Chapter 2

Force and Motion

Textual Evaluation

I. Choose the appropriate answer :

Question 1.

A particle is moving in a circular path of radius r. The displacement after half a circle would be

(a) Zero (b) R (c) 2r (d) r/2

Answer:

(c) 2r

Question 2.

From the given v-t graph it can be inferred that the object is



(a) in uniform motion Time

- (b) at rest
- (c) in non uniform motion
- (d) moving with uniform acceleration

Answer:

(d) moving with uniform acceleration

Question 3.

Which of the following figures represent uniform motion of a moving object correctly?



Question 4.

Suppose a boy is enjoying a ride on a merry go round which is moving with a constant speed of 10 m/s. It implies that the boy is.

- (a) at rest
- (b) moving with no acceleration
- (c) in accelerated motion
- (d) moving with uniform velocity

Answer:

(c) in accelerated motion

Question 5.

What is one way you might increase the stability of an object?

- (a) lower the centre of gravity
- (b) raise the centre of gravity
- (c) increase the height of the object
- (d) shorten the base of the object

Answer:

(a) lower the centre of gravity

II. Fill in the blanks :

- 1. The shortest distance between the two places is _____
- 2. The rate of change of velocity is _____
- 3. If the velocity of an object increases with respect to time, then the object is said to be in _____ acceleration.
- 4. The slope of the speed-time graph gives _____

5. In ______ equilibrium its centre of gravity remains at the same height when it is displacement

Answer:

- 1. displacement
- 2. acceleration
- 3. positive
- 4. velocity
- 5. neutral

III. Match the following :

1.	Displacement	(a)	Knot
2.	Light travels through vacuum	(b)	Geometric centre
3.	Speed of ship	(c)	Metre
4.	Centre of gravity of the geometrical shaped object	(d)	Larger base area
5.	Stability	(e)	Uniform velocity

Answer:

- 1. c
- 2. e
- 3. a
- 4. d
- 5. b

IV. Analogy :

Question 1. velocity : metre/ second :: acceleration : _____ Answer: metre/second²

Question 2.

length of scale : metre : : speed of aeroplane : _____ Answer: knot

Question 3. displacement / time : velocity : : speed / time : _____

acceleration

V. Give very short answer :

Question 1.

All objects having uniform speed need not have uniform velocity. Describe with the help of examples.

Answer:

An object moving in uniform circular motion is moving around the perimeter of the circle with a constant speed. While the speed of object is constant, its velocity is changing, Ex: Merry-go-round, roller coaster, planets orbiting the sun.

Question 2.

"She moves at a constant speed in a constant direction". Rephrase the same sentence in fewer words using concepts related to motion.

Answer:

She moves in a straight line with constant velocity.

Question 3.

Correct your friend who says "The acceleration gives the idea of how fast the position changes".

Answer:

There are two possible answers:

Velocity gives an idea of how fast the position changes, or Acceleration gives an idea of how fast the velocity changes.

VI. Give Short Answer :

Question 1.

Show the shape of the distance – time graph for the motion in the following cases.

a. A bus moving with a constant speed

b. A car parked on a road side.

Answer:

(a) A bus moving with constant speed.



(b) A car parked on road side



Question 2. Distinguish between speed and velocity.

S.No	Speed	Velocity
1.	Speed is the distance travelled by an object in unit time.	Velocity is the distance travelled by an object in unit time in a given direction.
2.	Speed of a moving body can never be zero.	Velocity of a moving body will be zero, if it returns to its original position. (i.e) when its displacement is zero.
3.	It is a scalar quantity	It is a vector quantity
4.	Speed = $\frac{\text{Distance travelled}}{\text{time taken}}$	$Velocity = \frac{Displacement}{time taken}$

Question 3.

What do you mean by constant acceleration?

A body is said to have constant acceleration, if it travels is a straight line and its velocity increases or decreases by equal magnitude in equal intervals of time.

Ex: the motion of a freely falling body.

Question 4.

What is centre of gravity ?

