# Physics PAG P3: Motion

# Combined Science PAG P3: Motion

# Suggested Activity 2: Investigating fluid flow

## Instructions and answers for teachers & technicians

These instructions cover the learner activity section which can be found on [page 7](#_Student_Activity). This Practical activity supports OCR GCSE Physics.

**When distributing the activity section to the learners either as a printed copy or as a Word file you will need to remove the teacher instructions section.**

|  |
| --- |
| This is a **suggested** practical activity that can be used as part of teaching the GCSE (9-1) Gateway Science (A) and Twenty First Century Science (B) specifications.  These are **not controlled assessment tasks**, and there is **no requirement to use these particular activities**.  You may modify these activities to suit your learners and centre. Alternative activities are available from, for example, [Royal Society of Biology](https://www.rsb.org.uk/education/teaching-resources/secondary-schools), [Royal Society of Chemistry](http://www.rsc.org/learn-chemistry), [Institute of Physics](http://www.iop.org/education/teacher/resources/index.html), [CLEAPSS](http://science.cleapss.org.uk/) and [publishing companies](https://global.oup.com/education/content/secondary/key-issues/gcse_science_2016/?region=uk), or of your own devising.  Further details are available in the [specifications](http://www.ocr.org.uk/science) (Practical Skills Topics), and in these [videos](https://www.youtube.com/playlist?list=PLBD9B84FF4BD54AA4). |

**OCR recommendations:**

**Before carrying out any experiment or demonstration based on this guidance, it is the responsibility of teachers to ensure that they have undertaken a risk assessment in accordance with their employer’s requirements, making use of up-to-date information and taking account of their own particular circumstances. Any local rules or restrictions issued by the employer must always be followed.**

**CLEAPSS resources are useful for carrying out risk-assessments: (**<http://science.cleapss.org.uk>**).**

**Centres should trial experiments in advance of giving them to learners. Centres may choose to make adaptations to this practical activity, but should be aware that this may affect the Apparatus and Techniques covered by the learner.**

### Introduction

In this experiment pupils will be investigating how to measure the flow of a fluid; water through a burette, and sand through a filter funnel.

### DfE Apparatus and Techniques covered

The codes used below match the OCR Practical Activity Learner Record Sheet ([**Physics**](http://www.ocr.org.uk/Images/295647-gcse-physics-learner-record-sheet.doc) / [*Combined Science*](http://www.ocr.org.uk/Images/304431-gcse-combined-science-learner-record-sheet.doc)) and Trackers ([**Physics**](http://www.ocr.org.uk/Images/323482-gcse-physics-practical-tracker.zip) / [*Combined Science*](http://www.ocr.org.uk/Images/323483-gcse-combined-science-practical-tracker.zip)) available online. **There is no requirement to use these resources.**

**1a***[1]***:** Use of appropriate apparatus to make and record a range of measurements accurately, including: **i**[*i*]) length; **iv**[*iv*]) time

**3** *[15]*) Use of appropriate apparatus and techniques for measuring motion, including determination of: i) speed; ii) rate of change of speed (acceleration/deceleration)

### Aims

To use appropriate apparatus to measure speed of a fluid flow, and describe how the speed changes over time.

To plot a graph of distance against time to find average speed and instantaneous speed.

### Intended class time

50-60 minutes

### Links to Specifications:

### Gateway Science (Suite A) including Working Scientifically (WS)

PM2.1ii recall and apply:

**acceleration (m/s2) = change in velocity (m/s) / time (s)**

P2.1h apply formulae relating distance, time and speed, for uniform motion, and for motion with uniform acceleration

WS1.2e Evaluate methods and suggest possible improvements and further investigations

WS1.3a Presenting observations and other data using appropriate methods

WS1.3b Translating data from one form to another

WS1.3e Interpreting observations and other data

WS1.4a Use scientific vocabulary, terminology and definitions

WS1.4b Recognise the importance of scientific quantities and understand how they are determined

WS1.4c Use SI units and IUPAC chemical nomenclature unless inappropriate

WS2a Carry out experiments

WS2c Presenting observations using appropriate methods

### Twenty First Century Science (Suite B) including Ideas about Science (IaS)

P4.2.6a recall and apply the relationship:

**acceleration (m/s2) = change in speed (m/s) ÷ time taken (s)**

P4.2.6b explain how to use appropriate apparatus and techniques to investigate acceleration

