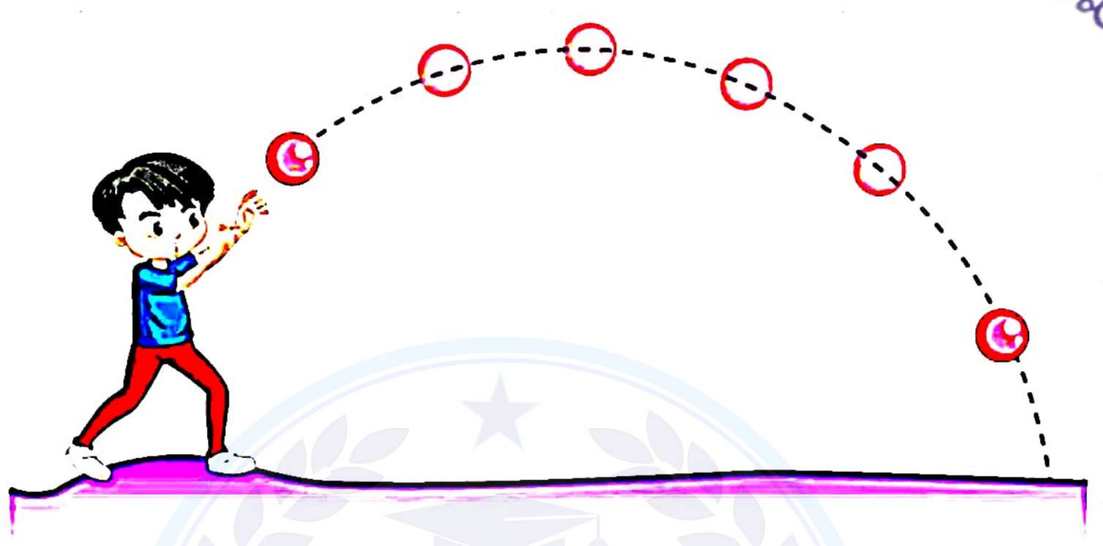
Chapter = 02

Kinematics

Q1)What is kinematics?

KINEMATICS

Kinematics is the branch of Mechanics which deals with motion of objects without reference of force which causes motion.



Q2)Define Rest and motion.

REST

A body is said to be in rest if it does not change its position with respect to its surroundings.

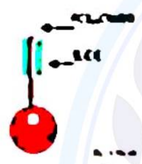
MOTION

A body is said to be in motion if it changes its position with respect to its surroundings.

Q3)Define the types of motion.

Types of Motions

	Linear Motion Motion in a straight line indefinitely.
	Rotation Motion Motion in a circle.
	Reciprocal Motion Back and forth motion.
	Oscillating Motion Oscillation is a back and forth motion about a pivot point

 Fan	 Metronome
Rotation	Oscillating
 Sewing machine needle	 Door
Reciprocating	Oscillating
 Cam & Follower	 Opening & closing a drawer
Rotation into Reciprocating	Reciprocating

TYPES OF MOTION

There are three types of motion

1. Translator motion
2. Rotatory motion
3. Vibratory motion

TRANSLATOR MOTION:

A motion in which all part of body moving in straight line is called translatory motion

EXAMPLE

Motion of car on straight road

ROTATORY MOTION

Rotatory motion can be defined as the movement of any object about an axis

EXAMPLE

Motion of blades of fan

VIBRATORY MOTION

A body moves to and fro about its mean position is called vibratory motion.

EXAMPLE

Motion of pendulum

Q4)What is linear, circular and random motion.

LINEAR MOTION

Motion of a body along a straight line is called linear motion.

