VISWASANTHI ENGLISH MEDIUM SCHOOL

PHIRANGIPURAM, GUNTUR

IIT & MEDICAL FOUNDATION

MECHANICS

SYNOPSIS-1

Mechanics: The branch of physics which deals with the motion of non-living objects in everyday life is called mechanics. It is divided into kinematics, dynamics and statics.

1. Kinematics: Kinematics which is derived from a Greek word ‘kineam’ meaning motion, it is a branch of physics, which deals with the motion of a body without taking into account the cause of motion.

2. Dynamics: Dynamics is derived from the Greek word ‘dyna’ meaning power, is a branch of physics which deals with the motion of bodies by considering the cause of motion (force).

3. Statics: Statics deals with bodies at rest under the effect of different forces.

Point object: An object is said to be a point object if its size is very small as compared to the distance travelled by it in the given time interval.

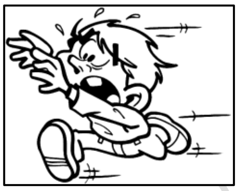
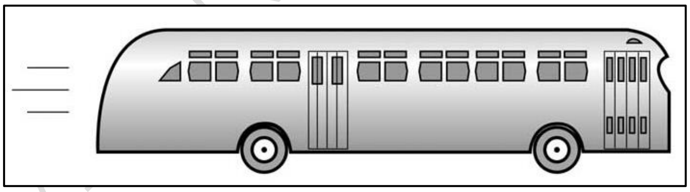
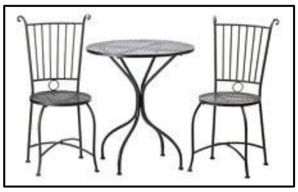
Ex: i) A bus travelling a distance of 100 km can be considered as a point object. This is because the size of the bus is very small as compared to distance travelled by it.

ii) A car travelling a distance of 50 km can be considered as a point object. This is because the size of car is very small as compared to the distance travelled by it.

Reference point: A fixed point or a fixed object with respect to which the given body changes its position is known as reference point.

Rest: A body is said to be at rest if it does not change its position with respect to the reference point. The objects which remain stationary at a place and do not change their position are said to be at rest.

Ex: A chair lying in a room is in the state of rest, because it does not change its position with respect to the surroundings of the room.

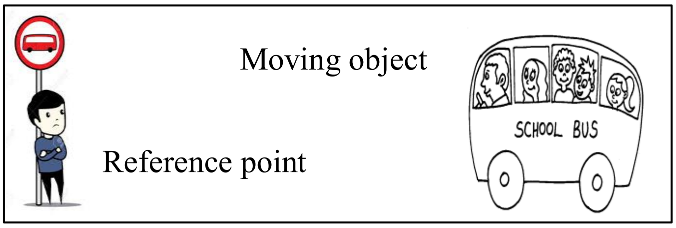




Motion: A body is said to be in motion if it changes its position with respect to the surroundings with the passage of time. All moving things are said to be in motion.

Ex: A car is changing its position w.r.t trees, houses etc., is in the state of motion.

Rest and motion are relative terms: Rest and motion are relative terms. A body can be at rest as well as in motion at the same time. When we say that a body or an object is in motion, then it is essential to see whether the body or object changes its position with respect to other bodies or objects around it or with respect to any fixed point known as reference point. For example when a bus moves on a road, then the bus as well as the passengers sitting in it change their position with respect to a person standing on the road side. So, the bus and the passengers sitting in it are in motion with respect to the person standing on the road side. However, the passengers sitting in the bus do not change their positions with respect to each other. It means, the passengers sitting in a moving bus are not in motion with respect to each other.

Ex: A person sitting in the compartment of a moving train is in the state of rest, with respect to the surroundings of compartment. Yet he is in the state of motions, if he compares himself with surroundings outside the compartment



Note: In order to describe the motion of an object we need to keep in mind three things.

1. The distance of the body from a reference point. This reference point is called the origin of the motion of the body.
2. The direction of motion of the body.
3. The time of motion.

PRACTICE SHEET-1

1. An object is in motion only if it changes its position with respect to a ( )
   A) Fixed point B) Random direction
   C) Fixed direction D) None of these
2. The branch of physics which deals with the motion of objects with considering the cause of motion is:
   A) Dynamics B) Kinematics
   C) Statics D) None of these ( )
3. A boy standing on the ground drops a ball from a certain height. The ball is in the state of ______w.r.t the boy.
   A) Rest B) Motion
   C) Both rest & motion D) None of these ( )
4. A body moving from one place to another place is a state of: ( )
   A) Rest B) Motion
   C) Both A and B D) None of these
5. A person sitting in a moving train is at rest with respect to ( )
   A) Trees B) Fields C) Buildings D) Other passengers
6. A tree in a park is a state of ______ w.r.t. the ground. ( )
   A) Rest B) Motion C) Both A and B D) None of these
7. A book lying on a table is an example of_____w.r.t. the table. ( )
   A) A body in motion B) A body at rest
   C) A body neither at rest nor in motion D) None of these
8. A branch of physics which deals with motion of a body without knowing the cause of motion is
   A) Dynamics B) Statics
   C) Kinematics D) Optics ( )
9. Ramu is in the moving bus and his friend Krishna standing at bus top. Ramu is in a state of___ with respect to driver of same bus ( )
   A) rest B) motion C) both A & B D) none
10. From above data Krishna is in a state of ___ with respect to passengers of a bus ( )
    A) rest B) motion C) both A & B D) none

SYNOPSIS-2

Motion: An object is said to be in motion if it changes its position from one place to another place. In other words, the movement of an object is known as the motion of the object.

Ex: Cars, cycles, motor cycles, scooters, buses, rickshaws, trucks etc., running on the road, Birds flying in the sky, Fishes swimming in water. All these objects are in motion.

Types of motion:

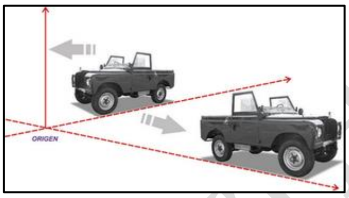
1. Translatory motion: The motion in which all the particles of a body move through the same distance in the same time is called Translatory motion. The consideration of motions is done between two points i.e., starting point and ending point.

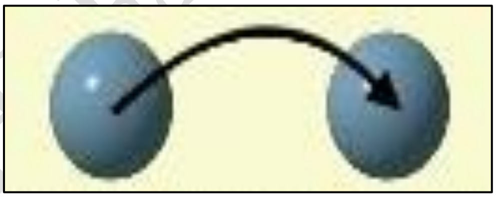
Ex: i) A car or a train moving along a road
ii) A ball rolling on the ground
iii) Firing of a bullet from a gun
iv) A stone hurled from a catapult
v) An apple falling from a tree
vi) A striker on the carom board going straight to hit the coin, are some of the examples of Translatory motion

There are two kinds of Translatory motions.

a. Rectilinear motion: When an object moves along a straight line, its motion is called rectilinear motion.

Ex: i) A ball rolling on the ground
ii) A car moving on a straight road
iii) A stone falling freely from the roof of a building
iv) A coin moving over a carom board





b. Curvilinear motion: If an object moves along a curved path, its motion is called curvilinear motion.

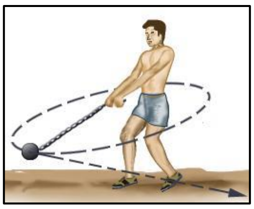
Ex: i) A stone thrown by a boy from a height
ii) A car moving along a curved path
iii) A javelin on shot put thrown by an athlete
iv) A ball thrown upward at an angle
v) A car or a train moving along a curved road track

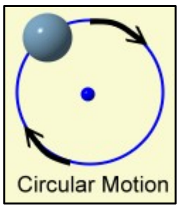
2. Rotatory motion: A motion in which a body moves about a fixed axis without changing its position is called the rotatory motion.

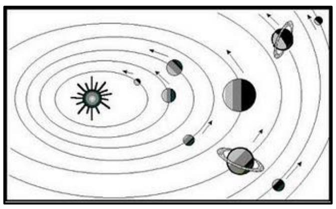
Ex: i) The motion of the blades of a fan
ii) The wheel of a sewing machine
iii) A giant wheel
iv) A spinning top
v) A spinning wheel
vi) A potter's wheel

3. Circular motion: A body has circular motion if it moves around a fixed point.

Ex: i) Motion of an electric fan
ii) Motion of merry-go-round
iii) Motion of a spinning top
iv) Motion of the earth around the sun





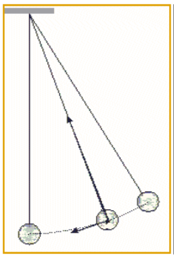


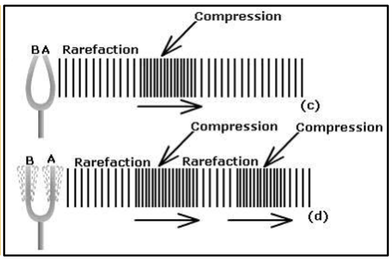
4. Oscillatory motion: The to-and-fro motion is called oscillatory motion. A motion in which the whole body moves to-and-fro about its mean position is called oscillatory motion.

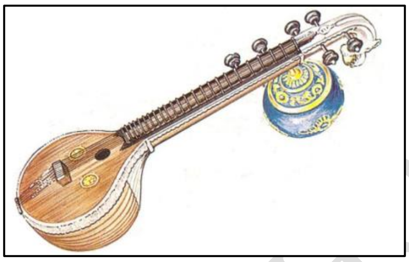
Ex: i) The motion of a swing   ii) The pendulum of a clock

iii) The needle of a sewing machine moving up and down

iv) The piston of a motor car the pressing cylinder of a juice machine, the piston of a spray







5. Vibratory motion: It is another kind of oscillatory motion in which the body does not move as a whole i.e., the entire object does not move. All vibrating bodies emit sound energy or heat energy.

Ex: All musical instruments such as guitar, sitar, violin, drums etc., produce vibratory motion. During breathing our chest expands and contracts, this motion is vibratory in nature. So the vibratory motion is a kind of oscillatory motion in which the moving object undergoes change in shape or size.

6. Periodic motion: A motion which repeats itself at regular intervals of time is called periodic motion.

Ex: i) The motion of the earth around the sun is periodic

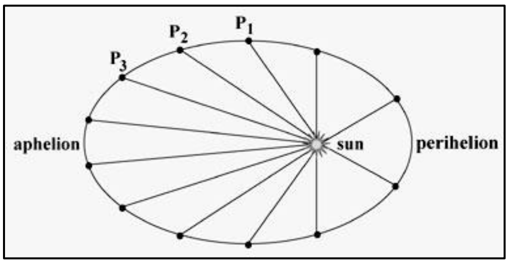
ii) The swinging pendulum of a wall clock

iii) The needle of a sewing machine running at constant speed

iv) Normal human heart beats

v) The motion of a swing

vi)The movement of the lungs during breathing



7. Non-periodic motion: A repetitive motion, which repeats itself, but not at fixed intervals of time, is called non-periodic motion.

Ex: i) A football player running in the field up and down is performing non-periodic motion as sometimes he runs fast and sometimes slows down.

ii) When the brakes are applied to a moving vehicle, the motion described by the wheels is non-periodic.

iii) A cricket ball rolling down the ground gradually slows down and finally stops and hence is performing non-periodic motion. When things move suddenly without any regularity are also non periodic motion.

Ex: 1. Earthquake   2. Eruption of a volcano   3. Storm

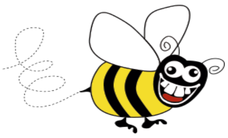
8. Random motion: A body which has a particular motion that suddenly changes to another kind of motion is said to have random motion. The motion without any sequence or direction is random motion.

Ex: i) A buzzing bee ii) A player of a football on the field

iii) The ball during a game of hockey or football

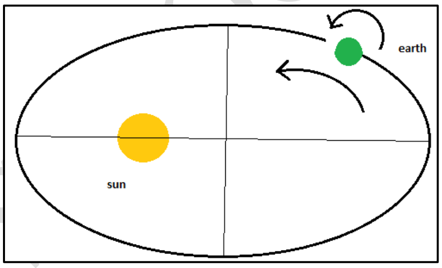
iv) Flying motion of a sparrow

v) A monkey performing antics on a tree



Note: Except rectilinear motion which is considered as one dimensional motion, remaining are considered as two dimensional motions.

9. Multiple motions: Sometimes an object possesses two or more types of motion at the same time. Such motion is called multiple motions. Some examples are as follows.

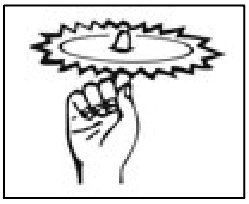


Ex: i) When a spin bowler delivers a ball, the ball has a motion of spin (rotary motion) while it moves towards the batsman (Translatory motion).

ii) A person drawing water from a well is another example of multiple motions. Here the pulley on which the rope runs has a rotatory motion while the bucket coming up has a Translatory motion.

iii) Another example of multiple motions is a girl riding a bicycle. The wheels of the bicycle rotate (rotatory motion) and at the same time the bicycle moves forward in a straight or curved path (Translatory motion).

iv) A drill used by a carpenter for drilling a hole in wood has both Translatory and rotatory motions. This is because while it is being rotated (rotatory motion), it is also getting pushed forward (Translatory motion) into the wood.



v) The earth rotates about its axis (rotatory motion) and at the same time it revolves around the sun in a circular path (Translatory motion).

vi) The mythological sudarshan chakra hurled by Lord Krishna to kill his enemies had both Translatory as well as rotatory motion.