Answer:

The centre of gravity of an object is the point through which the entire weight of the object appears to act.

VII. Answer in detail.

Question 1.

Explain the types of stability with suitable examples.

Answer:

Stability is a measure of the body's ability to maintain its original position. The three types of stability are

- 1. Stable equilibrium
- 2. Unstable equilibrium
- 3. Neutral equilibrium

Stable Equilibrium:

The frustum can be tilted through quite a big angle without toppling.



Its centre of gravity is raised when it is displaced. The vertical line through its centre of gravity still falls within its base. So it can return to its original position.

Unstable Equilibrium:

The frustum will topple with the slightest tilting. Its centre of gravity is lowered when it is displaced.



The vertical line through its centre of gravity falls outside its base.



Neutral Equilibrium:

- 1. It causes frustum to topple.
- 2. The frustum will roll about but does not topple.
- 3. Its centre of gravity remains at the same height when it is displaced.
- 4. The body will stay in any position to which it has been displaced.

Question 2.

Write about the experiment to find the centre of gravity of the irregularly shaped plate.

Answer:

1. Make three holes in the lamina.

2. Suspend the lamina from the optical pin through one of the holes



- 3. Suspend the plumb line from the pin and mark the position of the plumb line on the lamina'
- 4. Draw lines on the lamina representing the positions of the plumb line.
- 5. Repeat the above steps for the holes.
- 6. Label the intersection of the three lines as X, the position of the center of gravity of the lamina.

VIII. Numerical problems:

Question 1.

Geetha takes 15 minutes from her house to reach her school on a bicycle. If the bicycle lias a speed of 2 m/s, calculate the distance between her house and the school.

Answer:

Given : time taken = 15 minutes [1 min = 60 sec]= 15 x 60 = 900 sec Speed - 2 m/s Distance = ? Formula : Distance = Speed x time = 2 x 900 Distance between her house and the school = 1,800 m

Question 2.

A car started from rest and travelling with velocity of 20 m /s in 10 s. What is its acceleration?

Answer:

Given : Initial velocity of the car (u) = 0 m/s Final velocity of the car (v) = 20 m/s time taken = 10s Acceleration = ? Formula: Acceleration = 20-010 = 2010Acceleration of the car = 2 m/s 2

Question 3.

A bus can accelerate with an acceleration 1 m/s2. Find the minimum time for the bus to reach the speed of 100 km/s from 50 km/s. Given :

Acceleration of the bus (a) = 1 m/s2Initial velocity (u) = 50 km/s = 50 x 103 m/sFinal velocity (v) = 100 km/s = 100 x 103 m/stime (t) = ?

$$t = \frac{v - u}{t} = \frac{100 \times 10^3 - 50 \times 10^3}{1} = \frac{(100 - 50) \times 10^3}{1}$$
$$t = 50 \times 10^3 \text{ s}$$

IX. Fill in the boxes:

S.No.	First Move	Second Move	Distance (m)	Displacement
1.	Move 4 meters east	Move 2 meters west	6	2 m east
2.	Move 4 meters north	Move 2 meters south		
3.	Move 2 meters east	Move 4 meters west		
4.	Move 5 meters east	Move 5 meters west		
5	Move 5 meters south	Move 2 meters north		
6.	Move 10 meters west	Move 3 meters east		

Answer:

S.No.	First Move	Second Move	Distance (m)	Displacement
1.	Move 4 meters east	Move 2 meters west	6 m	2 m east
2.	Move 4 meters north	Move 2 meters south	6 m	2 m north
3.	Move 2 meters east	Move 4 meters west	6 m	2 m west
4.	Move 5 meters east	Move 5 meters west	10 m	0 (same place)
5	Move 5 meters south	Move 2 meters north	7 m	3 m south
6.	Move 10 meters west	Move 3 meters east	13 m	7 m west

Intext Activities

Activity

Question 1.

As shown in the above picture, Kavitha can reach her school in two ways. Can you tell, by choosing which path she could reach the school early.



Road A Road B

Answer:

By choosing road A kavitha could reach the school early as the distance is less compared to road B.

