The study of motion

KINEMATICS

Introduction Video

Scalar Quantities

- Scalar quantities have magnitude, but no direction.
- Examples are Speed, Distance, and Time

With your group, brainstorm additional quantities with magnitude, but no direction?

- Age
- Mass
- Height
- Size
- Length
- Width
- Temperature (unless you say which direction!)
- Density

With your group, discuss how you would measure speed?

$$Speed = \frac{Distance}{Time} \qquad v = \frac{d}{t}$$

The most common units are meters/second or kilometers/hour

- **Instantaneous Speed**: Speed at a particular instant!
- **Average Speed**: Calculated with total distance travelled, divided by total time of travel

$$v_{av} = \frac{\Delta d}{\Delta t}$$

With your group, discuss how you would measure time?

$$Time = \frac{Distance}{Speed} \qquad t = \frac{d}{v}$$

With your group, discuss how you would measure distance?

$$Distance = Speed * Time \qquad d = v * t$$

Linear Motion in One Dimension Example Problem

1. What is the average speed of a cheetah that springs 100 meters in 4 seconds?

What we know:

d = 100 meters

t = 4 seconds

Required:

v = speed??

Equation:

$$v_{av} = \frac{\Delta d}{\Delta t}$$

Solve:

$$v_{av} = \frac{100\ m}{4\ sec} \qquad v_{av} = 25\ m/s$$

Therefore, the average speed of the cheetah is 25 m/s.

Linear Motion in One Dimension Example Problem

2. If a truck has an average speed of 60 km/h, how far will it travel in 10 hours?

What we know:

v = 60 km/h

t = 10 hours

Required:

d = distance??

Equation:

$d = v * t$

Solve:

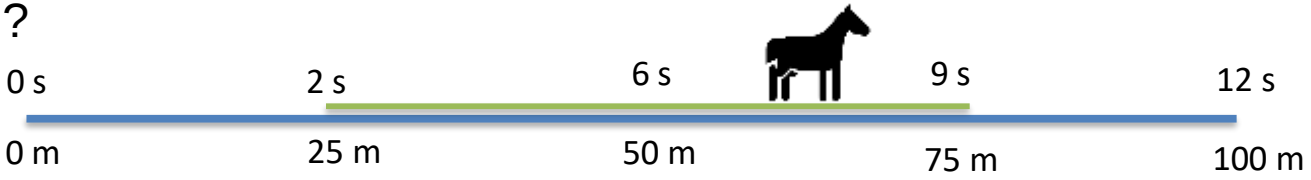
$d = 60\ km/h * 10 hours$

$d = 600\ km$

Therefore, the truck will travel 600km if it is travelling at an average speed of 60km/h for 10 hours.

Linear Motion in One Dimension Example Problem

3. What is the average speed of a horse in the middle 50 meters of a 100 meter track in?



What we know:

Δ d = 75 m – 25 m

Δ d = 50 meters

Δ t = 9 s – 2 s

Δ t = 7 seconds

Required:

v = speed??

Equation:

$$v_{av} = \frac{\Delta d}{\Delta t}$$

Solve:

$$v_{av} = \frac{75\ m\ - 25\ m}{9\ s\ - 2\ s} \qquad v_{av} = 7.14\ m/s$$

Therefore, the average speed of the horse in the middle 50 m of the 100 meter track is 7.14 m/s.

In your groups, design and conduct a working experiment.

Your Tasks:

- Design and conduct a working experiment to calculate the average speed of an object
- Code a Micro:bit timer that detects the motion of your object
- Include a detailed procedure
- Include materials needed
- Include at least 3 trials
- Include a completed observation table with calculations of the average speed
- Distance – Time Graph of results.

Use the previous problem solving slide to help design your experiment!

