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มหาวิทยาลัยราชภัฏนครปฐม

Nakhon Pathom Rajabhat University

NAKHON PATHOM RAJABHAT UNIVERSITY

Chapter 2
Motion in A Straight Line

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Core curriculum

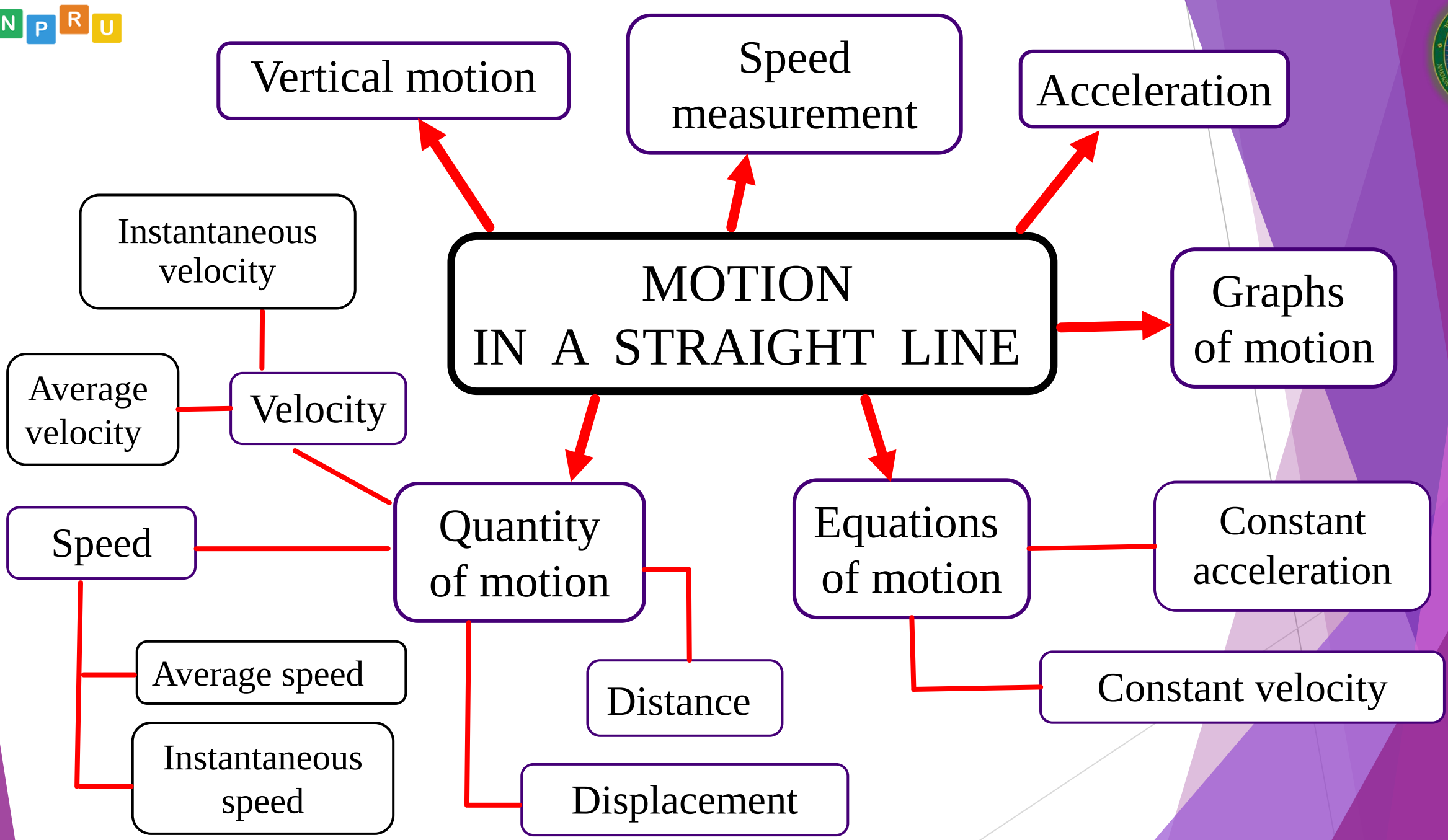
Content 4 : Force and motion.

The student should be able to understand types of motion of natural objects, apply investigative processes and develop a scientific mind, communicate knowledge acquired and make good use of it.

Indicators : m.3/3 and m.4-6/1

- Observing and explaining the movement of Straight and curved objects.

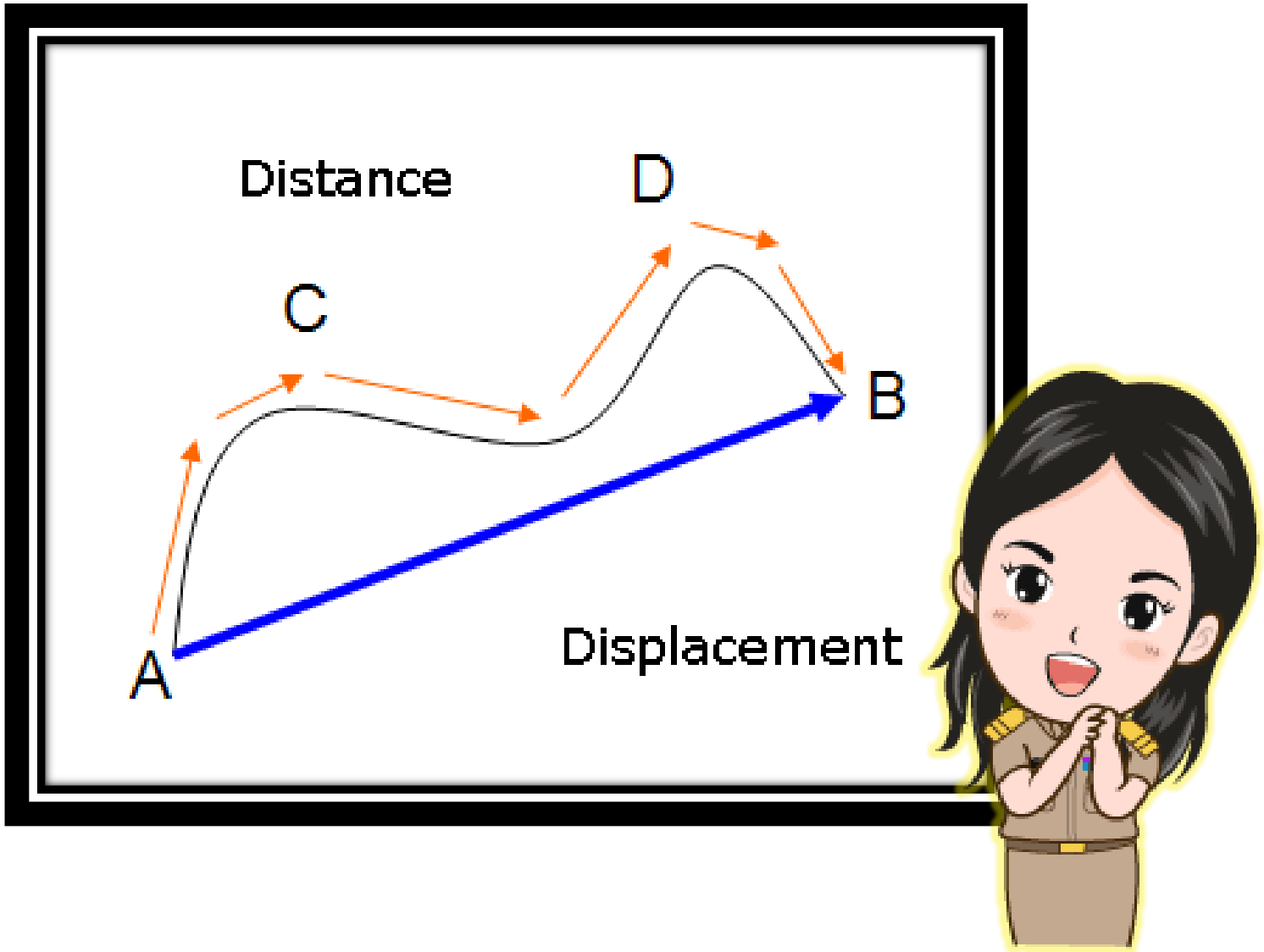
- Describe and test the relationship between displacement time velocity acceleration of linear motion.


