CLASS – IX CHAPTER-2 MOTION IN ONE DIMENSION DATE: 15/05/2020

*[**From Chapter1** : Vernier Calliper and Screw Gauge are practical work these videos are materialize so that you all get well acquainted with the subject matter which will help you to increase your concept before performing those in your physics lab. at school.*
Moreover, numerical related to Vernier Calliper and Screw Gauge are not in your syllabus but for your practice you may solve for your practical work.]

Vernier Callipers principle and description (Introduction) -.mp4

Screw gauge principle and description (Introduction) -.mp4

CHAPTER-2 MOTION IN ONE DIMENSION

(A) SOME TERMS RELATED TO MOTION

Scalar Quantity: Physical Quantity which has only magnitude but no specific direction
Example : Length, distance ,area, volume ,mass, time ,energy, speed

Vector Quantity: Physical quantity which has both magnitude as well as direction
Example : Displacement, velocity, acceleration, force, weight

e.g. Simond is pulling the wooden carton by applying a force of 50 N, thus displacing the carton from position 'A' towards the west direction covering a distance of 15 m.

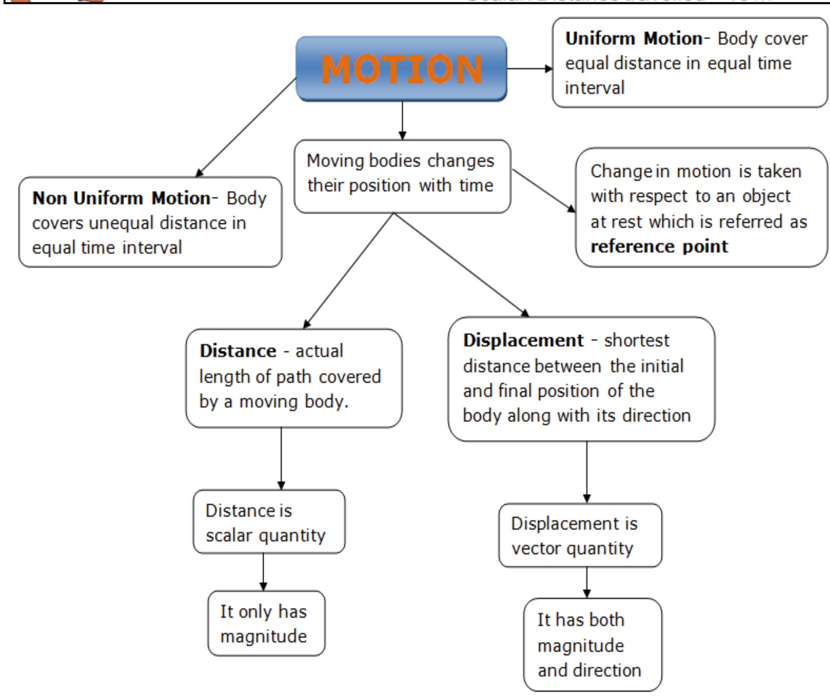
Vector: Displacement = 15 m to the west
Scalar: Distance travelled = 15 m

Definitions of Vectors and Scalars

Physical quantities can be classified under two main headings -- Vectors and Scalars.

A **vector quantity** is any quantity that has **both magnitude (size) and direction.**
E.g., velocity, acceleration, force, momentum.

A **scalar quantity** is any quantity that has **magnitude only**, while direction is not taken into account.
E.g., speed, pressure, temperature, energy.



.Concept of Rest and Motion

- *Rest* : A body is said to be in rest if its position does not vary with respect to a given referral point as time passes.
- *Motion*: A body is said to be in motion if there is a continues change in its position with respect to a given referral as time passes.
- Concept of rest and motion is related to referral change in position so a single object can be at rest or motion same time with different referral points.
- If we consider a single object as referral point and consider it as rest, as a absolute point any object which is at rest with respect to that point is considered at rest and same case with motion.
- In general we consider Earth as absolute point considering it at rest, Although It is in motion with respect to Sun and other planets

DISPLACEMENT vs. DISTANCE

- **Displacement** is the change in position of an object.
- It is a **vector quantity**, which means it has *magnitude & direction.*
- Objects at *rest* have a displacement of *zero.*

- **Distance** is the total length an object traveled.
- It is a **scalar quantity**, which means it only has *magnitude.*

(Magnitude refers to the amount)

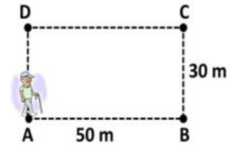
Displacement is *NOT* the same as the *distance* traveled.

