force and gravitational force between two protons is.....

(1) [Imp 2017]

a. 10^{-19}

b. 10^{19}

c. 10^{36}

d. 10^{-36}

6. Pick the odd one out among the following forces:

(1) [March 2017]

a. Gravitational force

b. Weak nuclear force

c. Viscous force

d. Electromagnetic force

7. Which one of the following fundamental forces in nature binds Protons and neutrons in a nucleus?

a. Gravitational force

b. Electromagnetic force

c. Strong nuclear force

d. Weak nuclear force

(1) [Imp 2016]

8. Which one of the following is present between all object in universe?

a. Electromagnetic force

b. Magnetic force

c. Gravitational force

d. Strong nuclear force

(1) [March 2016]

9. Choose the WRONG statement from the following statements. (1) [Imp 2015]
- Electromagnetic force is the force between charged particles.
 - Electrostatic force can be attractive or repulsive.
 - Nuclear force binds protons and neutrons in a nucleus.
 - Gravitational force is one of the strongest forces among fundamental forces in nature.
10. Choose the correct answer from the brackets: (1) [March 2015]
- Weakest force in nature is.... (1)
(Strong nuclear force, Electromagnetic force, Gravitational force, Weak nuclear force)
 - $98^{\circ}\text{F} = \dots\dots\dots\text{K}$ (1)
(36.7, 40, 309.7, 371)
11. The weakest force found in nature (1) [Imp 2013]
- Strong Nuclear Force
 - Weak Nuclear Force
 - Gravitational Force
 - Electromagnetic Force

CHAPTER 2 - UNITS & MEASUREMENT

1. The correctness of equation can be checked using the principle of homogeneity in dimensions.
- (a) State the principle of homogeneity.
- (b) Using this principle, check whether the equation $f = 2\pi\sqrt{\frac{l}{g}}$ is dimensionally correct, where f-frequency, l-length and g-acceleration due to gravity.
- (c) The velocity V of a particle depends on time 't' as $V = At^2 + Bt$. Find the dimensions and units of A and B. (1+2+2) [Imp 2019]
2. The lengths of two bodies measured by a meter scale are $l_1 = (20 \pm 0.5)\text{ cm}$ and $l_2 = (15 \pm 0.2)\text{ cm}$. Calculate
- (a) Sum of these lengths.
- (b) Difference between the lengths. (1+1) [March 2019]
3. "Velocity cannot be added to temperature"
- (a) This is in accordance with which law of physics?
- (b) Check the dimensional correctness of the equation $PV = Fx$ where P is the pressure, V is volume, F is force and x is displacement. (1+2) [March 2019]

4. a. The centripetal force depends on the mass of the body, velocity, and radius of a circular path. Find the expression for the centripetal force acting on the body using the principle of dimensional analysis.

(Take constant $k=1$)

b. When the planet Jupiter is at a distance of 824.7 million kilometres from the Earth, its angular diameter is measured to be $35.72''$ of an arc. Calculate the diameter of a Jupiter. **(3+2) [Imp 2018]**

5. Select a TRUE statement from the following: **(1) [March 2018]**

- a. A year and light year have the same dimensions.
- b. The intensity of the gravitational field has the same dimensions as that of acceleration.
- c. One angstrom is the mean distance between sun and earth.
- d. Parsec is a unit of time.

6. "The accuracy in measurement depends on the limit or the resolution of the measuring instrument".

a. State whether the above statement is TRUE or FALSE.

b. A physical quantity P is related to four observables a , b , c , and d as $P = \frac{a^3 b^2}{\sqrt{cd}}$. The percentage errors in measurements of a , b , c , and d are 1%, 3%, 2%, and 3% respectively. What is the percentage error in the measurement of P ? **(1+3) [March 2018]**

7. The nature of a physical quantity is described by its dimensions.

a) Check the correctness of the equation $v = v_0 + at$, by the method of dimensional analysis.

b) Besides the seven base units, there are two more units in SI. The unit of solid angle is.....

- i) radian
- ii) steradian
- iii) degree
- iv) candela

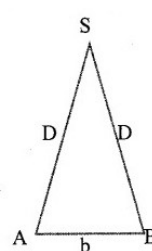
c) Which one of the following is a dimensional constant?

- i) Relative error of a measurement
- ii) Relative density
- iii) Gravitational constant
- iv) Strain

(2+1+1) [Imp 2017]

8. a. The figure below shows the 'parallax method' to measure the distance 'D' of a planet 'S' from the earth. Mark the parallax angle ' θ ' in the figure. Explain how the distance 'D' can be measured.

b. Check whether the equation $mv^2 = mgh$ is dimensionally consistent. Based on the above equation, justify the following statement. "A dimensionally correct equation need not be actually an exact equation". **(2+2) [March 2017]**



+1 Physics Chapterwise Previous Year Questions (2009-2019)

9. a) Length of a sheet is $17.3 \pm 0.3 \text{ cm}$ and breadth is $3.12 \pm 0.08 \text{ cm}$. Calculate the percentage error in the area. (2)
- b) Using the principle of homogeneity of equations, check whether the equation is correct. $T = 2\pi \sqrt{\frac{g}{l}}$
 $T \rightarrow \text{time}, g \rightarrow \text{acceleration}, l \rightarrow \text{length}$ (2) [Imp 2016]
10. a) The error in the measurement of radius of a circle is 0.6%. Find the percentage error in the calculation of the area of the circle. (2)
- b) Name the principle used to check the correctness of an equation. (1)
- c) What is the number of significant figures in 0.00820 J? (1) [March 2016]
11. The correctness of equations can be checked using the principle of homogeneity.
- a) State the principle of homogeneity. (1)
- b) Using this principle, check whether the following equation is dimensionally correct. $\frac{1}{2}mv^2 = mgh$, Where **m** is the mass of the body, **v** is its velocity, **g** is the acceleration due to gravity and **h** is the height. (2)
- c) If percentage errors of measurement in velocity and mass are 2% and 4% respectively, what is the percentage error in kinetic energy? (1) [Imp 2015]
12. a) Suggest a method to measure the diameter of the Moon. (1)
- b) Length, breadth and thickness of a block is measured using Vernier callipers. The percentage errors in the measurements are 2%, 1% and 3% respectively. Estimate the percentage error in its volume. (1)
- c) A physical quantity is given by $h = \frac{Fv^2}{l}$. F is the force, v is the velocity L and L is the angular momentum. Find the dimensions of h. (2) [March 2015]
13. Dimensional method helps in converting the units from one system to another. (1 + 2)
- a) Name the principle used for the above purpose.
- b) Using dimensions, prove 1 Newton = 10^5 dyne. [Imp 2014]
14. The correctness of an equation is checked using the principle of homogeneity. For an equation, $x = a + bt + ct^2$ where x is in metre and t in second. What will be the dimension of 'b'? (1) [Imp 2013]
15. Significant figures determine the accuracy of the measurement of a physical quantity.
- a) The radius of a sphere is given by $R = 1.03\text{m}$. How many significant figures are there in it? (1)
- b) If the percentage error in calculating the radius of the sphere is 2%, what will be the percentage error in calculating the volume? (1) [Imp 2013]
16. Pick out the fundamental unit from the following:
Second, m/s, Newton, Joule (1) [March 2013]
17. Velocity of sound depends on density ρ and modulus of elasticity E. (The dimensional formula of E is $ML^{-1}T^{-2}$).

- a) State the principle of homogeneity
- b) Using the above principle, arrive at an expression for the velocity of sound. (Take $K=1$). (1+3) [March 2013]
18. a) Which measurement is most precise?
- i. Vernier Calipers having 5 divisions on sliding scale.
 - ii. Vernier Calipers having 10 divisions on sliding scale.
 - iii. Vernier Calipers having 20 divisions on sliding scale.
- b) What happened to the accuracy when the least count is decreased? (1+1) [Imp 2012]
19. a) A boy recalls the relativistic mass wrongly as $m = \frac{m_0}{\sqrt{1-v^2}}$. Using dimensional method put the missing 'c' at the proper place.
- b) Name and state the principle used in solving the above problem. (3+2) [Imp 2012]
20. Select the correct answer:
- a) Light year is the unit of.....
- i) time ii) length iii) year iv) velocity
- b) kilowatt-hour is the unit of
- i) energy ii) power iii) time iv) mass
- (1+1) [March 2012]
21. All physical quantities can be expressed in terms of dimension.
- a) Write the physical quantities of the following dimensions:
- i) $[M^1 L^1 T^{-1}]$ ii) $[M^1 L^2 T^{-2}]$
- b) Check whether the equation $T = 2\pi \sqrt{\frac{m}{g}}$, Where $T \rightarrow$ Time period of a simple Pendulum, $m \rightarrow$ mass of the bob, $g \rightarrow$ acceleration due to gravity. (1+3) [March 2012]
22. To measure distance we use different units. Which of the following is the largest unit of the length?
- a) Kilometre
 - b) Astronomical unit
 - c) Light year
 - d) Parsec
- (1) [Imp 2011]
23. Which of the following measurement is more accurate? Why? (1) [Imp 2011]
- i. 500.00kg. ii. 0.0005kg. iii. 6.00kg.
24. a) Pick out the odd one in the given pairs.
- i. Angular velocity and frequency. ii. Work and energy.
 - iii. Angle and strain. iv. Impulse and momentum.

b) 1 light year = m

(1+1) [March 2011]

25. a) A student was asked to write the equation for displacement at any instant in a simple harmonic motion of amplitude 'a'. He wrote the equation as $y = a \sin \frac{2\pi v}{k} t$. Where 'v' is the velocity at instant's'. For the equation to be dimensionally correct, what should be the dimensions of k?

b) What is the area of a square of side 1.4 cm in proper significant figures?

[March 2011]

26. Give examples for the following:

a) A dimensionless, unit less physical quantity.

b) A dimensionless physical quantity but having unit in SI system.

c) Two physical quantities which have the same dimensions.

[Imp 2010]

27. A company manufacturing PVC pipes claims in an advertisement that the volume of water flowing out through the pipe in a given time is as per the equation $V = KA^2 ut$ where A is the area of cross section of the pipe, u is the speed of flow, t is the time and K is a dimensionless constant.

a) Name the principle that can be used to check the dimensional correctness of this equation.

b) Check the equation and state whether the claim can be correct.

[Imp 2010]

28. Mechanical power is represented by $P = Fv + Av^3\rho$. where, F is the force, v is the velocity, A is the area and ρ is the density.

a) The dimensional formula of power is.....

b) Check the dimensional validity of the above equation.

c) Which of the following equations can't be obtained by the dimensional method?

[March 2010]

i) $T = K \sqrt{\frac{l}{g}}$

ii) $E = kmv^2$

iii) $P = h \rho g$

iv) $N = N_0 e^{-\lambda t}$

29. Match the following:

[Imp 2009]

a	Coefficient of viscosity	$\frac{\text{Force / area}}{\text{number}}$	$ML^{-1} T^{-2}$
b	Gravitational constant	$\frac{\text{Force / area}}{\text{velocity gradient}}$	$M^{-1} L^3 T^{-2}$
c	Modulus of elasticity	$\frac{\text{Force} \times (\text{dis tan ce})}{(\text{mass})^2}$	$M L^{-1} T^{-1}$

30. Fill in the blanks:

[March 2009]

- a) 1 micron =m.
- b) Hertz is the unit of

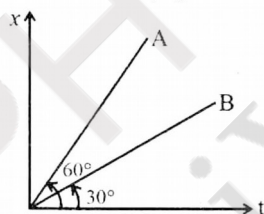
31. a) A student writes the equations for the relativistic variation of mass with velocity as $m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$

Where ' m_0 ' is the rest mass and ' c ' is the speed of light. What is the dimensional formula for ' x '?

b) If the percentage error in the measurement of radius ' R ' of a sphere is 2%, then what is the percentage error in its volume?
[March 2009]

CHAPTER 3 - MOTION IN A STRAIGHT LINE

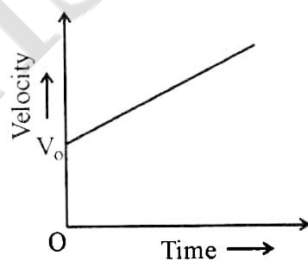
1. The position - time graph of two objects A and B are shown below.



- (a) Which body has greater velocity?
- (b) Find the ratio of velocities of A and B.

(1+1) [Imp 2019]

2. The velocity - time graph of an object is given below.



- (a) The area under this graph gives.....
- (b) Derive the relation $x = v_0 t + \frac{1}{2} at^2$ using the above graph

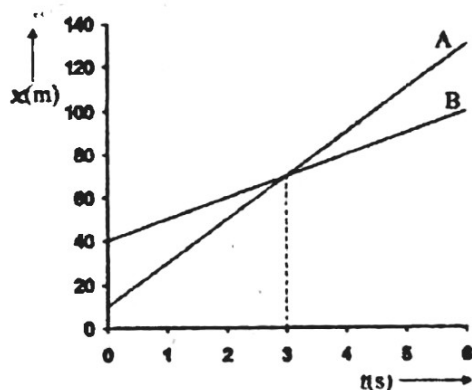
(1+2) [Imp 2019]

3. Free fall is a uniformly accelerated motion.

- a) Draw the velocity – time graph of free fall.
- b) A ball is thrown vertically upwards with a velocity of 20 ms^{-1} from the top of a building. The height of the point from where the ball is thrown is 25.0 m from the ground.
 - i) How high will the ball rise?
 - ii) How long will it be before the ball hits the ground?

(1+3) [March 2019]

4. Position (r) - time (t) graphs of two objects A and B are shown below. At what time the objects meet?



(1) [March 2019]

5. A car travelling at a speed 54 km/hr is brought to rest in the 90s. Find the distance travelled by car before coming to rest.

(2) [Imp 2018]

6. Two parallel rail tracks run north-south. Train A moves north with a speed of 15 m/s and train B moves south with a speed of 25 m/s.

a. What is the velocity of B with respect to A?

b. What is the velocity of the ground with respect to B?

c. What is the velocity of a monkey running on the roof of the train A against its motion (with a velocity of 5 m/s with respect to the train A) as observed by a man standing on the ground?

(1+1+1) [Imp 2018]

7. Using a suitable velocity-time graph, derive the relation $x = v_0t + \frac{1}{2}at^2$.

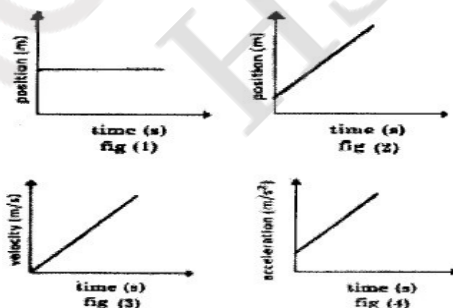
(2) [March 2018]

8. A body falling under the effect of gravity is said to be in free fall.

a. Draw the velocity-time graph for a freely falling object.

b. Define uniform acceleration.

c. From the given figures, identify the figure which represents uniformly accelerated motion.



(1+1+1) [March 2018]

9. An object moving along a straight line covers equal distances in equal intervals of time, it is said to be in uniform motion along a straight line.

a) The position - time graph of an object in uniform motion is.....

i) a straight line parallel to the time axis.

ii) a straight line parallel to the position axis.

iii) a straight line inclined to the time axis.

iv) a parabola.

b) Derive the relation $x = v_0 t + \frac{1}{2} a t^2$ for uniformly accelerated motion with the help of velocity-time graph.

c) Which of the following statements is/are TRUE?

i) An object with constant velocity has always constant speed.

ii) An object with constant speed has always constant velocity.

iii) An object with zero velocity has always zero acceleration.

iv) An object with zero acceleration has always zero velocity

(1+2+1) [Imp 2017]

10. An object released near the surface of the earth is said to be in free fall. (Neglect the air resistance)

a. Choose the correct alternative from the clues given at the end of the statement.

“Free fall is an example of..... accelerated motion”(uniformly/non-uniformly)

b. The incomplete table shows the velocity (v) of a freely falling object in a time interval of 1s. (Take $g=10 \text{ m/s}^2$).

Complete the table and draw the velocity time graph.

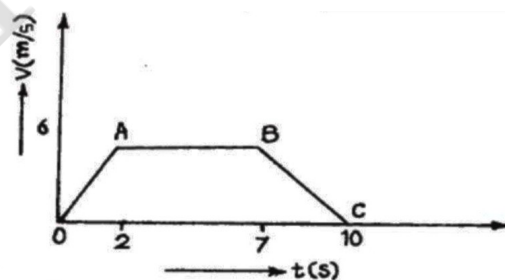
Time (t) s സമയം	Velocity (v) m/s പ്രവേഗം
0	0
1	...
2	...
3	30
4	40
5	50

c. Area under velocity-time graph gives

(1+3+1) [March 2017]

11. Velocity – time graph of a body is given below.

[Imp 2016]



a) Which portion of the graph represents uniform retardation?

(1)

(i) OA (ii) AB (iii) BC (iv) OC

b) Find the displacement in time 2s to 7s.

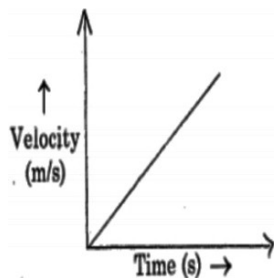
(1)

c) A stone is dropped from a height h. Arrive at an expression for the time taken to reach the ground.

(2)

12. Velocity – time graph of an object is given below.

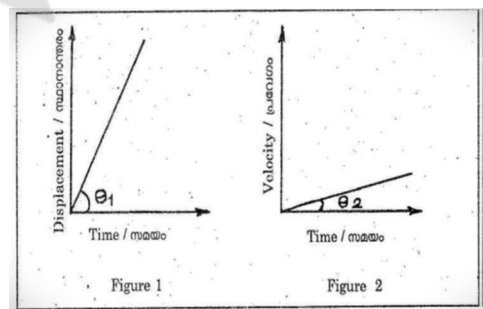
[March 2016]



- What type of motion is indicated by the above graph? (1)
- Derive a relation connecting the displacement and time for this type of motion. (2)
- The ratio of velocity to speed of an object is..... (1)
 - One
 - Greater than one
 - Less than one
 - Either less than one or equal to one.

13. Figure 1 shows displacement-time graph of runner A. Figure 2 shows velocity-time graph of runner B.

- Identify the type of motion the runner A has. (1)
 - Uniform motion
 - Non-uniform motion
 - Accelerated motion
 - Jerking motion



- Derive a mathematical relation that connects displacement, velocity and time for runner A. (2)
- Analysing the above two graphs, find which runner will win the race. Why? (Here $\theta_1 > \theta_2$). (1) [Imp 2015]

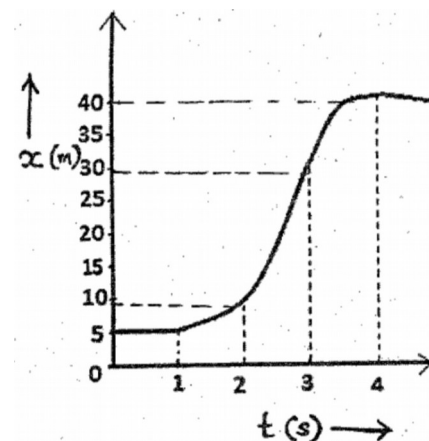
14. Position – time graph of a body is given.

(1+2) [March 2015]

- Estimate the velocity during the time interval $t = 2\text{s}$ to $t = 3\text{s}$.
- Displacement of an object is proportional to t^3 . Show that its acceleration is increasing with time.

15. Velocity is defined as the rate of change of displacement.

- Distinguish between average velocity and instantaneous velocity.
- When does the average velocity becomes equal to the instantaneous velocity?
- A car travels from A to B at 60 km/hr and returns to A at 90 km/hr. What is its average velocity and Average speed? (2+1+2) [Imp 2014]



16. Acceleration is defined as the rate of change of velocity.

a) Is it possible for a body to have acceleration without velocity? Explain.

b) Draw the velocity – time graph of a body moving with uniform acceleration 'a' and initial velocity V_0 .

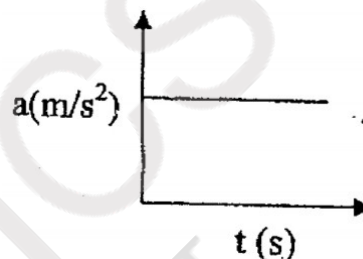
c) Using the above graph, obtain the equation for displacement in time 't'. (1+ 1+ 2) [March 2014]

17. Acceleration – time graph of a body is shown below:

a) Drawn the corresponding velocity-time graph.

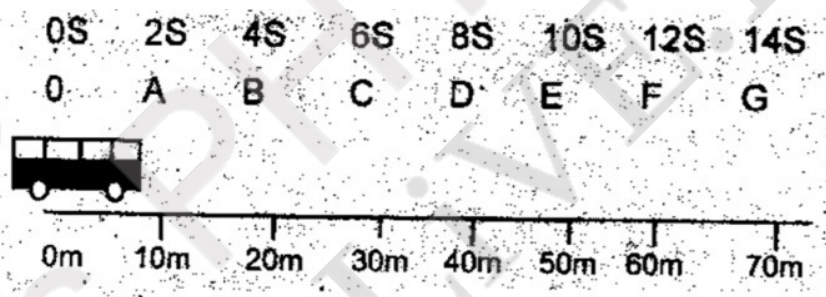
b) What does the area under the velocity – time graph represent?

c) Arrive at a relation connecting velocity (v) and time (t) for a uniformly accelerated body.