MOTION
IN A STRAIGHT LINE
Vertical motion
Speed measurement
Acceleration
Graphs of motion
Instantaneous velocity
Average velocity
Velocity
Speed
Average speed
Instantaneous speed
Quantity of motion
Distance
Displacement
Equations of motion
Constant acceleration
Constant velocity

Quantity of motion

Distance	Length along the path that all moving objects.
Displacement	The object moves from the starting position to the final position.

Quantity of motion



Quantity of motion

Speed → A body moves from one position to another in a measured time.

Average speed → $v_{av} = \frac{\Delta s}{\Delta t}$ or $v_{av} = \frac{s}{t}$

Instantaneous speed → $v_t = \frac{\Delta s}{\Delta t}$

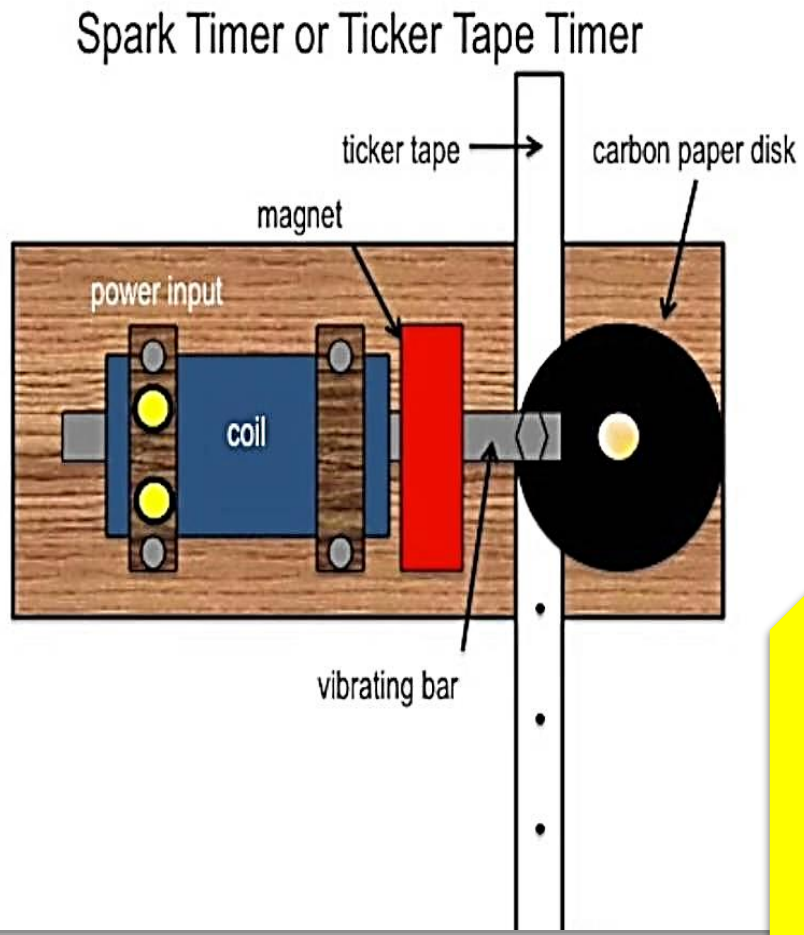
Quantity of motion

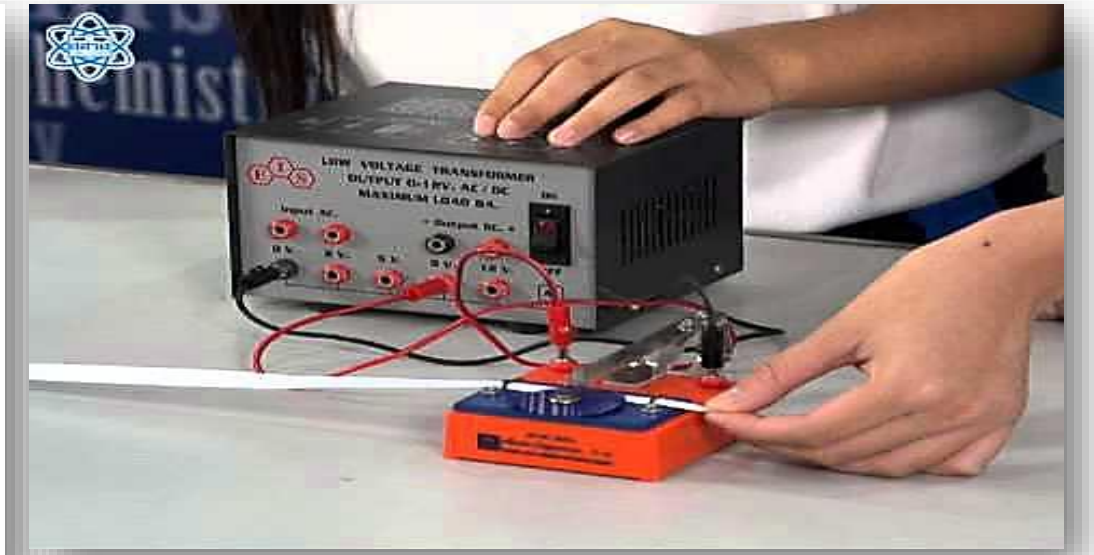
Velocity → Velocity is defined as the rate of change of displacement.

