

Chapter 6

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Speed

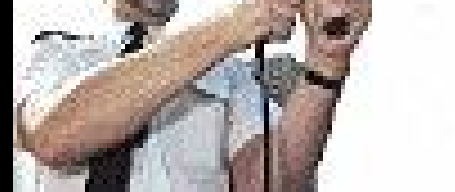
Displacement

Velocity

SPEED



Drivers need to control their speed!



Speed = ??

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

= distance travelled in unit time

= distance \div time

Average Speed = ??

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

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?

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

$$= \frac{100}{9.78}$$

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

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

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

$$2 = \frac{1000}{t}$$

$$t = \frac{1000}{2}$$

$$= 500 \text{ s}$$

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 $\frac{1}{4}$ hour?

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

(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?

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

(i)

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

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

$$\text{distance} = 17.5 \times 12$$

$$\text{distance} = 210 \text{ m}$$

(ii)

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

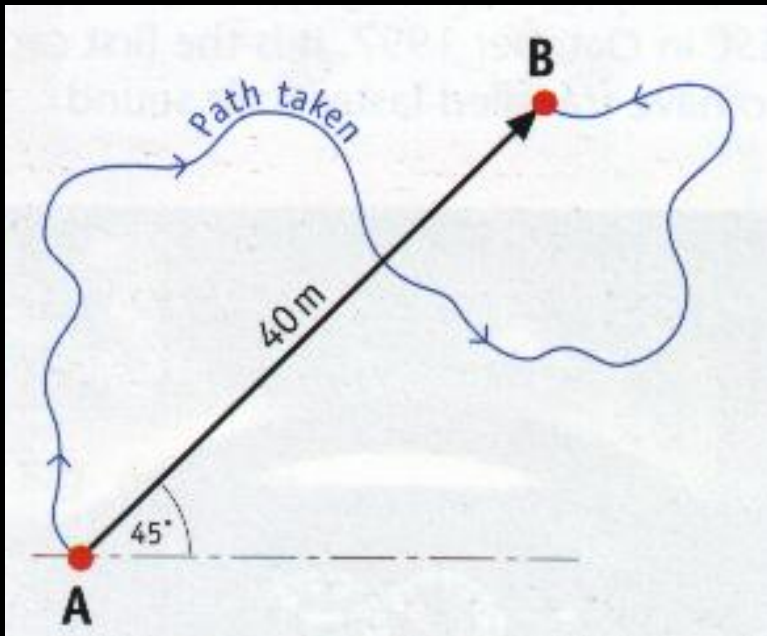
$$17.5 = \frac{400}{t}$$

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

$$= 22.9 \text{ s}$$

Displacement

Distance in a given direction



Displacement = ??

= 40 m north-east

Distance travelled = ??

Displacement

Distance in a given direction

Symbol

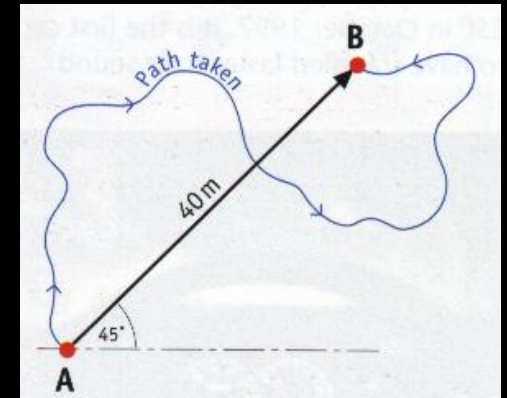
s

Unit

metre (m)

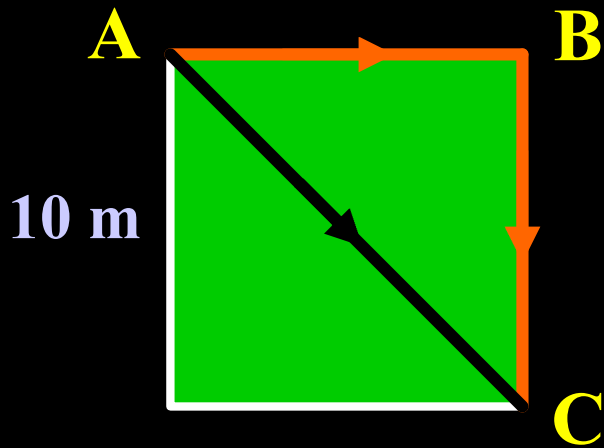
Vector

... magnitude & direction



Grass **Path**

A → B → C



Distance = ??

Displacement = ??