(1+1+2) [Imp 2013]

18. Figure given below shows the motion of a school bus starting from the point O and travels along a straight line.



a) Complete the following table:

Time taken	Displacement from 0	Velocity
2s	10-0=10m	.....
10s	.....	5m/s

b) Is the motion of the bus uniform or non-uniform? Justify your answer.

c) Draw the position – time graph of the above motion.

d) A student in the school bus notices the speedometer of the bus. Which type of speed is shown by the speedometer? [March 2013]

19. a) State in the following cases whether the motion is one, two or three dimensions.

i. A butterfly flying around a flower.

ii. A bus moving along a long and straight road.

b) Derive the equations of motion for non-uniform motion in one dimension.

c) Look at the graph in fig. (a) and fig.(b) carefully and state which of these can't possible represent one-dimensional motion with reasons. [Imp 2012]

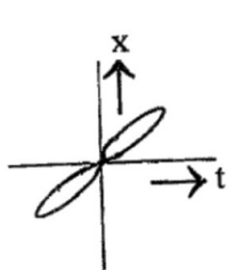


fig. (a)

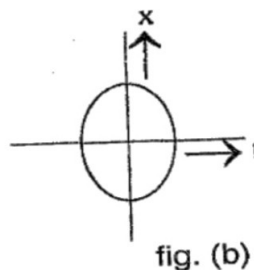


fig. (b)

20. A car is moving along the circumference of a circle of radius r .

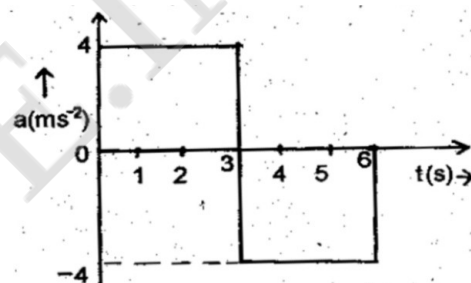
[Imp 2012]

- What is the distance travelled in one revolution?
- What is the displacement in one revolution?
- What is the speedometer of the car measure?
- Can a body have acceleration without velocity. Explain.

21. Acceleration – time graph of a body starts from rest as shown below:

[March 2012]

- What is the use of the acceleration-time graph?
- Draw the velocity – time graph using the above graph.
- Find the displacement in the given interval of time from 0 to 3 seconds.

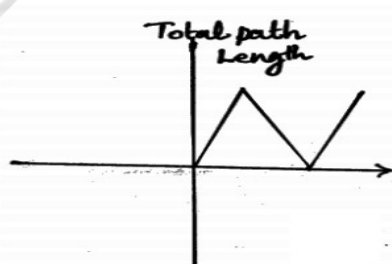
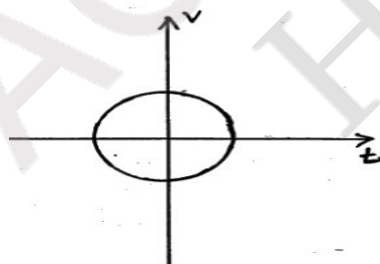


22. Acceleration is the time rate of change of velocity. Give an example of a body possessing zero velocity and still accelerating.

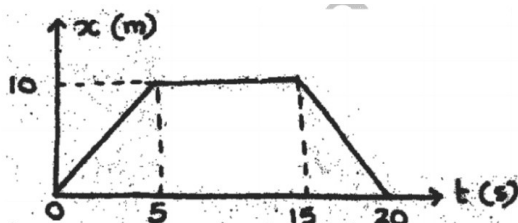
[Imp 2011]

23. Graph representing the motion of two bodies are shown below. State with reason whether it can represent one-dimensional motion.

[Imp 2011]



24. a) The figure shown the position – time graph of a body moving along a straight line.



- Draw the velocity-time graph of the body.
- From the graph, find the displacement in 20 seconds.

- b) From the velocity-time graph of a body moving with uniform acceleration, deduce the velocity-time relation and the velocity-displacement relation. **[March 2011]**
25. When breaks are applied on a moving vehicle, it stops after travelling a distance. This distance is called stopping distance.
- a) Write an expression for stopping distance in terms of initial velocity (u) and retardation (a).
- b) If the initial speed is doubled keeping the retardation same, by how much will the stopping distance change? **[March 2011]**
26. If v is the velocity and a is the acceleration, give an example of a physical situation for each of the following cases.
- a) $V \neq 0, a = 0$
- b) $V = 0, a \neq 0$
- c) $V > 0, a < 0$
- d) $V < 0, a > 0$ **[Imp 2010]**
27. A ball is thrown horizontally from the top of a tower with a velocity of 40 ms^{-1} . Take $g = 10 \text{ ms}^{-2}$.
- a) Find the horizontal and vertical displacement after 1,2,3,4,5 seconds, then the path of the motion of ball.
- b) If the ball reaches the ground in 4 seconds, find the height of the tower. **[March 2010]**
- 28.a) Acceleration is the time rate at which velocity of a body changes. Show that for a car, moving with constant acceleration for a period of time, the distance travelled in the second half is three times of that in the first half.
- b) The acceleration caused by the earth's attraction towards its centre is known as acceleration due to gravity. It is always directed towards the centre of earth. Show that in the absence of air resistance, for a ball thrown upwards, the time of ascent is equal to the time of descent.
- c) Show that when air resistance is also taken into account, the time of descent is greater than the time of ascent. **[Imp 2009]**
- 29.a) A ball thrown vertically upwards from the top of a tower with a velocity V . Another ball is thrown vertically downwards with the same velocity V . Which ball will hit the ground with greater velocity?
- b) A boy drops a ball through the window of a train, which is moving with the uniform velocity. What will be the path of the ball as observed by
1. The same boy sitting in the train?
 2. Another boy standing on the platform?
- and
3. A third boy sitting in a train moving in the opposite direction on a parallel track? **[Imp 2009]**
30. a) To describe the motion of a body we require a frame of reference. What are the inertial and non-inertial frames of references?
- b) Can a frame of reference fixed at a point on the surface of earth be truly inertial? Why? **[Imp 2009]**

31. In situations demanding our immediate action, normally it takes sometime before we really respond. This time is known as reaction time. A truck is moving forward at a constant speed of 20 m/s. The driver sees a car in front of him at a distance of 110 meters stopping suddenly. After a reaction time he applies the brakes which give the truck an acceleration of -3 m/s^2 . What will be the maximum allowable reaction time to avoid a collision and what distance the truck would have moved before the brakes take hold?

[Imp 2009]

32. Motion is common to everything in the Universe. It is the change of position of an object with time.

(a) The slope of position – time graph of a particle gives:

(A. Acceleration B. Displacement C. Velocity D. Momentum)

(b) Give an example of a body possessing zero velocity and that is still accelerating.

(c) A car starts accelerating from rest for some time, moves with a uniform velocity for some time and comes to rest with a uniform retardation. Draw the velocity time graph of the car.

(d) A car covers the first half of the distance between two places at a speed of 40kmph and the second half at 60kmph. Calculate the average speed of the car.

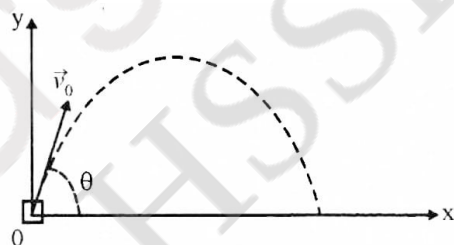
[March 2009]

CHAPTER 4 - MOTION IN A PLANE

1. Obtain the relation between linear velocity and angular velocity.

(2) [Imp 2019]

2. The figure below shows the path of a projectile motion.



(a) Obtain the expressions for maximum height and time of flight.

(b) What is the angle of projection for maximum horizontal range?

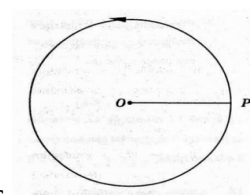
(3+1) [Imp 2019]

3. Find the magnitude of the resultant of two vectors A and B in terms of their magnitudes and angle θ between them.

(3) [March 2019]

4. a) Figure shows the path of an object in uniform circular motion.

Redraw the figure and mark the directions of velocity and acceleration of the particle at P.



b) An object moving uniformly in a circular path of radius 12cm completes 7 revolutions in 100s. What is the angular speed, and the linear speed of the motion?

(1+2) [March 2019]

5. An insect trapped in a circular groove of radius 12 cm moves along the groove steadily and completes 7 revolutions in 100s.
- What is the linear speed of the motion?
 - Is the acceleration vector a constant vector? What is its magnitude? **(1+2) [Imp 2018]**
6. A boy throws a ball of mass 200 g with a velocity 20 ms^{-1} at an angle of 40° with the horizontal. What is the kinetic energy of the ball at the highest point of the trajectory? **(2) [March 2018]**
7. A stone tied to the end of a string 80 cm long is whirled in a horizontal circle with a constant speed.
- What is the angle between velocity and acceleration at any instant of motion?
 - If the stone makes 14 revolutions in 25 s, what is the magnitude of the acceleration of the stone? **(1+3) [March 2018]**
8. a. If \vec{A} is perpendicular to \vec{B} . What is the value of $\vec{A} \cdot \vec{B}$? **(1+3) [March 2018]**
- b. Find the angle between the force $\vec{F} = (3\hat{i} + 4\hat{j} - 5\hat{k}) \text{ N}$ and displacement $\vec{d} = (5\hat{i} + 4\hat{j} + 3\hat{k}) \text{ m}$.
9. The angle between $\vec{A} = (\hat{i} + \hat{j})$ and $\vec{B} = (\hat{i} - \hat{j})$ **(1) [March 2018]**
- 45°
 - 90°
 - 60°
 - 180°
10. The parallelogram law is used to find the resultant of two vectors. Find the magnitude of the resultant of two vectors in terms of their magnitudes and angle between them. **(2) [March 2018]**
11. A projectile is anybody that is given an initial velocity and then follows a path determined entirely by the effects of gravitational acceleration and air resistance.
- a) The path of a projectile is.....
- straight line
 - parabola
 - circle
 - semi circle
- b) Derive an expression for time to reach maximum height and hence the time of flight of a projectile.
- c) A baseball leaves a bat with an initial speed of 37 m/s at an angle of 53.1° . Find the position of the ball when $t = 2\text{s}$ (treat baseball as a projectile and $g = 9.8 \text{ m/s}^2$) **(1+2+2) [Imp 2017]**
12. a. Choose the correct statement/statements related to uniform circular motion.
- The acceleration in uniform circular motion is tangential to the circle.
 - The acceleration in uniform circular motion is directed radially inwards.
 - The velocity in uniform circular motion has constant magnitude.
 - The velocity in uniform circular motion is directed radially inwards.

b. A particle is projected up into the air from the point with a speed of 20 m/s at an angle of projection 30° . What is the maximum height reached by it. (2+2) [March 2017]

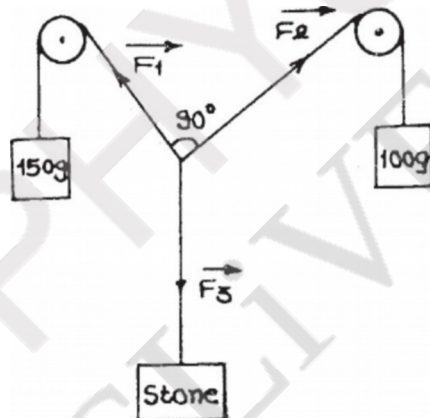
13. a) Identify the scalar quantity from the following alternatives. (1)

- (i) Momentum
- (ii) Work
- (iii) Torque
- (iv) Acceleration

b) A man throws a stone up into air at an angle ' θ ' with the horizontal. Draw the path of the projectile and mark directions of velocity and acceleration at the highest position. (2)

c) Derive an expression for the maximum height reached by the stone. (2) [Imp 2016]

14. Observe the following diagram.



a) The forces F_1 , F_2 , F_3 are together called (1)

b) Calculate the mass of the stone using the parallelogram law of vector addition. (2) [Imp 2016]

15. When a body is projected into air with certain initial velocity making an angle with the horizontal, it will travel in a parabolic path. [March 2016]

a) What are the vertical and horizontal components of velocity? (1)

b) With a diagram, derive an expression for :

- i. Maximum height
- ii. Time of flight. (4)

c) A ball is dropped through the window of a train travelling with high velocity, to a man standing near the track. The ball.....

- i. Falls down vertically
- ii. Moves straight horizontally
- iii. Follows an elliptical path
- iv. Follows a parabolic path (1)

16. A body is projected into air at an angle θ with the horizontal.

a) What is the trajectory followed by this projectile? (1)

- i) Ellipse
- ii) Parabola
- iii) Straight line
- iv) Circle

b) Give a mathematical proof for your answer. (2)

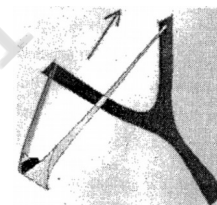
c) Trajectory of a body in a projectile motion is given by $y = x - \frac{x^2}{80}$. x and y are in meters. Find maximum height of this projectile. (2) [Imp 2015]

17. A stone is thrown with the help of a sling with initial velocity v_0 at an angle ' θ ' from the horizontal.

a) Working of sling is based on..... law of vector addition.

b) With the help of a vector diagram, state this law.

c) Derive the expression for the maximum height reached by the stone.



(1+1+1) [March 2015]

18. Projectile is a particle which is projected into the air with an initial velocity against the gravity.

a) What is the angle of projection for maximum horizontal range?

b) Draw the trajectory of a projectile.

c) Obtain the expression for time of flight. (1+1+2) [Imp 2014]

19. Uniform circular motion is a special case of two – dimensional motion having centripetal acceleration.

a) Define centripetal acceleration.

b) Can a body have acceleration with constant speed? Explain.

c) Express angular velocity in terms of angular displacement. (1+ 1+ 1) [Imp 2014]

20. The centripetal force on a body in circular motion is given by $F = \frac{mv^2}{r}$.

a) Write the dimension of force.

b) Using the above formula, write an equation to find % error in centripetal force.

c) What is the number of significant figures in 0.050 N? (1+ 1+ 1) [March 2014]

21. A and B are two objects moving with velocities V_A and V_B .

a) What is the velocity of A relative to B? (1)

b) Rain is falling vertically with a speed of 35 m/s. A woman rides a bicycle with a speed of 12 m/s in the east to west direction. What is the direction in which she should hold her umbrella? (3)

c) Assertion: the range of a projectile remains the same for the angle of projection 30° and 60° . (1)

Reason: the range does not depend on the angle of projection.

Choose the correct answer:

A: Both assertion and reasons are correct.

B: Both assertion and reason are wrong.

C: Assertion is correct, but reasons are wrong.

D: Assertion is wrong, but reason is correct.

[March 2014]

22. A stone is thrown upward from a moving train.

a) Name the path followed by the stone.

b) A particle is projected with a velocity 'u' in the direction making an angle θ with the horizontal. Find.

1) Time of flight

2) Maximum height

c) A man can jump on moon six times as high as on earth. Why?

(1+3+1) [Imp 2013]

23. An athlete jumps at an angle of 30° with a maximum speed of 9.4m/s.

a) What is the shape of the path followed by the athlete in the jump?

b) Obtain an expression to calculate the horizontal range covered by the athlete.

c) Find the range covered by him in the above jump. Suggest the angle by which the athlete can attain the maximum range.

[March 2013]

24. a) Find whether the given vectors $2\hat{i} + 3\hat{j} + 4\hat{k}$ and $4\hat{i} + 6\hat{j} + 8\hat{k}$ are parallel or not.

b) What are orthogonal unit vectors?

c) What is zero vector? Give its significance in Physics with an example.

[Imp 2012]

25. a) Obtain expression for Time of flight for a projectile motion.

b) What is the angle of projection for maximum horizontal range?

c) The ceiling of a long hall is 25m high. What is the maximum horizontal distance that the ball thrown with a speed of 40 m/s can go without hitting the ceiling of the hall?

[Imp 2012]

26. A parallelogram law helps to find the magnitude and direction of the resultant of two forces:

a) State the law.

b) If the magnitude of two vectors and their resultant are the same, what is the angle between the two vectors?

c) Determine the value of $(\vec{A} - \vec{B}) \times (\vec{A} + \vec{B})$

[March 2012]

27. A boy throws a cricket ball with a velocity u at an angle θ with the horizontal.

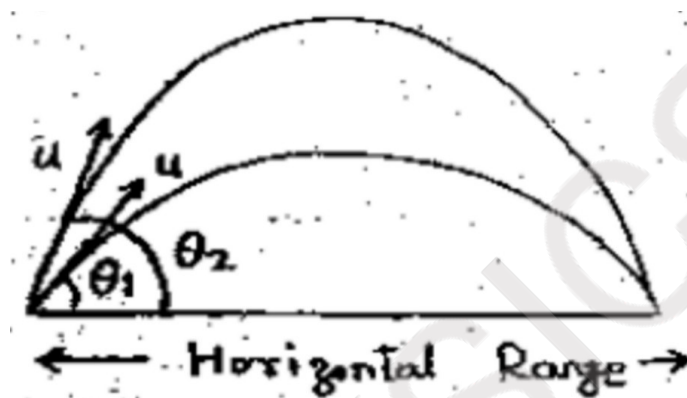
[March 2012]

a) Name the path followed by the ball.

b) At the highest point, what are the vertical and horizontal components of velocity?

c) Derive an expression for the maximum height reached by the ball.

d) If $\theta_1 = 30^\circ$, what is the value of θ_2 ?



28. A food packet is dropped from a plane flying horizontally.

a) Sketch the path of the falling food packet.

b) If the time taken by the packet to reach the earth's surface is '6' seconds, calculate the height from which the packet is dropped. (Take $g = 10\text{m/s}^2$)

[Imp 2011]

29. A physical quantity having both magnitude and direction is a vector and if has only magnitude it is a scalar. Categories the following physical quantities into scalars and vectors.

a) Force

b) Angular momentum

c) Time

d) Work

[Imp 2011]

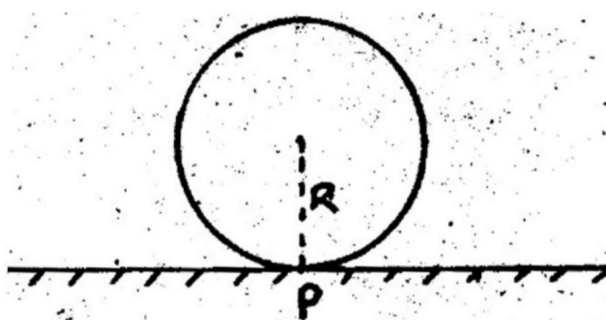
30. Motion along a plane is called two-dimensional motion. A body moving in two dimensions is found to have acceleration in one dimension.

[March 2011]

a) Identify the motion.

b) A ball thrown by a player reaches another player in 2s. What is the maximum height attained by the ball above the point of projection? (Take $g = 10\text{ms}^{-2}$).

c) In the figure, the point 'P' on a wheel of radius 'R' is in contact with the ground. What is the displacement of the point, when the wheel rolls a half revolution?



31. A stone is thrown up with the velocity u which makes an angle θ with the horizontal.

- a) What are the magnitudes of the vertical and horizontal components of velocity?
- b) How do these components change with time?

c) After 't' seconds what will be the magnitude and direction of the resultant velocity? **[Imp 2010]**

32. Ramesh observes the motion of an insect in a circle. He finds that it travels 6 revolutions in an anticlockwise direction for a time of 31.4sec.

a) Find the angular velocity of the insect.

b) If the insect travels 4 revolutions in the clockwise direction for a time of 8.6sec, what will be the angular speed averaged over the total time?

c) Obtain the expression for centripetal acceleration (a_c) in terms of angular speed (ω). **[March 2010]**

33. Imagine yourself in a rain steadily falling vertically with a speed of 2ms^{-1} .

a) If you start moving with 1ms^{-1} due east, in which direction should you hold the umbrella to protect yourself from the rain?

b) On a sunny day at 12 noon, you hold the umbrella vertically. If you run at certain speed, do you need to incline the umbrella? Justify your answer. **[March 2010]**

34. a) A body, moving along a circle has uniform speed but the velocity is varying. This is because of the centripetal acceleration of the body. From the relationship between linear and angular velocities, find the relationship between linear and angular accelerations.

b) Find the angular velocities of the minute and second hands of a clock.

c) A ball trapped in a circular path of radius 10 cm moves steadily and completes 10 revolutions in 100 seconds. What is the angular velocity and what is the linear velocity of its motion? Is the acceleration vector is a constant vector? **[Imp 2009]**

35. a boy throws a cricket ball with a velocity 'u' at an angle ' θ ' with the horizontal.

a) What is the path followed by the ball?

b) At the highest point, what are the vertical and horizontal components of velocity?

c) Derive the expressions for 'time of flight' and 'horizontal range' of the ball. **[March 2009]**

36. A and B are two non-zero vectors.

a) If $(\vec{A} \times \vec{B}) = \vec{A} \cdot \vec{B}$, what is the angle between \vec{A} and \vec{B} ?

b) Find the value of $\vec{A} \cdot (\vec{A} \times \vec{B})$

c) The parallelogram law is used to find the resultant of two vectors. Find the magnitude of the resultant of these two vectors in terms of their magnitudes and the angle between them. **[March 2009]**

CHAPTER 5 - LAWS OF MOTION



1. The static friction comes into play at the moment the force is applied.

(a) Write the relation between static friction and normal reaction.