Average velocity → $\vec{v}_{av} = \frac{\Delta\vec{s}}{\Delta t}$ or $\vec{v}_{av} = \frac{\vec{s}}{t}$

Instantaneous velocity → $\vec{v}_{av} = \frac{\Delta\vec{s}}{\Delta t}$

Speed measurement

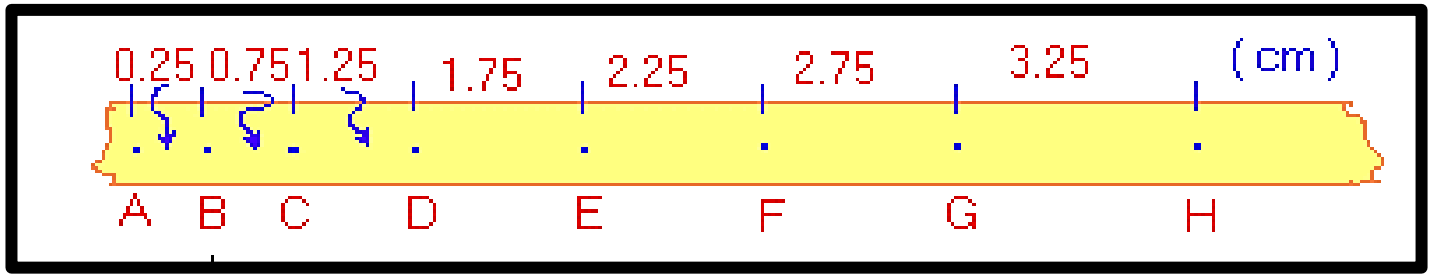




Knocked at 50 times per second.
Means in 1 second the tapping machine will knock 50 times.

Speed measurement

Speed measurement



$D \rightarrow H = ?$

$t = \frac{4}{50}\ s$

$s = 1.75 + 2.25 + 2.75 + 3.25$

$= 10\ cm$

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

$v = \frac{10\ cm}{\frac{4}{50}\ s}$

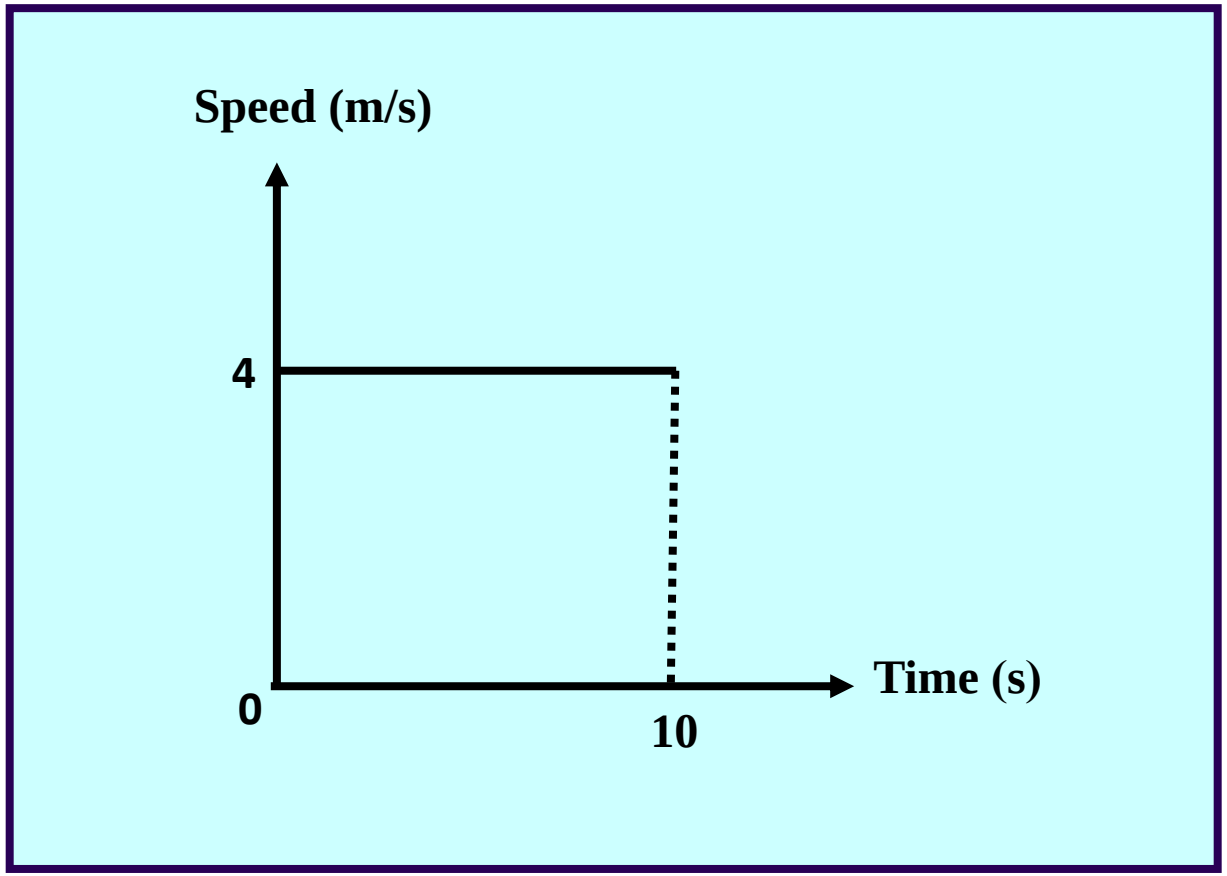
$v = 125\ cm/s$

Acceleration

If a driver steps on the accelerator , his car moves faster. It a accelerates. If he steps on the brake , his car slows down. It decelerates. Acceleration is defined as the rate of change of velocity.

