Cambridge Assessment International Education

# Teaching Pack

## Investigating the effect of particle size on the permeability of substrates

## Cambridge International AS & A Level Marine Science 9693

Version 0.1

Cambridge Pathway

# Contents

**Icons used in this pack:**

**Briefing lesson**

**Planning lesson**

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# Introduction

This pack will help you to develop your learners' experimental skills as defined by assessment objective 3 (AO3 Experimental skills and investigations) in the course syllabus.

**Important note**
Our *Teaching Packs* have been written by **classroom teachers** to help you deliver topics and skills that can be challenging. Use these materials to supplement your teaching and engage your learners. You can also use them to help you create lesson plans for other experiments.

***This content is designed to give you and your learners the chance to explore practical skills.***

This is one of a number of *Teaching Packs* and each pack is based on one experiment. The packs can be used in any order to suit your teaching sequence.

The structure is as follows:

**Planning lesson (1 hour*)**
This lesson focuses on planning an experiment.
It ends with a demonstration video of the experiment.

**Lab lesson (1 hour*)**
This lesson focuses on carrying out the experiment including the collection and recording of observations, measurements and estimates.

**Debriefing lesson (1 hour*)**
This lesson focuses on the analysis and interpretation of data.
This includes making conclusions, evaluating methods and the quality of data and how improvements could be made.

** the timings are a guide only; you may need to adapt the lessons to suit your circumstances.*

In this pack you will find lesson plans, worksheets and teacher resource sheets.

# Experiment: Investigating the effect of particle size on the permeability of substrates

This *Teaching Pack* focuses on an experiment into the effect of particle size on the permeability of the substrate, measured by allowing water to drain through the sediments.

The rate of drainage of sediments can affect organisms that live in the sediments on shorelines. This investigation explores the potential water retention by sediments of different sizes.

This experiment has links to the following syllabus content (see syllabus for detail):

- 2.2.4 describe sedimentation as the deposition of suspended particles
- 2.2.8 describe how weathering, erosion and sedimentation give rise to the morphology of rocky shores, sandy shores, muddy shores, estuaries and deltas
- 5.4.2 explain how the biotic and abiotic factors that affect a sandy shore lead to a relatively low biodiversity
- 5.4.3 investigate the effect of particle size on the permeability of substrates
- 5.4.4 explain, using named examples, the adaptations that organisms have to living on a sandy shore

The experiment covers the following experimental skills, as listed in **AO3: Experimental skills and investigations:**

- plan experiments and investigations
- collect, record and present observations, measurements and estimates
- analyse and interpret data to reach conclusions
- evaluate methods and quality of data and suggest improvements.

## Prior knowledge

No prior knowledge from the syllabus is required for this experiment.

# **Planning lesson:** Planning to investigate the effect of particle size on the permeability of substrates

| | |
|---|---|
| **Resources** | • **Worksheet A**: Planning an investigation into the effect of particle size on the permeability of substrates<br>• Resource plus Video: Investigating the effect of particle size on the permeability of substrates<br>• Resource plus Video: Designing Tables |
| **Learning objectives** | By the end of the lesson:<br>• ***all*** learners should be able to describe a safe plan describing how to compare the permeability of substrates.<br>• most learners should be able to describe an appropriate method to measure the permeability for a suitable range of substrates.<br>• some learners will be able to describe an detailed method to measure the permeability for a suitable range of substrates, obtain repeat measurements to produce means results and how to present their results as a graph. |

| Timings | Activity |
|---|---|
| 10 mins | **Starter/Introduction**<br>Pose the question: 'How can we measure the permeability of a substrate?' and ask learners to consider possible approaches to measure the permeability. Use the 'Think, Pair, Share' strategy to encourage learners to think about the question on their own and come up with ideas, then pair with a partner to discuss their ideas and possibly develop their answers further before sharing their ideas with the class. Each pair feeds back one idea to the group (many pairs will come up with similar approaches which is ok – the aim is to get learners thinking and consider more than one possible approach). |
| 40 mins | **Main lesson**<br>Learners design a plan to change the substrate and measure the permeability of each substrate. Worksheet A will help learners organise their plans to ensure that they include:<br>• What they will measure<br>• How they will measure/collect the data<br>• How many sets of data they plan to collect<br>• What equipment they will need to complete their investigation<br>• Identification of potential risks and plans to minimise the risks or identify steps to take should any incidents/changes occur – it is important if students are to carry out their own plans that you are confident their plans are safe.<br>• A results table to record the data they plan to collect – see Resource Plus video: Designing results tables for more support<br>• How they plan to analyse the data they collect |
| 10 mins | **Plenary**<br>Students swap plans with another student or group and give feedback on areas to improve their plans. Discuss any issues raised by students. |