(b) Determine the maximum acceleration of the train in which a box lying on its floor will remain stationary, given that the coefficient of static friction between the box and the train's floor is 0.15.

(c) State the laws of limiting friction.

(1+2+2) [Imp 2019]

2. A large force acting for a short interval of time is called impulsive force.

(a) What is the SI unit of impulse?

(b) Two billiard balls each of mass 0.05 kg moving in opposite direction with speed 6 m/s collide and rebound with the same speed. What is the impulse imparted to each ball due to the other?

(1+2) [Imp 2019]

3. A light bullet is fired from a heavy gun.

a) Choose the correct

- i. Speed of the gun and the bullet are equal.
- ii. Momenta of the bullet and gun are equal in magnitude and opposite in direction.
- iii. Momenta of the gun and bullet are equal in magnitude and are in the same direction.
- iv. Velocity of gun and bullet are equal.

b) By using a suitable conservation law in physics, prove your above answer.

(1+2) [March 2019]

4. Static friction opposes impending motion.

a) Write the mathematical equation connecting the limiting value of static friction with normal reaction.

b) Choose the correct statement

- i) Both kinetic friction and static friction are independent of the area of contact.
- ii) Kinetic friction depends on area of contact, but static friction do not.
- iii) Static friction depends on area of contact but kinetic friction do not.
- iv) Both kinetic friction and static friction depend of the area of contact.

c) A mass rests on a horizontal plane. The plane is gradually inclined until at an angle θ with the horizontal, the mass just begins to slide. Show that the coefficient of static friction between the block and the surface is equal to $\tan \theta$.

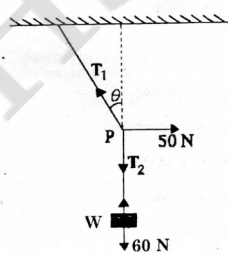
(1+1+3) [March 2019]

5. The rate of change of total momentum of a system of many-particle systems is proportional to the on the system.

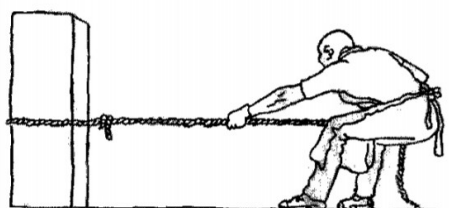
- i. external force
- ii. a sum of the internal forces

(1) [Imp 2018]

6. A car and a truck have the same kinetic energies at a certain instant while they are moving along two parallel roads. (1+2) [Imp 2018]
- a. Which one will have greater momentum?
- b. If the mass of truck is 100 times greater than that of the car, find the ratio of loci of the truck to that of the car.
7. A man jumping out of a slow moving bus falls forward.
- a. This is due to.....
- b. Which Newton's law gives the above concept? State the law.
- c. What is the net force acting on a book at rest on the table? (1+2+1) [Imp 2018]
8. To reduce friction and accident by skidding the roads are banked at curves. (1+1+2) [Imp 2018]
- a. What is meant by banking of roads?
- b. Sketch the schematic diagram of a vehicle on a banked road with friction and mark the various forces.
- c. Derive an expression for the maximum safe speed of a vehicle on a banked road with friction.
9. A gun moves backward when a shot is fired from it.
- a. Choose the correct statement.
- i. The momentum of the gun is greater than that of the shot.
- ii. The momentum acquired by the gun and shot have the same magnitude.
- iii. Gun and shot acquire the same amount of kinetic energy.
- b. A shell of mass 0.020 kg is fired by a gun of mass 100 kg. If the muzzle speed of the shell is 80 m/s, what is the recoil speed of the gun? (1+2) [March 2018]
10. a. What is the condition for the equilibrium of concurrent forces?
- b. A mass of 6 kg is suspended by a rope of length 2m from the ceiling. A force of 50 N in the horizontal direction is applied at the midpoint P of the rope, as shown. What is the angle, the rope makes with the vertical in equilibrium? (Take $g=10 \text{ ms}^{-2}$). Neglect the mass of the rope.



- c. What will be the angle made by the rope with the vertical if its length is doubled? (1+3+1) [March 2018]
11. A man pulls a rope of negligible mass attached to a block. The man wears shoes that does not slip on the floor. The block moves towards the stationary man.



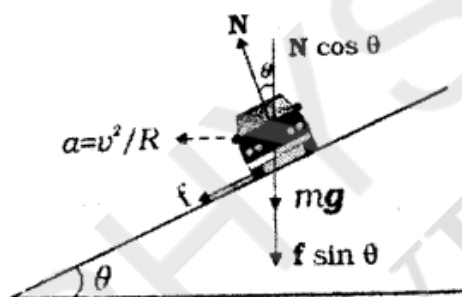
a) The law which relates the forces that two different bodies exert on each other is.....

- i) Newton's first law
- ii) Newton's second law
- iii) Newton's third law
- iv) Newton's law of cooling

b) 'The man remains stationary'. Substantiate the statement based on the various forces acting on the man.

c) Explain, how the block moves even if the net force on the moving block is zero, though a net nonzero force is initially required. (1+2+3) [Imp 2017]

12. The schematic diagram of the circular motion of a car on a banked road is shown in the figure.



a. If the centripetal force is provided by the horizontal components of 'N' and 'F' arrive at an expression for maximum safe speed.

b. The optimum speed of a car on a banked road to avoid wear and tear on its tyres is given by

- i. $\sqrt{Rg \tan \theta}$ ii. $\sqrt{Rg \cot \theta}$ iii. $\sqrt{Rg \sin \theta}$ iv. $\sqrt{Rg \cos \theta}$ (4+1) [March 2017]

13. A person drives a car along a circular track on a level ground.

a) Derive an expression for the maximum safe speed of the car. (2)

b) Why do we give banking to curved roads? (1) [Imp 2016]

14. When a horse suddenly starts moving, the rider falls backward. [March 2016]

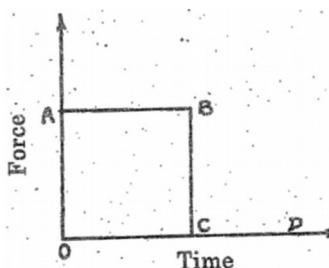
a) Name and state the law used to explain the above situation. (2)

b) State the law of conservation of linear momentum and prove it on the basis of second law of motion. (2)

c) State true or false.

An iron ball and a wooden ball of the same radius are released from a height in vacuum; the iron ball will reach the ground first. (1)

15. The given graph ABCD shows variation of force with time for a body placed on a smooth horizontal surface.



- a) Using the given graph, state whether the following statements are true or false.
- i) The force acting on a body along AB is constant.
 - ii) The force acting on a body along CD is zero. (2)
- b) i) State the law of conservation of linear momentum.
- ii) Find the region on the graph at which the body moves with constant momentum. (2)
- iii) Draw a momentum time graph for the given graph. (1) [Imp 2015]
15. a) State the following statements are True or False. Correct the statements if false. (2)
- i. A spring balance gives the mass of a body while a common balance gives its weight.
 - ii. If the same force is applied on two bodies of different masses for the same time, then the change in momentum of two bodies is the same.
- b) State Newton's second law and arrive at the equation of force. (2)
- c) A motorcycle and a bus are moving with same momentum. Which of them has greater kinetic energy? Justify. (1) [March 2015]
16. Newton formulated the famous laws of motion.
- a) Give the significance of Newton's first law.
- b) Action and reaction are equal and opposite, yet they do not cancel each other. Why? (1 + 1) [Imp 2014]
17. Friction is defined as the force which opposes the relative motion between two surfaces in contact. (2+ 1+ 3)
- a) Friction is a necessary evil. Explain.
- b) What is meant by banking of roads?
- c) Obtain an expression for maximum speed on a banked road without considering friction. [Imp 2014]
18. We are familiar with Newton's laws of motion.
- a) State Newton's second law of motion. (1)
- b) Using the above law, explain:
- i. Impulse – momentum principle
 - ii. Law of conservation of linear momentum (1)
- c) A circular racetrack of radius 300 m is banked at an angle of 15° . The coefficient of friction between the wheels of a race car and the road is 0.2. Find:
- i. The optimum speed of the race car to avoid wear and tear on its tyres. (1)
 - ii. Maximum permissible speed to avoid slipping. (2) [March 2014]
19. A circular track of radius 400m is kept with outer edge raised to make 5 degrees with the horizontal.
- a) What do you call this type of construction of tracks?
- b) Obtain an expression for the maximum permissible speed considering the force of friction.

c) Calculate the permissible speed of the car if the coefficient of friction is 0.2.

(1+3+2) [Imp 2013]

20. Match the following.

[March 2013]

Sl No	A	B
1	Newton's first law	Change in momentum
2	Conservation of linear momentum	Action ↔ reaction
3	Newton's third law	Law of inertia
4	Impulse	Momentum before collision = Momentum after collision

21A) According to Newton's law of motion, the force depends on the rate of change of momentum.

a) Name the law that helps to measure force.

b) Using the above law, deduce an expression for force.

c) A man jumping out of a moving bus falls with his head forward. What should he do in order to land safely.

OR

21B) The outer side of a circular track of radius 200 m is raised to make an angle of 15° with the horizontal.

a) Which force provides the necessary centripetal force for a car taking the circular track?

b) Name the process by which the outer side of a curved track is raised a little above the inner side.

c) Using the data provided in this case, determine the maximum permissible speed to avoid skidding (given $\mu_s = 0.25$).

[March 2013]

22. Write the reason for the following:

a) Action and reaction are equal and opposite. Yet they do not cancel each other.

b) A cricketer moves his hands backwards while holding a catch.

[Imp 2012]

23. According to Newton's law of motion, the force depends on the rate of change of momentum.

a) State whether the force is external or internal? Justify your answer.

b) What happens to the linear momentum when the force is absent?

c) The motion of a particle of mass m is described by $y = ut + \frac{1}{2}gt^2$. find the force acting on the particle.

d) Why is it more difficult to rotate a stone by tying it to a longer string than a shorter string? [March 2012]

24. A thief jumps from the top of a house with a box of weight 25kg.wt. on his head. What will be the weight of the box experienced by the thief during his downward fall? Justify your answer. [Imp 2011]

25. When a shot is fired from a gun, the gun is moved in the backward direction.

a) State the principle behind it.

b) Prove the principle using Newton's second law of motion.

(1+ 2) [Imp 2011]

26. Friction is a force acting between two surfaces in contact; when there is a relative motion between them. Consider a car moving over a horizontal road. What will be the direction of frictional force acting between the road and tyre? **(1) [Imp 2011]**

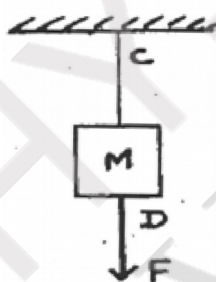
27. A stone breaks the window glass into pieces while a bullet almost pierces through the same. Give reason. **(1) [Imp 2011]**

28. Banking of road helps to increase the centripetal force and there by increases the limit of maximum speed of a vehicle with it can take the curve. **(1+ 1) [Imp 2011]**

a) Sketch the schematic diagram of a vehicle on a banked road and mark the various forces acting on it.

b) Give the expression for the maximum allowed speed of a vehicle on a banked road with friction.

29. A block of mass 'M' is suspended by a light cord 'C' from the ceiling and another strong cord 'D' is attached to the bottom of the block as shown.



The cord 'D' is pulled by a force 'F'. Which of these cords will break, if

a) The force is increased steadily?

b) The force is increased suddenly? **[March 2011]**

30. Raising the outer edge of a curved road a little above the inner edge is called banking of curves.

a) Derive an expression for the safe speed with which a car can negotiate a banked road by taking into account the friction between the tyres and the road.

b) A machine gun fires bullets of mass 40 g each with a speed of 1200 ms^{-1} . The person can hold the gun with a maximum force of 144 N. What is the maximum number of bullets that can be fired per second from the gun? **[March 2011]**

31. A man is standing at the centre of a large flat slab of ice. He can get himself to the edge of the slab by spitting or blowing air in the forward direction (assuming the ice to be frictionless)

a) Name the principle/law involved in this.

b) A horse cannot pull a cart and run in empty space. Why?

c) With the help of a free body diagram represent the various forces acting on a vehicle moving on a banked road. Neglecting frictional force obtain the expression for the maximum safe speed of the vehicle on the banked road. **[Imp 2010]**

32. A passenger of mass 30 kg is standing in a lift which is moving vertically downwards with an acceleration of 1.8 m/s^2

a) Will the passenger experience decrease or an increase in his weight. Explain?

b) What will be the effect if the cable is cut and the lift falls freely? **[March 2010]**

33. There are different types of forces in nature. We learnt their effects and applications. Give the exact reasons for the following.

a) Why can't a horse pull a cart in empty space?

b) Why are passengers thrown forward when a speeding bus stops suddenly? **[March 2010]**

34. A child is sitting inside a lift in a multi- storeyed building.

a) What will happen to the weight of the child if?

i. The lift moves up with a constant speed?

ii. The lift moves up with a constant acceleration?

b) Write down expressions for the apparent weight felt by the child when the lift is:

i. ascending.

ii. Descending with a uniform acceleration.

c) If the child weighs 20kg and if the lift is moving down with a uniform acceleration of 5ms^{-2} , what will be the apparent weight of the child? ($g = 10\text{ms}^{-2}$). **[March 2009]**

CHAPTER 6 - WORK, ENERGY AND POWER

1. Several games such as billiards, marbles or czurom involve collision.

(a) What is meant by completely inelastic collision?

(b) Show that in a perfectly elastic collision in one dimension, the relative velocity after collision is numerically equal to relative velocity before collision **(1+3) [Imp 2019]**

2. A light body and a heavy body have equal kinetic energies, which one has greater momentum?**(1)[Imp 2019]**

3. Power is the rate at which work is done.

a) Express power in terms of force and velocity.

b) An elevator carrying the maximum load of 1800 kg is moving up with a constant speed of 2 ms⁻¹. The frictional force opposing the motion is 4000 N. Determine the minimum power delivered by the motor to the elevator.

c) Express your above answer in horse power? **(1+2+1) [March 2019]**

4. Write any two properties of conservative force **(1) [March 2019]**

5. Select the CORRECT alternative.

a. When a conservative force does positive work on a body, the potential energy of the body

1.increases

2.decreases

3.remain unaltered

b. Work was done by a body against friction always results in a loss of it's.....

1. kinetic energy
2. potential energy

c. The quantity which is conserved in an in an elastic collision of two bodies is

1. total kinetic energy
2. total linear momentum

(1+1+1) [Imp 2018]

6. Write the work done in each of the following cases as zero, positive or negative.

- a. Work was done by centripetal force in circular motion.
- b. Work was done by friction.
- c. Work was done by the gravitational force on a freely falling object.
- d. Work was done by the applied force in lifting an object

(2) [March 2018]

7. The total mechanical energy of the system is conserved, if the forces doing work on it are conservative.

a) Derive a mathematical expression to explain work-energy theorem.

b) A particle of mass 4 m kg which is at rest explodes into three fragments. Two of the fragments each of mass m kg are found to move in mutually perpendicular directions with speed v m/s each. Find the energy released in the process of explosion.

(2+3) [Imp 2017]

8. Energy of a body is defined as its capacity of doing work".

a. The energy possessed by a body by virtue of motion is known as

b. A body of mass 5 kg initially at rest is subjected to a horizontal force of 20 N. What is the kinetic energy acquired by the body at the end of 10 s?

c. State whether the following statement is TRUE or FALSE. "The change in kinetic energy of a particle is equal to the work done on it by the net force".

(1+3+1) [March 2017]

9. a) State the work energy theorem.

(1)

b) Show that the potential energy of a body is completely converted into kinetic energy during its free fall under the gravity.

(2)

c) A man carefully brings down a glass sheet from a height 2 m to the ground. The work done by him is

- (i) negative
- (ii) zero
- (iii) positive
- (iv) unpredictable

(1) [Imp 2016]

10. Force is required to lift a body from the ground to a height h and work is measured as the product of force and magnitude of displacement.

a) Name the energy possessed by the body at maximum height. Write an equation for it.

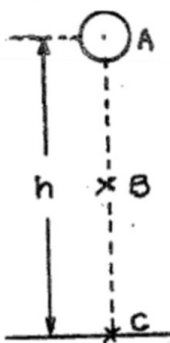
(2)

b) A man of mass 60 kg carries a stone of mass 20 kg to the top of a multi-storeyed building of height 50m.

Calculate the total energy spent by him? (9.8m/s^2)

(2) [March 2016]

11. The figure shows a body of mass m placed at a height h . A, B and C are the three points on the trajectory of this body.



a) Which is the type of energy possessed by this body at a height h ?

(1)

b) Prove that total mechanical energy is conserved at B and C.

(2)

c) A body of mass 5kg is thrown vertically up with a kinetic energy of 490 J. Find the height at which the kinetic energy of the body becomes half of the original value.

(2) [Imp 2015]

12A. The scalar product of force and displacement gives work. It can be negative, zero or positive.

a) The work done in sliding a load is with respect to frictional force.

(zero, positive, negative, infinity)

(1)

b) State and prove the work energy theorem for constant force.

(2)

c) A pump on the ground floor of a building can pump water to fill a tank of volume 30 m^3 in 15 minutes. If the tank is 40 m above the ground and the efficiency of the pump is 30%, how much electric power is consumed by the pump?

(2)

OR

12B. Several such as billiards, marbles, or caroms involve collisions.

a) When two object collide, after collision they could move together, the collision is.....

(1)

(elastic, completely elastic, inelastic, completely inelastic)

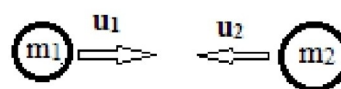
b) Show that in a perfectly elastic collision in one dimension, relative velocity after collision is equal to relative velocity before collision.

(2)

c) A ball at rest is dropped from a height of 12 m. It loses 25% of its kinetic energy on striking the ground. Find the height at which it bounces.

(2) [March 2015]

13. Below figure represents two point masses, m_1 and m_2 approaching each other with speeds u_1 and u_2 . Let them undergo one-dimensional collision and retrieve each other with velocities v_1 and v_2 .



Show that $(u_1 - u_2) = -(v_1 - v_2)$.

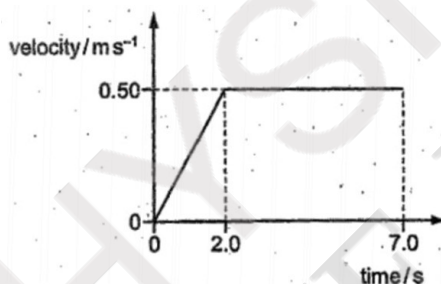
i.e. before and after collision, their relative velocities are equal.

(3) [Imp-2014]

14. From the table given below:

Force(N)	2	4	6	8	10
Displacement(M)	1	2	3	4	5

- Draw the force –displacement graph.
- How can you find the work done from the above graph?
- Suggest any two situations in which the work done by a force is zero.
- A ball is pushed with a force of 3N for 2s along a frictionless track. The graph shows the force on the body against time.



How much work is done by the force?

(1+ 1+ 1+ 2) [March 2014]

15. A car is moving with a constant speed on straight line

- What is the network done by the external force on the car?
- State work energy theorem.
- A bullet of mass 10g and velocity 800 m/s is passed through a mud wall of thickness 1 m. Its velocity reduces to 100m/s. Find the average resistance offered by the mud wall.

(1+2+3) [Imp 2013]

16. Fill in the blanks.

[March 2013]

a)	.....	$\rightarrow \rightarrow$ F . S	Scalar quantity
b)	Mass, m	Momentum, m	KE=.....
c)	..... collision	Momentum conserved	Energy conserved
d)	Unit of power	.....	746watt
e)	Body of mass, m	At a height, h	PE=.....
f)	Power, p	P=.....	Scalar product

17. a) State and explain the work done in the following situations:

- A person carrying a heavy load walks on a level road.
- A man spending his energy by pushing on a concrete wall.

b) A constant force of 200 N displaces a body through 5m in the direction of the force. Find the work done on the body.

[March 2013]

18. a) State and prove that the law of conservation of energy for a freely falling body.

b) Draw graphically the variation of kinetic energy and potential energy with the height of the body in the above case. **[Imp 2012]**

19. Fill in the blanks:

[March 2012]

a) water stored in a dam	Potential energy	.....
b)	Kinetic energy	$E = \frac{1}{2}mv^2$
c) Mass=10kg	Acceleration	Force=10N
d) Lift falls freely	a=g	R=.....

20. Work is required to lift a body through a height from the ground.

a) Calculate the work done in lifting a body of mass 10 kg to a height of 10 m above the ground.

b) State and prove the law of conservation of energy of a freely falling body.

c) Draw the variation of KE and PE with the height of the body.

[March 2012]

21. A force is required to do work. The work done by a force is the product of displacement and the component of force in the direction of displacement. Prove this statement.

[Imp 2011]

22. Consider a body falling freely through the atmosphere. Neglecting the air resistance prove that the total mechanical energy of the body remains constant throughout the fall.

[Imp 2011]

23. Ramesh lifts a body of mass 'm' to a height 'h' near the surface of the earth in a time 't'.

a) Draw the force-displacement graph.

b) If 'A' is the area of the graph, what quantity does $\frac{A}{t}$ indicate?

[March 2011]

24. According to the work-energy theorem, work done by a force on a body is equal to change in its kinetic energy.

[March 2011]

a) A lorry and a car moving with a same kinetic energy are stopped by applying breaks which provides the same retardation. Which of them will come to a rest in a shorter distance? Explain.

b) If the kinetic energy of a body is doubled, what is the percentage change in its linear momentum?