$$\text{Acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

Graphs of motion

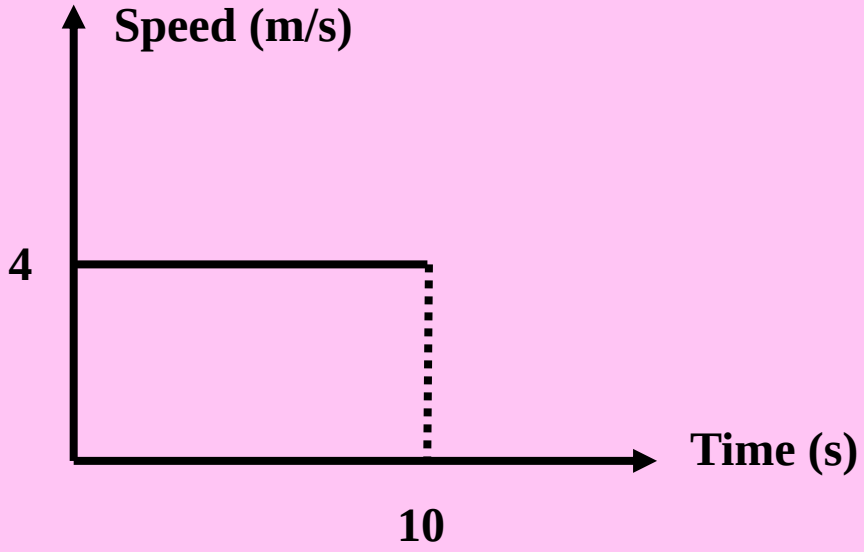


Non-reversing motion ⇒ Displacement = distance

Graphs of motion

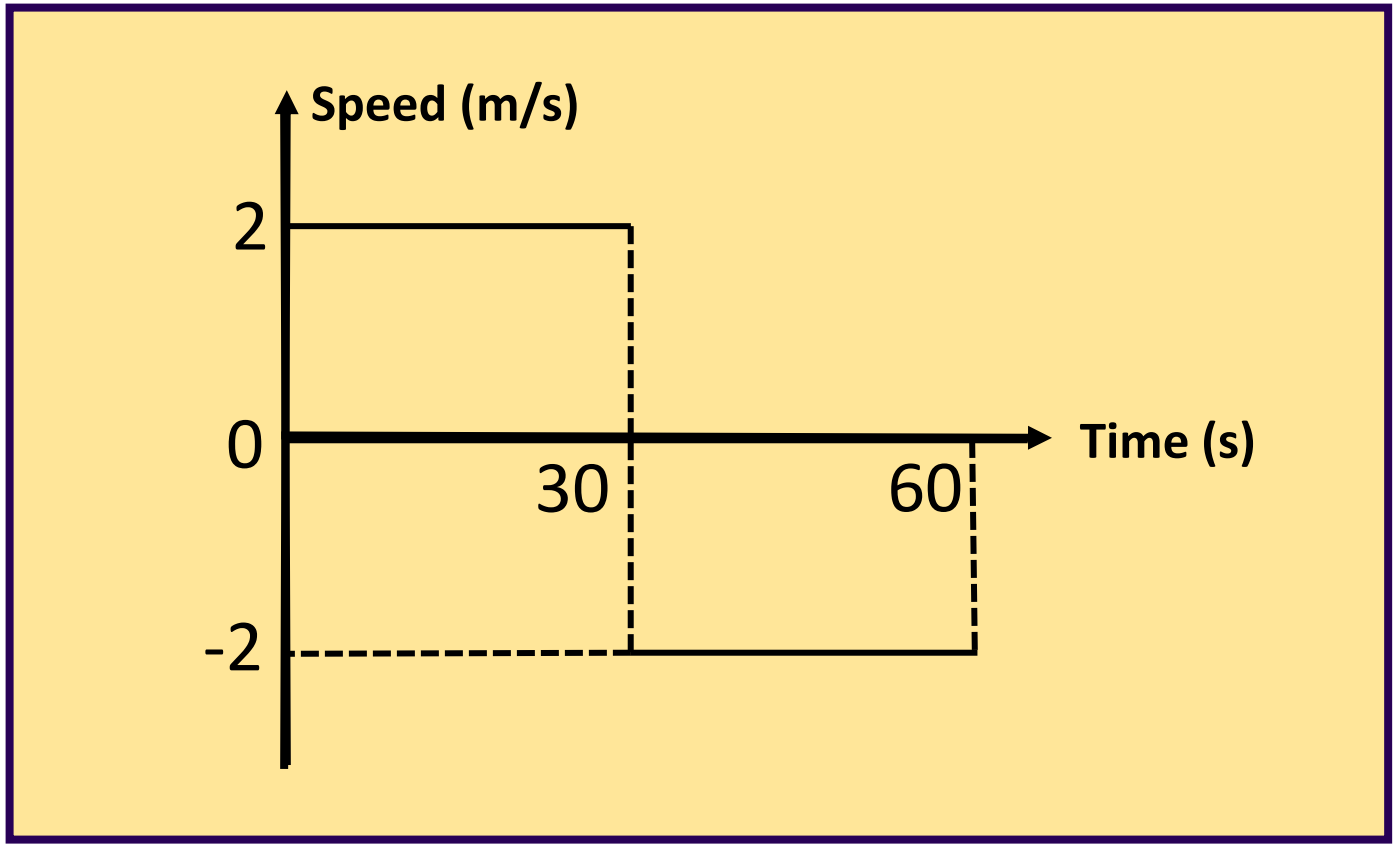
Non-reversing motion

The car moves in straight direction to the right with a steady speed of 4 meters per second for 10 seconds.



$$\Delta\vec{s} = \vec{v}_{av}\Delta t$$
$$= (4)(10)$$
$$= 40 \text{ m}$$

Graphs of motion

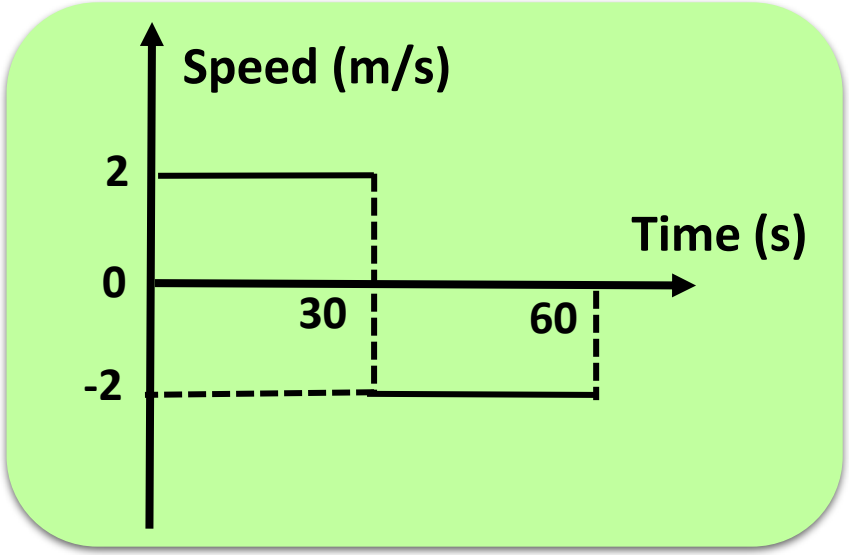


Reverse motion ➡ **Displacement ≠ distance**

Graphs of motion

Reverse motion

Truck moves in straight line to the right with a steady speed of 2 meters per second for 30 seconds, then sails back to the left with a constant velocity of 2 meters per second for 30 seconds.