Question 2.

Look at the nearby picture



In which path the leaf will reach the ground first?

Answer:

The leaf will reach the ground first by path – A, as it reaches the ground in straight line.

Question 3.

Uma and Priya are friends studying in the same school. After school hours, they go to the nearby playground, play games and return back home. One day

Uma told that she would reach the playground after visiting her grandmother's house. The path in which they took reached the playground is shown here.



Take a twine and measure the length of the two paths (A & B). Which is the longest path among the two?

Answer:

Path A is the longest among the two. as it is not a straight line.

Question 4.

The path in which a rabbit ran is shown in figure. Find the distance and displacement of it in the two figures. Let us consider that each square is in an unit of one square meter. The rabbit starts from point A and reaches the point B.



When will the distance and displacement be equal. Explain. But the starting and finishing points should be different. _____

Answer:

Distance : 17 Distance: 24 Displacement: 3

Displacement: 1

When the rabbit moves in a straight line from A to B, the distance and displacement will be equal.

Question 5.

Here we can consider the starting point as A and while the object moves from A to B the displacement is considered to be positive and from B to A it is negative.

Answer the following questions:

Subha goes to the nearby playground from her home.



Question 1. What is the distance she travelled?

Answer:

400 m

Question 2.

What is her displacement?

Answer:

100 m

Question 3.

The distance travelled by an object is 15 km and its displacement is 15 km. What do you infer from this?

Answer:

The object moves in a straight line in one direction without turning back.

Question 4.

The distance of a person is 30 km and his displacement is 0 km. What do you infer from this?

The distance of a person = 30 km Displacement = 0 km.

Question 5.

The person returns to the same position where he has started.

Answer:

(i.e.) The initial and the final position is same.

Question 6.

Answer the following questions:

(i) Calculate the velocity of a car travelling with a uniform velocity covering 100 m distance in 4 seconds.

Answer:

Velocity =
$$\frac{\text{Distance}}{\text{time}} = \frac{100}{4} = 25 \text{ m/s}$$

(ii) Usain Bolt covers 100 m distance in 9.58 seconds. Calculate his speed. Who will be the winner if Usain Bolt comepetes with a Cheetah running at a speed of 30 m/s

Speed of Usain Bolt =
$$10.43 \text{ m/s}$$

Speed of cheetah = 30 m/s

:. Cheetah will be the winner.

(iii) You are walking along east covering a distance of 4 m, then 2 m towards south, then 4 m towards west and at last 2 m towards north. You cover the total distance in 21 seconds, what is your average speed and average velocity? Total distance covered = 12 m Total time taken =21 seconds

Average speed = $\frac{\text{Total distnace covered}}{\text{total time}}$ = $\frac{12\text{m}}{21} = \boxed{0.571 \text{ m/s}}$ Average velocity = $\boxed{0 \text{ m/s}}$ 12m21 = 0.571 m/s Average velocity = 0 m/s

Average velocity is zero because the starting point and the finishing point is same

∴Displacement is zero so, average velocity is also

 $\therefore \qquad \text{Average velocity} = \frac{\text{Total displacement}}{\text{time}}$

Question 7.

(a) Change in speed

(b) Change in direction

. .

(c) Change in both speed and direction

The distance travelled by train	Initial velocity (u) m/s	Final velocity (v) m/s	Change in velocity (v – u) m/s	Time taken (t) s	Acceleration = change in velocity / time a = $(v - u) / 1$ m/s ²
A-B	0	6	6	10	0.6
B-C					
C-D					
D-E					
E-F					

The velocity at different times of a train departing direction is given in the figure. Analyse this and complete the table .