The displacement of an object is not the same as the distance it travels

- Example: Throw a ball straight up and then catch it at the same point you released it
  - The distance is twice the height
  - The displacement is zero

Example:

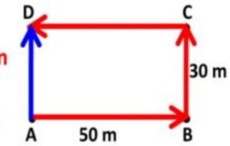
A man moves from point A to point B then to point C and finally to point D as shown in the opposite diagram. Find the distance and displacement travelled by the man



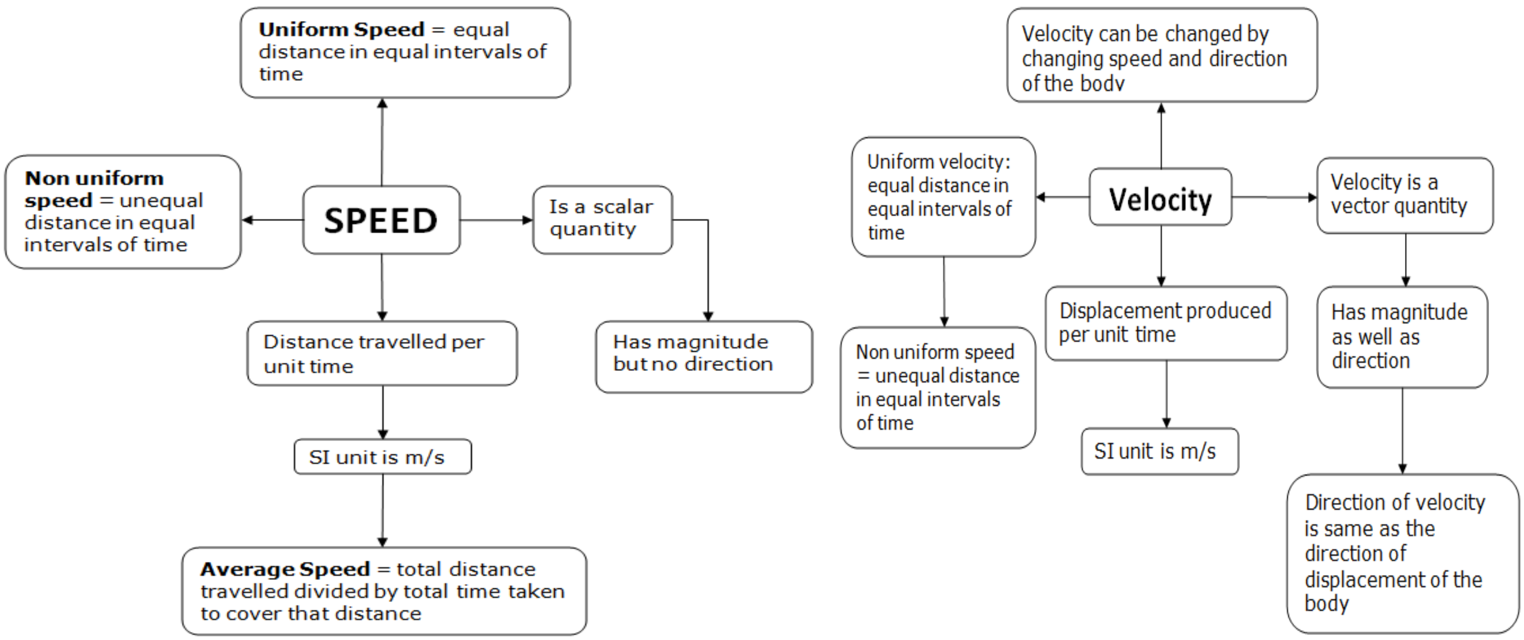
Answer:

Distance = 50 + 30 + 50 = 130 m

Displacement = 30 m to north



Concept Map of Speed and Velocity



Speed

1) The distance travelled by a body in unit time interval.

2) Speed = $\frac{\text{distance}}{\text{time}}$

3) It is a scalar quantity. No direction given.

4) SI unit of speed = $\frac{\text{SI unit of distance}}{\text{SI unit of time}}$

= metre/second

Velocity

1) The distance travelled by a body in a specified direction in a unit time interval. It is the displacement per unit time.