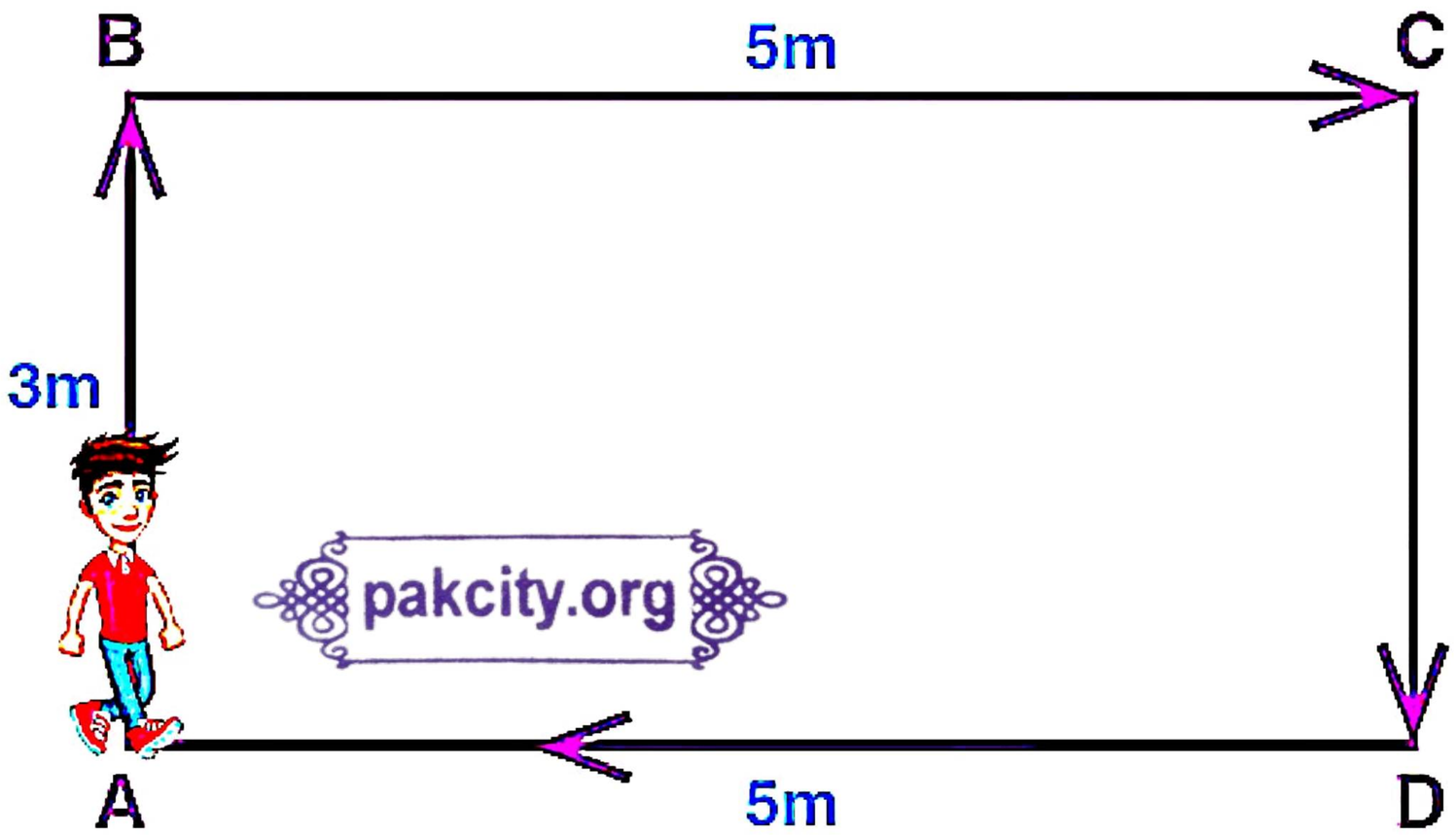
CIRCULAR MOTION

Motion of a body along a circular path is called circular motion

RANDOM MOTION

Irregular motion of an object is called random motion.

Q5)Differential between distance and displacement.



