2. Speed and velocity

Body at rest

When a body does not change its position, with respect to its surroundings, it is said to be at rest.

Body at motion

When a body changes its position, with respect to its surroundings, it is said to be in motion. The motion may be linear if the body moves in a straight line or it may be circular when it moves in a curved path.

Types of quantities

All physical quantities are classified into two types. They are

1 Scalar quantity

2 Vector quantity

1 Scalar quantity

1 Scalar quantity

A physical quantity having magnitude only is called scalar quantity. They have a numerical value only and these quantities do not specify the direction. It is represented by straight line.

E.g:

Length of a rod = 40 metre
Time taken = 3 hours
Speed of car = 60 km/hr

2 Vector quantity

A physical quantity having both magnitude and direction is called vector quantities. It is represented by a straight line with an arrow head.

E.g: Displacement, Velocity, Acceleration, Force

Terms relating to motion

Displacement

When a body is in motion from one place to another, the displacement is the distance from the starting position to the final position.

Speed

Speed

The speed is defined as the rate of change of distance. It is the distance travelled by an object in a certain time interval.

Speed = Distance travelled/Time taken

The unit of speed in the SI system is metre/second. For greater speed it is km/hr and for lesser speed it is cm/s. Speed is a scalar quantity having only magnitude.

Uniform speed

If a moving body covers equal distances in equal intervals of time, it is said to have uniform speed.

Variable speed

If a moving body travels unequal distances in equal intervals of time, it is said to have variable speed.

Average speed

The ratio between total distance travelled by a body and time taken for it, is called average speed.

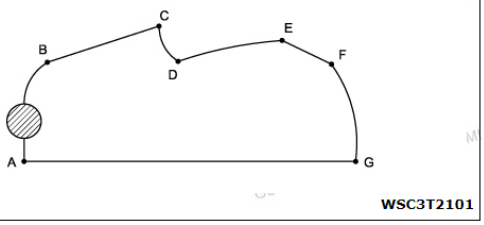
Displacement (Fig 1)

The distance travelled between the starting position to the final position of a moving body is called displacement. It is a vector quantity. In SI system its unit is metre.

Displacement = Velocity x Time

Fig 1

Fig 1



A B C D E F G Path of the body

A+ B+C+D+E+F+G=distance covered by the body

A G=Straight line distance - displacement

Velocity

It is the rate of change of displacement of a body in motion in a given direction. It is a vector quantity and can be represented both in magnitude and direction by a straight line. Velocity may be linear or angular. The unit of linearvelocity is metre/sec,Velocity =

$$\frac{S}{t} = \frac{\text{Displacement}}{\text{Time}}$$

Unit = m/s, km/Hr,mile/Hr.

Unit = m/s, km/Hr,mile/Hr.

Difference between speed & velocity-Annexure III

Speed	Velocity
The rate of change place of an object	The speed in a definite direction is called velocity
In the speed, direction is not indicated. only the magnitude is expressed.	Both the magnitude and direction are expressed.
$\text{Speed} = \frac{\text{Distance covered}}{\text{Time}}$	$\text{Velocity} = \frac{\text{Distance in definite direction}}{\text{Time}}$

Acceleration

Rate of change of velocity is known as acceleration or it is the change of velocity in unit time. Its unit is metre/sec^2. It is a vector quantity.

$$a = \frac{\text{change in velocity}}{\text{Time}}$$

unit = m/s^2

u = Initial velocity	= m/sec
v = Final velocity	= m/sec
s = Distance	= m
t = Time	= second
a = Acceleration	= m/s^2
R = Retardation	= m/s^2

Equations of motion

Then v = u + at

$s = ut + \frac{1}{2}$ at^2 and = $v^2 - u^2 = 2as$

Retardation

When the body has its initial velocity smaller than its final velocity it is said to be in acceleration. When the final velocity is smaller than the initial velocity the body is said to be in retardation. Then the three equation of motion will be in acceleration. When the final velocity is smaller than the initial velocity the body is said to be in retardation. Then the three equation of motion will be

$v = u - at$; $s = ut - at^2$; $u^2 - v^2 = 2as$

Derivation of the equations

(i) Acceleration $(a) = \frac{v - u}{t}$ m/sec^2

$at = v - u$

$\boxed{v = u + at}$ ..... equation 1

(ii) Average velocity $= \frac{\text{Distance travelled}}{\text{Time taken}}$

$\frac{u+v}{2} = \frac{s}{t} = 2s = t(u + v)$

$s = (u + v)\frac{t}{2}$

$s = (u + u + at)\frac{t}{2}$

Substitute the value of 'v' in equation 1.