25. A ball moves along a circle under the influence of centripetal force.

a) What is the work done by the centripetal force on the ball?

b) An arrow shot from a bow has kinetic energy. How does it get this kinetic energy?

c) Show that the total mechanical energy of a freely falling body is conserved.

[Imp 2010]

26. Collision between two particles need not be the physical contact of two particles as in the case of scattering of the α -particle by a nucleus.

- a) What is the quantity that remains conserved in all types of collisions?
- b) Suppose an electron and a proton are projected with equal kinetic energy, what will be the ratio of their linear momentums if the proton is 1830 times heavier than an electron?
- c) The bob of a pendulum released from 300 to the vertical hits on another bob of equal mass at rest. How high does the first bob rise after the collision? (Assume that the collision is elastic and the sizes of the bobs are negligible.)

[March 2010]

27. Work is related to force and displacement over which it acts.

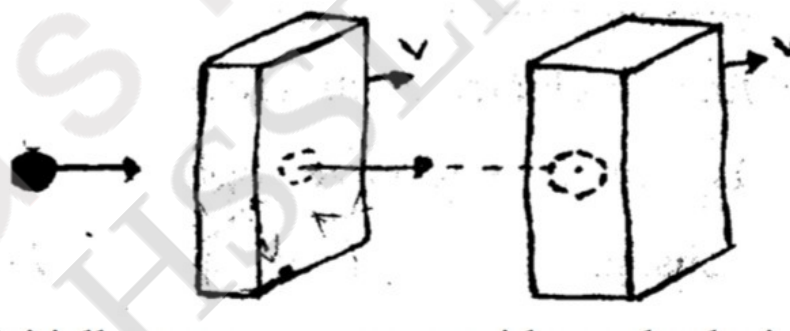
- a) A man tries to pull a rigid wall for a long time but fails to displace it. What is the external work done by him?
- b) Suggest two conditions for the work done by a force to be zero.
- c) A body of mass 1 kg travels in a 3 straight line with a velocity $v = k x^{\frac{3}{2}}$ where $k = 5$ SI units. Calculate the work done by the net force to displace from $x = 0$ to $x = 2$ m.

[March 2010]

28. a) State work-energy theorem.

b) Prove work-energy principle for a particle moving with a constant acceleration along a straight line.

c) A bullet of mass 20g pierces through a plate of mass 1 kilogram and then comes to rest inside a second plate of mass 2.98 kilograms as in figure. It is found that the two plates,



Initially at rest, now move with equal velocity. Find the percentage loss of the initial velocity of the bullet when it is between the plates.

[Imp 2009]

29. Work is required to be done to lift a body from the ground. Let the body be dropped from the height 'h'.

- a) State the work-energy theorem.
- b) Draw graphically, the variation of K.E and P.E. with the height of the body. Where do you find:
 - i) The maximum P.E. ?
 - ii) The maximum K.E.?
- c) State and prove the law of conservation of energy in this case.

[March 2009]

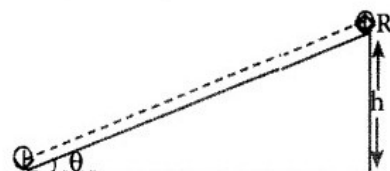
CHAPTER 7

SYSTEM OF PARTICLES AND ROTATIONAL MOTION

1. The rotational analogue of mass is called..... (1) [Imp 2019]
2. The moment of inertia of a thin rod of mass M and length l about an axis perpendicular to the rod at its midpoint is $\frac{Ml^2}{12}$. Find the moment of inertia of the rod about an axis perpendicular to it and passing through one end of the rod. (2) [Imp 2019]
3. A solid cylinder of mass 20 kg rotates about its axis with angular speed 100 rad. s^{-1} . The radius of the cylinder is 0.25 m. What is the kinetic energy associated with the rotation of the cylinder? What is the magnitude of angular momentum of the cylinder about its axis? (3) [Imp 2019]
4. Starting from rest, a solid sphere rolls down an inclined plane of vertical height h without slipping.
 - a) If M is the mass and R is the radius of the sphere, write an equation for the moment of inertia of the above sphere about a diameter.
 - b) Prove that the velocity with which the sphere reaches the bottom of the plane is $1.2 \sqrt{gh}$
 - c) If instead of sphere another object of the same mass and radius with a different shape is used in the above experiment, will it reach the bottom with the same or different velocity? (1+2+1) [March 2019]
5. Match the following (2) [March 2019]

A		B	
a)	Torque ($\vec{\tau}$) ടോർക്ക് ($\vec{\tau}$)	i)	Perpendicular to \vec{r} and \vec{P} \vec{r} ന്നും \vec{P} യ്ക്കും ലംബമായിരിക്കും.
b)	Angular Momentum (\vec{L}) കോണീയ ആക്കം (\vec{L})	ii)	$\sum \vec{F} = 0$
c)	Rotational equilibrium പരിക്രമണ സന്തുലിതാവസ്ഥ	iii)	$\vec{\omega} \times \vec{r}$
d)	Linear velocity (\vec{v}) രേഖീയ പ്രവേഗം (\vec{v})	iv)	$\vec{r} \times \vec{F}$
		v)	$\sum \vec{\tau} = 0$

6. A solid sphere of mass m and radius, R starts from rest and rolls down along an inclined plane of height h without slipping as shown below. (2+1) [Imp 2018]
 - a. Calculate the kinetic energy of the sphere when it reaches the ground.
 - b. Find the velocity when it reaches the base.



7. A girl rotates on a swivel chair as shown below.



- a. What happens to her angular speed when she stretches her arms?
b. Name and state the conservation law applied for your justification. (1+2) [Imp 2018]

8. State the theorem of parallel axes on a moment of inertia (1) [March 2018]

9. a. Write the equation connecting torque with force.

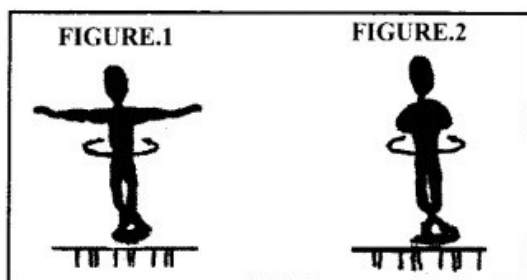
b. A meter stick is balanced at its centre (50 cm). When two coins, each of mass 5 g, are put one on the top of the other at the 12 cm mark, it is found to be balanced at 45 cm. What is the mass of the stick?

c. Derive the relation connecting torque with angular momentum. (1+2+2) [March 2018]

10. A ring of mass M and radius R rolls over a horizontal surface.

- a) Find the moment of inertia of the ring about its diameter.
b) In the case of this ring, show that both the translational and rotational kinetic energy have the same value.
c) In translatory motion, angular momentum.....
i) is always zero
ii) is always greater than one
iii) may be present
iv) is always infinite (2+2+1) [Imp 2017]

11. The demonstration of conservation of angular momentum is schematically shown in the figures.



Identify the figure which has more angular velocity.

(1) [March 2017]

12. The angular momentum of a particle is the rotational analogue of its linear momentum.

a. The equation connecting angular momentum and linear momentum are

i. $\vec{l} = \vec{p} \times \vec{r}$

ii. $\vec{l} = \vec{r} \times \vec{p}$

iii. $\vec{l} = \vec{r} \cdot \vec{p}$

iv. $\vec{l} = \frac{1}{2} \vec{r} \times \vec{p}$

b. Starting from the equation connecting angular momentum and linear momentum, deduce the relation between torque and angular momentum. (1+4)

OR

Moment of inertia in rotational motion is analogous to mass in linear motion.

a. The moment of inertia of a circular disc about an axis perpendicular to the plane, at the center is given by

i. $\frac{MR^2}{4}$

ii. $\frac{MR^2}{6}$

iii. $\frac{3MR^2}{2}$

iv. $\frac{MR^2}{2}$

b. State perpendicular axis theorem and by using the theorem, deduce the moment of inertia of the circular disc about an axis passing through the diameter. (1+4) [March 2017]

13A. a) Classical dancers bring their hands closer to their body to rotate faster. Name the principle employed by them. (1)

b) A wheel rolls along a straight line. Derive an expression for its total kinetic energy. (3)

c) The rotational analogue of force is (1)

OR

13B. Moment of inertia about a diameter of a ring is $I_0 = \frac{MR^2}{2}$

a) Name the theorem that helps to find the moment of inertia about a tangent parallel to the diameter. (1)

b) Draw a diagram and find the moment of inertia about a tangent, parallel to the diameter of the ring. (3)

c) The rotational analogue of mass is (1) [Imp 2016]

14. The rotational analogue of force is moment of force, also called torque.

a) The turning effect of force is maximum when the angle between \vec{r} and \vec{F} is..... (1)

b) A wheel starting from rest acquires an angular velocity of 10 rad/s in two seconds. The moment of inertia of the wheel is 0.4 kg m^2 . Calculate the torque acting on it. (3)

c) The possibility of falling backward with the ladder is more when you are high up on the ladder than when you just begin to climb. Explain why. (1) [March 2016]

15A. a) State perpendicular axis theorem. Use this theorem to find the moment of inertia of a ring about its diameter. (4)

b) Two identical concentric rings each of mass M and radius R are placed perpendicular to each other. What is the moment of inertia about an axis passing through the centre of mass of this system? (1)

i) $\frac{3}{2} MR^2$

ii) $2 MR^2$

iii) $3 MR^2$

iv) $\frac{1}{4} MR^2$

OR

15B. a) Derive the mathematical relation between angular momentum and torque. State the law of conservation of angular momentum. (4)

b) A solid sphere is rotating about a diameter at an angular velocity ω . If it cools so that the radius reduces to $1/n$ of its original value, its angular velocity becomes..... (1) [Imp 2015]

i) ω/n

ii) ω/n^2

iii) $n\omega$

iv) $n^2\omega$

16. Moment of inertia is the rotational analogue of mass in linear dynamics. Write the equation of the moment of inertia of a disc about an axis passing through its centre and perpendicular to its plane. (1)

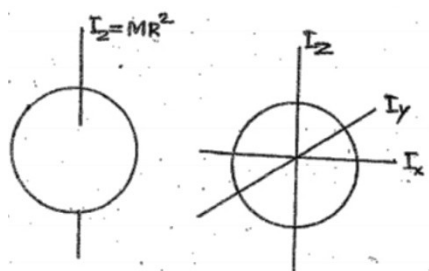
a) State the parallel axis theorem of moment of inertia. (1)

b) A coin is rolling on a plane surface. What fraction of its total kinetic energy is rotational? (2) [March 2015]

17. Moments of inertia of a ring about an axis passing through the centre is MR^2 . The moment of inertia about a diameter can be found using the perpendicular axis theorem.

a) State the perpendicular axis theorem.

b) Obtain the expression for the moment of inertia of a ring about its diameter. (1+ 2) [Imp 2014]



18. Moment of inertia is the analogue of mass in rotational motion. But unlike mass; it is not a fixed quantity.

a) Moment of inertia can be regarded as a measure of rotational inertia. Why?

b) Write any two factors on which the moment of inertia of a rigid body depends.

c) The moments of inertia of two rotating bodies A and B are I_A and I_B ($I_A > I_B$) and their angular momentum are equal. Which one has a greater kinetic energy? Explain. **(1+2+2) [March 2014]**

19. A thin circular ring is rotating about an axis.

a) State the theorem which will help you to find the moment of inertia about its diameter.

b) Using this theorem, find the moment of inertia of the ring about its diameter.

c) A rolls down the inclined plane without slipping. Find the velocity of the ring when it reaches the ground. **(1+2+2) [Imp 2013]**

20. In an experiment with a bicycle rim, keeping the ring in the vertical position with both the strings in one hand, put the wheel in fast rotation (see fig). When string B is released, the rim keeps rotating in a vertical plane and the plane of rotation turns around the string A. **[March 2013]**



a) Mention the law that explains the above result.

b) Explain the practical example (shown in the fig) based on the law mentioned in (a)



c) How will you distinguish a hard-boiled egg and a raw egg by spinning each on a table top?

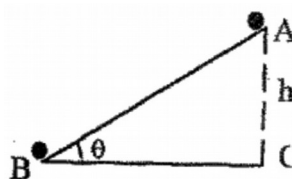
d) A solid cylinder of mass 20kg rotates about its axis with an angular speed of 100 rad s^{-1} . The radius of the cylinder is 0.25m. What is the magnitude of angular momentum of the cylinder about its axis?

21. A solid sphere of mass 'm' and radius 'r' starts from rest and rolls down along an inclined plane as shown.

a) Write an expression for the moment of inertia of the sphere about its axis passing through the centre.

b) Why moment of inertia is also called as rotational inertia?

c) Find the velocity when it reaches the ground.



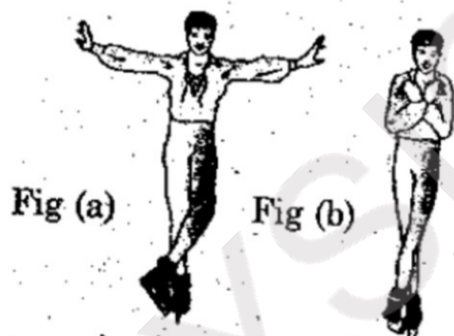
[Imp 2012]

22. Rotational inertia is the tendency of a rotating body to resist any change in its state of rotational motion.

a) What you mean by the radius of gyration of a rolling body?

b) Show that the disc has the moment of inertia $I = \frac{MR^2}{2}$ about an axis perpendicular to the disc at its centre.

c) The figure shows two different spinning poses of a ballet dancer.



In which spinning pose does the ballet dancer have less angular velocity? Justify your answer. [March 2012]

23. Moment of inertia plays the same roll in rotational motion as mass in linear motion. The moment of inertia of a body changes when the axis of rotation changes.

a) State the parallel axes theorem on moment of inertia.

b) Write the relation between moment of inertia and angular momentum.

c) If the moment of inertia of a disc about an axis passing through its centre and perpendicular to its plane is $\frac{MR^2}{2}$ (M is the mass of the disc and R is radius). Determine its moment of inertia about a diameter and about a tangent. [Imp 2011]

24. a) A body rolls over a horizontal, smooth surface without slipping with a translational kinetic energy E.

Show that the kinetic energy of the body is $E = (1 + \frac{K^2}{R^2})$, where K is the radius of gyration and R is the radius of the body. Using the above relation, find the total kinetic energy of a circular disc.

b) A wheel of mass 1000 kg and radius 1 m is rotating at the rate of 420 r.p.m. What is the constant torque required to stop the wheel in 14 rotations, assuming the mass to be concentrated at the rim of the wheel?

[March 2011]

25. The moment of inertia of a uniform thin circular disc about a diametric axis of the disc is $\frac{MR^2}{4}$ where M is the mass and R is the radius of the disc.

a) There is a theorem which helps to find the moment of inertia of the disc about another axis parallel to this axis. Give the statement of this theorem.

b) Using the theorem find the moment of inertia of the disc about a tangential axis in the plane of the disc.

c) A circular disc of mass 0.15kg and radius 0.1 m makes 120 revolutions in one minute about its own axis. Calculate its angular momentum. **[Imp 2010]**

26A. In a hammer throw event, a solid sphere of mass 16 kg is tied to a light 50 cm long chain. A sportsman gives to it a constant moment of 30 N-m for 10 seconds and then throws the sphere. Consider the sphere as a point mass.

- a) Find the moment of inertia about the axis of rotation.
- b) If 'L' is the angular momentum and 'T' is the torque, show that $T = dL/dt$.
- c) Write an example for the motion in which an angular momentum remains constant.

OR

26B. Remya stands at the centre of a turn- table with her two arms outstretched. The table with an angular speed of 40 revolutions / minute.

- a) What will happen to the moment of inertia if she folds her hands back?
- b) If the angular speed is increased to 100 revolutions / minute, what will be the new moment of inertia?
- c) Write the expression for the rotational kinetic energy of the system and explain the terms involved in it.

[March 2010]

27A. a) Moment of inertia of a particle is a measure of its rotational inertia. The moment of inertia of a system will be the sum of the moment of inertia of the components translated to the particular axis mentioned. Find the moment of inertia of a thin meter scale about a perpendicular axis through the centre. Take M as the mass of the scale.

b) Find the moment of inertia of a thin circular disc of mass m and radius R about one of its diameters.

c) If a student fixes two such discs at the ends of the meter scale and rotates the system about an axis perpendicular to the length of the scale as in figure. What will be the Moment of inertia of the system?



OR

27B. a) Explain the term radius of gyration of a body.

b) If the acceleration of a rolling body through an inclined plane is given by $a = \left(\frac{g \sin \theta}{1 + K^2/R^2} \right)$, find the acceleration of a sphere of mass M and radius R. K is the radius gyration.

c) Using the above equation find the acceleration of a disc of radius R and mass M. If a student allows the sphere and disc to roll down simultaneously, which will reach down first? Give the reason. **[Imp 2009]**

28. A solid sphere, a ring and a circular disc of identical radii are rolling down an inclined plane without slipping from the same height, starting from rest.

- a) Which will reach the bottom first?

- b) The moment of inertia of a disc about an axis passing through its centre and perpendicular to its plane is $\frac{MR^2}{2}$. Find its moment of inertia about an axis passing through its edge and parallel to its diameter.
- c) A ring of radius 2 m weighs 100 kg. It rolls along a horizontal floor so that its centre of mass has a speed of 20 cm s^{-1} . What is its total kinetic energy? **[March 2009]**

CHAPTER 8 - GRAVITATION

1. Derive an expression for the variation of g with height (h) above the surface of the earth. **(2) [Imp 2019]**
2. Kepler formulated three laws of planetary motion. **(1+2+1) [Imp 2019]**
 - (a) State the Kepler's law of periods?
 - (b) A Saturn year is 29.5 times the earth year. How far is the Saturn from the sun if the earth is 1.5×10^9 km away from the sun ?
 - (c) Of which conservation law is the Kepler's second law of planetary motion, a consequence
3. Earth satellites are objects which revolve around the earth. **(1+2+1) [March 2019]**
 - a) Time period of a geostationary satellite is.....
 - b) Derive an expression for the time period of a satellite.
 - c) By using the expression you derived above, show that motion of satellite obeys Kepler's law of periods.
4. Derive an expression for escape speed from a planet. **(2) [March 2019]**
5. Three objects with a mass of 40 kg each are placed in a straight line 50 cm apart. What is the net gravitational force at the centre object due to the other two? **(1) [Imp 2018]**
6. Satellites are objects which revolve around the earth. **(1+3+1) [Imp 2018]**
 - a. The direction of revolution of a geosynchronous satellite is from
 - i. east to west
 - ii. west to east
 - iii. north to south
 - iv. south to north
 - b. Derive an expression for a total energy of an orbiting satellite.
 - c. What is the magnitude of the angular velocity for a geosynchronous satellite?
7. If the zero of potential energy is at infinity, the total energy of an orbiting satellite is negative of its energy. **(1) [March 2018]**
8. Derive an expression for the escape velocity of an object from the surface of a planet. **(2) [March 2018]**
9. Acceleration due to gravity decreases with depth. **(2+1) [March 2018]**
 - a. Prove the above statement by deriving the proper equation.
 - b. Using the equation, show that acceleration due to gravity is maximum at the surface and zero at the centre of the earth.

10. The value of acceleration due to gravity (g) is same for all objects at a given place. Derive an equation for the acceleration due to gravity in terms of radius (R) and mass (M) of the earth. **(4) [Imp 2017]**

Arrive at mathematical expressions for variation of g below and above the surface of the earth.

OR

What is gravitational potential energy? Derive an expression for the gravitational potential energy and gravitational potential? **(4)**

11. The maximum value of gravitational potential is..... **(1) [Imp 2017]**

- a) one
- b) zero
- c) between one and zero
- d) infinite

12. a. The escape speed from the surface of the earth is given by

- i. $\sqrt{2gR_E}$
- ii. $\sqrt{gR_E}$
- iii. $\sqrt{3gR_E}$
- iv. $\sqrt{g^2 R_E}$

b. An artificial satellite circulating the earth is at a height 3400 km from the surface of the earth. If the radius of the earth is 6400 km and $g = 9.8 \text{ m/s}^2$, calculate the orbital velocity of the satellite **(1+3) [March 2017]**

13. a) State Kepler's second law of planetary motion. (Law of areas). **(1+2+2) [Imp 2016]**

b) Derive an equation for the orbital velocity of a satellite.

c) Escape the velocity of a planet is 20 Km/s. Find the orbital velocity of the smallest possible orbit.

14 A. The acceleration due to gravity may vary with altitude and depth.

a) Arrive at an expression for acceleration due to gravity at a height h . ($h \ll R_E$)

b) Why does satellite need no fuel to go around a planet in its fixed orbit?

c) Acceleration due to gravity is independent of (Mass of earth / mass of body) **(2+2 +1) [March 2016]**

OR

14 B. For a particle to overcome the gravitational pull of earth, it is projected with a minimum velocity.

a) Name the minimum velocity. **(1)**

b) Obtain an expression for the above minimum velocity. **(2)**

c) A ball bounces more on the surface of the moon than on the earth. Explain why. **(2) [March 2016]**

15. For a body to leave from earth's gravitational field, it should be projected with a minimum velocity.

a) i) Name the velocity

ii) Derive an expression for this velocity

b) The moon does not have an atmosphere around it. Give reason.

