

Question Bank

Class XI

Subject : Physics

Units and Measurement

VERY SHORT ANSWER TYPE QUESTIONS (1 MARK)

- The weakest fundamental force in nature is
 - gravitational force
 - nuclear force
 - electrostatic force
 - magnetic force
- A student when discussing the properties of a medium (except vacuum) writes :

Velocity of light in vacuum = velocity of light in medium. This formula is

 - dimensionally correct
 - dimensionally incorrect
 - numerically incorrect
 - Both (a) and (c)
- The strongest fundamental force in nature is
 - gravitational force
 - strong nuclear force
 - electrostatic force
 - magnetic force
- The equation of state for a real gas is given by
$$(P + a/V^2)(V-b) = RT$$

The dimensions of the constant 'a' are

 - $[ML^5T^{-2}]$
 - $[M^{-1}L^5T^2]$
 - $[ML^{-5}T^{-1}]$
 - $[ML^5T^{-1}]$
- The Indian born Physicists who have been awarded Nobel Prize is

- a) Sir C.V.Raman b) Meghnad Saha c) Vikram Sarabhai
d) Sir J.C. Bose
6. The pair of physical quantities that have the same dimensions are
- a) Torque and work
b) angular momentum and work
c) Planck's constant and torque
d) force and stress
7. _____ type of waves is used in SONAR.
8. If $Z = A + B$, then the maximum possible error in Z is $\Delta Z =$ _____.
9. Name any two laws of conservation in nature.
10. What is the unified atomic mass unit?
11. If $x = 0.72 + 0.8 + 3.87 - 1.089$, then find the number of significant digits in the value of 'x'.
12. What is Reductionism?

SHORT ANSWER TYPE QUESTIONS (2 MARK)

13. A SONAR (sound navigation and ranging) uses ultrasonic waves (frequency > 20 kHz) to locate objects under water. In a submarine equipped with SONAR the time delay between generation of a probe wave and the reception of its echo after reflection from an enemy submarine is found to be 77.0 s. What is the distance of the enemy submarine?
(Speed of sound in water = 1450 ms^{-1}).
14. Define parallax second and calculate its value in metres.
15. Describe parallax method to determine distance of a planet.
16. An astronomical unit (AU) is the average distance of the Earth from the Sun, approximately $1.50 \times 10^8 \text{ km}$. The speed of light is about $3.0 \times 10^8 \text{ m/s}$. Express the speed of light in terms of AU per minute.
17. What is %error in density of a cube when its mass is uncertain by 2% and length of its edge is uncertain by 1%?

18. The resistance $R = V / I$, where $V = (100 \pm 5) \text{ V}$ and $I = (10 \pm 0.2) \text{ A}$. Find the percentage error in R .
19. In CGS system the magnitude of the force is 100 dynes. In another system where the fundamental physical quantities are kilogram, meter, and minute, find the magnitude of the force.
20. The mass and volume of a body are 4.237 g and 2.5 cm^3 , respectively. Find the density of the material of the body in correct significant figures.

SHORT ANSWER TYPE QUESTIONS (3 MARK)

21. What is parallax? The parallax of a heavenly body measured from two points diametrically opposite on equator of earth is 2.0 minute. If radius of earth is 6400 km, calculate distance of heavenly body.
22. Explain how you would determine the size of a molecule of 'oleic acid' in the laboratory.
23. State the principle of homogeneity of dimensions. Give the dimensions of angular velocity. Give the dimensional formula for the combination: $v^2 x - \frac{1}{2} a^{-1/2}$, where 'x' is in m, v is in ms^{-1} , and a is in ms^{-2}
24. Name another physical quantity having the same dimensions as energy. Name a physical quantity which has a unit but dimensionless.
25. The force required to keep a body in uniform circular motion depends on the mass of the body, radius of the circle and the linear speed of the body. Using method of dimensions, derive a relation among these physical quantities.
26. The frequency 'f' of vibration of a stretched string depends upon (i) its length, (ii) its mass per unit length 'm' and (iii) the Tension 'T' in the string. Obtain dimensionally an expression for frequency 'f'.
27. If momentum (P), area (A) and time (T) are taken to be fundamental quantities, then what is the dimensional formula of energy?
28. Write the dimensions of a/b in the relation: $F = a x \sqrt{bt^2}$ Where F is force, x is distance and t is time.

29. A calorie is a unit of heat or energy and it equals about 4.2 J where $1\text{J} = 1\text{kg m}^2\text{ s}^{-2}$.

Suppose we employ a system of units in which the unit of mass equals α kg, the unit of length equals β m, the unit of time is γ s. Show that a calorie has a magnitude

$4.2 \alpha^{-1} \beta^{-2} \gamma^2$ in terms of the new units.

30. What is meant by scientific method? List the five main steps of scientific method.
31. The position of a particle at time t is given by the relation $x(t) = (v_0/\alpha)(1 - e^{-\alpha t})$, where v_0 is a constant and $\alpha > 0$. Find the dimension of v_0 and α are respectively.
32. If $\alpha = (F/v_2) \sin(\beta t)$ (here v = velocity, F = force, t = time)

Find the dimensions of α and β .

33. If velocity (V), force (F), and energy (E) are taken as fundamental units, then find the dimensional formula for mass.
34. You may not know integration, but using dimensional analysis you can check on some results. In the integral:

$$\int \frac{dx}{(2ax - x^2)^{1/2}} = a^n \sin^{-1} \left(\frac{x}{a} - 1 \right),$$

find the value of n .

LONG ANSWER TYPE QUESTIONS (5MARK)

35. What is the meaning of the terms (i) accuracy and (ii) precision? What are systematic errors and random errors? Two students are asked to find the mass of a piece of a metal whose mass is known to be 3.678 Kg. Measurements taken by them are 3.482Kg and 3.6Kg. Which of the measurement is (i) more precise and (ii) more accurate? Give reason.
36. In an experiment to determine the value of g in the lab, the readings for the period of oscillations of a simple pendulum, on successive measurements, recorded by a student are as: 2.71s, 2.56s, 2.80s, 2.63s, and 2.42s. Calculate the absolute error in the mean value for the period.

37. A physical quantity 'Z' has dimensional formula $M^a L^b T^{-c}$. If the percentage error in the measurement of mass, length and time are $\alpha\%$, $\beta\%$, $\gamma\%$ respectively, what is the maximum percentage error possible in 'Z'?
38. The instantaneous velocity of a particle is given by $v = b(t+c)^{-1}$, where b and c are constants. What are the dimension formulae of b and c?
39. The equation of state for one mole of some gas can be expressed as: $(P + a/V^2)(V - b) = RT$, where P, V, T are pressure, volume, and temperature of the gas. (i) Find dimension formula for (ab-1) and (ii) Find the ratio of SI units and CGS units of (ab-1).

QUESTIONS FOR ENHANCED LEARNING

1. Name a physical quantity whose dimensions are same as that of Planck's constant.
2. Find the angle subtended by a coin of radius 1cm held at a distance of 80 cm from your eyes. (1.43°)
3. If nth division of main scale coincides with the (n+1)th division of vernier scale, find the least count of the vernier. Given one main scale division is equal to 'a' units. ($a/(n+1)$)
4. The specific heats of a gas are measured as $C_p = (12.28 \pm 0.2)$ units and $C_v = (3.97 \pm 0.3)$ units. Find the value of real gas constant R and percentage error in R. (6.016%)
5. To find the distance d over which a signal can be seen clearly in foggy conditions, a railways engineer uses dimensional analysis and assumes that the distance depends on the mass density ' ρ ' of the fog, intensity (power/area) 'S' of the light from the signal and its frequency 'f'. The engineer finds that 'd' is proportional to $S^{1/n}$. What is the value of 'n'?

Motion in a straight line

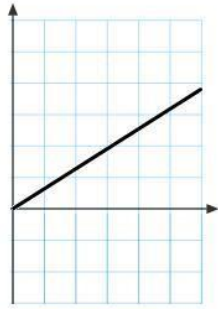
VERY SHORT ANSWER TYPE QUESTIONS (1 MARK)

1. The unit of linear acceleration is

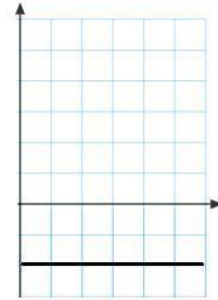
- a) kg-m
- b) m/s
- c) m/s^2
- d) Newton
2. _____ is the motion along a curved path.
- a) rectilinear motion
- b) curvilinear Motion
- c) both a) and b)
- d) none of the above mentioned
3. The acceleration 'a' of a particle starting from rest varies with time according to the relation $a = \alpha t + \beta$. The velocity of the particle after a time 't' will be
- a) $\alpha t^2/2 + \beta t$
- b) $\alpha t^2/2 + \beta t$
- c) $\alpha t^2 + \beta t/2$
- d) $(\alpha t^2 + \beta)/2$
4. When a particle moves with a uniform velocity along a straight line path, then the particle has
- a) tangential acceleration only
- b) centripetal acceleration only
- c) both tangential and centripetal acceleration
- d) none of the mentioned
5. Total distance covered in total time taken is termed as
- a) instantaneous speed
- b) average speed
- c) uniform speed

d) variable speed

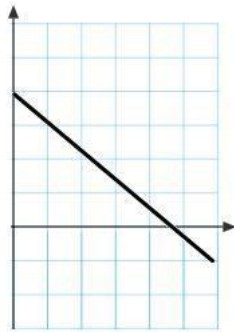
6. Which of the following graphs represents the velocity as a function of time of an object thrown straight up?



a)

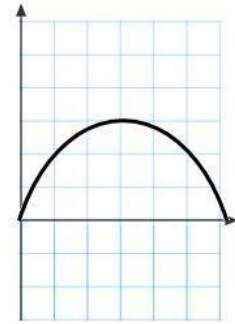


b.

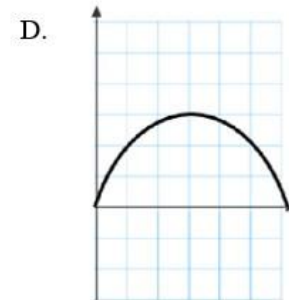
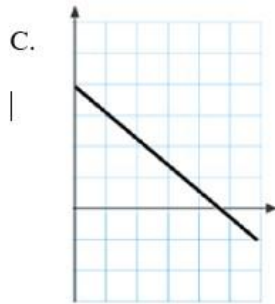
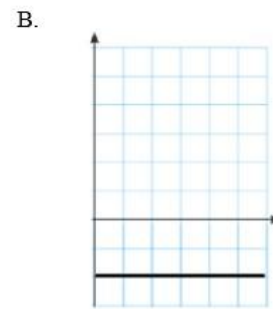
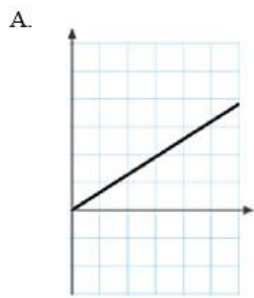


c.

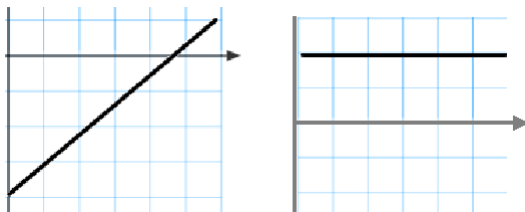
d.



7. Which of the following graphs represents the acceleration as a function of time of an object thrown straight up? Under what condition average velocity and average velocity become equal?



8.



The graphs above represent the velocity and acceleration (in this order) as a function of time for a marble moving in one dimension. Which of the following could describe the motion of the marble?

- Rolling along the floor and then bouncing off a wall.
 - Rolling down one side of a bowl and then rolling up the other side.
 - Rolling up a ramp and then rolling back down.
 - Falling and then bouncing elastically off a hard floor.
9. A moving car possesses average velocities of 5 ms^{-1} , 10 ms^{-1} , and 15 ms^{-1} in the first, second, and third seconds, respectively. What is the total distance covered by the car in these 3s?
10. B_1 , B_2 and B_3 are three balloons ascending with velocities v , $2v$ and $3v$, respectively.

- If a bomb is dropped from each balloon when they are at the same height, then:
- Bomb from B_1 reaches the ground first.
 - Bomb from B_2 reaches the ground first.
 - Bomb from B_3 reaches the ground first.
 - All bombs reach the ground simultaneously
11. A point moves with uniform acceleration and ' v_1 ', ' v_2 ' and ' v_3 ' denote the average velocities in the three successive intervals of time ' t_1 ', ' t_2 ' and ' t_3 '. Which of the following relation is correct?
- $(v_1 - v_2) : (v_2 - v_3) = (t_1 - t_2) : (t_2 + t_3)$
 - $(v_1 - v_2) : (v_2 - v_3) = (t_1 + t_2) : (t_2 + t_3)$
 - $(v_1 - v_2) : (v_2 - v_3) = (t_1 - t_2) : (t_1 - t_3)$
 - $(v_1 - v_2) : (v_2 - v_3) = (t_1 - t_2) : (t_2 - t_3)$
12. Fill in the blank: A body is projected upward. Up to the maximum height, the time taken will be greater to travel _____ (first half/second half).
13. State True/False:
Average acceleration and instantaneous acceleration are always equal in rectilinear motion.

ASSERTION REASONING TYPE OF QUESTIONS-

Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

- Both A and R are true and R is the correct explanation of A
- Both A and R are true but R is NOT the correct explanation of A
- A is true but R is false
- A is false and R is also false

14. Assertion: An object can have constant speed but variable velocity.
Reason: Speed is a scalar but velocity is a vector quantity.
15. Assertion : A physical quantity can have unit but dimensionless .
Reason : unit is a fundamental but dimension is a derived.
16. Assertion: The slope of displacement-time graph of a body moving with high _____ magnitude of velocity is steeper than the slope of a displacement-time _____ graph of a body with low magnitude of velocity.

Reason: |Slope of displacement-time graph| = magnitude of velocity of the body.

17. Assertion: The speed of a body can be negative.

Reason: If the body is moving in the opposite direction of positive motion, then its speed is negative.

Case-based questions

18. Answer question numbers (a) – (e) on the basis of your understanding of the following paragraph and the related studied concepts:

Measurement of any physical quantity involves comparison with a certain basic, arbitrarily chosen, internationally accepted reference standard called unit. The units for the fundamental or base quantities are called fundamental or base units. The units of all other physical quantities can be expressed in terms of fundamental units and are thus named as derived units. In SI system units of seven base quantities are taken as the fundamental units. The nature of a physical quantity is described by its dimensions. All the physical quantities can be expressed in terms of some combination of seven fundamental units. The dimensions of a physical quantity are thus the powers to which the base quantities are raised to represent that quantity.

If a given physical quantity depends on a^{th} power of mass, b^{th} power of length, c^{th} power of time etc., then its dimensions are expressed as $[M^a L^b T^c]$.

- Name the seven base quantities in SI system of units.
- Write the dimensional formula of Force and Energy.
- Can a quantity have units and still be dimensionless? If yes, give examples.
- Do you know any physical quantity which has dimensions but no units? (e) What is a dimensionless constant?

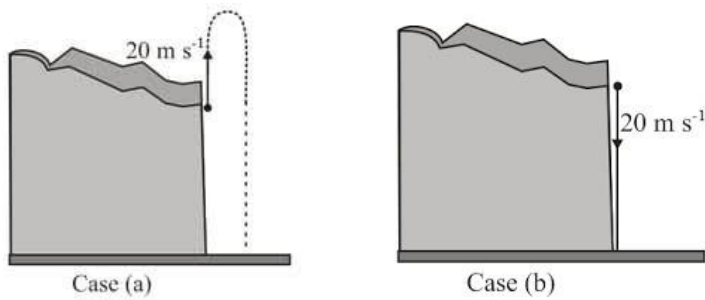
19. Answer question numbers (a) – (e) on the basis of your understanding of the following paragraph and the related studied concepts:

An object is in motion along a straight path along x-axis and its velocity is given by $v = \alpha + \beta t$, where $\alpha = 2.5 \text{ ms}^{-1}$ and $\beta = 0.5 \text{ ms}^{-2}$ and time is measured in seconds. The object starts moving from the origin point i.e. at $t = 0$, the object was situated at $x = 0$. Now answer the following questions:

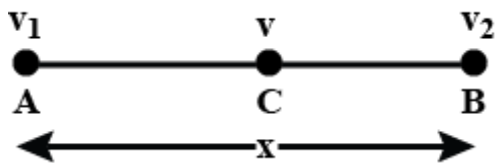
- Is the object in uniform motion?
- What is the acceleration of the moving object? Is it uniform?
- Draw v-t graph and a-t graph for the given object for a time ranging from $t = 0$ s to $t = 20$ s.
- What is the distance covered by the object in 50s?
- Calculate the average velocity of the object between $t = 10$ s and $t = 30$ s.

SHORT ANSWER TYPE QUESTIONS (2 MARK)

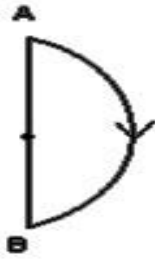
20. Define the terms: position vector, average speed.
21. Define the terms: average velocity, instantaneous velocity.
22. Define the terms: average acceleration and instantaneous acceleration.
23. What is the average speed for whole of the journey, when body covers half of its journey with speed V_1 and other half with V_2 ?
24. What is the average speed for whole of the journey, when body moves for half time of its journey with speed V_1 and other half time with V_2 ?
25. How long will a person sitting near the window of a train traveling with a speed of 54 km/h see another train passing by in the opposite direction with a speed of 36 km/h, if the length of the other train is 150 m?
26. A body moves along the x-axis. What is the sign of its acceleration if it is moving (a) in the positive direction with increasing speed, (b) in the positive direction with decreasing speed?
27. A body moves along the x-axis. What is the sign of its acceleration if it is moving (a) in the negative direction with increasing speed, and (b) in the negative direction with decreasing speed?
28. A particle starts moving rectilinearly at time $t = 0$ such that its velocity 'v' changes with time 't' according to the equation $v = t^2 - t$ where t is in seconds and v in m/s. Find the time interval for which the direction of velocity is opposite to the direction of acceleration.
29. Consider two cases, in case (a) a ball that has been thrown straight upward from the edge of a cliff. The initial speed of the ball is 20 m/s. It goes up and then falls back down, eventually hitting the ground beneath the cliff. In case (b) the ball has been thrown straight downward at the same initial speed. In the absence of air resistance, would the ball in case (b) strike the ground with (i) smaller speed than in case (a), (ii) same speed as in case (a), or (iii) greater speed than the ball in case (a)? Why?