PRACTICE SHEET-2

1. When a drill bores a hole in a piece of wood, it describes ( )
   A) Rotatory motion B) Translatory motion
   C) Curvilinear motion D) Rotatory and Translatory motion
2. The motion described by the string of violin is ( )
   A) Oscillatory motion B) Vibratory motion
   C) Non-periodic motion D) Rectilinear motion
3. Circular motion is the special case of ( )
   A) Translatory motion B) Rotatory motion
   C) Vibratory motion D) none of these
4. An apple falling from a tree shows_______ motion ( )
   A) Rotation B) Translatory C) Revolution D) Spin

5. The sudarshan chakra of Lord Krishna when hurled at the enemy, executes ( )
A) Oscillatory motion B) Translatory motion
C) Translatory as well as rotatory motion D) None of these

6. The handle and needle of a sewing machine ( )
A) both execute a rotatory motion B) both execute a Translatory and oscillatory motion
C) execute different types of motion D) None of these

7. Which of the following is not an example of linear motion ( )
A) A book at rest
B) A body in uniform circular motion
C) Wheel rotating at uniform speed on road
D) Body rolling down on an inclined plane

9. Which of the following in one dimensional motion ( )
A) Landing of an aircraft B) Earth revolving round the sun
C) Wheels of a moving train D) Train running on straight track

10. A body is imparted motion from rest to move in a straight line. It is then obstructed by an opposing force, then ( )
A) The body may necessarily change direction
B) The body is sure to slow down
C) The body will necessarily continue to move in the same direction at the same speed
D) Body stops

11. A body projected upwards, this is an example of ( )
A) One dimensional motion B) Two dimensional motion
C) Circular motion D) None

12. Find the odd-one out ( )
A) Apple falling from a tree B) Car moving on a straight road
C) Coins moving over a carom board D) Giant wheel

13. A spinning top has a ________ motion. ( )
A) Rotatory B) Oscillatory C) Translatory D) None of these

14. Match the following: ( )

Side A	Side B
i) A car moving on a straight road	a) Translatory motion
ii) A javelin put thrown by an athlete	b) Curvilinear motion
iii) Motion of a potter's wheel	c) Rotatory motion
iv) Motion of heart beats	d) Periodic motion

Choose the correct match:
A) i - b, ii - c, iii - a , iv - d B) i - b, ii - a, iii - c, iv - d
C) i - a, ii - c, iii - d, iv - b D) i - a, ii - b, iii - c, iv - d

15. The planer being moved to and fro by a carpenter to level a table surface is executing ( )
A) Translatory motion only B) An oscillatory as well as a Translatory motion
C) Oscillatory motion only D) None of these

16. A car moving an a straight road is an example of ( )
A) Oscillatory motion B) Rotatory motion
C) Rectilinear motion D) Periodic motion

17. The kind of motion that a pendulum has is ( )
A) Curvilinear B) Rotatory C) Oscillatory D) Rectilinear

18. An example of curvilinear motion is ( )
A) An apple falling from a tree B) A spinning wheel
C) The motion of a pendulum D) Throwing of a javelin

SYNOPSIS-3

The quantities which are measurable are called physical quantities. These can be classified as follows:

1. Scalar quantities **2. Vector quantities**

1. Scalar quantities: A physical quantity which is described completely by its magnitude is called a scalar quantity. It has only magnitude and no specific direction.

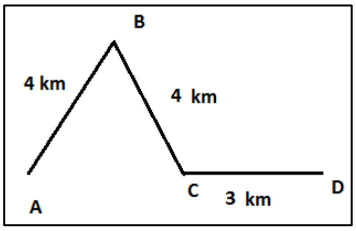
Ex: Length, distance, area, volume, mass, time and energy are examples of scalar quantities.

2. Vector quantities: A physical quantity which is described completely by its magnitude as well as specific direction is called vector quantity. It has both magnitude and direction.

Ex: Displacement, velocity, acceleration, force and weight are examples of vector quantities.

3. Distance: It is defined as the actual path followed by a body between the points between which it moves.

Notes: i) Distance travelled by a body never decreases with time.
ii) The distance travelled by the body never should be zero. It is a scalar quantity.



Ex: Suppose a person moves from A to B (4 km), B to C (4 km) and then from C to D (3 km). Then, the total path (length) covered by the person is

AB + BC + CD = 4km + 4 km + 3 km = 11 km

Therefore, the distance travelled by the person is 11 km.

4. **Displacement:** It is the shortest distance between two points. It is a vector quantity and for a moving body it can be positive, negative or zero.

(or)

It is the shortest distance between initial and final point.

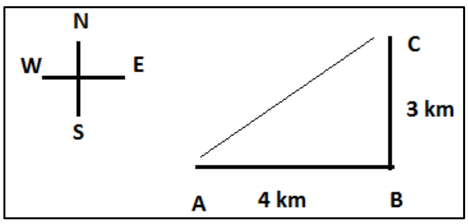
Suppose a person moves from A to B (4 km) due east, and from B to C (3 km) due north. Then, the distance travelled is

AB + BC = 4 km + 3 km = 7 km

Displacement = AC

$= \sqrt{AB^2 + BC^2} = \sqrt{4^2 + 3^2}$ km

$= = \sqrt{16+9}$ km$= \sqrt{25}$ km$=5$ km N-E



Note: The displacement of a satellite as it completes one round along its circular orbit is zero since its initial point and final point are same.

Difference between Distance and Displacement	
Distance	**Displacement**
1. It is defined as the actual path traversed by a body.	1. It is shortest distance between two points between which the body moves.
2. It is scalar quantity.	2. It is a vector quantity.
3. It can never be negative or zero.	3. It can be negative, zero or positive.
4. Distance can be equal to or greater than displacement	4. Displacement can be equal to or less than distance
5. Distance travelled is not a unique path between two points.	5. Displacement is a unique path between two points.
6. The distance between two points gives full information of the type of path followed by the body.	6. Displacement between two points does not give full information of the type of path followed by the body.
7. Distance never decreases with time. For a moving body it is never zero.	7. Displacement can decrease with time. For a moving body it can be zero.
8. S.I. unit of distance is meter and C.G.S. unit is centimeter.	8. S.I. unity displacement is meter and C.G.S. unit is centimeter.

PRACTICE SHEET-3

1. If a body moves in a circular path and reach back to its initial position then ( )
   A) distance = 0 B) magnitude of displacement = 0
   C) both A and B D) none of these
2. Distance is a ( )
   A) scalar quantity B) vector quantity C) normal quantity D) none of these
3. Match the following: ( )
   List A **List B**
   i) Pressure a) Scalar
   ii) Force b) Vector
   iii) Area
   iv) Velocity
   A) i - b, ii - a, iii - a, iv - b B) i - a, ii - b, iii - a, iv - b
   C) i - a, ii - b, iii - b, iv - a D) i - b, ii - a, iii - b, iv -a
4. Find the odd one out ( )
   A) Energy B) speed C) force D) mass
5. A boy starts from his house and travels 5 km to reach the market. After purchasing his book, he returns to his house. The magnitude of displacement of the boy is ( )
   A) 10 km B) 5 km C) 15 km D) 0 km
6. If the displacement of an object is zero, then the distance travelled by the object is: ( )
   A) zero B) not zero C) negative D) may or may not be zero
7. The device used to measure the distance is known as ( )
   A) speedo meter B) sono meter C) odometer D) galvanometer

8. If the distance travelled by an object is zero, then the displacement of the object is ( )

A) zero B) not zero C) negative D) may or may not be zero

9. Which of the following is the characteristic of distance travelled by an object ( )

A) It has magnitude as well as specific direction

B) It can be zero

C) It has only magnitude and no specific direction

D) The distance travelled by an object is less than the magnitude of the displacement of the object.

10. Which of the following is the characteristic of displacement of an object? ( )

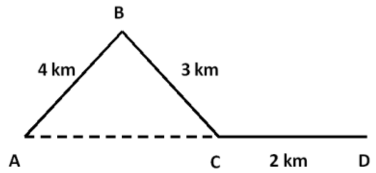
A) Displacement cannot be zero

B) The magnitude of the displacement is greater than the distance travelled by a moving object.

C) Displacement has only magnitude and no specific direction

D) Displacement has magnitude as well as specific direction.

11. The figure shows the path taken by a boy during walk. The total distance moved by the boy is



A) 12 km

B) 9 km

C) 10 km

D) 5 km ( )

12. If on a round trip you travel 6 km and then came back to home ( )

a) What is the distance you have travelled?

b) What is the magnitude of displacement?

A) Distance = 6 km, displacement = 0 km B) Distance = 0 km, displacement = 6 km

C) Distance = 4 km, displacement = 6 km D) Distance = 6 km, displacement = 4 km

13. A body is moving along a circular path of radius R. What will be the distance and magnitude of displacement of the body when it completes half revolution? ( )

A) 3R, πR B) πR 2R C) R, πR D) 2, πR

14. An ant travels a distance of 8 cm from P to Q and then moves distance of 6 cm at right angles to PQ, then what will be the magnitude of displacement ( )

A) 5 cm B) 20 cm C) 15 cm D) 10 cm

15. A body moves on three quarters of a circle of radius r. The magnitude of displacement and distance travelled by it are: ( )

A) r, 3r B) $\sqrt{2}r, \frac{3\pi r}{2}$ C) $2r, \frac{3\pi r}{2}$ D) $0, \frac{3\pi r}{2}$

16. A body travels a distance of 3 km towards east, then 4 km towards north and finally 9 km towards east ( )

a) What is the total distance travelled? b) What is the magnitude of displacement?

A) 12.6 km, 16 km B) 16 km, 12.6 km C) 16 km, 16 km D) 12.6 km, 12.6 km

17. A man travels a distance of 1.5 m towards east, then 2.0 m towards south and finally 4.5m towards east. ( )

a) What is the total distance travelled? b) What is his magnitude of displacement?

A) 8m, 6.3 m B) 7m, 5.3 m C) 5.3 m, 7m D) 6.3 m, 5.3 m

18. There is a square field of side 10 m in front of house. If a man completes this path in 40 seconds, then what will be the magnitude of the displacement of the man after 2 minutes and 20 seconds?

A) $10\sqrt{2}\,\text{m}$ B) $5\sqrt{2}\,\text{m}$ C) $15\sqrt{2}\,\text{m}$ D) $20\sqrt{2}\,\text{m}$

19. An athlete completes a round of a circular track of diameter 200 m in 20 s. What will be the

i) The distance travelled by the athlete and ( )

ii) The magnitude of the displacement of the athlete at the end of 1 minutes and 10 seconds?

A) 2000m, 2000 m B) 2200 m, 300 m C) 2200 m, 200 m D) 2000 m, 200 m

SYNOPSIS - 4

1. Speed: The rate of change of motion is called speed. The speed can be found by dividing the distance covered by the time in which the distance is covered.

$$\text{Speed} = \frac{\text{Distance covered by an object}}{\text{Time in which the distance is covered by the object}}$$

If 'S' is the distance covered by the object in time t, such that 'v' is its speed, then $v = \frac{s}{t}$.

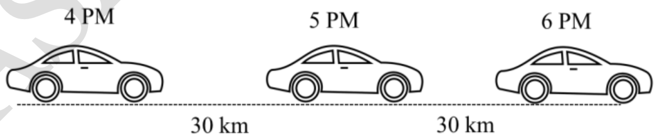
Speed is scalar quantity as it has magnitude, but no specific direction.

2. Units of speed: In the Standard International (SI) system, the unit of speed is $\frac{\text{metre}}{\text{second}}$, in abbreviated form, it is written as m/s or ms^{-1}.

- If the distance covered is very small, then the speed is expressed in cm/s or cms^{-1}.
- If the distance covered is fairly large, the speed is expressed in km/h or kmh^{-1}.

3. Uniform speed: When a body covers equal distances in equal intervals of time (however small the time intervals may be), the body is said to be moving with uniform speed.

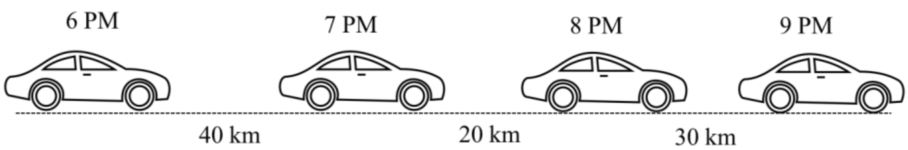
Ex: 1) A rotating fan, a rocket moving in space, etc., have uniform speeds.



2) Imagine a car covers 30 km in an hour as shown in figure, and then we can say it is moving with a uniform speed. Similarly, an aeroplane flying at 200 km/hr or a train running at 90km/h are moving with uniform speeds.

4. Non-Uniform speed: When a body covers unequal distances in equal intervals of time, the body is said to be moving with a non-uniform speed.

Ex: 1) Train starting from a station, a dog chasing a cat, have variable speeds.