(1+2+2) [Imp 2015]

16. Out earth has several artificial satellites. But the moon is the only natural satellite.

a) If acceleration due to gravity at the surface of earth is 'g', arrive at the expression for acceleration due to gravity at a depth 'd'.

b) Distance to the moon from the earth is 3.84×10^8 m and the time period of the moon's revolution is 27.3 days. Obtain the mass of the earth. (Gravitational constant $G = 6.67 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$)

c) How do you explain weightlessness in an artificial satellite?

(2+2+1) [March 2015]

17. Match the following

(3) [Imp 2014]

a) Kepler's laws	i) Scalar
b) Gravitational constant	ii) Planetary motion
c) Velocity	iii) Inertia
d) Newton's first law of motion	iv) 9.8 ms^{-2}
e) Acceleration due to gravity	v) $[LT^{-1}]$
f) Distance	vi) $6.67 \times 10^{-11} \text{ Nm}^2 \text{ kg}^{-2}$

18. The velocity of a satellite in its orbit is called orbital velocity.

a) Find the relation between orbital velocity and escape velocity.

b) What is a geostationary satellite?

c) Moon has no atmosphere. Why?

(2+ 1+ 1) [Imp 2014]

19. Choose the correct alternative.

(1+1)

a) Escape velocity is independent of the mass of the earth / the mass of the body.

b) Gravitational force / weak nuclear force is the weakest fundamental force.

[March 2014]

20A. Earth satellites are objects which revolve around the earth. Consider a satellite at a height 'h' from the surface of the earth

a) Give an equation for its orbital velocity.

(1)

b) Obtain an equation for the period of the above satellite.

(2)

c) Distinguish between geo stationary satellites and polar satellites.

(1)

OR

20 B. The value of acceleration due to gravity is maximum on the surface of the earth.

- a) Write the relation between acceleration due to gravity and gravitational constant.
- b) Obtain an equation for the variation of 'g' with height
- c) Draw a graph showing the variation of 'g' with depth and height from the surface of the earth. Assume that the density of earth is constant. **(1+ 2+ 1) [March 2014]**

21 A. For a particle to leave from the earth's field, it should be projected with a minimum velocity. **(1+2+2+1)**

- a) Name the velocity.
- b) Obtain the expression for the above velocity.
- c) An elephant and an ant are to be projected from earth into space. Whether the velocities required for doing so are the same or different? Justify your answer.
- d) Find the period of a simple pendulum, if this experiment is performed inside a satellite?

OR

21 B. The acceleration due to gravity (g) on the surface of the earth is 9.8m/s^2

- a) Define acceleration due to gravity (g).
- b) Derive an expression for the variation of (g) with height (h) above the surface of the earth.
- c) At what height 'h' the value of 'g' will be half of that on the surface of the earth? **(1+3+2) [Imp 2013]**

22 A. The escape speed for an object from the earth is 11.2km/s .

- a) What is mean by escape speed?
- b) Arrive at an expression for the escape speed from the earth.
- c) Explain whether the escape speed depends on the mass of the object or not.
- d) The earth contains an atmosphere while the moon does not. Give the reason.

OR

22 B. The acceleration due to gravity (g) on the surface of the earth is 9.8m/s^2 .

- a) Define the acceleration due to gravity (g).
- b) Derive an expression for the variation of g at a depth 'd' below the surface of earth.
- c) At what height 'h' will the value of 'g' be half of that on the surface of the earth? **[March 2013]**

23. Match the following: **[Imp 2012]**

Fundamental force	Planetary motion
Newton's first law	Centripetal force
Strong force	Recoil of the gun
Kepler's law	Nuclear force
Circular motion	Inertia
Newton's third law	Gravitational force

24. Nowadays we are familiar with satellites.

a) Name any two satellites.

b) Differentiate escape velocity from orbital velocity.

c) For an earth satellite show that, $\text{Escape Velocity} = \sqrt{2} \times \text{Orbital Velocity}$.

[Imp 2012]

25. a) The value of acceleration due to gravity is maximum at the.....

i. Poles

ii. Equator

iii. Center of the earth

b) Find the height at which 'g' is reduced to $g/2$.

c) A rat and a horse are to be projected from earth into space. State whether the velocity is the same or different in projecting each animal. Justify.

[March 2012]

26. Imagine a point mass 'm' maintained at the centre of a shell of uniform density having mass 'M'. If the radius of the shell is R, what will be the gravitational force exerted by the shell on the point mass? Explain.

[Imp 2011]

27. The acceleration of a body due to the force exerted by earth on it is known as acceleration due to gravity.

a) Why does earth impart same acceleration on all bodies?

b) Show graphically the variation of strength with distance from the centre of the earth outwards.

(1+ 2) [Imp 2011]

28. A person in an artificial satellite of the earth experiences weightlessness. The moon is a natural satellite of the earth.

a) Can a person on the moon experience weight? Why?

b) A satellite is revolving very close to earth. What is the percentage increase in velocity needed to make it escape from the gravitational field of the earth?

c) Acceleration due to gravity 'g' depends on the distance 'r' from the center of the earth. Draw a graph showing the variation of 'g' with 'r'.

[March 2011]

29. The earth revolves around the sun in an elliptical orbit. The closest approach of the earth with the sun is called perihelion. When it approaches the perihelion, its speed increases. Explain this principle. [March -2011]

30. Weight of a body is the force of gravitational attraction experienced by it. It is equal to the product of mass of the body and acceleration due to gravity.

a) Obtain an expression for the acceleration due to gravity of a body in terms of the mass of the earth.

b) If you imagine the motion of a body from the centre of the earth to the surface of the moon, what change will you observe in the weight of the body during that motion? (Neglect the effect of all other objects).

[Imp 2010]

31. There are different types of forces in nature. We learnt their effects and applications. Give the exact reasons for the following.

a) Why does a satellite revolve around the earth in a circular path?

b) Why is it easy to lift a heavy stone in water?

[March 2010]

32 A. a) The minimum velocity with which a body is to be projected so that it never returns to earth is called the escape velocity. Arrive at an expression for escape velocity of earth.

b) Explain whether escape velocity depends on mass of the body or not.

c) Show how escape velocity and orbital velocity are related.

OR

32 B a) What will happen to acceleration due to gravity

i. If the earth stops rotating

ii. If the rotational speed is increased?

b) Keeping the mass of earth the same if the diameter is shrunk by 1%, what will be the percentage change in acceleration due to gravity on the surface.

c) If the radius of earth suddenly reduces to half its value, what will be its effect on the duration of the day?

[Imp 2009]

33. When we throw a stone into the air, it comes back to the earth. But when we increase the speed of the stone, it may escape from the gravitational attraction of the earth.

a) Explain the term escape velocity. What is its value on the surface of the earth?

b) The radius of the earth is reduced by 4 % of its initial value. The mass of the earth remains unchanged. What will be the percentage of change in the escape velocity?

c) Assuming that planets move in circular orbits, derive Kepler's third law on planetary motion. [March 2009]

CHAPTER 9

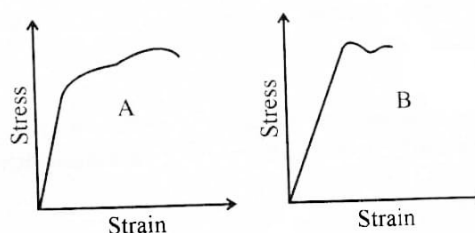
MECHANICAL PROPERTIES OF SOLIDS

1. The stress-strain graph of two materials A and B are shown below.

(a) State the law which relates stress with strain.

(b) Which of the two materials has the greater Young's modulus?

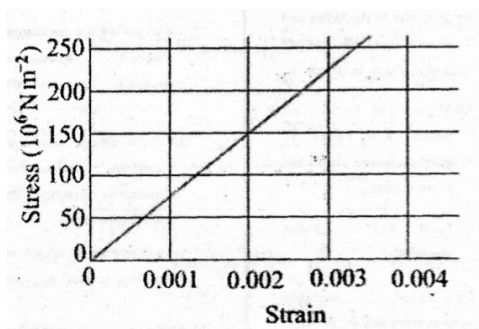
(c) Which of the two materials is more ductile



(1+1+1) [Imp 2019]

2. a) Figure shows the strain stress curve for a material. What is the young's modulus of the material?

b) Young's modulus of Aluminum is $70 \times 10^9 \text{ Nm}^{-2}$ and that of copper is $120 \times 10^9 \text{ Nm}^{-2}$. Same strain is to be produced on an aluminium wire and a copper wire of equal cross section. Which wire requires more force?



(2+1) [March 2019]

3. The stress required to double the length of a wire of Young's modulus Y is

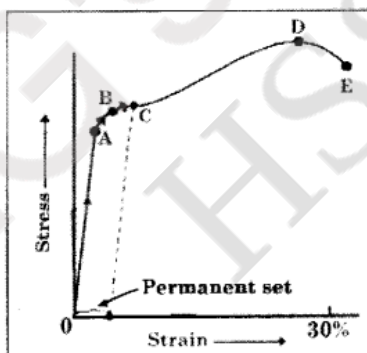
- a. $Y/2$
- b. $2Y$
- c. Y
- d. $4Y$

(1) [Imp 2018]

4. A steel wire of length 1.5 m and diameter 25 cm is loaded with a force of 98 N. The increase in the length of the wire is $1.5 \times 10^{-4} \text{ m}$. Calculate the tensile stress and the fractional change in length of the wire.

(2) [Imp 2018]

5. A typical stress-strain graph of a metallic wire is shown below.



a. Write the name of the point B labelled in the graph.

b. For materials like copper, the points D and E are (close/far apart).

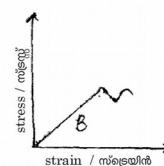
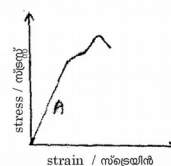
(1+1) [March 2018]

6. The stress-strain curve of two bodies A and B are given in the figure.

(2) [Imp 2017]

Which of the materials has greater Young's modulus? Which of the two materials is preferable to be used as a rope in a crane?

Substantiate your answers.



7. A metal cube of side 10 cm is subjected to a shear stress 10^4 N/m^2 . Calculate the rigidity modulus, if the top of the cube is displaced by 0.05 cm with respect to its bottom.

[March 2017]

8. a) The ratio of shear stress to shear strain is

- (i) Poisson's ratio
- (ii) Young's modulus
- (iii) Bulk modulus
- (iv) Rigidity modulus

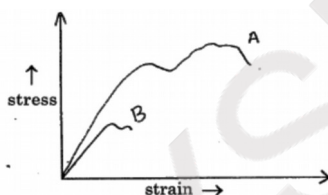
(1)

b) State Hooke's law.

(1) [Imp 2016]

9. The stress-strain graph for wires of two materials A and B are given below.

(1+2) [March 2016]



a) Which material is more ductile?

b) When a spring balances are continuously used for long time, they show wrong reading. Explain why.

10. Young's moduli of three materials are given in the below table.

[Imp 2015]

a) What do you mean by Young's modulus? Write a mathematical expression for it.

(2)

b) Select the material from the table, which shows more elasticity.

(1)

Substance	Young's Modulus(N/m^2)
X	70×10^9
Y	120×10^9
Z	200×10^9

11. A rubber band can be pulled to several times its original length.

a) Draw the stress-strain graph of a rubber band.

(1)

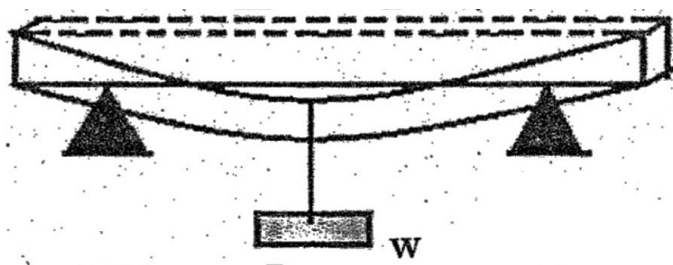
b) Rope of cranes is made of a number of thin wires braided together. Why?

(1) [March 2015]

12. A rigid body is a body with a perfectly unchanging shape under the influence of an external force.

a) What do you mean by the centre of mass of a rigid body?

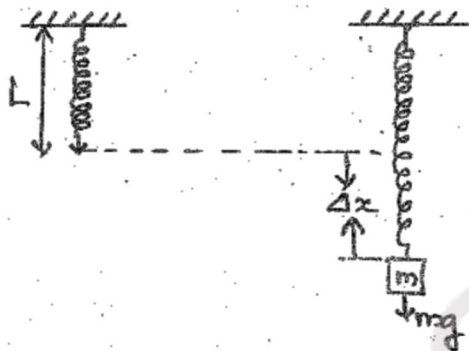
(1)



b) A rigid beam of length L , breadth b and depth d is supported near its ends as shown in the figure. A load W is suspended at its centre of mass. Write the expression for the amount of sagging.

(1) [March 2015]

13. When a force is applied to a spring, it gets extended by an amount Δx as shown.



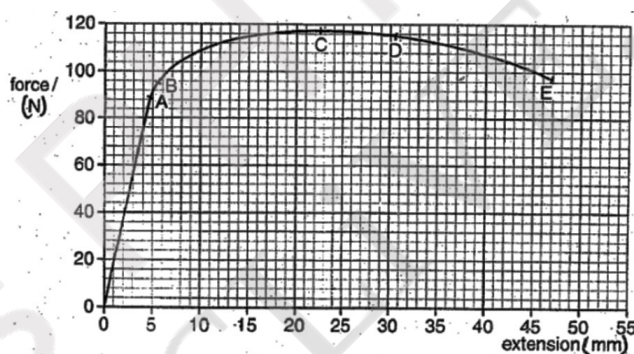
(a) Name the law relating stress and strain.

(b) Calculate the stress developed in a metal wire when it is strained by 30%. Given young's modulus of material is 200 GPa.

(c) Which is more elastic, steel or rubber? Why?

(1+2+2) [Imp 2014]

14. The graph below shows how the force applied to a metal wire is related to the extent ion of the wire.



a) Write the letter that corresponds to:

(2 x 1/2 =1)

i) Elastic limit

ii) Fracture point

b) The wire has an unstretched length of 2.40 m and an area of cross section of $3.90 \times 10^{-7} \text{ m}^2$. Determine the Young's modulus Y of the material.

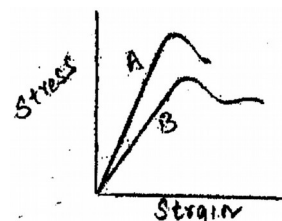
(2) [March 2014]

15. Stress – Strain graph of two materials is show below:

a) State the law which relates stress with strain.

b) Which materials is more ductile (A or B)?

c) Which material is preferred for making springs (A or B)? Why?



(1+1+1) [Imp 2013]

16. Hooke's law states that stress \propto strain.

a) What is the necessary condition for the above law to be valid?

b) Explain with the help of a graph, the relation between stress and strain for a given solid material under increasing tensile stress.

[March 2013]

17. When a wire is stretched with a very large force it breaks.

- a) Represent the variation of extension with load on a graph
- b) Discuss the behaviour of wire at various stages.
- c) State Hooke's law. For which part of the above graph is this applicable.
- d) Which is more elastic; steel or rubber? Why?

[Imp 2012]

18. When a mass is suspended on a metallic wire, the length of the wire increases slightly.

- a) Name and the state law that relates to the restraining force developed in the wire and its deformation.
- b) Draw the stress – strain graph of a loading wire. Mark the following points:
 - i. Elastic limit
 - ii. Fracture point
 - iii. Plastic region
 - iv. Elastic region

c) If the young's moduli of iron and glass are $190 \times 10^9 \text{ Nm}^{-2}$ and $65 \times 10^9 \text{ Nm}^{-2}$ respectively. Which is more elastic? Justify your answer.

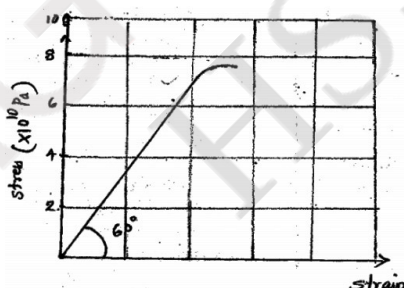
[March 2012]

19. Elasticity is the property of a body by which it regains its original state on the removal of the deforming force.

a) Why Steel is more elastic than Rubber?

b) The figure given below shows the stress-strain curve for a given material. What are the Young's modulus and approximate yield strength for this material?

(1+ 2) [Imp 2011]



20. When the pressure on a sphere is increased by 80 atmospheres, its volume decreases by 0.01%. Find the bulk modulus of elasticity of the material of the sphere.

(2) [Imp 2011]

21. Elasticity is an internal property of matter. Fluids possess volume elasticity. Which is more elastic, air or water? Why?

[March 2011]

22. Modulus of elasticity of a material is the ratio of stress and strain.

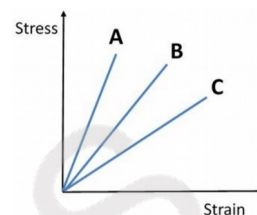
a) Young's modulus for a perfectly rigid body is -----

b) One end of a rope of a length 4.5 m and diameter 6 mm is fixed to the branch of a tree. A monkey weighing 100 N jumps to catch the free end and stays there. Find the elongation of the rope. (Young's modulus = $4.8 \times 10^{11} \text{ N/m}^2$).

[Imp 2010]

23. Elasticity is the property of matter that is characterized by atomic packing. For an elastic solid, stress applied is directly proportional to the strain produced in it. The stress versus strain graph for three materials A, B and C is shown below.

- Which is more elastic A, B or C? Justify your answer.
- If the bulk modulus of water is $2 \times 10^9 \text{ Nm}^{-2}$, find its compressibility.
- Why are girders for supporting roofs formed in the shape of I?



[March 2010]

CHAPTER 10

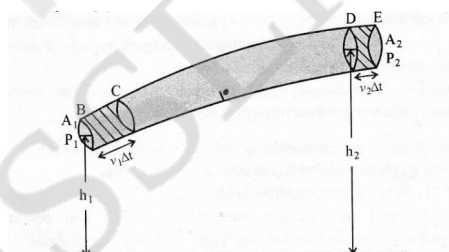
MECHANICAL PROPERTIES OF FLUIDS

1. When a metallic sphere falls through castor oil, its velocity become uniform, called terminal velocity.

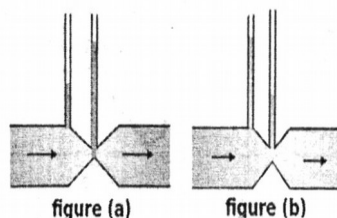
- Write the expression for terminal velocity.
- The terminal velocity of a copper ball of radius 2 mm falling through a tank of oil at 20°C is 6.5 cm/s. Compute the viscosity of the oil at 20°C . Density of oil is $1.5 \times 10^3 \text{ kg/m}^3$. Density of copper is $8.9 \times 10^3 \text{ kg/m}^3$.
- Rain drops falling under gravity do not acquire very high velocity. Why ?

(1+2+1) [Imp 2019]

2. A fluid moving in a pipe of varying cross-sectional area is shown below.



- What is the difference between streamline flow and turbulent flow ?
 - State and prove Bernoulli's principle.
3. a) Derive Bernoulli's equation for the stream line flow of an incompressible liquid. (4+1) [March 2019]
- b) Figures (a) and (b) refer to the steady flow of a (non-viscous) liquid. Which one of the following two figures is INCORRECT?



4. a) Define angle of contact.
- b) Water proofing agents are added to create a (large/ small) angle of contact between the water and fibres.
- c) Calculate the excess of pressure inside an air bubble of radius 1 mm formed just below the free surface of water. Given surface tension of water $72 \times 10^{-3} \text{ Nm}^{-1}$. (1+1+2) [March 2019]

5. For a liquid-gas interface, the convex side has a high Pressure than the concave side. (3+1) [Imp 2018]

a. Derive an expression for excess pressure inside a drop.

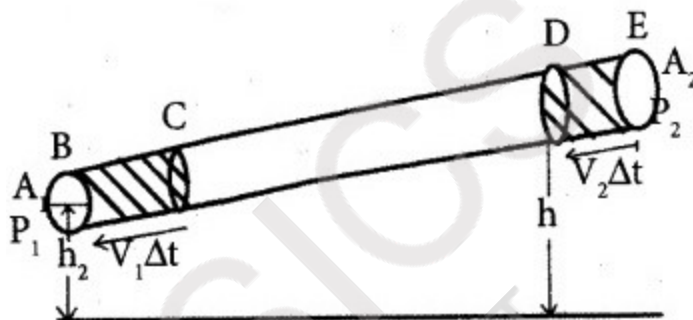
b. Which is better, washing of cloth in cool soap wafer or warm soapy water? Why

6. The flow of an ideal fluid in a pipe of a varying cross-section is shown below. (1+3+1) [Imp 2018]

a. Write Bernoulli's equation.

b. Find the speed of efflux using Bernoulli's principle.

c. State Torricelli's law.



7. The terminal velocity of a copper ball of radius 2.0 mm falling through a tank of oil at 20°C is 6.5 cm s⁻¹. Calculate the viscosity of the oil at 20°C.