	0 m/s	6 m/s	14 m/s	14 m/s	6 m/s	2 m/s
	A	в	C	D	E	F
AND CROAT	0 s	10 s	20 s	30 s	40 s	50 s

The distance travelled by train	Initial velocity (u) m/s	Final velocity (v) m/s	Change in velocity (v – u) m/s	Time taken (t) s	Acceleration = change in velocity / time $a = (v - u) / t m/s^2$
A-B	0	6	6	10	0.6
B-C	6	14	14-6 = 8	10	0.8

C-D	14	14	14 - 14 = 0	10	0
D-E	14	6	6-14 =-8	10	-0.8
E-F	6	2	2 - 6 = -4	10	-0.4

Analysis:

When the train covers the distance A to B and B to C, it is accelerated motion. When it covers the distance C-D, there is no acceleration (i.e) uniform velocity. When it covers the distance D to E and E to F it has negative acceleration or deceleration or retardation, (i.e.) Its velocity decreases with respect to time.

Question 8.

My name is cheetah. I can run at a great speed. Do you know what my speed is? 25 m/s to 30 m/s. My speed changes from 0 to 20 m/s in 2 second. See how good my acceleration is !

From the above information, can you calculate the acceleration of the cheetah?

Answer:

Acceleration of the cheetah =
$$\frac{\text{Final velocity(v)-Initial velocity(u)}}{\text{time taken}}$$
$$= \frac{v - u}{t} = \frac{20 - 0}{2} = \frac{20}{2} = \frac{10 \text{ m/s}^2}{10 \text{ m/s}^2}$$
Acceleration of the cheetah = 10 m/s^2

Question 9.

Time (s)	10,01	2	3	4	5			
Velocity (m/s)	20 + 20	40 + 20	60 + 20	80 + 20	100 + 20			
	(Accelera	tion)			e fi finner			
	100 - 20	80 - 20	60 - 20	40 - 20	20 - 20			
	(Deceleration)							

When the velocity of the object is increasing by 20 m/s the acceleration is 20 m/s2 $\,$

When the velocity of the object is decreasing by 20 m/s the deceleration is 20 m/s2.

When the velocity of the object is decreasing by 20m/s the deceleration is $20m/s^2$.

Deceleration =
$$\frac{\text{Decrease in velocity}}{\text{time}}$$
$$t = \frac{\text{Decrease in velocity}}{\text{Deceleration}}$$
$$t = \frac{20}{20} = 1$$

The velocity of the object is decreasing by 20m/s in one second.

Question 10.

Imagine and write a story on your own for the given graph?



Answer:

Raghul and his father starting from home to the school by car. At the school gate, he stopped the car to drop Raghul. After 2 minutes he went back to home to pick up his mother. Then they both started to go to their work. On the way, they are waiting for the signal.

Additional Questions

I. Choose the correct answer.

Question 1.

Distance travelled by a body in a given time (a) is always positive (b) can be zero or positive (c) is always negative (d) either (a) or (c)

Answer:

(b) can be zero or positive

Question 2.

Which of the following is correct

- (a) magnitude of displacement may be greater than distance.
- (b) Distance is always greater than or equal to the magnitude of displacement.
- (c) Distance is always greater than the magnitude of displacement.
- (d) Both are scalar quantities.

Answer:

(b) Distance is always greater than or equal to the magnitude of displacement

Question 3.

Average speed of a moving object is equal to the magnitude of its average velocity when it travels.

(a) in a straight line without turning back

- (b) in a circle
- (c) back and forth
- (d) in a zig-zag path

Time

Answer:

(a) in a straight line without turning back

Question 4.

A car is moving along a straight road with uniform velocity which is the correct representation



Question 5.

The slope of a velocity-time graph gives

- (a) velocity
- (b) distance
- (c) displacement
- (d) acceleration

Answer:

(d) acceleration

Question 6.

Velocity-time graph of an object is given below the object has(a) uniform velocity(b) uniform retardation(c) uniform speed

(d) variable retardation

Answer:



(b) uniform retardation

Question 7.

Which one of the following graphs is showing an object is stationary?



Question 8.

