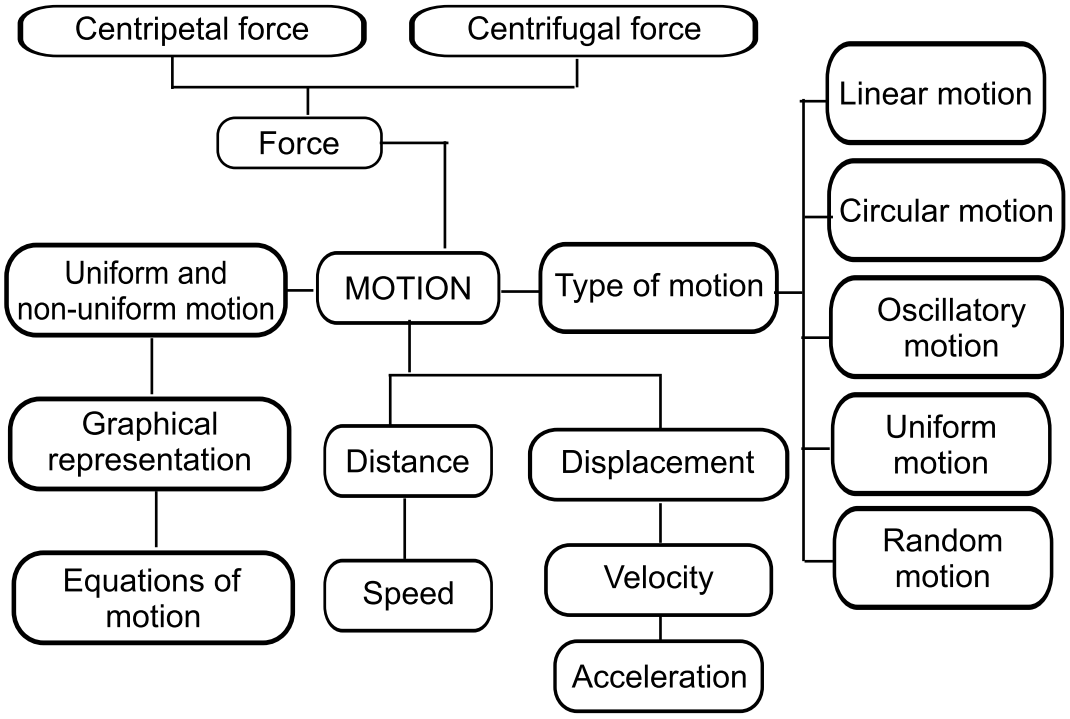
UNIT - 2 Motion

MIND MAP



TEXT BOOK EXERCISES

I. Choose the correct answer.

1. The area under velocity - time graph represents the

a) velocity of the moving object b) displacement covered by the moving object
c) speed of the moving object d) acceleration of the moving object

Ans : b) displacement covered by the moving object

2. Which one of the following is most likely not a case of uniform circular motion ?

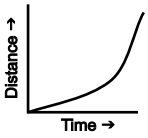
a) Motion of the Earth around the Sun. b) Motion of a toy train on a circular track.
c) Motion of a racing car on a circular track. d) Motion of hours' hand on the dial of the clock.

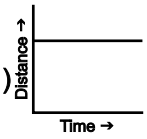
Ans : c) Motion of a racing car on a circular track

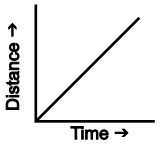
3. Which of the following graph represents uniform motion of a moving particle ?

a) 

b) 

c) 

d) 

Ans : b) 

4. The centrifugal force is .....

a) a real force b) The force of reaction of centripetal force
c) a virtual force d) directed towards the centre of the circular path.

