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.

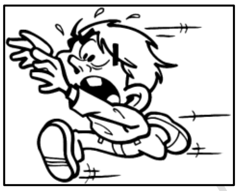
Ex: i) A bus travelling a distance of 100 km can be considered as a point object. This is because the size of the bus is very small as compared to distance travelled by it.

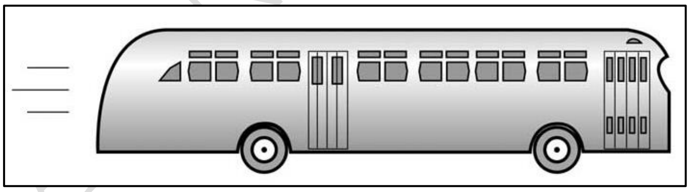
ii) A car travelling a distance of 50 km can be considered as a point object. This is because the size of car is very small as compared to the distance travelled by it.

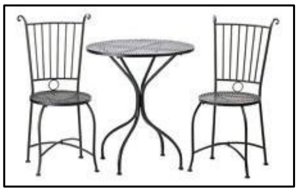
Reference point: A fixed point or a fixed object with respect to which the given body changes its position is known as reference point.

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.

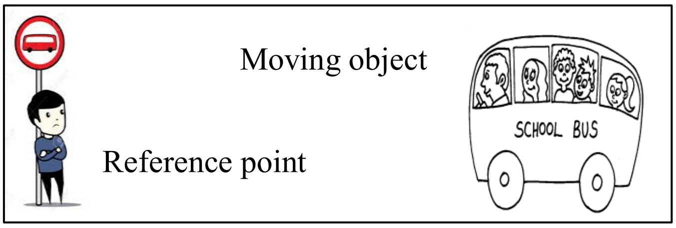
Ex: A car is changing its position w.r.t trees, houses etc., is in the state of motion.

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:

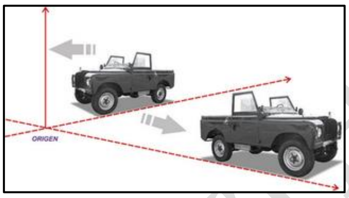
1. Translatory motion: The motion in which all the particles of a body move through the same distance in the same time is called Translatory motion. The consideration of motions is done between two points i.e., starting point and ending point.

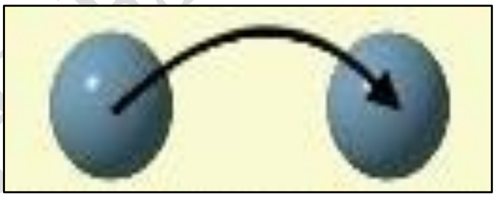
Ex: i) A car or a train moving along a road
ii) A ball rolling on the ground
iii) Firing of a bullet from a gun
iv) A stone hurled from a catapult
v) An apple falling from a tree
vi) A striker on the carom board going straight to hit the coin, are some of the examples of Translatory motion

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.

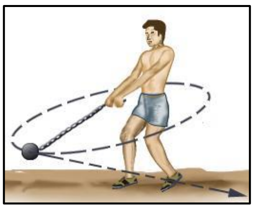
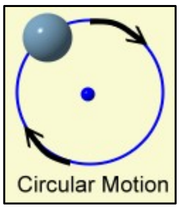
Ex: i) A stone thrown by a boy from a height
ii) A car moving along a curved path
iii) A javelin on shot put thrown by an athlete
iv) A ball thrown upward at an angle
v) A car or a train moving along a curved road track

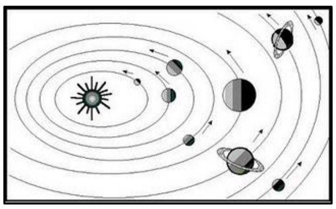
2. Rotatory motion: A motion in which a body moves about a fixed axis without changing its position is called the rotatory motion.

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

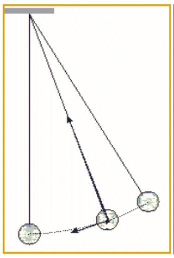


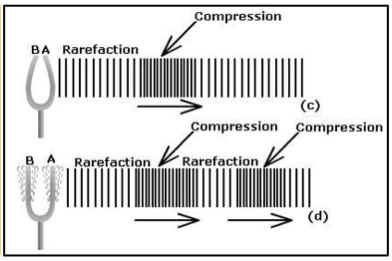
4. Oscillatory motion: The to-and-fro motion is called oscillatory motion. A motion in which the whole body moves to-and-fro about its mean position is called oscillatory motion.

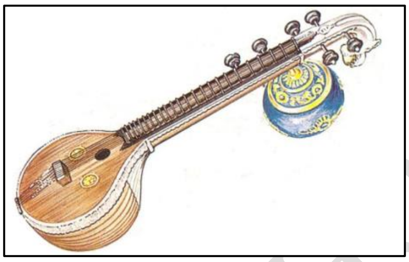
Ex: i) The motion of a swing ii) The pendulum of a clock

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

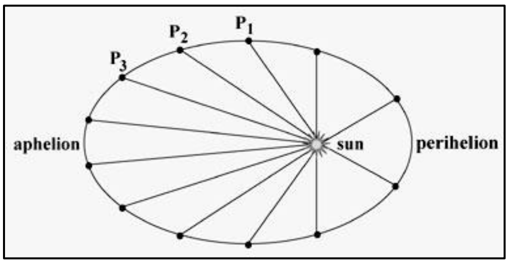
ii) The swinging pendulum of a wall clock

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

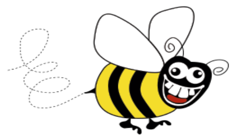
8. Random motion: A body which has a particular motion that suddenly changes to another kind of motion is said to have random motion. The motion without any sequence or direction is random motion.