$s = (u + u + at)\frac{t}{2}$

$\boxed{= (2u + at)\frac{t}{2}}$ ..... equation 2

$s = ut + \frac{1}{2}at^2$

(iii) v=u+a t [Taking square on both sides]

$v^2 = (u + at)^2 \left[(a+b)^2 = a^2 + 2ab + b^2\right]$

$= u^2 + 2uat + a^2t^2$

$= u^2 + 2a\left(ut + \frac{1}{2}at^2\right)$

Equation can be obtained by substituting

$S = ut + \frac{1}{2}at^2$

$\boxed{v^2 = u^2 + 2as}$ ..... equation 3

(i) $v = u + at$

(ii) $s = ut + \frac{1}{2}at^2$

(iii) $v^2 = u^2 + 2as$

The distance travelled by the object after 'n' seconds.

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

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

If displacement of the object (s) is asked then use the following formula to solve it, provided data for u, v, t is given.

(iv) $s = \frac{u+v}{2} x\, t$

Gravitational force

The force which attracts all the objects to the centre of the earth with a uniform acceleration is called gravitational force.

Acceleration due to gravity

When an object thrown vertically upward against the force of gravity, its velocity is decreasing and then to zero. After that the velocity of a freely falling object under gravity increases at a constant rate. It is said to accelerate. This acceleration produced in an object on account of the force of gravity is called acceleration due to gravity. It is denoted by "g". Value of g=9.81 m/sec^2 (SI system)

The value of 'g' is high in polar areas (9.83m/sec2) and less in equator areas (9.78m/sec2).

At a given place, the value of 'g' is the same for all bodies irrespective of their masses. So, in motion equation it is assumed that a = g.

$$v = u + gt$$

$$s = ut + \frac{1}{2}gt^2$$

$$V^2 - u^2 + 2gs$$

An object thrown vertically upwards, against the force of gravity has negative acceleration.

$\therefore a = -g$

Height obtained by the object when it is thrown up vertically $\Big\}$ $h = \frac{u^2}{2g}$

Newton's Laws of Motion

Equations of motions under gravity

Upward	Downward
$v = u - gt$	$v = u + gt$
$s = ut - \frac{1}{2}gt^2$	$s = ut + \frac{1}{2}gt^2$
$V^2 - u^2 = 2gs$	$V^2 - u^2 = 2gs$

Motion under gravity

$V^2 - u^2 = 2gs$ $\qquad$ $V^2 - u^2 = 2gs$

Motion under gravity

A body falling from a height, from rest, has its velocity goes on increasing and it will be maximum when it hits the ground. Therefore a body falling freely under gravity has a uniform acceleration. When the motion is upward, the body is subjected to a gravitational retardation. The acceleration due to gravity is denoted with 'g'.

Momentum

It is the quantity of motion possessed by a body and is equal to the product of its mass, and the velocity with which it is moving. Unit of momentum will be kg metre/sec. Momentum = mass x velocity

Newton's laws

First law

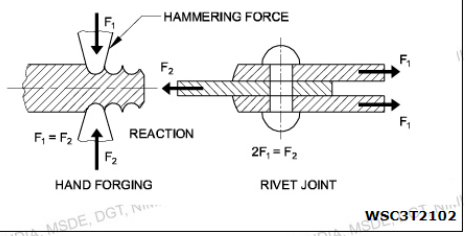
Every body continues to be in a state of rest or of uniform motion in a straight line unless it is compelled to change that state of rest or of uniform motion by some external force acting upon it.

Second law

The rate of change of momentum of a moving body is directly proportional to

In the rivet joint equal forces act on the strap and they opposite force F^2. (Fig 2)

Fig 2



Law of conservation of momentum

When two moving bodies have an intentional or unintentional impact, then sum of the momentum of the bodies before impact = sum of the momentum after impact, or the change in momentum after the impact is zero.

m_1 - mass of one body and

v_1 - velocity with which it moves

m_2 - mass of second body

v_2 - velocity with which it moves

m_2 - mass of second body

v_2 - velocity with which it moves

Momentum = m x v= mass of the body x its velocity
Rate of change of momentum = force acting on the body

$$m = \left(\frac{(V - u)}{t}\right) = F$$

force = mass x acceleration

Momentum of two bodies before impact = momentum after impact

$m_1 \times v_1 + m_2 \times v_2 = (m_1 + m_2)V$

Circular or Angular motion (Fig 3)

When a body rotates about an axis, it is said to have angular motion or circular motion.