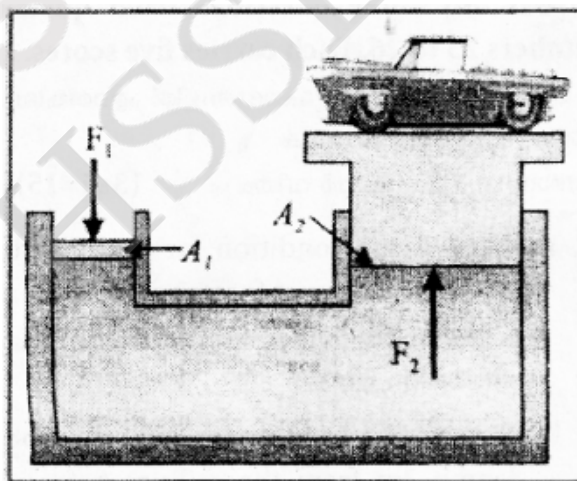
(Hints: Density of oil is $1.5 \times 10^3 \text{ kg m}^{-3}$, a density of copper is $8.9 \times 10^3 \text{ kg m}^{-3}$.) (2) [March 2018]

8. a. Water rises up in a narrow tube in spite of gravity. This phenomenon is called.....

b. Derive an expression for the height of water in the tube in terms of the radius of the tube and surface tension of the liquid.

c. Water with detergent dissolved in it should have an angle of contact. (Small/large) (1+3+1) [March 2018]

9. A device used to lift automobiles is shown in the figure.



a. Write the name of the device

b. In the situation shown in the figure, a mass of the car is 3000 kg and area of the piston carrying it is 425cm². What pressure is to be applied to the smaller piston? (1+2) [March 2018]

10. Bernoulli's principle has a large number of useful applications in our day-to-day life. (4) [Imp 2017]

a) State the Bernoulli's principle.

b) Explain with mathematical derivation how the venturimeter is helpful to measure the flow speed of a liquid.

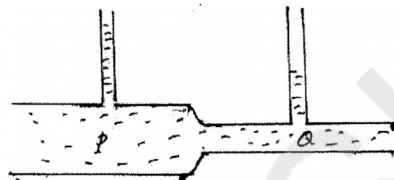
OR

Hairs of a paint brush do not cling together when dipped in water, but form a fine tip when taken out of it. The formation of the fine tip is due to the surface tension. (4)

a) What do you mean by surface tension?

b) Derive an expression for the capillary rise.

11. Portion P of a horizontal tube has uniform area of cross-section A and that of portion Q is a. Both portions have similar vertical capillaries fitted to them. A liquid of density ρ flows through P with the velocity 3 m/s and through Q with 7 m/s. Find the difference in levels of two vertical capillaries. (2) [Imp 2017]



12. Draw the schematic diagram of a hydraulic lift. Give its working principle. (2) [March 2017]

13. A region of streamline flow of an incompressible fluid is shown in the figure.

a. By considering mass conservation in the fluid flow, arrive at the 'equation of continuity'.

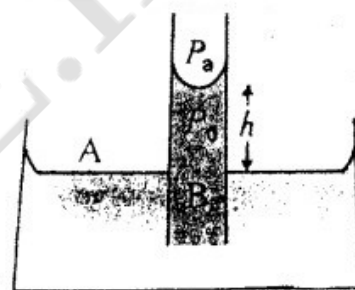
b. The onset of turbulence in a fluid is determined by 'Reynolds number', given as

i. $\frac{\rho v d}{2\eta} = \text{Re}$

ii. $\frac{2\rho v d}{\eta} = \text{Re}$

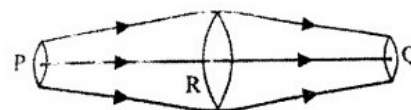
iii. $\frac{\rho v d}{\eta} = \text{Re}$

iv. $\frac{\rho v m}{d} = \text{Re}$



OR

Schematic diagram of capillary rise in a narrow tube is shown in the figure.



a. Arrive at an expression for capillary height 'h' in terms of the surface tension of the liquid.

b. On the surface of the moon, the liquid in a capillary tube will rise to the

- i. same height as on earth,
- ii. less height as on earth
- iii. more height than that on earth
- iv. infinite height.

(4+1) [March 2017]

14A. Consider the flow of a liquid through a pipe of varying cross section.

[Imp 2016]

- a) Write the equation of continuity of flow. (1)
- b) Draw a figure and drive Bernoulli's equation. (4)
- c) A tank of 5 m height is filled with water. Calculate the velocity of efflux through a hole, 3 m below the surface of water. (2)

OR

14B. Surface tension is a property of liquids and it causes capillary rise in small tubes.

- a) What do you mean by surface tension? (1)
- b) Draw a figure and derive an equation for capillary rise in a tube of radius 'r'. (4)
- c) Excess pressure inside a liquid drop is 60 N/m^2 . What will be the excess pressure inside a liquid bubble of the same radius formed by the same liquid? (2)

15A. In case of fluids law of conservation of energy can be explained with Bernoulli's principle. [March 2016]

- a) State and prove Bernoulli's principle. (4)
- b) While travelling in aeroplane, it is advisable to remove ink from fountain pen. Why? (2)

OR

15B. Viscosity is the frictional force in fluids.

- a) When a small metal ball is falling through a viscous medium, what are the various forces acting on it? Using this arrive at an expression for terminal velocity. (4)
- b) Raindrops falling under gravity do not acquire very high velocity. Why? (2)

16A. a) State and prove Bernoulli's theorem. (4) [Imp 2015]

- b) A steady flow of nonviscous liquids are shown in figures 1 and 2. Which one of the figures is INCORRECT? Why? (2)

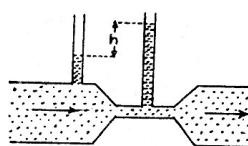


Figure 1

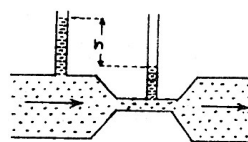


Figure 2

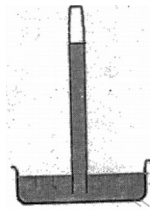
OR

16B. a) What is the SI unit of pressure? Derive a mathematical expression for excess pressure inside a liquid drop. (4)

- b) What will happen to two soap bubbles of radii, which are in contact with each other? Why? (2)

17A. The pressure of the atmosphere at any point is the weight of the air column of a unit cross sectional area.
Its unit is bar. (1+3+2) [March 2015]

a) Identify the given diagram and write its use.

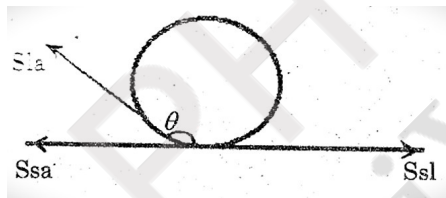


b) State Pascal's law for transmission of fluid pressure and explain the principles of working of a hydraulic lift.
c) The above arrangement is placed in an elevator which is accelerating upwards. What happens to the possible height of the liquid column in the tube? Justify.

OR

17B. The antiseptic used for cuts and wounds in human flesh have low surface tension. Due to low surface tension, they spread over the wounds easily.

a) In the following figure, the angle of contact θ is.....



b) Surface tension causes capillarity. Define capillarity and arrive at the expression for capillary rise in terms of surface tension.

c) In a capillary tube, water rises to a height. If the capillary tube is inclined at an angle 60° with the vertical, what will be the length of the water column in the tube. (1+3+2)

18A. Law of conservation of energy is a universal law for all states of matter. (1+ 3) [Imp 2014]

a) Which theorem gives the law of conservation of energy for a flowing liquid?

b) State and prove the above theorem.

OR

18B. A liquid surface behaves like a stretched elastic membrane.

a) Name the liquid property for the above behaviour.

b) Define angle of contact. What is its value for pure water with glass?

c) Derive an expression for the rise of liquid in a capillary tube of radius r , having density ρ and surface tension S

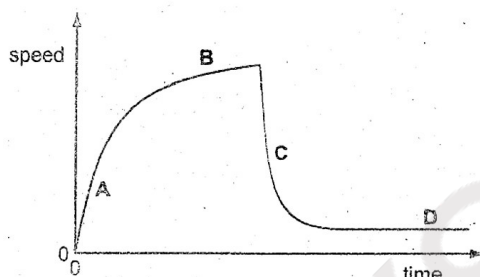
19. Fill in the blanks. (1) [March 2014]

Venturimeter: Bernoulli's theorem

Hydraulic lift:

20A. The viscous force exists when there is a relative motion between the layers of the fluid.

- State true or false: "The viscosity of gases decreases with an increase in temperature."
- Obtain the expression for the terminal velocity attained by an object falling through a viscous medium.
- The speed – time graph of a falling sky diver is shown below. During the fall he opens his parachute. Which part of the graph shows the sky diver falling with terminal velocity?



(1+ 3+1) [March 2014]

OR

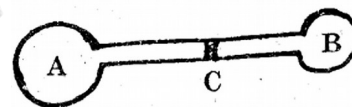
20B. There is always an excess of pressure inside drops and bubbles.

(1+ 3+ 1)

- State true or false: "A drop of liquid under no external forces is always spherical in shape."
- Obtain an expression for excess of pressure inside a drop of radius r and surface tension S .
- Two soap bubbles A and B are blown at the ends of a tube, as shown below.

Choose the correct answer:

When the block C is removed...



- The size of A increases and that of B decreases
- The size of B increases and that of A decreases
- No change occurs in their sizes
- Their sizes become equal

21. Pick the odd one out from the following

(1) [Imp 2013]

- Atomiser
- Hydraulic Lift
- Venturimeter
- Aerofoil

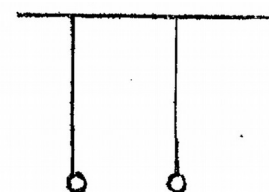
22A. (a) When air is blown in between the two balls, will they attract or repel?

(1+1+3)

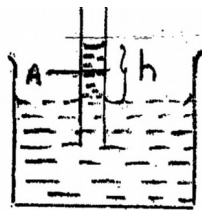
(b) State the principle that explains your observation.

(c) Using this principle, derive Torricelli's equation [Speed of Efflux]

OR



22B. When a thin tube is dipped in water, water rises in the tube through a height 'h'.



a) Name the phenomenon.

b) Arrive at an expression for the height of the water rise (h) in the tube.

c) Will water overflow, if the tube is cut at level A? Justify your answer.

(1+3+1) [Imp 2013]

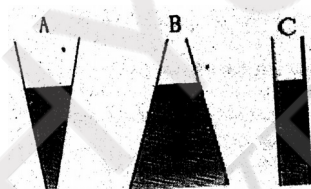
23. A small water drop placed on a lotus leaf is spherical in shape.

[March 2013]

a) Define surface tension.

b) Why does the small water drop acquire a spherical shape?

24. Three vessels of different shapes are filled with water to the same height 'h' and their bottom parts are connected to manometers measuring the pressure. The water levels in all the vessels remaining the same.



a) Identity the above phenomenon.

b) Predict the pressure level shown by the manometers.

c) Blood pressure in humans is greater at the feet than at the brain. Explain why.

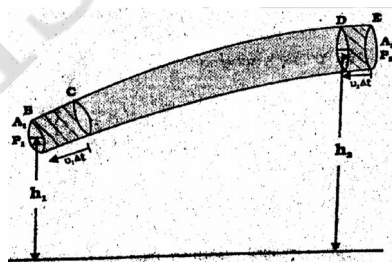
d) Pick the odd one out.

Dentist chair, hydraulic brake, hydraulic press, venture meter.

[March 2013]

25. The flow of an ideal fluid in a pipe of varying cross section is shown.

[March-2013]



a) Differentiate between streamline flow and turbulent flow.

b) State and prove Bernoulli's principle.

26A. Surface Tension changes with temperature.

[Imp 2012]

a) Hot soup is tastier than cold one. Why?

b) What is the value of the angle of contact for pure water?

c) Calculate the work done in breaking a water drop of radius 1mm to 1000 droplets. Surface tension of water is $72 \times 10^{-3} \text{N/m}$.

OR

- 26B. a) Is pressure in a liquid, scalar or vector.
b) State the law associated with liquid pressure.
c) Briefly explain the working of hydraulic lift.

27. Match the following:

[March 2012]

A	B
a) Reynold's number	Equation of continuity
b) Magnus effect	Surface tension
c) Action of detergent	Archimedes principle
d) $a_1 v_1 = a_2 v_2$	Viscosity
	Bernoulli's principle
	Pressure

28. Raindrops falling due to gravity do not acquire high velocity.

[March 2012]

- a) Define the velocity of the raindrop when unbalanced force on it is zero.
b) Why do bubbles of air rise up through water?
c) The terminal velocity of copper ball of radius 2.0 mm falling through a tank of oil at 20°C is 6.5 cm s⁻¹. Compute the viscosity of the oil at 20°C. Density of oil is 1.5 × 10³ kg m⁻³, density of copper is 8.9 × 10³ kg m⁻³.
d) Viscosity of gases.....with temperature, whereas viscosity of liquidswith temperature (increases/decreases).

29A. The rise or fall of a liquid against gravitational force through fine tubes is known as capillarity.

- a) Give an example for capillarity from practical life. (1)
b) Derive an expression for the capillary rise through a capillary tube. (2)

OR

29B. When we blow between two light balls suspended nearby they approach each other. Why?

- a) State the principle that can explain your observation. (1)
b) Use this principle to arrive at Torricelli's equation. (Velocity of Efflux) (2) [Imp-2011]

30. A solid sphere falling through a viscous medium attains a constant velocity called terminal velocity after some time of its fall. What are the different forces acting on the sphere? Derive an expression for terminal velocity in terms of the coefficient of viscosity of the medium. [March 2011]

31. a) Hydraulic lift is a device used to lift heavy loads. State the principle behind the working of this device.
b) The velocity of outflow of a liquid from an open tank is identical to that of a freely falling body.

i. Name this law and the principle behind this law.

ii. Derive this law based on this principle.

[March 2011]

32A. Water does not wet the feathers of ducks. A physical quantity called angle of contact determines whether a liquid will spread on the surface of a solid or it will form droplets on it.

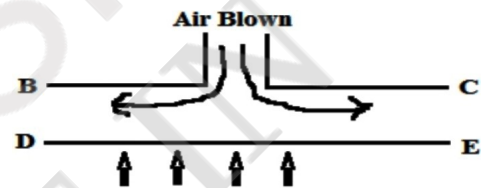
a) Define angle of contact.

b) A wire ring of internal radius 3 cm is rested on the surface of a liquid and is then raised. An extra pulling force equivalent to the weight of 3.03 g is required before the film breaks than it is after. Calculate the surface tension of the liquid.

c) Derive an expression for the capillary height of a liquid in a narrow tube.

OR

32B. If air is blown through the space between two discs BC and DE shown in the figure, the lower disc DE instead of being blown off from BC, will move towards BC.



a) State the principle which is used to explain this phenomenon.

b) A garden hose having an internal diameter of 2 cm is connected to a lawn sprinkler that consists of an enclosure with 12 holes, each 0.2 cm in diameter. If the water in the hose has a speed does it leave the sprinkler holes?

c) Show that the speed of liquid flowing out of a small hole in a tank filled with liquid will be $\sqrt{2gh}$ where h is the height of liquid above the hole and g is the acceleration due to gravity. [Imp 2010]

33. Match the following

[March 2010]

Equation of continuity.	$F = ma$	Hydraulic lift.
Pascal's law	$A_1U_1 = A_2U_2$	Rocket propulsion.
Newton's law of motion	$P_1V_1 = P_2V_2$	Quill tube
Boyle's law	$\frac{F_1}{A_1} = \frac{F_2}{A_2}$	Venturimeter.

34. Washing with water doesn't remove grease stains from clothes but addition of detergent removes the molecules of greasy substances. [March 2010]

a) Which property of a liquid causes the above effect?

b) A single drop of liquid is split into 8 identical drops. What will be the excess pressure in each drop?

c) How can the coefficient of viscosity of a highly viscous liquid be determined by Stokes method?

35. a) Explain the terms surface tension and surface energy. [Imp 2009]

b) Show that surface tension is numerically equal to surface energy.

c) Calculate the amount of energy evolved when eight drops of mercury of radius 1mm each, combine to form one drop, (surface tension of mercury is 0.55 N/m).

36. Mercury barometer is a device used to measure the atmospheric pressure. **[Imp 2009]**
- a) If a student places the barometer in a lift, falling freely under gravity, how the barometer reading will change.
- b) If the same barometer is placed in a lift that is ascending with an acceleration f , how the barometer reading will change.
- c) Find an expression for pressure P at a depth h below the surface of a liquid of density ρ in a container moving vertically upwards with an acceleration f ? What happens to pressure for a free fall of the container?
37. Rain drops are being accelerated while falling through the atmosphere. But they reach at the surface of the earth with a uniform velocity. **[March 2009]**
- a) What is this velocity called?
- b) Obtain an expression for the excess pressure inside a rain drop.
- c) Draw a neat diagram of an atomiser (spray gun) and explain the principle involved in its working.
- d) Eight spherical rain drops of equal in size are falling vertically through air with a uniform speed of 1 ms^{-1} . What would be the uniform speed if these drops were to combine to form one large spherical drop?

CHAPTER 11

THERMAL PROPERTIES OF MATTER

1. A body cools from 80°C to 50°C in 5 minutes. Calculate the time it taken to cool from 60°C to 30°C . The temperature of the surrounding is 20°C . **(3) [Imp 2019]**
2. Which among the following possesses the highest specific heat capacity? **(1) [Imp 2019]**
- (i) Metals
- (ii) Ice
- (iii) Water
- (iv) Glass
3. What is sublimation? Write an example for a sublime material. **(2) [March 2019]**
4. Draw a graph showing the variation of volume of a given mass of water with temperature from 0°C . In the graph mark the temperature at which water has maximum density. **(2) [March 2019]**
5. Linear expansion is a change in length of an object with temperature. **(1+2+1) [Imp 2018]**
- a. Write the equation for the coefficient of α linear expansion.
- b. Show that the coefficient of volume expansion is thrice its coefficient of linear expansion.
- c. The absolute zero is
- $[273.15^\circ\text{C}, 273.15\text{K}, 273.15^\circ\text{F}, 0^\circ\text{C}]$
6. When 0.15 kg of ice at 0°C is mixed with 0.30 kg of water at 50°C in a container, the resulting temperature is 6.7°C . Calculate the latent heat of fusion of ice. Given specific heat capacity of water $4186 \text{ J kg}^{-1}\text{K}^{-1}$. **(3) [March 2018]**

7. The change in temperature of a substance, when a given quantity of heat is absorbed or rejected by it, is characterized by the heat capacity.

a) Define specific heat capacity, molar specific heat capacity at constant pressure and molar specific heat capacity at constant volume. Give the reason for using water as a coolant in automobile radiators.

b) At what temperature, water has minimum volume?

i) 100°C

ii) 0°C

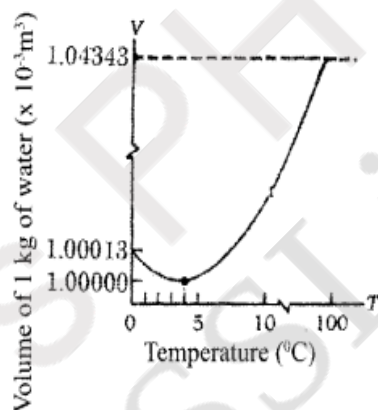
iii) 4°C

iv) 10°C

(2+1) [Imp 2017]

8. A steel rod has a radius of 10 mm and a length of 1.0 m. A 100 kN force stretches it along its length. Calculate the elongation of the steel rod. [Young's modulus of steel is $2.0 \times 10^{11} \text{ N/m}^2$.] (2) [March 2017]

9. The graph below exhibits the anomalous expansion of water. Based on the graph, explain how lakes freeze from the top to bottom rather than from bottom to top. (3) [March 2017]



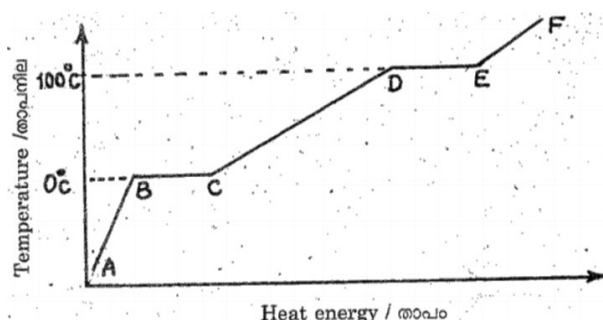
10. a) Triple point of water is 0.01°C . Express this temperature in Kelvin scale. (1)

b) How does sea breeze occur? Explain. (2) [Imp 2016]

11. A hole is drilled in a copper sheet. The diameter of the hole is 4.24 cm at 27°C . What is the change in diameter of the hole when the is heated to 227°C ? (2) [March 2016]

(Coefficient of linear expansion of copper = $1.7 \times 10^{-5} / ^{\circ}\text{C}$).

12. The below graph represents temperature versus heat for water at 1 atm. Pressure. [Imp 2015]



a) Match the following using the above graph.

(2)

Graph	Process	State
i) BC	a) Melting	p) Water
ii) DE	b) Sublimation	q) Ice
	c) Regelation	r) Partially Solid and liquid
	d) Vapourisation	s) Partially liquid and vapour

b) The slopes of AB and CD are different. Why?