Example Observation Table

Trial #	d1 (meters)	T1 (seconds)	d2 (meters)	t2 (seconds)	Calculate Average Speed (m/s) $v_{av} = \frac{\Delta d}{\Delta t}$
1					
2					
3					

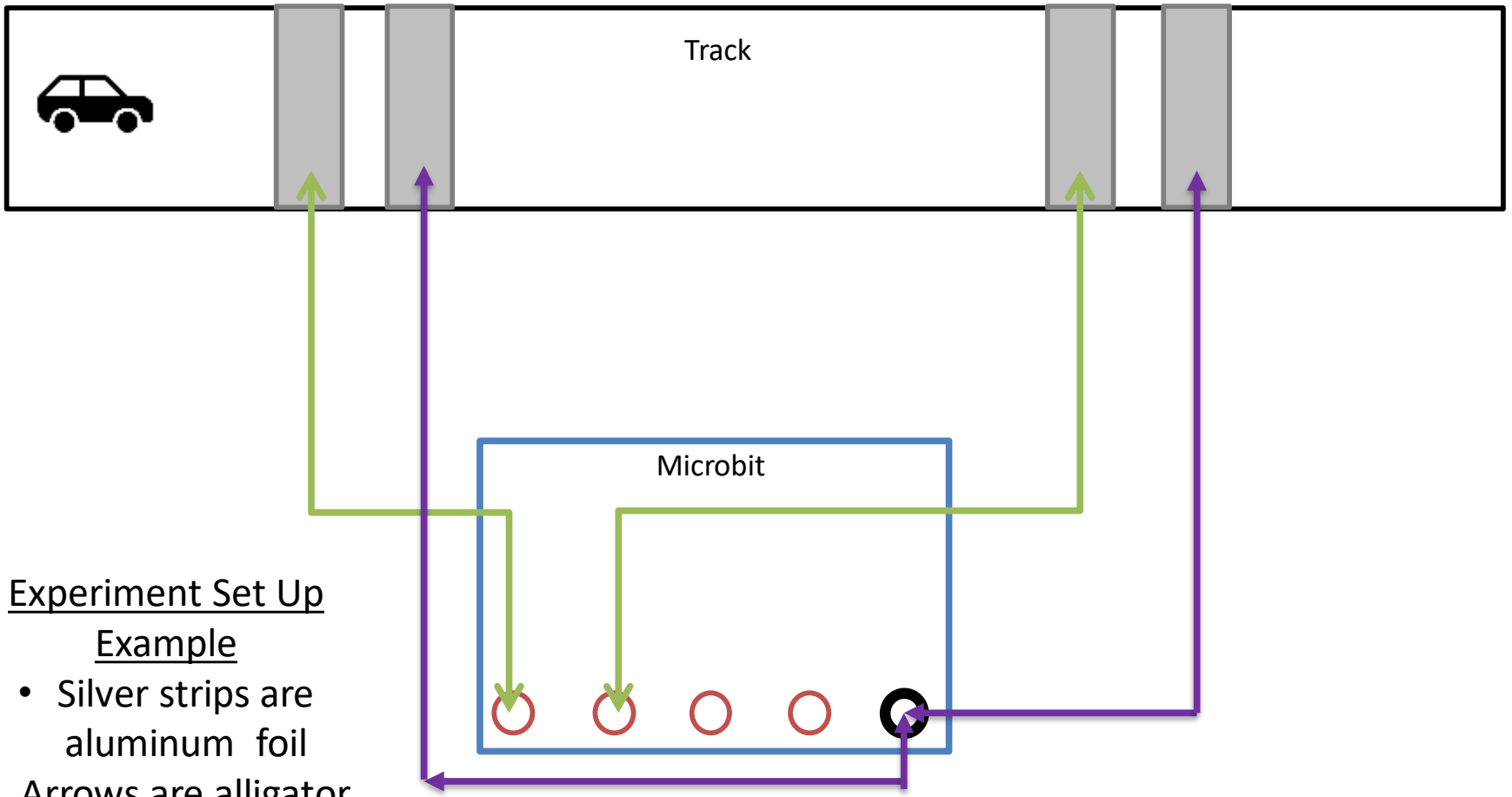
To submit:

Video

- 1 minute abstract video stating the purpose, condensed procedure, and results.

