Physics: SS1 First Term

WEEK 7: Linear Motion: Speed, Velocity and Acceleration

Speed

The speed of an object is a measure of how fast something is traveling.

speed (m/s) = distance (m) ÷ time (s)

Alternatively the units are kilometers per hour (km/h).

You will also see miles and miles per hour:

- 1 mile = 1.6 km = 1600 m
- 1 mph = 0.44 m/s

Despite this country's love of **imperial** distance measurements, all Highways and many main roads have distance markers in **kilometers**.

Most modern engineering is done entirely **metrically**, and has been for many years.

The equation can be rearranged to:

distance = speed × time

or

time taken = distance ÷ time

OR:

1. Distance (s)

This is the separation or space between two points. It is measured in meters and it is a scalar quantity.

2. Displacement (s)

It is distance in a specified direction. It is a vector quantity and it is measured in meters.

3. Speed (v)

It is the rate of change of distance moved with time. The unit is m/ and it is a scalar quantity.

Speed=distancetimev=st

(a) Uniform speed

It is obtained if the rate of change of distance with time is constant or when a body travels equal distances in equal time intervals.

(b) Average speed

Average speed is the total distance travelled divided by the total time taken. The average speed is a better representation of the motion of a body not moving at a constant or uniform speed.

Average speed=Total distance coveredTotal time taken

(c) Instantaneous speed

It is the actual speed of a body at any instant during the course of motion.

4. Velocity

It is the rate of change of displacement with time. The unit is m/s. It is avector quantity.

Velocity=displacementtime

Uniform Velocity

It occurs when the rate of change of displacement with

time is constant or when a body travels equal displacement in equal time interval.

EVALUATION

1. Define speed, velocity and uniform velocity.
2. Differentiate between velocity and speed.

Calculations on Speed and Velocity

1. A car covers a distance of 60km in half an hour. What is the average speed of the car in (a) km/hr (b) m/s

Solution:

(a) Time = ½ hour = 0.5 hour =12hour=0.5hour

Average speed=Total distance coveredTotal time taken=600.5=120km/h

(b) Convert km/hr to m/s

1km/h=100060×60m/s1km=1000m1hr=3600s120km/h=120×100060×60=33.33m/s

2. A car travelled to Lagos a distance of 150m in 100 seconds. Calculate his average speed.

Solution:

Average speed=Total distance coveredTotal time taken=150100=1.5m/s

3. A car covers 1500m in 10 secs. What is the speed in km/hr?

Solution:

Speed=distancetime=150010=150m/s

Convert to km/hr

1km/h=100060×60m/s1m/s=60×601000km/h150m/s=150×60×601000=540km/h

EVALUATION:

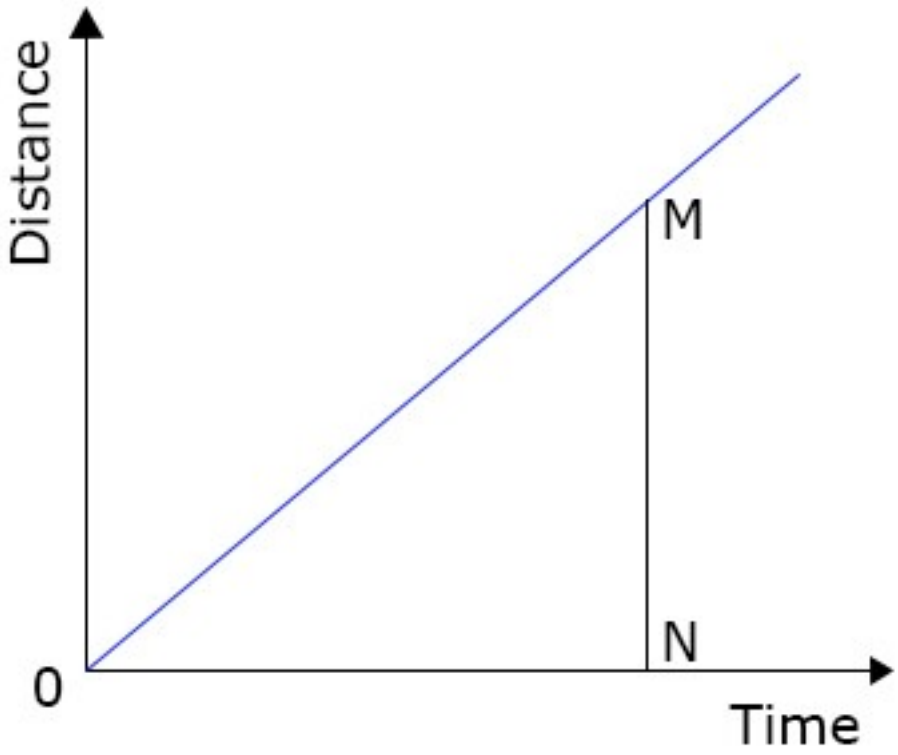
1. Convert 144km/h to m/s.

2. A car covers a distance of 40m in 2 sec. What is his speed in km/h?

Distance-Time Graph, Displacement-time Graph

It is the graphical representation of the motion of a body. There are Distance-time graph, Displacement-time graph and Velocity-time graph.