2) In figure, the car covers 40 km from 6 a.m. to 7 a.m., 20 km form 7 a.m. to 8 a.m. and 30 km from 8 a.m. to 9 a.m. So, the body is moving with a non-uniform speed.

5. **Average speed :** When a body is moving with a variable speed, then the average speed of the body is defined as the ratio of total distance travelled by the body to the total time taken i.e.,

$$\text{Average speed} = \frac{\text{Total distance covered}}{\text{Total time taken to cover the distance}}$$

In the above figure the total distance covered is (40 + 20 + 30) km = 90 km, whereas the total time taken is 3 hours.

$$\text{Average speed} = \frac{90\,\text{km}}{3\,\text{h}} = 30\,\text{km/h}.$$

PRACTICE SHEET-4

1. A scooterist covers a distance of 3 kilometers in 5 minutes. Calculate his speed in kilo meters per hour (km/h) ( )

   A) 28 B) 36 C) 42 D) 78

2. The train 'A' travelled a distance of 120 km in 3 hours whereas another train 'B' travelled a distance of 180 km in 4 hours. Which train travelled faster? ( )

   A) train A B) train B C) both are equally faster D) none

3. A car travels 30 km at a uniform speed of 40 km/hr and the next 30 km at a uniform speed of 20 km/h. Find its average speed. ( )

   A) 35 km/hr B) 40 km/hr C) 22 km/hr D) 26.6 km/hr

4. On a 120 km track, a train travels the first 30 km at a uniform speed of 30 km/hr. How fast must the train travel the next 90 km so as to average 60 km/hr for the entire trip? ( )

   A) 30 km/hr B) 120 km/hr C) 90 km/hr D) 45 km/hr

5. A train travels at a speed of 60 km/hr for 0.52 hr, at 30 km/hr for the next 0.24 hr and then at 70 km/hr for the next 0.71 hr. What is the average speed of the train? ( )

   A) 59.9 km/hr B) 38 km/hr C) 69.78 km/hr D) 74.56 km/hr

6. When a body covers first one third distance with speed 1 m/s, the second 1/3 distance with speed 2m/s and the last 1/3 distance with speed 3m/s then average speed is ( )

   A) 2 m/s B) 1.79 m/s C) 2.66 m/s D) 1.64 m/s

7. A particle moving in a straight line covers half the distance with speed of 3m/s. The other half of the distance is covered in two equal time intervals with speeds of 4.5 m/s and 7.5 m/s respectively. The average speed of the particle during this motion is ( )

   A) 4.0 m/s B) 5.0 m/s C) 5.5 m/s D) 4.8 m/s

8. An aero plane flies round a square field PQRS of each side 100 km. Its speed along PQ is 400 km/hr, along QR is 500 km/hr, along RS is 600 km/hr and along SP is 700 km/hr. The average speed of the aero plane over the entire trip is:

   A) 550.68 km/hr B) 600.32 km/hr C) 526.32 km/hr D) 500.32 km/hr ( )

9. A cars odometer reads 22687 km at the start of a trip and 22791 km at the end of the trip. If the trip takes 4 hours, then the average speed of the car in (i) km h^{-1} (ii) ms^{-1} is ( )

   A) (i) 0 (ii) B) (i) (ii) 0 C) (i) 0 (ii) 0 D) (i) 26 (ii) 7.2

10. A toy car travels from A to B at a constant speed of 20 kmh^{-1} and without stopping at B returns to A at a constant speed v. If the average speed of the car is 24 kmh^{-1}, then v is ( )

A) 24 kmh^{-1} B) 28 kmh^{-1} C) 30 kmh^{-1} D) 32 kmh^{-1}

11. A boy walks to his school at a distance of 6 km with constant speed of 2.5 kmh^{-1} and walks back with a constant speed of 4 kmh^{-1}. His average speed for round trip, expressed in kmh^{-1} is: ( )

A) 1/2 B) 3 C) 24/13 D) 40/13

12. A car travels from A to B at a speed of 20 kmh-1 and returns at a speed of 30 kmh-1. The average speed of the car for the whole journey is: ( )

A) 5 kmh^{-1} B) 24 kmh^{-1} C) 25 kmh^{-1} D) 50 kmh^{-1}

13. A body covers one half of its journey at 40 ms^{-1} and the next half at 50 ms^{-1}. Its average speed is:

A) 44.4 ms^{-1} B) 50 ms^{-1} C) 45 ms^{-1} D) 40 ms^{-1} ( )

SYNOPSIS - 5

1. Velocity:

- Velocity is the rate of change of motion in a specified direction.
- The velocity of a body is a vector quantity.
- The velocity of a body can be zero, negative or positive.
- The numerical value of velocity of a body can be equal to speed only if the body is moving along a straight line in the same direction.
- The velocity of a body can never be greater than the speed of that body.

2. Unit of velocity:

The C.G.S. unit of velocity is cm/s

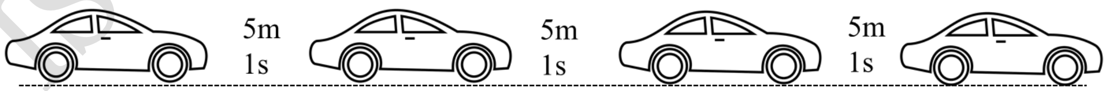
The S.I. unit of velocity is m/s

Velocity has same units as speed in C.G.S. as well as in S.I. system.

3. Kinds of velocity:

a) Uniform velocity: When a body covers equal distances in equal intervals of time in a specified direction, (how so ever, short the time intervals may be) the body is said to be moving with a uniform velocity.

Ex: Imagine a car is moving along a straight road towards east, such that in every one second it covers a distance of 5 m.



In such a case, the uniform velocity of car is 5 m/s East as illustrated in figure.

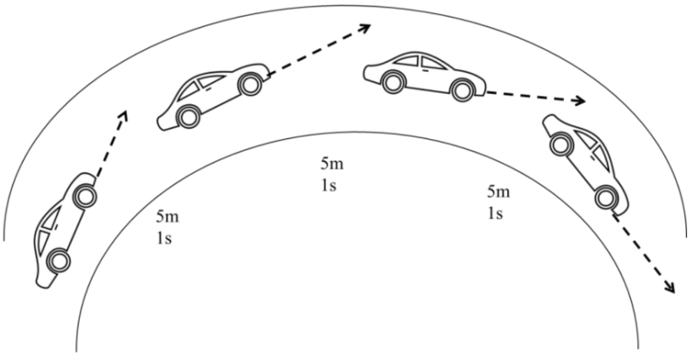
A body will have a uniform velocity only, if:

i) It covers equal distance in equal intervals of time, i.e., the magnitude does not change.

ii) Its direction remains the same.

If any of the two conditions is not fulfilled, then the body will not be moving with a uniform velocity, but with a variable velocity.

b) Variable velocity: When a body covers unequal distances in equal intervals of time in a specified direction or equal distances in equal intervals of time, but its direction changes, then the body is said to be moving with a variable velocity.



Ex: Now imagine the car is moving along a circular path, such that it is covering 5 m in every one second, as illustrated in figure.

Certainly, the car has a uniform speed of 5m/s, but its uniform velocity is not 5 m/s, because the direction of car is changing continuously.

c) Average velocity: It is the ratio of total displacement to total time taken.

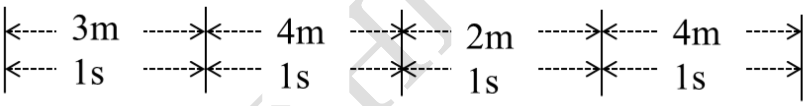
$$\text{Average velocity} = \frac{\text{Total displacement}}{\text{Total time taken}}$$

Example: In figure, the total displacement (total distance travelled) of a body towards east is

(3m + 4m + 2m + 4m) =13 m. The total time is 4s.

$$\text{Average velocity} = \frac{\text{Total displacement}}{\text{Total time taken}} = \frac{13\text{m}}{4\text{s}} = 3.25\ \text{m/s towards East}$$

It is possible to have a body with average velocity zero but not with average speed zero.



PRACTICE SHEET-5

1. If a motorist completes half a revolution in a circular track of radius 100 m in one minute, then what will be his average speed and magnitude of average velocity? ( )

   A) 314 meter/minute, 0

   B) 0, 314 meter/minute

   C) 314 meter/minute, 200 meter/minute

   D) 200 meter/minute, 314 meter/minute

2. There is a square field of side ‘a’ units. An insect starts from one corner and reaches the diagonally opposite corner in a time t. The magnitude of its average velocity is ( )

   A) $\frac{\sqrt{2}a}{t}$ B) $\frac{2a}{t}$ C) $\frac{4\sqrt{2}a}{t}$ D) 2at

3. If a body starts from a point and returns back to the same point, then its ( )

   A) average velocity is zero but not average speed

   B) average speed is zero, but not average velocity

   C) both average speed and velocity are zero

   D) average speed and velocity depends upon the path

4. A person walks along a straight road for first half time with velocity v_1 and the second half time with velocity v_2. The average velocity V is given by ( )

A) $V = \frac{v_1 + v_2}{2}$ B) $V = \frac{v_1 + v_2}{2}$ C) $V = \frac{v_1 + v_2}{4}$ D) $V = \sqrt{v_1 v_2}$

5. A boy runs along a straight path for the first half distance with a velocity v_1 and the second half distance with a velocity v_2. The mean velocity V is given by ( )

A) $\frac{2}{V} = \frac{1}{v_1} + \frac{1}{v_2}$ B) $V = \frac{v_1 + v_2}{2}$ C) $V = \sqrt{v_1 v_2}$ D) $v_1 + v_2$

6. A man leaves his house for a cycle ride. He comes back to his house after half-an-hour after covering a distance of one km. What is his magnitude of average velocity for the ride? ( )

A) 0 B) $2\,kmh^{-1}$ C) $2\,kms^{-1}$ D) $\frac{1}{2}kms^{-1}$

7. The numerical ratio of velocity to speed of a particle is always ( )

A) equal to or less than one B) equal to one
C) less than one D) zero

8. A car travels equal distances in the same direction with velocities 60 kmh^{-1}, 20 kmh^{-1} and 10 kmh^{-1} respectively. The magnitude of average velocity of the car over the whole journey of motion is:

A) 8 ms^{-1} B) 7 ms^{-1} C) 6 ms^{-1} D) 5 ms^{-1} ( )

9. A car travels a distance of 200 km from Delhi to Ambala towards north in 5 hours. The velocity, of the car for this journey is : ( )

A) 40 m/h towards east B) 40 km/h towards south
C) 40 km/h towards north D) 40 m/h towards west

SYNOPSIS - 6

1. Acceleration: In general, the moving bodies do not have uniform velocity. For example, a cyclist moving through a busy street does not have a uniform velocity. The velocity of the cyclist may change in magnitude or direction or both. In such a case the cyclist is said to have an accelerated motion.

The rate of change of velocity of a body is called acceleration.

Positive acceleration: If the velocity of a body is increasing with respect to time, the acceleration is said to be positive.

Negative acceleration: If the velocity of a body is decreasing with respect to time, the acceleration is said to be negative. The negative acceleration is sometimes called de-acceleration or retardation.

$$\text{Thus, acceleration} = \frac{\text{Change in velocity}}{\text{Time}}$$

Unit of Acceleration: The C.G.S. system acceleration is expressed in cm/s^2 or cms^{-2}. Similarly in S.I. system it is expressed in m/s^2 or ms^{-2}.

It must be remembered that acceleration is a vector quantity, as it is expressed in magnitude and direction. It is generally represented by letter ‘a’.

Uniform acceleration: When a body describes equal changes in velocity in equal intervals of time (however small may be the time intervals) it is said to be moving with uniform acceleration.

2. **Acceleration due to gravity:** When a body falls freely, its velocity constantly increases with respect to time, and hence, is acted upon by a uniform acceleration. The acceleration of a freely falling body, under the action of gravity of earth, is called acceleration due to gravity.

The value of acceleration due to gravity is constant at a given place. However, its value changes from place to place.

For example, acceleration due to gravity is maximum at poles. Its value with respect to poles decreases, if the body is taken towards equator, or to a high altitude, or deep inside a mine.

Magnitude of acceleration due to gravity: The average value of acceleration due to gravity (denoted as 'g') is taken as 9.8 m/s^2 in S.I. system and 980 cm/s^2 in CGS system. The value of 'g' is 9.8 m/s^2 if a body falls towards earth and –9.8 m/s^2 if the body rises vertically upward.

