Chapter 6

Chapter 6

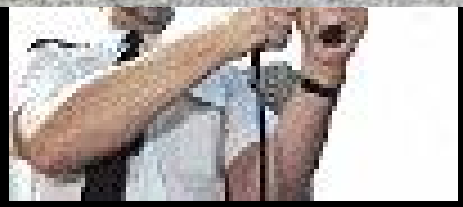
Speed

Displacement

Velocity

SPEED

Drivers need to control their speed!



Speed = ??

= rate of change of distance w.r.t. time

= distance travelled in unit time

= distance ÷ time

Average Speed = ??

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

Symbol for speed

u or v

Units for speed

$m\ s^{-1}$

P1 **An athlete runs the 100 m in a world record time of 9.78 s. What is his average speed?**

$$speed = \frac{distance}{time} = \frac{100}{9.78}$$

$$= 10.22 \text{ m s}^{-1}$$

P2 **A man walks with an average speed of 2 m s^{-1}. How long will it take him to walk 1 km?**

$$speed = \frac{distance}{time} \qquad 2 = \frac{1000}{t} \qquad t = \frac{1000}{2}$$

$$= 500 \text{ s}$$

Constant Speed

Instantaneous Speed

P3 A dog runs along a road at a constant speed of 3 m s^{-1}.

(i) How far will it travel in 10 s?

(ii) How far will it travel in ¼ hour?

$$speed = \frac{distance}{time} \Rightarrow distance = speed \times time$$

(i) distance = 3 x 10

= 30 m

(ii) distance = 3 x (15 x 60)

= 2700 m

P4 **A car has a steady speed of 63 km h^{-1}.**

(i) How far does it travel in 12 seconds?

(ii) How long does it take to travel 400 m?

$$63\ km\ h^{-1} \quad 63 \times 10^3\ m\ h^{-1} \quad = \frac{63 \times 10^3}{60 \times 60}\ m\ s^{-1} \quad = 17.5\ m\ s^{-1}$$

(i)

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

$$17.5 = \frac{distance}{12}$$

$$distance = 17.5 \times 12$$

$$distance = 210\ m$$

(ii)

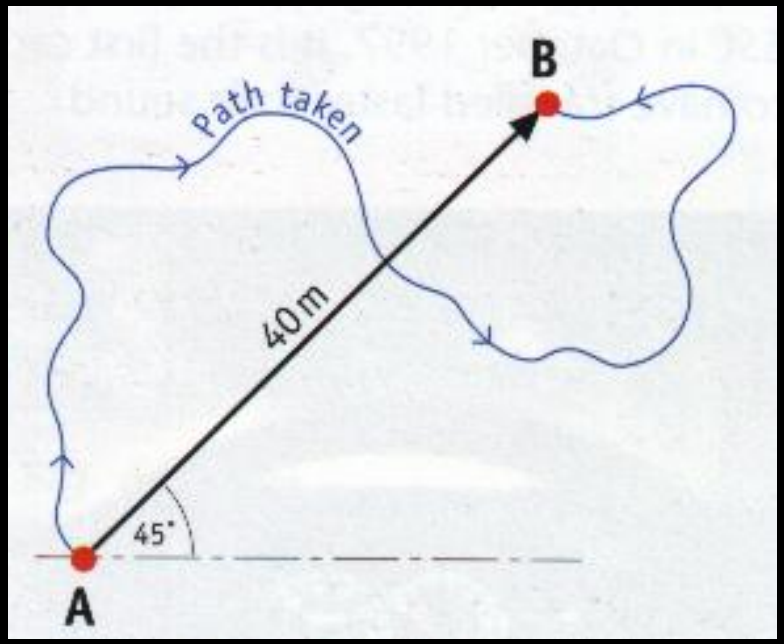
$$speed = \frac{distance}{time}$$

$$17.5 = \frac{400}{t}$$

$$t = \frac{400}{17.5} \quad = 22.9\ s$$

Displacement

Distance in a given direction



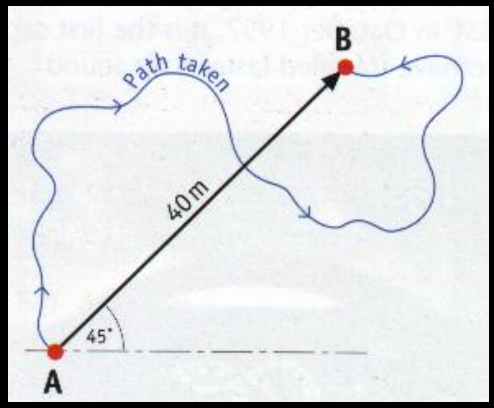
Displacement = ??

= 40 m north-east

Distance travelled = ??

