MODULE: *Marvellous Motion*

Episode 1: How Fast?

Episode Teaching Guide

Learning Objectives

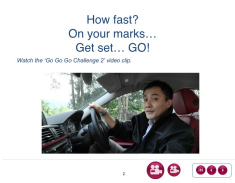
Students will be able to**:**

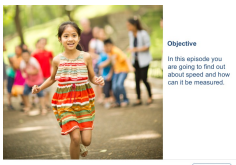
- compare the speed of different objects by observation.
- compare the speed of falling objects through measurement of time (and distance).
- calculate the speed of a moving object from given data and be able to sketch a graph to show the motion of an object.

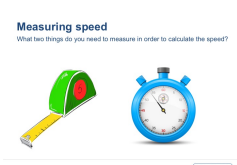
Note: It may be useful for you to try out the Interactive for yourself before teaching Episode 1, to ensure that you are familiar with the content of this module.

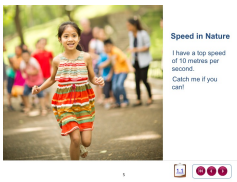
Running the Activity

This episode covers a range of higher order thinking skills including scoping the problem and the development of research techniques in investigating a parachute activity. The activity is flexible and open ended in that it gets the students to think about what variables they can change in order to investigate the effect of drag under the influence of gravity ipon a falling object and parachute. The experimental procedure is repeated three times each time enabling the student to better construct their own personal understanding of what is happening.









Period 1
Activity 1.1 – Hot lap at Sepang

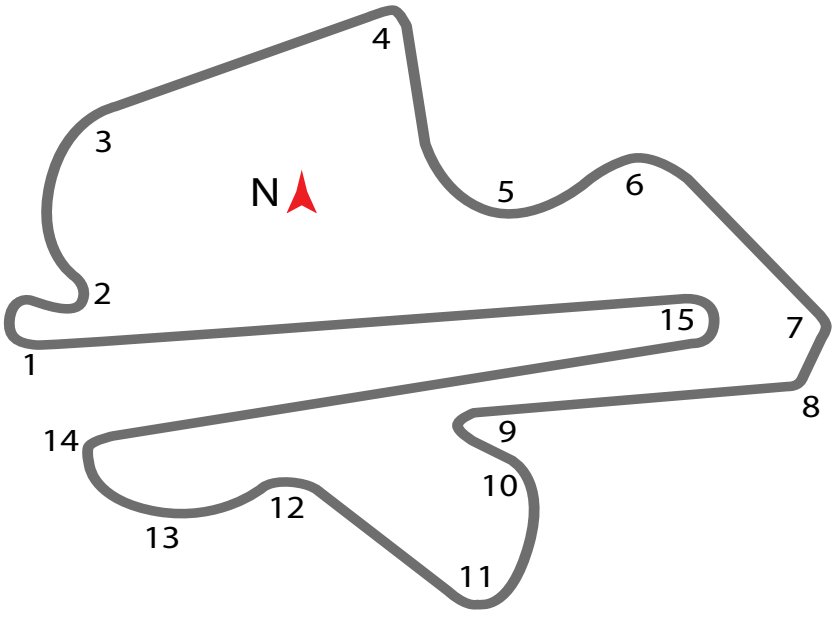
- Introduce this module by showing PPT slide 1, then using the video clip; ‘Go Go Go Challenge 2’ on PowerPoint slide 2. While the students are watching the video they should note the speeds and time displayed on the screen during the time trial.
- After the video clip, ask your students to discuss the car journey they have seen. When was the car travelling the fastest? How does this affect the distance travelled by the car during this period?

- Try to elicit from them that higher speed means that more distance is covered in a certain interval of time. Help them to understand this concept in their mind's eye, as well as using data to confirm it.
- Which parts of the time trial allow the fastest speed to be reached? What would this mean for the distance covered in each second of time on one of these parts of the circuit compared to one of the bends?
- The long straights allow the greatest speed to be reached, when the distance travelled in each second (per second) is much greated than on the turns.
- Introduce the learning objective for this episode with PPT slide 3.
- Show PPT slide 4 and ask the students to discuss it in pairs for a few minutes. In the course of their discussion, they should become aware that the measurements needed to calculate speed are the distance travelled and the time taken.
- You may also wish to introduce the equation:

$$\text{Average speed} = \frac{\text{Total distance travelled}}{\text{Total time taken}} \quad \begin{matrix}\text{(in metres)} \\ \text{(in seconds)}\end{matrix}$$

and a unit for speed, which is metres per second, written as m/s.

- This new knowledge can be consolidated by using data from the Sepang race circuit.
- For any students who do not already know, the Sepang International Circuit is a race track quite near to KL airport, and is where the Formula 1 Malaysian Grand Prix and other high-profile car and bike races are run.