Distance = 20 m

Displacement = $\sqrt{200}$ m, E45°S

Velocity

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

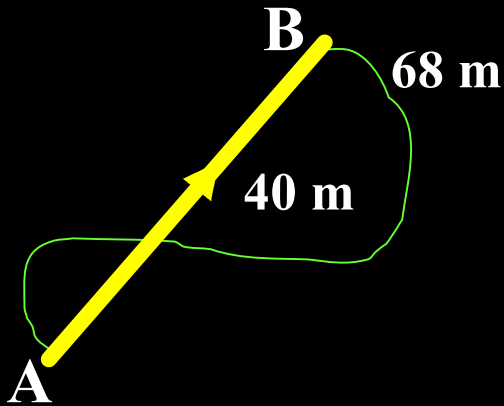
Example	15 m s⁻¹	north
Symbol	<i>u</i> <u>or</u>	<i>v</i>
Unit	m s⁻¹	

Velocity

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

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

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

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

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

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

Constant Velocity

Average Velocity

Instantaneous Velocity

Changing Velocity

==> Acceleration / (Deceleration)

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



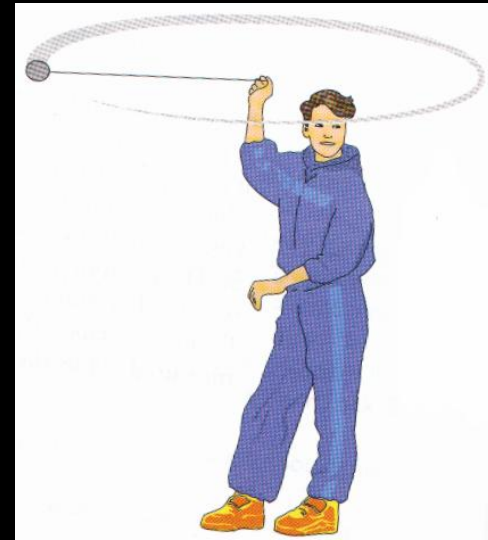
Changing Velocity

Acceleration / (Deceleration)

Magnitude changing



Direction changing



Measuring Velocity & Acceleration

Powder Track Timer

Air Track Timer

Ticker Tape Timer

Powder Track Timer



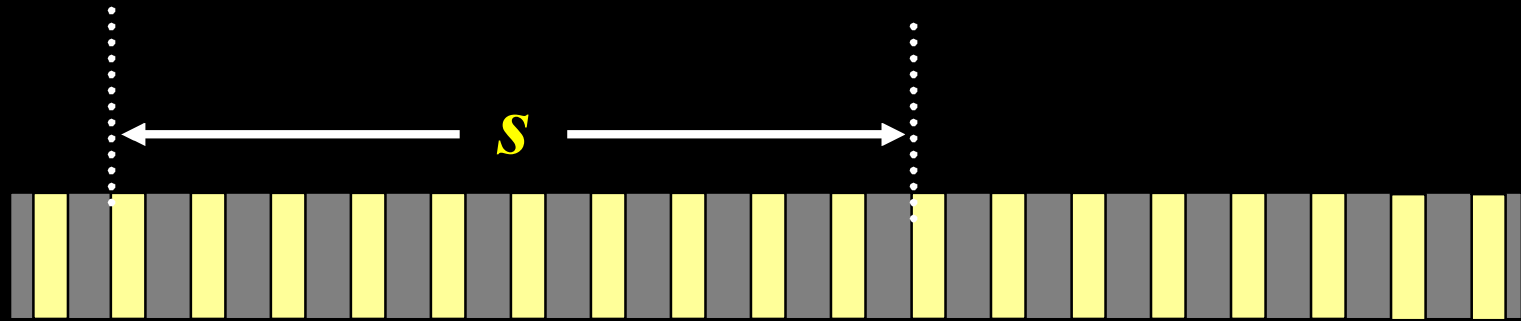
Trolley

A.C. Power Supply

Track

Sulphur Powder

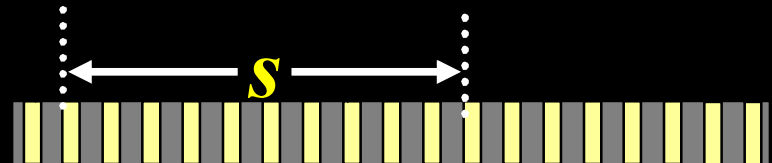
PTT - Measuring Velocity



$$\text{Velocity} = \text{spread of 10 patches} \div (10 \times 0.02)$$

Results

(PTT - Measuring Velocity)