Displacement

Distance in a given direction

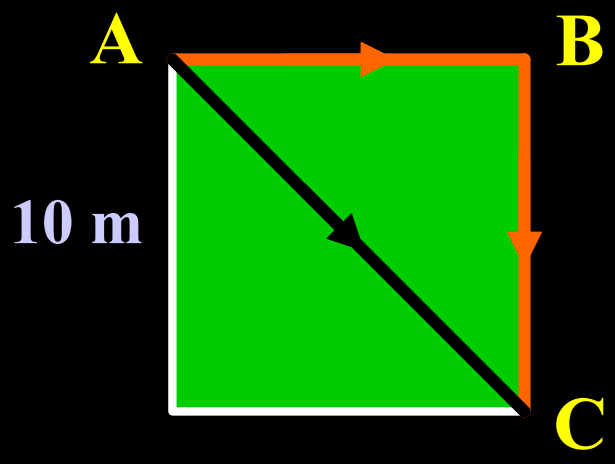


Symbol	*s*
Unit	metre (m)

Vector

… magnitude & direction

Grass Path



$A \rightarrow B \rightarrow C$

Distance = ??

Displacement = ??

Distance = 20 m

Displacement = $\sqrt{200}$ m, E45°S

Velocity

Rate of change of displacement w.r.t. time

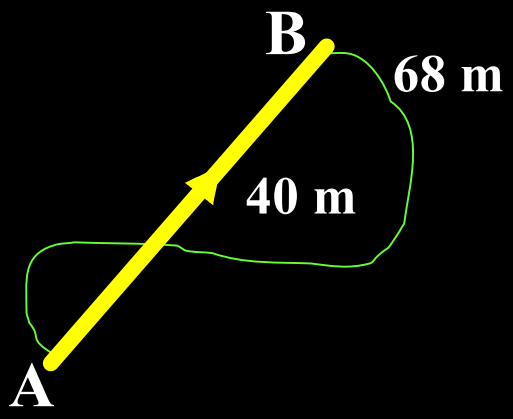
Example	**15 m s^{-1}**	**north**
Symbol	***u*** ***or***	***v***
Unit	**m s^{-1}**	

Velocity

Rate of change of displacement w.r.t. time

$$Average\ Velocity = \frac{Displacement\ Undergone}{Time\ Taken}$$

P5 **In 12 s a girl travels from A to B by the green path shown in the diagram. The total distance travelled is 68 m. The overall displacement she undergoes is 40 m North-East. Calculate, (i) her average speed, (ii) her average velocity.**



(i) $$\text{Average speed} = \frac{\text{Distance travelled}}{\text{Time taken}}$$

$$= \frac{68}{12} \qquad = 5.67 \text{ m s}^{-1}$$

(ii) $$\text{Average velocity} = \frac{\text{Displacement}}{\text{Time taken}} = \frac{40 \text{ m} \quad \text{north-east}}{12 \text{ seconds}}$$

$$= 3.33 \text{ m s}^{-1} \quad \text{north-east}$$

Constant Velocity

Average Velocity

Instantaneous Velocity

Changing Velocity

==> Acceleration / (Decelleration)

Velocity is a vector

⇒ it can change magnitude ⇒ acceleration

e.g. dropping a stone (9.8 m s^{-2})

or

it can change direction ⇒ acceleration

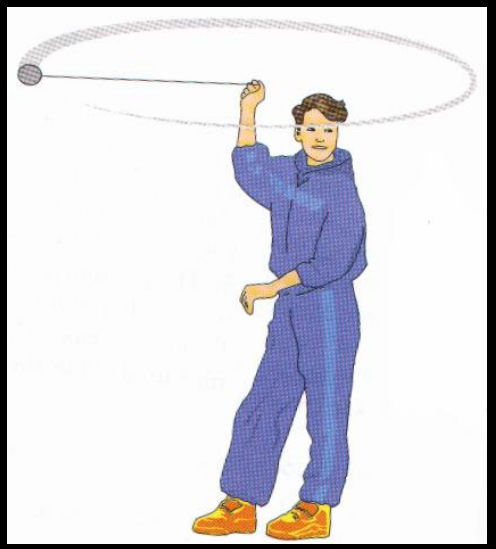
e.g. stone in a circle

Changing Velocity

Acceleration / (Decelleration)