# **Lab lesson:** Carrying out the plans

| | |
|---|---|
| **Resources** | • Equipment identified by students in their plans |
| **Learning objectives** | By the end of the lesson:<br>• ***a***ll learners should collect some results following a method<br>• most learners should be able to collect sufficient results to be able to draw conclusions<br>• some learners will be able to collect sufficient repeat data to calculate mean results |

| Timings | Activity |
|---|---|
| 10 mins | **Starter/Introduction**<br>**Safety**<br>Brief all learners on key safety points that all must follow while collecting their data.<br>Ask learners if they have any questions about the safety instructions to check everyone understands.<br><br>Give learners an opportunity to review their plans before starting.<br>Distribute equipment to learners as necessary to complete their plans. |
| 40 mins | **Main lesson**<br>Learners follow their plans and collect data.<br><br>**Safety**<br>Circulate the working area at all times during the lab work so that you can make sure that your learners are safe and that the data they are collecting is accurate. |
| 10 mins | **Plenary**<br>Gather learners back together and check for problems and that all equipment is tidied away.<br><br>Discuss any immediate issues or problems that learners have faced collecting their data. |

# Teacher notes

Watch the investigating the effect of particle size on the permeability of substrates video (teacher version) and read these notes.

Each group will require:

- plastic bottle with the bottom cut off
- rubber band
- small piece of cloth to wrap around the top
- five samples of sediment: e.g. different grades of gravel and sand
- clamp stand
- 2x measuring cylinders (100 $cm^3$)
- stopwatch
- marker pen

**Safety**

The information in the table below is a summary of the key points you should consider before undertaking this experiment with your learners.

**It is your responsibility to carry out an appropriate risk assessment for this experiment.**

## Safety Note

Wash hands after the practical – sediment samples may contain harmful microorganisms or pollutants

## Experiment set-up

# Teacher method

This is your version of the method for this experiment that accompanies the *Teacher walkthrough* video.

Do not share this method with learners until after they have planned their own methods.

## Before you begin

Plan how you will group your learners during the experiment session.

Think about:

- the number of groups you will need (group size 2–4 learners)
- the amount of equipment/chemicals required

## Method

1. Prepare the bottle for the experiment by placing a piece of cloth over the top where the bottle cap was. secure this in place using a rubber band tightly wrapped around the neck of the bottle. Mark a line half way up the bottle to indicate a level to fill the sediment to. Place the bottle into a clamp stand.
2. Add the coursest /largest grade of gravel to the bottle up to the fill line, ensuring the top is fairly level.
3. Use a measuring cylinder to measure 100 $cm^3$ of water.
4. Place the other measuring cylinder beneath the bottle ready to catch the water.
5. Add the water to the bottle and start timing how long it takes to pass through the 10-15 mm gravel before the flow noticeably slows.
6. Record the volume of water collected in this time.
7. Repeat the experiment with the second largest diameter gravel. Record the volume of water collected after the same time taken for the first sample.
8. Repeat the experiment again with the other types of sediment, each time measuring the volume of water that passes through after the same time taken for the first sample.
9. Repeat the investigation two more times to obtain repeat readings to enable you to calculate a mean for each type of sediment.

| Type of sediment | Volume of water collected / $cm^3$ | Time taken / s |
|---|---|---|
| gravel (20 – 30 mm) | | |
| gravel (10 – 20 mm) | | |
| gravel (5 – 10 mm) | | |
| gravel (0 – 5 mm) | | |
| sand (course) | | |

## Clean-up

After the experiment learners should:

- clean all glassware and equipment
- tidy up their work space
- ensure any spillages including sediments have been mopped or swept up
- return all equipment to you.

## Alternative methods

If you do not have access to the required equipment or the suggested method would not work for your class, here are some possible alternatives that you could use.