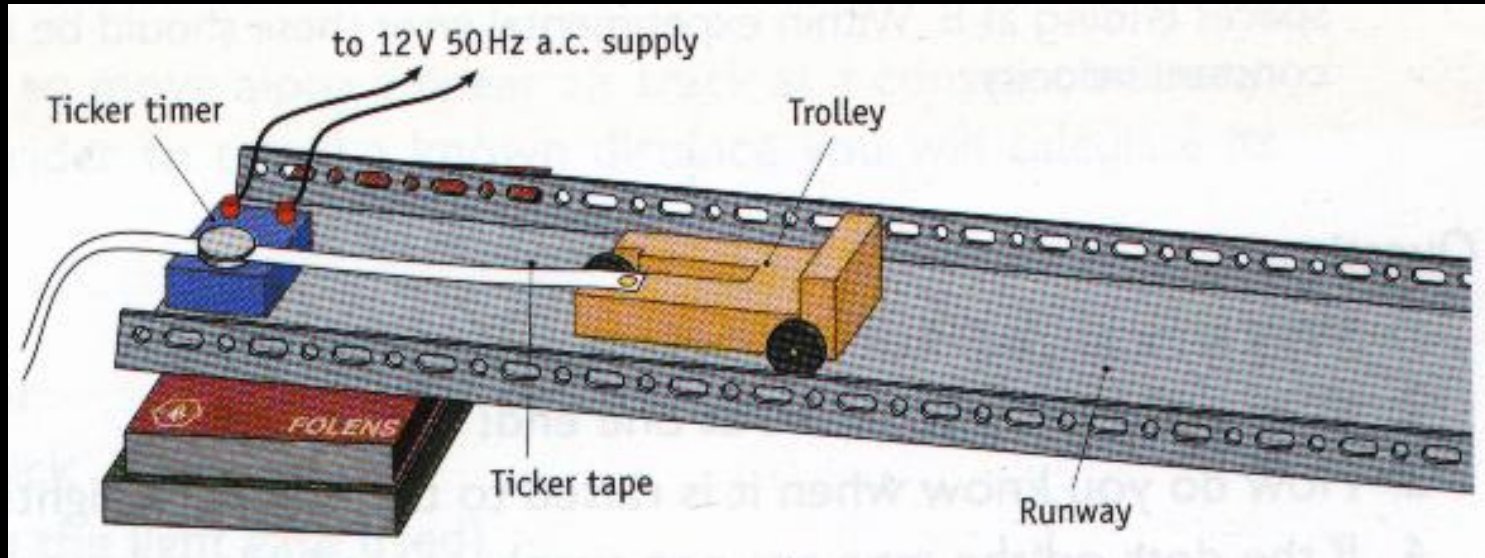
Distance (Spread) s / m	No. Of Patches n	Time Taken t / s ($= n \times 0.02$)	Velocity $v / m s^{-1}$

Average Velocity =

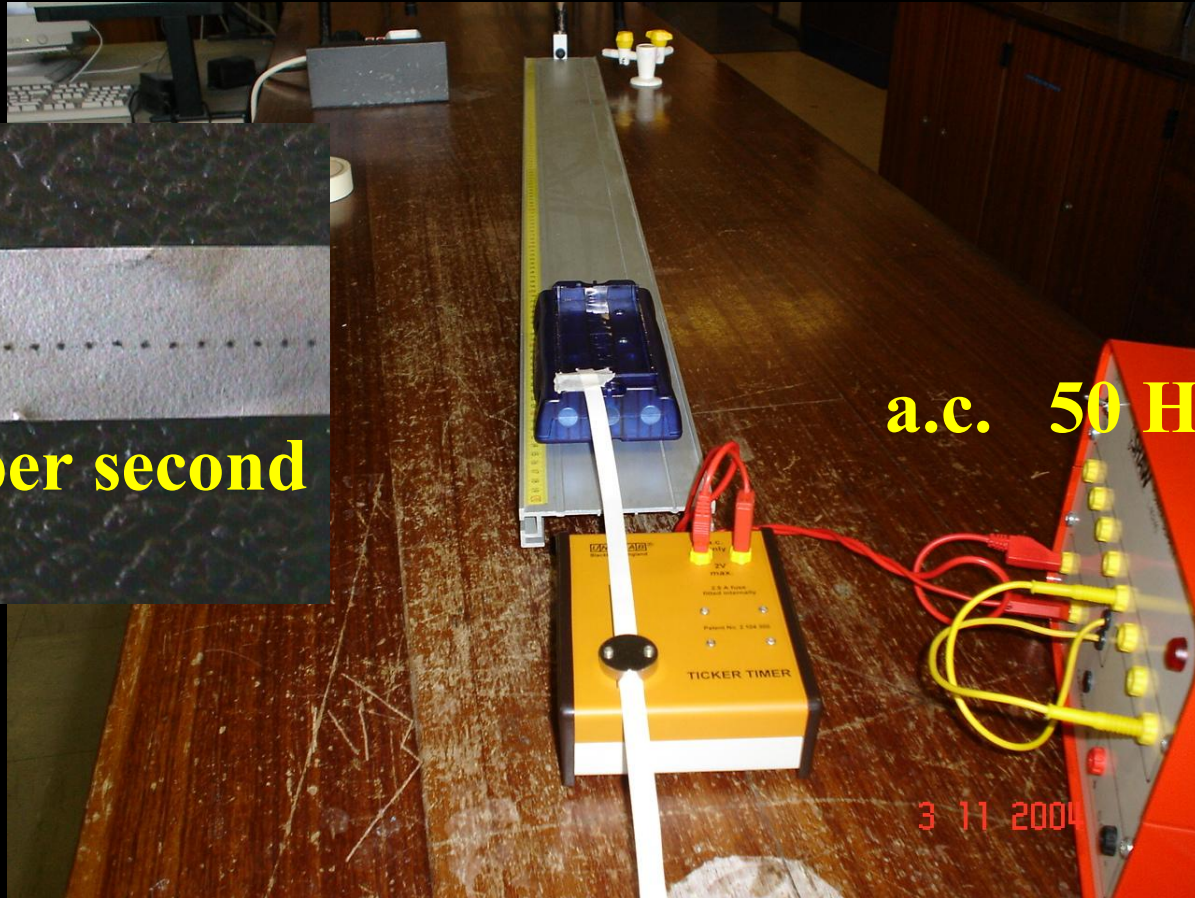
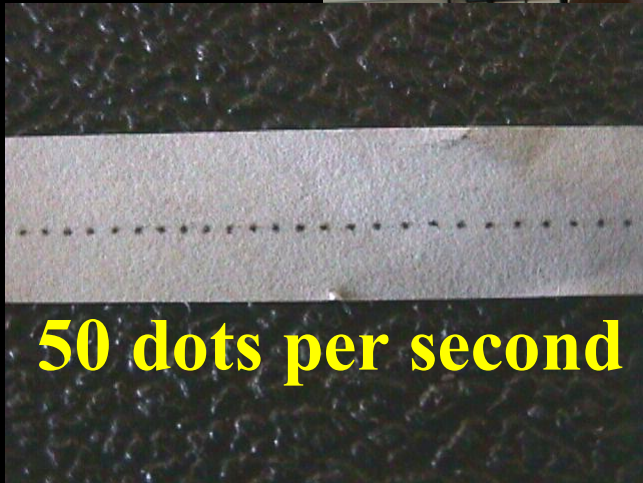
PTT - Precautions