(a) Distance-Time Graph for Uniform Motion



distance time graph

Slope of distance–time graph = speed

1 Diagram 2 shows the distance-time graph for the journeys of a Lorry and a van. The graph PQRS represents the journey of the lorry and the graph PRT represents the journey of the van.Both vehicles depart from the same town at the same time and travel along the same road.

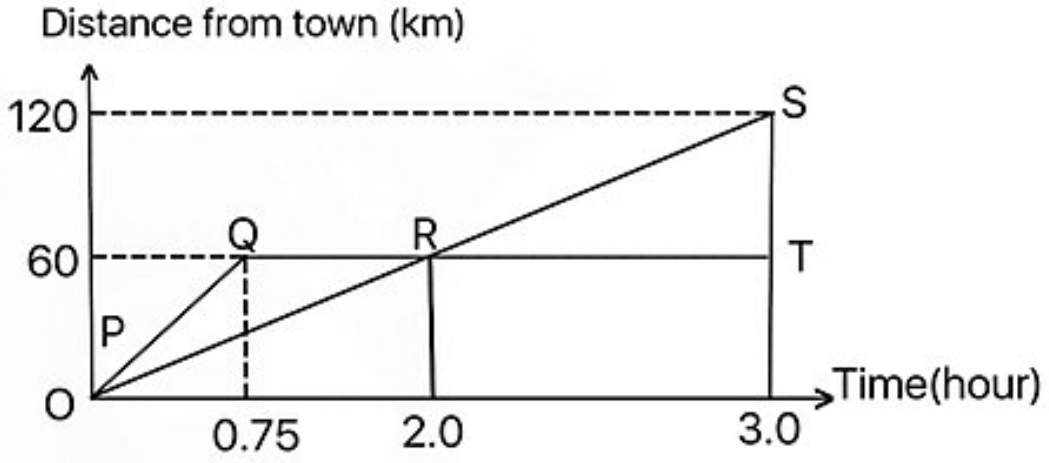


Diagram 2

(a)State the length of time,in hours,during which the lorry is stationary.

(b)Calculate the speed,in km h^{-1},of the lorry,in the first 45 minutes of the journey.

(c)At a certain instant during the journey,both vehicles are at the same location.

(i)Calculate the distance,in km,between that location and the town.

(ii)State the time taken by the van to reach that location from the town.

Distance-Time Graphs and Velocity-Time Graphs:

Distance time graphs for Stoplearn.com

The Concept of Acceleration

When an object increases or changes its velocity within a set time, the object is said to undergo acceleration (or to accelerate). **We therefore define acceleration as the rate of change of velocity with time.**

Acceleration=Change in VelocityTime takena=v–ut

Where a: acceleration

v: final velocity

u: initial velocity

Acceleration is a vector quantity and its SI unit is m/s2

However, be reminded that:

(i) When a body starts from rest, its initial velocity, ‘u’ is zero.

(ii) When a body comes to rest, its final velocity, ‘v’ is zero.

Uniform and Non-uniform Acceleration

Acceleration is said to be uniform if the velocity increases by equal amounts in equal intervals of time. That is, the time rate of change of velocity is constant. If the rate of change of velocity with time is not constant, then, the acceleration is non-uniform.

Deceleration

Deceleration is defined as a negative change in velocity with time. When such happens, the body’s velocity is said to be reducing or coming to rest.

Deceleration is said to be uniform if the velocity decreases by equal amounts in equal intervals of time. That is, the negative change in velocity with time is constant.

Also, Deceleration=Change in VelocityTime taken=v–ut

Deceleration is also called retardation and its SI unit is m/s^2. It is also a vector quantity.

EVALUATION

1. Define acceleration.
2. Differentiate between acceleration and deceleration.
3. Quote the formula for acceleration and its SI unit.

Worked Examples on Acceleration and Deceleration

Example 1: A body experienced a change in velocity of 10m/s in 15s. What is the acceleration of the body?

Solution:

Data: $\Delta v = 10m/s$, $t = 15s$, $a = ?$

Now, $a=\Delta v\Delta t=1015=0.67m/s2$

Example 2: A car accelerated uniformly at $6m/s^2$ in 20s. What was the change in velocity?

Solution:

Data: $a = 6m/s^2$, $t = 20s$, $\Delta v = ?$

Now, $a=\Delta v\Delta t\Delta v=a\times\Delta t\Delta v=6\times20\Delta v=120m/s$

Example 3: The velocity of a lorry decreased from 60km/h to 35km/h within 0.5mins. Find the deceleration.

Solution:

Data: $u=60kmh=60\times100060\times60=60003600=16.67m/s, v=35km/h=9.72m/s, t=0.5mins=30s, d=?$

Now, $d=\Delta v\Delta t=v–ut=9.72–16.6730=–6.9530d=–0.23m/s2$

The negative sign shows that it is decelerating thus coming to rest.

(NOTE: you can convert velocity in km/h to m/s by simply dividing by **3.6**)