Magnitude changing

Direction changing



Measuring Velocity & Acceleration

Powder Track Timer

Air Track Timer

Ticker Tape Timer

Powder Track Timer

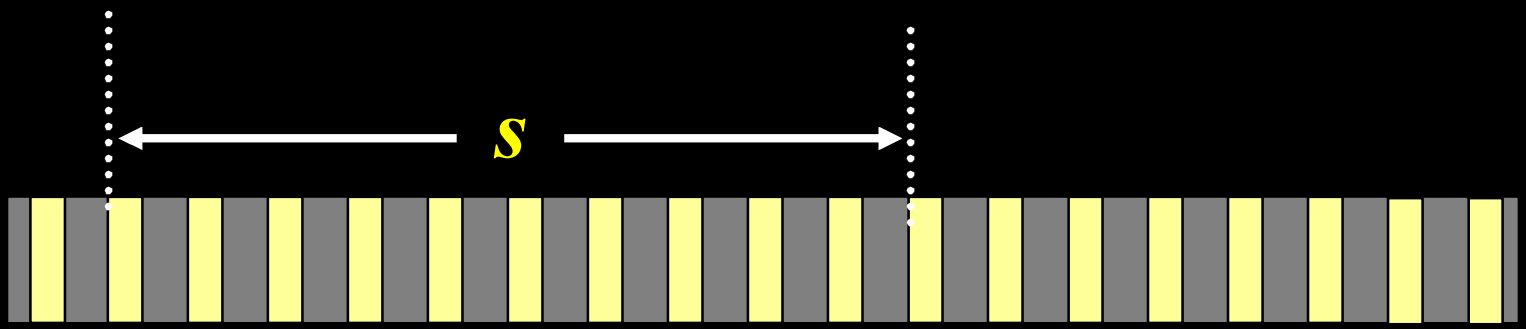
Trolley

Track

A.C. Power Supply

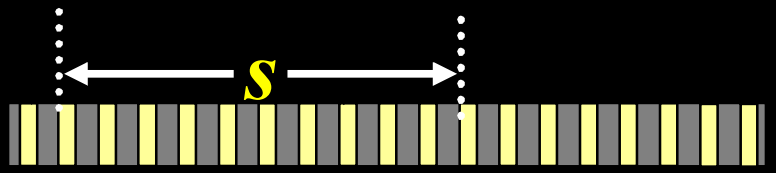
Sulphur Powder

PTT - Measuring Velocity



Velocity = spread of 10 patches ÷ (10 x 0.02)

Results (PTT - Measuring Velocity)



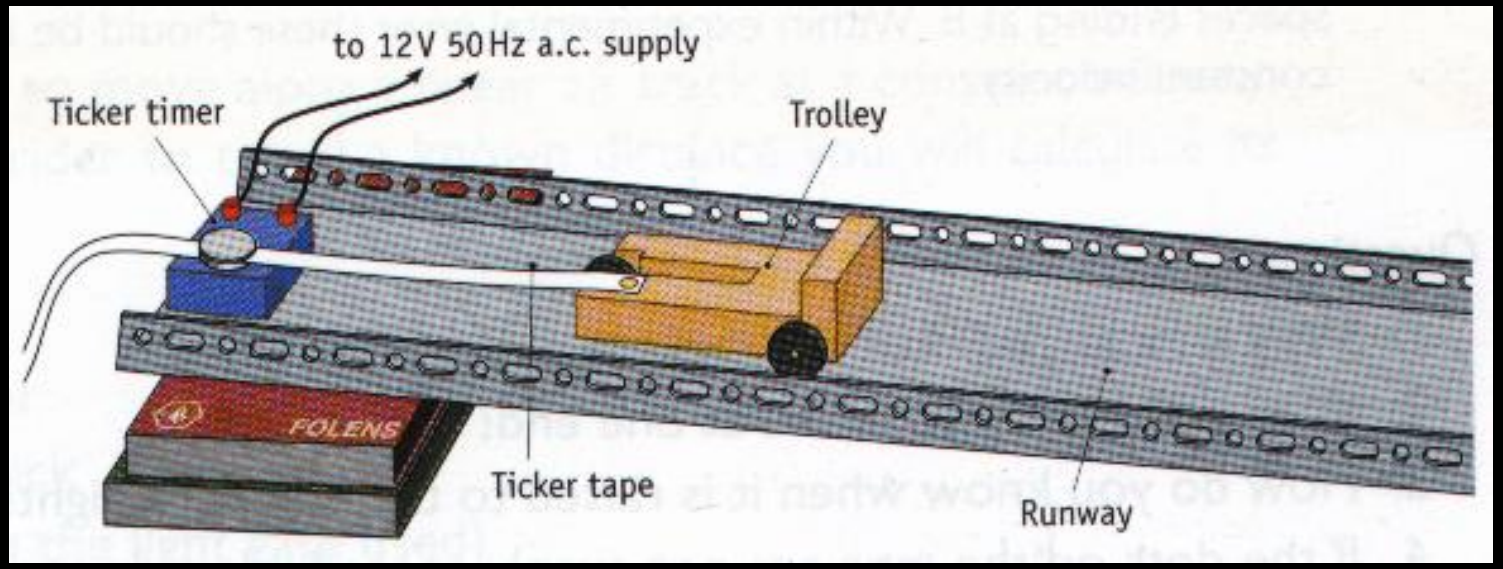
Distance (Spread) s / m	No. Of Patches n	Time Taken t / s (= n x 0.02)	Velocity v / m s^{-1}

Average Velocity =

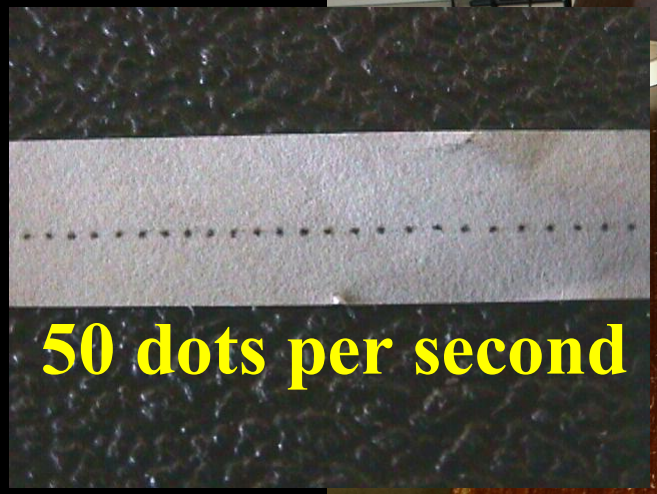
PTT - Precautions

- **Wedge … to compensate for ??**
- **Repeat for other patches ...**
- **Velocity … use more than 10 patches**