Ans : b) The force of reaction of centripetal force

II. Fill in the blanks.

1. Speed is a ..... quantity whereas velocity is a ..... quantity.
Ans : Scalar, Vector
2. The slope of the distance - time graph at any point gives ..... **Ans : speed**
3. Negative acceleration is called ..... **Ans : retardation**
4. Area under velocity - time graph shows ..... **Ans : displacement**

III. State whether true or false. If false, correct the statement.

1. The motion of a city bus in a heavy traffic road is an example for uniform motion.
Ans : False. Correct statement : The motion of a city bus in a heavy traffic road is an example for **Non-uniform motion.**
2. Acceleration can get negative value also. **Ans : True**
3. Distance covered by a particle never becomes zero but displacement becomes zero.
Ans : True
4. The velocity - time graph of a particle falling freely under gravity would be a straight line parallel to the x axis.
Ans : False. Correct statement : If the object moves at uniform velocity a straight line parallel to x-axis
5. If the velocity - time graph of a particle is a straight line inclined to X - axis then its displacement - time graph will be a straight line. **Ans : True**

IV. Assertion and Reason Type Questions.
Mark the correct Choice as :

1. Assertion : The accelerated motion of an object may be due to change in magnitude of velocity or direction or both of them.
Reason : Acceleration can be produced only by change in magnitude of the velocity. It does not depend the direction.
a) If both assertion and reason are true and reason is the correct explanation of assertion.
b) If both assertion and reason are true but reason is not the correct explanation of assertion.
c) If assertion is true but reason is false.
d) If assertion is false but reason is true.
Ans : d) If assertion is false but reason is true.

---

2. Assertion : The speedometer of a car or a motor - cycle measures its average speed.
Reason : Average velocity is equal to total displacement divided by total time taken.
a) If both assertion and reason are true and reason is the correct explanation of assertion.
b) If both assertion and reason are true but reason is not the correct explanation of assertion.
c) If assertion is true but reason is false.
d) If assertion is false but reason is true.
Ans : b) If both assertion and reason are true but reason is not the correct explanation of assertion.

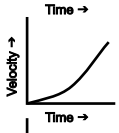
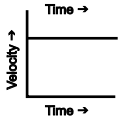
---

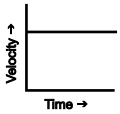
3. Assertion : Displacement of a body may be zero when distance travelled by it is not zero.
Reason : The displacement is the shortest distance between initial and final position.
a) If both assertion and reason are true and reason is the correct explanation of assertion.

b) If both assertion and reason are true but reason is not the correct explanation of assertion.
c) If assertion is true but reason is false.
d) If assertion is false but reason is true.

a) If both assertion and reason are true and reason is the correct explanation of assertion.

V. Match the Following.

List I	List II
1. Motion of a body covering equal distances in equal interval of time	A 
2. Motion with non uniform acceleration	B 
3. Constant retardation	C 
4. Uniform acceleration	D 

List I	List II
1. Motion of a body covering equal distances in equal interval of time	**D** 
2. Motion with non uniform acceleration	**C** 
3. Constant retardation	**A** 
4. Uniform acceleration	**B** 

VI. Answer briefly.

1. Define velocity.

Velocity is the rate of change of displacement. It is the displacement in unit time. It is a vector quantity. The SI unit of velocity is ms^{-1}

$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time taken}}$$

2. Distinguish distance and displacement.

Distance	Displacement
1. The actual length of the path travelled by a moving body irrespective of the direction is called the distance travelled by the body.	It is defined as the change in position of a moving body in a particular direction.
2. It is a scalar quantity having magnitude only.	It is a vector quantity having both magnitude and direction.
3. It is measured in metre in SI system.	It is also measured in metre in SI system.

3. What do you mean by uniform motion ?

Uniform motion : An object is said to be in uniform motion if it covers equal distances in equal intervals of time.

4. Compare speed and velocity.

S.No	Speed	Velocity
1.	It is the rate of change of distance	It is the rate of change of displacement.
2.	It is a scalar quantity having magnitude only	It is a vector quantity having both magnitude and direction.
3.	It is measured in ms^{-1} in SI system	It is also measured in ms^{-1} in SI system.