30. Train 'A' moves north with a speed of 54 km/hr and a monkey is running on its roof at a speed of 18 km/hr in opposite direction. What is the speed of the monkey with respect to the ground?
31. Can a body have
- Zero instantaneous velocity and yet be accelerating?
 - Zero average speed but non-zero average velocity?
 - Negative acceleration and yet be speeding up?
 - The magnitude of average velocity be equal to average speed?
32. A person is throwing two balls in the air one after the other. He throws the second ball when the first ball is at the highest point. If he is throwing the balls every second, how high do they rise?
33. A particle moving with uniform acceleration from A to B along a straight line has velocities v_1 and v_2 at A and B, respectively. If C is the mid-point between A and B, then determine the velocity of the particle at C.



34. A particle moves from A to B along a semi-circular path (as shown) of radius 2.0 m in 0.5 sec. What is the average speed and magnitude of the average velocity?

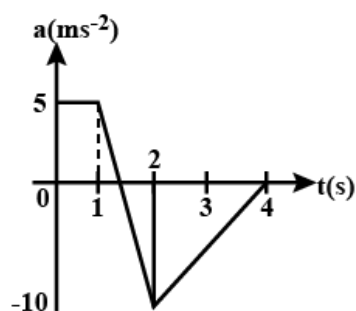


SHORT ANSWER TYPE QUESTIONS (3 MARK)

35. Derive the relation $X_2 - X_1 = V_1t + \frac{1}{2}at^2$ for uniformly accelerated motion using graphical method.
36. Derive the relation $V^2 - U^2 = 2aS$ for uniformly accelerated motion using graphical method.
37. A diwali rocket moves vertically up with a constant acceleration $a_1 = 20/3 \text{ ms}^{-2}$. After sometimes, its fuel gets exhausted and then it falls freely with an acceleration $a_2 = 10\text{ms}^{-2}$. If the maximum height attained by the diwali rocket is 'h', using graphical method, find its speed when the fuel is just exhausted. Assume $h = 50 \text{ m}$.
38. Between the two stations, a train accelerates from rest uniformly at first, then moves with constant velocity and finally retards uniformly to come to rest. If the ratio of the time taken be 1:8:1 and the maximum speed attained be 60 km/h , then, what is the average speed over the whole journey?
39. A body starting from rest is moving along a straight road with uniform acceleration. It passes through two points P and Q separated by a distance of 100 meters with velocities 36 km/hr and 54 Km/hr respectively. What is the acceleration? What time would it take to cover the distance P to Q? How far from point P did the body start?
40. A stone is dropped from a rising balloon at a height of 96m from the ground and it reaches the ground after 6 sec, what was the velocity of the balloon when the stone was dropped?
41. A car accelerates from rest at a constant rate A for some time, then it retards at constant rate B to come to rest. If the total time lapsed is T,

evaluate the maximum velocity acquired and the total distance travelled in terms of A, B and T.

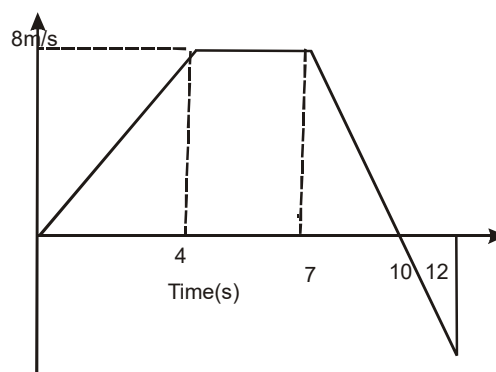
42. A boy on a 20 m high cliff drops a stone. One second later, he throws down another stone such that both the stones hit the ground simultaneously. Find the initial velocity of the second stone. ($g = 10 \text{ m/s}^2$)
43. Position coordinates of a particle are $x = at^2$, $y = bt^2$ and $z = 0$. Find the expression for the speed of the particle as a function of time.
44. Two trains P and Q are moving along parallel tracks with the same uniform speed of 20 ms^{-1} . The driver of train P decides to overtake train Q and accelerates his train by 1 ms^{-2} . After 50 s, train P crosses the engine of train Q. Find out what was the distance between the two trains initially, provided the length of each train is 400m.
45. A body is thrown vertically up from the ground with a speed of 30 m/s.
(a) What is the acceleration of the body when it is at the highest point? (b) How long would it take to reach highest point of its journey? And how high is this point?
46. In a car race on straight road, car A takes time 't' less than car B at the finish and passes finishing point with a speed 'v' more than that of car B. Both the cars start from rest and travel with constant acceleration α and β respectively. Then show that $v = \sqrt{ta_1a_2}$.
47. A particle moves along x-axis with an initial speed $v_0 = 5 \text{ ms}^{-1}$. If its acceleration varies with time as shown in a-t graph in figure, (a) Find the velocity of the particle at $t = 4\text{s}$. (b) Find the time when the particle starts moving along -x direction.



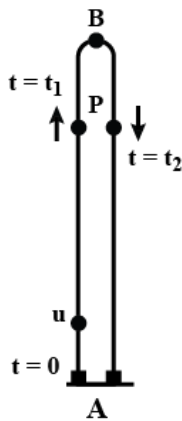
48. A car starts from rest and accelerates uniformly for 10 s to a velocity of 8 m/s. It then runs at a constant velocity for some time. It is finally brought to rest in 64 meters with a constant negative acceleration. The total distance covered by the car is 584 meters.
- Find the value of the two accelerations and the total time taken.

LONG ANSWER TYPE QUESTIONS (5 MARK)

49. A body is thrown vertically up from the ground with a speed of 30 m/s.
- (a) What is the acceleration of the body when it is at the highest point? (b) How long would it take to reach highest point of its journey? And how high is this point? (c) After how many seconds will it have (i) an upward speed of 10 m/s? (ii) a downward speed of 10 m/s? (d) When will it return back to the ground? (e) Sketch the velocity- time graph. (f) What is the area under the graph for $t = 0$ to 3s?
50. A player throws a ball upwards with an initial speed of 29.4 m s^{-1} .
- Choose the $x = 0 \text{ m}$ and $t = 0 \text{ s}$ to be the location and time of the ball at its initial point, vertically upward direction to be the positive direction of x -axis. Write the signs of position and acceleration of the ball during its upward and downward motion. After how long does the ball return to the player's hands? (Take $g = 9.8 \text{ m s}^{-2}$ and neglect air resistance).
51. The variation of velocity of a particle along a straight line, with time is as shown: For how much time does it accelerate and what is the acceleration? What are the total distance travelled and displacement of the body for entire motion? What are the average speed and average velocity of the body for entire motion? For how much distance is it having uniform motion?



52. Two towns A and B are connected by a regular bus service with a bus leaving in either direction every T minutes. A man cycling with a speed of 20 km h^{-1} in the direction A to B notices that a bus goes past him every 18 min in the direction of his motion, and every 6 min in the opposite direction. What is the period T of the bus service and with what speed (assumed constant) do the buses ply on the road?
53. A ball thrown down from the top of a tower takes time t_1 to reach the ground. It takes time t_2 to reach the ground if it is thrown from the same point with the same speed in the upward direction. Show that the time it will take to fall freely to the ground from the top of the tower is $\sqrt{t_1 t_2}$. (Neglect air resistance)
54. A ball is projected vertically up such that it passes through a fixed point after a time t_1 and t_2 , respectively. Find
- The height at which the point is located with respect to the point of projection
 - The speed of the projection of the ball.
 - The velocity of the ball at the time of passing through point P.
 - (i) The maximum height reached by the ball relative to the point of projection A and (ii) maximum height reached by the ball relative to point P under consideration. (iii) The average speed and average velocity of the ball during the motion from A to P for the time t_1 and t_2 , respectively.



55. Say Yes or No:

- Can an object moving towards north have acceleration towards south?
- Can an object reverse the direction of its motion even though it has constant acceleration?
- Can an object reverse the direction of its acceleration even though it continues to move in the same direction?
- Average speed is the magnitude of average velocity
- At any instant of time the directions of change in velocity and acceleration are different.

ENHANCED LEARNING

- A body moving with a uniform acceleration describes 12 m in third second of its motion and 20 m in the fifth second. Find its velocity after 10 second.
- The acceleration experiences by a boat after the engine is cut off, is given by $dv/dt = kv^3$ where k is a constant. If v_0 is the magnitude of the velocity at cut-off, find the magnitude of the velocity at time t after the off.
 $(v = v_0 / (1 + 2ktv_0^2)^{1/2})$
- The relation between t and distance x is $t = ax^2 + bx$, where a and b are constants.
 Express the instantaneous acceleration in terms of instantaneous velocity.
 $(\text{acceleration} = -2av^3)$

4. The position of a particle moving along x-axis is related to time as follow:
- $$x = 2t^2 - t^3, \text{ where } x \text{ is in meters and } t \text{ is in seconds.}$$
- (a) What is the maximum displacement of particle along x-axis and at what instant does it attain it?
- (b) What is the distance covered in the first 3 seconds?
- (c) What is the displacement in the first 4 seconds?
- (d) What is the particle's average speed and average velocity in the first 3 seconds?
- (e) What is the average acceleration between the interval $t = 2s$ to $t = 4s$?

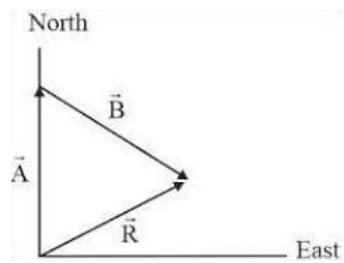
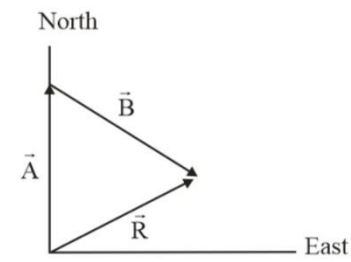
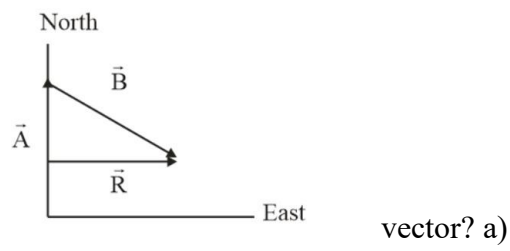
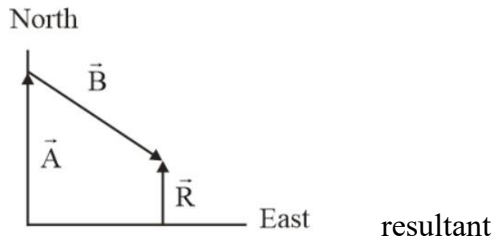
MOTION IN A PLANE

VERY SHORT ANSWER TYPE QUESTIONS (1 MARK)

1. Which of the following is a vector quantity?
- a. Distance b. Displacement c. Area d. Mass
2. The value of $\mathbf{i} \cdot \mathbf{j}$ is
- a. zero b. 1 c. -1
- d. \mathbf{k}
3. The value of $\mathbf{i} \times \mathbf{j}$ is
- a. zero b. 1 c. -1
- d. \mathbf{k}
4. The value of $\mathbf{i} \cdot \mathbf{i}$ is
- a. zero b. 1 c. -1
- d. \mathbf{k}
5. The value of $\mathbf{j} \times \mathbf{i}$ is
- a. zero b. $-\mathbf{k}$ c. -1 d. \mathbf{k}
6. How many minimum number of vectors in different planes can be added to give zero resultant:
- a. 2 b. 3 c. 4
- d. 5

direction south of east. The two displacement vectors \vec{A} and \vec{B} can be added together to give a resultant vector \vec{R} .

Which drawing correctly shows the

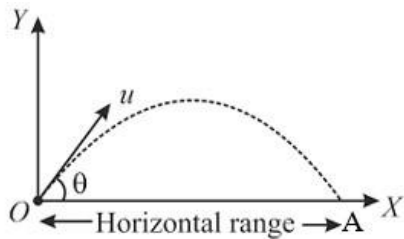


b)

c)

d)

15. The only vector quantity among mass, pressure, impulse, time, energy is _____.
16. State true/false: The magnitude of a vector is always a scalar.
17. State true/false: Each rectangular component of a vector is always a scalar.
18. Define centripetal force?
19. What is the average velocity when the projectile moves from O to A?



20. The equation of projectile is $y = 16x - x^2/4$. Find the horizontal range.
21. What is the value of $\mathbf{A} \times \mathbf{A}$?

CASE BASED QUESTION:

22. Answer question numbers (a) – (e) on the basis of your understanding of the following paragraph and the related studied concepts:

Let two objects A and B be moving with velocities \mathbf{v}_A and \mathbf{v}_B respectively at a particular instant of time, then velocity of object A with respect to velocity of object B (i.e. presuming object B to be at rest) is called relative velocity of A with respect to B and is expressed as \mathbf{v}_{AB} .

$$\mathbf{v}_{AB} = \mathbf{v}_A - \mathbf{v}_B$$

Similarly, relative velocity of object B with respect to object A:

$$\mathbf{v}_{BA} = \mathbf{v}_B - \mathbf{v}_A$$

From the above two relations, it is clear that

$$\mathbf{V}_{AB} = -\mathbf{V}_{BA}$$

The concept of relative velocity is very important in daily life.

- a) If two objects are in motion along a straight line path in same direction then what is the relative velocity of one object with respect to another.
- b) What will be the relative velocity of object A w.r.t. object B when they are moving in opposite directions?
- c) Write the kinematic equations for relative motion.
- d) A thief snatches a bag from a person and then moves along a straight road with a constant velocity 36 km/h. A police inspector observed the incident of snatching. He starts his bike within 10s and accelerates it so that he is able catch the thief after 30 s.

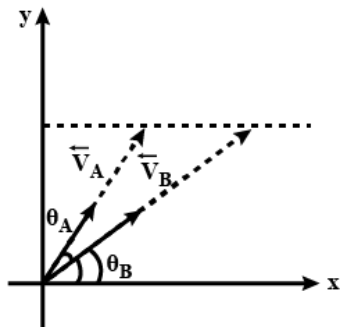
What is the acceleration of his bike?

- e) What is the average velocity of the police inspector's bike?

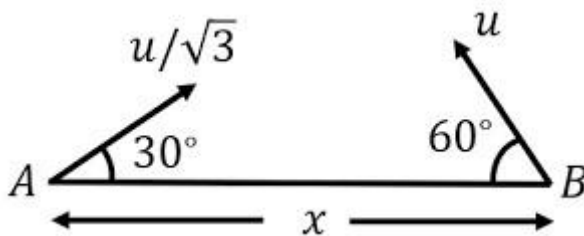
SHORT ANSWER TYPE QUESTIONS (2 MARK)

23. A ball is thrown at different angles with the same speed u and from the same point and it has the same range in both cases. If ' y_1 ' and ' y_2 ' be the maximum heights attained in the two cases, find the value of ' y_1+y_2 ' in terms of ' u ' and ' g '.
24. A projectile is thrown so as to have a maximum possible horizontal range of 400 m. Taking the point of projection as the origin, find the co-ordinates of the point where the velocity of the projectile is minimum.
25. Calculate the area of the triangle determined by the two vectors $\vec{A}=3\hat{i}+4\hat{j}$ and $\vec{B}=-3\hat{i}+7\hat{j}$.
26. Two vectors \mathbf{A} and \mathbf{B} have the same magnitude. At what angle should they act so that magnitude of $\mathbf{A} + \mathbf{B}$ is equal to the magnitude of \mathbf{A} or \mathbf{B} ?

27. What is the angle made by vector $\mathbf{A} = 2\mathbf{i} + 2\mathbf{j}$ with x-axis?
28. On a certain day, rain was falling vertically with a speed of 35ms^{-1} . A wind started blowing after some time with a speed of 12ms^{-1} in the east to west direction. In which direction should a girl waiting at a bus stop hold her umbrella?
29. At what point in its trajectory does a projectile have its (i) minimum speed; (ii) maximum speed?
30. On a certain day, rain was falling vertically with a speed of 35ms^{-1} . A woman rides a bicycle with a speed of 12ms^{-1} in the east to west direction. In which direction should the woman hold her umbrella?
31. Find a unit vector along vector: $\mathbf{a} = \hat{i} - \hat{j}$
32. A bomb is released from a horizontally flying bomber, when it is vertically above the target, shall it hit the target? Explain.
33. The resultant of two vectors \mathbf{A} and \mathbf{B} is perpendicular to the vector \mathbf{A} and its magnitude is equal to half the magnitude of vector \mathbf{B} . What is the angle between \mathbf{A} and \mathbf{B} ?
34. A hunter aims his gun and fires a bullet directly at a monkey on a tree. At the instant the bullet leaves the barrel of the gun, the monkey drops. Will the bullet hit the monkey? Substantiate your answer with proper reasoning.
35. A grasshopper can jump upto a height h . Find the maximum distance through which it can jump along the horizontal ground.
36. Two particles A and B are projected from the same point in different directions in such a manner that vertical components of their initial velocities are same in above figure.
Find the ratio of range.



37. Two particles separated at a horizontal distance x as shown in fig. they projected at the same line as shown in fig. with different initial speeds. What is the time after which the horizontal distance between them become zero?

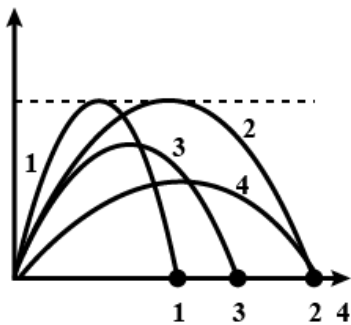


38. The point from where a ball is projected is taken as the origin of co-ordinate system. The components of its displacement along x and y are given by $x = 6t$ and $y = 8t - 5t^2$.
What is the velocity and angle of projection?
39. A boy throws a ball in the air at 60° to the horizontal along a road with a speed of 10m/s . Another boy sitting in a passing by car observes the ball. Sketch the motion of the ball as observed by the boy in the car. If the car has a speed of 5 m/s . Give an explanation to support your diagram.

