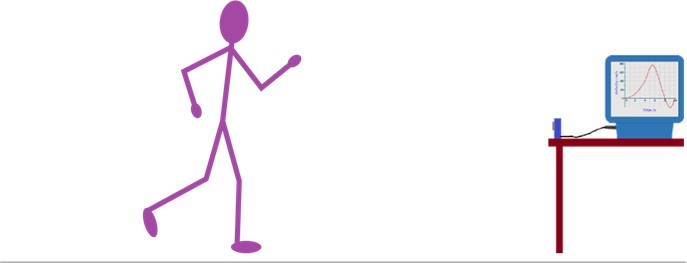
**Shaping the graph**

A motion sensor can be used to help plot a velocity-time graph.



**Apparatus and materials**

* Motion sensor
* Data-logger
* Connecting cables

**Method**

Set up the equipment to plot a velocity-time graph.

For velocity-time graph you are shown,

* Write a description of how a person should walk to copy the motion it shows.
* Walk in front of the motion sensor to check your answer\*.
* If necessary, improve your description and try again.

*\*This works best at slower speeds.*

Follow the method for each graph, before moving on to the next one.

|  |  |
| --- | --- |
| **1** | **2** |
| **3** | **4** |
| **5** | **6** |
| **7** | **8** |

*Physics > Big idea PFM: Forces and Motion > Topic PFM4: Measuring and calculating motion > Key concept PFM4.3: Velocity-time graphs*

|  |
| --- |
| **Response activity** |
| **Shaping the graph** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | A velocity-time graph of an object moving in one dimension can be read to find the object’s velocity at any moment of time. The gradient of the graph at a given time gives the object’s acceleration; and the area under the graph between any two times gives the change in the object’s displacement, or the distance it has travelled. |
| Observable learning outcome: | Describe the motion of an object from a velocity-time graph, and identify the velocity-time graph from a description of motion. |
| Activity type: | Application and practice – practical/demonstration |
| Key words: | Velocity, time, graph |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic question:

* Diagnostic question: Choosing the graph

**What does the research say?**

The visual presentation of data in graphical form makes graphs valuable for analysing data and, perhaps more importantly, for showing relationships between data sets (Rogers, in Carson, 1999). It is common for teachers to assume students can readily extract information from graphs when this is not necessarily the case (Beichner, 1994). Misunderstandings and difficulties in interpreting graphs arise even when students have a good understanding of kinematic concepts (position, displacement, velocity and acceleration) and are evident amongst different student populations and across different academic levels (McDermott, Rosenquist and van Zee, 1987). Even when students have the necessary mathematical knowledge about how to plot and read graphs, and how to calculate gradients and areas, they may struggle with the same skills in a physics context (McDermott, Rosenquist and van Zee, 1987; Bollen et al., 2016).

A common error that some students make is to see a graph as a literal picture of a physical situation and, rather than viewing a graph as a mathematical representation of a motion, they may see it as a sort of ‘photograph’ that duplicates the motion (Clement, 1985; Leinhardt, Zaslavsky and Stein, 1990; Beichner, 1994; Bollen et al., 2016). This can make it hard for them to describe qualitatively a motion represented by a graph, or to draw the shape of a graph from a description of a motion.

**Ways to use this activity**

This activity gives students the opportunity to practise applying their understanding and to clarify their thinking through discussion. Students should work in groups to agree a description of the motion represented by the graphs before trying their ideas practically.

The practical as shown here works well as a whole class demonstration.

If students are working in pairs or in small groups, it is advisable to get them to move a dynamics trolley backwards and forwards along a bench in front of a motion sensor.

Listening to individual groups as they work often highlights any difficulties they might have. These can often be overcome through a whole class clarification or redirection part way through the activity.

Asking students to report their findings at the end of their discussions is important before trying out students’ ideas. After a group has fed back, it might be helpful to model an even better answer. You could do this, for example, by asking another group to add to, or clarify, the first description, then ask another group to sum up the important part of the observation, and so on.

Set up a motion sensor and computer connected to a projector so that the whole class can observe. The motion sensor should be set up to allow students to walk up and down in front of it to produce graphs.

**Equipment**

For the class (The dynamics trolley is not needed for a class demonstration):

* Motion sensor
* Data-logger (and computer if required)
* Projector
* Connecting cables
* Dynamics trolley – see ‘Ways to use this activity’ above

**Technician notes**

There is a wide variety of motion sensors, and each type needs to be tested in order that settings are adjusted to obtain the best results.

The software should be set up so that velocity-time graphs are drawn.

**Health and safety**

Practical work should be carried out in accordance with local health and safety requirements, guidance from manufacturers and suppliers, and guidance available from CLEAPSS.

**Expected answers**

Students should be able to achieve graphs that are approximately the same as those shown.

It is not expected that exact times or gradients will be achieved.

**Acknowledgments**

Developed by Simon Carson (UYSEG).

Images: Peter Fairhurst (UYSEG) and Simon Carson (UYSEG)

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