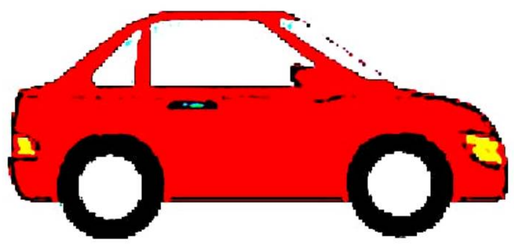
Displacement at point **A = 0**

Distance travelled at point **A = 0**

DISPLACEMENT	**DISTANCE**
Shortest straight-line distance is known as displacement	Total length in any direction is Known as distance
It symbol is $\vec{S}$	It symbol is S
It is a vector quantity	It is a scalar quantity

Q6)Differential between speed and velocity

VELOCITY	**SPEED**
Displacement covered by the body in unit time is known as velocity	Distance covered by the body in unit time is known as speed.
It formula is $\vec{V} = \frac{\vec{S}}{t}$	It formula is $V = \frac{S}{t}$
Its S.I unit is m/s.	Its S.I unit is m/s.



Velocity

Car is travelling at a speed of
60 Km/h in east direction

Q7)Define uniform speed and uniform velocity

UNIFORM SPEED

An object covers an equal distance in equal interval of time its speed is known as uniform speed.

UNIFORM VELOCITY

A body is said to have uniform velocity if it covers equal distance in equal interval of time in a particular direction.

Q8)What is acceleration? Also write its formula and unit.

ACCELERATION

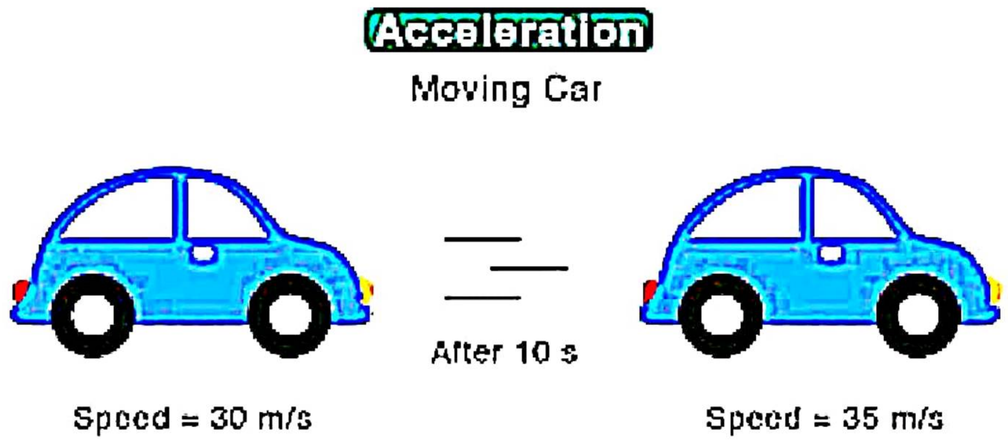
Rate of change of velocity is known as velocity.

FORMULA

$$a = \frac{vf - vi}{t}$$

UNIT

Its S.I unit is m/s^2.



Q9)What is uniform acceleration.