Typed Formal lab Sections:

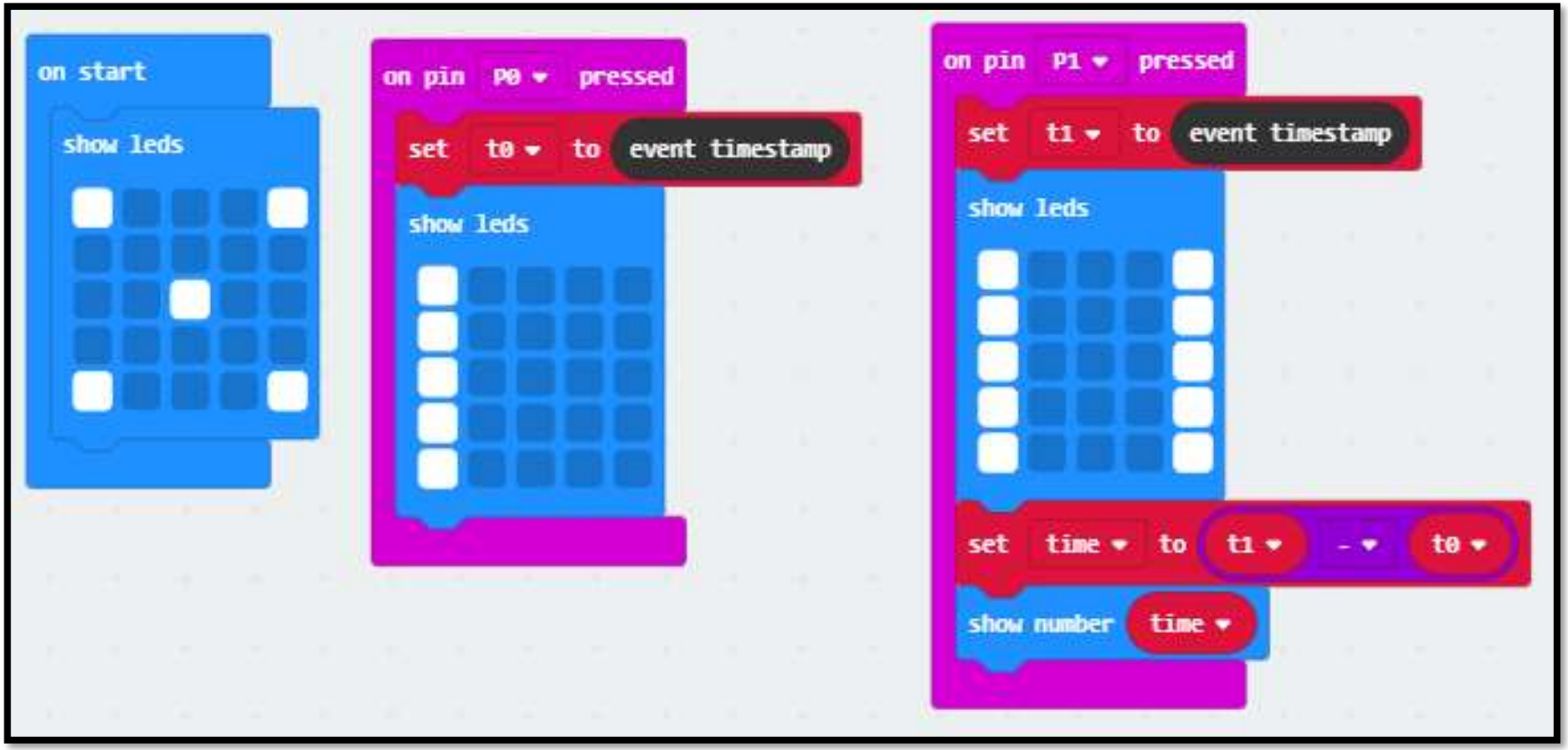
- Detailed procedure (numerical list form)
- Include a completed observation table with the average speed calculations
- Distance-Time Graph of Results
- The code for your Micro:bit timer that detects the motion of your object