PRACTICE SHEET-6

1. Choose the wrong statement: ( )
A) Retardation is a vector quantity B) Acceleration due to gravity is a vector quantity
C) Average speed is a vector quantity D) Displacement is a vector quantity

2. ms^{-2} is the unit of ( )
A) retardation B) acceleration C) rate of change of velocity D) all of these

3. A rubber ball dropped from a certain height is an example of ( )
A) uniform acceleration B) uniform retardation
C) uniform speed D) non-uniform speed

4. If the velocity of a body does not change, its acceleration is ( )
A) zero B) infinite C) unity D) none of these

5. The ratio of S.I. unit to C.G.S. unit of retardation is: ( )
A) 10^{-2} B) 10^{2} C) 10 D) 10^{-1}

6. When the distance of an object travelled is directly proportional to the length of time, it is said to travel with: ( )
A) zero velocity B) constant speed
C) constant acceleration D) none

7. A body has an acceleration of –4ms^{-2}. What is its retardation? ( )
A) –4ms^{-2} B) 4 ms^{-2} C) zero D) none of these

8. Statement - 1: A body may have acceleration even when its velocity is zero.
Statement - 2: Acceleration is rate of change of velocity ( )
A) Both the statements are true B) Statement-1 is false whereas statement-2 is ture
C) Both the statements are false D) Statement-1 is true whereas statement-2 is false

9. If the velocity of a body is decreasing with respect to time, the acceleration is said to be ( )
A) negative B) positive C) zero D) none of these

10. Latha said to Lavanya, the acceleration due to gravity on Hyderabad is same as on the planet moon. Lavanya said to Latha, the acceleration due to gravity on Hyderabad is different from the planet moon. Then who is correct? ( )

A) only Lavanya B) only Latha C) Both are correct D) Both are wrong

11. Statement I: The value of 'g' is –9.8 m/s^2 if a body falls towards earth.

Statement II: The value of 'g' is +9.8 m/s^2 if the body rises vertically upward. ( )

A) Statement - I is correct, statement - II is also correct

B) Statement - I is wrong, statement - II is also wrong

C) Statement - I is correct, statement - II is wrong

D) Statement - I is wrong, statement - II is correct

SYNOPSIS - 7

Introduction: There are three equations for the motion of those bodies which travel with a uniform acceleration. These equations give relationship between initial velocity, final velocity, time taken, acceleration and distance travelled by the bodies. We will study these equations one by one.

1. First equation of motion (Velocity - Time relation):

The first equation of motion is v = u + at.

It gives the velocity acquired by a body in time t.

Derivation: Consider a body having initial velocity 'u'. Suppose it is subjected to a uniform acceleration 'a' so that after time 't' its final velocity becomes 'v'. Now, from the definition of acceleration we know that:

$$\text{Acceleration} = \frac{\text{change in velocity}}{\text{time taken}} \text{ (or) } \text{Acceleration} = \frac{\text{final velocity} - \text{initial velocity}}{\text{time taken}}$$

So, $a = \frac{v-u}{t} \Rightarrow at = v - u \Rightarrow v = u + at$

Where, v = final velocity of the body, u = initial velocity of the body
a = acceleration t = time taken

By paying due attention to the sign of acceleration, this equation can also be applied to the problems of uniform retardation. In this case 'a' will be replace by '–a'.

2. Second equation of motion:

The second equation of motion is: $s = ut + \frac{1}{2}at^2$.

It gives the displacement of the body in time t.

Derivation: Suppose a body has an initial velocity 'u' and a uniform acceleration 'a' for time 't' so that its final velocity becomes 'v'.

Let the displacement of the body in this time be 's'. The displacement of the moving body in time 't' can be found out by considering its average velocity. Since the initial velocity of the body is 'u' and its final velocity is 'v', the average velocity is given by:

$$\text{Average velocity} = \frac{\text{initial velocity} + \text{final velocity}}{2} = \frac{u+v}{2}$$

also, Displacement = Average velocity Time so, $S = \frac{(u+v)}{2} \times t$ ———(1)

From the first equation of motion we have, v = u + at. Substituting this value of v in equation (1), we get

$$s = \frac{(u+u+at)\times t}{2} \text{ (or) } s = \frac{(2u+at)\times t}{2} \text{ (or) } s = \frac{2ut+at^2}{2} \text{ (or) } s = ut + \frac{1}{2}at^2$$

where s = displacement of the body in time t u = initial velocity of the body and a = acceleration

Note: i) If a body starts from rest, its initial velocity, u = 0

ii) If a body comes to rest (it stops), its final velocity, v = 0

iii) If a body moves with uniform velocity, its acceleration, a = 0

PRACTICE SHEET-7

1. A car starts from rest and moves with uniform acceleration of 0.3 m/s^2 of 5 minutes. Calculate the velocity acquired by the car. ( )

   A) 1.5 m/s B) 90 m/s C) 15 m/s D) 900 m/s

2. A scooter acquires a velocity of 36 km/h in 10 seconds just after the start. The acceleration of the scooter is: ( )

   A) 1 ms^{-2} B) 10 ms^{-2} C) 3.6 ms^{-2} D) 360 ms^{-2}

3. A car travelling at 20 km/h speeds up to 60 km/h in 6 seconds. What is its acceleration? ( )

   A) 3 m/s^2 B) 12 m/s^2 C) 1.3 m/s^2 D) 1.85 m/s^2

4. An object undergoes an acceleration of 8ms^{-2} starting from rest, find the distance travelled in one second. ( )

   A) 1 m B) 2 m C) 3 m D) 4 m

5. A bus starting from rest moves with a uniform acceleration of 0.1 ms^{-2} for 2 minutes. The distance travelled by the bus is ______ ( )

   A) 720 m B) 12 m C) 120 m 4) none of these

6. A body moving with an initial velocity of 36 km h^{-1} and accelerating uniformly at the rate of 5ms^{-2} for 20 seconds. Calculate the total distance travelled in 20 seconds. ( )

   A) 400 m B) 1200 m C) 1200 km D) 300 m

7. A car initially at rest, picks up a velocity of 72 kmh^{-1} in 1/4 minutes. The distance travelled by car is: ( )

   A) 162 m B) 1/12 m C) 450 m D) none of these

8. A train starting from rest and making with a uniform acceleration attains a speed of 90 km/h in 5 minutes. Find the distance traversed by the car? ( )

   A) 3.75m B) 1/12 m C) 450 m D) none of these

9. A car starting from rest acquires a velocity of 36 km/h in 5 seconds. Calculate distance moved by it.

   A) 75.8 km B) 52.53 m C) 75 m D) 25 m ( )

10. In the equation of motion, $x = at + bt^2$, the units of 'a' and 'b' are respectively ( )

    A) m/s^2, m/s B) m/s, m/s^2 C) m/s, m/s D) m/s^2, m/s^2

ADDITIONAL PRACTICE SHEET

1. Displacement is a_____ ( )
   A) Vector quantity B) scalar quantity
   C) either vector or scalar D) neither vector nor scalar

2. A player hits a baseball at some angle. The ball goes up high in space. Another player runs and catches that ball before it reaches the ground. Which of the two has greater displacement ( )
   A) the player B) the ball C) both D) none

3. A ball is thrown up in air with some velocity. It attains a height of 40 m and come back to the thrower, then the
   A) Total distance covered is 40 m B) Magnitude of displacement is 80m ( )
   C) displacement is zero D) Total distance covered is zero

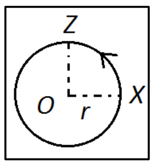
4. Pick out the false statement from the following ( )
   A) Displacement is a vector quantity and hence direction is important
   B) Displacement can be both positive and negative
   C) Displacement is always positive, it never decrease with time
   D) Distance can be negative

5. When a moving particle returns to its initial point ( )
   A) displacement is not zero B) distance is zero
   C) displacement is zero D) both distance and displacement are zero

6. Which of the following are not a character of displacement ( )
   A) It is always positive
   B) The magnitude is equal to the shortest distance between the initial and final positions
   C) It can be represented geometrically
   D) It has both magnitude and direction

7. A man has to go 50 m due north, 40 m due east and 20 m due south to reach a field. What distance he has to walk to reach the field? ( )
   A) 110m B) 100m C) 120 m D) 130 m

8. A cyclist moves from a certain point x and completes one revolution around a circular path of radius 'r'. The distance travelled and magnitude of displacement of the cyclist are respectively ( )
   A) $2r, \pi r$ B) $\frac{\pi}{2}, 2$ C) $2\pi r, 0$ D) r, 2r



9. From above data, the cyclist reaches exactly the other side of the point x (i.e diametrically opposite point to x), then the distance travelled and magnitude of displacement of cyclist are respectively
   A) πr, 2r B) $\frac{\pi r}{2}, 2$ C) $2\pi r, 0$ D) r, 2r ( )

10. from above problem if the cyclist reaches a point Z as shown in the figure, then the distance travelled and magnitude of displacement of the cyclist are respectively ( )
    A) $\frac{\pi r}{2}, 2r$ B) $\frac{\pi r}{4}, 4r$ C) $\frac{\pi r}{2}, 2$ D) $2\pi r, 0$

11. A player completes a circular path of radius 'r' in 40 s. At the end of 2 minutes 20 seconds, displacement will be
    A) 2r B) $2\pi r$ C) $7\pi r$ D) zero ( )

12. A man walks 8m towards east and then 6m towards north, His displacement is ( )

A) 10m N-E B) 14 m S-E C) 2 m S-W D) zero

13. In the above problem what is the displacement from his house to the field ( )

A) 20 m N-E B) 50 m N-E C) 50 m E-N D) 20 m EN

14. A particle stars from the origin, goes along the X-axis to the point(20m,0) and then returns along the same line to the point (-20m,0). Find the distance and displacement of the particle during the trip.

A) 80m,20m in the negative direction B) -20m,50m in the negative direction

C) 60m,20m in negative direction D) -20m,80m in the negative direction ( )

15. A spy report about a suspected car reads as follows." the car moved 2.00 km towards east, made a perpendicular left turn, ran for 500m ,made a perpendicular right turn, ran for 4.00 km and stopped". Find the displacement of the car.

A) 6km B) 6.5km C) $\sqrt{36.25}$ D) none ( )

16. A carom board (4ft x 4ft) has the queen at the center. The queen, hit by the striker moves to the front edge, rebounds and goes in the hole being the striking line. The magnitude of displacement of the queen from the center to the front edge is

A) $\frac{2}{3}\sqrt{10}$ft B) $\frac{4}{3}\sqrt{10}$ft C) $2\sqrt{2}$ft D) $\frac{5}{3}\sqrt{10}$ft ( )

17. From the above data the magnitude of displacement of the queen from the front edge to the hole

A) $\frac{2}{3}\sqrt{10}$ft B) $\frac{4}{3}\sqrt{10}$ft C) $2\sqrt{2}$ft D) $\frac{5}{3}\sqrt{10}$ft ( )

18. From the above data the magnitude of the displacement of the queen from center to hole ( )

A) $\sqrt{2}$ft B) $\frac{5}{3}\sqrt{10}$ft C) $\frac{2}{3}\sqrt{10}$ft D) $2\sqrt{2}$ft

19. A mosquito net over a 7ft x 4 ft bed is 3 ft high. The net has a hole at one corner of the bed and through which a mosquito entered into the net. It flies and sits at the diagonally opposite upper corner of the net. The magnitude of the displacement of the mosquito is ( )

A) 7ft B) $\sqrt{7}$ft C) $\sqrt{3}$ft D) $\sqrt{74}$ft

20. A body covers an arc of a circle of radius 'r', subtending an angle of 120^0 at the center of the circle. The magnitude of the displacement of the body is ( )

A) $r\sqrt{3}$ B) $r\sqrt{2}$ C) 2r D) 3r

21. A man travels 30m due north, 20m due east and $30\sqrt{2}$ m due south west, the displacement of man is

A) 10m west B) 10m east C) 20 m west D) $20\sqrt{2}$ m west ( )

SYNOPSIS - 8

1. Third equation of motion (Velocity - Displacement relation): The third equation of motion is $v^2 - u^2 = 2as$. It gives the velocity acquired by a body for a displacement s.

Derivation: Suppose a body has an initial velocity ‘u’ and a uniform acceleration ‘a’ for time ‘t’ so that its final velocity becomes ‘v’.

Let the displacement of the body in this time be ‘s’. The displacement of the moving body in time ‘t’ can be found out by considering its average velocity.

Since the initial velocity of the body is ‘u’ and its final velocity is ‘v’, the average velocity is given by:

$$\text{Average velocity} = \frac{\text{initial velocity} + \text{final velocity}}{2} = \frac{u+v}{2}$$

also, Displacement = Average velocity x Time,

$$\text{so, } s = \frac{(u+v)}{2} \times t \text{ ———— } (1)$$

And from the first equation of motion we have: $v = u + at$ or $at = v - u$ or $t = \frac{v-u}{a}$

Putting this value of ‘t’ in equation (1), we get : $s = \frac{u+v}{2} \times \frac{v-u}{a}$

$$= \frac{v^2 - u^2}{2a}$$

$$\Rightarrow v^2 - u^2 = 2as$$

Where, v = final velocity, u = initial velocity, a = acceleration and s = displacement

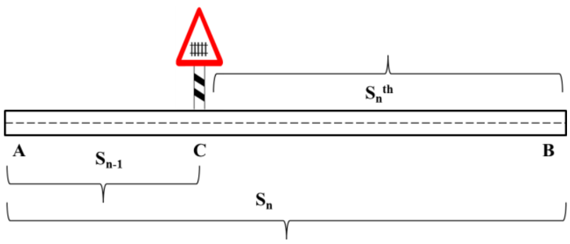
This equation gives us the velocity acquired by a body for the displacement s.