Example

In circular motion bodies (like shafts, axles, gear-wheels, pulleys, flywheels, grinding wheels) turn with constant speed around its axis.

Second law

The rate of change of momentum of a moving body is directly proportional to the external force acting upon it and takes place in the direction of the force.

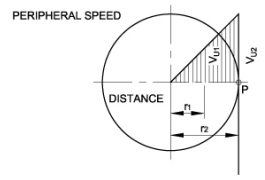
Third law

To every action there is always an equal and opposite reaction.

In circular motion bodies (like shafts, axles, gear-wheels, pulleys, flywheels, grinding wheels) turn with constant speed around its axis.

The angular of circular motion is also called Angular velocity or Peripheral speed.
Expressed in Metre/sec or Radians per second.

Fig 3



CIRCULAR MOTION

WSC3T2103

1. A trains covers a distance of 2000 km in 40 hour. Find the average speed of the trains.

Distance covered by the train = 2000 km

Time taken = 40 hrs

$$\text{Average speed} = \frac{\text{Total Distance Covered}}{\text{Total time taken}} = \frac{2000}{40}$$

$$= 50 \text{ km/hr}$$

2. A train is moving at a speed of 40 Kmph. It reaches a destination in 10 minute. What is the distance covered by the train?

Speed of train = 40 Km / hour

Time taken = 10 minute

If the distance covered in 60 minute = 40 Km, then

$$\therefore \text{Distance covered in 10 minute} = \frac{40}{60} \times 10 = 6.66 \text{ Km}$$

3. If average speed of a train is 16.66 m/sec. Find out the time taken by the train to travel distance of 60 Km between two stations.
4. A vehicle travels for the first 5 minute at 30 Km per hour and for the next 40 minute at 60 km per hour and finally for 15 minute at 40 km per hour. Find the average speed of the vehicle and the distance covered in first 30 minute.

Speed in first 5 minutes = 30 Km/hour

$$\text{Distance covered} = 30 \times \frac{5}{60} = 2.5\text{Km}$$

Speed in next 40 minute = 60 Km/hour

Total time taken = 5+40+15 = 60 minute; = 1 hour

Total distance covered = 2.5 +40 +10 = 52.5 Km.

$$\text{Average speed} = \frac{\text{Distance travelled}}{\text{Time}}$$

$$= \frac{52.5}{1} = 52.5 \text{ Km / hour}$$

To find the distance covered in first 30 minute

Distance covered in first 5 minute = 2.5 Km

$$\text{Distance covered in next 25 minute} = 60 \times \frac{25}{60} = 25\text{Km}$$

Distance covered in first 30 minute = 2.5+25 = 27.5 Km

5. A 80 metre long train passes a railway bridge of 120 metre length in 20 second. Find speed of the train.

Length of the train = 80 metre

Length of the bridge= 120 metre

6. A train 1200 metre long running at 36 km/hrcrosses another train 1200 metre long running at 48 Km/hr in opposite direction. Find the time in which they cross each other.

2. A train is moving at a speed of 40 Kmph. It reaches a destination in 10 minute. What is the distance covered by the train?

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Speed in first 5 minutes = 30 Km/hour

Distance covered = $30 \times \frac{5}{60} = 2.5$Km

Speed in next 40 minute = 60 Km/hour

Distance covered = $60 \times \frac{40}{60} = 40$ Km

Speed in next 15 minute = 40 Km/hour

Distance covered = $40 \times \frac{15}{60} = 10$ Km

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Speed in first 5 minutes = 30 Km/hour

Distance covered = $30 \times \frac{5}{60} = 2.5$Km

Speed in next 40 minute = 60 Km/hour

Distance covered = $60 \times \frac{40}{60} = 40$ Km

Speed in next 15 minute = 40 Km/hour

Distance covered = $40 \times \frac{15}{60} = 10$ Km

Distance covered in first 5 minute = 2.5 Km

Distance covered in next 25 minute= $60 \times \frac{25}{60} = 25$Km

Distance covered in first 30 minute = 2.5+25 = 27.5 Km

5. A 80 metre long train passes a railway bridge of 120 metre length in 20 second. Find speed of the train.

Length of the train = 80 metre

Length of the bridge= 120 metre

6. A train 1200 metre long running at 36 km/hrcrosses another train 1200 metre long running at 48 Km/hr in opposite direction. Find the time in which they cross each other.