Ticker-Tape Timer



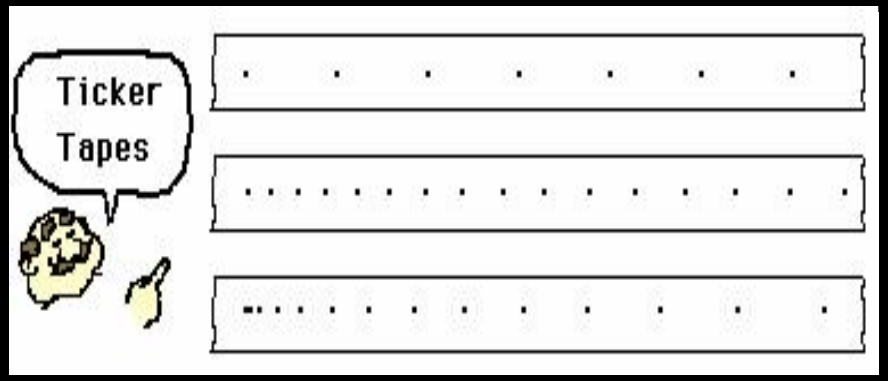
Ticker-Tape Timer

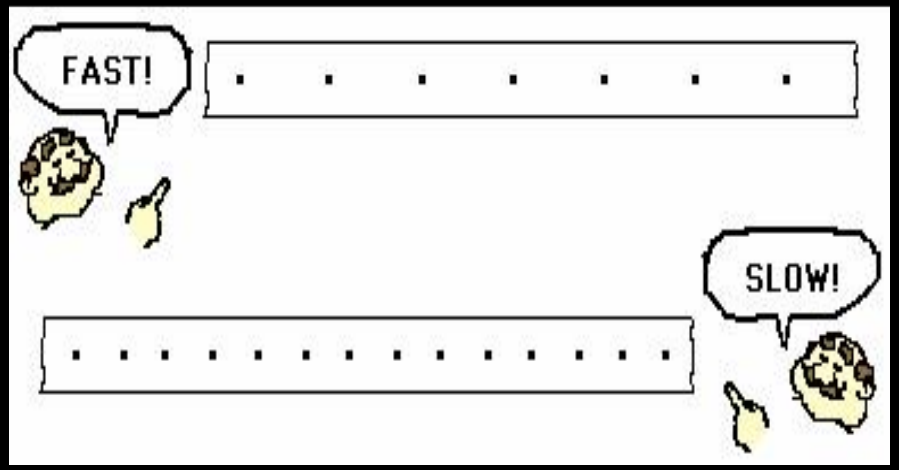


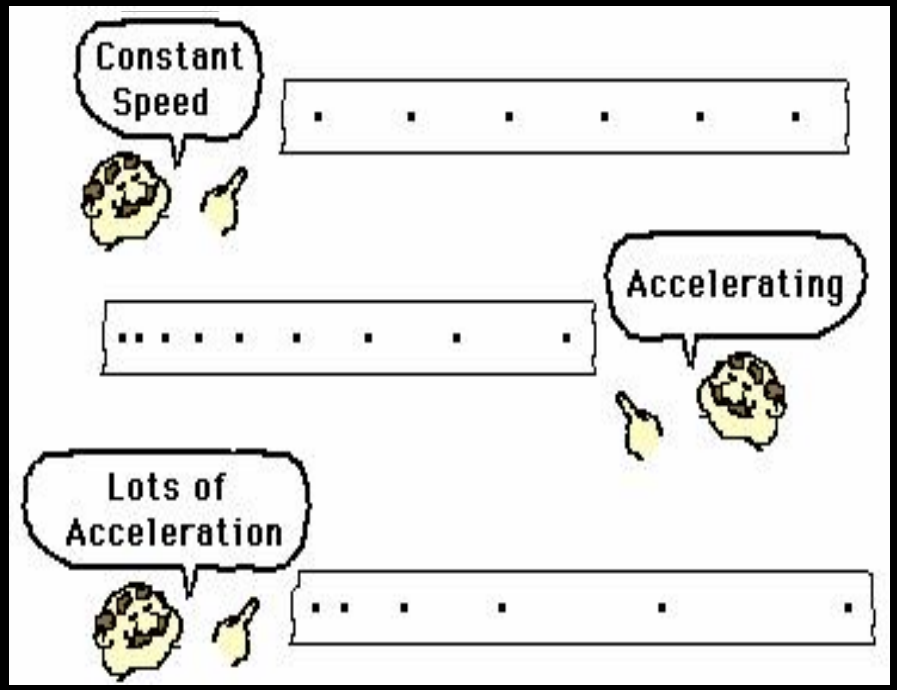
50 dots per second

a.c. 50 Hz

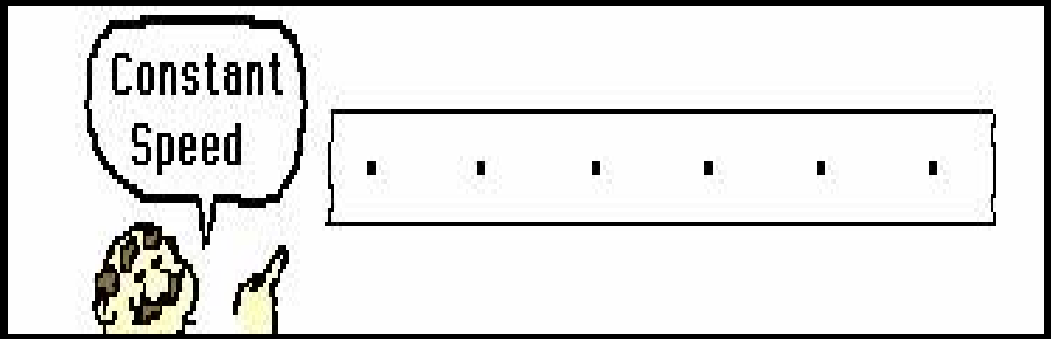
Ticker-Tape Timer





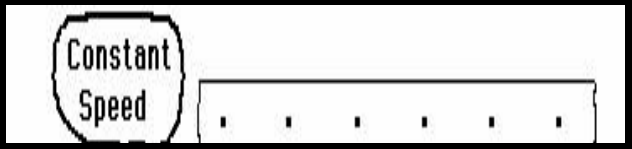


Ticker-Tape Timer



$$Speed = \frac{Spread\ of\ 10\ spaces}{10 \times 0.02}$$

Results (Ticker-Tape Timer)

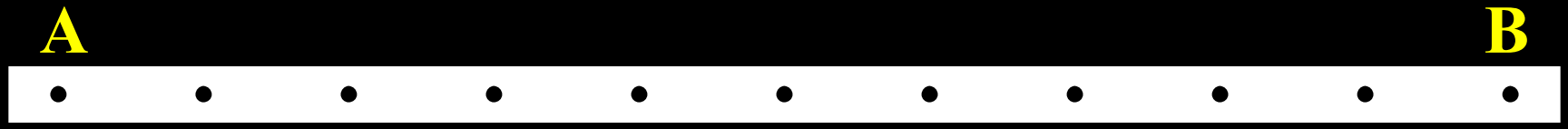


$$Speed = \frac{Spread\ of\ 10\ spaces}{10 \times 0.02}$$

Distance (Spread) s / m	No. Of Spaces n	Time Taken t / s (= n x 0.02)	Velocity v / m s^{-1}