2. Distance travelled in nth second

Consider a body moving with uniformly accelerated motion having acceleration ‘a’. The distance of a particle in time ‘t’ is given by

$S = ut + \frac{1}{2}at^2$, where u = initial velocity when time = 0

If S_n and S_{n-1} are the distance of the particle in n and n – 1 seconds, then distance of the particle in nth second is, $S_{n^{th}} = S_n - S_{n-1}$



$$S_n = un + \frac{1}{2}an^2$$

$$S_{n-1} = u(n-1) + \frac{1}{2}a(n-1)^2$$

Now $S_{n^{th}} = S_n - S_{n-1}$

$$= \left(un + \frac{1}{2}an^2\right) - \left(u(n-1) + \frac{1}{2}a(n-1)^2\right) = \left(un + \frac{1}{2}an^2\right) - \left(un - u + \frac{a}{2}(n^2 + 1 - 2n)\right)$$

$$= \left(un + \frac{1}{2}\right) - \left(un - u + \frac{an^2}{2} + \frac{a}{2} - an\right) \qquad = un + \frac{1}{2}an^2 - un + u - \frac{an^2}{2} - \frac{a}{2} + an$$

$$= u + an - \frac{a}{2} \qquad = u + a\left(n - \frac{1}{2}\right) \qquad = u + a\left(\frac{2n-1}{2}\right)$$

$$S_{n^{th}} = u + \frac{a}{2}(2n-1)$$

Note: i) If a body starts from rest, u = 0 $S_{n^{th}} = \frac{a}{2}(2n-1)$

ii) Equation of kinematics are valid only for uniformly accelerated motion i.e., when a = constant.

PRACTICE SHEET-8

1. A car, initially at rest, picks up a velocity of 72 km/h, over a distance of 25 m. The acceleration of car is ? ( )

   A) 10 ms^{-2} B) 8 ms^{-2} C) 7ms^{-2} D) 9ms^{-2}

2. A wooden slab, starting from rest, slides down an inclined plane of length 10m with an acceleration of 5ms^{-2}. What would be its speed at the bottom of the inclined plane? ( )

   A) 40 ms^{-1} B) 30 ms^{-1} C) 20 ms^{-1} D) 10 ms^{-1}

3. A body is released from rest from a height of 20m. If a = 10 ms^{-2}. The velocity of the body when it about to hit the ground is ( )

   A) 40 ms^{-1} B) 30 ms^{-1} C) 20 ms^{-1} D) 10 ms^{-1}

4. A body starting from rest is travelling with an acceleration of 4ms^{-2}. The distance travelled by it in the 4th second is : ( )

   A) 14 m B) 28 m C) 30 m D) 45 m

5. A body originally at rest is subjected to uniform acceleration of 4ms^{-2}. The distance travelled by it in 5th second is : ( )

   A) 7 m B) 18 m C) 16 m D) 24 m

6. A body starts with a velocity of 40 ms^{-1} and moves with an acceleration of 10 ms^{-2}. The distance travelled by it in 15th second is : ( )

   A) 50 m B) 100 m C) 185 m D) 163 m

7. The velocity of particle increases from 'u' to 'v' in time 't' during which it covers a distance 's'. If the particle has a uniform acceleration, which one of the following equation does not apply to the motion? ( )

   A) $2s=(v+u)t$ B) $a=\frac{v-u}{t}$ C) $v=u-2as$ D) $s=\left(u+\frac{1}{2}at\right)t$

8. A car moving on a road with uniform acceleration covers 20m in the first second and 30 m in the next second. The acceleration of the car is: ( )

   A) 20 ms^{-2} B) 10 ms^{-2} C) 30 ms^{-2} D) 5 ms^{-2}

9. A bullet initially moving with a velocity 20ms^{-1} strikes a target and comes to rest after penetrating a distance of 10 cm in the target. The retardation caused by the target is : ( )

   A) 2000 ms^{-2} B) 1500 ms^{-2} C) 1347 ms^{-2} D) 2007 ms^{-2}

10. A body moving with a constant acceleration travels the distance 3m and 7m respectively in the first and the third seconds. The initial velocity and the acceleration of the body respectively are: ( )

    A) 4ms^{-1}, 4ms^{-2} B) 5ms^{-1}, 5ms^{-2} C) 2ms^{-1}, 2ms^{-2} D) 3ms^{-1}, 3ms^{-2}

11. When the engine of an electric train 45 m long passes a stationary car with uniform acceleration, its velocity is 6ms^{-1}. When the tail end of the train passes the same car, its velocity is 9ms^{-1}. What time does it take to pass the car? ( )

    A) 8 s B) 6 s C) 10 s D) 4 s

12. A car moving with a velocity of 30 ms^{-1} is stopped by the application of brakes which impart a retardation of 6 m/s^2 to the car. How far does the car travel during the time brakes are applied?
A) 60 m B) 30 m C) 40 m D) 75 m ( )

13. A body starts from rest and moves with a uniform acceleration. The ratio of the distance covered in the n^{th} second to the distance covered in 'n' sec is: ( )
A) $\frac{2}{n}-\frac{1}{n^2}$ B) $\frac{1}{n^2}-\frac{1}{n}$ C) $\frac{2}{n^2}-\frac{1}{n^2}$ D) $\frac{2}{n}+\frac{1}{n^2}$

14. A car accelerates from rest at a constant rate α for some time after which it decelerates at a constant rate β to come to rest. If the total time elapsed is t, the maximum velocity acquired by the car is given by: ( )
A) $\left(\frac{\alpha^2+\beta^2}{\alpha\beta}\right)t$ B) $\left(\frac{\alpha^2-\beta^2}{\alpha\beta}\right)t$ C) $\left(\frac{\alpha+\beta}{\alpha\beta}\right)t$ D) $\left(\frac{\alpha\beta}{\alpha+\beta}\right)t$

15. A car moves with uniform acceleration and v_1, v_2 and v_3 denote the average velocities in t_1, t_2 and t_3 seconds. Which of the following relation is correct? ( )
A) $(v_1-v_2):(v_2-v_3)=(t_1-t_2):(t_2+t_3)$
B) $(v_1-v_2):(v_2-v_3)=(t_1+t_2):(t_2+t_3)$
C) $(v_1-v_2):(v_2-v_3)=(t_1-t_2):(t_1-t_3)$
D) $(v_1-v_2):(v_2-v_3)=(t_1-t_2):(t_2-t_3)$

16. A particle accelerates from rest at a constant rate for some time and attains a velocity of 8 m/s. Afterward it decelerates with the constant rate and comes to rest. If the total time taken is 4s, the distance travelled is: ( )
A) 32 m B) 16 m C) 4 m D) none of these

17. A particle experience constant acceleration for 20 seconds after starting from rest. If it travels a distance s_1 in the first 10 seconds and distance s_2 in the next 10 seconds, then ( )
A) $s_2 = s_1$ B) $s_2 = 2s_1$ C) $s_2 = 3s_1$ D) $s_2 = 4s_1$

18. A body covers 26, 28, 30, 32 meters in 10^{th}, 11^{th}, 12^{th} and 13^{th} seconds respectively. The body starts : ( )
A) From rest and moves with uniform velocity
B) From rest and moves with uniform acceleration
C) With an initial velocity and moves with uniform acceleration
D) With an initial velocity and moves with uniform velocity

19. A particle is moving in a straight line with initial velocity 'u' and uniform acceleration 'a'. If the sum of the distance travelled in t^{th} and $(t + 1)^{th}$ seconds is 100cm, then its velocity after 't' seconds in cm/s is : ( )
A) 80 B) 50 C) 20 D) 30

20. A highway motorist travels at a constant velocity of 45 kmh^{-1} in a 30 kmh^{-1} zone. A motor cyclist police officer has been watching from behind a bill board and at the same moment, the speeding motorist passes the bill board, the police officer accelerates uniformly from rest to overtake him. If the acceleration of the police officer is 90 kmh^{-2}, how long does he take to reach the motorcyclist?
A) 1 second B) 10 second C) 1 min D) 60 min ( )

21. A car travels 200 cm in the first two second and 220 cm in the next four second. What will be the velocity at the end of seventh second from start? ( )
A) 4 cm/s B) 6 cm/s C) 8 cm/s D) 10 cm/s

SYNOPSIS - 9

1. **Equations of motion:** The equations of motion of a body travelling with uniform acceleration are known to us.

   For a body in motion, these equations give the relationship between its initial velocity (u), its final velocity (v), its uniform acceleration (a) and the distance (s) travelled by the body in time (t). These equations are given below:

   i) $v = u + at$ ii) $s = ut + \frac{1}{2}at$ iii) $v^2 - u^2 = 2as$ iv) $s_n = u + \frac{a}{2}(2n-1)$

2. **The equation of motion for a body falling down under gravity:**

   Here a = +g. You know that earth exerts a gravitational force on all bodies. At any given place the acceleration due to this force, 'g', is a constant.

   It is directed towards the earth. Therefore, bodies moving under gravity will be subjected to this uniform acceleration due to gravity 'g'.

   Thus, equation (i) to (iv) can be used for bodies in motion under gravity by replacing the acceleration 'a' by 'g'.

   As, the bodies travel vertically 's' may be replaced by the height 'h'. Therefore, for bodies in motion under gravity, the above four equations can be written as:

   i) $v = u + gt$ ii) $h = ut + \frac{1}{2}gt^2$ iii) $v^2 - u^2 = 2gh$ iv) $s_n = u + \frac{g}{2}(2n-1)$

3. **Equations of motion of a freely falling body:**

   Imagine that you are on the top of a tower. When a body is dropped from the tower no initial force is applied.

   However, the body falls with a uniform acceleration 'g' under the action of gravity. Such bodies are said to be freely falling bodies.

   For a freely falling body, with initial velocity, u = 0, the velocity continuously increases as it falls through a height.

   The direction of 'g' and the direction of motion of the body are same (i.e., downwards, therefore, 'g' is taken as positive.

   Hence, equations of motion can now be written as

   $$v = gt \Rightarrow h = \frac{1}{2}gt^2 \Rightarrow v^2 = 2gh \Rightarrow s_n = \frac{g}{2}(2n-1).$$

PRACTICE SHEET-9

1. The distance travelled by a freely falling body is proportional to ( )
   A) the mass of the body
   B) the square of the acceleration due to gravity
   C) the square of the time of fall
   D) the time of fall
2. A body strikes the floor vertically with a velocity 'u' and rebounds at the same velocity. The magnitude of change in velocity would be: ( )
   A) u B) 3u C) 2u D) zero
3. To estimate the height of a bridge over a river, a stone is dropped freely in the river from the bridge. The stone takes 2 seconds to touch the water surface in the river. The height of the bridge from the water level is _________ (g = 9.8 m/s^2) ( )
   A) 19.6m B) 39.2m C) 17.4 m D) 18.8m
4. A cricket ball is dropped from a height of 20 meters. The time it takes to fall through this height is
   A) 1s B) 2s C) 3s D) 4s ( )

5. Two stones of different masses are dropped simultaneously from the top of a building. Then which is correct among these? ( )
A) larger stone hits the ground earlier
B) smaller stone hits the ground earlier
C) which of the stones reaches the ground earlier will be depending on the composition of the stone.
D) none of these

6. Take the uniform acceleration near the surface of earth to be 9.8 ms^{-2} for a free fall. What is the velocity of a body at the end of two second of free fall, if the initial velocity is zero? (g = 9.8 ms^{-1})
A) 9.8 ms^{-1} B) 19.6 ms^{-1} C) $3\times 9.8 ms^{-1}$ D) $4\times 9.8 ms^{-1}$ ( )

7. How far a stone shall free fall in 1 second released from rest? ( )
A) 4.9 m B) 9.8 m C) 19.6 m D) $3\times 9.8m$

8. A stone is dropped from a height of 490 m. It will hit the ground after (g = 9.8 m/s^2) ( )
A) 5s B) 10s C) 20s D) 30s

9. A ball released from a certain height falls 5m in one second. In 4s, it falls through ( )
A) 80m B) 40m C) 1.25 m D) 20 m

10. A ball takes 't' seconds to fall from a height h_1 and 2t second to fall from a height h_2. Then, h_1/h_2 is
A) 2 B) 4 C) 0.5 D) 0.25 ( )

11. A stone is dropped from the top of the tower and reaches the ground in 3s. Then the height of the tower is: (g = 9.8 m/s^2) ( )
A) 18.6 m B) 39.2 m C) 44.1m D) 98 m

12. A ball released from certain height 'h' reaches the ground in time T. Where will it be from the point of release at time $\frac{5T}{6}$? ( )
A) $\left(\frac{1}{2}\right)^2 h$ B) $\left(\frac{3}{4}\right)^2 h$ C) $\left(\frac{5}{6}\right)^2 h$ D) none of these

13. A ball of mass m_1 and another ball of mas m_2 are dropped from equal height 'h'. If the time taken by the balls aret t_1 and t_2 respectively, then : ( )
A) $t_1 = \frac{t_2}{2}$ B) $t_1 = t_2$ C) $t_1 = 4t_2$ D) $t_1 = \frac{t_2}{4}$

14. A body falling from rest describes distances S_1, S_2 and S_3 in the first, second and third seconds for its fall. The ratio of $S_1 : S_2 : S_2$ is ( )
A) 1 : 2 : 3 B) 1 : 3 : 5 C) 1 : 1 : 1 D) 1 : 4 : 9

15. A body released from a great height falls freely toward earth. Another body is released from the same height exactly one second later. The separation between both the bodies two seconds after the release of the second body is: ( )
A) 4.9m B) 9.8m C) 19.6m D) 24.5m

16. A body falls freely from rest. It covers as much distance in the last second of its motion as covered in the first three seconds. The body has fallen for a time of ( )
A) 3s B) 5s C) 7s D) 9s

17. Drops of water fall from the roof of a building 9m high at regular intervals of time, the first drop reaching the ground at the same instant the fourth drop starts its fall. What are the distances of the second and third drops from the roof? ( )
A) 4m and 1m B) 4m and 2m C) 6m and 2m D) 6m and 3m

18. Two bodies begin a free fall from rest, from the same height, 1 second apart. How long after the first body begins to fall will the two bodies be 10m apart? ( )
A) 2s B) 3.5s C) 0.5s D) 1.5s

SYNOPSIS - 10

1. Equation of motion for a body thrown vertically upwards:

Can a body move away from the earth on its own? You know that it is not possible because of the gravitational attraction. Therefore, if you want a body to move upwards, you have to use force and throw it up with an initial velocity u.