- Tell your students to note down that the Sepang Circuit is 5.543km (or 5,543m). And to note the fastest time recorded for a lap, which was 1 minute, 34.223 seconds (or 94.223 seconds). (This was achieved in a Formula 1 race in 2004, by Juan Pablo Montoya in a Williams–BMW).

  So his speed was... Ask if any of your students can work out the speed. If they don't have a calculator, an approximate answer will be fine.

  Average speed = 5543 ÷ 94.223 = 58.83m/s (or, approximating, 5550 ÷ 100 = 55.5 m/s). (The actual speed was more than 210 kph!)

  You could also consider the world's fastest runner - Usain Bold. In Beijing in 2008, his world record time for 100m was 9.58 seconds.

  So his speed was…
  Average speed = 100 ÷ 9.58 = 10.4m/s (or, approximating, 100 ÷ 10 = 10m/s)

  (and his actual speed was more than 37 kph!)

  Note: These values are the average speeds for each whole race. At times the car/ runner will be going faster than the average, and at other times more slowly.

- Hand out Activity Sheet 1.1, then show PPT slides 5, 6 and 7.
  Students first need to match the animals to the speeds given in the table:

Speed in m/s	Animal
28	Cheetah
18	Horse
17	Greyhound
16	Rabbit
15	Monkey
5	Lizard
2.5	Tiger Beetle
2	Red Crab

They then need to say which animals the girl (top speed = 10m/s) could outrun.
Answer: Lizard, tiger beetle, red crab.

Out of School Learning

Continur with the idea of highest speeds; ask students to complete a research exercise to identify three world record linked to speed. This may relate to the animal kingdom, cars, etc - students choice.

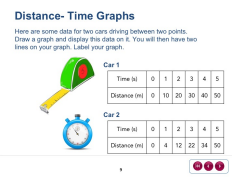
Resources

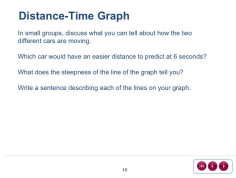
- *PowerPoint* Presentation- Episode 1: How Fast? On your mark...Get Set...Go!
- *Prezi* Presentation- Episode 1: How Fast? On your mark...Get Set...Go!
- Video clip ‘Go Go Go Challenge 2’
- Activity Sheet 1.1: Catch me if you can

You will need

- calculator

Period 2
Activity 1.2 – Acceleration – Go Go Go!





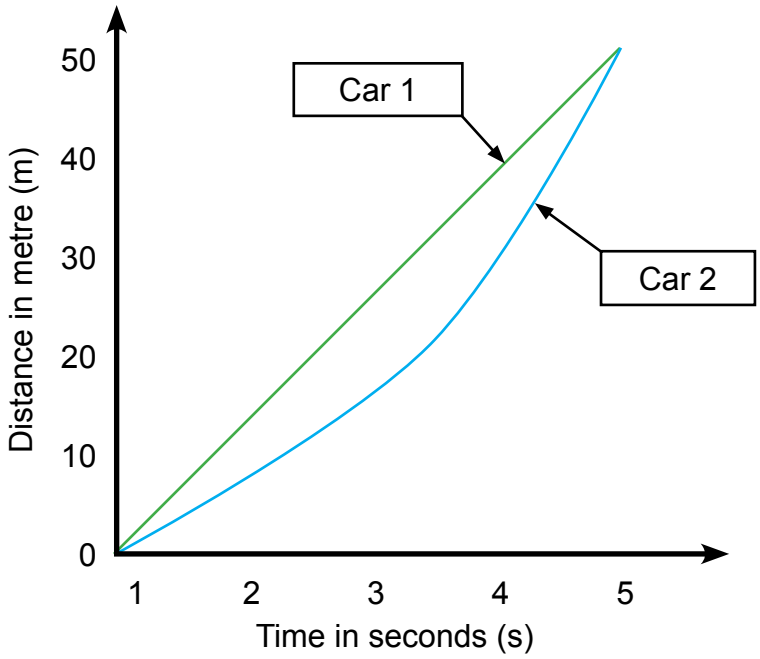
- This lesson looks at how distance–time and speed–time graphs can be used to display data for a journey and show the motion of an object.

- Hand out Activity Sheet 1.2.

- Show PPT slides 8 and 9. Students will need to draw up a graph and plot the data given. In order to compare the two cars, they should draw both lines on a single graph.

  Average speed = total distance travelled ÷ total distance travelled = 50 ÷ 5 = 10m/s for both cars.

  The straight line for Car 1 shows that it is travelling at a constant speed all the way through its journey. The curved line for Car 2 shows that it travels at a slower speed initially but then accelerates, so after 5 seconds it has covered the same distance as Car 1.



- Put the students into pairs to discuss the graph showing the motion of Car 1 and Car 2, and show PPT slide 10. This will help them summarise the outcomes of their discussions.