SHORT ANSWER TYPE QUESTIONS (3 MARK)

40. A particle is projected at angle θ with horizontal. Calculate the time when it is moving perpendicular to the initial direction. Also calculate the velocity at this position.
41. The range R of a projectile is same when its maximum heights are h_1 and h_2 . What is the relation between R and h_1 and h_2 ?
42. Calculate the angle between the vectors: $\mathbf{A} = 2\mathbf{i} - 5\mathbf{j}$ and $\mathbf{B} = 5\mathbf{i} + 2\mathbf{j}$.

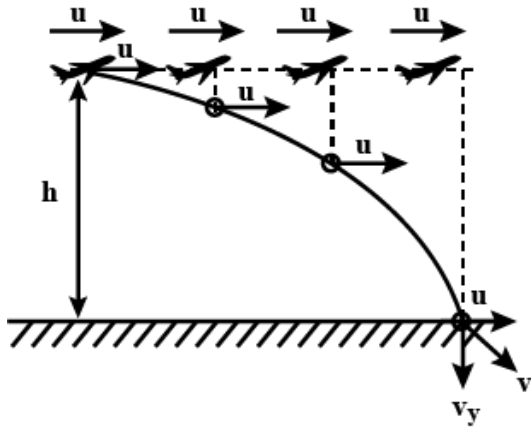
43. A man rows a boat with a speed of 18 km/hr in north-west direction. The shoreline makes an angle of 15° south of west. Obtain the components of the velocity of the boat along the shoreline and perpendicular to the shoreline.
44. Three boys are pulling a heavy trolley by means of three ropes. The boy in the middle is exerting a pull of 100N. The other two boys, whose ropes both make an angle of 30° with the central rope, are pulling with forces of $50\sqrt{3}$ N and $100\sqrt{3}$ N. Find the magnitude of the resultant pull on the trolley.
45. Four cannon ball (1), (2), (3) and (4) are fired from level ground. Cannon ball (1) is fired at an angle of 60° above the horizontal and follows the path shown in the figure. Cannon balls (2) and (3) are fired at an angle of 45° and (4) is fired at an angle of 30° above the horizontal. Which ball has the largest initial speed?



46. A force vector \mathbf{F}_1 points due east and has a magnitude of 200 Newtons, A second force \mathbf{F}_2 is added to \mathbf{F}_1 . The resultant of the two vectors has a magnitude of 400 newtons and points along the due east/west line. Find the magnitude and direction of \mathbf{F}_2 . Note that there are two answers.
47. Consider the following four force vectors: $\mathbf{F}_1 = 50.0$ N, due east $\mathbf{F}_2 = 10.0$ N, due east $\mathbf{F}_3 = 40.0$ N, due west $\mathbf{F}_4 = 30.0$ N, due west. Which

- two vectors add together to give a resultant with the smallest magnitude, and which two vectors add to give a resultant with the largest magnitude? In each case specify the magnitude and direction of the resultant.
48. Two vectors **A** and **B** have the same magnitude. At what angle should they act so that (i) magnitude of **A - B** is equal to the magnitude of **A** or **B**? (ii) magnitude of **A + B** is equal to the magnitude of **A - B**?
 49. Derive the expression for the magnitude and direction of the addition of the two vectors acting at an angle of θ .
 50. Find the vector products of two vectors **A** = $3\mathbf{i}-4\mathbf{j}+5\mathbf{k}$ and **B** = $(-2\mathbf{i}+\mathbf{j}-3\mathbf{k})$.
 51. A particle starts from the origin at $t=0$ s with a velocity of $10.0\mathbf{j}$ m/s and moves in the x- y plane with a constant acceleration of $(8.0\mathbf{i}+2.0\mathbf{j})$ m/s². At what time is the x coordinates of the particle 16 m? What is the y-coordinate of the particle at that time? What is the speed of the particle at that time?
 52. An accelerating train is passing over a high bridge. A stone is dropped at an instant when speed is 10 ms^{-1} and acceleration is 1 ms^{-2} . Find the horizontal and vertical component of the velocity and acceleration and speed of the stone one second after it is dropped. Take $g = 10\text{ ms}^{-2}$.
 53. To a person going westwards with a speed of 6 km/h, rain appears to fall vertically downwards with a speed of 8 km/h. Find the actual direction of the rain.
 54. A body is moving on a circular path of radius 'R' with uniform angular speed ' ω '. Calculate the magnitude of the change in the acceleration of the particle after time interval of ' $T/4$ '.
 55. State triangle law of vector addition. Give analytical treatment to find the magnitude and direction of the resultant vector for two vectors inclined at an angle θ using this law.
 56. State parallelogram law of vector addition. Give analytical treatment to find the magnitude and direction of the resultant vector for two vectors inclined at an angle θ using this law.

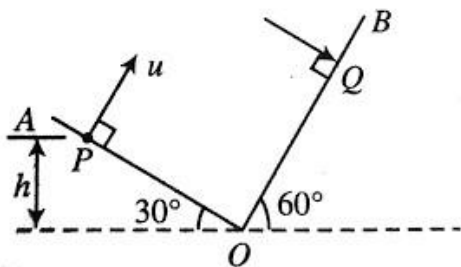
57. A relief food package is dropped from a airplane which is moving horizontal with a velocity of 30 m s^{-1} at a height $h = 50 \text{ m}$. Find the (a) time of flight of the package, (b) location of the point of striking of the food package, (c) velocity of the package at the time of striking the ground, and (d) displacement of the food package.



58. A ball is thrown from the top of a building 45 m high with a speed 20 m s^{-1} above the horizontal at an angle of 30° . Find:
- The time taken by the ball to reach the ground.
 - The speed of ball just before it touches the ground.

LONG ANSWER TYPE QUESTIONS (5 MARK)

59. Two inclined planes OA and OB having inclination (with horizontal) 30° and 60° respectively, intersect each other at O as shown in figure. A particle is projected from point P with velocity along a direction perpendicular to plane OA. if the particle strikes plane OB perpendicularly at Q, calculate:



- Velocity with which particle strikes the plane OB.
- Time of flight
- Vertical height h of P from O

- (iv) Maximum height from O attained by the particle
 (v) Distance PQ
60. A projectile is thrown, from the origin (0, 0), at an angle α to the horizontal level and with speed V under the action of constant gravity g. Obtain expressions for the time of flight, maximum height and the range of the projectile. Write the components of its displacement vector at time t, namely: X (t) and Y (t) and find equation of trajectory.
61. A body is moving on a circular path of radius 'R' with uniform angular speed ' ω '. Find the expression for the magnitude of its velocity and show that it is tangential to the path. Find the expression for the magnitude of its acceleration and show that it is towards the centre of curvature.
62. A projectile is thrown, from the origin (0, 0), at an angle α to the horizontal level and with speed V under the action of constant gravity g. Sketch how its i) horizontal velocity ii) vertical velocity varies with time. Also calculate angle of projectile at which, range is maximum?
63. Define a projectile. Show that the path of a projectile projected at an angle θ with the horizontal is a parabola. Find the angle of projection at which horizontal range and maximum height of the projectile are equal.

ENHANCED LEARNING

- The x and y component of **A** are 4m and 6m respectively. The x and y components of vector (**A +B**) are 10 m and 9m respectively. Calculate for the vector **B** (i) its x and y components (ii) its length and (iii) the angle it makes with the x-axis.
 (6m, 3m, $\sqrt{45}m$, 26.6°)
- Show that the motion of one projectile as seen from another projectile will always be a straight line motion.

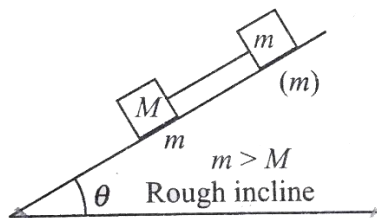
Laws of motion

VERY SHORT ANSWER TYPE QUESTIONS (1 MARK)

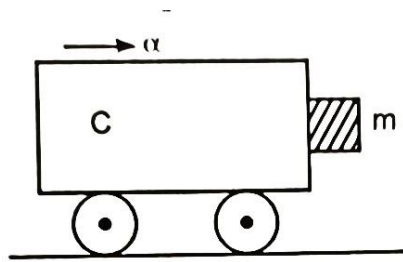
- No force is required for

- (a) an object moving with constant velocity
 - (b) an object moving in circular motion
 - (c) an object moving with constant acceleration.
 - (d) an object moving in an elliptical path.
2. A person sitting in an open car moving with constant velocity throws a ball vertically into air, the ball falls
- (a) exactly in the hand of thrower.
 - (b) ahead of the person
 - (c) behind the person
 - (d) the information given is insufficient to choose between (a), (b) and (c)
3. The quantity given by the area of Force vs time graph is-
- a) Kinetic energy
 - b) Force
 - c) Acceleration
 - d) Impulse

4. In figure the tension in the rope (rope is light) is



- (a) $(M + m)g\sin\theta$
 - (b) $(M + m)g \sin\theta - mg\cos\theta$
 - (c) Zero
 - (d) $(M + m)g\cos\theta$
5. A block of mass 'm' is in contact with cart as shown.



The coefficient of static friction between the block and the cart is μ . The acceleration α of the cart that will prevent the block from falling satisfies:

(a

)

α

\geq

$g/$

μ

(b

)

α

$<$

$g/$

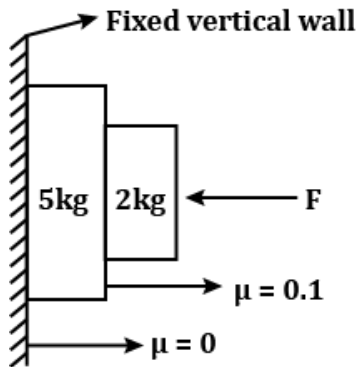
μ

(c) $\alpha > m g/\mu$

(d) $\alpha > g/\mu m$

6. Three different objects of masses m_1 , m_2 and m_3 are allowed to fall from rest and from the same point O along three different frictionless paths. The speeds of the three objects on reaching the ground will be in the ratio of:
- (a) $m_1 : m_2 : m_3$
- (b) 1: 1: 1
- (c) $1/m_1 : 1/m_2 : 1/m_3$
- (d) $m_1: 2m_2 : 3m_3$
7. In the arrangement shown in the figure, the wall is smooth and the coefficient of static friction between the blocks is $\mu=0.1$. A horizontal

force $F=1000\text{ N}$ is applied on the 2 kg block. Identify the wrong statement from the options given below: (Let $g = 10\text{ m/s}^2$)



- (a) The normal force between the blocks is 1000 N .
- (b) The friction force between the blocks is zero.
- (c) Both the blocks accelerate downwards with acceleration g .
- (d) Friction force acting on 2 kg block is 20 N .
8. If a body is in equilibrium under a set of non-collinear forces, then the minimum number of forces has to be:
- (a) 4
- (b) 2
- (c) 3
- (d) 5
9. A particle is moving in a vertical circle. The tensions in the string while passing through two positions at angles 30° and 60° from the vertical (lowest position) are T_1 and T_2 respectively. Then:
- (a) $T_1 = T_2$
- (b) $T_2 > T_1$
- (c) $T_1 > T_2$
- (d) The mass of the particle determines the whether (a), (b) or (c) is correct.
10. Name the quantity given by the slope of momentum vs time graph.
11. State law of conservation of linear momentum of a system of interacting bodies.
12. Write one way of reducing kinetic friction in a machine.
13. What are concurrent forces?

14. Under what condition is the total linear momentum of two colliding balls conserved?

CASE - BASED QUESTION

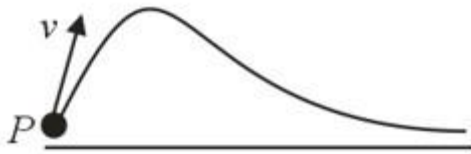
15. A person weighing 60 kg is standing on a platform scale balance kept on the floor of an elevator cab. The elevator cab is capable of motion in up and down direction with either a uniform velocity or a constant acceleration. The value of velocity as well as acceleration may be adjusted at any suitable value. Newton's second law of motion can be applied to the motion of elevator cab.

Find the observed weight of the person as recorded by the balance, when

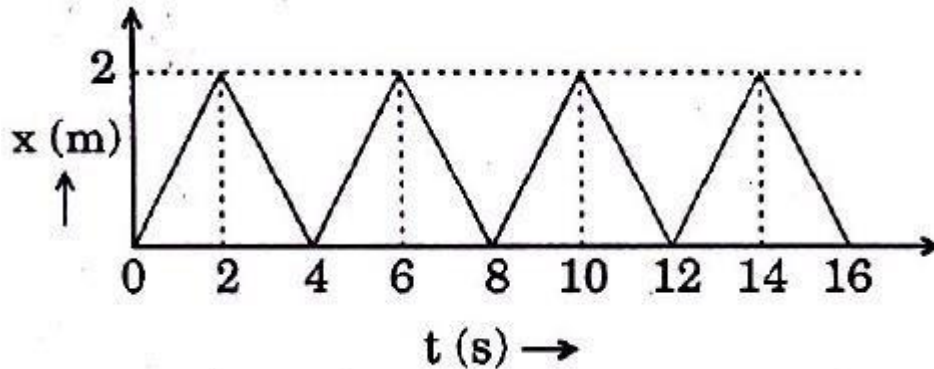
- (a) the elevator cab is moving upward with a constant velocity of 2m/s.
- (b) the elevator cab starts going upwards with a constant acceleration of $a = g/4$.
- (c) the elevator cab is in an accelerated motion in vertical downward direction with an acceleration of $g/4$
- (d) the elevator going downward with velocity of 20 m/s is being stopped and in the process a deceleration of $g/2$ is acting on it.
- (e) the elevator cab starts falling downward freely due to some mechanical failure in its control system.

SHORT ANSWER TYPE QUESTIONS (2MARK)

- 16. Using Newton's laws of motion, verify law of conservation of linear momentum of a system of interacting bodies.
- 17. State the two laws regarding the value of maximum static friction.
- 18. How does the limiting value of static friction depend on area of contact and normal force?
- 19. Explain why it is easier to pull a lawn mower than to push it.
- 20. A cricketer moves his hands backwards while holding a catch. Why?
- 21. A particle P moves with a constant speed v in a curve as shown in the figure. Discuss the variation of magnitude of centripetal acceleration with time and distance.



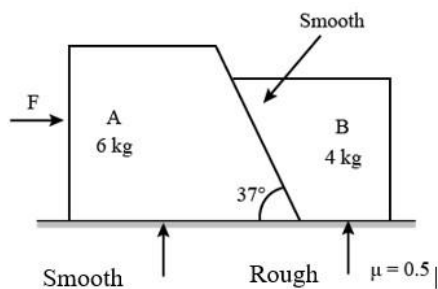
22. The figure shows the position time ($x-t$) graph of one-dimensional motion of a body of mass 0.4 kg. What is the magnitude of each impulse?



23. A block of mass m rests on an inclined plane which makes an angle θ with the horizontal. The coefficient of friction between the block and the surface is μ . What is the force of friction acting on the block?

SHORT ANSWER TYPE QUESTIONS (3MARK)

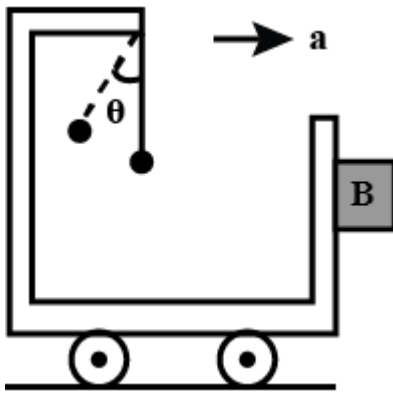
24. Two blocks A of 6 kg and B of 4 kg are placed in contact with each other as shown in figure.



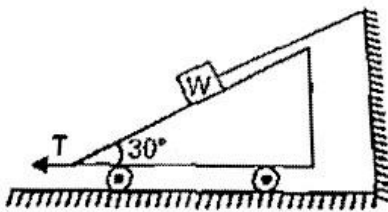
There is no friction between A and ground and between both the blocks. The coefficient of friction between B and ground is 0.5. A horizontal force F is applied on A. Find the minimum and maximum values of F ,

which can be applied so that both the blocks can move combinedly without any relative motion between them.

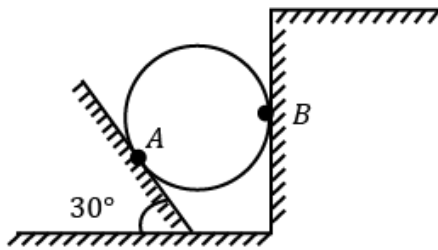
25. A trolley A has a simple pendulum suspended from a frame fixed to its desk. A block B is contact on its vertical slide. The trolley is on horizontal rails and accelerates towards the right such that the block is just prevented from falling. The value of coefficient of friction between A and B is 0.5. What is the inclination of the pendulum to the vertical?



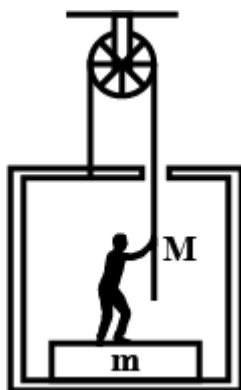
26. A block of weight 'W' is placed on a wedge and arranged as shown in the figure. What is the force F needed to hold the wedge in static equilibrium if there is no friction between any of the surfaces?