If the velocity of a body does not a changes , then its acceleration is _____

- (a) Infinity
- (b) unity
- (c) Zero
- (d) between zero and unity

Answer:

(c) Zero

II. Fill in the Blanks.

- 1. The SI unit of displacement is _____
- 2. The SI unit of speed is _____
- 3. _____ is the length of actual path covered by a body.
- 4. _____ is the distance trtavelled by a body per unit time
- 5. Distance is a _____quantity.
- 6. The displacement is zero when the initial and final positions are _____
- 7. Speed is always positive or zero but never be _____
- 8. When the velocity of a body increases with time, its acceleration is
- 9. The acceleration of a body moving with uniform velocity is _____
- 10.A car increases its speed from 20 km/h to 50km/h in 10 seconds. Its acceleration is _____

Answer:

- 1. metre (m)
- 2. m/s
- 3. Distance
- 4. speed
- 5. scalar
- 6. same
- 7. negative
- 8. positive
- 9. zero
- 10.0.83 m/s2

III. Match the following :

	Column I		Column II
a.	Uniform motion.	(i)	Body having uniform acceleration
b.	Non-uniform motion.	(ii)	Body at rest.
c.	The velocity-time graph is a circle.	(iii)	Unequal distance covered in equal interval of time.
d.	Straight line parallel to time axis in position-time graph.	(iv)	Equal distances covered in equal intervals of time.
e.	Straight line inclined to 45° with time axis is velocity-time graph.	(v)	Not possible.

- 1. iv
- 2. iii
- 3. v
- 4. i
- 5. ii

Very short Answers:

Question 1.

Give one example where the displacement is zero but the distance travelled is not zero.

Answer:

When an object travels is a circular path (ie. the initial and positions are same).

Question 2.

Is displacement a scalar quantity?

Answer:

No, displacement is a vector quantity as it depends on direction.

Question 3.

Give some examples for vector quantity.

Answer:

Displacement, velocity, force.

Question 4. Give some examples for scalar quantity.

Answer: Mass, distance, speed, temperature.

Question 5. Give one example for uniform acceleration.

Answer: The motion of a freely falling object.

Question 6. Give one example for non-uniform acceleration.

Answer:

The motion of a car on a crowded road.

Question 7.

Give an example for retardation or declaration.

Answer:

When a person applies brake on a moving car, its velocity decreases with time.

Question 8.

What are three types of stability of an object?

Answer:

- 1. Stable equilibrium
- 2. Unstable equilibrium
- 3. Neutral equilibrium

Question 9.

Mention any two conditions for stability of a body? **Answer:**

- 1. Increase the area of its base.
- 2. Lower its centre of gravity.

V. Give Short Answer.

Question 1.

A body moves is a circle of radius '2R' what is the distance covered and displacement of the body after 2 complete rounds?

Distance covered after 2 complete rounds = 2 x circumference of a circle Distance = $2 \times 2 \pi (2R) = 4\pi (2R)$

After 2 complete rounds, the body comes back to its initial position, so, displacement = 0

Question 2.

What are the uses of graphical study of motion?

Answer:

- 1. By simply looking at the graph, one can tell whether motion is uniform or not.
- 2. It is useful for comparing the motions of two moving bodies.

Question 3.

Draw distance-time graphs for the following

- 1. a stationary body
- 2. a body moving with variable velocity

Answer:



Question 4.

Draw centre of gravity of the following regular shaped objects.





Question 5.

Mention the real life applications of centre of gravity.

Answer:

- 1. Luggage compartment of a tour bus is located at the bottom and not on the roof.
- 2. Racing cars are built low and broad for stability.
- 3. Table lamps and fans are designed with large heavy bases to make them stable

Question 6.

Explain the concept which is used in the continuous movement of Thanjavur doll?

Answer:

The centre of gravity and the total weight of the doll is concentrated at its bottom most point, generating a dance-like continuous movement with slow oscillations.

Question 7.

Write note on the following :

- 1. Nautical mile
- 2. knot.

Answer:

- 1. Nautical mile is the unit for measuring the distance in the field of aviation and sea transportation. One nautical mile is 1.852 km.
- 2. The unit for measuring the speed of aeroplanes and ships is knot. One knot is the speed taken to travel one nautical mile in hour.