Distance covered in first 5 minute = 2.5 Km

Distance covered in next 25 minute= $60 \times \frac{25}{60} = 25$Km

Distance covered in first 30 minute = 2.5+25 = 27.5 Km

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Length of the train = 80 metre

Length of the bridge= 120 metre

6. A train 1200 metre long running at 36 km/hrcrosses another train 1200 metre long running at 48 Km/hr in opposite direction. Find the time in which they cross each other.

7. A train moving at a speed of 40 km/hr accelerated to 80 km/hr in 20 seconds. Find the rate of acceleration.

Initial velocity (u) = 40 Km/hour

$= \frac{40000}{3600} = 11.11$m/sec

Final velocity (v) = 80 Km/hour

$= \frac{80000}{3600} = 22.22$ m/sec

Time (t) = 20 second

Acceleration (a) = $\frac{v - u}{t}$ m/sec^2

$= \frac{22.22 - 11.11}{20} = \frac{11.11}{20} = 0.556$ m/sec^2

8. A motor car running with a speed of 36km/hour is made to stop in 10 second. What is the retardation in metre/sec^2 and km/hour^2?

Initial velocity (u)=36Km / hour

$a = \frac{v - u}{t}$ m/s^2

$= \frac{65 - 20}{6}$ m/s^2

$= \frac{45}{6}$ m/s^2 $= 7.5$ m/s^2

10. If the speed of a car is increased from 25 kmph to40 kmph in 1 min, find the acceleration.

11. A train starting from rest picks up a velocity of 36kmph in 20 second. What is its acceleration?

8. A motor car running with a speed of 36km/hour is made to stop in 10 second. What is the retardation in metre/sec^2 and km/hour^2?

Initial velocity (u)=36Km / hour

$$= \frac{36000}{3600} = 10\,m/sec$$

Final velocity (v) = 0

Time (t) = 10 second

Acceleration (a) = $\frac{v - u}{t}$

$$= \frac{0 - 10}{10} = -\frac{10}{10}$$

$$= -1 m/sec^2$$

Acceleration in km/hour^2 = $\frac{v - u}{t}$

$$= \frac{0 - 36}{\frac{10}{3600}} = -\frac{36 \times 3600}{10}$$

$$= -12960\ Km/hour^2$$

Retardation (-a) = 1m/sec^2; 12960 Km/hour^2

9. A car changes its velocity from 20m/sec to 65 m/sec in 6 seconds find the acceleration.

u=20 m/sec; v=65 m/sec; t=6 sec

12. By applying the brakes the velocity of a car decreases from 80 kmph to 36 kmph in 1/2 min. Calculate the retardation.

$$u = 80 \text{ kmph} = 80 \times \frac{5}{18} m/s = \frac{200}{9} m/s$$

$$v = 36 \text{ kmph} = 36 \times \frac{5}{18} m/s = 10\,m/s$$

$$t = \frac{1}{2} min = \frac{1}{2} \times 60 sec = 30 sec.$$

$$a = \frac{v - u}{t} m/s^2$$

$$= \frac{10 - \frac{200}{9}}{30} m/s^2$$

$$= \frac{\frac{90 - 200}{9}}{30} m/s^2$$

$$= \frac{-110}{9} \times \frac{1}{30} m/s^2$$

$$\therefore \text{Retardation } R = 0.4074\ m/s^2$$

13. A body with initial velocity of 12 metre / secondwith an acceleration of 10m/sec^2. How much distance will it cover in 6 second?

$$a = \frac{v - u}{t} m/s^2$$

$$= \frac{\frac{200}{18} - \frac{125}{18}}{60} m/s^2$$

$$= \frac{200 - 125}{\frac{18}{60}} m/s^2$$

$$= \frac{75}{\frac{18}{60}} m/s^2$$

$$= \frac{75}{18} \times \frac{1}{60} m/s^2 = 0.06944\ m/s^2$$

11. A train starting from rest picks up a velocity of 36kmph in 20 second. What is its acceleration?

u = 0

v = 36 kmph

$$= 36 \times \frac{5}{18} = 10\,m/s$$

t = 20 sec

$$a = \frac{v - u}{t} m/s^2$$

v = $\sqrt{1100}$ = 33.17m/sec

v = u+a t

$$t = \frac{v - u}{a} = \frac{33.17 - 30}{0.1} = \frac{3.17}{0.1}$$

Time taken = 31.7 second

15. An aeroplane is taking off from landing field has arun of 600 metre. What is its acceleration, if it leaves the ground in 5 second from the start?