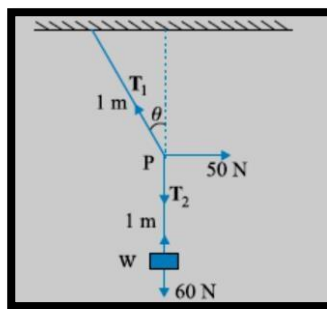
27. A 50 kg homogeneous smooth sphere rests on the 30° inclined plane A and bears against the smooth vertical wall B. What is the contact force at point B:
(Take $g=10 \text{ m/s}^2$)



28. An iron ball of mass $m = 50\text{g}$ falls from a height of $h_1 = 5\text{m}$ and rises upto $h_2 = 2\text{m}$ after colliding with the horizontal surface. If the time of contact with the surface $\Delta t = 0.02\text{s}$, find the average contact force exerted on the ball by the horizontal surface.
29. A body of mass 2 kg at rest, at the origin is acted upon for 10 s , by a force $\mathbf{F} = 6\mathbf{i} + 8\mathbf{j}\text{ N}$. Calculate the x and y - component of the acceleration produced. Also find the location (co-ordinates) of the body after 10 s .
30. A man of mass 70 kg stands on a weighing scale in a lift which is moving, (i) upward with a uniform speed of 10 ms^{-1} , (ii) upward with a uniform acceleration of 5 ms^{-2} , (iii) downward with a uniform acceleration of 5 ms^{-2} . What is the reading of the scale in each case?
31. A man of mass ' M ' is standing on a plank kept in a box. The plank and box as a whole has mass ' m '. A light string passing over a fixed smooth pulley connects the man and box. If the box remains stationary, find the tension in the string and the force exerted by the man on the plank.
(Given $M > m$)



32. Two masses 7 kg and 12 kg are connected at the two ends of a light, inextensible string that goes over a frictionless pulley. Find the acceleration of the masses and the tension in the string, when the masses are released.
33. Two bodies of masses 10 kg and 20 kg respectively kept on a smooth, horizontal surface are tied to the ends of a light string. A horizontal force $F = 600 \text{ N}$ is applied to 20 kg body along the direction of string. What is the acceleration of the system and tension in string?
34. A body is in limiting equilibrium on a rough inclined plane inclined at angle of 30° with the horizontal. Calculate the acceleration with which the body will slide down, when inclination of the plane is changed to 45° . (Use $g = 10 \text{ m/s}^2$).
35. A helicopter of mass 1000Kg rises with a vertical acceleration of 15 m/s^2 . The crew and the passengers weigh 300Kg. Give the magnitude and direction of the (a) force on the floor by the crew and passengers, and (b) action of the rotor of the helicopter on the surrounding air.
36. A mass of 6 kg is suspended by a rope of length 2 m 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 $g = 10 \text{ m s}^{-2}$).
- Neglect the mass of the rope.

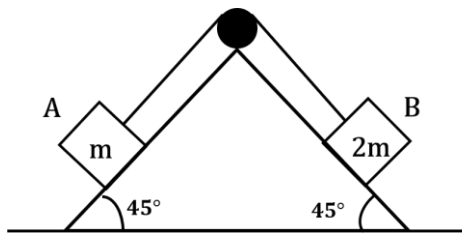


LONG ANSWER TYPE QUESTIONS (5MARK)

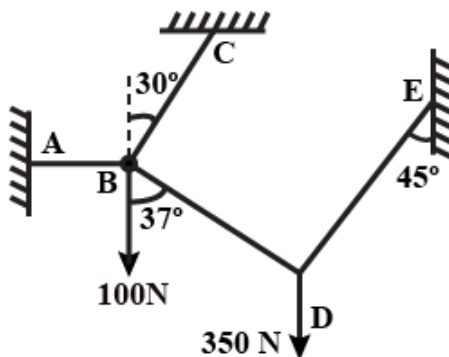
37. Block A of mass 'm' and block B of mass '2m' are placed on a fixed triangular wedge by means of a massless inextensible string and a frictionless pulley as shown in figure . The wedge is inclined at 45° to the

horizontal on both sides. If the coefficient of friction between the block A and the wedge is $\frac{2}{3}$ and that between block B and the wedge is $\frac{1}{3}$ and both the blocks A and B are released from rest, then find:

- the acceleration of A
- the tension in the string
- the magnitude and direction of the frictional force acting on A

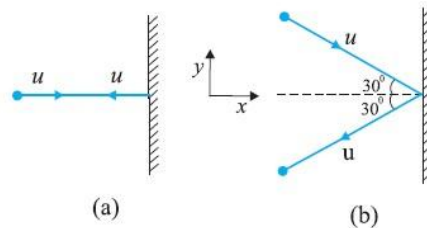


38. Two particles of masses 10 kg and 35 kg are connected with four strings at points B and D as shown in the figure. Determine the tensions in various segments of the string.



39. Derive the expressions for (i) Maximum speed and ii) Recommended speed (no role of friction) of a car on a banked rough circular road. The coefficient of friction between the wheels and the road being μ and the banking angle θ . Also write the condition for a car to be parked on a banked rough circular road.

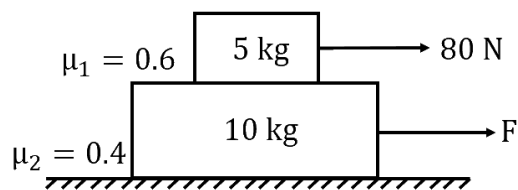
40. Two identical billiard balls strike a rigid wall with the same speed but at different angles, and get reflected without any change in speed, as shown in Fig. What is (i) the direction



- of the force on the wall due to each ball? (ii) the ratio of the magnitudes of impulses imparted to the balls by the wall?
41. A bullet of mass 'm', moving with speed 'v' along the +x-axis, strike a block of mass 'M' lying on a surface and comes to rest with respect to the block. Calculate the distance covered by the block. The coefficient of the friction between the block and the surface is ' μ '.
42. A body of mass 1 kg initially at rest explodes and breaks into three fragments of masses in the ratio 1: 1: 3. The two pieces of equal masses fly off perpendicular to each other with speed of 30 m/s each. What is the velocity of heavier fragment?

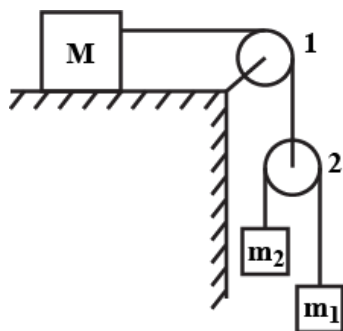
ENHANCED LEARNING

- The driver of a truck travelling with a velocity v suddenly notices a brick wall in front of him at a distance d . is it better for him to apply brakes or to make a circular turn without applying brakes in order to just avoid crashing into the wall? Explain.
- A system of two blocks is shown in figure. Friction coefficient between 5 kg and 10 kg block is $\mu=0.6$ and between 10 kg and ground is $\mu=0.4$. What will be the maximum value of force F , which is applied at the lower block so that 5 kg block does not slip over 10 kg block? ($g=10 \text{ m/s}^2$) The force applied at the upper block has a fixed magnitude of 80 N (both forces start to act simultaneously).



3. Action and reaction forces do not balance each other. Why?
4. In the arrangement shown in figure, $m_1=1$ kg, $m_2=2$ kg. Pulleys are massless and strings are light. For what value of M the mass m_1 moves with constant velocity?

(Neglect friction)



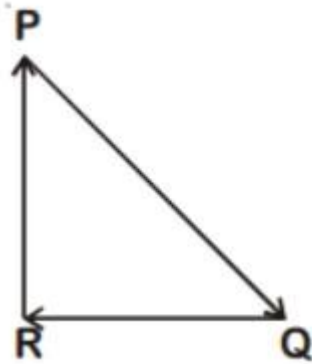
Work power and energy

VERY SHORT ANSWER TYPE QUESTIONS (1 MARK)

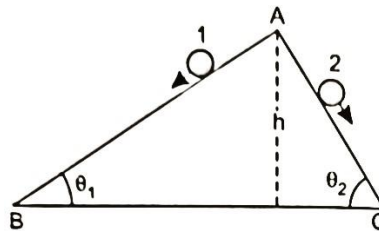
1. Two bodies A and B having mass M and m respectively possesses same kinetic energy. Given that $M > m$. If ρ_A and ρ_B be their momentum, then which of the following statements is true?
 - (a) $\rho_A = \rho_B$
 - (b) $\rho_A > \rho_B$
 - (c) $\rho_A < \rho_B$
 - (d) It cannot be predicted.
2. A body P moving with a velocity of 20ms^{-1} collides with another body Q of same mass at rest. After collision P comes to rest. What is the velocity of the body Q ?
 - (a) 10 m/s
 - (b) 30 m/s
 - (c) 20 m/s

(d) 40 m/s

3. A particle moving with velocity \mathbf{v} is acted by three forces shown by the vector triangle PQR. The Kinetic Energy of the particle will :



- (a) decrease
(b) remain constant
(c) change according to the smallest force QR
(d) increase
4. Two inclined frictionless planes, one gradual and the other steep meet at A, from where two identical stones are allowed to slide down from rest, one on each track, as shown in the figure. Which of the following statements are correct?



- a) Both stones reach the bottom at the same time but not with the same speed.
b) Both stones reach the bottom with the same speed but stone 1 reaches the bottom earlier than stone 2.
c) Both stones reach the bottom with the same speed but stone 2 reaches the bottom earlier than stone 1.
d) Both stones reach the bottom with different speeds and at different times.

5. A stationary particle explodes into two particles of masses m_1 and m_2 which move in opposite direction with velocities v_1 and v_2 . The ratio of their kinetic energies E_1/E_2 is (a) 1:1
- (b) m_2/m_1
- (c) m_1/m_2
- (d) m_1v_2/ m_2v_1
6. Work done by a conservative force on a system is equal to:
- (a) The change in kinetic energy of the system
- (b) The negative of the change in potential energy of the system
- (c) The change in total mechanical energy of the system
- (d) None of the above
7. Define work done by a force.
8. Write relation between the change in potential energy of a system and work done by the conservative force.
9. State work energy theorem.
10. What is a conservative force?
11. State principle of conservation of mechanical energy.
12. Assertion : The work done during a round trip is always zero.
Reason : No force is required to move a body in its round trip.
13. Assertion : Work done by friction on a body sliding down an inclined plane is positive.
Reason : Work done is greater than zero, if angle between force and displacement is acute or both are in same direction.
14. Assertion : A spring has potential energy, both when it is compressed or stretched.
Reason : In compressing or stretching, work is done on the spring against the restoring force.

SHORT ANSWER TYPE QUESTIONS (2 MARK)

15. Show that the work done by any force is given by the area under the force vs displacement curve.
16. A block of mass m moving with velocity v_0 on a smooth horizontal surface hits the spring of constant k as shown.
 - a) Find the maximum compression in the spring.
 - b) Is the work done by the spring (while it is being compressed) negative or positive?
17. State carefully if the following quantities are positive or negative:(a) work done by a man in lifting a bucket out of a well by means of a rope tied to the bucket. (b) work done by gravitational force in the above case.
18. Write the correct alternative on your answer sheet: (a) When a conservative force does positive work on a body, the potential energy of the body increases/decreases/remains unaltered. (b) Work done by a body against friction always results in a loss of its kinetic/potential energy.
19. Prove work energy theorem for a variable force.
20. Show that for a freely falling body, the total of KE and PE remains constant.
21. Distinguish between elastic collision and completely Inelastic collision.
22. The mass of a truck is thrice the mass of a car. If both have equal kinetic energy, what is the ratio of their momentum?

SHORT ANSWER TYPE QUESTIONS (3 MARK)

23. A mass m is attached to free end of a massless spring of spring constant 'k'. Draw a graph of spring force with extension in the spring and derive an expression for the potential energy of an elastic stretched spring.
24. A particle moves along the loop $A-B-C-D-A$ while a conservative force acts on it.

Work done by the force along the various sections of the path are:

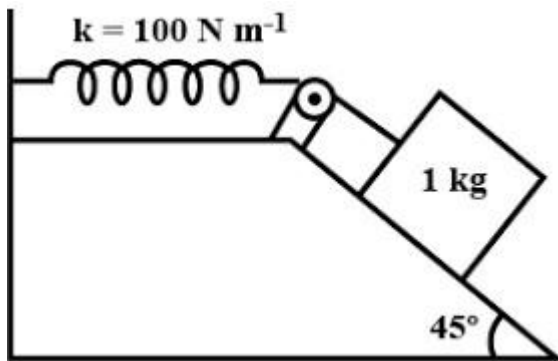
$$W_{A \rightarrow B} = 50 \text{ J};$$

$$W_{B \rightarrow C} = 25 \text{ J};$$

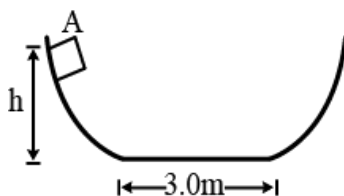
$$W_{C \rightarrow D} = 60 \text{ J}.$$

Assume that potential energy of the particle is zero at A. Write the potential energy of particle when it is at B and D.

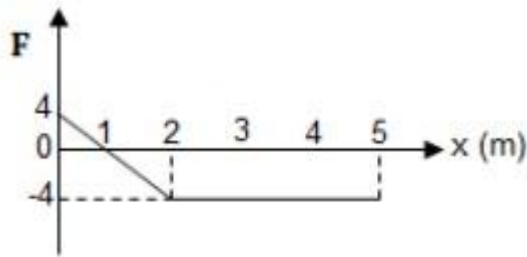
25. A 1 kg block situated on a rough incline is connected to a spring of spring constant 100 N/m as shown in the figure. The block is released from rest with the spring in the unstretched position. The block moves 10 cm down the incline before coming to rest. Find the coefficient of friction between the block and the incline. Assume that the spring has a negligible mass and the pulley is frictionless.



26. A small particle slides along a track with elevated ends and a flat central part as shown in figure. The flat part has a length of 3 m and the curved portions of the track are frictionless. For the flat part, coefficient of kinetic friction is $\mu = 0.2$. The particle is released at a point A, which is at a height 0.3 m above the flat part of track. Find the position where the particle finally come to rest.



27. The only force acting on a 2.0 kg body as it moves along the x - axis varies as shown in the figure. The velocity of the body at $x = 0$ is 4.0 m/s .



- What is the KE of the body at $x=3.0$ m?
- At what value of 'x' will the body have a KE of 8.0 J?
- What is the maximum K.E attained by the body between $x=0$ m and $x=5$ m?

28. The displacement of a particle of mass '1kg' on a horizontal smooth surface is a function of time given by $x = \frac{1}{3}t^3$. Find out the work done by the external agent for the first one second.

29. A block of mass 10 kg is slowly slid up a smooth inclined plane of inclination 37° by a person. Calculate the work done by the person in moving the block through a distance of 20 m along the incline, if the person applies the force

- parallel to the inclined plane
- In the horizontal direction (Take $g=10$ m/s²).

30. A body is dropped from small height 'h' and strike to the ground with speed $1.2 \sqrt{gh}$.

$\sqrt{\quad}$

Calculate the work done by the resistive (viscous and buoyant) force on the body.

31. Obtain the expression of velocity (i) at the equilibrium position and (ii) at any intermediate position x. Sketch the variation of PE and KE with the extension in the spring.

32. A horizontal constant force F pulls a block of mass m placed on a horizontal surface.

If the coefficient of kinetic friction between the block and ground is μ , find the power delivered by the external agent after a time t measured from the beginning of action of the force.

33. A rain drop of radius '2 mm' falls from a height of 500 m, above the ground. It falls with decreasing acceleration until at half its original height, it attains its max speed and moves with uniform speed thereafter. What is the work done by the resistive force in the entire journey if its speed on reaching the ground is 10 ms^{-1} ? (density of water = 10^3 kg m^{-3})

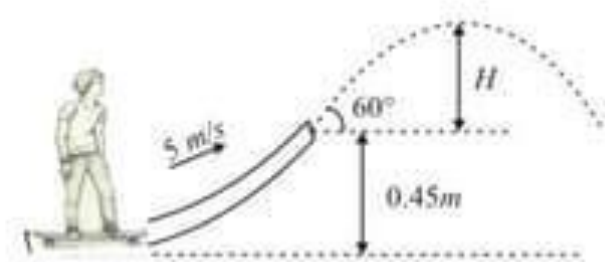
LONG ANSWER TYPE QUESTIONS (5MARK)

34. A body of mass m_1 collides elastically (one dimension) with another body of mass m_2 at rest. Show that velocity of approach between the two masses before elastic collision is equal to the velocity of separation after collision, and deduce expression for the velocities after the collision.
35. A woman pushes a trunk on a railway platform which has a rough surface. She applies a force of 100 N over a distance of 10 m. Thereafter, she gets progressively tired and her applied force reduces linearly with distance to 50 N. The total distance through which the trunk has been moved is 20 m. Plot the force applied by the woman and the frictional force, which is 50 N versus displacement. Calculate the work done by the two forces over 20 m.
36. A block is projected along a rough inclined plane making an angle of 30° with the horizontal. Obtain coefficient of friction between the block and the plane if the time of ascent is half the time of descent.

ENHANCED LEARNING

1. Springs A and B are identical except that A is stiffer than B. in which spring is more work expended if they are stretched by the same force?
2. Two bodies of masses m_1 and m_2 have the same linear momentum. What is the ratio of their kinetic energies?
3. Two bodies of masses m_1 and m_2 have equal kinetic energies. What is the ratio of their linear momenta?
4. A particle of mass m is moving in a horizontal circle of radius r , under a centripetal equal to $(-K/r^2)$, where K is constant. What is the total energy of the particle?

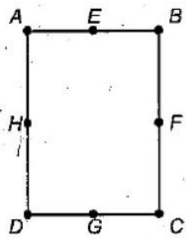
5. In the figure shown, a skateboarder is moving at 5.0 m s^{-1} along the horizontal section of a track that is slanted upward by 60° above the horizontal at its end, which is 0.45 m above the ground. When he leaves the track, he follows the characteristic path of projectile motion. Ignoring friction and air resistance, find the maximum height H to which he rises above the end of the track.



System of particles and rotational motion

VERY SHORT ANSWER TYPE QUESTIONS (1 MARK)

- A couple is acting on a two-particle system. The resultant motion will be:
 - purely rotational
 - purely linear
 - depends on the magnitude of force.
 - a mix of rotational and linear motion.
- The moment of inertia of an object does not depend upon:
 - mass of object
 - mass distribution
 - angular velocity
 - axis of rotation
- Out of the given options, in a rectangle ABCD ($BC=2AB$), the moment of inertia along axis will be minimum through :



- (a) BC
- (b) CD
- (c) EG
- (d) HF

4. Two bodies have their moments of inertia I and $2I$ respectively about their axis of rotation. If their kinetic energies of rotation are equal, their angular momentum will be in the ratio: (a) 1 : 2

- (b) 2 : 1
- (c) $\sqrt{2} : 1$
- (d) $1 : \sqrt{2}$

- 5. Define torque of a force.
- 6. Define angular momentum of a particle.
- 7. Define moment of inertia of a particle about an axis of rotation.
- 8. State law of conservation of angular momentum.