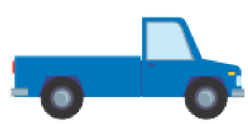
2) Velocity = $\frac{\text{displacement}}{\text{time}}$

3) It is a vector quantity. It gives direction .

4) SI unit of velocity = $\frac{\text{SI unit of displacement}}{\text{SI unit of time}}$

= metre/second

The car covers a distance of 20 km due east in two hours and truck covers 60 km in 3 hours due west. What is their speed and velocity?



Speed of car = $\frac{20}{2}$ = 10km/hr

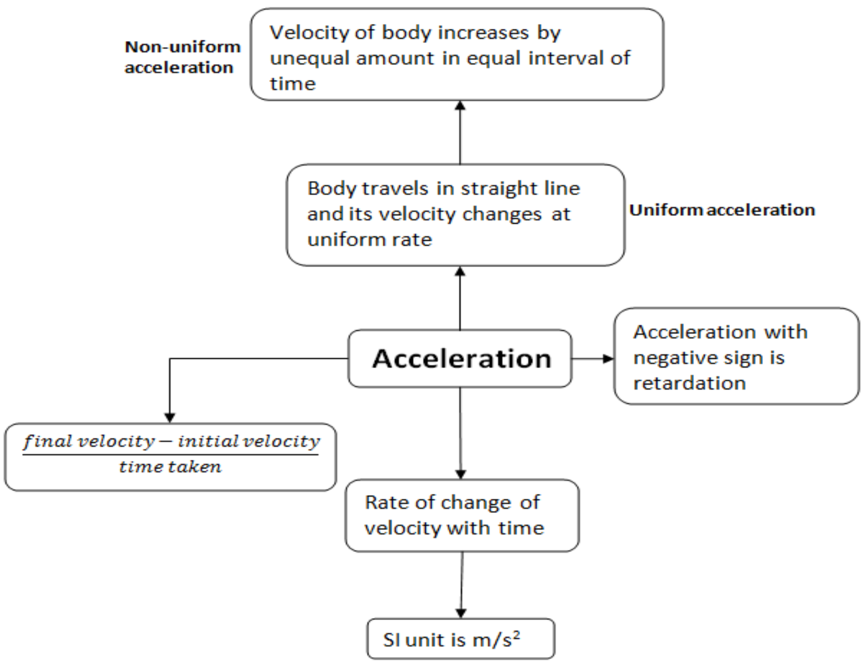
Speed of truck = $\frac{60}{3}$ = 20km/hr

Velocity of car = $\frac{20}{2}$ = 10km/hr due east

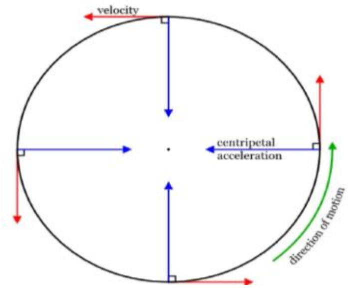
Velocity of truck = $\frac{60}{3}$ = 20km/hr due west

Truck moves faster than car. Hence speed and velocity decides how fast a body is moving.

Concept Map of Acceleration



In this case, the direction of velocity is keep on changing, but the magnitude is constant. Such kind of motion is also an example of accelerated motion.



Acceleration

- Acceleration = Rate of change of velocity with respect to time
- Same as velocity there is a concept of Instant and average acceleration
- Acceleration is a vector quantity.
- Acceleration is related to change in velocity. Therefor change of velocity in terms of magnitude or direction both can be regarded as accelerated motion.

Selina Solutions For Class 9 Physics
Chapter 2 – Motion in One Dimension

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1. Differentiate between the scalar and vector quantities, giving two examples of each.

Solution:

Scalar quantity	Vector quantity
It is a physical quantity that is expressed only by its magnitude	It is a physical quantity that requires the magnitude as well as the direction to express it, only after which its meaning is complete.
It is a pure number and has no unit	The numerical value of a vector quantity along with its unit gives us the magnitude of that quantity.
Scalars can be added, Subtracted, multiplied and divided by simple arithmetic methods	Vectors have a different algebra to perform basic addition, subtraction, multiplication and division
Example – mass of a body is 5kg The hospital is at a distance of 5kms.	Example – velocity, displacement, force

2. State whether the following quantity is a scalar or vector?
(a) Pressure
(b) Force
(c) Momentum
(d) Energy
(e) Weight
(f) Speed

Solution:

The table below depicts the categorization:

Scalar quantity	Vector quantity
Pressure	Force
Energy	Momentum
Speed	Weight

3. When is a body said to be at rest?

Solution:

A body is referred to be in a state of rest or stationary when there is no change in the position of the body with regards to its immediate surroundings.