Initial velocity (u) = 0

Distance travelled (s) = 600 m

Time (t) = 5 second

To find acceleration (a).s = $ut + \frac{1}{2} a t^2$

$$600 = 0 \times 5 + \frac{1}{2} \times a \times 5 \times 5$$

$$600 = 0 + 12.5a$$

$$a = \frac{600}{12.5}$$

Acceleration (a) = 48 m/sec^2

13. A body with initial velocity of 12 metre / secondwith an acceleration of 10m/sec^2. How much distance will it cover in 6 second?

Initial velocity (u) = 12m/sec

Acceleration (a) = 10m/sec^2

Time (t) = 6 second

$$s = ut + \frac{1}{2} a t^2$$

$$= 12 \times 6 + \frac{1}{2} \times 10 \times 6 \times 6$$

$$= 72 + 180 = 252 \text{ m}$$

14. The initial velocity of a body is 30 m/sec andacceleration 0.1 m/sec^2. How long the body will take to cover a distance of 1000m?

Initial velocity (u) = 30 m/sec

Acceleration (a) = 0.1 m/sec^2

Distance to be covered (s) 1000 m

To find the final velocity $v^2 = u^2 + 2as$

$= 30^2 + 2 \times 0.1 \times 1000$

$= 900 + 200$

$v^2 = 1100$

Acceleration (a) = 48 m/sec^2

16. A body starts from rest with an acceleration of 5cm/sec^2. Calculate the distance travelled in 5 second. Also calculate the velocity after travelling a distance of 50 cm.

Initial velocity (u) = 0

Acceleration (a) = 5 cm/sec^2

Time (t) = 5 second

Distance travelled in 5 sec (s) $= ut + \frac{1}{2} a t^2$

$$= 0 \times 5 + \frac{1}{2} \times 5 \times 5 \times 5 = 0 + 62.5\text{cm}$$

$= 62.5$cm

Velocity after travelling a distance of 50cm

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

$= 0^2 + 2 \times 5 \times 50$

$v^2 = 500$

$v = \sqrt{500}$; V= 22.36 cm/sec

17. A train running at velocity of 20 metre/sec, after applying the brakes train stop in 6 second. Calculate the distance covered after applying the brakes.

Initial velocity (u) = 20m/sec

Final velocity (v) = 0m/sec

Time (t) = 6 second

Distance travelled (s) $= \frac{u+v}{2} \times t$

$$= \frac{20+0}{2} \times 6 = \frac{20}{2} \times 6 = 60\text{m}$$

18. If a train attains a speed of 40 km/hr and stops after travelling 200 metre. Calculate the acceleration, is the acceleration is positive or negative.

Initial velocity (u) = 40 km/hour

$$= \frac{40000}{3600} = 11.11\text{m/sec}$$

Final velocity (v) = 0m/sec

Distance travelled (s) = 200m

Acceleration

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

$0 = 11.11^2 + 2a \times 200$

$0 = 123.43 + 400a$

$a = -\frac{123.43}{} = -0.309$ m/sec^2

20. A motor car starting from rest travels a distance of 240 feet in 8 second. Find its acceleration

u = 0 m/s

s = 240 feet

t = 8 second

$s = ut + \frac{1}{2} a t^2$

$240 = (0)(8) + \frac{1}{2}(a) \times 8 \times 8$

$\therefore a = \frac{240}{32} = 7.5$ feet / s^2

21. A body has an initial velocity of 15 m/s and moveswith an accleration of 12 m/s. Find how long will it take to travel 7.5 km.

u = 15 m/s; a = 12 m/s; s = 7.5 km; t = ?

$v^2 = u^2 + 2as = 15^2 + 2 \times 12 \times 7500$

$= 225 + 180000 = 180225$

$v = \sqrt{180225} = 425.5$ m/s

$v = u + at$

$\therefore t = \frac{v-u}{a}$ second

$0 = 123.43 + 400a$

$a = -\frac{123.43}{400} = -0.309 \text{ m/sec}^2$

Ans: The acceleration is negative.

19. A body starts at an initial velocity of 10 m/s and travels with an uniform acceleration of 4 m/s. Calculate the distance travelled at the end of 5th second.

$u = 10 \text{ m/s}$
$a = 4 \text{ m/s}^2$
$t = 5 \text{ second}$
$v = u + a\,t$
$= 10 + 4 \times 5m = 30m$

$s = ut + \frac{1}{2} a\,t2$

$= 10 \times 5 + \frac{1}{2} \times 4 \times 5 \times 5$

$= 50 + 50 = 100m$

on the road 30 metre ahead. He immediately applied the brake to stop the car with in 5 m of the child. Find the retardation and the time taken to stop the car.