IaS1.2 Suggest appropriate apparatus, materials and techniques, justifying choice with reference to the precision, accuracy and validity of the data that will be collected

IaS1.4 Identify factors that need to be controlled, and the ways in which they could be controlled

IaS2.1 Present observations and other data using appropriate formats

IaS2.2 When processing data use SI units where appropriate (e.g. kg, g, mg, km, m, mm, kJ, J)

IaS2.4 Be able to translate data from one form to another

IaS2.7 When displaying data graphically select an appropriate graphical form, use appropriate axes and scales, plot data points correctly, draw an appropriate line of best fit, and indicate uncertainty (e.g. range bars)

IaS2.11 In a given context interpret observations and other data (presented in diagrammatic, graphical, symbolic or numerical form) to make inferences and to draw conclusions, using appropriate scientific vocabulary and terminology to communicate the scientific rationale for findings and conclusions

### Mathematical Skills covered

M3b Change the subject of an equation

M3c Substitute numerical values into algebraic equations using appropriate units for physical quantities

M3d Solve simple algebraic equations

M4a Translate information between graphical and numerical form

M4b Understand that y=mx+c represents a linear relationship

M4c Plot two variables from experimental or other data

### Health and Safety

This is a very safe experiment when performed sensibly; the burettes are glass so care must be taken to not drop them.

### Method 1: A. Fluid flow through a burette

Stuendtss calculate the average speed of water leaving a burette. Using the scale on the side of the burette learners can measure the height of the water, and the time it takes for the miniscus to travel the full length of the burette as the water leaves. The average speed can then be calculated using speed = distance ÷ time.

### Method 2: B. Fluid flow through a burette

Studentss use the same set up as in A. This time they record the time taken for the miniscus to move 5 graduations. This is most easily done in pairs. Studentss can then draw up a graph of distance travelled by the miniscus and time taken. Studentss can then evaluate their results and try to describe how the speed changes, and suggest reasons why this is the case.

### Method 3: Sand flow

Studetnss measure the time taken for a set volume of sand to fall through a filter funnel into a beaker. From this they can plot an appropriate graph and discuss the changes in speed of the flow of the sand and reasons behind these changes.

### Notes

Studentss should appreciate the difference between average speed and instantaneous speed and the need for graphical methods to highlight these from method 1 and 2. Method 3 is provided to give an alternative to the water flow, and is purposefully more brief.

The teacher may want to amend the student sheet to ensure it is appropriate for their learners.

### Technician Notes

### For this practical the teacher will require for a class of 30:

* 15x burette
* 15x clamp stands
* 15x clamps
* 15x bosses
* 15x metre rulers
* 15x stop watches
* 15x filter funnels
* 15x beakers
* Access to water
* Play sand (or clean and dry sand)

### Answers for quiz questions

|  |  |  |
| --- | --- | --- |
| **1. (a) (i)** | Two students are going to measure the speed of a wind up toy as it runs along a bench. What measurements do they need to take and how will they use them? **[3 marks]** |  |
|  | *Time*✓ *and distance*✓*. Speed = distance / time*✓ |  |

|  |  |  |
| --- | --- | --- |
| **(a) (ii)** | The wind toy falls off the bench. Describe the changes in vertical speed of the toy as it falls and hits the ground. **[3 marks]** |  |
|  | *To start with the vertical speed is zero.* ✓  *As it falls the speed increases or it accelerates* ✓  *It will be fastest/maximum speed when it hits the floor.* ✓ |  |

|  |  |  |
| --- | --- | --- |
| **(b)** | In a different experiment students recorded the velocity and time as a toy car descended the ramp using a set a light gates. They got the following results and plotted a graph. |  |
|  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **(b)(i)** | Use the graph to work out the acceleration of the toy car. **[2 marks]** | | |  |
|  | Correct gradient calculation using change in y ÷ change in x ✓  Answer 10 cm/s2 ✓ | | |  |
|  |  |  | cm/s2 |  |

|  |  |
| --- | --- |
| **(b)(ii)** | A second toy car goes down the ramp, it has double the acceleration.  On the graph above draw a line to show this. Use the space below for any working out. **[1 mark]** |
|  | Correct gradient drawn – reaching about 30 cm/s in 1.5 s ✓ |

**OCR Resources**: *the small print*This formative assessment resource has been produced as part of our free GCSE teaching and learning support package. All the GCSE teaching and learning resources, including delivery guides, topic exploration packs, lesson elements and more are available on the qualification webpages.