- Any type of sediments can be used that would give a range of sizes to drain through.
- filter funnels could be used instead of a plastic bottle with a loose plug of cotton wool to retain the sediments

# Alternative Lab lesson: Virtual experiment

| | |
|---|---|
| **Resources** | • Resource plus Video: Designing Tables<br>• Resource plus Video: Investigating the effect of particle size on the permeability of substrates<br>• Copy of teacher method handout<br>• Worksheet B: Example results table<br>• Worksheet B Answers: Completed results table |
| **Learning objectives** | By the end of the lesson:<br>• all learners should record permeability results related to the video<br>• most learners should be able to record sufficient data to be able to draw conclusions<br>• some learners will be able to identify if there are any anomalies |

| Timings | Activity |
|---|---|
| 25 minutes | **Starter/Introduction**<br>Go through the teacher method handout with the learners and discuss the method.<br><br>Learners construct a results table to record the data. See video: Designing tables to remind students if necessary, |
| 20 minutes | **Main lesson**<br>Watch the video in full detailing the process.<br><br>Learners complete their results table by watching the video and completing results in their results tables. |
| 15 minutes | **Plenary**<br>Hand out worksheet B Answers (Completed results table) – ask learners to compare their data with the table provided and suggest reasons for any differences. Learners could also compare their results with those from others/other groups in the class. |

# Debriefing lesson: Interpreting results

| | |
|---|---|
| **Resources** | • Results from lab lesson / alternative lab lesson<br>• Graph paper<br>• Resource plus Video: Drawing Graphs |
| **Learning objectives** | By the end of the lesson:<br>• all learners should produce a graph of their results<br>• most learners should be able to produce a line graph of their results evaluate the reliability of their data<br>• some learners will be able to suggest improvements to their method and how they might confirm their findings |

| Timings | Activity |
|---|---|
| 10 mins | **Starter/Introduction**<br>Recap from lab lesson and check learners have their data/results. Discuss how the data can be analysed – learners should have planned how they will process their data. |
| 10 minutes<br><br>15 minutes<br><br>15 minutes | **Main lesson**<br>Watch the video: Drawing Graphs and discuss the most appropriate type of graph for the data they have collected.<br><br>Learners process the data by line graphs using the data they have collected.<br><br>Learners make conclusions about their findings and evaluate their method to establish any potential improvements they could make to improve the quality of their results. |
| 10 minutes | **Plenary**<br>Discuss outcomes and compare conclusions – if any groups not achieve an obvious trend in their results ask them to share their suggestions with the class where they think they went wrong and how they could improve their method. |

# Worksheets and answers

| | Worksheet | Answers |
|---|---|---|
| **For use in *Planning lesson*:** | | |
| **A:** Planning to investigate the effect of particle size on the permeability of substrates | x | |
| **For use in *Alternative Lab lesson*:** | | |
| **B:** Results table | x | x |

# **Worksheet A:** Planning to investigate the effect of particle size on the permeability of substrates

Use this worksheet with the planning lesson: Planning to investigate the effect of particle size on the permeability of substrates

When planning an investigation, you should consider what you are trying to find out and how you can achieve that.

The first question is what is the hypothesis or question being investigated? This should clearly identify variables. For an investigation into the effect of particle size on the permeability of substrates the hypothesis should relate a change in particle size of the solution to the change in permeability of the substrate, such as: 'The increase in particle size increases the permeability of the substrate'.

Once your hypothesis has been established you can begin to plan how to carry out the investigation and collect data.

Some key questions to consider include:

- What will you measure?
  - This should be linked to the hypothesis, i.e. the permeability of the substrate.
  - How will you change the particle size?
- How will you measure/collect the data?
  - What equipment will you need to make the measurements?
  - Is the chosen equipment precise enough?
- How many sets of data do you plan to collect?
  - What range of particle sizes will you use (maximum and minimum)?
  - How many different sizes will you test?
  - What will the intervals be between particle sizes?
  - Will you repeat the experiment for each size?
- Identification of potential risks and plans to minimise the risks or identify steps to take should any incidents/changes occur.
  - What could go wrong?
  - What risks are there?
  - How can you reduce the risk of these occurring?
  - What will you do if it did occur?
- What equipment do you need to complete your investigation?
  - Equipment for measuring the permeability
  - Safety equipment
- Design a results table to record the data you plan to collect
  - see video on Resource plus on designing results tables
- How do you plan to analyse the data you collect

# Worksheet B: Results table

| Type of sediment | Volume of water collected / $cm^3$ | Time taken / s |
|---|---|---|
| gravel (20 – 30 mm) | | |
| gravel (10 – 20 mm) | | |
| gravel (5 – 10 mm) | | |
| gravel (0 – 5 mm) | | |
| sand (course) | | |

# Worksheet B: Completed results table from video

| Type of sediment | Volume of water collected / $cm^3$ | Time taken / s |
|---|---|---|
| gravel (20 – 30 mm) | 88 | 275 |
| gravel (10 – 20 mm) | 75 | 275 |
| gravel (5 – 10 mm) | 70 | 275 |
| gravel (0 – 5 mm) | 62 | 275 |
| sand (course) | 58 | 275 |

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