9. CASE STUDY BASED QUESTIONS-

A monkey was sitting on a tree in a Zoo. a rope is tied to one of the branches of the tree, hanging freely. Raheem who was in the zoo saw that monkey, put some bananas on the ground near to the free end of the rope. immediately the monkey came down with acceleration “a” by using that rope to get the bananas, after eating these bananas monkey climbs up on the tree again with acceleration “a” by using the rope.

- (i) when the apparent weight of the monkey will be more in climbing up or down? (1M)
- (ii) state the situation when the string can break? (1M)
- (iii) what will be the tension in string when monkey moves down with an acceleration g ? (1M)

(iv) write any two units of weight. (1M)

10. A physics teacher explained about conservation of Angular momentum in the class. After the completion of her explanation, she want to test how far the students are able to understand the topic. In the process she selected two students. Both could explain the topic with examples.

(i) What is the S.I. unit of angular momentum? (1M)

(ii) A physics teacher sits on a stool that is free to rotate nearly without friction about a vertical axis. Her outstretched hands each hold a large mass so that the rotational inertia is 12kgm^2 . By pulling her arms close to her body she is able to reduce her rotational inertia to 6kgm^2 . If her student starts spinning at 0.5rad/s , what is her speed after she draws her arms in? (2M)

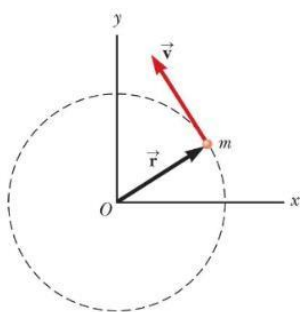
(iii) Find the relation between torque and angular momentum. (1M)

SHORT ANSWER TYPE QUESTIONS (2 MARK)

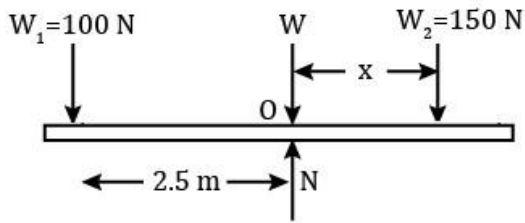
11. Three small masses m , $2m$ and $3m$ are placed at three vertices of a triangle. The coordinates of the vertices of the triangle are (x_1, y_1) , (x_2, y_2) and (x_3, y_3) respectively. Find the centre of mass of the system.

12. A particle moves in the x - y plane in a circular path of radius ' r ' as shown in the figure.

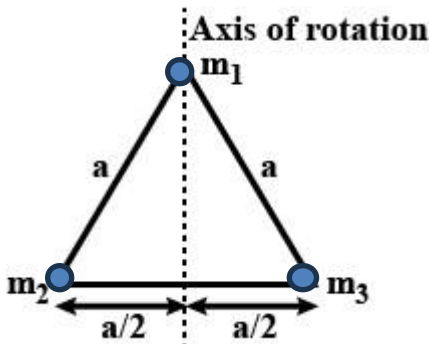
Find the magnitude and direction of its angular momentum relative to a axis through 'O' when its velocity is ' v '.



13. Two small kids weighing 10kg and 15kg respectively, are trying to balance a seesaw of total length 5.0m , with the fulcrum at the centre. If one of the kids is sitting at one end, where should the other one sit?



14. Three masses m_1 , m_2 and m_3 are located at the vertices of an equilateral triangle of side 'a'. What is the moment of inertia of the system about the axis along the median passing through m_1 ?



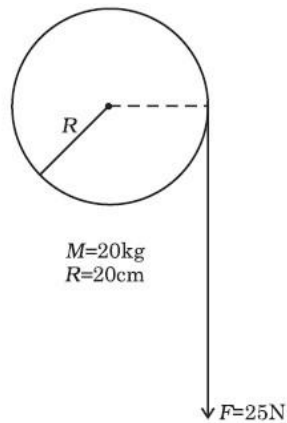
15. Consider a two-particle system with the particles having masses m_1 and m_2 . If the first particle is pushed towards the centre of mass through a distance 'd', by what distance should the second particle be moved, and in which direction, so as to keep the centre of mass at the same position?
16. Write two conditions for a rigid body to be in mechanical equilibrium.
17. Explain why it is difficult to open a door by pushing or pulling near the hinge?
18. Is it possible to have net torque on the body without net force? Explain with an example.
19. A particle revolves uniformly along a circle by means of a string connected to it. Does angular momentum of the particle change from its initial value, if the string is cut suddenly?

Justify your answer.

SHORT ANSWER TYPE QUESTIONS (3 MARK)

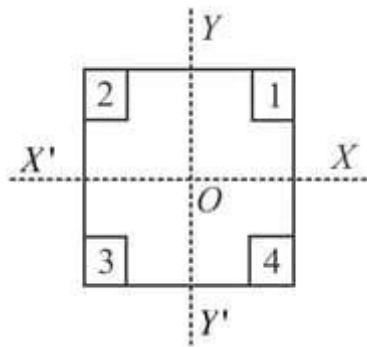
20. In the HCl molecule, the separation between the nuclei of the two atoms is about 1.27 \AA ($1 \text{ \AA} = 10^{-10} \text{ m}$). Find the approximate location of the CM of the molecule, given that a chlorine atom is about 35.5 times as massive as a hydrogen atom and nearly all the mass of an atom is concentrated in its nucleus.

21. A projectile is fired at a speed of 100 m/s at an angle of 37° above the horizontal. At the highest point, the projectile breaks into two parts of mass in ratio 1 : 3, the smaller coming to rest. Find the distance from the launching point to the point where the heavier piece lands.
22. A child sits stationary in the middle of a long trolley, moving uniformly with a speed 'v' on a smooth horizontal floor. What is the speed of the centre of mass of the trolley-child system, if the child gets up and runs on the trolley (i) in the direction of the motion of the trolley and (ii) in the direction opposite to the motion of the trolley?
23. A child stands at the centre of a turntable with his two arms outstretched. The turntable is set rotating with an angular speed of 40 rev/min. How much is the angular speed of the child if he folds his hands back and thereby reduces his moment of inertia to $\frac{2}{5}$ times the initial value? Assume that the turntable rotates without friction.
24. The angular speed of a motor wheel is increased from 1200 rpm to 3120 rpm in 16 seconds. (i) What is its angular acceleration, assuming the acceleration to be uniform? (ii) How many revolutions does the engine make during this time?
25. From a uniform disk of radius R , a circular hole of radius $R/2$ is cut out. The centre of the hole is at $R/2$ from the centre of the original disc. Locate the centre of gravity of the resulting flat body.
26. A metre stick is balanced on a knife edge at its centre. When two coins, each of mass 5 g are put one on top of the other at the 12.0 cm mark, the stick is found to be balanced at 45.0 cm. What is the mass of the metre stick?
27. A cord of negligible mass is wound round the rim of a fly wheel of mass 20 kg and radius 20 cm. A steady pull of 25 N is applied on the cord as shown in the figure. The flywheel is mounted on a horizontal axle with frictionless bearings. (a) Compute the angular acceleration of the wheel. (b) Find the work done by the pull, when 2m of the cord is unwound. (c) Find also the kinetic energy of the wheel at this point. Assume that the wheel starts from rest. (d) Compare answers to parts (b) and (c).



28. A uniform square plate from which four identical squares at the corners will be removed is shown in figure.

Answer the following questions on the basis of above data.



- (i) Where is the centre of mass of the uncut plate?
 - (ii) Where does the CM lie after square 1 is removed?
 - (iii) Where does the CM lie after square 1 and 2 are removed?
 - (iv) Where does the CM lie after square 1 and 3 are removed?
 - (v) Where does the CM lie after square 1, 2 and 3 are removed?
 - (vi) Where does the CM lie after all four squares are removed?
- (Give answers in terms of quadrants and axes)

29. A solid sphere rolls down two different inclined planes of the same heights but different angles of inclination. (a) Will it reach the bottom with the same speed in each case? (b) Will it take longer to roll down one plane than the other? (c) If so, which one and why?

30. A disc is rolling without slipping on horizontal surface and its speed of centre of mass is v_{cm} . What is the velocity of the topmost point and lowermost point of the disc? Also write the condition for forward slipping.

LONG ANSWER TYPE QUESTIONS (5 MARK)

31. Define angular momentum of a rigid body. State its SI unit. Derive the relation between angular momentum and torque. Which physical quantity is conserved when a planet revolves around the sun?

ENHANCED LEARNING

1. An isolated particle of mass m is moving in a horizontal plane (x - y) along the x -axis at a certain height above the ground. It suddenly explodes into two fragments of masses $m/4$ and $3m/4$. An instant later, the smaller fragment is at $y = +15\text{cm}$. What is the position of larger fragment at this instant? (-5cm)

2. The instantaneous angular position of a point on a rotating wheel is given by the equation $\theta(t) = 2t^3 - 6t^2$. Find the time at which the torque becomes zero. ($t = 1\text{s}$)

Gravitation

VERY SHORT ANSWER TYPE QUESTIONS (1 MARK)

1. Two satellites P and Q are in the same circular orbit round the earth. The mass of P is greater than that of Q. It follows that:

- (a) the speed of P is equal to that of Q.
- (b) the speed of P is greater than the speed of Q
- (c) the speed of Q is greater than the speed of P
- (d) the KE of P is equal to the KE of Q

2. If the mass of a body is M on the earth surface, then the mass of the same body on the moon surface is:

- (a) $M/6$
- (b) zero
- (c) M
- (d) $M/2$

3. The acceleration due to gravity at a height 1 km above the earth is the same as at a depth d below the surface of earth. Then:

- (a) $d = \frac{1}{2}$ km
- (b) $d = 1$ km
- (c) $d = \frac{3}{2}$ km
- (d) $d = 2$ km

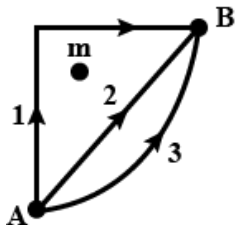
4. The velocity with which a projectile must be fired so that it escapes earth's gravitation does not depend on

- (a) mass of earth
- (b) mass of projectile
- (c) radius of the projectile's orbit
- (d) gravitational constant

5. Particles of masses $2M, m$ and M are respectively at points A, B and C, where distance $AB = 21(BC)$, $m \ll M$ and at times $t=0$ they are all at rest (as shown in the figure) at subsequent times before any collision takes place:

- (a) m will remain at rest
- (b) m will move towards M
- (c) m will move towards $2M$
- (d) m will have oscillatory motion

6. If W_1, W_2 and W_3 represent the work done in moving a particle from A to B along three different paths, 1, 2 and 3, respectively, (as shown in the figure) in the gravitational field of a point mass m , find the correct relation between W_1, W_2 and W_3 .



- (a) $W_1 > W_2 > W_3$
- (b) $W_1 = W_2 = W_3$
- (c) $W_1 < W_2 < W_3$
- (d) $W_2 > W_1 > W_3$

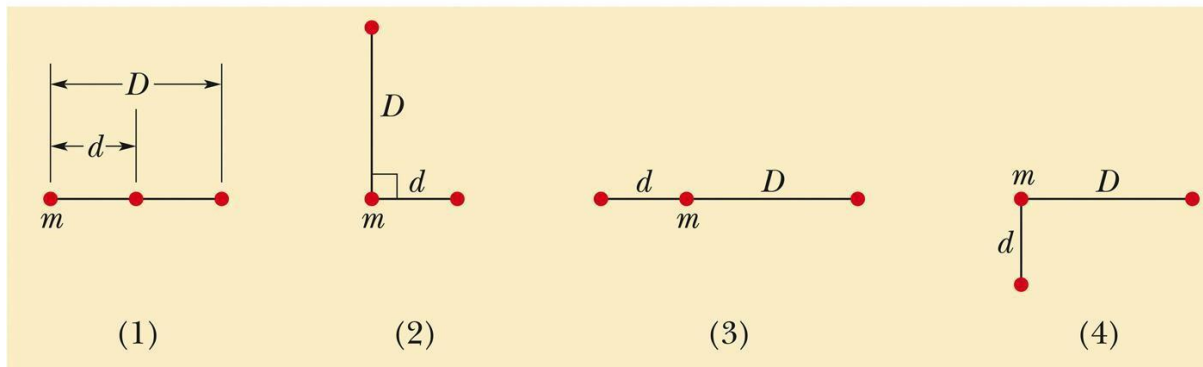
7. Two spheres of masses m and M are situated in air and the gravitational force between them is F . The space around the masses is now filled with a liquid of specific gravity 3. The new gravitational force will be :
- $3F$
 - F
 - $F/3$
 - $F/9$
8. The earth is assumed to be a sphere of radius R . A platform is arranged at a height R from the surface of Earth. The escape velocity of a body from this platform is kv , where v is its escape velocity from the surface of the earth. The value of k is
- $\sqrt{2}$
 - $1/\sqrt{2}$
 - $1/2$
 - $1/3$
9. Name two factors which determine whether a planet would have atmosphere or not.
10. Write one important use of (i) geostationary satellite (ii) polar satellite
11. What is escape velocity?
12. What is a geostationary satellite?
13. What are the polar satellites?
14. Define gravitational potential energy of a system of two mass particles.
15. Draw areal velocity versus time graph for Mars.
16. **Assertion:** Escape velocity of a tennis ball from the surface of earth is the same as the escape velocity of a cricket ball from the surface of earth.

Reason: Escape velocity of a body is independent of the mass of the body

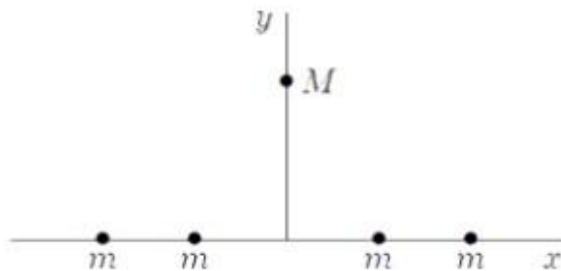
SHORT ANSWER TYPE QUESTIONS (2 MARK)

17. Draw graphs showing the variation of acceleration due to gravity with (i) height above earth is surface (ii) depth below the earth's surface.

18. The gravitational force between a hollow spherical shell (of radius R and uniform density) and a point mass is F . Show the nature of F versus r graph where r is the distance of the point from the centre of the hollow spherical shell of uniform density.
19. Explain why a tennis ball bounces higher on hills than in plane?
20. Obtain relations to show how the value of 'g' changes with altitude.
21. Why space rockets are usually launched from west to east in the equatorial plane?
22. The radius of a planet is R_1 and a satellite revolves round it in a circle of radius R_2 the time period of revolution is T . Find the acceleration due to the gravitation of the planet at its surface.
23. The figure shows four arrangements of three particles of equal masses. Arrange them according to the magnitude of the net gravitational force on the particle labelled m , in decreasing order.



24. Four particles, each with mass m are arranged symmetrically about the origin on the x axis. A fifth particle, with mass M , is on the y axis. What is the direction of the gravitational force on M ?



25. An object of mass m is raised from the surface of the earth to a height equal to the radius of the earth, that is, taken from a distance R to $2R$ from the centre of the earth.
What is the gain in its potential energy?
26. Out of aphelion and perihelion, where is the speed of the earth more and why?

SHORT ANSWER TYPE QUESTIONS (3 MARK)

27. Find the potential energy of a system of four particles, each of mass m , placed at the vertices of a square of side a . Also obtain the potential at the centre of the square.
28. The escape velocity of a projectile on earth's surface is 11.2 km s^{-1} . A body is projected out with thrice this speed. What is the speed of the body far away from the earth?
Ignore the presence of the sun and other planets.
29. Obtain relations to show how the value of 'g' changes with depth.
30. What do you mean by weightlessness? How is it applied inside the spacecraft?
31. If the radius of earth shrinks by 2%, mass remaining constant. How would the value of acceleration due to gravity change?
32. Calculate the period of revolution of the Neptune around the sun, given that diameter of its orbit is 30 times the diameter of the earth's orbit around the sun. Assume both the orbits to be circular.
33. Three masses, each equal to M are placed at the three corners of a square of side a .
Calculate the force of attraction on unit mass placed at the fourth corner.
34. Two stationary particles of masses M_1 and M_2 are at distance d apart. A third particle, lying on the line joining the particles, experiences no resultant gravitational force. What is the distance of this particle from M_1 (in terms of M_1 , M_2 and d)?

35. If the radius of the earth were to be increased by a factor of 3, by what factor would its density have to be changed to keep the 'g' same?
36. A high jumper can jump 2.0 m on earth, With the same effort how high will he be able to jump on a planet whose density is one-third and radius one-fourth those of the earth?
37. Three mass points each of mass m are placed at the vertices of an equilateral triangle of side 1 . What is the gravitational field and potential at the centroid of the triangle?

LONG ANSWER TYPE QUESTIONS (5 MARK)

38. Derive expression for the orbital velocity of a satellite and its time period. Obtain the expression for the height of the geostationary satellite.
39. Derive the expression for gravitational potential energy of two mass particle system. Show that when mass m taken from surface of earth to a small height change in potential energy is 'mgh'.

ENHANCED LEARNING

1. Draw graphs showing the variation of acceleration due to gravity with (i) height above the earth's surface and (ii) depth below the earth's surface.
2. A simple pendulum has a time period T_1 when on the earth's surface, and T_2 when taken to a height R above the earth's surface, where R is the radius of the earth. What is the value of T_2/T_1 ?
($T_2/T_1=2$)
3. Where will a body weigh more-1 km above the surface of earth or 1 km below the surface of earth?