4. When is a body said to be in motion?

Solution:

A body is referred to be in a state of motion when there are changes in the position of the body with regards to its immediate surroundings.

5. What do you mean by motion in one direction?

Solution:

Motion in one direction with reference to a body is when the body moves in a straight line path only.

6. **Define displacement. State its unit.**
Solution:
Displacement is the shortest distance from the initial to the final position of the body – magnitude wise. Direction of displacement is considered from the initial position to the final position.
The S.I unit of displacement is metre (m)

7. **Differentiate between distance and displacement.**
Solution:
The differences are as follows:

Distance	Displacement
It is the length of the pathway moved by any body/object at a particular time	It is the distance covered by an object in a particular direction at a certain time.
Scalar quantity	Vector quantity
Dependent on the path followed by the object	Independent of the path followed by the object
Since it has magnitude only, the value is always positive	Since it has both magnitude and direction, it value can be positive or negative
Can be more than or equal to the magnitude of displacement	Can be less than or equal to the distance, but never greater than the distance

8. **Can displacement be zero even if distance is not zero? Give one example to explain your answer.**
Solution:
Yes, the displacement can be zero even if the distance is not zero. Example – Circular motion of a body results in zero displacement but the distance cannot be zero.

9. **When is the magnitude of displacement equal to the distance?**
Solution:
The magnitude of displacement is equal to the distance when the motion is in a fixed direction.

10. **Define velocity. State its unit.**
Solution:
Velocity can be defined as the distance covered per second by a body in a particular direction. The S.I. unit of velocity is metre/second (m/s).

11. **Define speed. What is its S.I. unit?**
Solution:
Speed can be defined as the rate of change of distance with regards to time. The S.I. unit of time is metre/second (m/s).

12. **Distinguish between speed and velocity.**
Solution:
The difference between speed and velocity is:

Speed	Velocity
Rate of change of distance with time	Rate of change of displacement of a body with time
Scalar quantity	Vector quantity
It indicates rapidity of object	Along with rapidity, it indicates direction of a object
When the body returns to its initial position, speed will not be zero	When the body returns to its initial position, velocity can be zero
Speed can never be negative	It can either be negative or positive, sometimes zero

13. **Which of the quantity speed or velocity gives the direction of motion of body.**
Solution:
Speed is a scalar quantity whereas velocity is a vector quantity. Hence, velocity gives direction of motion of body.

14. **When is the instantaneous speed same as the average speed?**
Solution:
The instantaneous speed is same as the average speed when the acceleration of the body is zero. In order for the acceleration to be zero, neither the speed nor the direction changes.

15. Distinguish between uniform velocity and variable velocity.

Solution:

The difference between uniform velocity and variable velocity is:

Uniform velocity	Variable velocity
If a body travels equal distances in a particular direction, in equal intervals of time, the body is said to be moving with a uniform velocity	If a body moves unequal distances in a particular direction in equal intervals of time or it moves equal distances in equal intervals of time, but its direction of motion does not remain the same, then the velocity of the body is said to be variable.

16. Distinguish between average speed and average velocity.

Solution:

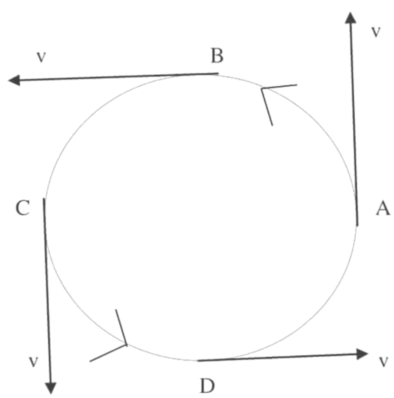
The differences between average speed and average velocity is:

Average speed	Average velocity
It is the ratio of the total distance covered by the body to the total time of journey.	It is the velocity of a body that moves in a specific direction and that which changes with time. This ratio of displacement to the total time taken gives the average velocity
Average speed can never be zero	It can be zero, even if average speed is a non-zero value.