However, the body will not go up indefinitely but will fall back after reaching a certain height.

This is because; its velocity continuously decreases and finally becomes zero. Why? It is because, the acceleration due to gravity 'g' acts in a direction opposite to the motion of the body.

Therefore, the sign of 'g' is negative for bodies projected vertically upwards.

The equation of motion get modified as

$v = u - gt$ ——— (1) $\qquad h = ut - \frac{1}{2}gt^2$ ——— (2)

$v^2 - u^2 = -2gh$ ——— (3) $\qquad h = u - g\left(n - \frac{1}{2}\right)$ ——— (4)

How high does the body go up? Let us find out

2. Maximum height reached by a body thrown vertically up:

Let a body be projected vertically upwards with an initial velocity u. Since, it is moving upwards, its acceleration is '–g'.

As the body goes up, its velocity decreases and finally becomes zero (v = 0) at some point (h).

This point (h) is the maximum height reached by the body. Using relation (3) for bodies projected upwards.

$$v^2 - u^2 = -2gh_{max}$$

$$\Rightarrow 0 - u^2 = -2gh_{max} \Rightarrow h_{max} = \frac{u^2}{2g} \text{ ——— (5)}$$

Hence, maximum height attained by the body is directly proportional to the square of the initial velocity u.

Times of ascent:

The time taken by the body thrown up to reach maximum height 'h' is called its time of ascent. Let 't_1' be the time of ascent. At the maximum height, its velocity v = 0

Hence, from equation (1) we get $0 = u - gt_1$ or $t = \frac{u}{g}$ ——— (6)

Hence, time of ascent (t_1) is directly proportional to the initial velocity u.

Time of descent:

After reaching the maximum height, the body begins to travel downwards like a freely falling body and finally reaches the ground.

The time taken by a freely falling body to touch the ground is called the time of descent. The initial velocity (at the point h) for the downward journey is obviously zero.

Let t_2 be the time of descent. Using these relations,

we get $h = 0 + \frac{1}{2}gt_2^2$ or $t_2 = \sqrt{\frac{2h}{g}}$ ——— (7)

but from equation $h = \frac{u^2}{2g}$ (5) , substituting this in equation (7)

we get $t_2 = \sqrt{\frac{2u^2}{2g^2}} = \frac{u}{g}$ ——— (8)

Compare this with equation (6), it shows that $t_1 = t_2$.

The time of ascent is equal to the time of descent in the case of bodies moving under gravity.

Time of flight:

Time of flight is the time for which a body remains in the air and is given by the sum of time of ascent and time of descent.

Hence, $t = t_1 + t_2$ or $t = \frac{u}{g} + \frac{u}{g}$ time of flight $t = \frac{2u}{g}$ ———(9)

Velocity on reaching the ground:

When a body is dropped from a height h, its initial velocity is zero. Let the final velocity on reaching the ground is 'v'. For a freely falling body,

$v^2 - u^2 = 2gh$, but u = 0 therefore, $v^2 - 0 = 2gh$ or $v = \sqrt{2gh}$ ————(10)

further, in case of a body thrown upwards, we have for initial velocity

$u = \sqrt{2gh}$ ————(11)

Comparing equation (10) and (11), we conclude that the velocity of the body falling from height h, on reaching the ground is equal to the velocity with which it is projected vertically upwards to reach the same height h.

The upwards velocity at any point in its flight is the same as its downward velocity at the point.

PRACTICE SHEET-10

1. A body is projected vertically upwards with a velocity 20 m/s. Find the maximum height reached by the body. Take g = 10 m/s^2. ( )
   A) 10m B) 20m C) 30m D) 40m
2. A body is thrown vertically upwards and rises to a maximum height of 10m. The velocity with which the body was thrown upwards is (Take g = 9.8 m/s^2) ( )
   A) 10 m/s B) 14 m/s C) 20 m/s D) none of these
3. A ball is thrown vertically upwards. It returns 6 seconds later. The greatest height reached by ball is ________ (taken g = 10 ms^{-2}) ( )
   A) 90 m B) 70m C) 20m D) 45m
4. A pebble is thrown vertically upwards with a speed of 20ms^{-1}. How high will it be after 2 seconds? (Take g = 10ms^{-2}) ( )
   A) 20m B) 30m C) 40m D) 60m
5. A body is projected vertically upwards with a velocity of 19.6 m/s. The total time for which the body will remain in the air is ________ (take g = 9.8 m/s^2) ( )
   A) 4s B) 6s C) 9s D) 12s
6. A stone is thrown vertically upwards with an initial velocity of 30ms^{-1}. The time taken for the stone to rise to its maximum height as ( )
   A) 0.36 s B) 3.26 s C) 30.6 s D) 3.06 s
7. A ball is thrown upwards from the surface of earth with an initial velocity of 5ms^{-1}. The ball comes to rest at a height of (take g = 10 m/sec^2) ( )
   A) 1250 m B) 125 m C) 12.5 m D) 1.25 m
8. An object is projected upwards with a velocity of 100ms^{-1}. It will strike the ground in nearly (given g = 10 m/s^2) ( )
   A) 5 s B) 10 s C) 15 s D) 20 s

9. A football kicked vertically up reaches a height 'h' and comes down to the starting point in 4 seconds. The value of 'h' is ( )

A) 9.8 m B) $2\times9.8\text{m}$ C) $3\times9.8\text{m}$ D) $4\times9.8\text{m}$

10. A ball thrown vertically upwards with a speed of 'v' attains a height h_1. Another ball thrown upwards from the same point with a speed of 2v attains a height h_2. Then, h_2 is equal to ( )

A) h_1 B) $2h_1$ C) $3h_1$ D) $4h_1$

11. A body is thrown vertically upwards with a speed of 100 ms^{-1}. On the return journey, the speed in ms^{-1} at the starting point will be ( )

A) $100ms^{-1}$ B) 9.8 ms^{-1} C) $100\times9.8ms^{-1}$ D) $\frac{100}{9.8}ms^{-1}$

12. A body is thrown upwards and reaches its maximum height. At that position ( )

A) Its acceleration is minimum

B) Its velocity is zero and its acceleration is also zero

C) Its velocity is zero but its acceleration is one

D) Its velocity is zero and its acceleration is the acceleration due to gravity

13. A ball is thrown upward. After it has left the hand, its acceleration ( )

A) remains constant B) increases C) decreases D) zero

14. Let A, B, C, D be points on a vertical line such that AB = BC = CD. If a body is released from position A, the times of descent through AB, BC and CD are in the ratio is ( )

A) $1:\left(\sqrt{3}-\sqrt{2}\right):\left(\sqrt{3}+\sqrt{2}\right)$ B) $1:\left(\sqrt{2}-1\right):\left(\sqrt{3}-\sqrt{2}\right)$

C) $1:\left(\sqrt{2}-1\right):\left(\sqrt{3}\right)$ D) $1:\sqrt{2}:\left(\sqrt{3}-1\right)$

15. A stone thrown vertically upwards attains a maximum height of 45m. In what time the velocity of stone become equal to one half the velocity of throw? (given g = $10ms^{-2}$) ( )

A) 2 s B) 1.5 s C) 1 s D) 0.5 s

16. A ball is projected upward with a velocity of $100ms^{-1}$. It will strike the ground in nearly ( )

A) 5 s B) 10 s C) 15 s D) 20 s

17. A ball is thrown vertically upwards from the top of a tower at $4.9ms^{-1}$. It strikes the pond near the base of the tower after 3 second. The height of the tower is ( )

A) 29.4 m B) 44.1 m C) 73.5 m D) 490 m

18. A stone is dropped from the top of a tower 200m high and at the same time another is projected vertically upwards from the ground with a velocity of $50ms^{-1}$. Find where the two will meet? (g = $9.8ms^{-2}$). ( )

A) 121.6 m above the ground B) 200 m above the ground

C) 150 m above the ground D) 100m above the ground

19. A body is dropped from a balloon rising vertically with a uniform velocity $12.25ms^{-1}$, when the balloon is at a height 61.25m above the ground. Find (i) the maximum height reached by the body, (ii) the time taken by the body to reach the ground. ( )

A) (i) 7.65 m (ii) 5 s B) (i) 7.65 m (ii) 4s

C) (i) 68.9 m (ii) 3 s D) (i) 68.90 m (ii) 5s

20. A stone thrown vertically upwards with a speed of 5 m/s attains a height H_1. Another stone thrown upwards from the same point with a speed of 10 m/s attains a height H_2. The correct relation between H_1 and H_2 is : ( )

A) $H_2 = 4H_1$ B) $H_2 = 3H_1$ C) $H_1 = 2H_2$ D) $H_1 = H_2$

21. A parachutist bails out and freely falls 49m. Then the parachute opens, and there after he decelerates at $2 m/s^2$. He reaches the ground with a speed of 3.0 m/s. How long is the parachutist in the air? ($g = 9.8 ms^{-2}$). ( )

A) 3.16 s B) 17.15 s C) 13.99 s D) 20 s

22. In the above problem at what height did the fall begin? ( )

A) 49 m B) 200 m C) 286.76 m D) 237.76 m

SYNOPSIS - 11

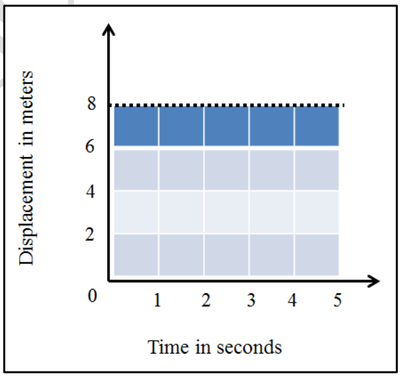
1. Displacement - Time graphs and Distance – time graphs

These graphs are very useful in studying the linear motion of the body. The displacement is plotted on the Y–axis and the time on X–axis.

These graphs are very helpful in finding the velocity of body, as the slope of graph $\left(\frac{Y-\text{axis}}{X-\text{axis}}\right)$ is equal to $\frac{\text{Displacment}}{\text{Time}}$. Following are various types of displacement time graphs.

a) Displacement - time graph is parallel to time axis

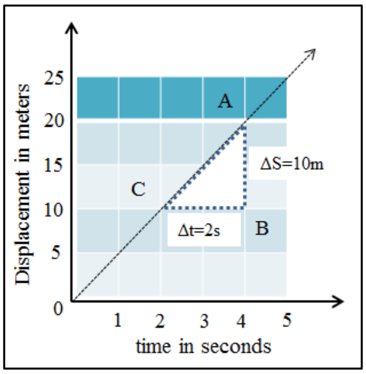
If a displacement - time graph is parallel to time axis as shown in figure. It means body is not changing its position with respect to time. In other words, body is stationary.



b) When displacement-time graph is a straight line, but is not parallel to time axis:

If the displacement - time graph is a straight line, such that it starts from origin and moves away from time and displacement axis, the body is said to be moving with uniform velocity.

Figure shows a displacement-time graph of a body. The values of displacement and time are shown in the table below:



Since graph is a straight line, therefore it means that displacement is proportional to time. In other words, body is covering equal distances in equal intervals of time in specified direction, and hence, is moving with a uniform velocity.

Displacement in meters	0	5	10	15	20	25
Time in seconds	0	1	2	3	4	5

The slope of this graph gives uniform velocity

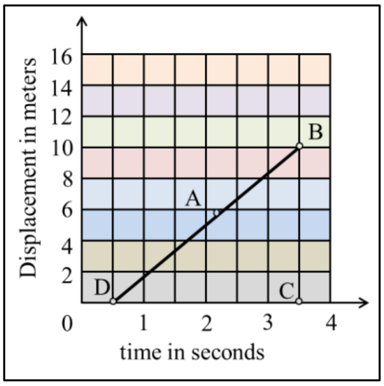
Thus, velocity of body $= \frac{\Delta x}{\Delta t} = \frac{AB}{BC} = \frac{10m}{2s} = 5m/s$

Where Δx is short distance and Δt is a short interval of time.

c) When displacement - time graph is not a straight line:

If the displacement - time graph is a curve as shown in figure.

It represents variable velocity of a moving body.



Slope of graph $\left(\frac{\overrightarrow{BC}}{DC}\right)$ at any point gives the instantaneous velocity at the point.

For example, velocity at A is $\frac{\overrightarrow{BC}}{DC} = \frac{(8-2)m}{(3-1)s} = \frac{6}{2}\frac{m}{s} = 3m/s$.