$\Delta\vec{s} = \text{sum } \vec{v}_{av}\Delta t$ Each range

$= (2)(30)+(-2)(30)$

$= 0$ m

$\Delta\vec{s} = \text{sum } \vec{v}_{av}\Delta t$ Each range

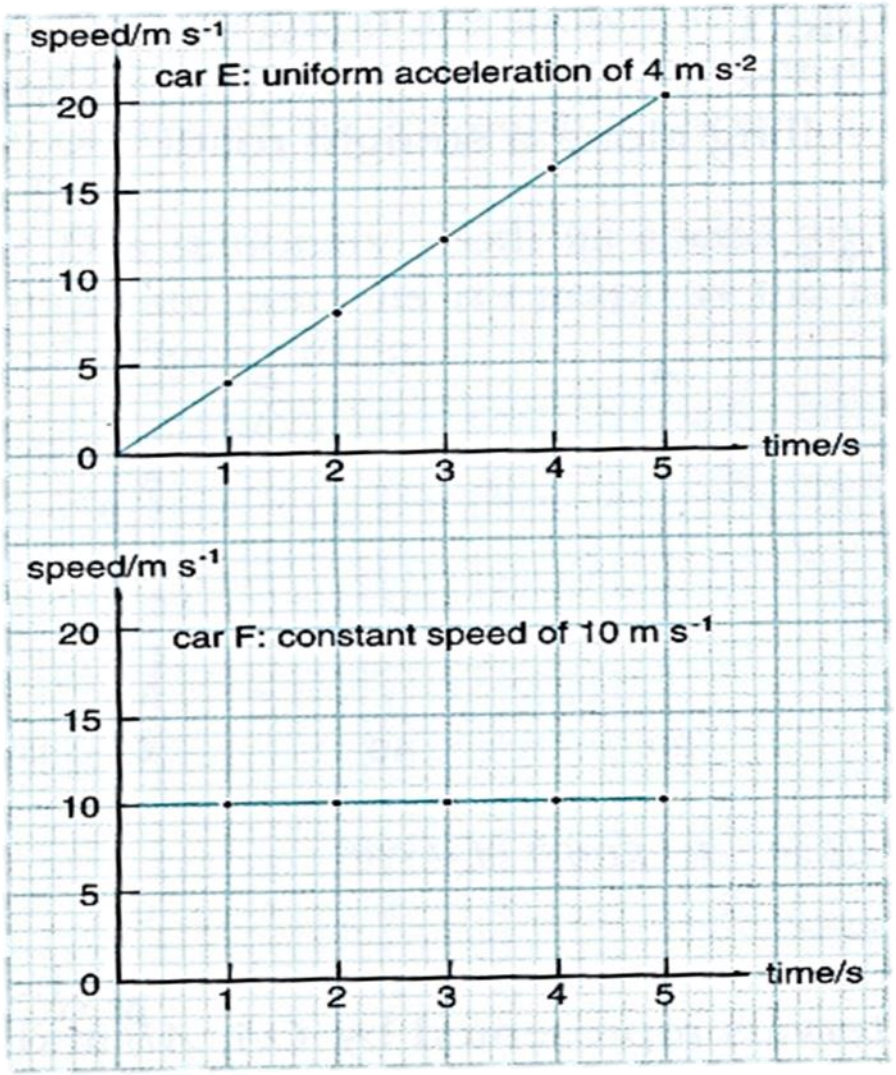
$= (2)(30)+(2)(30)$

$= 120$ m

Graphs of motion

simulation

Graphs of motion



Car E is accelerating uniformly at 4 m/s^2. The graph is a straight line which rises 4 m/s on the speed-axis for every 1 s on the time axis.

Car F is travelling at an uniform speed of 10 m/s. The speed stays the same, so the graph is a horizontal line.

Equations of motion

Constant velocity

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

s = distance (m)

t = time (s)

v = speed (m/s)

Equations of motion

Constant acceleration

$$v = u + at$$

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

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

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

s = displacement(m)

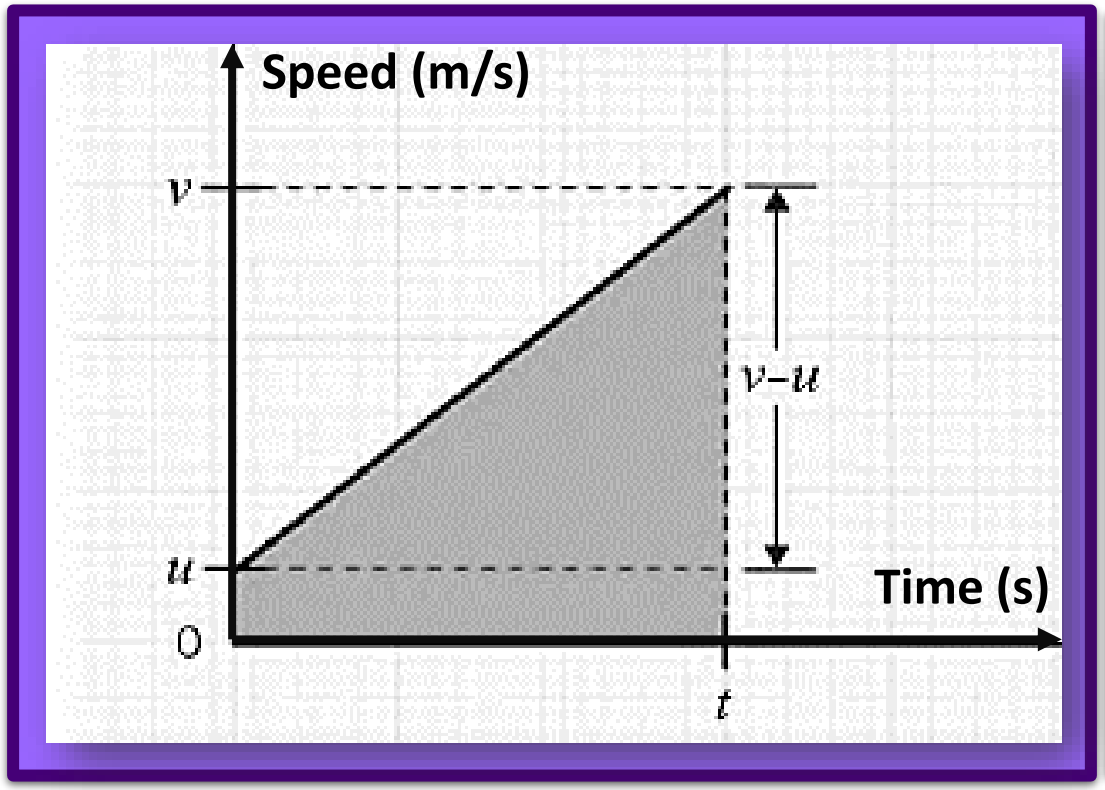
u = initial velocity (m/s)

v = final velocity (m/s)

a = acceleration(m/s^2)

t = time (s)