17. Give an example of motion of a body moving with a constant speed, but with a variable velocity. Draw a diagram to represent such a motion.

Solution:

An example of motion of a body moving with a constant speed with variable velocity is the motion o a body in a circular path as in a circular path, the direction of motion of the body changes continuousl with time. At any instant, the velocity is along the tangent to the circular path at that point.



18. Give an example of motion in which average speed is not zero, but average velocity is zero.

Solution:

When a body is travelling in a circular car race track where in the initial and the final path are the same, the average speed in not zero but the average velocity is zero.

19. Define acceleration. State its S.I unit.

Solution:

Acceleration can be defined as the rate of change of velocity with time. It can also be defined as the increase in velocity per second. The S.I unit of acceleration is meter per second square or ms^{-2}.

20. Distinguish between acceleration and retardation.

Solution:

The differences are as follows:

Acceleration	Retardation
It is the increase in velocity per second	It is the decrease in the velocity per second
If the final velocity is greater than initial velocity, acceleration is positive	If the final velocity is lesser than initial velocity, acceleration becomes negative, hence it is the retardation.

21. Differentiate between uniform acceleration and variable acceleration.

Solution:

The differences are as follows:

Uniform Acceleration	Variable acceleration
Here, equal changes in velocity occur in equal intervals of time	If change in velocity is not the same in the same intervals of time, then it is variable acceleration

Example – Motion of a body under gravity(free fall of a body)	Example – Motion of a vehicle on a hilly road

22. What is meant by the term retardation? Name its S.I. unit.

Solution:

Retardation can be defined as the decrease in the velocity per second. Since negative acceleration is retardation, its S.I. unit is the same as acceleration.

i.e., metre per second square ms^{-2}

23. Which of the quantity, velocity or acceleration determines the direction of motion?

Solution:

Velocity determines the direction of motion.

The acceleration of the body does not determine its direction of motion while velocity determines its direction of motion. Positive or negative sign of acceleration indicates if the velocity is increasing or decreasing whereas positive or negative sign of velocity indicates the direction of motion.

24. Give one example of each type of the following motion:

(a) Uniform velocity

(b) Variable velocity

(c) Variable acceleration

(d) Uniform retardation

Solution:

Examples for each are as follows:

(a) Uniform velocity – Rain drops reach the earth's surface falling with uniform velocity

(b) Variable velocity – Motion of a body in a circular path

(c) Variable acceleration – Motion of a vehicle on a crowded road

(d) Uniform retardation – A train reaching a station

25. The diagram below shows the pattern of the oil on the road, dripping at a constant rate from a moving car. What information do you get from it about the motion of car?

Solution:

Observing the car gives the following information.

- The car is initially moving with a constant speed
- The dripping of the oil shows that the car is slowing down.

26. Define the term acceleration due to gravity. State its average value.

Solution:

It can be defined as the acceleration produced by a body when it is falling freely under gravity. The acceleration is produced as a result of earth's gravitational attraction. Usually, it is denoted by the letter 'g'. The average value of 'g' is $9.8ms^{-2}$ or nearly 10 ms^{-2} and varies from place to place.

27. **'The value of g remains same at all places on the earth surface'. Is this statement true? Give reason for your answer.**

Solution:

No, the value of 'g' is not the same at all places. The average value of 'g' is 9.8 ms^{-2} and varies from place to place. The value of 'g' is minimum at the equator on the surface of the earth and the maximum at the poles.

28. If a stone and a pencil are dropped simultaneously in vaccum from the top of a tower, which of the two will reach the ground first? Give reason.

Solution:

In vaccum, there is no resistance from the viscous force of air hence both the objects i.e., the pencil and the stone will reach the ground at the same time from the top of the tower as the value of acceleration due to gravity 'g', is the same on both the objects.