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

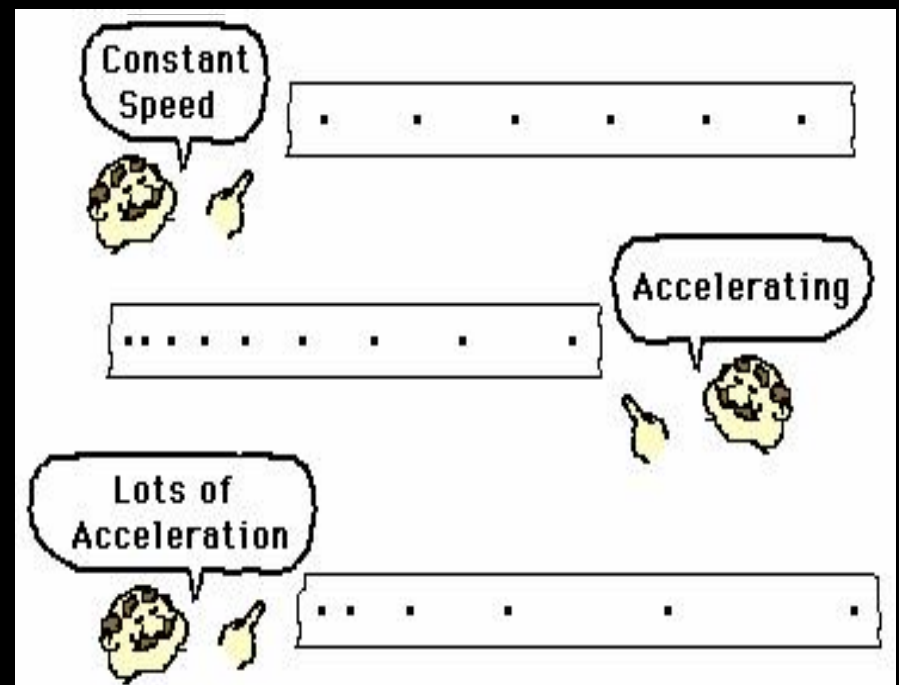
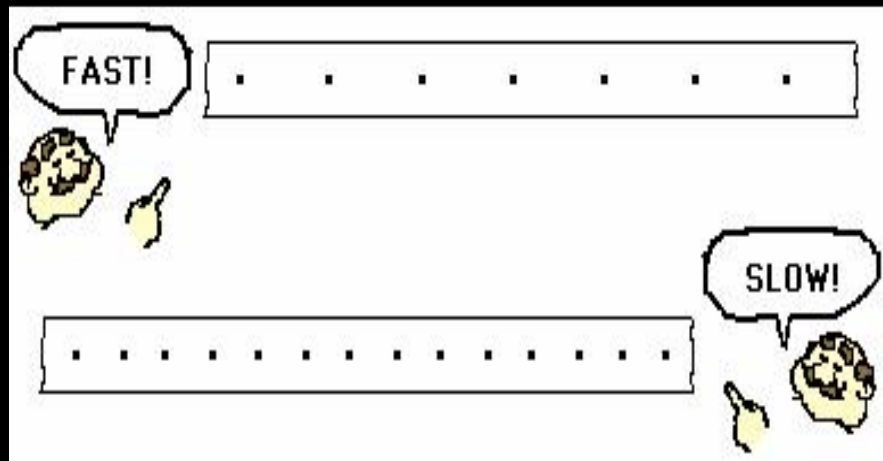
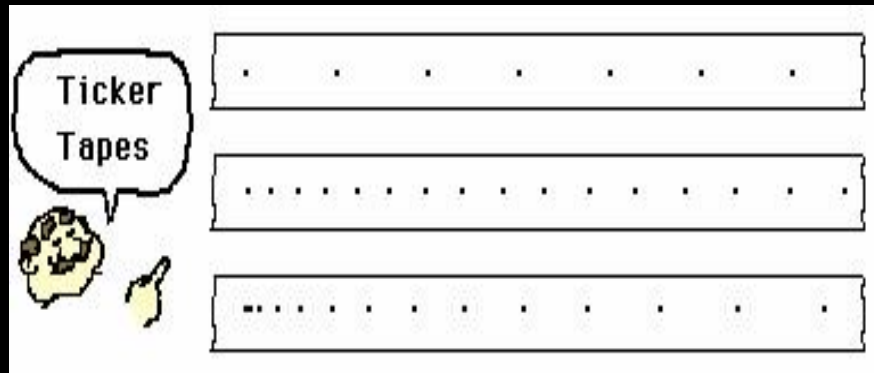
Ticker-Tape Timer