5. What do you understand about negative acceleration ?

Negative acceleration : If final velocity is less than initial velocity, the velocity decreases with time and the value of acceleration is negative. It is called negative acceleration.

Negative acceleration is called retardation or deceleration.

---

6. Is the uniform circular motion accelerated ? Give reasons for your answer

Yes the uniform circular motion is accelerated.

Reason : When an object is moving with a constant speed along a circular path, the velocity changes due to the change in direction. Hence it is an accelerated motion.

---

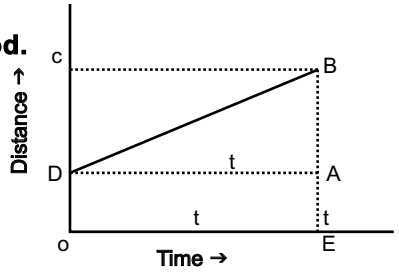
7. What is meant by uniform circular motion ? Give two examples of uniform circular motion.

Uniform circular motion : When an object moves with constant speed along a circular path, the motion is called uniform circular motion.

Examples : 1. Revolution of earth around the sun.
2. Revolution of moon around the earth.

VII. Answer in detail.

1. Derive the equations of motion by graphical method.



The object starts from the point D in the graph with velocity u.

Its velocity keeps increasing and after time, t it reaches the point B on the graph.

The initial velocity of the object = u = OD = EA

The final velocity of the object = v = OC = EB

Time = t = OE = DA

from the graph we know that, AB = DC

First equation of motion

By definition, Acceleration = Change in velocity / Time

= (Final velocity - Initial velocity) / Time

= (OC - OD) / OE

= DC / OE

$a = DC / t$

$DC = AB = at$

From the graph $EB = EA + AB$

$$\boxed{v = u + at} \quad \text{.....(1)}$$

This is the first equation of motion

Second equation of motion

From the graph the distance covered by the object during time, t is given by the area of quadrangle DOEB.

s = Area of the quadrangle DOEB
= Area of the rectangle DOEA + Area of the triangle DAB
= (AE x OE) + (½ x AB x DA)

$$s = ut + \tfrac{1}{2}at^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

This is the second equation of motion

Third equation of motion :

We see that the distance covered by the object during time, t is given by the area of the quadrangle DOEB. Here, DOEB is a trapezium. Then,

s = Area of trapezium DOEB
= ½ x Sum of length of parallel side x Distance between parallel sides
= ½ x (OD + BE) x OE
s = ½ x (u + v) x t
since, $a = (v-u)/t$ or $t = (v-u)/a$
s = ½ x (v + u) x (v - u)/a
$2as = v^2 - u^2$

$$v^2 = u^2 + 2as \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

This is the third equation of motion.

---

2. Explain different types of Motion.

In physics, motion can be classified as below.

Linear motion: Motion along a straight line.

Circular motion: Motion along a circular path.

Oscillatory motion: Repetitive to and fro motion of an object at regular interval of time.

Random motion: Motion of the object which does not fall in any of the above categories.

Uniform and Non-uniform motion

Uniform motion

An object is said to be in uniform motion if it covers equal distances in equal intervals of time howsoever big or small these time intervals may be.

Non-uniform motion

An object is said to be in non-uniform motion if it covers unequal distances in equal intervals of time.

VIII. Exercise Problems.

1. A ball is gently dropped from a height of 20m. If its velocity increases uniformly at the rate of 10ms^{-2} with what velocity will it strike the ground ? After what time will it strike the ground ?

Solution :

distance (s) = 20 m

acceleration(a) = 10 ms^{-2}

Here we have initial distance (u) = 0

final velocity (v) = ?

time (t) = ?