Equations of motion



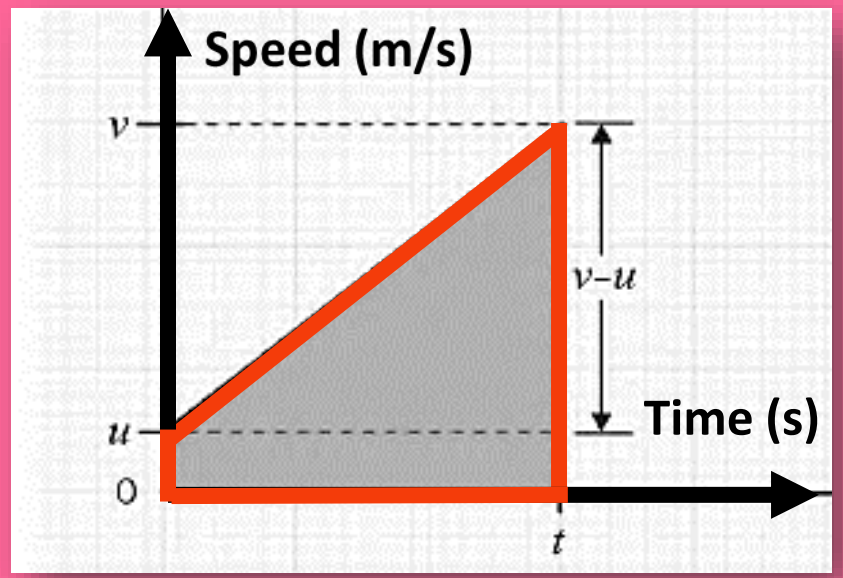
Slope = acceleration

$$a = \frac{v-u}{t-0}$$

$$v = u+at$$

Equations of motion

Trapezium



Area under the graph

$$s = \frac{1}{2}(u + v)t$$

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

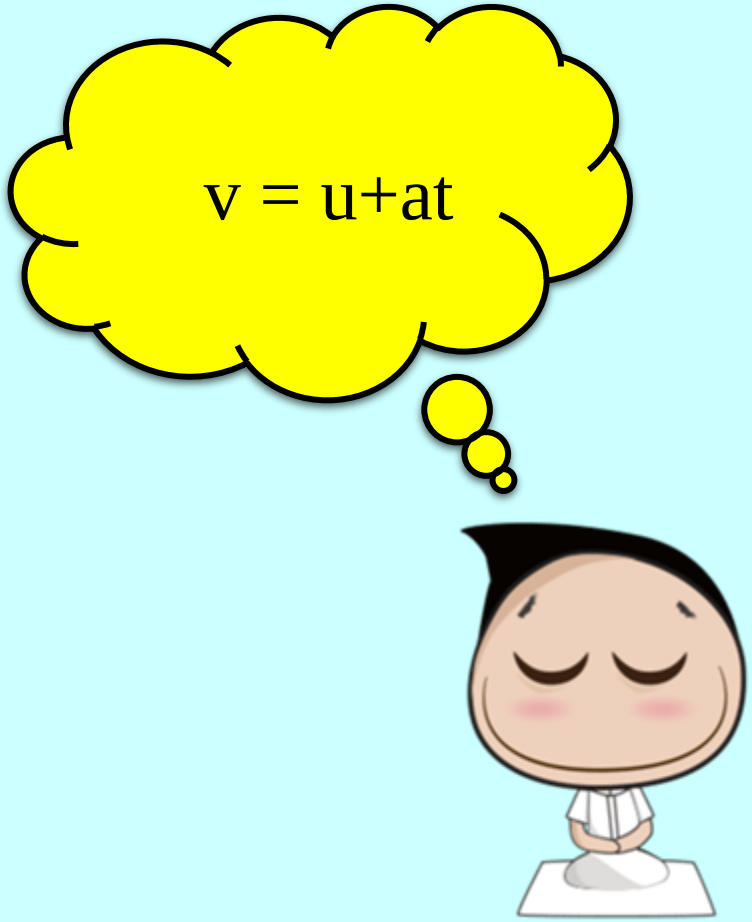
2

Equations of motion

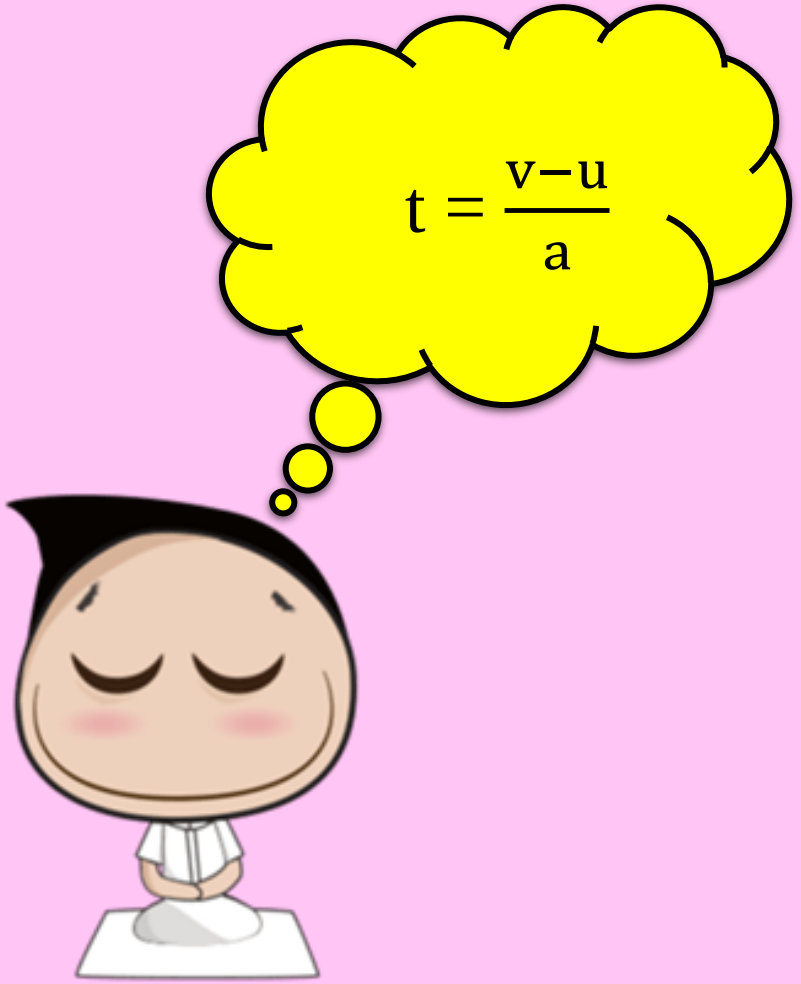
$$s = \frac{(u+v)}{2}t$$

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

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



Equations of motion



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

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

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

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

4

Equations of motion

1.Car moves from a stand still to a straight road with steady acceleration and a distance of 75 meters with in 5 seconds. How much is the acceleration of the car?

s =75 m t = 5 s

s = 75 m
u = 0
v = -
a = ?
t = 5 s

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

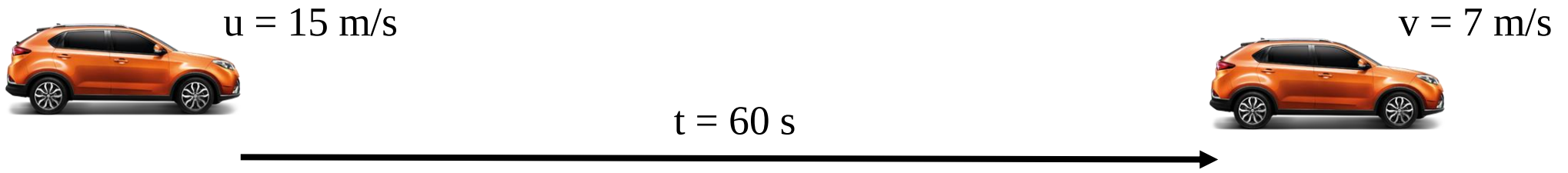
$$75 = 0+\frac{1}{2}a(25)$$

$$a = 6\ m/s^2$$

∴ acceleration of the car 6 m/s^2.

Equations of motion

2.The car moves on the road at a speed of 15 meters per second. There after 1 minute speed 7 meters per second. How much is the acceleration of the car?



s = -
u = 15 m/s
v= 7 m/s
a = ?
t = 60 s

$v = u + at$

$7 = 15 + a(60)$

$a = -0.13\ m/s^2$

∴ acceleration of the car $0.13\ m/s^2$.