(1)

13. A steel beam of length 5m is kept at a temperature of 20°C . On a hot day, the temperature rises to 40°C . What is the change in its length due to thermal expansion? (Coefficient to linear expansion of steel is $1.2 \times 10^{-5} / ^{\circ}\text{C}$). (2) [March 2015]

14. $98^{\circ}\text{F} = \dots\dots\dots\text{K}$

(36.7, 40, 309.7, 371)

(1) [March 2015]

15. Complete the table. ($4 \times 1/2 = 2$)

[March 2014]

Temperature	Kelvin scale	Celsius scale	Fahrenheit scale
Steam point	373.15 K	.....	212.00°F
Ice point	.....	0.00°C}	.....
Absolute zero	0.00K	.....	459.69°F

16. The coefficient of thermal expansion in solids are mainly

- i) Coefficient of Linear Expansion (α)
- ii) Coefficient of Area Expansion (β)
- iii) Coefficient of Volume Expansion (γ).

a) What is the ratio of α , β and γ ?

(1)

b) Invar is used for making pendulum of clocks. Why?

(1) [Imp 2013]

17. There are three distinct modes of heat transfer.

a) The main mode of transmission of heat by which the sun heats the surface of the earth is:

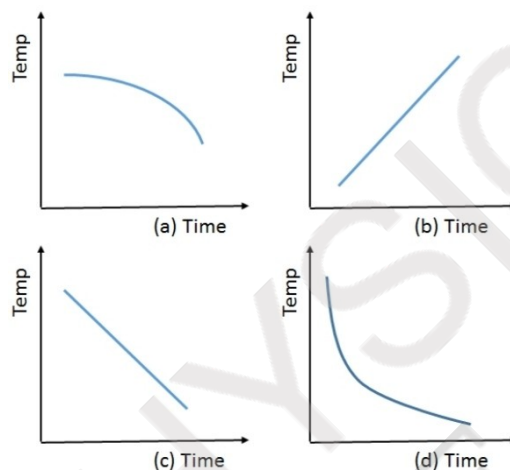
- i) Conduction
- ii) Convection
- iii) Radiation
- iv) None of these

- b) Explain briefly, the occurrence of a sea breeze based on heat transfer. **[March 2013]**
18. Heat from the sun reaches earth through vacuum.
- a) Name the mode of heat transfer in the above case.
- b) Name the different modes of heat transfer in metals and in liquids?
- c) Aquatic animals are protected in cold countries as ice is formed on the surface of river. How? **[Imp 2012]**
19. Temperature is the degree of 'hotness' of the body. **[March 2012]**
- a) Temperature of a normal human body is 98.6°F . What is the corresponding temperature shown in the Celsius scale?
- b) Specific heat capacity of water is 4186J/kg/K . What do you understand by the term, specific heat?
- c) A brass tumbler feels much colder than a wooden tray on a chilly day. Why?
- d) A brass boiler has a base area of 0.15m^2 and thickness 1.0 cm . It boils water at the rate of 6.0 kg/minute when placed on a gas stove. Estimate the temperature of the part of the flame in contact with the boiler. Thermal conductivity of brass = $109\text{ Js}^{-1}\text{ m}^{-1}\text{ K}^{-1}$. Heat of vaporization of water = $2256 \times 10^3\text{ J kg}^{-1}$.
20. Sitha prepared tea for her brother. After preparing tea the temperature of the tea was 80°C . She kept it for 5 minutes and gave to her brother when the temperature reached 50°C . If the surrounding temperature is 20°C . Calculate the time it takes to cool from 60°C to 30°C . **(2) [March 2011]**
21. Water kept in earthen pots gets cooled. Why? **[March 2011]**
22. The increase in dimensions of a body due to increase in temperature is called thermal expansion. **[Imp 2010]**
- a) The ratio among the coefficients of linear expansion, area expansion and volume expansion is -----
- b) Railway lines are laid with gaps to allow for expansion. If the gap between steel rails 66m long is 3.63 cm at 10°C , then at what temperature will the lines just touch? Co-efficient of linear expansion for steel is $11 \times 10^{-6} / ^{\circ}\text{C}$.
23. a) Which among the following possess the highest specific heat capacity?
- i. Water
 - ii. Silver
 - iii. Copper
 - iv. Steel
- b) You are in restaurant waiting for your friend and ordered coffee. It has arrived. Do you add sugar in your friend's coffee and then wait for him or do you add sugar after he arrives? Explain with respect to the concept of cooling.
- c) Read the statement given in a book "All thermal conductors also." Do you agree with this statement? If your answer is No, clarify it. **[March 2010]**
24. a) At atmospheric pressure melting of ice is 0°C . If the melting point of ice increases by 0.0073°C for fall in every one atmosphere pressure, what will be the melting point of ice in vacuum. Also mention briefly why water under ice in polar region of earth is not freezing.

b) When you are about to make tea from hot tea and cold milk, your phone is ringing. Which of the following can be done to keep the cup of tea hotter when you return after attending the phone call?

- 1) Pour hot tea and cold milk in your cup and leave it to attend phone call.
- 2) Mix the two after attending the call.

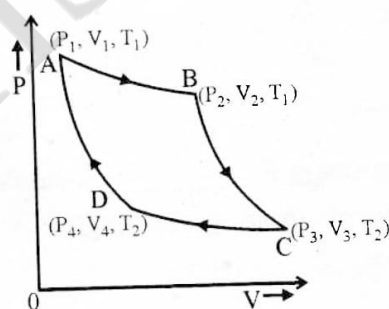
Also indicate which among the curves below represents a cooling curve.



c) Explain the difference between heat and temperature. Find out the work done to convert 10 gram of ice at -5°C to steam at 100°C . Specific heat capacity of ice is $2100\text{ J kg}^{-1}\text{K}^{-1}$, specific latent heat of fusion of ice is $336 \times 10^3\text{ J kg}^{-1}$. Latent heat of steam is $2250 \times 10^3\text{ J kg}^{-1}$ specific heat capacity of water is $4200\text{ J kg}^{-1}\text{K}^{-1}$. **[Imp 2009]**

CHAPTER 12 - THERMODYNAMICS

1. Carnot cycle for a heat engine with an ideal gas as the working substance is shown below. **(2+1) [Imp 2019]**



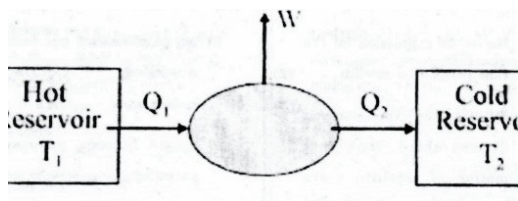
(a) Name the four processes taking place in Carnot cycle

(b) Can a Carnot engine work if its sink and source are interchanged? Explain.

2. Derive the relation $C_p - C_v = R$ where C_p and C_v are molar specific heat capacities of an ideal gas at constant pressure and volume respectively and R is the universal gas constant. **(2) [Imp 2019]**

3. Schematic diagram of a heat engine is shown below.

(1+1+2) [March 2019]



a) Modify the given diagram for a refrigerator.

b) Write the equation for the coefficient of performance of a refrigerator.

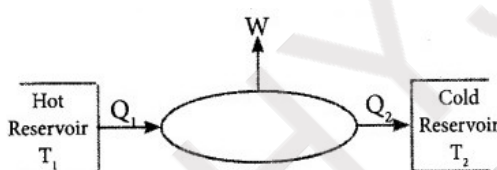
c) In the given diagram, $T_1 = 900\text{K}$, $T_2 = 300\text{K}$, $Q_1 = 6400\text{J/cycle}$. calculate the value of Q_2 .

4. State first law of thermodynamics.

(1) [March 2019]

5. The basic features of a device are schematically represented in the figure below.

(1+2+2) [Imp 2018]



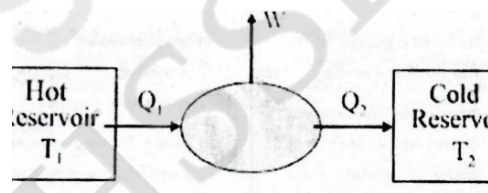
a. Which type of device is this, a heat engine or a refrigerator?

b. Draw the indicator diagram and label the four processes in the Carnot cycle.

c. A steam engine delivers $5.4 \times 10^8 \text{ J}$ of work per minute and services $3.6 \times 10^9 \text{ J}$ of heat per minute from its boiler. What is the efficiency of the engine? How much heat is wasted per minute?

6. Schematic diagram of a device is shown below.

(1+1+2) [March 2018]



a. Write the equation for the efficiency of the device.

b. Write the name of the four processes in the working cycle of the device.

c. If $T_1 = 100^\circ\text{C}$, $T_2 = 0^\circ\text{C}$, and $Q_1 = 4200 \text{ J}$. Find the value of Q_2 .

7. In an adiabatic process, the system is insulated from the surroundings and heat absorbed or released is zero.

a) Derive an expression for the work done in an adiabatic change of an ideal gas from the state

(P_1, V_1, T_1) to the state (P_2, V_2, T_2) .

b) Two samples, A and B, of oxygen at the same initial temperature and pressure are compressed from volume V to $V/2$. A is compressed isothermally and B adiabatically. Find out the ratio of the final pressure of A and B.

($\gamma = 1.4$)

(2+2) [Imp 2017]

8. "Two systems in thermal equilibrium with a third system, are in thermal equilibrium with each other".

Identify the law given by the above statement.

(1) [March 2017]

9. Match the following in three columns.

(3) [March 2017]

മൂന്നു കോളങ്ങളിലായി ചേരുമ്പടി ചേർക്കുക.

Thermodynamic process തെർമോ ഡൈനാമിക് പ്രക്രിയ	Feature മുഖഭാവം	Work done during the process പ്രക്രിയയിലെ പ്രവർത്തി
Isobaric process ഐസോബാരിക് പ്രക്രിയ	Temperature constant താപനില സ്ഥിരസഖ്യയാണ്	$\mu RT \ln \left[\frac{V_2}{V_1} \right]$
Isothermal process ഐസോതെർമൽ പ്രക്രിയ	Pressure constant മർദ്ദം സ്ഥിരസഖ്യയാണ്	Zero
Adiabatic process അഡിയബാറ്റിക് പ്രക്രിയ	Volume constant വ്യാപ്തം സ്ഥിരസഖ്യയാണ്	$P[V_2 - V_1]$
	No heat exchange between system and surroundings സിസ്റ്റവും ചുറ്റുപാടും തമ്മിൽ താപവെച്ചുമുതില്ല	$\frac{R}{\gamma - 1} [T_1 - T_2]$

10. a) What is the difference between isothermal and adiabatic processes?

(1)

b) Explain Carnot's cycle.

(2)

c) Write the expression for the efficiency of a Carnot engine.

(1) [Imp 2016]

11. a) Heat engine is a device used to convert..... energy intoenergy.

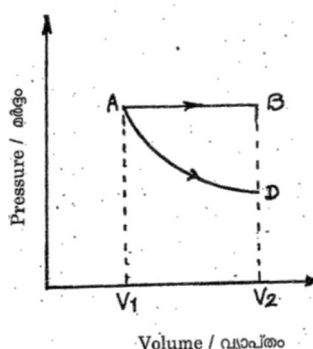
(1) [March 2016]

b) Name the four processes taking place in Carnot cycle. Draw indicator diagram of Carnot cycle.

(4)

12. P-V diagram of a gas is shown in the figure. In this figure AB represents isobaric process and AD represents isothermal process.

[Imp 2015]



a) Explain isobaric process and isothermal process.

(2)

b) Using the above graph, find the process in which the work done is maximum. Give the reason.

(2)

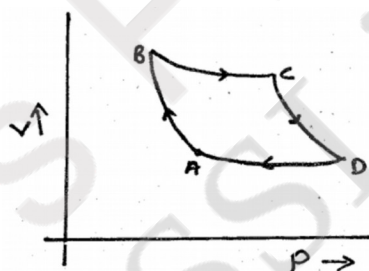
13. The variables which determine the thermodynamic behaviour of a system are called thermodynamic variables.

- a) Pick out the one which is NOT a thermodynamic variable. (1)
(temperature, pressure, work, volume)
- b) What happens to the internal energy of a gas during
i) isothermal expansion?
ii) adiabatic expansion? (2)
- c) Gases have two specific heat capacities, C_p and C_v . Why? (1)
- d) Laplace pointed out that when sound is propagating through a gaseous medium, the change is adiabatic.
Show that adiabatic bulk modulus is γP . (2) [March 2015]

14. A thermodynamic process characterized by pressure, volume and temperature.

- a) What is meant by an isothermal process? Give the equation.
- b) Name the four processes in a Carnot's cycle.
- c) Draw the P - V diagram for a Carnot's cycle. (1+1+1) [Imp 2014]

15. The figure shows the pressure – volume relationship of an ideal gas that undergoes a Carnot cycle. The process B to C takes place at a constant temperature of 1000K and the process from D to A at a constant temperature of 500K. [March 2014]



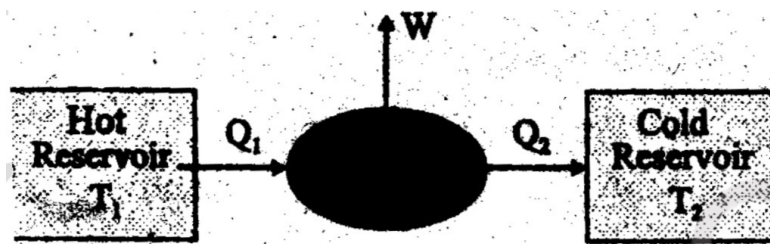
- (a) Name the process occurring between
i) A and B
ii) B and C
- (b) During which of the four processes, is work done by the gas?
- (c) How can you find the total work done during a cycle from the graph?
- (d) Calculate the efficiency of the cycle. (1+ 1+ 1+ 1)

16. A refrigerator takes a quantity of heat 'Q' from the cold body, with work done 'W' on it, transfers heat to the hot body. (1+2+1) [Imp 2013]

- a) What does the ratio Q/W represent?
- b) The value of Q/W cannot be infinity. State the law of thermodynamics that explains this statement.
- c) It is possible to cool a room by leaving the door of the electric refrigerator open. Comment on this statement.

17. Figure given below depicts the schematic representation of an engine.

[March 2013]



- Which type of engine is this, a heat engine or a refrigerator?
- Write the four steps of operation in the Carnot cycle.
- A Carnot engine is working between temperatures of 27°C and 327°C . Find its efficiency (η).

18. Three moles of an ideal gas kept at a constant temperature of 300 K are compressed from the volume of 10 litre to 5 litre.

- Which thermodynamic process is involved in this process?
- Calculate the work done required to compress this gas.
- At constant temperature, $P \propto \frac{1}{V}$. Explain it briefly on the basis of Kinetic theory of Gases. [Imp 2012]

19. A heat engine is a device which converts heat energy into work.

[March 2012]

- What is the working substance in an ideal heat engine?
- Draw the Carnot cycle and explain its working.
- Calculate the efficiency of an engine working between steam point and ice point. Can you design an engine of 100% efficiency?

20. A heat engine is a device that converts heat energy into mechanical energy.

[Imp 2011]

- Briefly explain the working of a heat engine taking Carnot engine as an ideal engine. (3)
- A refrigerator is a reverse heat engine. Can we decrease the temperature of a room by keeping the door of a refrigerator opened? Explain. (2)

21. a) Isothermal, Isobaric, isochoric and adiabatic processes are some special thermodynamic processes. In which of these processes, the work done is maximum, when a gas expands from V_1 to V_2 ?

- Which law of thermodynamics implies that no heat engine can be 100% efficient?
- One mole of an ideal gas expands from volume V_1 to volume V_2 at a constant temperature T . Derive an expression for the work done. [March 2011]

22. A heat engine is a device which converts heat energy into mechanical energy. Carnot designed an ideal heat engine which uses an ideal gas as working substance. [Imp 2010]

- Draw a graph showing the variation of pressure and volume of the working substance during the operations of this engine in one cycle.
- A Carnot engine working between 527°C and 127°C has a work output of 800 J per cycle. How much heat is supplied to the engine from the source per cycle?

23A. Thermodynamics deals with the concept of heat and the exchange of heat energy.

- Which law of thermodynamics is used to explain the working of heat engine?
- What are the sink, source and working substances of a domestic refrigerator?
- Explain briefly, the operations of a Carnot's engine draw the Carnot's cycle and deduce the expression for its efficiency.

OR

23B. a) Which thermodynamics process is also called an isentropic process?

b) The efficiency of a Carnot engine is $1/6$. If one reducing the temperature of the sink by 65°C , its efficiency becomes $1/3$. find the temperature of the sink and the source.

c) Obtain the expression for the work done during an adiabatic process.

[March 2010]

24. A sudden expansion or compression is considered as an adiabatic process as there will be no sufficient time for exchanging the heat generated to the surroundings. Now if a gas is compressed to half its volume first rapidly and then slowly, in which case the work done will be greater

(1) [Imp 2009]

25. Match the following:

[March 2009]

	A	B
a)	Mayer's relation	$TV^{\gamma-1} = \text{Constant}$
b)	Isothermal process	$C_p - C_v = R$
c)	Adiabatic process	Lord Kelvin
d)	Absolute scale of temperature	$PV = \text{Constant}$
		$V = \text{Constant}$
		$\frac{C_p}{C_v} = \gamma$

26A. A thermodynamic process is one in which the thermodynamic variables (P, V, T etc.) Change.

- Name the thermodynamic process in which $PV^\gamma = \text{constant}$.
- State and explain first law of thermodynamics.
- Derive an expression for the work done in an adiabatic process involving an ideal gas in terms of pressure and volume.

OR

26B. A heat engine is a device which converts heat energy into work.

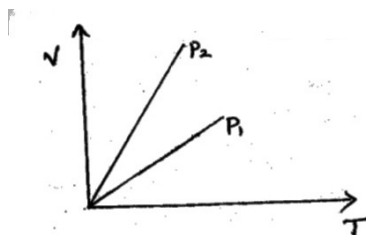
- What is the working substance in an ideal heat engine?
- Draw the indicator diagram for the Carnot cycle. Mention the process involved in the cycle.
- Derive an expression for the efficiency of a Carnot engine in terms of source and sink temperatures.

[March 2009]

CHAPTER 13 - KINETIC THEORY OF GASES

1. What do you mean by Mean free path ? Give an equation for Mean free path. (2) [Imp 2019]
2. By using the law of equipartition of energy, derive the value of ratio of specific heats of a mono atomic gas. (3) [March 2019]
3. According to the kinetic theory of gases, gas molecules are always in random motion. (1+1) [Imp 2018]
 - a. State the law of equipartition of energy.
 - b. Write the average value of energy of a molecule for each vibrational mode
4. Based on the kinetic theory of gases, derive an expression for the pressure exerted by an ideal gas. (3) [March 2018]
5. A mixture of gas consists of 2 moles of oxygen and 4 moles of argon at the temperature 27°C. Find the total internal energy of the system. (Neglect all vibrational modes). (2) [Imp 2017]
6. Estimate the average thermal energy of the helium atom at a temperature of 27°C. [Boltzmann constant is $1.38 \times 10^{-23} \text{ J/K}$.] (2) [March 2017]
7. What do you understand by the term, mean free path of molecules? Name the factors on which it depends. (2) [Imp 2016]
8. Write four postulates of kinetic theory of gases. (2) [March 2016]
9. Mention two conditions under which the real gases obey the ideal gas equation. (2) [Imp 2015]
10. "No real gas is truly ideal".
 - a) When does a real gas approach ideal gas behaviour? (1)
 - b) Define the law of equipartition of energy. (1) [March 2015]
11. a) Write the ideal gas equation.
b) Write any four postulates of the kinetic theory of gases. (1 + 2) [Imp 2014]
12. According to the kinetic theory of gases, gas molecules are always in random motion.
 - a) State the law of equipartition of energy.
 - b) What do you mean by 'mean free path'? Give an equation for the mean free path. (1+ 2) [March 2014]
13. A gas is made up of hydrogen and oxygen molecules. (1+2) [Imp 2013]
 - a) Which molecules moves faster?
 - b) Find the ratio of the velocities of hydrogen and oxygen molecules.
14. Kinetic theory of gases is based on the molecular picture of matter. [March 2013]
 - a) Write any two postulates of kinetic theory of gases.
 - b) Write short note on:
 - i) Equipartition of energy.
 - ii) Mean free path

15. The volume temperature graph of a certain amount of perfect gas at two pressures P_1 and P_2 are shown. Which pressure is larger P_1 or P_2 ? Give Reason. (2)



OR

Absolute zero is the minimum temperature that can be reached by a system. Explain why temperature below absolute zero is not possible. (2) [Imp 2011]

16. a) According to the kinetic theory of gases, the molecules of a gas are identical and in random motion. The collisions made by these molecules on the walls of the container exert pressure on the walls.