Properties of matter (solids and liquids)

VERY SHORT ANSWER TYPE QUESTIONS (1 MARK)

1. According to Hooke's law of elasticity, if stress is increased, then the ratio of stress to strain :
(a) increases
(b) decreases

- (c) remains the same
 - (d) becomes zero
2. Two spherical rain drops with radii in the ratio 1:2 fall from a great height through the atmosphere. The ratio of their momenta after they have attained terminal velocity is (a) 1:8
- (b) 1:32
 - (c) 1:16
 - (d) 1:2
3. The Young's modulus of the material of a wire of length L and radius r is Y newton per square metre. If the length of the wire is reduced to $L/2$ and the radius to $r/2$, then its Young's modulus will be.
- (a) $Y/2$
 - (b) Y
 - (c) $2Y$
 - (d) $4Y$
4. A steel ball is dropped in a long glass tube filled with oil, then
- (a) the ball attains constant velocity after some time
 - (b) the ball stops
 - (c) the speed of the ball will keep on increasing
 - (d) the starts moving upwards
5. An aeroplane gets its upward lift due to a phenomenon described by the:
- (a) Archimedes' Principle
 - (b) Bernoulli's Principle
 - (c) Buoyancy principle
 - (d) Pascal Law
6. When a capillary tube is dipped into a liquid, the liquid neither rises nor falls in the capillary. Then the angle of contact is:
- (a) 0°
 - (b) 180°
 - (c) 90°
 - (d) 45°

7. Which of the following physical quantities do not have same dimensions?
- pressure and stress
 - tension and surface tension
 - strain and angle
 - energy and work
8. Viscous force exerted by the liquid flowing between two plates in a streamline flow depends upon the:
- velocity gradient in the direction perpendicular in the plates
 - area of plates
 - coefficient of viscosity of the liquid
 - all of these
9. The radii of two soap bubbles are in the ratio 2:1. The excess pressures will be in the ratio :-
- 1 : 2
 - 2 : 1
 - 1: 4
 - 4:1
10. Three liquids of densities ρ_1 , ρ_2 , and ρ_3 (With $\rho_1 > \rho_2 > \rho_3$), having the same value of surface tension T , rise to the same height in three identical capillaries. The angles of contact θ_1 , θ_2 , and θ_3 obey:-
- $\pi/2 < \theta_1 < \theta_2 < \theta_3 < \pi$
 - $\pi > \theta_1 > \theta_2 > \theta_3 > \pi/2$
 - $\pi/2 > \theta_1 > \theta_2 > \theta_3 \geq 0$
 - $0 \leq \theta_1 < \theta_2 < \theta_3 < \pi/2$
11. Modulus of rigidity of an ideal liquid is:
- infinity
 - zero
 - unity
 - some finite small non-zero constant value

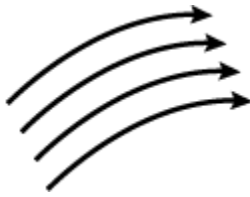
12. The maximum load a wire can withstand without breaking, when its length is reduced to half of its original length, will :
- be double.
 - be half.
 - be four times.
 - remain same.
13. A spring is stretched by applying a load to its free end. The strain produced in the spring is
- volumetric
 - shear
 - longitudinal and shear
 - longitudinal
14. A spring of unstretched length l and force constant k is stretched by a small length x . It is further stretched by another small length y . The work done in the second stretching is:
- $\frac{1}{2} ky^2$
 - $\frac{1}{2} k (x^2 + y^2)$
 - $\frac{1}{2} k (x+y)^2$
 - $\frac{1}{2} ky(2x + y)$
15. A wire elongates by l mm when a load W is hanged from it. If the wire goes over a pulley and two weights W each are hung at the two ends, the elongation is
- zero
 - $l/2$
 - l
 - $2l$
16. Two wires are made of the same material and have the same volume. However wire 1 has cross-sectional area A and wire 2 has cross-sectional area $3A$. If the length of wire 1 increases by Δx on applying force F , how much force is needed to stretch wire 2 by the same amount?
- $6F$
 - $9F$
 - F
 - $4F$

17. Choose the wrong statement:

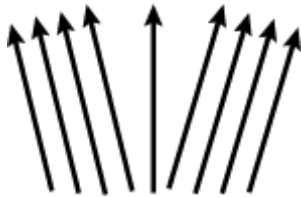
- (a) The bulk modulus for solids is much larger than for liquids.
- (b) Gases are least compressible.
- (c) The incompressibility of solids is due to the tight coupling between neighbouring atoms
- (d) The reciprocal of bulk modulus is called compressibility.

18. Which of the following diagrams does not represent a streamline flow?

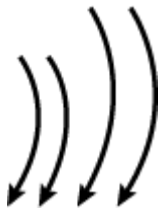
(a)



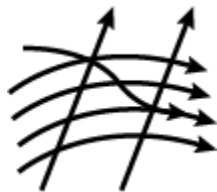
(b)



(c)



(d)



19. Along a streamline:

- (a) the velocity of all fluid particles crossing a given position is constant.
- (b) the velocity of a fluid particle remains constant.
- (c) the velocity of all fluid particles at a given instant is constant.
- (d) the speed of a fluid particle remains constant

20. The angle of contact at the interface of water-glass is 0° , Ethylalcohol-glass is 0° , Mercury-glass is 140° and Methyl iodide-glass is 30° . A glass capillary is put in a trough containing one of these four liquids. It is observed that the meniscus is convex. The liquid in the trough is
- ethylalcohol
 - water
 - mercury
 - methyl iodide
21. If 'S' is stress and 'Y' is Young's modulus of a wire material, then energy stored in the wire per unit volume, is?
- $2Y/S^2$
 - $S/2Y$
 - $2S^2Y$
 - $S^2/2Y$
22. Copper of fixed volume 'V' is drawn into wire of length 'l'. When this wire is subjected to a constant force 'F', the extension produced in the wire is ' Δl '. Which of the following graph is a straight line?
- Δl verses $1/l$
 - Δl verses $1/l^2$
 - Δl verses l^2
 - Δl verses l
23. Draw stress - strain curve for elastomers (elastic tissue of Aorta)
24. State Pascal's law for fluids.
25. Why do the clouds float in sky?
26. What is capillary action?
27. What does the slope of stress versus strain graph give?
28. Why are springs made of steel and not of copper?

29. Why is the tip of the nib of a pen split?
30. Why new earthen pots keep water cooler than the old one?
31. Water rises in a capillary tube whereas mercury falls in the same tube. Why?
32. Why does soap help us to remove dirt better while washing clothes?
33. Roofs of the huts are blown up during stormy days. Why?
34. Why does a rain drop falling freely does not acquire a very high velocity?
35. Why does a mercury barometer always reads less than the actual value of pressure?
36. The iron needle will float on clean water but sink when some detergent is added to this water. Why?
37. Antiseptics have low surface tension. Why?
38. How do trees draw water from the ground?
39. 'Smaller is the angle of contact, better is the detergent'. Is this true?
40. Assertion : It is easier to spray water in which some soap is dissolved.
Reason : Soap is easier to spread.
41. Assertion : When height of a tube is less than liquid rise in the capillary tube, the liquid does not overflow.
Reason : Product of radius of meniscus and height of liquid in capillary tube always remains constant.

42. **CASE STUDY BASED QUESTION:**

While studying the elastic properties of solids it is observed that for small deformations, stress is directly proportional to strain for many materials. This is known as Hooke's law. The constant of proportionality is called modulus of elasticity. Three elastic moduli viz,

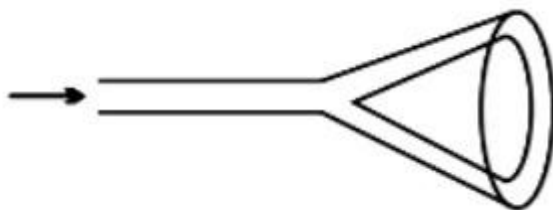
Young's modulus, shear modulus and bulk modulus are used to describe the elastic behaviour of objects as they respond to deforming forces that act on them.

- (a) What do you mean by the term elasticity?

- (b) Under what condition is Hooke's law valid?
- (c) Is Hooke's law a universal law?
- (d) Define Young's Modulus and give its mathematical expression.
- (e) What would be the effect on the Young's Modulus of the material of a wire if its length as well as radius are doubled?

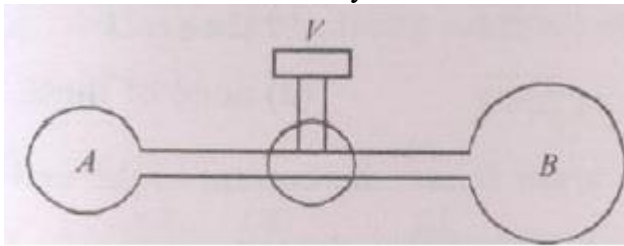
SHORT ANSWER TYPE QUESTIONS (2 MARK)

- 43. What amount of energy will be liberated if 1000 droplets of water each 10^{-8}m in diameter mixes together to form one large spherical drop (surface tension = 0.075Nm^{-1})?
- 44. A clean glass capillary tube is held vertically in water raised to a height of 7cm. The tube is down depressed and only 5cm of its length is above water. What will be the angle of contact?
- 45. With the help of a neat labelled diagram, explain the principle and working of hydraulic lift.
- 46. Why can we not remove a filter paper from a funnel by blowing air into narrow end?

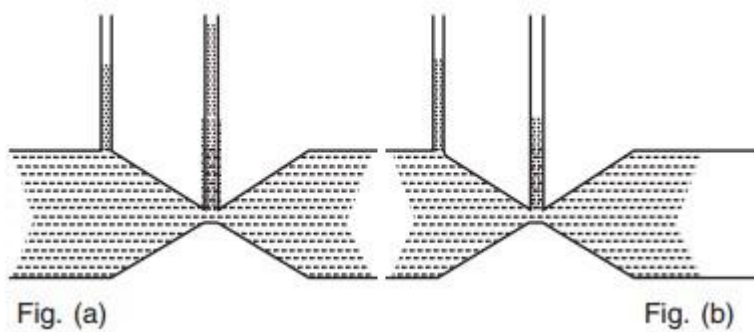


- 47. A material has Poisson's ratio 0.50. If a uniform rod of it suffers a longitudinal strain of 2×10^{-3} , then what is the percentage change in its volume?
- 48. Name any two application of the Bernoulli's principle.
- 49. Calculate excess pressure in an air bubble of radius 6mm. Surface tension of liquid is 0.58 N/m .
- 50. What is the effect of temperature on the viscosity of (a) liquids (b) gas?

51. A wire stretches by a certain amount under a load. If the load and radius both are increased to four times, find the stretch caused in the wire.
(L/4)
52. Why clocks do not keep correct time in summer and winter? Explain.
53. Which is more elastic- rubber or steel? Explain.
54. Two soap bubbles A and B are formed at the two open ends of a tube. The bubble A is smaller than bubble B. What will happen if valve V is opened and air can flow freely between the bubbles?



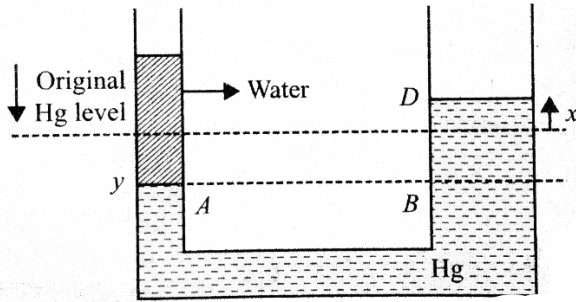
55. The fig (a) & (b) refer to the steady flow of a non-viscous liquid. Which of the two figures is incorrect? Why?



SHORT ANSWER TYPE QUESTIONS (3 MARK)

56. Derive expression for the excess of pressure for a (a) spherical liquid drop
(b) soap bubble.
57. Two communicating cylindrical tubes contain mercury. The diameter of one vessel is four times large than the diameter of the outer. A column of

water of height 70cm is poured into the narrow vessel. How much will the mercury level rise in the other vessel and how much will it sink in the narrow one? How much will the mercury level rise in the narrow vessel, if a column of water of the same height is poured into the broad vessel?



58. When the tension in a metal wire is T_1 , its length is l_1 . When the tension is T_2 , its length is l_2 . What is the natural length of wire in terms of l_1 , l_2 , T_1 and T_2 ?
59. The breaking stress for a metal is $7.8 \times 10^9 \text{ Nm}^{-2}$. Calculate the maximum length of the wire made of this metal which may be suspended without breaking. The density of the metal = $7.8 \times 10^3 \text{ kg m}^{-3}$. Take $g = 10 \text{ N kg}^{-1}$
60. If a ball is thrown and given a spin, then the path of the ball is more curved than in a usual spin free path. Explain.
61. State and derive Torricelli's law of efflux.
62. The length of an elastic string is 'a' metre when the longitudinal tension is 4N and 'b' metre when the longitudinal tension is 5N. What is the length of the string in metre when longitudinal tension is 9N in terms of 'a' and 'b'?
63. A 14.5 kg mass, fastened to the end of a steel wire of unstretched length 1.0 m, is whirled in a vertical circle with an angular velocity of 2 rev/s at the bottom of the circle. The cross-sectional area of the wire is 0.065 cm^2 . Calculate the elongation of the wire when the mass is at the lowest point of its path. Given: $Y_{\text{steel}} = 2 \times 10^{11} \text{ Nm}^{-2}$

LONG ANSWER TYPE QUESTIONS (5 MARK)

64. State and prove Bernoulli's theorem. Give its limitation.
65. Define terminal velocity. Obtain an expression for terminal velocity of a sphere falling through a viscous liquid. Use the formula to explain the observed rise of air bubbles in a liquid.
66. Derive an expression for Ascent formula. How does liquid rise in a tube of insufficient length?
67. Explain why:
- A balloon filled with liquid helium does not rise in air indefinitely but halts after a certain height.
 - The angle of contact of mercury with glass is obtuse while that of water with glass is acute.
 - A drop of water under no external force is always spherical in shape.
 - To keep a piece of paper horizontal, you should blow over it and not under it.
 - Insects can run on the surface of water.

ENHANCED LEARNING

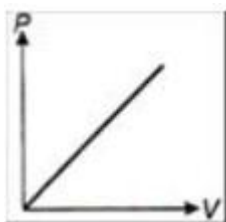
- A 40 kg boy whose leg bones are 4 cm^2 in area and 50 cm long falls through a height of 50 cm without breaking his leg bones. If the bones can stand a stress of $0.9 \times 10^8 \text{ Nm}^{-2}$, calculate the Young's modulus for the material of the bone. Take $g = 10 \text{ ms}^{-2}$.
($Y = 2.025 \times 10^9 \text{ Nm}^{-2}$)
- A boat floating in a water tank carrying a number of large stones. If the stones are unloaded into water, what will happen to the water level? Explain.
- A horizontal pipe line carries water in a streamline flow. At a point along the pipe where the cross-sectional area is 10 cm^2 , the water velocity is 1 ms^{-1} and the pressure is 2000Pa. What is the pressure at another point where the cross-sectional area is 5 cm^2 ? (500Pa)

4. A man sitting in a boat, which is floating on a pond. If the man drinks some water from the pond, how does the level of water in the pond change? Explain.
5. A light rod of length 2m is suspended from the ceiling horizontally by means of two vertical wires of equal length tied to its ends. One of the wires is made of steel and is of cross-section 0.1 cm^2 and the other of brass of cross-section 0.2 cm^2 . Along the rod at what distance a weight may be hung to produce equal stresses in both the wires.
($Y_{\text{steel}}=20 \times 10^{11} \text{ Nm}^{-2}$, $Y_{\text{brass}}=10 \times 10^{11} \text{ Nm}^{-2}$)

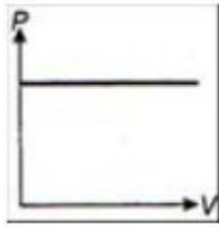
THERMODYNAMICS

VERY SHORT ANSWER TYPE QUESTIONS (1 MARK)

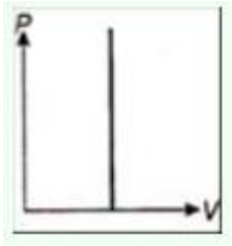
1. The state of a thermodynamic system is represented by:
 - (a) pressure only
 - (b) volume only
 - (c) temperature only
 - (d) pressure, volume and temperature
2. Which of the following is an intensive property?
 - (a) volume
 - (b) mass
 - (c) volumetric density
 - (d) weight
3. Which of the following graphs between pressure and volume correctly shows isochoric change?
 - (a)



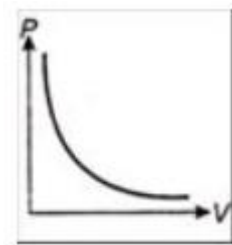
(b)



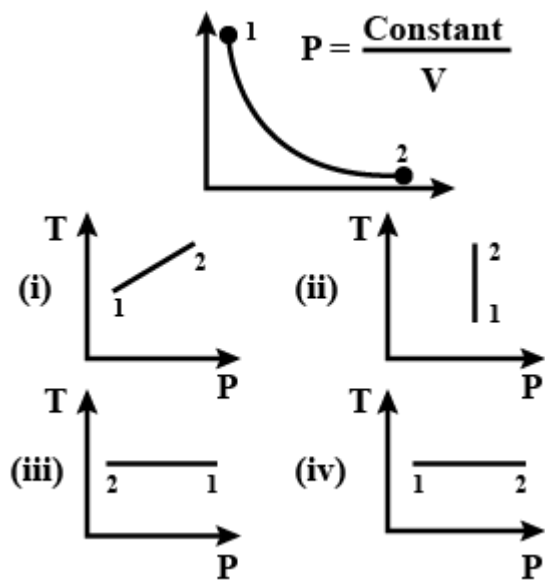
(c)



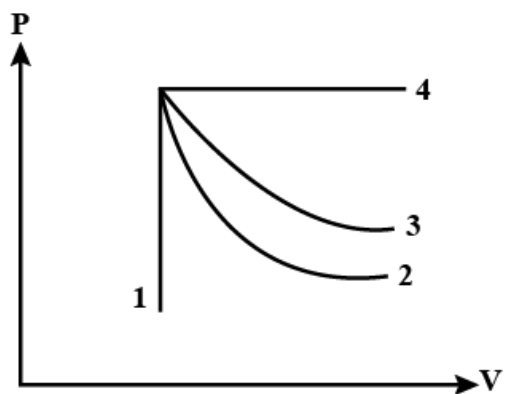
(d)



4. $\Delta U + \Delta W = 0$ is valid for:
- adiabatic process
 - isobaric process
 - isochoric process
 - isothermal process
5. When heat is given to an ideal gas in an isothermal change, the result will be
- external work done
 - rise in the gas' temperature
 - increase in internal energy
 - external work done and also rise in temperature
6. Consider P–V diagram for an ideal gas shown in Figure. Out of the following diagrams (Figure), which represents the T–P diagram?