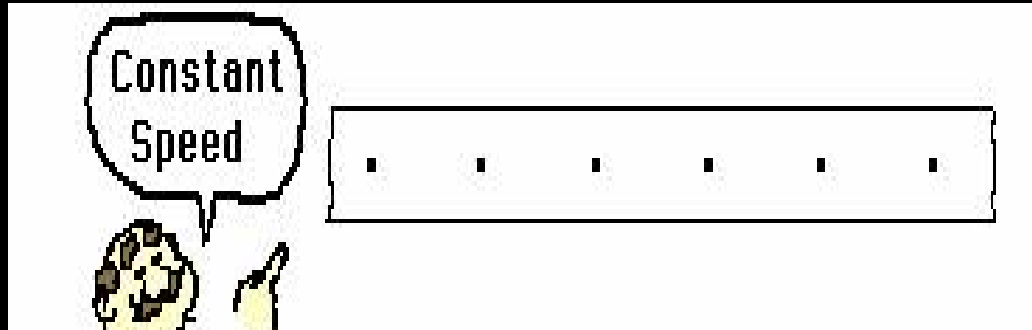
Ticker-Tape Timer



Ticker-Tape Timer



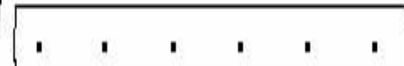
Ticker-Tape Timer



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

Results (Ticker-Tape Timer)

Constant Speed

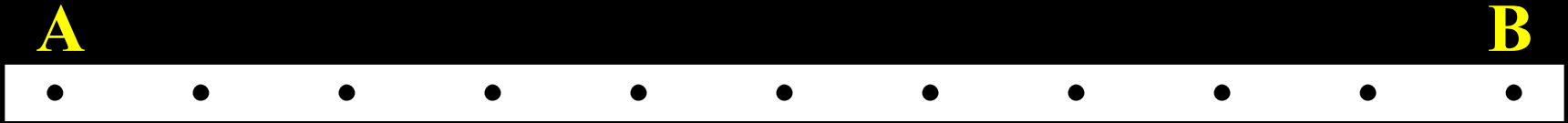


$$Speed = \frac{\text{Spread of 10 spaces}}{10 \times 0.02}$$

Distance (Spread) <i>s / m</i>	No. Of Spaces <i>n</i>	Time Taken <i>t / s</i> (= <i>n</i> x 0.02)	Velocity <i>v / m s⁻¹</i>