  It would be easier to predict the distance that Car 1 would travel after 6 seconds, as it is travelling at a constant speed.

  In this distance–time graph, the steepness of the line on the graph tells you the **speed** of the car at any instant in time. If the line on the graph is steeper, the car is travelling faster and if the line goes up more gently the car is not going so fast.

- Display the speed–time data from the video clip in Period 1. Ask students, working individually, to use the data to plot a graph of the journey of the car around the Sepang circuit.

- Their graphs should look like this:

  - In this speed–time graph, the steepness of the line will show how fast the car is accelerating.

  - If the line goes horizontal at any point, this will show the car is travelling at a steady speed.

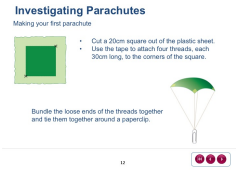
  - Students should be able to identify the highest speed, and the areas where acceleration/deceleration are taking place (ie where the line rises/falls).

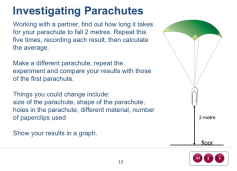
Resources

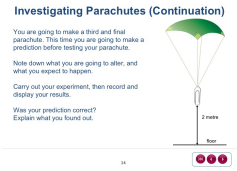
- *PowerPoint* Presentation- Episode 1: How Fast? On your mark...Get set...Go!
- *Prezi* Presentation- Episode 1: How Fast? On your mark...Get set...Go!
- Activity Sheet 1.2 Distance-time graph
- Data from Video Clip - 'Go GO Go Challenge 2'
- Graph Paper
- 30cm rulers
- Pencils

Period 3, 4, 5
Activity Sheet 1.3–1.5 Gravity and Fall – Investigating parachute

- Introduce this practical investigation using PPT slide 11 and Student Activity Sheet 1.3.
- This investigation will look at the physics of falling objects, in this case a parachute.
- Give the students time to read the introduction on their Activity Sheet. Make sure that they understand that a parachute only lessens the effect of gravity on the object hanging from it – the parachute doesn't reduce gravity itself.
- A simple parachute can be made using a square of thin plastic sheeting. This can be sourced from many areas: plastic carrier bags for shopping, protective plastic sheets used when painting, or sheeting purchased from a scientific supplier.







- Some students find drawing a square onto plastic sheeting difficult and/or time-consuming; it is helpful if you provide them with cardboard templates of the correct dimensions to draw around.
- Show PPT slide 12. The students should attach cotton thread to the corners as shown below, then tie all four threads together and attach a paperclip to ensure the parachute falls correctly.

- Students should work in pairs to carry out the basis test of their parachute; they drop it from a height of 2 metres, and time how long it takes to fall to the ground. The parachute must be dropped away from the wall so that it falls without being impeded in any way. (The height can be marked on a wall using a measuring tape, or two metre rules can be loosely attached to the wall. For a fair trial of the different parachutes, it is the paperclip that must start at 2 metres high each time, not the top of the parachute.)

- They should repeat their drops five times, recording the timings, then find an average value. A useful discussion here relates to reliability of readings, and the accuracy to which the readings should be recorded.

- This average value is then compared with readings for a second, different, parachute.

- You may wish to discuss with students, or brainstorm, the variables which may affect how fast the parachute falls. The variables should include:
  - size/ area of the parachute
  - number of paperclips attached to the strings
  - the shape of the parachute
  - the material used to make the parachute
  - whether the parachute canopy contains a single hole, or several holes.

- Each pair of students should select one of these variables to test. Show PPT slide 13 as a reminder.

- The easiest (quickest) variables to test are either: the number of paperclips used (as more can easily be added) or the number of holes cut in the canopy (draw five circles on the original canopy and cut one more out for each test).

- The ideal is that five tests are carried out, each with repeat readings, and an average calculated. This allows students to create a graph and draw conclusions or detect trends from the data.

- An expected results table would look like this:

Variable tested	Time given for parachute to fall 2 metres (s)					Average time (s)

- Show PPT slide 14. The final activity looks at the skill of prediction. Students should select a different variable to investigate and predict what they expect to happen.
  A sentence to scaffold this might be:

  The variable I will test is…….. I expect that ……...

  This is because……

  When students have completed their practical recording, they should display their results in graph form, state their conclusion(s) and discuss how this matches their original predictions.

Resources

- *PowerPoint* Presentation - Episode 1: How Fast? On your mark...Get set...Go!
- *Prezi* Presentation - Episode 1: How Fast? On your mark...Get set...Go!
- Activity Sheet 1.3: Investigating parachute

Tools needed (every pair of students)

- Scissors
- Plastic sheeting
- Card template
- Thread
- Paper clip
- Stopwatch
- measuring tape or metre rules
- sticky tape
- step stool or some other safe place for the students to stand on so that they can reach about 2.6m high, to hold their parachutes with the paperclip at 2m.