Conclusions from displacement - time graph

1. If the graph is parallel to time axis, then body is stationary.

2. If graph is a straight line and making some angle with axes, then body is said to be moving with a uniform velocity. The velocity can be found out by finding the slope of the graph.

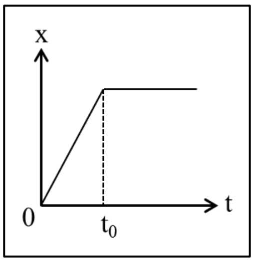
3. The graph can never be parallel to displacement axis, as it means that displacement increases indefinitely, without any increase in time, which is impossible.

4. If graph is a curve, it means the body is moving with a variable velocity, and hence, has some acceleration.

5. The distance time graph will follow the same rules except that they shouldn't be drawn under negative axes.

PRACTICE SHEET-11

1. Figure shows the displacement (x) - time (t) graph of a particle moving on the x-axis. Which is correct in the given below?



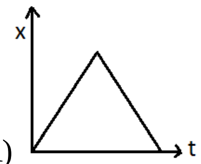
A) The particle is at rest

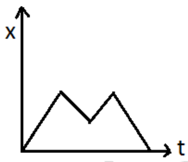
B) The velocity of particle increases up to time t_0 and then increases

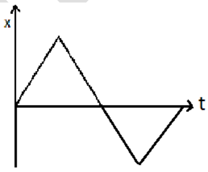
C) The velocity of particle increases up to time t_0 and then becomes constant

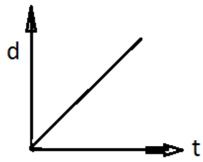
D) The particle moves at a constant velocity up to a time t_0 and then stops.

2. Which of the following distance-time graph is not possible? ( )

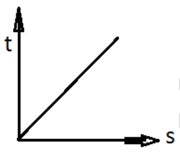
A) 

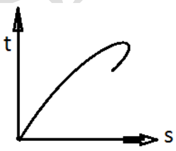
B) 

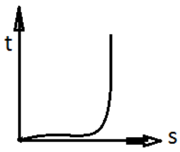
C) 

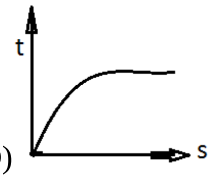
D) 

3. Which of the following time-displacement graph is not possible in nature? ( )

A) 

B) 

C) 

D) 

4. The distance-time graph of an object moving in a fixed direction is shown in figure. Then The object: ( )

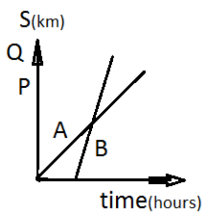
A) is at rest

B) is moving with constant velocity

C) is moving with variable velocity

D) is moving with constant acceleration

5. A and B start their journey towards their homes 'P' and 'Q' from different points. Which of the following statements is not represented by the graph given here?



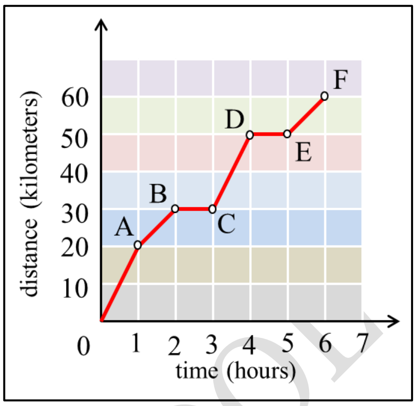
A) A starts his journey earlier

B) B is faster than A

C) A and B meet during their journey

D) A and B reach their homes at the same time

* Study the distance graph for a girl on a cycle ride as shown in the graph and answer the questions from 6 to 8



6. What was the total distance covered by her?

   A) 40 km B) 60 km

   C) 50 km D) 20 km

7. How long did she take to complete ther journey ?

   A) 6 hr B) 5 hr

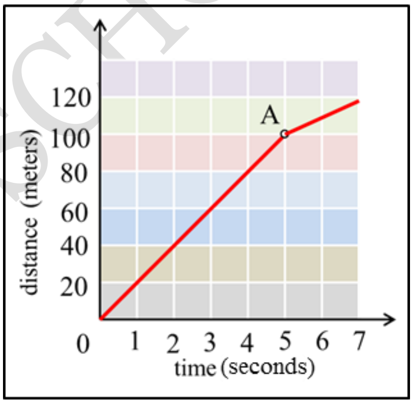
   C) 3.5 hr D) 3 hr

8. How may stops did she make?

   A) 1 B) 2

   C) 3 D) 4

* Study the graph given below showing the movement of a car and answer the questions from 9 to 11.



9. How far has the car travelled at the end of 5 seconds? ( )

   A) 40 m B) 60 m

   C) 100 m D) 50 m

10. What is the speed of the car during the first 5 seconds? ( )

    A) 40 ms^{-1} B) 20 ms^{-1}

    C) 25 ms^{-1} D) 100 ms^{-1}

11. What happens to the car after the 5th second? ( )

    A) continues with the same speed B) slows down

    C) speeds up D) none of these

SYNOPSIS – 12

1. Velocity - Time graphs and Speed – time graphs

In these graphs the velocity or speed will be plotted on Y–axis and time on X–axis. The slope of such graph gives acceleration.

As, $\text{acceleration} = \dfrac{\text{change in velocity}}{\text{time}}$, the acceleration will be positive if the slope is positive, and negative if the slope is negative.

The area of graph under velocity – time curve, gives displacement of body.

Displacement = Velocity x Time.

a. When velocity - time graph is parallel to time axis

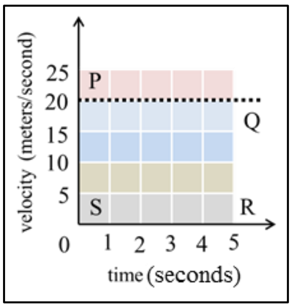


Figure represents velocity - time graph PQ, when a body is moving with a uniform velocity of $20ms^{-1}$. As the slope of graph is zero, therefore its acceleration will be equal to zero.

The distance covered by body in specified direction (displacement) can be calculated by finding the area of rectangle PQRS.

Thus, Displacement = $PS \times SR = 20\,ms^{-1} \times 4s = 80\,m$.

Conclusions:

If velocity time graph is parallel to time axis, then:

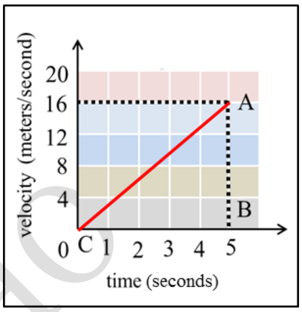
a) Body is moving with uniform velocity.

b) Its acceleration is zero.

c) Its displacement can be found by finding the area of the graph.

b) When velocity-time graph is a straight line, but not parallel to time axis.

Figure (i) represent a velocity time graph when the body starts from rest, and its velocity increases at a uniform rate.



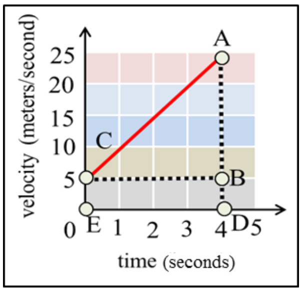
The slope of the graph AC, i.e., $\frac{AB}{BC}$ gives the acceleration of body.

$\therefore$ Acceleration $= \frac{(16-0)\,ms^{-1}}{5\,s} = 3.2\,ms^{-2}$

The area of triangle ABC, gives the displacement.

Thus, displacement in $5s = \frac{1}{2} \times AB \times BC = \frac{1}{2} \times 16\,ms^{-1} \times 5s = 40\,m$.

Figure (ii) represents velocity – time graph, where the body is initially not at rest.



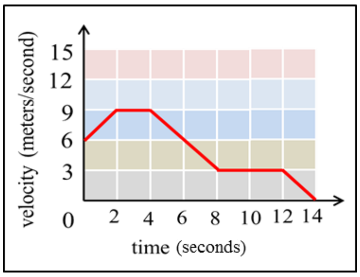
The slope of graph AC, i.e., $\frac{AB}{BC}$ gives the acceleration.

$\therefore$ Acceleration $= \frac{AB}{BC} = \frac{(25-5)\,ms^{-1}}{4\,s} = \frac{20}{4}\,ms^{-2} = 5\,ms^{-2}$

The distance covered by the body in specified direction is area of trapezium ECAD.

$\therefore$ Displacement $= \frac{1}{2}(CE + AD) \times ED = \frac{1}{2}(5+25)\,ms^{-1} \times 4s = 60\,m$

Figure (iii) represents a velocity - time graph in which velocity does not change uniformly with respect to time. Displacement of body can be found by counting the square enclosed by velocity - time curve and multiplying them with area of one square.



Displacement = Number of squares $\times$ Area of one square

= 12×6 = 72 m

The acceleration at any instant can be found by the slope of velocity time curve at that point.

Conclusions:

i) If velocity - time graph is a straight line but moving away from velocity time axis, then

a) Body is moving with variable velocity.

b) It has uniform acceleration, which can be found by the slope of graph.

c) Displacement can be found, by finding area under the velocity - time graph.

d) If slope is positive, then the body has positive acceleration and vice - versa.

ii) If the velocity - time graph is a curve, then:

a) The body has variable velocity and variable acceleration.

b) Area under the curve represents displacement.

c) Acceleration at any instant can be found by finding slope at that point.

iii) Same type of analysis can be done for speed – time graph, except that they shouldn't be drawn on negative axes.

2. Acceleration - Time graph

Figure (i) represent acceleration - time graph, AB coinciding with time axis. From the figure it is clear that acceleration of the body is zero, and hence, it is moving with a uniform velocity.

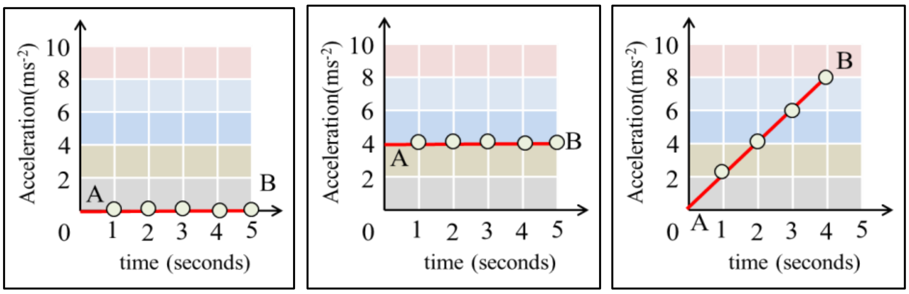


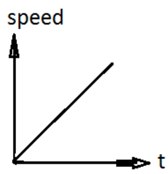
Figure (ii) represents an acceleration time graph, parallel to time axis. From figure it is clear that as acceleration does not change, therefore body is moving with a uniform acceleration and variable velocity. The area of graph, i.e.

Acceleration × Time → gives velocity.

Figure (iii) represents an acceleration time graph moving away from time as well as acceleration axis. From the graph it is clear that the body is moving with variable velocity and variable acceleration. Area of the graph gives velocity.

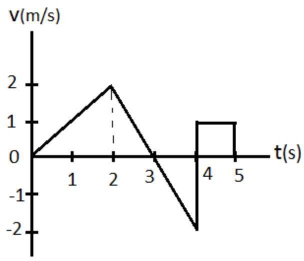
PRACTICE SHEET-12

1. The figure below shows a speed-time graph. What can be inferred from the graph?



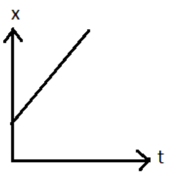
A) speed is constant
B) speed is decreasing
C) speed is increasing
D) speed increases to a maximum and then decreases

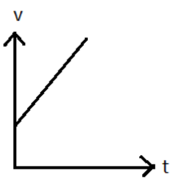
2. The velocity ‘v’ versus ‘t’ graph of a body in a straight line is as shown in figure. The displacement of the body in five seconds is

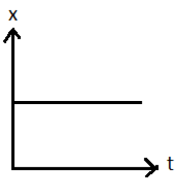


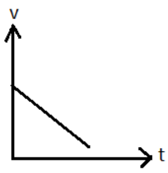
A) 2 m
B) 3 m
C) 4 m
D) 5 m

3. Which graph represents uniform motion? ( )

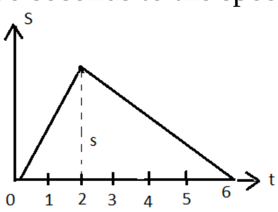
A) 

B) 

C) 

D) 

4. Refer figure, find the ratio of speed in first two seconds to the speed in the next 4 seconds. ( )



A) 1 : 2
B) 2 : 1
C) $\sqrt{2}:1$
D) 3 : 1

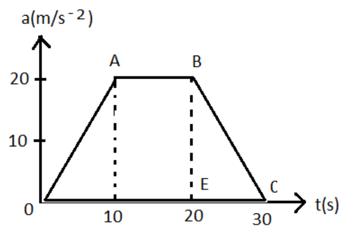
5. Figure shows the time acceleration graph for a particle in rectilinear motion. The average acceleration in first twenty seconds is: ( )