Average Velocity =

Ticker-Tape Timer



AB = 15 cm

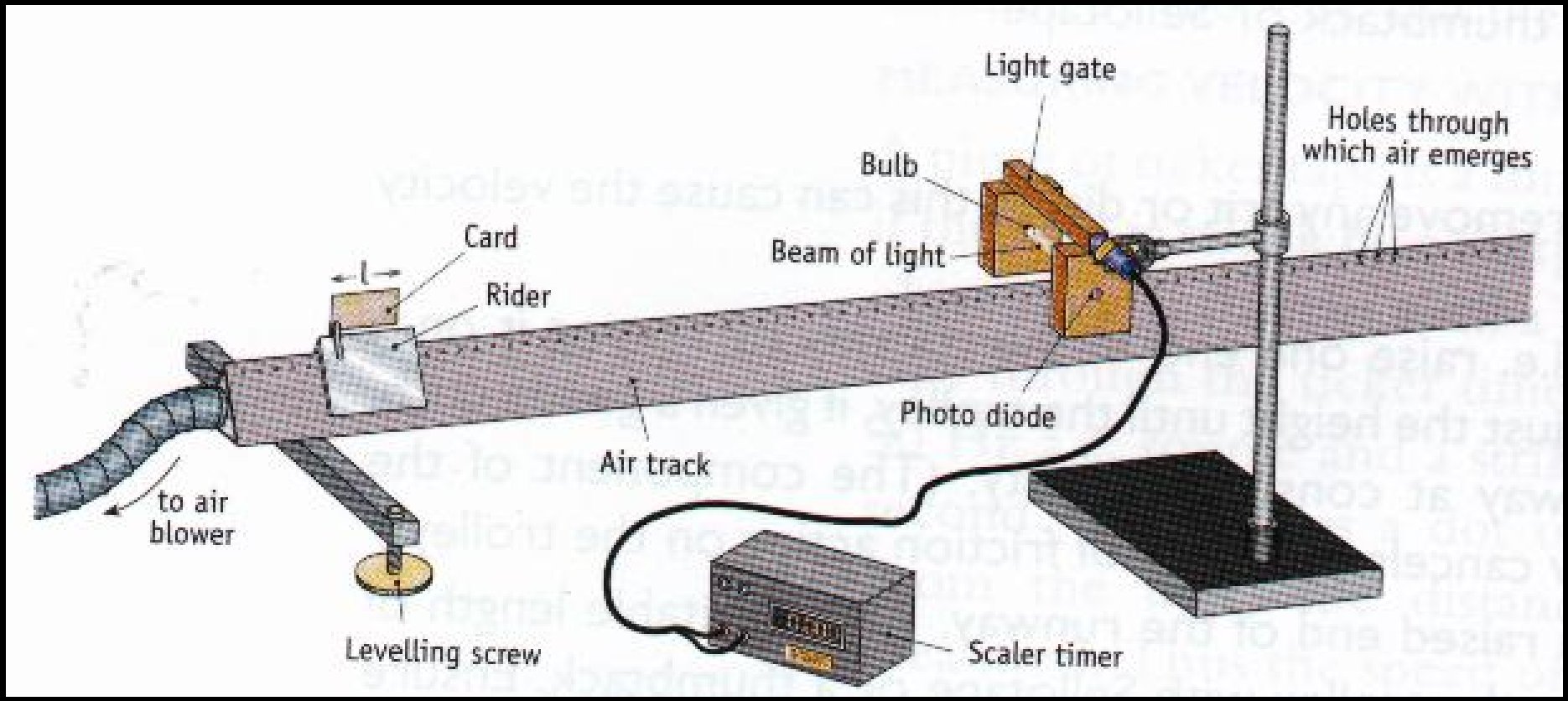
10 spaces between A and B

⇒ Time = 10 x 0.02 seconds

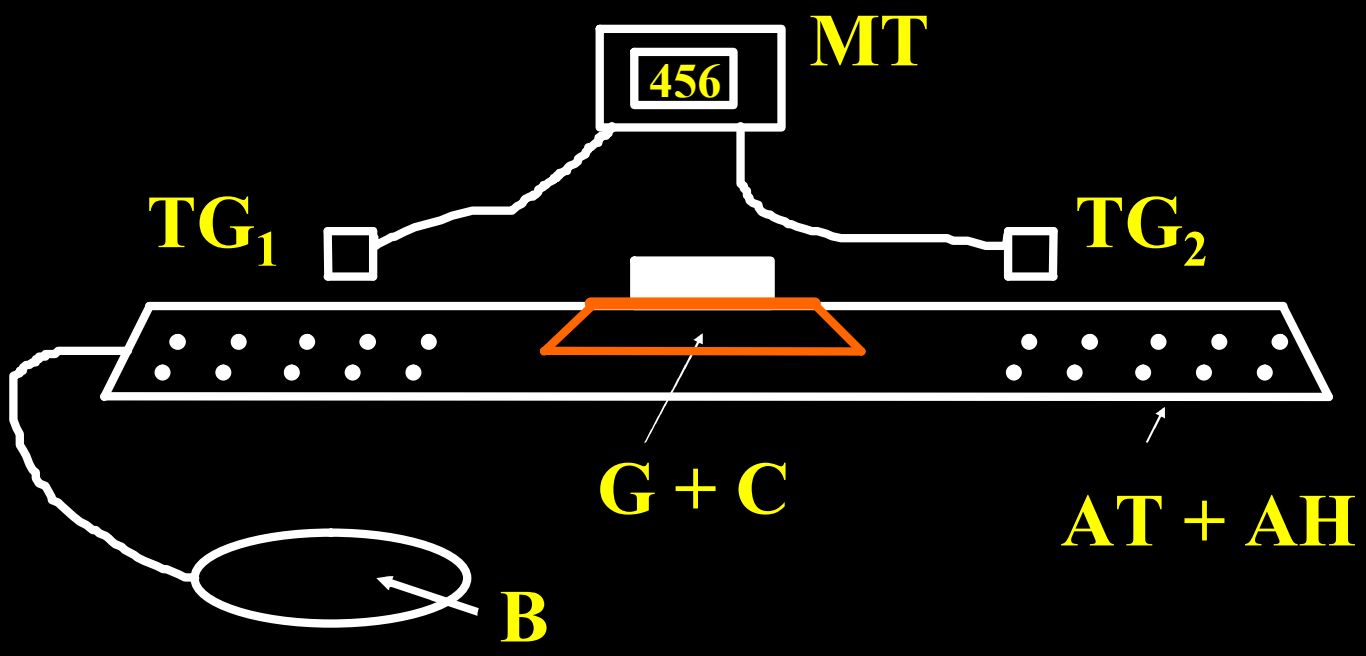
$$Velocity = \frac{displacement}{time} = \frac{15}{10 \times 0.02} = 75\ cm\ s^{-1}$$

$$= 0.75\ m\ s^{-1}$$

Air Track Timer



Air Track Timer



Air Track + Air Holes

Timing Gates

Blower

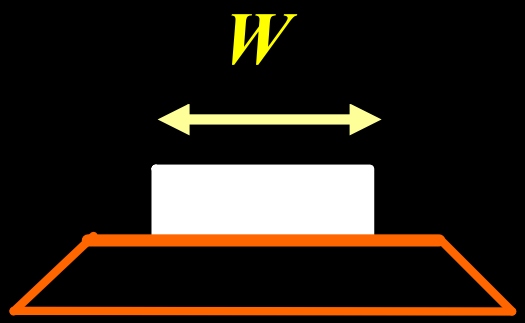
Glider + Card

Millisecond Timer

ATT - Measuring Velocity

Only one timing gate is needed.