Deduce an expression for the pressure of an ideal gas and also find at what temperature the r.m.s. speed of hydrogen is double its value at STP.

b) For a gas $\gamma = \frac{5}{2}$ and R is the universal gas constant, find the values of C_p and C_v . [March 2011]

17. Two vessels of the same size are at the same temperature. One of them contains 1 kg of hydrogen (molecular weight 2) and the other contains 1 kg of nitrogen (molecular weight 28).

a) Which of the vessels contains more molecules?

b) In which vessel is the average molecular speed greater? How many times greater?

c) Which of the vessels is at higher pressure? Why? [Imp 2010]

18. a) State the law of equipartition of energy.

b) A sudden expansion or compression is considered as an adiabatic process as there will be no time sufficient for exchanging the heat generated to the surroundings. Now if a gas is compressed to half its volume first rapidly and then slowly, in which case the work done will be greater.

c) The root mean square velocity of molecules of a gas depends on temperature only. Find the temperature at which r.m.s. velocity of a gas at 0°C will get doubled. [Imp 2009]

CHAPTER 14 - OSCILLATIONS

1. Derive an expression for period of oscillation of a loaded spring. (3) [Imp 2019]

2. A particle executes SHM of amplitude A . At what distance from the mean position is its kinetic energy equal to its potential energy? (2) [Imp 2019]

3. a) Prove that the oscillations of a simple pendulum are simple harmonic and hence derive an expression for the time period of a simple pendulum.

b) What is the length of a simple pendulum, which ticks seconds? (4+1) [March 2019]

4. Which one of the following relationships between the acceleration 'a' and the displacement 'x' of a particle involve simple harmonic motion? **(1) [Imp 2018]**
- $a = 5x$
 - $a = -200 x^2$
 - $a = -5x$
 - $a = 100 x^3$
5. The simplest example of simple harmonic motion is the oscillations of a simple pendulum.
- Derive an expression for the period of oscillation of a simple pendulum.
 - In a simple pendulum made of a metallic wire, what will happen to the period when the temperature increases? Give a reason. **(3+1) [Imp 2018]**
6. What is the time period of a second's pendulum? **(1) [March 2018]**
7. a. Which one of the following relationships between the acceleration (a) and the displacement (x) of a particle involves simple harmonic motion?
- $a = 0.7 x$
 - $a = 200 x$
 - $a = 10x$
 - $a = 100x$
- b. A simple harmonic motion is represented as $x = A \cos t$. Obtain the expression for velocity and acceleration of the object and hence prove that acceleration is directly proportional to the displacement. **(1+3) [March 2018]**
8. All types of simple harmonic motion are periodic in nature. Derive the mathematical expressions for kinetic and potential energies of a particle executing simple harmonic motion. **(4)**
- OR
- Oscillation of a simple pendulum is an example for simple harmonic motion. Derive the period of oscillation of a simple pendulum. **(4) [Imp 2017]**
9. a. Among the following, which are examples of simple harmonic motion?
- The rotation of the earth about its axis.
 - Vertical oscillations of a loaded spring.
 - Oscillations of a simple pendulum.
 - Uniform circular motion.
- b. The displacement in simple harmonic motion can be represented as $x(t) = A \cos(\omega t + \Phi)$, where 'Φ' is the phase constant. Identify and define 'A' and 'ω' in the equation. **(2+2) [March 2017]**
10. a) Define Simple Harmonic motion (SHM). **(1+2+1) [Imp-2016]**
- b) For a SHM, time period $T=2s$. If displacement from the mean position is 10 cm, calculate the instantaneous acceleration.
- c) Graphically show the variation of Kinetic energy of a simple pendulum in SHM with its position.
11. Motion of a simple pendulum is an example for simple harmonic motion.
- a) What do you mean by simple harmonic motion?

b) The acceleration due to gravity on the surface of the moon is 1.7 m/s^2 . What is the time period of a simple pendulum on the moon, if its time period on the earth is 3.5 second? **(2+2) [March 2016]**

12. a) Write the mathematical expression for the time period of simple pendulum. Derive it. **(3)**

b) The time period of a simple pendulum of length L as measured in a lift descending with the acceleration $g/3 \text{ m/s}^2$ is **[Imp 2015]**

i) $2\pi\sqrt{\frac{3l}{2g}}$

ii) $\pi\sqrt{\frac{3l}{g}}$

iii) $2\pi\sqrt{\frac{3l}{g}}$

iv) $2\pi\sqrt{\frac{2l}{3g}}$

13. a) A particle executing SHM is an example of

- i) acceleration of constant magnitude and direction.
- ii) acceleration of changing magnitude and direction.
- iii) acceleration of changing magnitude but constant direction.
- iv) acceleration of constant magnitude but changing direction.

b) List any two conditions for a motion of a body to be simple harmonic.

c) An SHM is given by $x = 8 \sin(10\pi t - \pi/4)$. At which position will its kinetic energy become equal to its potential energy? **(1+2+2) [March 2015]**

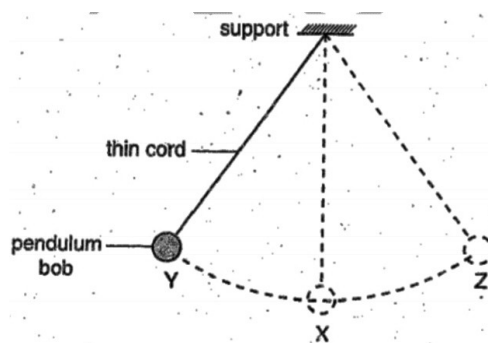
14. Time period of a particle in simple harmonic motion (SHM) depends on the force constant K and mass m of the particle. **[Imp 2014]**

a) A simple pendulum executes SHM approximately. Why then is the time period of a simple pendulum independent of the mass of the pendulum?

b) A man with wristwatch on his hand falls from the top of a tower. Does the watch give the correct time during the free fall? Why?

c) What is the frequency of a simple pendulum mounted in a cabin that is freely falling under gravity?

15. A simple pendulum starts with its bob at position X, shown in the figure. The bob is pulled aside to Y and then released. It swings from Y to Z and back to Y.



a) Take suitable words from the bracket and fill in the gaps.

(Potential, constant, kinetic, different, work, resonance)

To move the bob from X to Y,has to be done on it and itsenergy increases. As it moves from Y to X, some of this energy is converted toenergy. Throughout the swing from Y to Z and back to Y, the total energy is (4 x 1/2 =2)

b) What is the acceleration of the bob when it is at X? (1)

c) What are damped oscillations? (1) [March 2014]

16. Simple pendulum is an example for a harmonic oscillator. (1+1+1) [Imp 2013]

a) Define Simple Harmonic Motion.

b) What is the expression for the period of oscillation of a simple pendulum?

c) A girl is swinging on a swing in the sitting position. How will the period of swing be affected if she stands up?

17. The motion represent by the equation $y(t) = A \cos(\omega t + \Phi)$ is called simple harmonic motion (SHM).

a) Which one of the following examples closely represents SHM? Substantiate your answer.

i) The rotation of the earth about its axis.

ii) Oscillations of a swing.

b) A vibrating simple pendulum of period T is placed in a lift which is accelerating downwards. What is the effect of this on the time period of the pendulum?

c) The displacement of y (in cm) of an oscillating particle varies with time t (in sec) according to the equation. $y = 2 \cos(0.5\pi t + \pi/3)$. Find the amplitude and period of the particle. [March 2013]

18A. Represent Simple Harmonic Motion graphically.

a) Write the differential equation representing Simple Harmonic Motion.

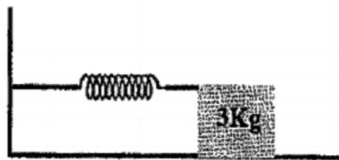
b) Name two examples for simple harmonic motion.

c) A spring with spring constant 1200 N/m is mounted on a horizontal table as shown. A mass of 3 kg is attached to the free end of the spring. The mass is then pulled sideways to a distance of 2 cm and released.

Determine:

i) Frequency of Oscillations.

ii) Maximum acceleration of the mass.



OR

18B. a) What is a seconds pendulum?

b) Time period of a particle in SHM is $T = 2\pi \sqrt{\frac{m}{k}}$. A simple pendulum executes SHM approximately.

Why then the period of pendulum is independent of mass?

c) What is the frequency of oscillation of a simple pendulum mounted in a cabin that is freely falling under gravity? [Imp 2012]

19. Oscillation of a loaded spring are simple harmonic motion.

a) What do you mean by simple harmonic motion?

b) Derive an expression for period of oscillation of a loaded spring.

c) A body oscillate with S.H.M.is given by $x = 5 \cos(2\pi t + \pi/4)$. Calculate the displacement at time $t=1.5s$ [March 2012]

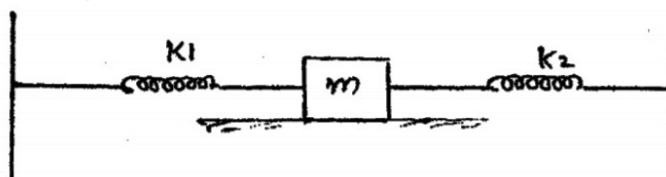
20. Fill in the blanks: [Imp 2011]

$R=8.3 \text{ Jmol}^{-1}\text{K}^{-1}$	$r = \frac{C_p}{C_v} = \frac{7}{5}$	$C_v = \dots$
$F(t)=20\sin(16t+0.3)$	Frequency $f=$	$\phi=0.3$
Energy= $[ML^2 T^{-2}]$	Frequency= $[T^{-1}]$	Plank's Constant =
Natural Oscillation $\omega = \dots$	Damped Oscillation $\omega = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$	Forced Oscillation $\omega = \omega_d$

21A. The amplitude of oscillation of a simple pendulum oscillating in air decreases continuously. This is because of damping. If the damping force is proportional to the velocity of the oscillator, derive an expression for its frequency. (3)

OR

21B. Two spring of force constant ' K_1 ' and ' K_2 ' are connected to a mass ' m ' placed on a horizontal frictionless surface as shown in the figure. Derive an expression for the time period of the horizontal oscillation of the system. (3) [Imp-2011]



22. Say true or false: [Imp 2011]

- The total energy of a body is equal to the work it can do in being brought to rest.
- A block of wood is floating in water its apparent weight is zero.
- Greater the mass of the pendulum bob shorter is its frequency of oscillation.
- The location of centre of mass of a system is independent of the frame of reference used to locate it.

23. a) A simple pendulum is an object suspended by a weightless and inextensible string fixed rigidly to a support.

- i. Under what conditions for the amplitude, are the oscillations of the pendulum simple harmonic?
- ii. The period of oscillation of pendulum is T . What will be the period if the pendulum is suspended in a lift moving down with acceleration equal to $g/3$.

b) A particle executing SHM possess both potential energy and kinetic energy. During the oscillation, the total energy remains constant. If A is the amplitude of oscillation of the particle,

- i. Show graphically, the variation of potential energy and kinetic energy with displacement.
- ii. At what displacement are these energies equal?

[March 2011]

24. The amplitude of a simple harmonic oscillation is doubled. What change will you observe in the following physical quantities of the oscillator?

- a) Period
- b) Maximum velocity
- c) Maximum acceleration
- d) Total energy.

[Imp 2010]

25. The motions that repeat themselves are called periodic motions but for a simple harmonic motion, the force must be proportional to the displacement and it is directed towards the centre of motion.

a) Write an example for a periodic motion that is not a simple harmonic.

b) Write the expression for a period of oscillation of :

- i. A loaded spring
- ii. A simple pendulum

c) A particle executes a SHM of amplitude ' a '.

- i) At what distance from the mean position is its kinetic energy equal to its potential energy?
- ii) At what points is its speed half the maximum speed?

[March 2010]

26. a) A particle of mass m (bob), suspended from one end of an extensible string on negligible mass from a rigid support, forms a simple pendulum. If T is period of oscillation of a simple pendulum show that the time taken by the bob to go directly from its mean position to half the amplitude is $T/12$.

b) Arrive at an expression for the period of oscillations of a simple pendulum. Using the result explaining whether three students, finding the period of oscillations of simple pendulums of same length but with bobs of different masses will get the same value for period of oscillations or not.

c) Explain what happens to the period of oscillation, if the point of suspension of the simple pendulum.

- i. Moves vertically upwards with an acceleration f .
- ii. Moves downwards vertically with acceleration less than the acceleration due to gravity.
- iii. Falls freely under gravity.

iv. Moves horizontally with an acceleration f .

v. Is taken to a height equal to the radius of earth (experiment to find the period of oscillations is done at height equal to the radius of earth). **[Imp 2009]**

27. Ramu tied a spherical pot with a string and suspended on a clamp. He then filled it with water. Length of the string is 90 cm and radius of the pot is 10 cm. He then slightly displaced the pot to one side and made it to oscillate.

a) Name the system to which the above system is identical.

b) Calculate the period of oscillation of pot.

c) Ramu made a small hole at the bottom of the pot, so that there is a steady leakage of water and found that the period of oscillation increases. But, when the water is completely drained out, the period suddenly decreased to the original value. Give reasons for the above variations. **[March 2009]**

CHAPTER 15 - WAVES

1. While conducting a resonance column experiment in the laboratory you can hear the maximum sound at a certain height. **(1+1+3) [Imp 2019]**

(a) Which phenomenon is responsible for this ?

(b) Is resonance column apparatus an open pipe or a closed pipe ?

(c) Find the ratio of frequencies of the first three harmonics in the resonance column apparatus.

2. A wave travelling along a string is described by $y(x,t) = 0.005 \sin(80.0x - 3.0t)$ in which the numerical constants are in SI units. Calculate the wavelength and frequency of the wave. **(2) [March 2019]**

3. a) Draw diagrams showing the first and third harmonics produced in a closed pipe.

b) Write the equation for the fundamental frequency in terms of length of the pipe. **(1+1) [March 2019]**

4. A transverse harmonic wave on a string is described by $y(x, t) = 3.0 \sin(36t + 0.018x + \pi/4)$ where 'x' and 'y' is in cm and 't' is in s. The positive direction of 'x' is from left to right.

a. Is this a travelling wave or a stationary wave? If it is travelling, what are the speed and direction of its propagation?

b. What are its amplitude and frequency?

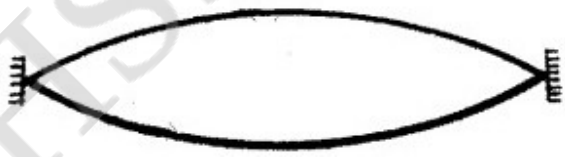
c. What is the least distance between two successive crests in the wave? **(2+2+1) [Imp 2018]**

5. The fundamental mode of vibration of a stretched string is shown below.



a. Draw the second and third harmonics.

b. Prove that frequencies produced in the string are in the ratio of 1: 2: 3.

- c. Let the fundamental frequency is 45 Hz and the length of the wire is 87.5 cm. If the linear density of the wire is 4.0×10^{-2} kg/m. Find the tension in the string. **(1+2+2) [March 2018]**
6. Standing waves can be produced in the air column of a pipe.
- a) Standing waves produced in an open pipe contains.....
- i) fundamental frequency only
 - ii) odd harmonics only
 - iii) even harmonics only
 - iv) all harmonics
- b) Which harmonic mode of the pipe is resonantly excited by 1.1 kHz in an open pipe of length 30 cm? (Velocity of sound = 330 m/s)
- c) If an open pipe produces a fundamental frequency 'f' in air, the fundamental frequency produced by the same pipe dipped half in water is.....
- i) f
 - ii) f/2
 - iii) 2f
 - iv) no harmonics is produced
- (1+2+1) [Imp 2017]**
7. a. A transverse harmonic wave is described by $y = 3.0 \sin(0.018x + 36t)$, where 'x' and 'y' are in cm. The amplitude of this wave is
- b. The figure below shows the fundamental mode or first harmonic in a stretched string when a standing wave is formed in the string.
- 
- Draw the figure that shows the second harmonic in the string. If 'L' is the length of the string and V is the speed of the wave in the string, what are the equations of first and second harmonic frequencies. **(1+3) [March 2017]**
8. A woman is travelling in a car at a speed of 25 m/s. She is moving away from a source producing a sound of 512 Hz. **(2+1+1) [Imp 2016]**
- a) Calculate the frequency of sound heard by her. (speed of sound in air = 340 m/s)
- b) Name the phenomenon that explains this variation in frequency.
- c) Draw the second harmonic of an open pipe (both end open). Mark node and an antinode in the figure.
9. In resonance column experiment, we can hear maximum sound at a certain height. This is due to the phenomenon of resonance. **(2+2) [March 2016]**
- a) Show that for a pipe closed at one end, the frequencies are in the ratio $\nu_1 : \nu_2 : \nu_3 = 1 : 3 : 5$.
- b) Open pipes are preferred to closed pipes in musical instruments. Why?

10. The pitch of the siren of a fire engine increases as it approaches a boy standing at bus stop.

a) The phenomenon behind it, is due to.....

- i) Doppler effect
- ii) Standing wave
- iii) Newton's law of cooling
- iv) Resonance

b) Obtain a general expression for the apparent frequency of the siren as heard by the boy.

(3) [Imp 2015]

11. Fill in the blanks.

[March 2015]

$\hat{i} \cdot \hat{i} = 1$	$\hat{i} \cdot \hat{i} = 1$	$|\hat{i} + \hat{i}| = \dots$
Frequency $\nu = \frac{1}{T}$	$\dots = \frac{2\pi}{\lambda}$	Angular frequency $\omega = \frac{2\pi}{T}$
Two strings A and B are vibrating together. Frequency of string A decreasing from 324Hz	Fixed frequency of string B =Hz	Number of beats increasing from 6 per second.

12. A transverse harmonic wave on a string is described by, $y(x, t) = 3.0 \sin(36t + 0.018x + \pi/4)$ Where x and y are in centimetres and t in seconds. The positive direction of x is from left to right.

a) Is this a travelling wave or a stationary wave?

b) If it is travelling, what is the speed and direction of its propagation ?

c) What is its amplitude and frequency?

d) What is the initial phase at the origin?

(1+1+2) [March 2015]

13. While performing the resonance column apparatus experiment in a laboratory at a certain height, you can hear maximum sound.

a) Name the physical concept behind it.

b) Explain with diagrams, the normal modes of vibration in the case of air in an open tube.

c) Open pipes are preferred to closed ones in musical instruments. Why?

(1+3+1) [Imp 2014]

14. The equation for a wave is given below. $y = A \sin(kx + \omega t)$.

a) It is a travelling or stationary wave?

b) Draw the stationary waves in a stretched string in the second harmonic.

c) Show that the fundamental frequency of an open pipe is twice the fundamental frequency of a closed of the same length.

(1+ 1+ 2) [March 2014]

15. A sound travelling along a string is described by $y = 0.005 \sin (80.0 x - 3.0 t)$. (1+1+1) [Imp 2013]

a) Calculate:

i) Amplitude

ii) Wavelength

b) Where will a man hear a louder sound in the case of stationary wave (node or antinode) ? Why?

16. A student plucks at the centre of a stretched string and observes the wave pattern produced.

a) What type of wave is produced in the string?

b) Plot the above wave pattern pictorially. Label the nodes and antinodes on the pattern. [March 2013]

17. A transverse harmonic wave on a string is described by $Y (x , t) = 3.0 \sin(36 t + 0.018 x + \pi/4)$, where x and y are in centimetres and t in seconds. The positive direction of x is from left to right.

a) Is it is travelling or stationary wave?

b) What are its amplitude and frequency?

c) What is the initial phase at the origin?

d) If it is a travelling wave, what are the speed and direction of its propagation? [Imp 2012]

18. While conducting a resonance column experiment in the laboratory, you can hear the maximum sound at a certain height.

a) Explain the phenomenon of sound.

b) Show that in a closed pipe at one end, the frequencies of the first three harmonics are in the ratio of $v_1 : v_2 : v_3 = 1 : 3 : 5$.

c) Open pipes are preferred to closed ones in musical instruments. Why? [March 2012]

19. In a Laboratory Raju uses a tuning fork in resonance column experiment.

a) Why type of wave is produced by the tuning fork in this case?

b) Mention any four characteristics of these waves. [Imp 2011]

20. a) Wave motion is a propagation of energy through a material medium due to repeated periodic motion.

i. Transverse waves cannot be propagated through gases. Why?

ii. What was the condition assumed by Laplace in correcting Newton's equation for the velocity of sound in a gas? Write the Newton's-Laplace equation.

b) A source of sound of frequency 256 Hz is in –between a listener and a wall. If the source is moving towards the wall with a velocity of 5 ms^{-1} , how many beats per second will be heard if the sound travels with a speed of 330 ms^{-1} ? [March 2011]

21. A flute is an example of an open pipe.

a) Sketch the pattern of wave forms of the first two harmonics formed in an open pipe.

b) Show that in an open pipe the frequencies of the first three harmonics are in the ration 1:2:3. [Imp 2010]

22. Nobody can image a world without sound. Sound is a part of our life - music's, ripples, echoes etc have a lot of applications. **[March 2010]**

a) Can you say how a bat can ascertain directions and distances without 'eyes'? **(1)**

b) Doctor's use an ultrasonic scanner to diagnose tumour tissues. If the frequency of the scanner is 4.2Mhz and the speed of sound wave in the tissue is 1.7kms^{-1} find the wavelength of the wave. **(1)**

c) Obtain the equation of a standing wave. Then plot it to locate the nodal and antinodal points. **(3)**

23. a) Depending on the direction of the displacement caused in the medium and that of direction of propagation, we can have transverse and longitudinal waves in solids. But we can have only longitudinal waves in fluids. Why? **(1)**

b) For a passenger standing in a railway station, the frequencies of the whistle of the train differ as it approaches and moves away from him. This apparent change in frequency due to the relative motion of the source or observer is called Doppler effect. Find a general expression for the apparent frequency. Using this expression explain the variation of frequency.

i. When the source of sound is moving and listener is stationary.

ii. When listener is moving and the source is stationary. **(2)**

c) If the apparent frequency of the whistle of an engine changes in the ratio 5:4 as the engine passes a man at rest in the railway station, find the velocity of the train. (The velocity of sound is 340 m/second.) **(2)[Imp 2009]**

24. A train is approaching the station blowing its siren. A man standing on the platform observes a change in frequency of the sound produced.

a) What is this phenomenon called?

b) Write down the expression for the apparent frequency heard by a stationary observer when the source is approaching him with a velocity 'u'.

c) Write the general expression for a plane progressive wave.

d) Distinguish between transverse and longitudinal waves. Give one example for each. **[March 2009]**



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