A) 45 $m.s^{-2}$

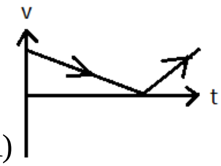
B) 40 $m.s^{-2}$

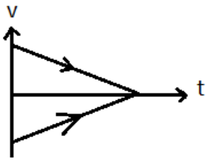
C) 15 $m.s^{-2}$

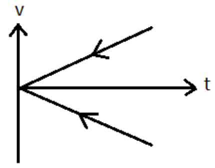
D) 20 $m.s^{-2}$

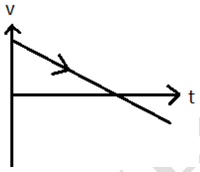


6. A body thrown vertically upward. Which of the following graphs represents the velocity of the body with time correctly? ( )

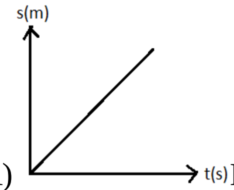
A) 

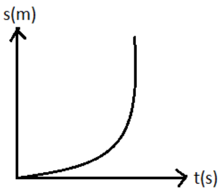
B) 

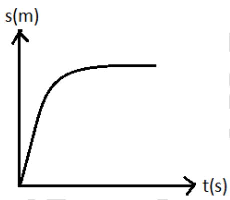
C) 

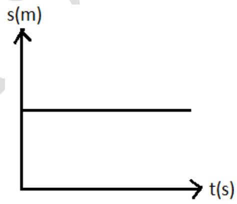
D) 

7. The distance travelled varies with time for four different bodies as shown below. In which case the acceleration of the body is minimum? ( )

A) 

B) 

C) 

D) 

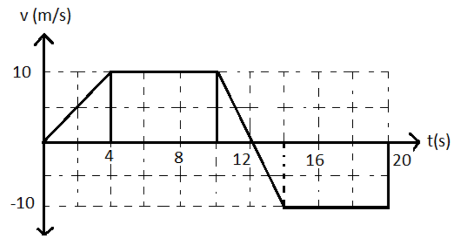
8. The graph below represents motion of car. The displacement of the car in 20s is ( )

A) 160 m

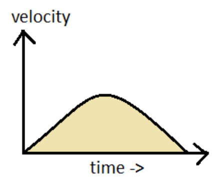
B) 20 m

C) 90 m

D) 10 m



9. Diagram shows a velocity time graph for a car starting from rest; the graph has three sections AB, BC and CD. From the graph compare the distance travelled in section BC with distance travelled in section AB.



A) 1 : 2

B) 2 : 1

C) 1: $\sqrt{2}$

D) $\sqrt{2}$:1

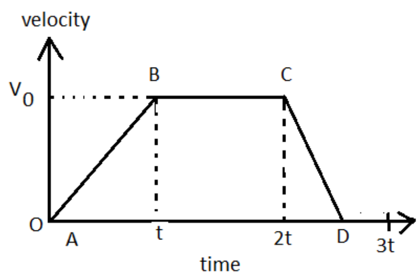
10. The figure given here shows the velocity - time graph of a one-dimensional motion. Which of the following characteristics of the particle is represented by the shaded area?

A) velocity

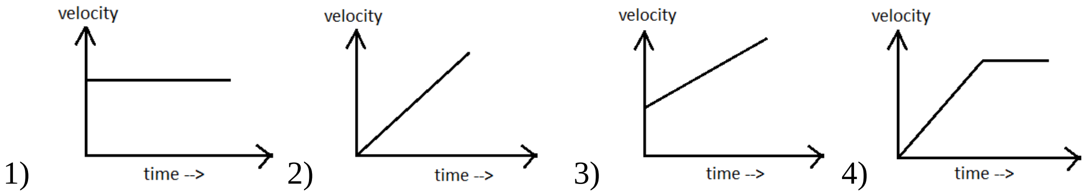
B) acceleration

C) distance covered

D) speed



* The velocity of a body in four different situations is shown below. Based on these, answer the questions from 11 to 15.



11. Uniform velocity is represented by : ( )
A) 1 B) 2 C) 3 D) 4

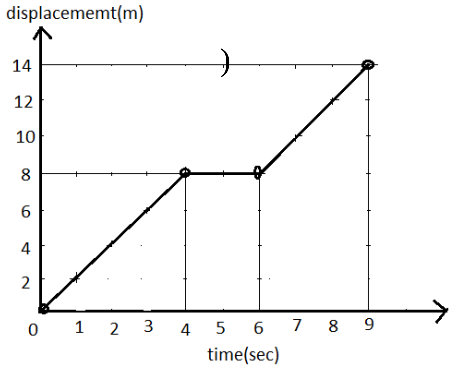
12. Uniform acceleration of the body from rest is represented by: ( )
A) 1 B) 2 C) 3 D) 4

13. Uniform acceleration of the body (initially not at rest) is represented by: ( )
A) 1 B) 2 C) 3 D) 4

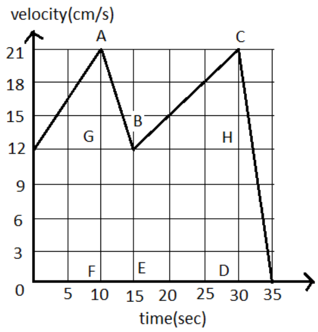
14. Body starting with uniform acceleration that becomes zero is represented by: ( )
A) 1 B) 2 C) 3 D) 4

15. Which graph represents the motion of rockets (cracker) used in fireworks? ( )
A) 1 B) 2 C) 3 D) 4

16. The displacement - time graph shown below: From the graph the velocity between 4 s to 6 s is ________ ( )
A) 1.33 m/s
B) 2 m/s
C) 4 m/s
D) none of these

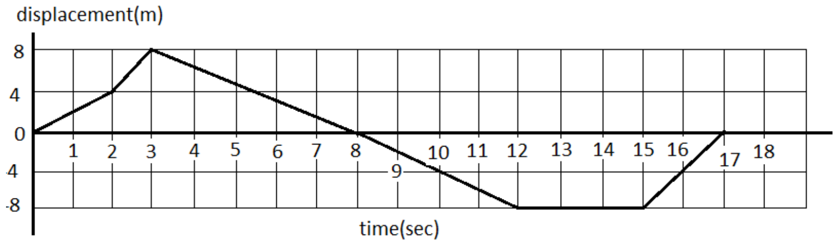


17. From the diagram the average velocity between 10 s and 30 s is ________ ( )



A) 33 cm/s B) 16.5 cm/s C) 19 cm/s D) 21.25 cms/

18. The displacement - time graph shows below

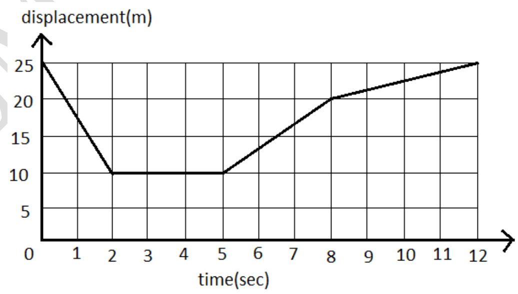


From the graph pick the exact matching from given below ( )

List A	List B
i) Average velocity in first three seconds	a) 8 s, 17 s
ii) Displacement from initial position at the end of 13 s	b) zero
iii) Time after which the body is at the initial position	c) 2.67 ms/
iv) Average velocity after 8 s	d) –8 m
	e) 12 s, 15 s

A) i - a, ii - b, iii - c, iv - d B) i - c, ii - d, iii - b, iv - a
C) i - c, ii - d, iii - a, iv - b D) i - a, ii - d, iii - e, iv - c

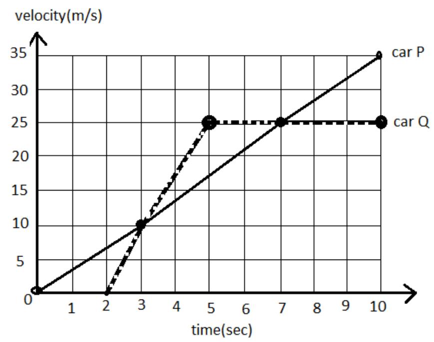
19. The displacement - time graph shown below:
From the graph pick the exact matching from given below



List - A	List - B
i) Velocity between 0 -2	a) 1.25 ms^{-1}
ii) Velocity between 8s – 12s	b) zero
iii) Average velocity between 5s – 12s	c) –7.5 ms^{-1}
	d) 2.1 ms^{-1}

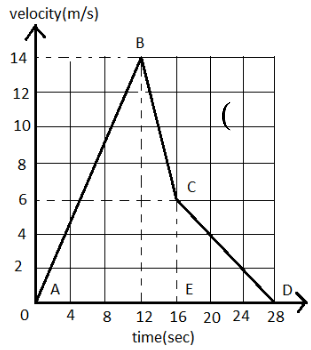
A) i - c, ii - a, iii - d B) i - c, ii - d, iii - b
C) i - a, ii - a, iii - d D) i - c, ii - a, iii – b

20. Diagram shows velocity - time graphs of car P and Q, starting from same place and in same direction. Which car is ahead after 10s and by how much?



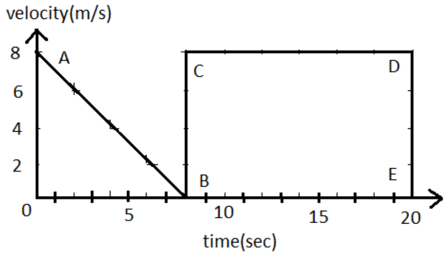
A) both cars have the same distance and at the same time
B) car P is ahead by 12.5 m
C) car Q is ahead by 12.5 m
D) none of these

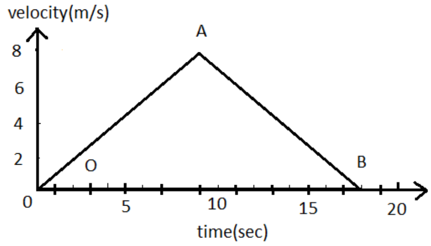
21. Figure shows the velocity - time graph.
From the figure, the distance covered in the region ABCE is ______ ( )

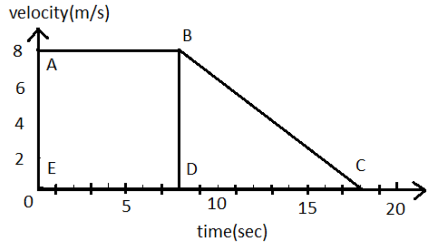


A) 100 m
B) 50 m
C) 120 m
D) none of these

22. A cyclist is cycling at a uniform rate of 8 ms^{-1} for 8 seconds. He then stops pedaling and the cycle comes to rest in next ten seconds. From the above data which one of the following is a correct graph? ( )

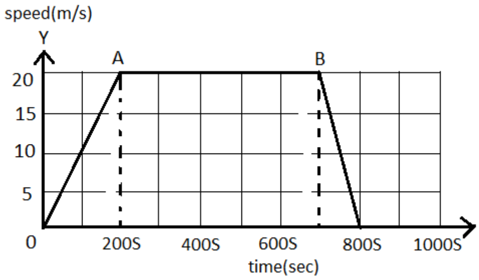
A) 

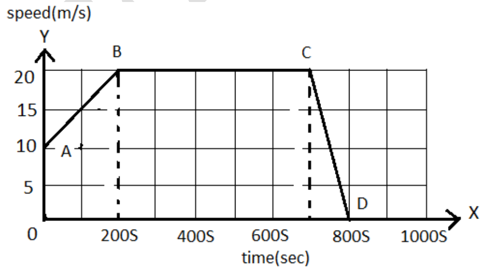
B) 

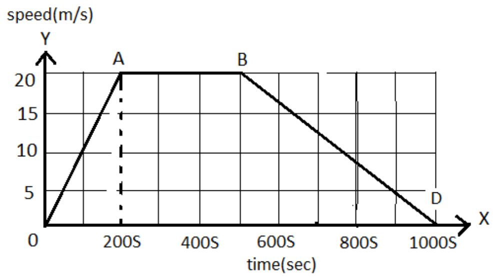
C) 

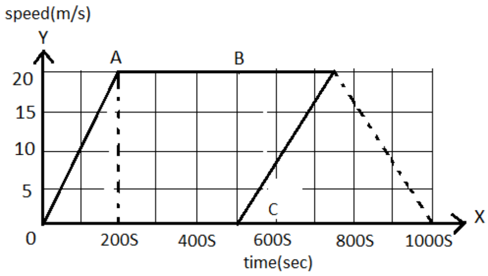
D) NONE

23. A train starting from rest picks up a speed of 20 ms^{-1} in 200s. It continues to move at the same rate for next 500s, and is then brought to rest in another 100s. From the data, which one of the following is a correct plotted graph? ( )

A) 

B) 

C) 

D) 

24. A ball is thrown up vertically, and returns back to thrower in 6s. Assuming there is no air friction, then pick the exact matching from the below: ( )

List - A	List - B
i) acceleration	a) 15 ms^{-1}
ii) average velocity	b) 10 ms^{-2}
iii) displacement	c) 90 m
iv) total distance covered by stone	d) 0
	e) 100 m

A) i - b, ii - a, ii - e, iv - d
B) i - e, ii - a, iii - b, iv - c
C) i - b, ii - d, iii - d, iv - c
D) i - b, ii - a, iii - e, iv - c