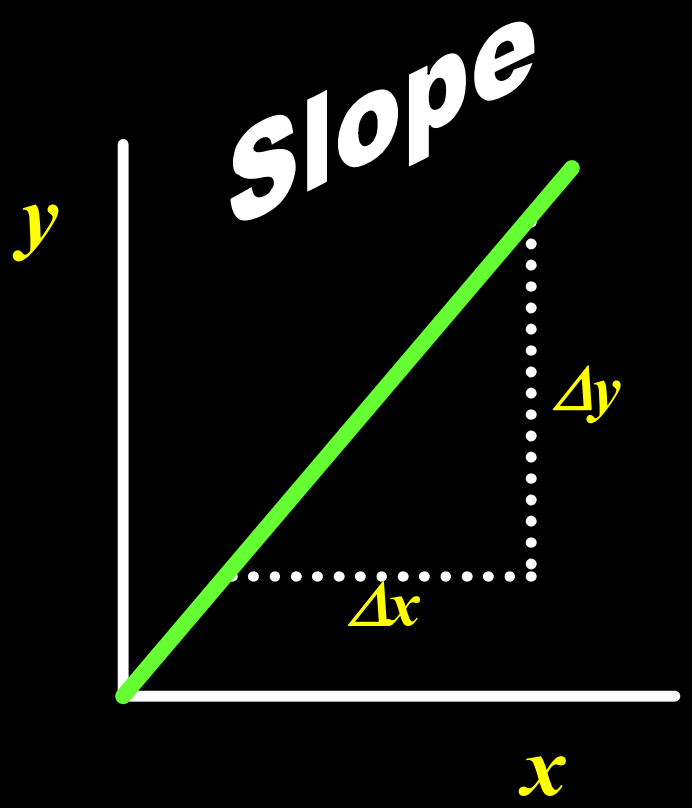
$$Velocity = \frac{Width\ of\ card\ (W)}{Time\ from\ gate}$$