Experiment Set Up Example

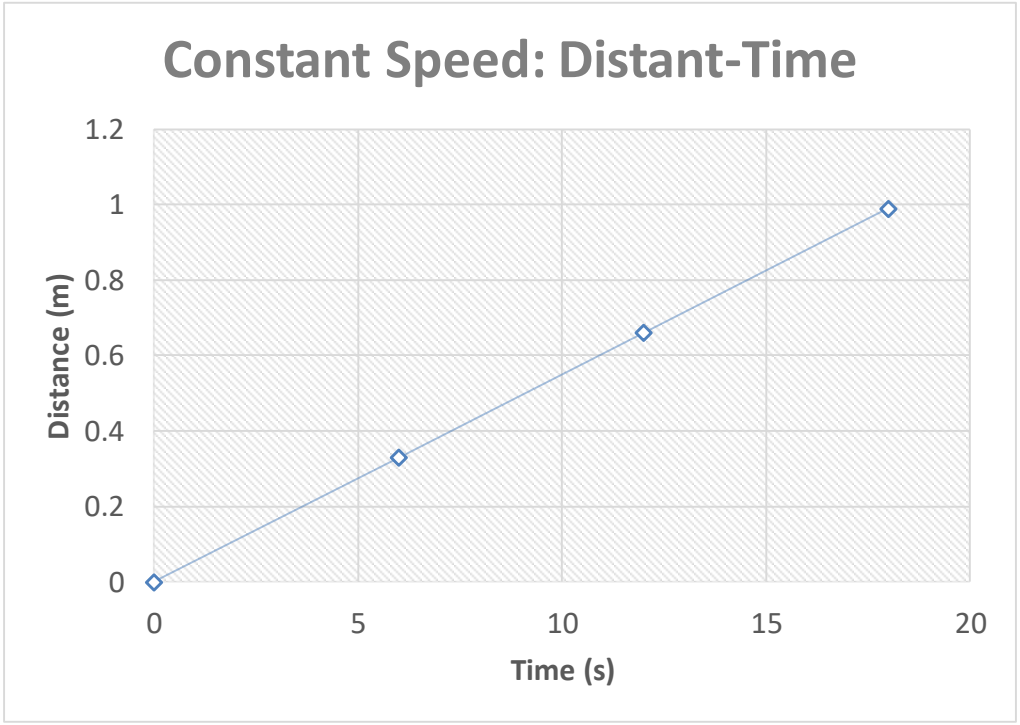
- Silver strips are aluminum foil
- Arrows are alligator clips

Example Timer Code



Example Distance-Time Graph

Time (t)	Distance (m)
0	0
6	.33
12	.66
18	.99



Consolidation

1. Describe any trends in your Distance-Time Graph.

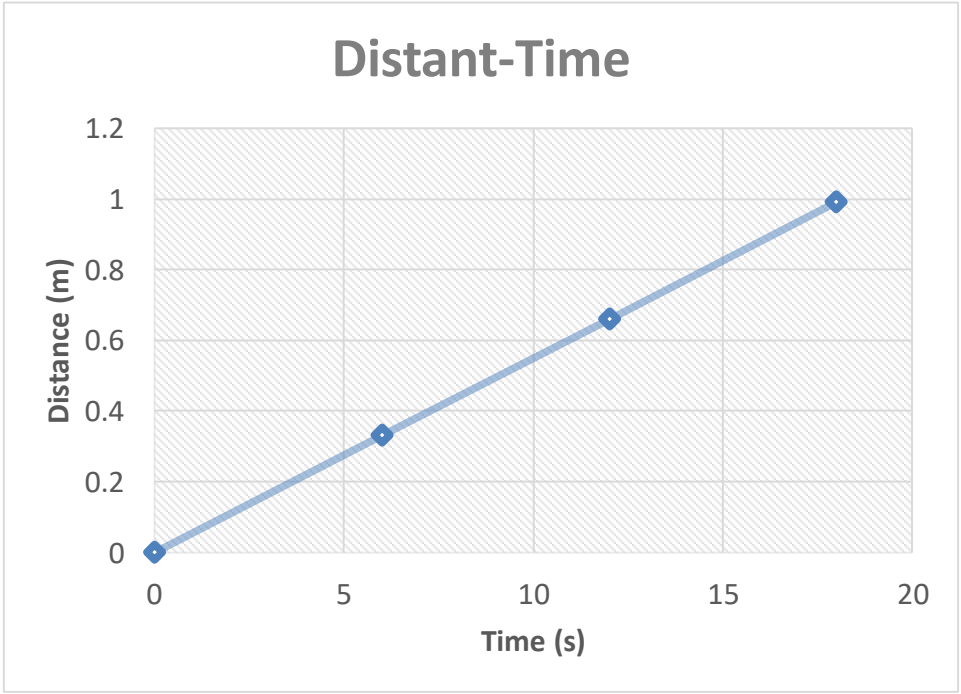
2. Create a Constant Speed-Time Graph of your results.