(a) calculation of final velocity, v - we know that,

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

$$v^2 = 0 + 2 \times 10 \times 20$$

$$v^2 = 400$$

$$v = \sqrt{400}$$

$$\boxed{v = 20 \text{ m/s}}$$

∴ Ball will strike the ground at a velocity of 20 ms^{-1}

(b) Calculation of time, t - we know that,

$$v = u + at$$

$$20 = 0 + (10) \times t$$

$$t = \frac{20}{10} = 2 \text{ s}$$

$$\boxed{t = 2 \text{ s}}$$

∴ Time taken to reach the ground = 2s

---

2. An Athlete completes one round of a circular track of diameter 200m in 40s. What will be the distance covered and the displacement at the end of 2m and 20s ?

diameter = 200m

time = 40s

circumference of circular track = $2\pi r$

$$r = \frac{200}{2} = 100\text{m}$$

Distance covered = $2\pi r$

$$= 2 \times \frac{22}{7} \times 100$$

$$= 2 \times 3.14 \times 100$$

Distance covered = 628 m

Time for completing one round = 40s

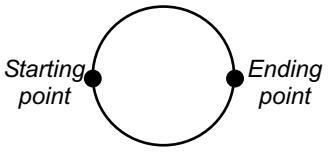
Time duration = 2m 20s

= 2 x 60 + 20s

= 120 + 20 = 140 s

For one round the time taken = 40s

In 140s an athlete can complete = $\frac{140}{40}$ = 3.5 rounds



Displacement = shortest distance between two points

So displacement = $\frac{628}{2}$ = 314m

Displacement at the end of 2m and 20s = 314m

---

3. A racing car has a uniform acceleration of $4ms^{-2}$. What distance it covers in 10s after the start ?

Here we have acceleration (a) = $4/ms^2$
Initial velocity (u) = 0
time (t) = 10 s
distance (s) = ?

We know that (s) = $ut + \frac{1}{2} at^2$

$S = 0 \times 10\,s + \frac{1}{2} \times 4\,m/s^2 \times (10s)^2$

$= \frac{1}{2} \times 4m/s^2 \times 100\,s^2$

$= 2 \times 100\,m = 200\,m$

Thus racing car will cover a distance of 200 m after start in 10s with given acceleration

---

Additional questions and answers

I. Fill in the blanks

1. In ..... motion the object moves along a straight line. **Ans : Linear**
2. ..... is the rate of change of velocity. **Ans : Acceleration**
3. Speed is a ..... quantity. **Ans : scalar**
4. The formula for centripetal force is ..... **Ans : $F = \frac{mv^2}{r}$**
5. Motion along a circular path..... **Ans : circular motion**
6. ..... force acts in a direction which is opposite to the direction of the ..... force. **Ans : centrifugal, centripetal**
7. The acceleration of an object is the change in..... per unit time. **Ans : velocity**

II. Short answers.

1. What is motion?

Motion is a change of position, which can be described in terms of the distance moved or the displacement.

---

2. Write equations of Motion.

$v = u + at$

$s = ut + 1/2\,at^2$

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

---

3. Define - centrifugal force.

Force acting on a body away from the centre of circular path is called centrifugal force.

Activity 1

1. The objects which remain fixed at their position - trees, plants, houses.
2. The objects which keep on changing their position - birds, cars, buses.

Activity 2

The bus covers unequal distance in equal intervals of time but the train covers equal distances in equal intervals of time.

Activity 3

1. The distance covered by the car through the path ABC = 7m
   The distance covered by the car through the path AC = 5m
   ABC gives distance(7m)
   AC gives displacement(5m) (Shortest distance between two points)
2. The path AD gives the shortest distance to reach D from A.
3. The total distance covered by the car when it travels the path ABCDA = 14m
   It finally reaches at A
   When the car reaches at A its displacement is zero. But distance is 14m
   Distance = 14m
   Displacement = 0

Activity 4

The stone and the eraser reach the surface of the earth almost at the same time.

Activity 5

On being released the stone moves along a straight line tangetial to the circular path.

Activity 6

We will experience a pulling force. In this, a pulling force that acts away from the centre is experienced. This is called as centrifugal force.