Precautions

- **Level track** **(How would you check it?)**
- **Strong enough air supply**

Graphs



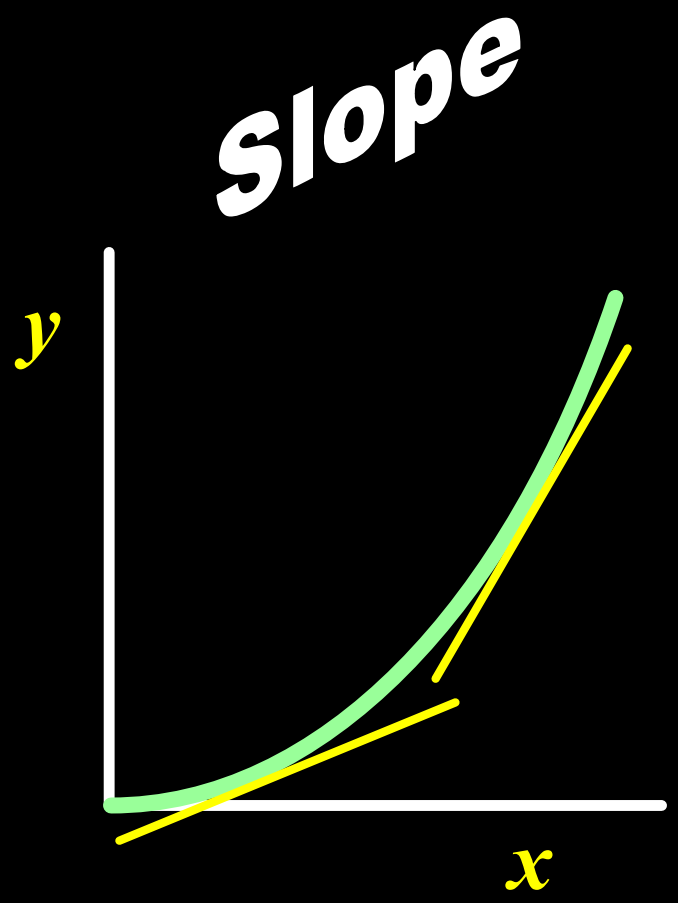
$$Slope = \frac{y_2 - y_1}{x_2 - x_1}$$

$$Slope = \frac{\Delta y}{\Delta x}$$

Δy = change in y

Δx = change in x

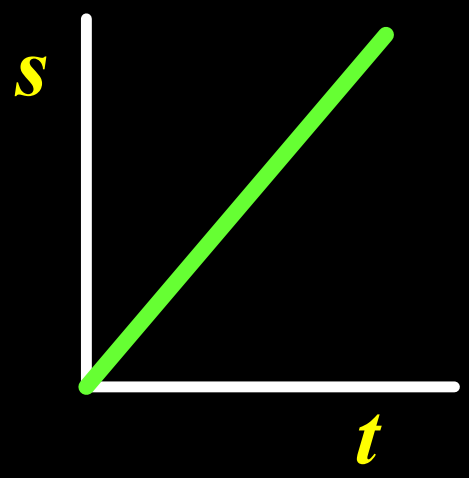
Graphs

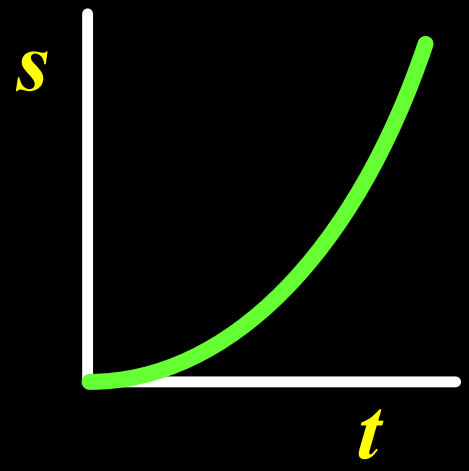


Slope ($\Delta y/\Delta x$)

increasing

Distance - Time Graphs





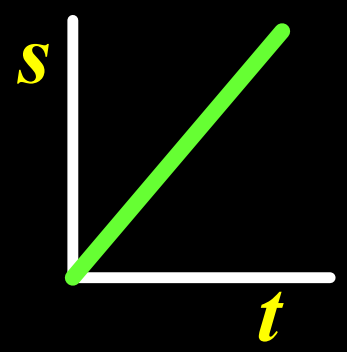
$$Slope = \frac{\Delta s}{\Delta t}$$

$$Slope = speed\ (v)$$

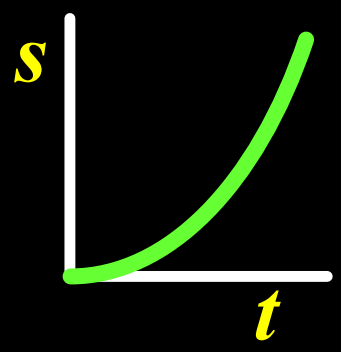