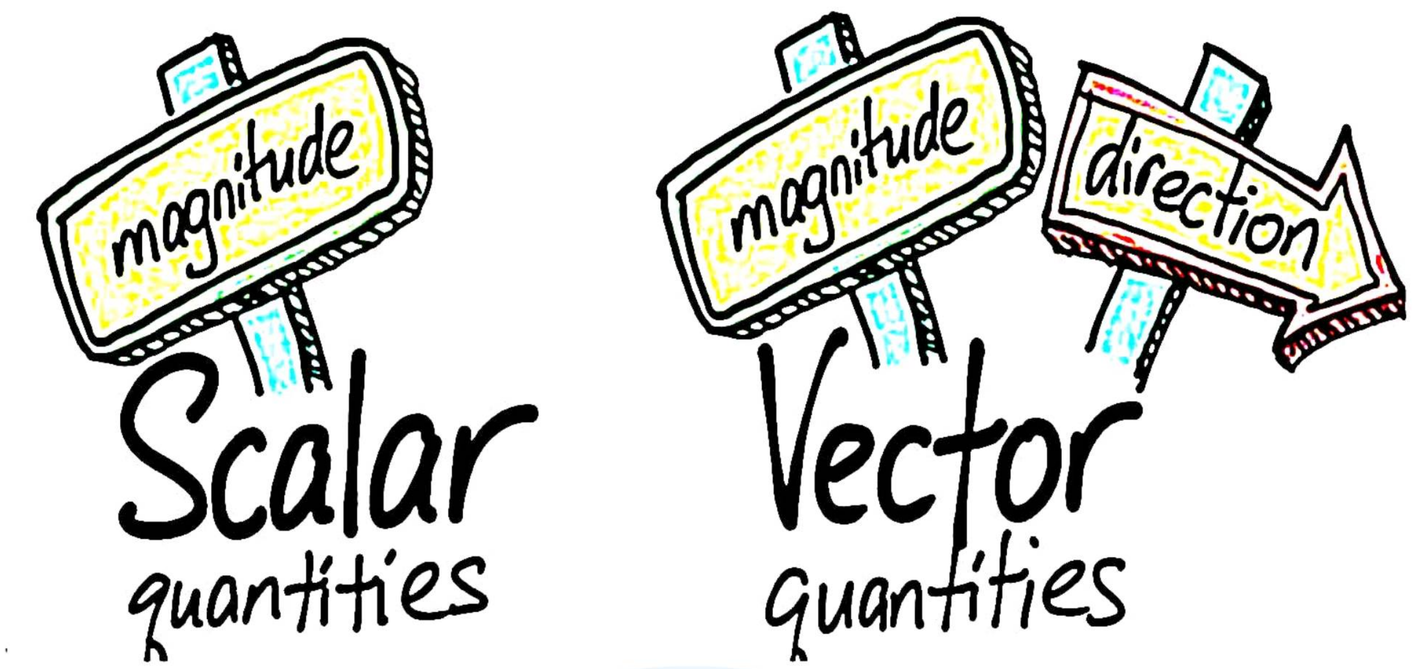
UNIFORM ACCELERATION

A constant rate of change of velocity is called uniform acceleration.

Q10) Differentiate between scalar and vector

SCALAR	VECTOR
Quantities having magnitude only are scalar quantities	Quantities having magnitude as well as direction are vector quantities
They are added or subtracted by simple arithmetic method	They are added by graphical method
Time, speed, etc are scalar quantities	Displacement, velocity, etc are vector quantities

Scalar vs Vector



Q11) Derive first equation of motion: Vf = Vi + at

Derivation

Suppose a body starts with initial velocity" Vi" after time "t" Its velocity becomes "Vf". Let the change in acceleration be "a" and distance covered by the body in this time by "S"

$$a = \frac{\Delta V}{t}$$

Since, $\Delta V = vf - vi$

$$a = \frac{vf - vi}{t}$$

$$at = vf - vi$$

$$at + vi = vf$$

Or $vf = vi + at$

Q12) Derive second equation of motion: $S = Vit + \frac{1}{2} at^2$

Derivation

Suppose a body starts with initial velocity" Vi" after time "t" Its velocity becomes "Vf". Let the change in acceleration be "a" and distance covered by the body in this time by "S"

Distance = average velocity **x** time

$$S = V_{av} \mathbf{x} t \text{ ---------- (A)}$$

$$\text{As we know that } V_{av} = \frac{Vf + Vi}{2}$$

Putting Vav in equation (A)

$$S = \frac{Vf + Vi}{2} \times t$$

By using first equation of motion and putting Vf in above

$$Vf = Vi + at$$

$$S = \frac{Vi+at+Vi}{2} \times t$$

$$S = \frac{2Vi+at}{2} \times t$$

$$S = \frac{2Vi}{2} + \frac{at}{2} \times t$$

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

Q13) Derive third equation of motion: $2aS = Vf^2 - Vi^2$

Derivation

Suppose a body starts with initial velocity" Vi" after time "t" Its velocity becomes "Vf". Let the change in acceleration be "a" and distance covered by the body in this time by "S"

Distance = average velocity **x** time

$$S = V_{av} \textbf{ x } t \text{ ----------(A)}$$

$$\text{As we know that } V_{av} = \frac{Vf + Vi}{2}$$

By using first equation of motion and separating "t"

$$Vf = Vi + at$$

$$t = \frac{Vf - Vi}{a}$$

Putting V_{av} and t in eq (A)

$$S = \frac{Vf + Vi}{2} \times \frac{Vf-Vi}{a}$$

$$S = \frac{(Vf + Vi)(Vf-Vi)}{2a}$$

$$2aS = Vf^2 - Vi^2$$

Chapter = 02

Numerical problems

Numerical # 1

A car travels 700m in 35 seconds what is the speed of car?