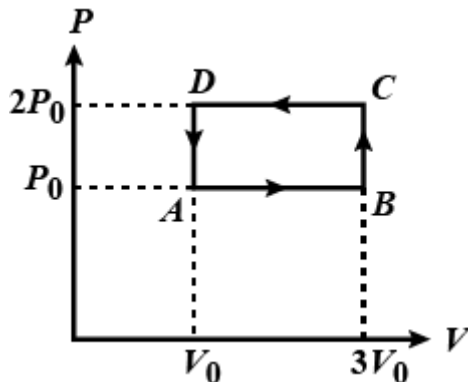


- (a) (i)
 - (b) (ii)
 - (c) (iii)
 - (d) (iv)
7. During adiabatic compression of gas, its temperature
- (a) falls
 - (b) rises
 - (c) remains constant
 - (d) becomes constant
8. An ideal gas undergoes four different processes from the same initial state (Figure Four processes are adiabatic, isothermal, isobaric and isochoric. Out of 1,2,3 and 4, which one is adiabatic?)



- (a) 4

- (b) 3
 (c) 2
 (d) 1
9. Which of the following is path dependent?
 (a) P
 (b) V
 (c) U
 (d) PdV
10. The first law of thermodynamics confirms the law of
 (a) conservation of momentum of molecules
 (b) conservation of energy
 (c) flow of heat in a particular direction
 (d) both (a) and (c)
11. An ideal gas undergoes cyclic process ABCDA as shown in given PV diagram. The amount of work done by the gas is:



- (a) $6P_0V_0$
 (b) $-2P_0V_0$
 (c) $2P_0V_0$
 (d) P_0V_0
12. When an ideal gas undergoes an adiabatic change causing a temperature change of ΔT , then which of the following statements are correct
 (i) there is no heat gained or lost by the gas
 (ii) the work done by the gas is equal to change in internal energy.

- (iii) the change in internal energy per mole of the gas is $C_P \times \Delta T$,
 where C_P is the molar heat capacity at constant pressure. (a) (i), (ii)
 and (iii) are correct
 (b) only (i) and (ii) are correct
 (c) only (ii) and (iii) are correct
 (d) only (i) is correct
13. An ideal gas expands isothermally from volume V_1 to V_2 and is then
 compressed to original volume V_1 adiabatically. Initial pressure is P_1 and
 final pressure is P_3 . The total work done is W . Then
 (a) $P_3 > P_1$, $W > 0$
 (b) $P_3 < P_1$, $W < 0$
 (c) $P_3 > P_1$, $W < 0$
 (d) $P_3 = P_1$, $W = 0$
14. "Heat cannot by itself flow from a body at lower temperature to a body at
 higher temperature" is a statement or consequence of:
 (a) conservation of mass
 (b) first law of thermodynamics
 (c) second law of thermodynamics
 (d) conservation of momentum
15. The molar specific heat at constant pressure of an ideal gas is $(7/2)R$. The
 ratio of specific heat at constant pressure to that at constant volume is:-
 (a) $9/7$
 (b) $8/7$
 (c) $7/5$
 (d) $5/7$
16. Write Kelvin-Planck's statement for the second law of thermodynamics.
 17. State first law of thermodynamics.
 18. What are the limitations of first law of Thermodynamics?
 19. What are the limitations of second law of Thermodynamics?

SHORT ANSWER TYPE QUESTIONS (2 MARK)

20. Obtain an expression for work done in an isothermal process.
21. Does the internal energy of an ideal gas change in the case of :
 - (a) an isothermal process
 - (b) an adiabatic process
22. When a bore is made with a small drill into a hard board, the drill becomes hot to touch. Why? What happens if hard board is replaced by a soft board?

SHORT ANSWER TYPE QUESTIONS (3 MARK)

23. Using first law of thermodynamics, establish the relation between two molar specific heat for a gas.
24. Explain reversible and irreversible processes by giving one examples of each.
25. Explain the working of a heat engine with a block diagram.
26. Explain the working of a refrigerator with a block diagram.
27. A thermometer of mass 0.055 kg and heat capacity 46.1 J/K reads 15.0°C. It is then completely immersed in 0.300 kg of water and it comes to the same final temperature as the water. If the thermometer reads 44.4°C, what was the temperature of the water before insertion of the thermometer, neglecting other heat losses?

LONG ANSWER TYPE QUESTIONS (5 MARK)

28. The P–V diagram for a cyclic process is a triangle ABC drawn in order. The coordinates of A,B,C are (4,1), (2,4) and (2,1) respectively. The coordinates are in the order (P,V) Pressure is in Nm^{-2} and volume is in litre. Calculate work done during the process from A to B, B to C and C to A. Also, calculate work done in the complete cycle.

ENHANCED LEARNING

1. Two samples of a gas initially at the same temperature and pressure are compressed from a volume V to V/2, one isothermally, the other adiabatically. In which sample is the final pressure greater?

2. A liquid is being converted into steam at its boiling point. What will be the specific heat of the liquid at this time?
3. A thermos flask contains coffee. It is vigorously shaken. Consider the coffee as the system. (i) Has any heat been added to it? (ii) Has any work been done on it? (iii) Has its internal energy changed? (iv) Does its temperature rise?
4. Two moles of an ideal monoatomic gas occupies a volume V at 27°C . The gas expands adiabatically to a volume $2V$. Calculate (a) the final temperature of the gas and (b) change in its internal energy.

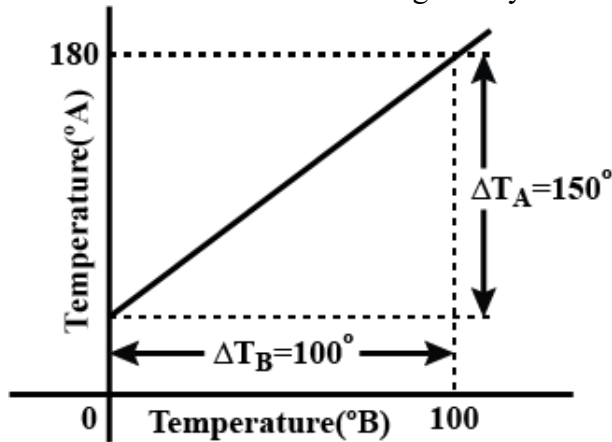
THERMAL PROPERTIES OF MATTER KINETIC THEORY OF GASES

VERY SHORT ANSWER TYPE QUESTIONS (1 MARK)

1. Mud houses are cooler in summer because (a) mud is a good conductor of heat.
(b) mud is a bad conductor of heat.
(c) mud doesn't radiate any heat
(d) mud absorbs all thermal radiations
2. In order that the heat flows one part of a solid to another part, what is required ?
(a) uniform density
(b) temperature gradient
(c) density gradient
(d) uniform temperature
3. Which of the following statements is wrong?
(a) Stefan's constant is same for all black bodies
(b) Thermal radiation travels with a speed of 3×10^8 m/s in vacuum.
(c) Stefan's law is applicable to all bodies
(d) Wien's Displacement Law can be used to determine the temperature of a distant star.

4. We plot a graph having temperature in $^{\circ}\text{C}$ along X-axis and in $^{\circ}\text{F}$ along Y-axis. If the graph is a straight line, then it
- intercepts on the positive X-axis
 - intercepts on the positive Y-axis
 - passes through the origin
 - intercepts negative axis of both X and Y.
5. At a common temperature, a block of wood and a block of metal feel equally cool or hot. The temperatures of metal and wood are
- equal to temperature of body
 - less than temperature of the body
 - greater than temperature of the body
 - could be (b) or (c)
6. Two gases A and B having the same temperature T, same pressure P and same volume V are mixed. If the temperature is at the same temperature T and occupies a volume V the pressure of the mixture is
- P
 - 2P
 - 3P
 - 4P
7. A bimetallic strip is made of aluminium and steel ($\alpha_{\text{AL}} > \alpha_{\text{steel}}$). On heating, the strip will
- remain straight
 - get twisted
 - will bend with aluminium on concave side
 - will bend with steel on concave side.
8. A uniform metallic rod rotates about its perpendicular bisector with constant angular speed. If it is heated uniformly to raise its temperature slightly, then
- its speed of rotation increases
 - its speed of rotation increases
 - its speed of rotation remains same
 - the information is insufficient
9. The graph between two temperature scales A and B is shown in figure . Between upper fixed point and lower fixed point there are 150 equal

division on scale A and 100 on scale B. The relationship for conversion between the two scales is given by



(a)

$$\frac{T_A - 180}{100} = \frac{T_B}{150}$$

(b)

$$\frac{T_A - 30}{150} = \frac{T_B}{100}$$

(c)

$$\frac{T_B - 180}{150} = \frac{T_A}{100}$$

(d)

$$\frac{T_B - 40}{100} = \frac{T_A}{180}$$

10. An aluminium sphere is dipped into water. Which of the following is true? (a) Buoyancy will be less in water at 0°C than that in water at 4°C. (b) Buoyancy will be more in water at 0°C than that in water at 4°C. (c) Buoyancy will be the same in water at 0°C as that in water at 4°C. (d) Buoyancy may be more or less in water at 4°C depending on the radius of the sphere.
11. As the temperature is increased, the time period of a pendulum (a) increases as its effective length increases due to shifting of centre of mass below the centre of the bob. (b) decreases as its effective length remains same but the centre of mass shifts above the centre of the bob (c) decreases as its effective length increases even though its centre of mass still remains at the centre of the bob.

(d) increases as its effective length increases even though its centre of mass still remains at the centre of the bob.

12. The radius of a metal sphere at room temperature T is R , and the coefficient of linear expansion of the metal is α . The sphere is heated a little by a temperature ΔT so that its new temperature is $(T+\Delta T)$. The increase in the volume of the sphere is approximately:

(a) $\pi R^2 \alpha \Delta T$ (b) $2\pi R \alpha \Delta T$

(c)

4π

$R^3 \alpha$

ΔT

(d)

4π

$R^3 \alpha$

$\Delta T /$

3

13. Which of the following quantities must be determined so that the thermal capacity of a body may be calculated, when the specific heat of a body is known?

(a) Emissivity

(b) Latent Heat

(c) mass

(d) temperature

14. The temperature of a radiating body increase by 30%. Then the increase in the amount of radiation is

(a) 185%

(b) 285%

(c) 325%

(d) 245%

15. An ideal gas is expanding such that $PT^2 = \text{constant}$. The coefficient of volume expansion of the gas is

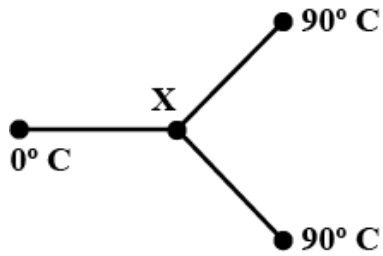
(a) $1/T$

(b) $2/T$

(c) $3/T$

(d) $4/T$

16. Three metal rods of the same material and identical in all respects are joined as shown in the figure. The temperatures at the ends are maintained as indicated. Assuming no loss of heat from the curved surfaces of the rods, the temperature at the junction X would be

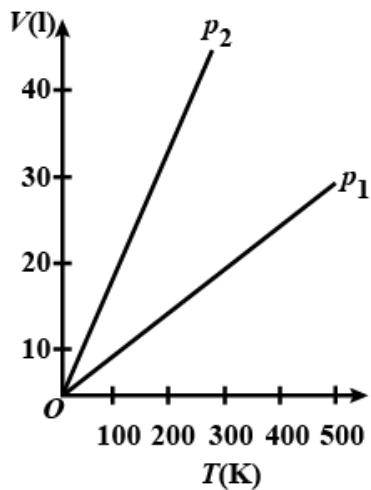


- (a) 45°C
- (b) 60°C
- (c) 30°C
- (d) 20°C

17. Two sides of A and B of a heat-conducting slab are at temperatures T_1 and T_2 respectively. The heat flows from A to B and the amount of heat conducted (in a certain amount of time) is Q . If the temperature of side A is doubled, to keep the amount of heat conducted Q unchanged (in the same amount of time), the temperature of side B should be:

- (a) $T_1 + T_2$
- (b) $2T_2$
- (c) $T_1 - T_2$
- (d) $2T_1 - T_2$

18. Volume versus temperature graphs for a given mass of an ideal gas are shown in figure at two different values of constant pressure. What can be inferred about relation between P_1 and P_2 ?

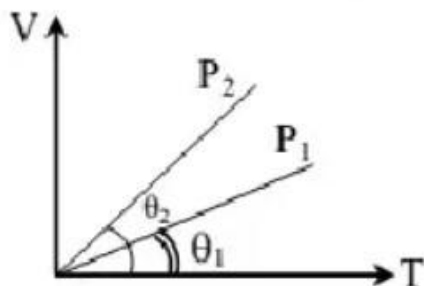


- (a) $P_1 > P_2$
- (b) $P_1 < P_2$
- (c) $P_1 = P_2$
- (d) data is insufficient

19. If C_p and C_v denote the specific heats (per unit mass) of an ideal gas of molecular weight M , where R is the molar gas constant:

- (a) $C_p - C_v = R/M^2$
- (b) $C_p - C_v = R$
- (c) $C_p - C_v = R/M$
- (d) $C_p - C_v = M/R$

20. In the given ($V - T$) diagram, what is the relation between pressures P_1 and P_2 ?



- (a) $P_1 = P_2$
- (b) $P_1 > P_2$
- (c) $P_1 < P_2$
- (d) Cannot be predicted

21. Root mean square speed of the molecules of ideal gas is v . If pressure is increased two times at constant temperature, the rms speed will become:
- (a) $v/2$
 - (b) v
 - (c) $2v$
 - (d) $4v$
22. What are the characteristics of an Ideal Gas?
23. The absolute temperature of gas is increased 3 times. What will be the increase in root mean square velocity of the gas molecule?
24. What is meant by degree of freedom of a gas?
25. Draw a labelled graph to show the anomalous behaviour of water.
26. Define the coefficient of thermal conductivity.
27. Write unit and dimension of coefficient of thermal conductivity.
28. Birds often swell their feathers in winter. Why?
29. Why are stainless steel cooking pans provided with extra copper bottom?

SHORT ANSWER TYPE QUESTIONS (2 MARK)

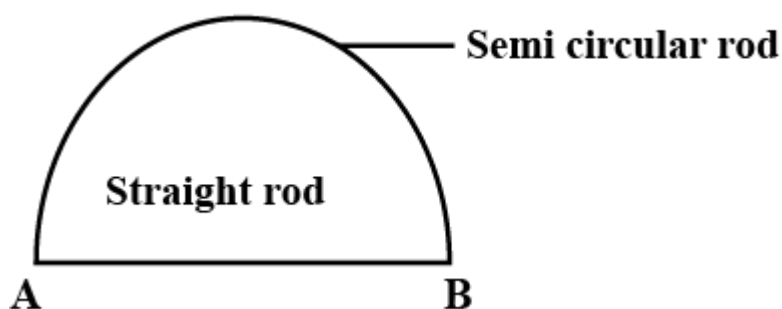
30. Explain importance of anomalous behaviour of water for sustaining life under water.
31. Equal volumes of monoatomic and diatomic gases at the same temperature are given equal quantities of heat. Which of the two will undergo a larger temperature rise?
Why?
32. Two bodies at different temperatures T_1 and T_2 if brought in thermal contact do not necessarily settle to the mean temperature $(T_1 + T_2)/2$.
Why?

33. The absolute temperature of a gas is increased 3 times what is the effect on the root mean square velocity of the molecules?
34. Imagine a fire-ball suspended in air. Would you experience more heat above the ball or below the ball? Why?
35. When touched, iron chairs appear to be colder than wooden chairs in winter. Why?
36. Draw energy distribution curve of black body radiation.
37. State Wien's displacement law of radiation. Draw its graph.
38. Find the value of γ for mono-atomic and di-atomic gases.

SHORT ANSWER TYPE QUESTIONS (3 MARK)

39. Define (i) heat capacity (ii) Specific Heat capacity (iii) Molar specific heat capacity.
40. The temperatures of equal masses of three liquids A, B, C are 20°C , 30°C and 40°C respectively. On mixing A and B, resulting temperature of the mixture is 26°C . On mixing A and C the resulting temperature of the mixture is 32°C . Find the final resulting temperature of the mixture B and C.
41. Railway lines are laid with gaps to allow for expansion. If the gap between the steel rails 66 m long be 3.63 cm at 10°C . At which temperature will the lines just touch (coefficient of linear expansion for steel = 11×10^{-6} per $^{\circ}\text{C}$)?
42. What are the basic assumptions of kinetic theory of gases?
43. On the basis of assumptions of kinetic theory of gases, derive an expression for the pressure exerted by an ideal gas.
44. On what factors does the rate of heat conduction in a metallic rod in the steady state depend? Write the necessary expression.
45. What do you mean by mean free path and Avogadro's number? Give its expression.

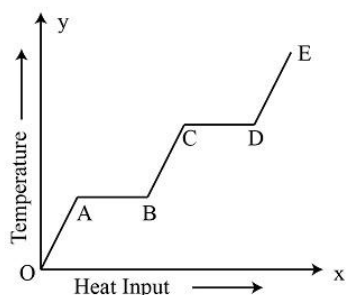
46. Calculate the molecular K.E. of translation of a mole of hydrogen at NTP. Given $R = 8.31 \text{ J/mol. K}$
47. Two bodies of specific heat capacities s_1 and s_2 have the same heat capacities. They are combined to form a single composite body. What is the specific heat capacity of the composite body?
48. The temperature of 100g of water is to be raised from 24°C to 90°C by adding steam to it. Calculate the mass of the steam required for this purpose. [Take specific heat of water = $4.2 \times 10^3 \text{ Jkg}^{-1}\text{C}^{-1}$ and latent heat of vaporisation = $2268 \times 10^3 \text{ Jkg}^{-1}$]
49. Two rods (one semi-circular and other straight) of same material and of same cross sectional area are joined as shown in the figure. The points A and B are maintained at different temperatures. What is the ratio of heat transferred through a cross-section of a semi-circular rod to the heat transferred through a cross section of the straight rod in a given time?
(2)



50. One end of a 0.25m long metal bar is in steam and the other is in contact with ice. If 12g of ice melts per minute, then calculate the thermal conductivity of the metal
(Given cross section of the bar = $5 \times 10^{-4} \text{ m}^2$ and latent heat of ice is 80 calg^{-1})
51. Calculate the temperature at which the rms speed of a gas molecule is double its speed at 27°C , with pressure remaining constant.

