

Speed

Learning Aims	
Knowledge	Skills
• Speed can be recorded in a range of units which can be inter-converted • Instantaneous speed is the speed over a short time period • Average speed is the speed for a whole journey • The calculation of speed, distance and times	• Working collaboratively • Using stopwatches • Measuring distances to an appropriate level of precision • Construction and interpretation of distance-time graphs and speed-time graphs • Appreciate the difference between speed and velocity

Simplifying:

Graph axes can be pre-prepared for students for both distance-time and speed-time plots

Extending:

Students can calculate gradients from the graphs and work out what they mean. Students could also explore velocity-time graphs, where the line will go below the x-axis indicating backwards movement.

Slides 18 through to 24 give additional elaboration about the theme of speed, and introduce the concepts of **relative speed** with two adjacent moving objects, the **speed of light**, and the difference between **speed and velocity**.

In this lesson, students build an understanding of the concept of speed as well as growing in confidence with using simple equipment and evaluating the quality of data.

The plotting and interpreting of graphs presents opportunities for in-context teaching of mathematics

There are also independent work materials for students containing photographs and video links in the VLE Folder of resources and a simulation experiment.

Speed

Teaching Guide	
0-15 minutes	Slides 1-3 Introduce theme of Speed. Explain it can be quoted using many different units. If we know the speed and the distance, we can estimate the time a journey can take etc. Slides 4 & 5 show simple calculations Slides 6 & 7 show an application of Siemens engineering technology in action and allows students to also consider the difference between instantaneous speed and average speed. Further information on Safezone is available with the other resources in this unit.
10-20 minutes	Slide 8 Explain the activity: Select your preferred toy from the selection – ideally the toys will be slow moving clockwork toys which will last more than 20 seconds. Students start the toy running alongside a metre ruler and record the distance covered after each 5 second interval. This can be adjusted if the toys do not run for so long. This activity can be extended to use faster toys outside, students walking or running, or even insects running along narrow tracks!
20-30 minutes	Slide 9 Handout the Student Class Work Sheet. Student work through the questions on a range of questions relating to speed, distance, and time. Slides 10 to 12 Review the answers Slide 13 Optional slide with a more advanced question
30-40 minutes	Slide 14 Show how the distance-time graph is constructed, and encourage the students to draw a distance-time graph for their activity results. Basic Give the students pre-prepared graph axes Advanced Students calculate gradients for the different sections of their graph.
40-50 minutes	Slides 15 & 16 Introduce the concept of speed-time graphs and share the information they can provide
50-60 minutes	Slide 17 Hand out the Formula E speed-time graph blank This is the Miami Formula E from 2015. If the embedded video will not run, it can be found at https://www.youtube.com/watch?v=qTKqeL_UTqI If students have access computers, (either working in groups or individually) watch the video carefully noting down the speed shown in the graphic for each corner (by corner number from the commentary) Note – max speed is 180, min speed is 60 km/h and the lap lasts 69 seconds. Ask students to plot a basic speed-time graph. Slides 18 & 19 Compare their estimated graphs to the real data, and encourage students to annotate their sketches with similar labels, and relate high and low speeds to features on the track
	Slide 27 – end/summary.
Extension	Slides 20 – 26 Contain introductory materials for the concepts of the constant speed of light, relative speed with moving objects, and the difference between distance, displacement, speed and velocity.

Speed

If computers are available, students could explore the simulation Moving Man, which allows them to see the relationship between distance (position), speed and time, and create graphs for their own situations. This simulation is kindly provided by the University of Colorado.

<http://phet.colorado.edu/en/simulation/moving-man>

Range of clockwork toys	Locally sourced	
Stopwatches	Locally sourced	
Metre rulers (or longer measuring tapes)	Locally sourced	
Alternative moving objects to measure		
Pre-prepared graph axes if required		

Notes:

- Clockwork toys are better than battery operated as the speed will change during the activity allowing the discussion of instantaneous speed vs average speed.

Safety:

Hazard	Likelihood	Injury	Action Recommended
Toy falling and injuring	likely	minor	Only small light toys used on table tops. Heavier moving toys tested on floor

Typical Results

Time (s)	Distance (cm)	Speed (cm/s)
0	0	
5	6	1.2
10	12	1.2
15	17.5	1.1
20	22	0.9
25	24	0.4
30	24.5	0.1

Speed

Worked Solutions for student question sheet

1. $speed = \frac{distance}{time} = \frac{300\text{ m}}{20\text{ s}} = \mathbf{15\text{ m/s}}$

2. $speed = \frac{distance}{time} = \frac{50\text{ m}}{10\text{ s}} = \mathbf{5\text{ m/s}}$

3. $speed = \frac{distance}{time} = \frac{90\text{ m}}{45\text{ s}} = \mathbf{2\text{ m/s}}$

4. $speed = \frac{distance}{time} = \frac{3000\text{ m}}{15\text{ s}} = \mathbf{200\text{ m/s}}$

5. $time = \frac{distance}{speed} = \frac{5\text{ m}}{0.1\text{ s}} = \mathbf{50\text{ s}}$

6. $distance = speed \times time = 12 \times 5400 = 64800\text{ m, or } \mathbf{64.8\text{ km}}$

7. $speed\text{ (Tianjin} - \text{Beijing)} = \frac{distance}{time} = \frac{55000\text{ m}}{3000\text{ s}} = \mathbf{18.3\text{ m/s}}$

This average speed is within the speed limit

7. Continued

$$speed\text{ (Baoding} - \text{Beijing)} = \frac{distance}{time} = \frac{159000\text{ m}}{5400\text{ s}} = \mathbf{29.4\text{ m/s}}$$

This average speed is in excess of the speed limit

Average speed = total distance covered / journey time

Instantaneous Speed = the speed at which it is travelling in a very short period.

The instantaneous speed may be much greater or much less (even zero) than the average speed.