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

iii) The ball during a game of hockey or football

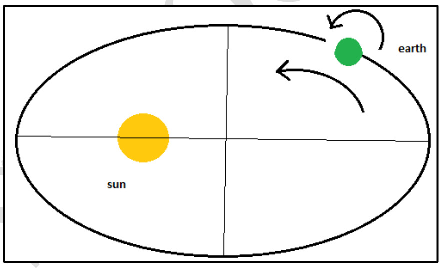
iv) Flying motion of a sparrow

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.

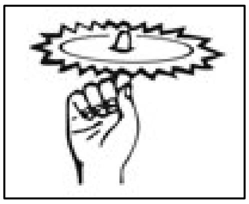


Ex: i) When a spin bowler delivers a ball, the ball has a motion of spin (rotary motion) while it moves towards the batsman (Translatory motion).

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.

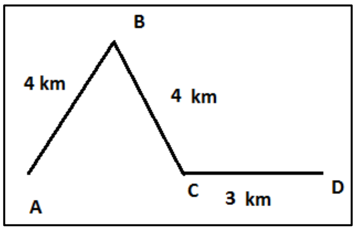
2. Vector quantities: A physical quantity which is described completely by its magnitude as well as specific direction is called vector quantity. It has both magnitude and direction.

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.

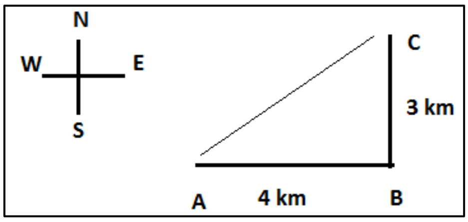
Suppose a person moves from A to B (4 km) due east, and from B to C (3 km) due north. Then, the distance travelled is

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? ( )

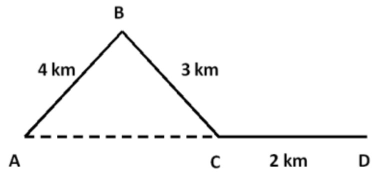
A) Displacement cannot be zero

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 $v = \frac{s}{t}$.

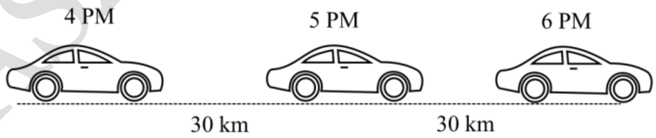
Speed is scalar quantity as it has magnitude, but no specific direction.

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.

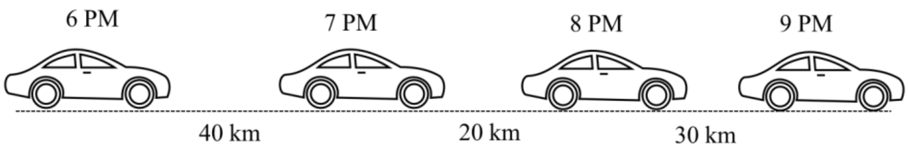
Ex: 1) A rotating fan, a rocket moving in space, etc., have uniform speeds.



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

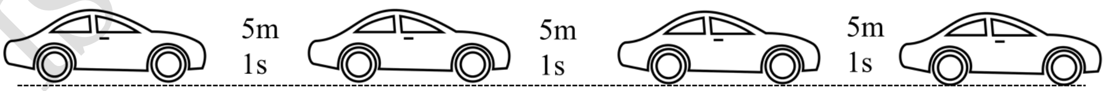
The S.I. unit of velocity is m/s

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.

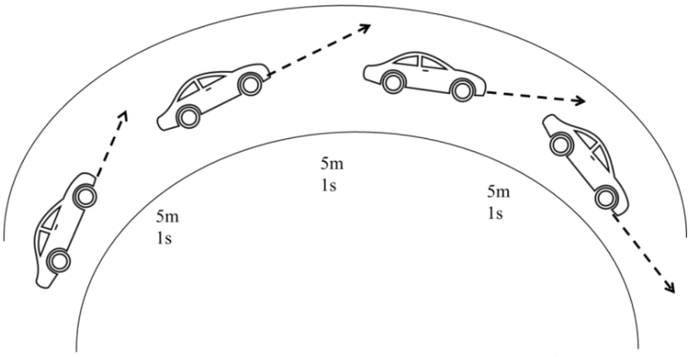
A body will have a uniform velocity only, if:

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.

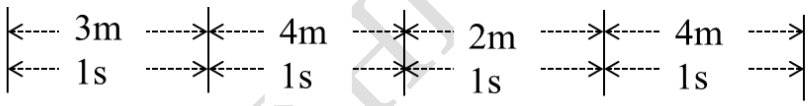
$$\text{Average velocity} = \frac{\text{Total displacement}}{\text{Total time taken}}$$

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

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

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 ( )

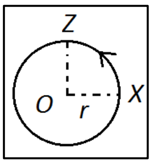
A) It is always positive
B) The magnitude is equal to the shortest distance between the initial and final positions
C) It can be represented geometrically
D) It has both magnitude and direction

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 ( )