$u = 60 \text{ kmph}$

$= 60 \times \frac{5}{18} = \frac{50}{3} \text{m/s}$

$v = 0$

$s = 30m - 5m = 25m$

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

$(0)^2 = \left(\frac{50}{3}\right)^2 + 2 \times a \times 25$

$0 = \frac{2500}{9} \times 50a$

$-50a = \frac{2500}{9}$

$-a = \frac{2500}{9} \times \frac{1}{50} = 5.556 \text{ m/s}^2$

or $R = 5.556 \text{ m/s}^2$

24. A body falls freely from a height of 100m. Find the time taken by it to reach the ground and the velocity when it strikes the ground.

(i) $v^2 = u^2 + 2gs$

$= (0) + 2 \times 9.8 \times 100 = 1960$

$\therefore t = \frac{v - u}{a}$ second

$= \frac{424.5 - 15}{12} = \frac{409.5}{12} = 34.125 \text{ m/s}$

22. A body moving with a velocity of 30 m/s accelerates uniformly at the rate of 5 m/s^2. Calculate the distance travelled when the velocity reaches 45 m/s and also the time taken to cover this distance.

$u=30 \text{ m/s}; \quad a=5m/s^2; \quad v=45 \text{ m/s}; \quad S=?; \quad t=?$

$u^2 + 2aS = v^2$

$30^2 + 2 \times 5 \times S = 45^2$

$2 \times 5 \times S = 45^2 - 30^2$

$10S = 1125$

$S = \frac{1125}{10} = 112.5 \text{ m}$

$u + at = v$

$30 + 5t = 45$

$5t = 45 - 30 = 15$

$t = 3 \text{ second}$

23. A person driving a light car at 60 kmph finds a child

26. A body is thrown vertically upwards and raises to a height of 10m. Calculate (a) the velocity with which the body was thrown upwards. (b) the time taken by the body to reach the highest point

a) $V^2 = u^2 - 2gs$

$0^2 = u^2 - 2x9.8x10$

$u^2 = 2 \times 9.8 \times 10$

$u^2 = 1960$

$u = \sqrt{1960} = 44.27 \text{ m/s}$

b) $V = u - gt$

$0 = 14 - 9.8\,t$

$9.8\,t = 14$

$t = 14/9.8 \text{ s}$

$t = 1.429 \text{ s}$

27. A stone is dropped from the top of tower 19.6 m high. What will be its velocity on striking the ground. taking g=9.8 m/sec^2?

Initial velocity (u) = 0

Height (h) = 19.6m

Acceleration due to gravity (g) = 9.8 m/sec2

Velocity of the stone on striking the ground (Downward velocity)

24. A body falls freely from a height of 100m. Find the time taken by it to reach the ground and the velocity when it strikes the ground.

(i) $v^2 = u^2 + 2gs$

$= (0) + 2 \times 9.8 \times 100 = 1960$

$v = \sqrt{1960} = 44.27$ m/s

(ii) $v = u + gt$

$44.27 = 0 + 9.8\ t$

$t = \frac{44.27}{9.8}$ s

$= 4.5178$ s.

25. A ball is dropped from a tower. It reaches the ground in one second. Find the height of the towers.

$s = ut + \frac{1}{2} gt^2$

$= 0 \times 1 + \frac{1}{2} \times 9.8 \times 12$

$s = 58.8$ m.

Height (h) = 19.6m

Acceleration due to gravity (g) = 9.8 m/sec2

Velocity of the stone on striking the ground (Downward velocity)

$= \sqrt{2gh} = \sqrt{2 \times 9.8 \times 19.6}$

Velocity (v) = 19.6 m/sec

28. A ball is dropped from a height of 30m. How much time will it take to reach the ground?

Initial velocity (u) = 0m/sec

Height (h) = 30m

Distance travelled (s) $= ut + \frac{1}{2} gt^2$

$30 = 0 \times t + \frac{1}{2} \times 9.8 \times t^2$

$30 = 4.9\ t^2$

$t^2 = \frac{30}{4.9} = \frac{300}{49}$

$t = \frac{\sqrt{300}}{\sqrt{49}} = \frac{17.32}{7}$

Time (t) = 2.474 second

29. A solid sphere is dropped from the top of a tower takes 4 second to reach the ground. Find the height of the tower.

Initial velocity (u) = 0

Time (t) = 4 second

Height (h) $= ut + \frac{1}{2} gt^2$

$= 0 \times 4 + \frac{1}{2} \times 9.8 \times 4 \times 4$

$= 0 + 78.4$

Height (h) = 78.4 m

30. The body falls freely under the influence of gravity from a height of 200m. Find out the time taken for it to reach the ground and its velocity when it strikes the ground.