Average Velocity =

Ticker-Tape Timer



$$AB = 15 \text{ cm}$$

10 spaces between A and B

$$\Rightarrow \text{Time} = 10 \times 0.02 \text{ seconds}$$

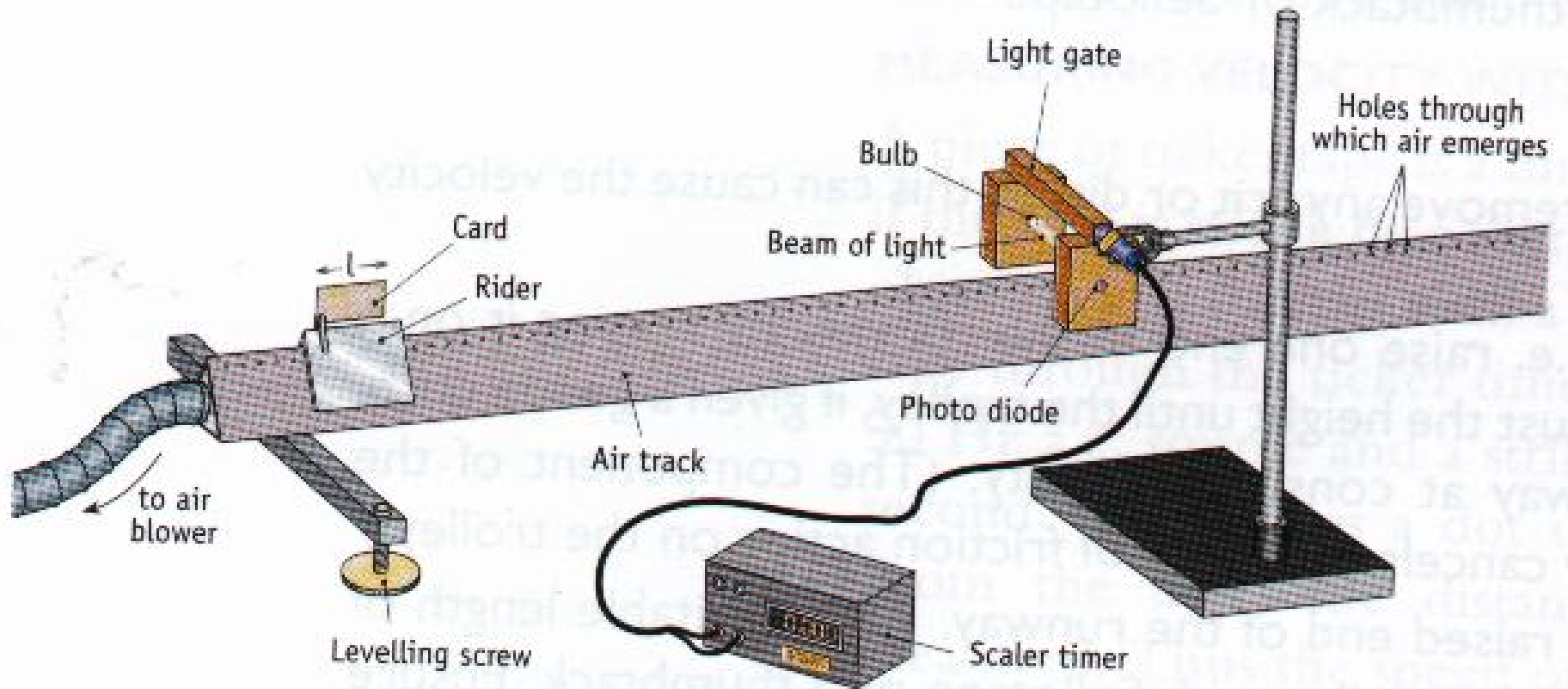
$$\text{Velocity} = \frac{\text{displacement}}{\text{time}}$$