Speed increasing

Distance - Time Graphs

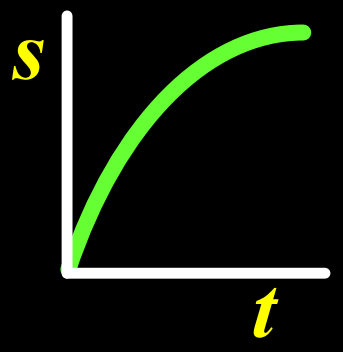
Is speed - increasing, decreasing or constant ??



Constant



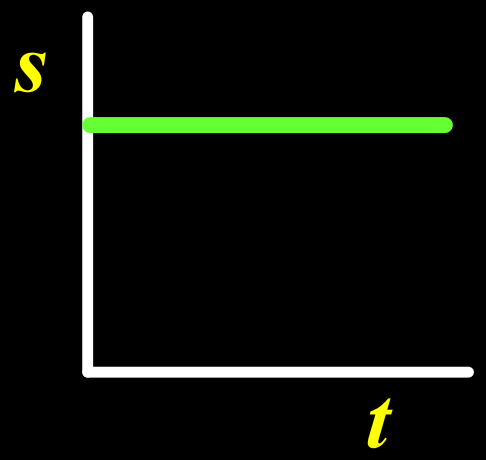
Increasing



Decreasing

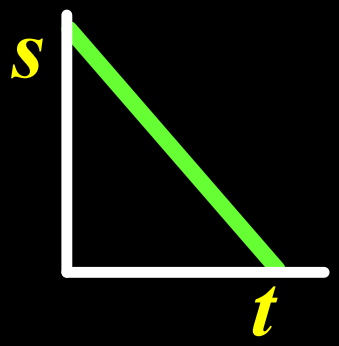
Distance - Time Graphs

Speed = ??

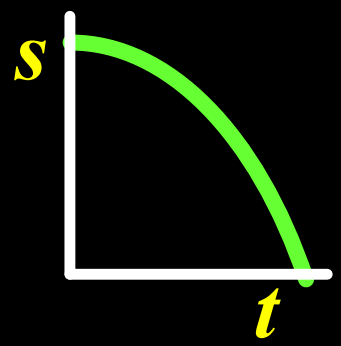


Distance - Time Graphs

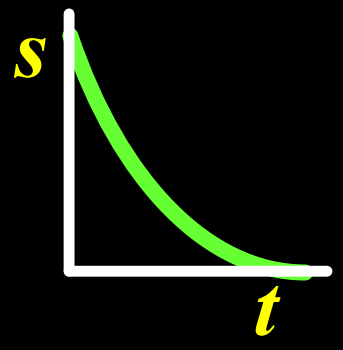
Is speed - increasing, decreasing or constant ??



Constant (approaching)



Increasing (approaching)



Decreasing (approaching)