Equations of motion

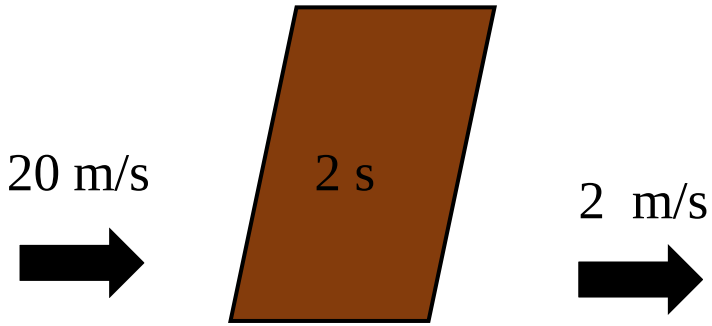
3.Shoot a bullet through the wall with constant acceleration, with the velocity of the bullet falling from 20 meters per second to 2 meters per second. If the bullet is penetrated by the wall, it is equal to 2 seconds. Find the thickness of the wall?

s = ?
u = 20 m/s
v = 2 m/s
a = -
t = 2 s

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

$$s = \frac{(20+2)}{2}2$$

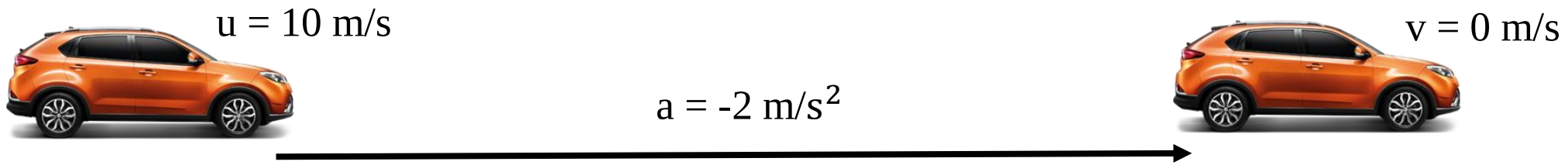
$$s = 22 \text{ m}$$



∴ Wall thickness 22 m.

Equations of motion

4.Car moves at a speed of 10 meters per second. Brake to stop the car with a lag 2 meters per second. Find the distance to stop from the start of the brake?



$s = ?$
$u = 10$ m/s
$v = 0$
$a = -2$ m/s²
$t = -$

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

$$0 = 10^2 + 2(-2)s$$

$$s = 25 \text{ m}$$

$\therefore$ distance to stop 25 m.

Vertical motion

$$v = u + gt$$

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

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

$$v^2 = u^2 + 2gs$$

s = displacement(m)

u = initial velocity (m/s)

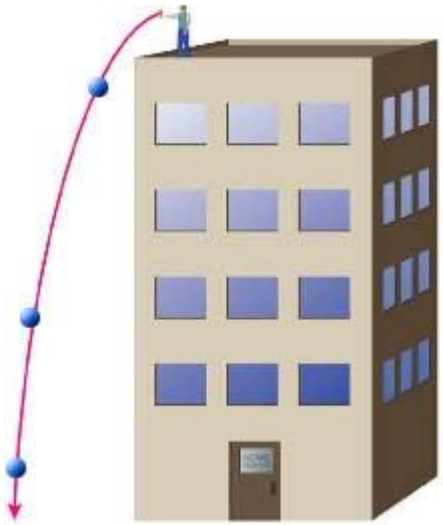
v = final velocity (m/s)

g = gravitational acceleration ($9.8\ m/s^2$)

t = time (s)

Vertical motion

NOTE



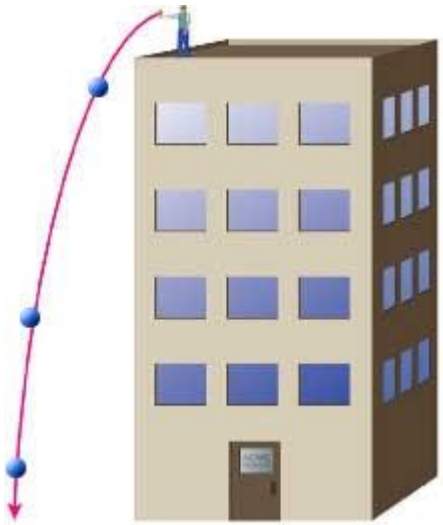
- Determine the direction u is always positive if the quantity of the opposite direction u is negative.

- Mark of g
  - moving object up g is negative.
  - moving object down, g is positive.

- When the object reaches maximum, v = 0.

Vertical motion

NOTE

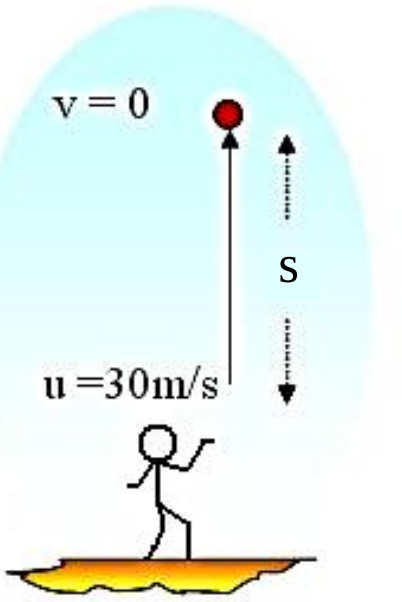


- When releasing an object on a moving object such as releasing a rock on a vehicle while the car is moving the stones will have an early speed. Equal to the speed of the car.

- When objects thrown up straight in the air and fell in. If points fall below the level of the release point, the value s will be negative.

Vertical motion

1.Jon threw the ball up in the air from the floor with a speed of 30 m/s. Find out how much the ball will go up to the maximum?