Numericals:

1. **The speed of a car is 72km h^{-1}. Express it in ms^{-1}.**
   Solution:
   Given: speed = 72km/hr
   Express speed in m/s
   72 km/hr = $\frac{72 \times 1000m}{60 \times 60}$ = 20 m/s

2. **Express 15 ms^{-1} in km h^{-1}**
   Solution:
   Express ms^{-1} in km h^{-1}
   15 ms^{-1} = $\frac{15 \times 60 \times 60}{1000}$ = 54 km h^{-1}

3. **Express each of the following in ms^{-1}:**
   (a) 1km h^{-1}
   (b) 18 km min^{-1}
   Solution:
   (a) Expressing 1km h^{-1} in ms^{-1}
   1 km/hr = $\frac{1 \times 1000m}{60 \times 60}$ = 0.278 ms^{-1}

   (b) Expressing 18km h^{-1} in ms^{-1}
   18 km/hr = $\frac{18 \times 1000m}{60}$ = 300 ms^{-1}

4. **Arrange the following speeds in increasing order:**
   10 ms^{-1}, 1km min^{-1}, 18 km h^{-1}
   Solution:
   In order to arrange the following in increasing order of their speeds, we must first bring them all to a similar unit.

Expressing all the three in ms^{-1}
10 ms^{-1} is already in ms^{-1}

1 km min^{-1} = 1 x 1000/60 = 16.67 ms^{-1}

18 km h^{-1} = $\frac{18 \times 1000m}{60 \times 60}$ = 5 ms^{-1}

Hence, the increasing order is 18 km h^{-1}, 10 ms^{-1}, 1 km min^{-1}

5. **A train takes 3h to travel from Agra to Delhi with a uniform speed of 65 km h^{-1}. Find the distance between the two cities.**
   Solution:
   Given: time = 3hours
   Speed = 65 km h^{-1}
   Distance =?

   Speed = $\frac{distance}{time}$

   $\Rightarrow$ distance = speed x time
   = 65 x 3
   = 195 km

6. **A car travels first 30km with a uniform speed of 60km h^{-1} and then next 30km with a uniform speed of 40 km h^{-1}. Calculate: (i) the total time of journey, (ii) the average speed of the car.**
   Solution:
   Given:
   Let t1, d1 and s1 be the time, distance and speed travelled by the car in the first part of the journey.
   Let t2, d2 and s2 be the time, distance and speed travelled by the car in the second part of the journey.
   d1 = 30km, s1 = 60km h^{-1},t1 = ?
   d2 = 30km, s2 = 40km h^{-1},t2 = ?

   (i) Total time of the journey = t1 + t2
   We know that,

   Speed = $\frac{distance}{time}$ $\Rightarrow$ time = $\frac{distance}{speed}$
   $\Rightarrow t1 = \frac{d1}{s1}$
   = 30/60 = ½ hr = 0.5hr

Total time = t1 + t2 = 0.5 + 0.75 = 1.25hrs or 75 minutes

(ii) Average speed = $\frac{\text{total distance travelled}}{\text{total time taken}}$

$= \frac{d1+d2}{t1+t2} = \frac{30+30}{1.25} = \frac{60}{1.25}$ = 48 km h^{-1}

7. A train takes 2h to reach station B from station A, and then 3 h to return from station B to station A. The distance between the two stations is 200km. Find:

(i) The average speed

(ii) The average velocity of the train

Solution:

(i) Given: distance = 200km,
Let,
time taken to travel from station A to B be 't1'
time taken to travel back from station B to station A be 't2'.
Total time = t1+t2
Total distance travelled is from station A to B and back from station B to A, hence it is 200km+200km = 400km

Average speed = $\frac{\text{total distance travelled}}{\text{total time taken}}$

$= \frac{400}{t1+t2} = \frac{400}{2+3} = \frac{400}{5}$ = 80 km h^{-1}

(ii) As the train travels from Station A to station B and back from station B to A, the displacement is zero. Hence, the average velocity is also zero.

8. A car moving on a straight path covers a distance of 1km due east in 100s. What is (i) the speed and (ii) the velocity of car?

Solution:

Given: d=1km = 1000m, t=100s

(i) Speed = $\frac{\text{distance}}{\text{time}}$

$= \frac{1000}{100}$ = 10ms^{-1}

(ii) The velocity of the car is the same as speed in magnitude along with direction, hence velocity = 10 ms^{-1} due east

9. A body starts from rest and acquires a velocity 10 ms^{-1} in 2s. Find its acceleration.

Solution:

Given: velocity = 10 ms^{-1}, time = 2s

Acceleration = $\frac{\text{Change in velocity}}{\text{time interval}}$ = 10/2 = 5ms^{-2}

10. A car starting from rest acquires a velocity 180 ms^{-1} in 0.05h. Find the acceleration.

Solution:

Given: velocity = 180m/s, time = 0.05h = 0.05 x 60 x 60 = 180s

Acceleration = $\frac{\text{Change in velocity}}{\text{time interval}} = \frac{180}{180}$ = 1 ms^{-2}

11. A body is moving vertically upwards. Its velocity changes at a constant rate from 50 ms^{-1} to 20 ms^{-1} in 3s. What is its acceleration?