Question 8.

Saranya jogs from one end A to the other end B of a straight road of length 320m in 2min 40 seconds. Then she turns back and jogs 100m to point C in 1 min. what is her average velocity in jogging.

Total displacement = 320mFrom A to C displacement = 320 - 100 = 220mTime taken = $3 \min 40 \sec$ = 180+40=220

Average velocity = $\frac{\text{Displacement}}{\text{total time}}$ = $\frac{220}{220} = 1 \text{ m/s}$ Average velocity = 1 m/s

Question 9.

A train starting from a railway station and moving with uniform acceleration attains a speed of 40 km/h in 10 minutes. Find its acceleration?

Answer:

Initial velocity (u) = 0 km/hFinal velocity (v) = 40 km/hTime (t) = 10 min = 1060h = 16hAcceleration (a) = v-ut $40-01 = 40 \times 6$ = 240 km/h

Question 10.

Define speed Mention its formula and unit.

Answer:

Speed is the rate of change of distance . Formula : Speed = distance /time Unit is meter/second (m/s)

Question 11.

Define velocity Mention its formula and unit.

Answer:

Velocity is the rate of change in displacement. Formula : Velocity (v) = displacement / timeSI unit of velocity is meter / second (m/s).

Question 12.

What is uniform velocity? Give one example.

A body has uniform velocity, if it covers equal displacement in the same direction in equal intervals of time. Eg. light travels through vacuum.

Question 13.

What is non-uniform velocity? Give example.

Answer:

If either speed or direction changes, then the velocity is non uniform. Eg. a train starting and moving out of the station.

Question 14.

Define acceleration. Mention its formula and unit.

Answer:

Acceleration is the rate of change in velocity. Formula : Acceleration = change in velocity / time SI unit of acceleration is m/s^2

Question 15.

Define the following:

- 1. positive acceleration
- 2. negative acceleration.

Answer:

(i) Positive acceleration:

If the velocity of an object increases with respect to time, then the object is said to be in positive acceleration or just acceleration.

(ii) Negative acceleration or deceleration or retardation:

If the velocity of an object decreases with respect to time, then the object is said to be in negative acceleration or deceleration or retardation.

VI. Long Answer

Question 1. Write the differences between distance and displacement

Answer:

Distance

Displacement

1.	The total length of a path taken by an object to reach one place from the other is called distance.	The shortest distance from the initial to the final position of an object.
2.	Distance between two gives points may be same or different paths chosen.	Displacement between two given points is always same
3.	It is a scalar quantity	It is a vector quantity
4.	Distance covered is always positive or zero.	Displacement covered may be positive, negative or zero

Question 2.

Draw velocity-time graph for the following data:

Ti	ime (s)	0	1	2	3	4	5
S	peed (m s ^{•1})	0	0	0	0	0	0

Answer:



 Question 3.

 Bus travelling at uniform speed of m/s

 Time (s) 0 1 2 3 4 5

 Speed (m s⁻¹) 10 10 10 10 10 10



Question 4. Bus travelling at uniform acceleration

		0				
Time (s)	0	1	2	3	4	5
Speed (m s ⁻¹)	0	18	32	42	48	50

Answer:



The speed of the car increases by 10 m s⁻¹, every second. Hence, the graph has a positive and constant gradient, and the acceleration is constant.

Question 5. Bus travelling at uniform deceleration

Time (s)	0	1	2	3	4	5
Speed (m s-1)	50	40	30	20	10	0

Answer:



The speed of the car decreases by 10 m s⁻¹, every second. Hence, the graph has a negative and constant gradient, and the acceleration is constant.

Question 6. Bus travelling with increasing acceleration (non – uniform acceleration)

Time (s)	0	1	2	3	4	5
Speed (m s ⁻¹)	0	2	8	18	32	50

Answer:



The increase in speed is increasing with time. Hence, the graph has a positive and increasing gradient, and the acceleration increases.

The instantaneous acceleration of the car at t = 3 s is given by the gradient of the tangent at the point.