$$v^2 = u^2+2gs$$

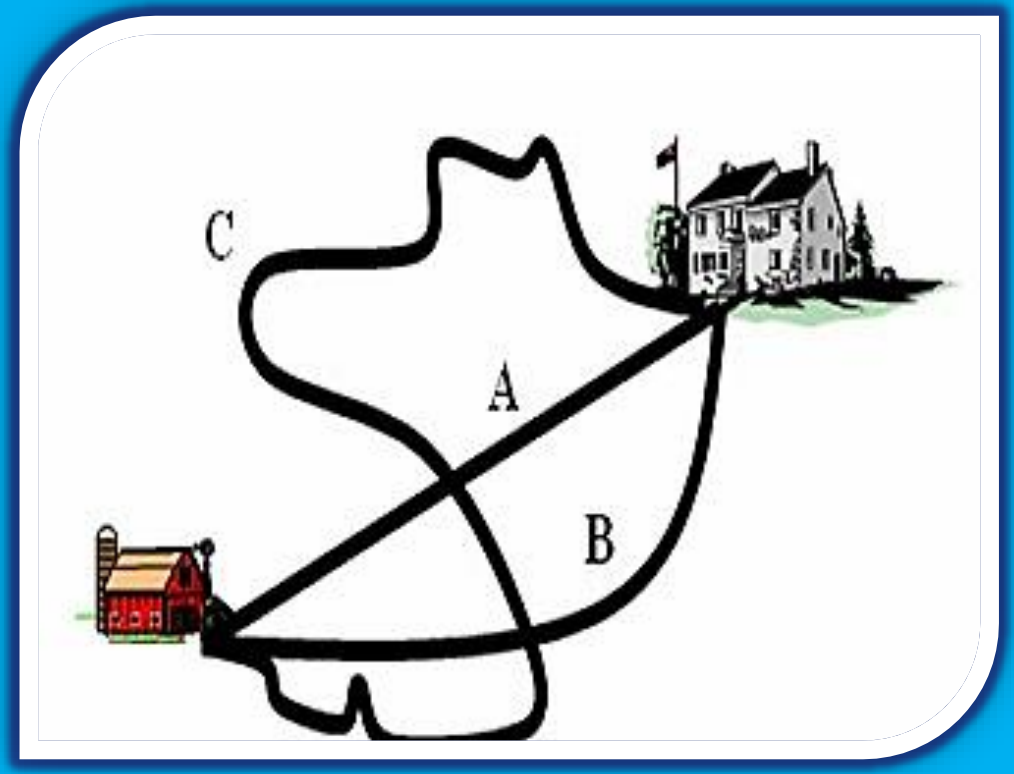
$$0 = 30^2+ 2(-9.8)s$$

$$s = 45.91 \text{ m}$$

u = 30 m/s
v = 0 m/s
g = -9.8 m/s²
s = ?

∴ The ball will go up to the maximum 45.91 m.

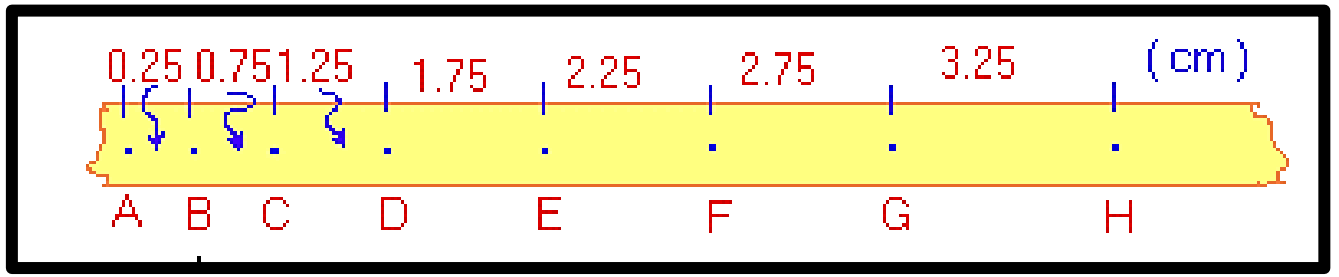
Question



Distance: B , C

Displacement: A

Question



D→G ?

$t = \frac{3}{50}$

$s = 1.75+2.25+2.75$

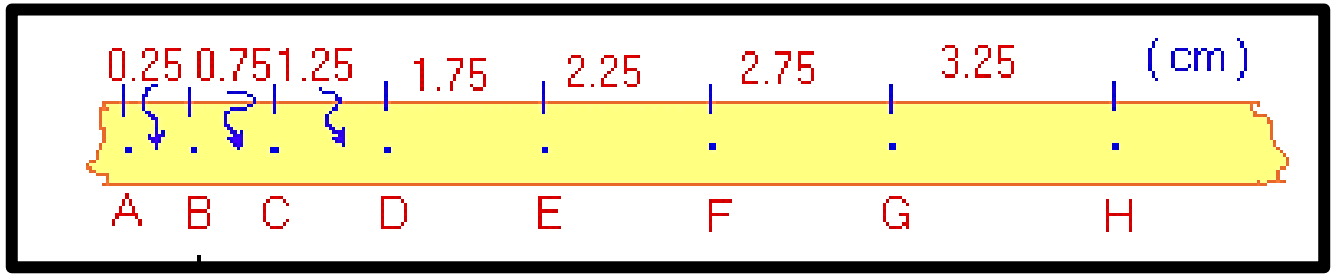
$= 6.75$ cm

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

$= \frac{6.75\text{cm}}{\frac{3}{50}\text{s}}$

$= 112.5$ cm/s

Question



A→H ?

$t = \frac{7}{50}\ s$

s = 0.25+0.75+1.25+1.75+
2.25+2.75+3.25

= 12.25 cm

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

$= \frac{12.25 cm}{\frac{7}{50} s}$

= 87.5 cm/s

Question

1.Car moves from a stand still to a straight road with steady acceleration and a distance of 95 meters with in 5 seconds. How much is the acceleration of the car?

s = 95 m
u = 0
v = -
a = ?
t = 5 s

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

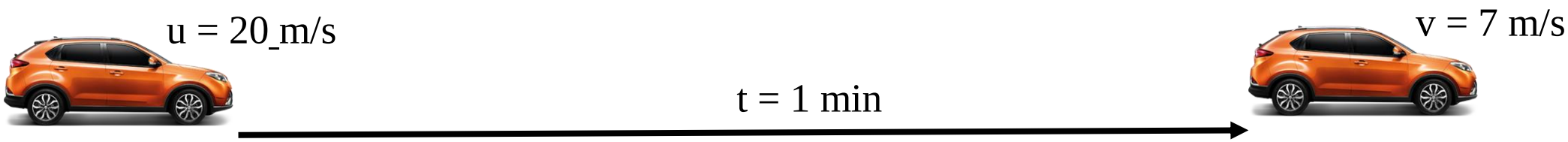
$$95 = 0 + \frac{1}{2}a(25)$$

$$a = 7.6\ m/s^2$$

$\therefore$ acceleration of the car is $7.6\ m/s^2$.

Question

2.Car moves on the road at a speed of 20 meters per second there after 1 minute speed 7 meters per second. How much is the acceleration of the car?



s = -
u = 20 m/s
v = 7 m/s
a = ?
t = 60 s

$v = u + at$

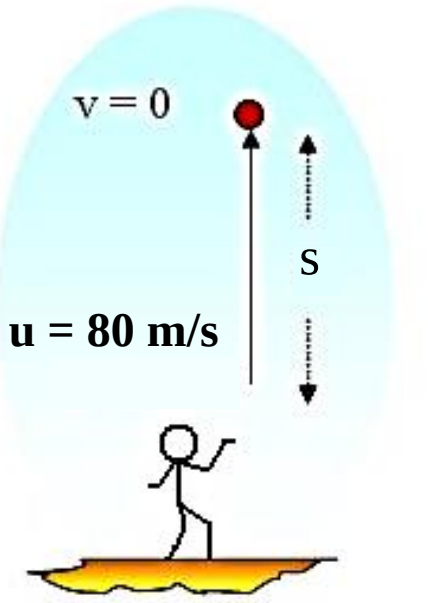
$7 = 20 + a(60)$

$a = -0.21\ m/s^2$

∴ acceleration of the car is $0.21\ m/s^2$.

Question

1.Jon threw the ball up in the air from the floor with a speed of 80 m/s. Find out how much the ball will go up to the maximum?



$$v^2 = u^2 + 2gs$$

$$0 = 80^2 + 2(-9.8)s$$

$$s = 326.53 \text{ m}$$

$u = 80$ m/s
$v = 0$ m/s
$g = -9.8$ m/s^2
$s = ?$

∴ The ball will go up to the maximum 326.53 m.

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