Solution:

Given: u=50m/s; v=20m/s, t=3s

Acceleration = $\frac{v-u}{t} = \frac{-30}{3}$ = -10m/s^2

The negative sign indicates velocity decreases with time, hence retardation is 10m/s^2.

12. A toy car initially moving with a uniform velocity of 18km h^{-1} comes to a stop in 2s. Find the retardation of the car in S.I units.

Solution:

Given: u=18km h^{-1}, v=0, t=2s

Converting 18km/hr to m/s

18 km h^{-1} = $\frac{18 \text{ x } 1000\text{m}}{60 \text{ x } 60}$ = 5 ms^{-1}

Acceleration = $\frac{v-u}{t} = \frac{0-5}{2}$ = - 2.5ms^{-2}

Retardation is 2.5 ms^{-2}

13. A car accelerates at a rate of 5 ms^{-2}. Find the increase in its velocity in 2s.

Solution:

Given: a=5 ms^{-2}, t=2s, v=?

$$\text{Acceleration} = \frac{\text{Change in velocity}}{\text{time interval}}$$

$\Rightarrow$ change in velocity = acceleration x time

= 5 x 2 = 10 ms^{-1}

14. A car is moving with a velocity 20m/s. The brakes are applied to retard it at a rate of 2m/s². What will be the velocity after 5s of applying the brakes?

Solution:

Given: u = 20m/s, retardation=2m/s^2, t=5s

If 'v' is the final velocity, then as we know,

$$\text{Acceleration} = \frac{v-u}{t}$$

$$-2 = \frac{v-20}{5} \quad \text{(retardation is negative acceleration)}$$

$\Rightarrow$ v -20 = -(2 x 5)

v = 10 - 20

= -10 m/s

The negative sign is an indication that the velocity is decreasing.

15. A bicycle initially moving with a velocity 5m/s accelerates for 5s at a rate of 2 m/s². What will be its final velocity?

Solution:

Given: u = 5m/s, t=5s, a=2m/s^2. V=?

$$\text{Acceleration} = \frac{v-u}{t}$$

$$2 = \frac{v-5}{5}$$

10 = v-5

v = 15 m/s

16. A car is moving in a straight line with speed 18km h^{-1}. It is stopped in 5s by applying the brakes. Find: (i) the speed of car in m/s, (ii) the retardation and (iii) the speed of car after 2s of applying the brakes.

Solution:

Given: t=5s, intial velocity=18km/hr

(i) Expressing 18km/hr to m/s

$$18 \text{ km h}^{-1} = \frac{18 \times 1000\text{m}}{60 \times 60} = 5 \text{ ms}^{-1}$$

(ii) As the car comes to a halt, the final velocity is 0

Retardation is negative acceleration,

$$\text{Retardation} = \frac{v-u}{t} = \frac{0-5}{5} = -1\text{m/s}^2$$

Retardation is 1m/s^2

(iii) If 'v' is the speed of the car after 2s of applying brakes, then acceleration is

$$\text{Acceleration} = \frac{v-u}{t}$$

$$-1 = \frac{v-5}{2}$$

v -5= -2

v = 3m/s

<u>Assignment</u> :

- **Selina Book Exercise work. (first you all try to solve all and then finally check with answers provided to you in the study materials whether correct or not)**
- **Try to solve exercise numerical related to chapter 1 (also vernier caliper and screw gauge), answers will be uploaded next class.**

Note:

- **Materials provided to you are strictly based on board syllabuses as provided.**
- **Remember concept related to the chapter are more important so, understand it, do not go through only reading. While going through study materials or your book if you face any problem in understanding write it in your notebook ask during class hour as school reopen, doubts will be surely clarify.**

See you all soon till then stay at home with your family members, stay safe, keep well and obviously study hard maintaining a daily routine made by you.
Thank you.