Initial velocity (u) = 0

Height (h) = 200m

Acceleration due to gravity (g) = 9.8 m/sec^2

To find final velocity (v) $= \sqrt{2gh}$

$= \sqrt{2 \times 9.8 \times 200}$

$= \sqrt{3920}$

32. A stone is thrown upward with an intial velocity of 20 metre per second. What will be the velocity of the stone when it reaches at the height of 10 metre?

Initial velocity (u) = 20 m/sec

Height (h) = 10 m

To find the velocity of the stone when it reaches at the height of 10m

$v^2 = u^2 - 2gh$

$= 20^2 - 2 \times 9.8 \times 10$

$= 400 - 196$

$v^2 = 204$

$v = 204$

$v = 14.283$ m/sec

33. A ball was thrown vertically upwards from the ground. It went up to height of 5 metre and then came down to the ground. How long was it in the air?

When the ball travels in the upward direction

Final velocity (v) = 0

Height (h) = 5 m

Acceleration due to gravity (g) = 9.8 m/sec^2

To find the initial velocity (u) = $\sqrt{2gh}$

To find final velocity (v) $= \sqrt{2gh}$

$= \sqrt{2 \times 9.8 \times 200}$

$= \sqrt{3920}$

$v = 62.61$ m/sec

To find the time taken to reach the ground

$v = u+g\,t$

$62.61 = 0+9.8t$

31. A body is thrown upwards with a velocity of 20 metre per second. If the value of g is 10 m/sec2. What maximum height will it reach?

Initial velocity (u) = 20 m/sec

Final velocity (v) = 0

Acceleration due to gravity (g) = 10 m/sec^2

$$h = \frac{u^2}{2g} = \frac{20 \times 20}{2 \times 10} = \frac{400}{20}$$

Height (h) = 20 m

Height (h) = 5 m

Acceleration due to gravity (g) = 9.8 m/sec^2

To find the initial velocity (u) = $\sqrt{2gh}$

$= \sqrt{2 \times 9.8 \times 5} = \sqrt{98}$

$u = 9.9$ m/sec

To find the travel time for upward direction

$$t = \frac{u}{g} = \frac{9.9}{9.8} = 1 \text{second}$$

$$\begin{pmatrix}\text{Travel time for}\\ \text{upward direction}\end{pmatrix} = \begin{pmatrix}\text{Travel time for}\\ \text{downward direction}\end{pmatrix}$$

To total time (The ball in the air) 1 + 1 = 2 second.

Assignment

1. A train is moving with a speed of 72 kmph, reaches a destination in 2 minutes. What is the distance covered by the train?
2. A train is running at a speed of 30 kmph. Find its speed in metre per second and also distance it will cover in four hour in metre.
3. A 0.1 km long train is running at a speed of 90 km/hr. Find out the time taken by the train in crossing 200 metre long bridge.
4. How much time a train will take to cover 60 km distance between the two stations. If its average speed is 20 m/ sec?
5. A cyclist cover a distance of 15 km at 5 km/hr and next 25 km at 8 km/hr. If he returns the whole distance with a speed of 6 km/hr, find the difference in time taken in forward and reverse journey.
6. Dia. of a bus wheel is 1000 mm. The speed of wheel is 424 rpm/minute. Find out the speed of bus per hour.
7. A body covers a straight distance of 100m in 13.5 sec. What is the velocity?
8. If a car at 40 kmph accelerates and attains a speed of 100 kmph in 6 sec. Calculate the acceleration.
9. A train starting from rest picks up a velocity of 50 kmph in 15 second. What is the acceleration?
18. A car starts from rest with an acceleration of 15 cm/ sec^2. In how much time its velocity will be 45 cm/ second?
19. A car runs 5 m/sec^2 at constant acceleration. It covers 100 metre in 10 second. Find the initial velocity of car.
20. A train is moving with a uniform velocity of 50 metre per second. After seeing the station, the driver applies brake and the train stops after 10 second. What is the retardation?
21. A vehicle starts with a velocity of 20 m/sec. If it is accelerated with 5 m/sec^2 then find out the distance covered after 10 second.
22. An aeroplane is taking off from a landing field has a run of 700 metre. What is the acceleration if it leaves the ground in 10 seconds from the start?
23. A vehicle accelerates steadily from 8 km/hr to 24 km/ hr in 4 second. Find out the acceleration and the distance travelled during this period.
24. A body has an initial velocity of 15 metre per second and moves with an acceleration of 12 metre per sec^2. Find how long will it take to travel 7.5 km.
25. A car moving along a highway with a speed of 126 km per hour is brought to rest with in a distance of 200 metre. How long (time) does it take for the car to stop?