3. In the Olympic 200 m race, is it possible for the runner with the greatest speed crossing the finish line to lose the race? Explain?

Describe any trends in your Distance-Time Graph.

There is a positive linear trend, showing there is a consistent speed.

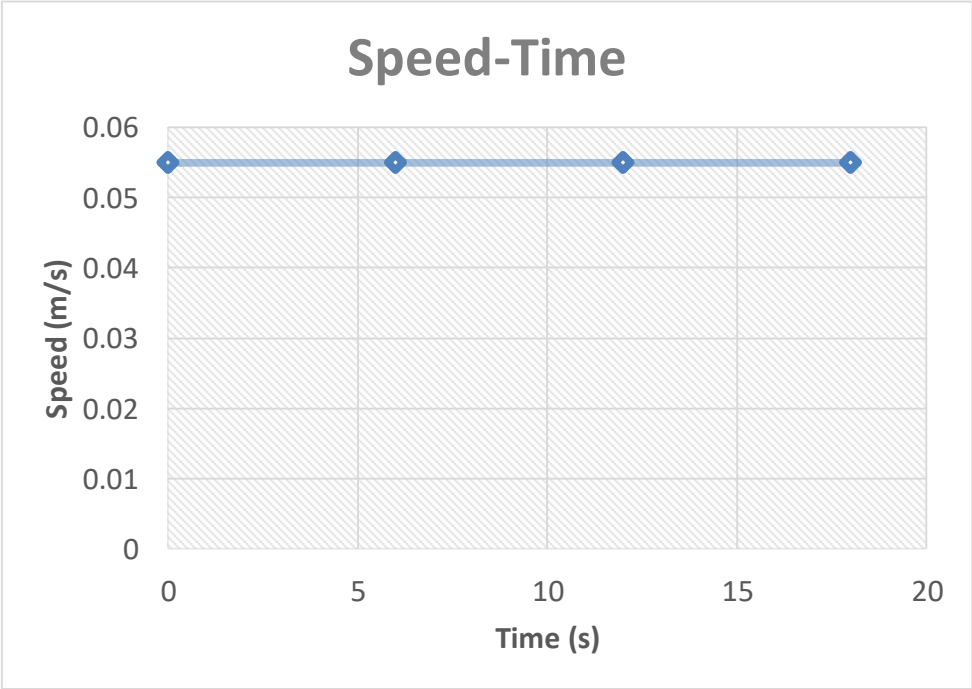
Time (t)	Distance (m)
0	0
6	.33
12	.66
18	.99



Create a Constant Speed-Time Graph of your results.

There is a straight horizontal line because the speed is constant.

Time (t)	Distance (m)	v = d/t
0	0	0
6	.33	0.055 m/s
12	.66	0.055 m/s
18	.99	0.055 m/s



Consolidation

In the Olympic 200 m race, is it possible for the runner with the greatest speed crossing the finish line to lose the race? Explain?

Yes, it is possible! The runner with the greatest speed at the end could win if they just had a burst of speed at the end but their average speed was lower.