Data

S= 700m

t = 35sec

V = ?

Solution

$V = \frac{S}{t}$

$V = \frac{700}{35}$

V = 30 m/s

Practice of Numerical # 1

A bus travels 1210m in 55 seconds what is the speed of car?

Numerical # 2

Calculate the acceleration of a bus that speed up from $20ms^{-1}$ to $40ms^{-1}$ in 8 seconds

Data

$V_i = 20\ ms^{-1}$

$V_f = 40ms^{-1}$

t = 8 sec

a = ?

Solution

$a = \frac{vf - Vi}{t}$

$a = \frac{40 - 20}{8}$

$a = \frac{20}{8}$

$a = 2.5\ ms^{-2}$

Practice of Numerical # 2

Calculate the acceleration of a bus that speed up from $40ms^{-1}$ to $50ms^{-1}$ in 5 seconds

Numerical # 3

The speed of train is 108 kmh^{-1}. How much distance will be covered in 2 hours?

Data

V = 108kmh^{-1}

t = 2hour

S = ?

Solution

V= $\frac{S}{t}$ OR S = Vt

S = 108 x 2

S = 216 km

Practice of Numerical # 3

The speed of train is 36 kmh^{-1}. How much distance will be covered in 3 hours?

Numerical # 4

A bus is moving on a road with 15ms^{-1} and it accelerates at 5ms^{-2}. Find the final velocity of bus after 6 seconds.

Data

Vi = 15ms^{-1}

a = 5 ms^{-2}

t = 6sec

Vf = ?

Solution

Vf = Vi + at

Vf = 15 + 5x6

Vf = 15 + 30

Vf = 45 ms^{-1}

Practice of Numerical # 4

A bus is moving on a road with 25ms^{-1} and it accelerates at 8ms^{-2}. Find the final velocity of bus after 3 seconds.

Numerical # 5

A bus start from rest and travels along a straight path its velocity become 15ms^{-1} in 5 seconds. Calculate acceleration of the bus?

Data

Vi = 0(start from rest)

Vf = $15ms^{-1}$

t = 5 sec

a = ?

Solution

$$a = \frac{15 - 0}{5}$$

$$a = \frac{15}{5}$$

$a = 3\ ms^{-2}$

Practice of Numerical # 5

A bus start from rest and travels along a straight path its velocity become $18ms^{-1}$ in 3 seconds. Calculate acceleration of the bus?

Numerical # 6

A motorcyclist moving along a straight path applies brakes to slow down from $10ms^{-1}$ to $3ms^{-1}$ in 5 seconds. Calculate its acceleration.

Data

Vi = $10\ ms^{-1}$

Vf= $3\ ms^{-1}$

t = 5 sec

a = ?

Solution

$$a = \frac{3 - 10}{5}$$

$$a = \frac{-7}{5}$$

$a = 1.4\ ms^{-2}$

Practice of Numerical # 6

A motorcyclist moving along a straight path applies brakes to slow down from $14ms^{-1}$ to $7ms^{-1}$ in 4 seconds. Calculate its acceleration.

Numerical # 7

A car starts moving from rest with an acceleration of $5ms^{-2}$. Find out the time to travel 50m distance.

Data

$V_i = 0$

$a = 5ms^{-2}$

$s = 50m$

$t = ?$

Solution

$S = Vit + ½ at^2$

$50 = 0xt + ½ x5xt^2$

$50 = 2.5t^2$

$t^2 = \frac{50}{2.5}$

$t^2 = 20$

$t = \sqrt{20}$

$t = 4.47$ sec

Practice of Numerical # 7

A car starts moving from rest with an acceleration of $6ms^{-2}$. Find out the time to travel 72m distance.