LONG ANSWER TYPE QUESTIONS (5 MARK)

52. A solid material is supplied with heat at a constant rate. The temperature of material is changing with heat input as shown in the figure.



- (i) What is represented by AB and CD?
- (ii) What conclusion would you draw if $CD = 2AB$
- (iii) What is represented by the slope of DE?
- (iv) What conclusion can you draw from the fact that the slope of OA is greater than the slope of BC?

ENHANCED LEARNING

1. Calculate the root mean square speed of smoke particles each of mass 5×10^{-17} kg in their Brownian motion in air at N.T.P. Given $k_B = 1.38 \times 10^{-23}$ Jmolecule⁻¹ K⁻¹.
(1.5×10^{-2} ms⁻¹).
2. An insulated container containing monoatomic gas of molar mass m is moving with a velocity v_0 . If the container is suddenly stopped, find the change in temperature. ($mv_0^2/3R$)
3. Three copper blocks of masses M_1, M_2 and M_3 kg respectively are brought into thermal contact till they reach equilibrium. Before contact, they were at T_1, T_2, T_3 ($T_1 > T_2 > T_3$). Assuming there is no heat loss to the surroundings, the equilibrium temperature T is (s is specific heat of copper).
(a) $T = \frac{T_1 + T_2 + T_3}{3}$

(b) $T =$

$$\frac{M_1 T_1 + M_2 T_2 + M_3 T_3}{M_1 + M_2 + M_3}$$

$$M_1 + M_2 + M_3$$

(c) $T =$

$$\frac{M_1 T_1 + M_2 T_2 + M_3 T_3}{3(M_1 + M_2 + M_3)}$$

$$)$$

(d) $T =$

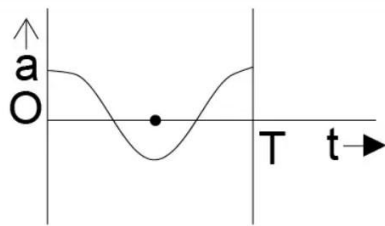
$$\frac{M_1 T_1 s + M_2 T_2 s + M_3 T_3 s}{M_1 + M_2 + M_3}$$

$$3$$

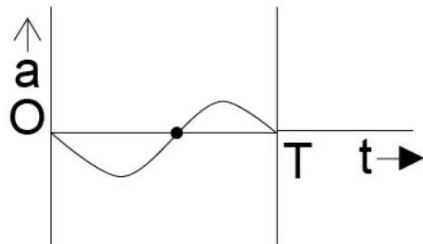
OSCILLATIONS WAVES

VERY SHORT ANSWER TYPE QUESTIONS (1 MARK)

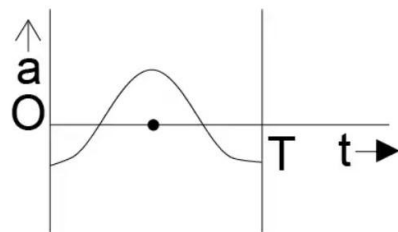
1. A simple pendulum is attached to the roof of a lift. Its time period of oscillation, when the lift is stationary is 0.5 s. Its frequency of oscillation when the lift falls freely will be:
 - (a) zero
 - (b) T
 - (c) 1/T
 - (d) infinity
2. The circular motion with constant speed is:
 - (a) periodic but not simple harmonic
 - (b) simple harmonic but not periodic
 - (c) periodic and simple harmonic
 - (d) neither periodic nor simple harmonic
3. The oscillation of a body on a smooth horizontal surface is represented by the equation, $x = A \cos(\omega t)$ where x = displacement at time ω = frequency of oscillation.
Which one of the following graph shows correctly the variation 'a' with 't'?
Here a = acceleration at time t
 T = time period
 - (a)



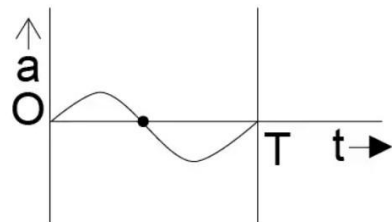
(b)



(c)



(d)



4. The particle executing simple harmonic motion has a kinetic energy of $K_0 \cos^2 \omega t$. The maximum values of the potential energy and the total energy are respectively
- K_0 and K_0
 - $K_0/2$ and K_0
 - K_0 and $K_0/2$
 - 0 and $2K_0$
5. If the equation of a transverse wave is:

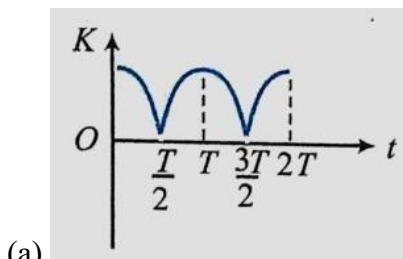
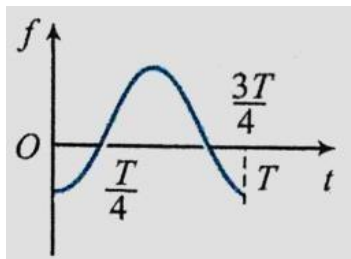
$y = 5\sin 2\pi (t/0.04 - x/40)$ where distance is in cm and time in seconds, then the wavelength of the wave will be: (a) 20 cm

(b) 40 cm

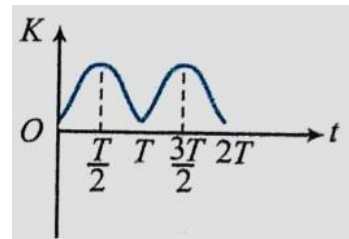
(c) 60 cm

(d) 80 cm

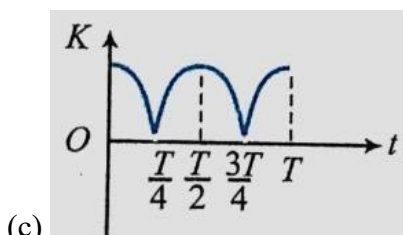
6. A particle is performing SHM with amplitude 'a' and time period 'T'. Its acceleration f varies with time as shown in the following figure. If at time 't', kinetic energy of the particle is K, which of the following graphs is correct?



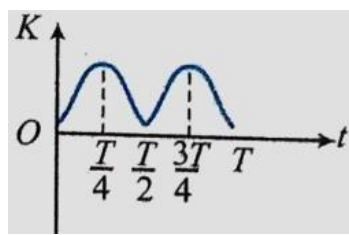
(a)



(b)



(c)



(d)

7. Two simple harmonic motions, are represented by the equations:

$$y_1 =$$

$$10\sin(3\pi t +$$

$$\pi/3)$$

$$y_2 = 5(\sin 3\pi t + \sqrt{3}\cos 3\pi t)$$

Here 't' is in seconds and 'y₁' and 'y₂' are in cm.

Ratio of amplitude of y_1 to $y_2 = x:1$. What is the value of 'x'?

- (a) 1
- (b) 2
- (c) 10
- (d) 100

8. The following equations represent progressive transverse waves

$$z_1 = A \cos$$

$$(\omega t - kx)$$

$$z_2 = A \cos$$

$$(\omega t + kx)$$

$$z_3 = A \cos$$

$$(\omega t + ky)$$

$$z_4 = A \cos (2\omega t - 2ky)$$

A stationary wave will be formed by superposing:

- (a) z_1 and z_2
- (b) z_1 and z_4
- (c) z_2 and z_3
- (d) z_3 and z_4

9. The tension in piano wire is 10N. What should be the tension in the wire to produce a note of double the frequency?

- (a) 5 N
- (b) 20 N
- (c) 40 N
- (d) 80 N

10. What are the beats?

11. Write general expression for displacement from mean position for S.H.M.

12. Draw the graph between restoring force and extension in the spring.

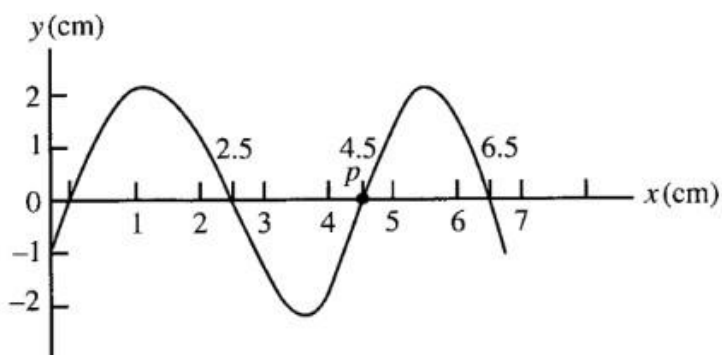
13. Will a pendulum clock lose or gain time when taken to the top of a mountain?

14. What will be the period of oscillation, if the length of a second's pendulum is halved?

15. The length of a second's pendulum on the surface of earth is 1m. What will be the length of a second's pendulum on the surface of the moon?
16. How would the time period of a spring mass system change, when it is made to oscillate horizontally, and then vertically?
17. Assertion : Simple harmonic motion is a uniform motion.
Reason : Simple harmonic motion is the projection of uniform circular motion.
18. Assertion : Acceleration is proportional to the displacement. This condition is not sufficient for motion in simple harmonic.
Reason : In simple harmonic motion direction of displacement is also considered.
19. Assertion : The graph of total energy of a particle in SHM w.r.t., position is a straight line with zero slope.
Reason : Total energy of particle in SHM remains constant throughout its motion.

CASE - BASED QUESTION

20. Consider a snapshot of a sinusoidal travelling wave as shown in the figure. The wave velocity is + 40 cm/s.



Find:

- (i) the frequency of the wave
(a) 20 Hz (b) 30 Hz (c) 25 Hz (d) 10 Hz
- (ii) the phase difference between points 2.5 cm apart
(a) $3\pi/4$ rad (b) $5\pi/4$ rad (c) $7\pi/4$ rad (d) $9\pi/4$ rad
- (iii) the time it takes for the phase at a given position to change by 60°

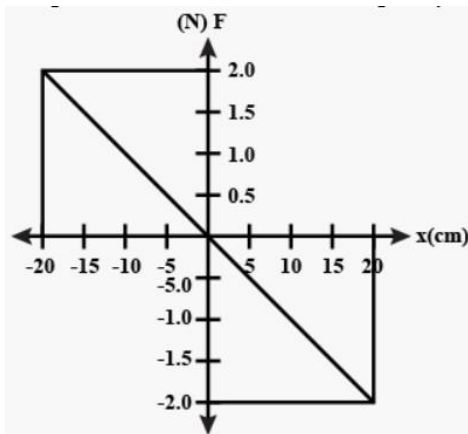
(a) $1/30$ s (b) $1/60$ s (c) $1/20$ s (d)

$1/40$ s (iv) the amplitude of the wave:

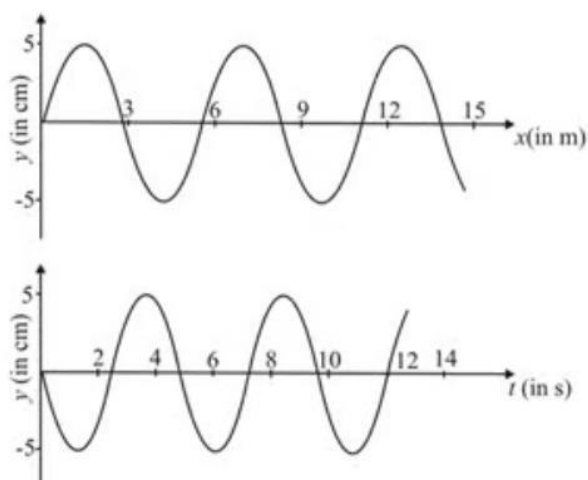
(a) 1 cm (b) 2 cm (c) 2.5 cm (d) 4.5 cm

SHORT ANSWER TYPE QUESTIONS (2 MARK)

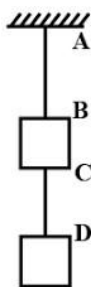
21. There are two springs, one delicate and another hard. For which spring, the frequency of the oscillator will be more?
22. The figure shows the variation of restoring force acting on a particle of mass 400 g executing simple harmonic motion, where 'x' is the displacement from the equilibrium position. Find the frequency of oscillation of the particle.



23. A transverse wave is travelling along a horizontal string. The first figure is the shape of the string at an instant of time. The second picture is a graph of the vertical displacement of a point on the string as a function of time. Find the wave speed.



24. Deduce an expression for the velocity of a particle executing S.H.M.
25. When is the particle velocity (i) Maximum (ii) minimum for S.H.M.?
26. Why are there so many holes in a flute?
27. When we start filling an empty bucket with water, the pitch of sound produced goes on changing. Why?
28. Two blocks each having a mass of 3.2 kg are connected by a wire CD and the system is suspended from the ceiling by another wire AB. The linear mass density of the wire AB is 10 g m^{-1} and that of CD is 8 g m^{-1} . Find the speed of a transverse wave pulse produced in AB and in CD.



29. Why are strings of different thickness and materials used in a sitar or a violin?
30. How does frequency of a tuning fork change, when the temperature is increased?
31. An organ pipe is in resonance with a tuning fork. What change will have to be done in the length L to maintain the resonance, if (i) the temperature increases, (ii) hydrogen is filled in place of air and (iii) the pressure becomes higher?

SHORT ANSWER TYPE QUESTIONS (3 MARK)

32. Derive expressions for the kinetic and potential energies of a body performing simple harmonic motion.
33. A simple pendulum is hung in a stationary lift and its periodic time is T . what will be the effect on its periodic time if-
- (a) The lift goes up with a uniform velocity v ;
 - (b) The lift goes up with uniform acceleration a ;
 - (c) The lift comes down with uniform acceleration a ?
34. Two identical piano strings of length 0.75m are each tuned exactly to 440Hz. The tension in one of the strings is then increased by 1%. If they are now struck, what is the beat frequency between the fundamental modes of the two strings?
35. A tuning fork of frequency 340 Hz is vibrated just above an empty tube of 120 cm height. Water is poured slowly in the tube. What is the minimum height of water necessary for resonance (speed of sound in the air =340 m/s)?
36. Three successive frequencies for a string are 75, 125, 175 Hz.
- (a) State whether the string is fixed at one end or at both ends.
 - (b) What is the fundamental frequency?
 - (c) To which harmonics do these frequencies corresponds?
 - (d) Taking the speed of the transverse wave on the string as 400 m/s, determine the length of the string.
37. Two traveling sinusoidal waves are described by the wave functions:
- $$y_1 = (5 \text{ m}) \sin[\pi(4.0x - 12t)] \text{ and}$$
- $$y_2 = (5 \text{ m}) \sin [\pi(4.0x - 12t - 0.250)]$$
- superimpose.
- Here x , y_1 & y_2 are in meters and t is in seconds. [Given: $\cos \pi/8 = 0.92$]
- (a) What is the amplitude of the resultant wave function?
 - (b) What is the frequency of the resultant wave function?

38. A particle undergoes SHM with a time period of 2 seconds. In how much time will it travel from its mean position to the very next position with a displacement equal to half of its amplitude?
39. A boy is executing SHM under the action of a force whose maximum magnitude is 50 N. Find the magnitude of force acting on the particle at the time when its energy is half kinetic and half-potential (Assume potential energy to be zero at mean position).
40. When a train of plane wave traverses a medium, individual particles execute periodic motion given by the equation: $y = 4 \sin\left[\frac{\pi}{2}\left(2t + \frac{x}{8}\right)\right]$ where the length are expressed in centimetres and time in seconds. Calculate the amplitude, wavelength. Also calculate the phase different (a) for two positions of the same particle which are occupied at time interval 0.4 s apart and (b) at any given instant of two particle 12 cm apart.
41. Show that the total energy is conserved in S.H.M. At what position of the oscillator, the energy is completely (i) kinetic (ii) potential?
42. A particle of mass 0.2 kg undergoes SHM according to the equation $x(t) = 3 \sin(\pi t + \pi/4)$.
- What is the total energy of the particle if potential energy is zero at mean position?
 - What are the kinetic and potential energies of the particle at time $t = 1$ s?
 - At what time instants is the particle's energy purely kinetic?
43. One end of U-tube containing mercury is connected to a suction pump and the other end is connected to the atmosphere. A small pressure difference is maintained between the two columns. Show that when the suction pump is removed, the liquid in the U-tube executes S.H.M.
44. Distinguish between stationary and progressive waves.

45. Deduce the expression for the beat frequency. Briefly discuss one application for this phenomenon.
46. Write the formula for speed of longitudinal waves, v in a given medium of density ρ . Use this formula to explain why the speed of sound in air- (i) is independent of pressure; (ii) increases with temperature; (iii) increases with humidity?
47. Write Newton's formula for the speed of sound in air. What is wrong with this formula? What correction was made by Laplace in this formula?

LONG ANSWER TYPE QUESTIONS (5 MARK)

48. Explain different modes of vibrations in an open organ pipe. Prove analytically that in the case of open organ pipe of length L , the frequencies of vibrating air column are given by $v = n(v/2L)$.
49. Explain different modes of vibrations in a closed organ pipe. Prove analytically that in the case of closed organ pipe of length L , the frequencies of vibrating air column are given by $v = (2n+1)(v/4L)$.
50. What are beats? Explain their formation analytically. Prove that the beat frequency is equal to the difference in frequencies of the two superposing waves.

ENHANCED LEARNING

1. The length of a string tied to two rigid supports is 40 cm. What is the maximum length of the stationary wave produced on it?
(80 cm)
2. Two monoatomic ideal gases 1 and 2 of molecular masses m_1 and m_2 respectively are enclosed in separate containers kept at the same temperature. What is the ratio of the speed of sound in gas 1 to that in gas 2?
 $[(m_2/m_1)^{1/2}]$
3. An open pipe is suddenly closed at one end with the result that the frequency of the third harmonic of the closed pipe is found to be higher by 100 Hz than the

fundamental frequency of the open pipe. What is the fundamental frequency of the open pipe? (200Hz)