$$= \frac{15}{10 \times 0.02}$$

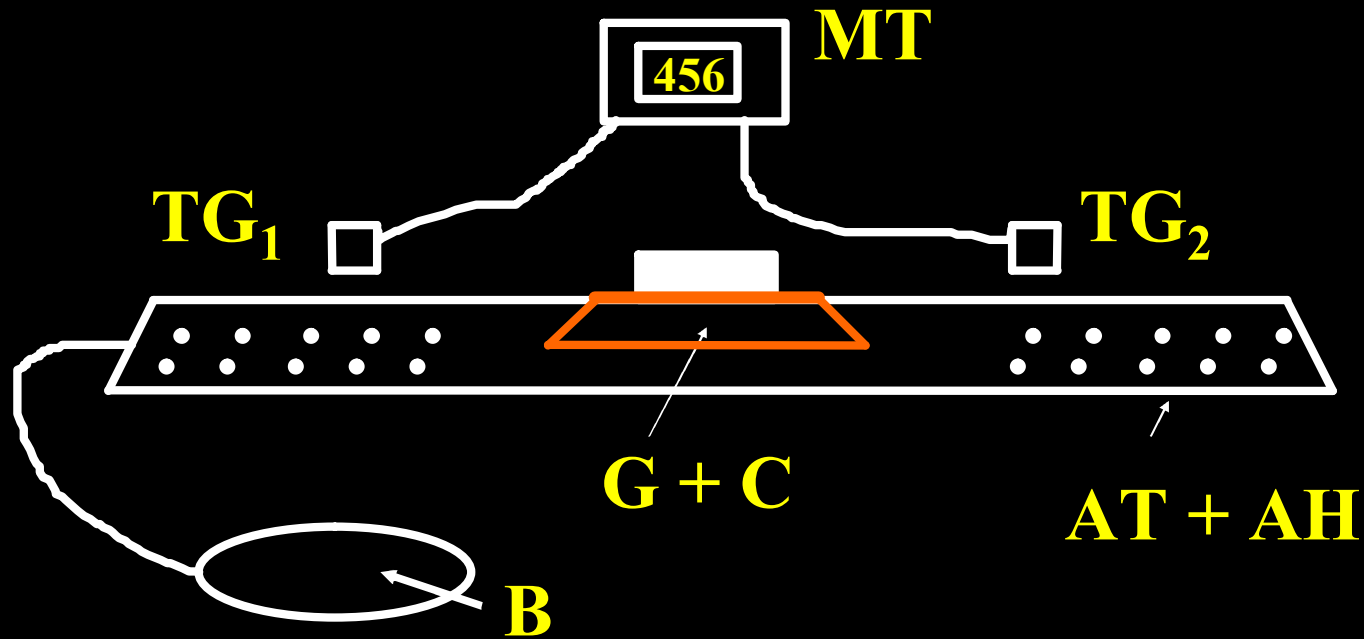
$$= 75 \text{ cm s}^{-1}$$

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

Air Track Timer



Air Track Timer



Air Track + Air Holes

Timing Gates

Blower

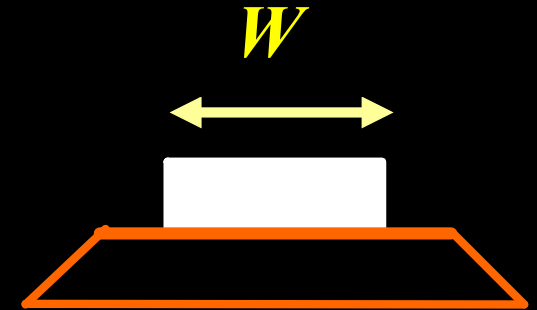
Glider + Card

Millisecond Timer

ATT - Measuring Velocity

Only one timing gate is needed.

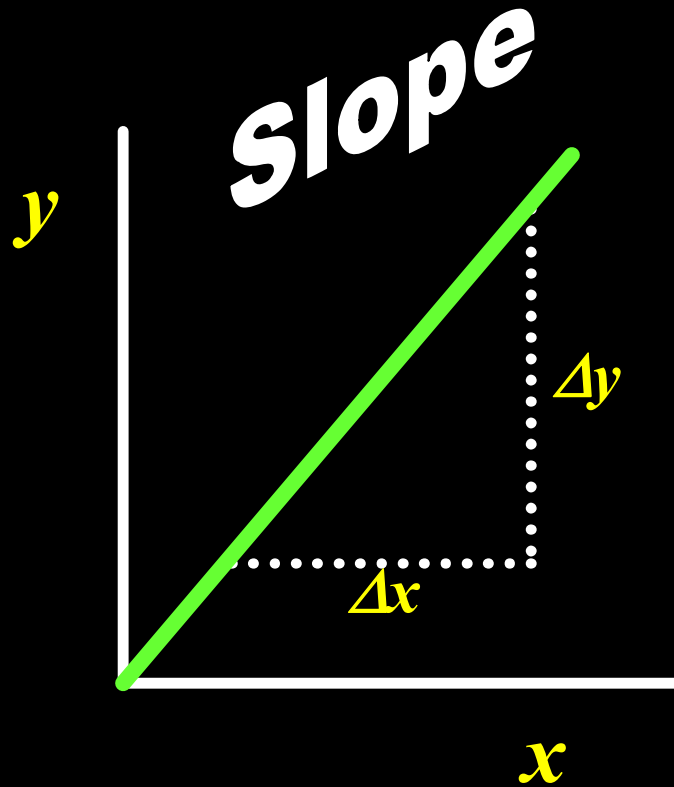
$$\text{Velocity} = \frac{\text{Width of card } (W)}{\text{Time from gate}}$$



Precautions

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

Graphs



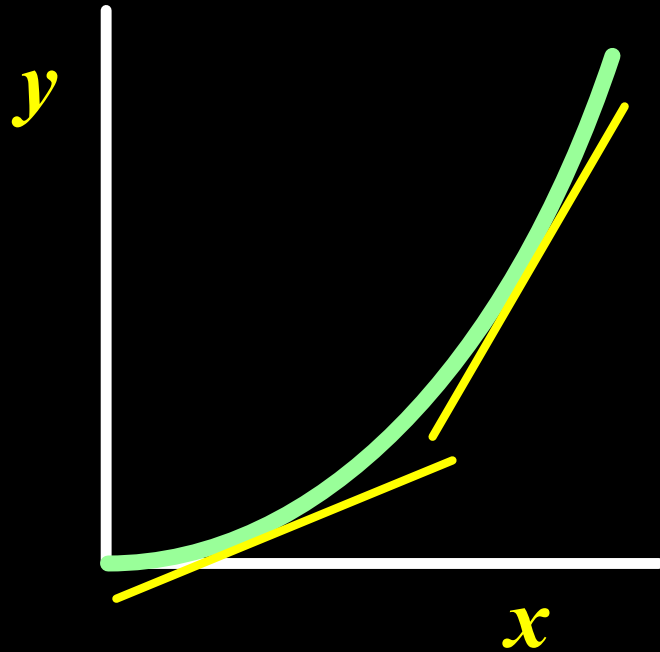
$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1}$$