Numerical # 8

A car moving on a road with velocity 30 ms^{-1}, when brakes are applied its velocity decreases at a rate of 6 meter per second square. Find the distance it will cover before coming to rest.

Data

$V_i = 30\ ms^{-1}$

$V_f = 0$

$a = 6ms^{-2}$

$S = ?$

Solution

$2aS = V_f^2 - V_i^2$

$2x6xS = 0^2 - 30^2$

$12S = 0 - 900$

$S = -\frac{900}{12}$

$S = 75$ m

Practice of Numerical # 8

A car moving on a road with velocity 20 ms^{-1}, when brakes are applied its velocity decreases at a rate of 5 meter per second square. Find the distance it will cover before coming to rest.

Numerical # 9

A motor cycle moving with velocity of 40 ms^{-1}. It gets accelerating at a rate of 8 ms^{-2} . How much distance will it cover in the next 10 seconds.

Data

Vi = $40ms^{-1}$

a = 8 ms^{-2}

t = 10 sec

S = ?

Solution

S = 40x 10 + ½ x8 x 10^2

S = 400 + 4 x 100

S = 400 + 400

S = 800m

Practice of Numerical # 9

A motor cycle moving with velocity of 50 ms^{-1}. It gets accelerating at a rate of 4 ms^{-2} . How much distance will it cover in the next 12 seconds.

Numerical # 10

A ball is dropped from a height of 50m. What will be its velocity before touching ground?

Data

h = 50m

vi = 0

g = $10ms^{-2}$

Vf = ?

Solution

$2gh = Vf^2 - Vi^2$

$2 \times 10 \times 50 = Vf^2 - 0^2$

$1000 = Vf^2$

$Vf = \sqrt{1000}$

$Vf = 31.62\ ms^{-1}$

Practice of Numerical # 10

A ball is dropped from a height of 70m. What will be its velocity before touching ground?

Numerical # 11

A ball is thrown vertically upward with velocity of 12 ms^{-1} . The ball will be slowing down due to pull of Earth's gravity on it, and will return back to Earth. Find out the time the ball will take to reach the maximum height

Data

$Vi = 12\ ms^{-1}$

$Vf = 0$

$g = -10\ ms^{-2}$

$t = ?$

Solution

$Vf = Vi + gt$

$0 = 12 + (-10) \times t$

$10t = 12$

$t = \frac{12}{10}$

$t = 1.2$ sec

Practice of Numerical # 11

A ball is thrown vertically upward with velocity of 16 ms^{-1} . The ball will be slowing down due to pull of Earth's gravity on it, and will return back to Earth. Find out the time the ball will take to reach the maximum height

Numerical # 12

If a body is thrown up ward with vertical velocity 50ms^{-1}. Calculate maximum height which body can reach.

Data

$Vi = 50\ ms^{-1}$

$Vf = 0$

$g = -10\ ms^{-2}$

h = ?

$2gh = Vf^2 - Vi^2$

$2 \times (-10) \times h = 0^2 - 50^2$

$-20h = -2500$

$h = \frac{-2500}{-20}$

h = 125 m

Practice of Numerical # 12

If a body is thrown up ward with vertical velocity $30ms^{-1}$. Calculate maximum height which body can reach.

Numerical # 13

A ball falls down from top of height of 70m. How much time the ball will take to reach the ground.

h = 70m

vi = 0

$g = 10ms^{-2}$

t = ?

Solution

$h = Vit + \frac{1}{2} gt^2$

$70 = 0xt + \frac{1}{2} \times 10 \times t^2$

$70 = 5t^2$

$t^2 = 70/5$

$t^2 = 70/5$

$t^2 = 14$

$t = \sqrt{14}$

t = 3.74 sec

Practice of Numerical # 13

A ball falls down from top of height of 40m. How much time the ball will take to reach the ground.