If you are looking for examination practice materials, you can find Sample Assessment Materials (SAMs) on the qualification webpages: [here](http://www.ocr.org.uk/qualifications/by-type/gcse/physics/)

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[[www.ocr.org.uk/i-want-to/find-resources/](http://www.ocr.org.uk/i-want-to/find-resources/)](http://www.ocr.org.uk/i-want-to/find-resources/)

# Physics PAG P3: Motion

# Combined Science PAG P3: Motion

# Suggested Activity 2: Investigating fluid flow

## Learner Activity

### Introduction

In this experiment you will be investigating how to measure the flow of a fluid; water through a burette, and sand through a filter funnel.

### Aims

To use appropriate apparatus to measure speed of a fluid, and describe how the speed changes over time.

To plot a graph of distance against time to find average speed and instantaneous speed.

### Intended class time

50-60 minutes

### Equipment (per group)

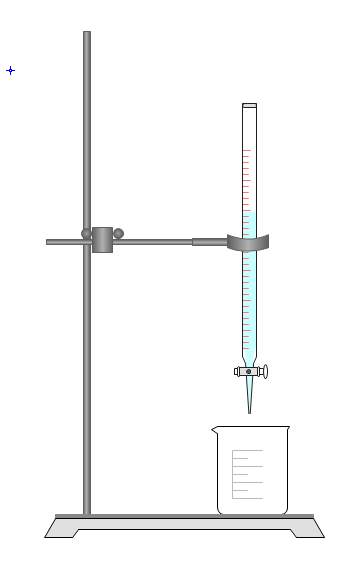
* burette
* clamp stand
* clamp
* boss
* metre ruler
* stop watches
* filter funnel
* beaker
* water
* Play sand (or clean and dry sand)

### Health and Safety

This is a very safe experiment when performed sensibly; the burettes are glass so care must be taken to not drop them. Eye protection should be worn.

### Method 1: A. Fluid flow through a burette

1. Set up the burette securely as shown in the diagram below.



beaker to collect water

burette with water

clamp

meniscus

clamp stand

1. Fill the burette with water, so that the meniscus is on the zero line. Place a beaker underneath.
2. Open the burette tap fully, and start the timer.
3. Stop the timer when all of the water has left the burette.
4. Record the time in the results table
5. Repeat steps 2 to 4 three times.
6. Calculate a mean time for the water to leave the burette.
7. Measure the height of the water in the burette.
8. Calculate the speed of the water leaving the burette using the equation:

Speed = distance / time taken

### Results

Height water in the burette = cm

|  |  |  |  |
| --- | --- | --- | --- |
| **Time 1 (s)** | **Time 2 (s)** | **Time 3 (s)** | **Mean time (s)** |
|  |  |  |  |

Speed water leaving the burette

cm/s

This is the average speed of the water leaving the burette

### Method 2: B. Fluid flow through a burette

This method uses the same set up as method 1.

1. Fill the burette with water, so that the meniscus is on the zero line. Place a beaker underneath.
2. Open the burette tap fully, and start the timer.
3. Record the time taken for the meniscus to move 5 cm (usually 5 graduations on the burette)
4. Record the time in the results table
5. Repeat steps 2 to 4 three times.
6. Plot a graph of the distance the meniscus travels against time taken

### Results

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Distance travelled by the miniscus (cm)** | **Time taken (s)** | | | **Average time taken (s)** |
| **Repeat 1** | **Repeat 2** | **Repeat 3** |
| **0** |  |  |  |  |
| **5** |  |  |  |  |
| **10** |  |  |  |  |
| **15** |  |  |  |  |
| **20** |  |  |  |  |
| **25** |  |  |  |  |
| **30** |  |  |  |  |
| **35** |  |  |  |  |
| **40** |  |  |  |  |
| **45** |  |  |  |  |
| **50** |  |  |  |  |