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

Δy = change in y

Δx = change in x

slope

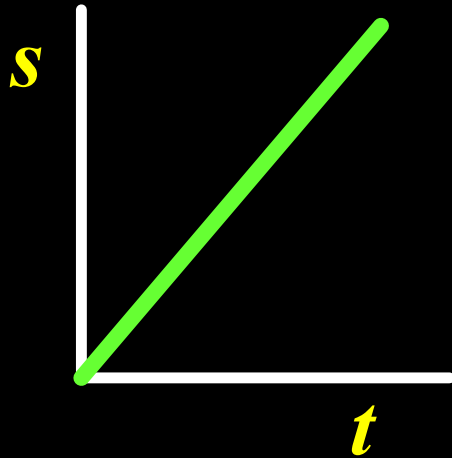


Graphs

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

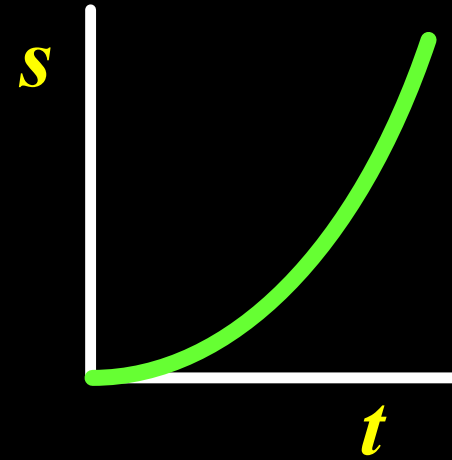
increasing

Distance - Time Graphs



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

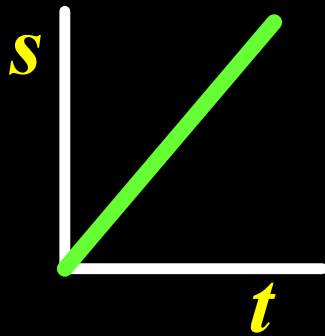
$$\text{Slope} = \text{speed } (v)$$



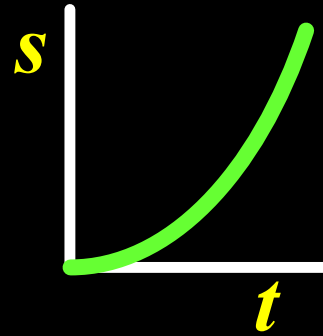
Speed
increasing

Distance - Time Graphs

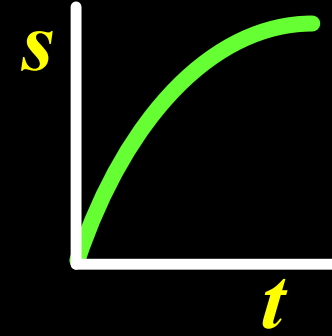
Is speed - increasing, decreasing or constant ??



Constant



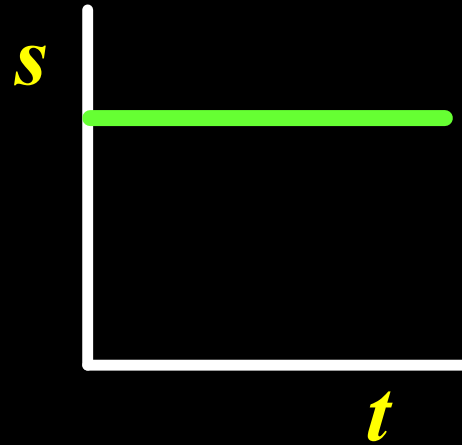
Increasing



Decreasing

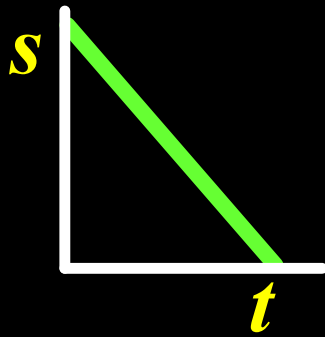
Distance - Time Graphs

Speed = ??

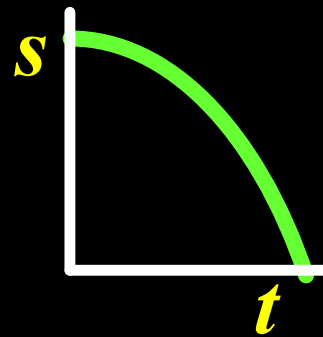


Distance - Time Graphs

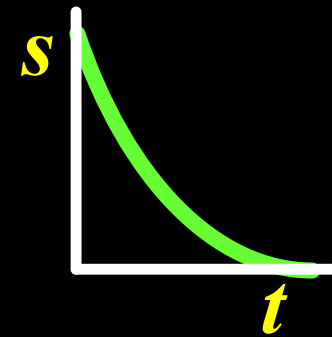
Is speed - increasing, decreasing or constant ??



Constant
(approaching)



Increasing
(approaching)



Decreasing
(approaching)