9. A train starting from rest picks up a velocity of 50 kmph in 15 second. What is the acceleration?

10. A bus starting from rest picks up a velocity of 40 kmph in 20 seconds. What is the acceleration of the bus?

11. A car is running at 30 kmph. If it takes 30 seconds to halt by applying brakes then find out the retardation.

12. A train moving at 72 kmph shuts off steam and is brought to rest in 1/6 min. Calculate the retardation.

13. A car running at 81 kmph is brought to rest by applying the brakes which cause a retardation of 5 m/s^2. Calculate the time taken.

14. If the initial velocity of a car is zero and after 15 second last velocity is 60 km/hour. Find out the acceleration.

15. The speed of a car has increased from 25 kmph to 40 kmph in one minute. Find its acceleration.

16. A bus starting from rest picks up a velocity 40 kmph in 20 second. What is the acceleration of the bus?

17. If initial velocity of a car is 15 km/hr and its final velocity after 30 second is 60 km/hr. Find the acceleration.

25. A car moving along a highway with a speed of 126 km per hour is brought to rest with in a distance of 200 metre. How long (time) does it take for the car to stop?

26. A train moving with a velocity of 15 m/sec is uniformly retarded by applying brakes. It comes to stop after travelling in 3 second. Calculate the distance travelled after the brake is applied.

27. A train starts from rest and travels a distance of 5 km at a uniform velocity of 30 kmph. Find the acceleration.

28. A vehicle accelerates steadily from 8 kmph to 24 kmph in 4 seconds. Find out the acceleration and the distance travelled during this period.

29. A body starts from rest with an acceleration of 5cm/ sec^2. Calculate the distance travelled in 5 second. Also calculate the velocity after travelling a distance of 50cm.

30. A vehicle is moving with a velocity of 20 m/s. If it is accelerated with 5 m/s2, then find out its velocity and the distance covered after 10 sec.

31. A train is travelling at 10 m/s with an acceleration of 2 m/s^2. Find the speed after travelling 5.6m and time to travel 144 m.

32. A car running at 72 kmph stops at a distance of 25m on applying brakes. Calculate the average retardation.

33. A train moving with a retardation of 6.5 m/s2 comes to rest in 12 second. Find the initial velocity and the distance travelled before coming to rest.

34. A train running with a velocity of 30 m/s comes to stop after 2 min. Give the distance travelled by the train before coming to stop and also find the retardation.

35. A train leaves a station with an initial velocity of 5 m/min and acceleration of 2 m/min^2. Calculate the distance travelled in 15 min. After the brake is applied which produces a retardation of 35 m/min^2, calculate the distance travelled before coming to rest

36. A ball is dropped from a height of 30 m. How much time it will take to reach the ground?

37. A stone is dropped from Qutabminar reaches the ground in 4 secs. Find out the height of the Qutabminar.

38. An aeroplane, taking off from a landing field, has a run of 700 mtrs. What is its acceleration if its leaves the ground in 20 seconds from the start?

39. A body falls freely under the influence of gravity from a height of 200m. Find out the time taken for it to reach the ground and its velocity when it strikes the ground.

42. A stone dropped from the top of a tower reaches the ground after 7.5 second. Find out the height of the tower. What is the height of the stone after 4 second from the time of dropping?

43. A body is thrown upwards with a velocity of 20 m/s. At what maximum high it will reach?

44. A stone thrown vertically upwards drops back on earth in 3 second. Find the maximum height attained by the stone.

45. Calculate the weight of a body of mass 10 kg. (value of g=9.8 m/sec^2)

46. A body is dropped from the top of a building. Calculate its velocity after 10 second.

47. A solid when dropped from the terrace of high rise building takes 6 second to reach the ground. Calculate the height of the building.

48. The ball is dropped from a height of 30 metre. Find the time taken to reach the ground. (Assume 'g'=9.8 m/ sec^2)

49. A body falls down from a height of 500 metre. Find out the time taken by it to reach the ground and the velocity when it touches the earth. Take g=10 m/sec^2.

50. A stone is projected upwards. It returns back after 10 second. Find the velocity which it was projected.