### Draw up a graph of your result below

### Graph paper

### Analysis

|  |
| --- |
| Look at your graph. Describe the trend observed |

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  | Using your graph calculate the speed at two different points  Use the space here to show your working |  |
|  |  |  |
|  | Can you use these two values to calculate the acceleration? |  |
|  |  |  |

|  |
| --- |
| Can you explain why this happens? |

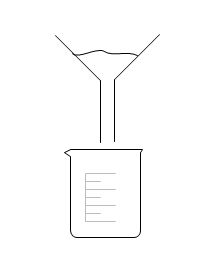
|  |  |  |
| --- | --- | --- |
|  |  |  |

### Evaluation

|  |  |  |
| --- | --- | --- |
|  | Compare and contrast the two methods of measuring the speed of water leaving the burette. What were the potential errors?? |  |
|  |  |  |
|  | Which method was more accurate and why? |  |
|  |  |  |
|  | How could using a video camera or film improve your data recording? If you have time try this out |
|  |  |

### Method 3: Sand flow

1. Set up the equipment as shown below



beaker to measure volume of sand

sand

1. Fill the funnel with clean, dry sand with the base of the funnel covered with your finger
2. Uncover the base of the funnel, and start the timer
3. Record the time taken for the sand to fall through into the beaker below
4. Repeat steps 2 to 4, three times and calculate a mean.
5. Measure the total volume of the sand in the beaker.
6. Repeat the experiment, but this time record the time taken for set volumes to fall through into the beaker. Use the scale on the beaker to decide on the volumes to use.
7. Draw an appropriate graph.

### Results

Volume of sand =

|  |  |  |  |
| --- | --- | --- | --- |
| **Time 1 (s)** | **Time 2 (s)** | **Time 3 (s)** | **Mean time (s)** |
|  |  |  |  |

Calculate the rate of flow of the sand from these results.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Volume of sand fallen (cm3)** | **Time 1 (s)** | **Time 2 (s)** | **Time 3 (s)** | **Mean time (s)** |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

### Draw up a graph of your result below

### Graph paper

### Analysis

|  |
| --- |
| Look at your graph. Describe the trend observed |

|  |  |  |
| --- | --- | --- |
|  |  |  |
|  | Using your graph calculate the rate at two different points.  Use the space here to show your working and suggest what the units of this flow should be. |  |
|  |  |  |
|  | Why do these values vary? Can you explain why this happens? |  |
|  |  |  |

### Evaluation

|  |  |  |
| --- | --- | --- |
|  | How do the methods for measuring the flow of sand through a funnel compare? |  |
|  |  |  |

### Quiz - test your knowledge and understanding

|  |  |  |
| --- | --- | --- |
| **1. (a) (i)** | Two students are going to measure the speed of a wind up toy as it runs along a bench. What measurements do they need to take and how will they use them? **[3 marks]** |  |
|  |  |  |

|  |  |  |
| --- | --- | --- |
| **(a) (ii)** | The wind toy falls off the bench. Describe the changes in vertical speed of the toy as it falls and hits the ground. **[3 marks]** |  |
|  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **(b)** | In a different experiment students recorded the velocity and time as a toy car descended the ramp using a set a light gates. They got the following results and plotted a graph. | | |  |
| **Time (s)** | **Speed (cm/s)** |
| 0.5 | 5 |
| 1.0 | 9 |
| 1.5 | 15 |
| 2.0 | 21 |
| 2.5 | 24 |
| 3.0 | 30 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **(b)(i)** | Use the graph to work out the acceleration of the toy car. **[2 marks]** | | |  |
|  |  | | |  |
|  |  |  | cm/s2 |  |

|  |  |
| --- | --- |
| **(b)(ii)** | A second toy car goes down the ramp, it has double the acceleration.  On the graph above draw a line to show this. Use the space below for any working out. **[1 mark]** |

|  |  |  |
| --- | --- | --- |
|  |  |  |

### DfE Apparatus and Techniques covered

If you are using the OCR Practical Activity Learner Record Sheet ([**Physics**](http://www.ocr.org.uk/Images/295647-gcse-physics-learner-record-sheet.doc) / [*Combined Science*](http://www.ocr.org.uk/Images/304431-gcse-combined-science-learner-record-sheet.doc)) you may be able to tick off the following skills:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Physics** | | | |  | ***Combined Science*** | | | |
| 1a-i | 1a-iv | 3-i | 3-ii |  | *1-i* | *1-iv* | *15-i* | *15-ii* |