Cambridge Assessment International Education

Teaching Pack

Investigating the effect of pH on the loss of mass of empty mollusc shells

Cambridge International AS & A Level Marine Science 9693

Version 0.1

Cambridge Pathway

Contents

Icons used in this pack:

Briefing lesson

Planning lesson

Lab lesson

Debriefing lesson

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 pH on the loss of mass of empty mollusc shells

This *Teaching Pack* focuses on an experiment into the effect of changing pH of a solution on the loss of mass from empty mollusc shells.

Ocean acidification is causing concerns due to the potential risk of decreasing pH on wildlife in the oceans. Many organisms use calcium carbonate structures to provide protection in the form of external shells or skeletons such as hard corals. This investigation explores the potential impact of more acidic sea water on calcium carbonate shells.

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

- 9.3.1 explain the relationships between atmospheric carbon dioxide, dissolved carbon dioxide and acidity in the ocean, and understand how the oceans help to limit the increase in atmospheric carbon dioxide concentrations
- 9.3.2 describe how carbon dioxide reacts with water to form hydrogen ions and hydrogen carbonate ions, and, the impact this has on pH and carbonate ion availability
- 9.3.3 describe the impact of 9.3.2 on hard corals and shelled organisms
- 9.3.4 investigate the effect of pH on the loss of mass of empty mollusc shells

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

Knowledge from the following syllabus topics is useful for this experiment.

- 1.2.1 explain the terms solute, solvent, solution and solubility
- 1.2.7 describe the pH scale as a measure of the hydrogen ion concentration in water, including the terms acidic, neutral and alkaline
- 1.2.8 use litmus indicator, Universal Indicator and pH probes to measure the pH of water samples
- 5.2.8 discuss the causes and effects of reef erosion, including pH change, temperature change, predation, physical damage and the presence of sediment

Planning lesson: Planning to investigate the effect of pH on the loss of mass of empty mollusc shells

Resources	• **Worksheet A**: Planning an investigation into the effect of pH on the loss of mass of empty mollusc shells • Resource plus Video: Investigating the effect of pH on the loss of mass of empty mollusc shells • Resource plus Video: Designing Tables
Learning objectives	By the end of the lesson: • ***all*** learners should be able to describe a safe plan describing how to measure the loss of mass of empty mollusc shells in solutions of different pH. • most learners should be able to describe an appropriate method to produce solutions of different pH and plan to collect a suitable range of results. • some learners will be able to describe a detailed plan describing how to produce a suitable range of solutions of different pH, obtain repeat measurements to produce means results and how to present their results as a graph.

Timings	Activity
10 mins	**Starter/Introduction** Pose the question: 'Does the pH of a solution affect the change in mass of empty mollusc shells?' and ask learners to consider possible approaches to measure the change in mass of empty shells. 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** Learners design a plan to collect change the pH of the solution used and measure the rate of loss of mass for empty mollusc shells. Worksheet A will help learners organise their plans to ensure that they include: • What they will measure • How they will measure/collect the data • How many sets of data they plan to collect • What equipment they will need to complete their investigation • 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. • A results table to record the data they plan to collect – see Resource Plus video: Designing results tables for more support • How they plan to analyse the data they collect
10 mins	**Plenary** 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: • ***a***ll learners should collect some results following a method • most learners should be able to collect sufficient results to be able to draw conclusions • some learners will be able to collect sufficient repeat data to calculate mean results

Timings	Activity
10 mins	**Starter/Introduction** **Safety** Brief all learners on key safety points that all must follow while collecting their data. Ask learners if they have any questions about the safety instructions to check everyone understands. Give learners an opportunity to review their plans before starting. Distribute equipment to learners as necessary to complete their plans.
40 mins	**Main lesson** Learners follow their plans and collect data (depending on planned methods this might involve more than one lesson to allow for drying of shells before recording masses). **Safety** 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** Gather learners back together and check for problems and that all equipment is tidied away. Discuss any immediate issues or problems that learners have faced collecting their data.

Teacher notes

Watch the investigating the effect of pH on the loss of mass of empty mollusc shells video (teacher version) and read these notes.

Each group will require:
- access to an electronic balance
- 50 cm^3 or 100 cm^3 measuring cylinder
- 5x 100 cm^3 beakers
- 15 empty mollusc shells of similar size (e.g. mussel, oyster, snail, etc)
- 150 cm^3 1.0 M hydrochloric acid (pH = 0)
- 150 cm^3 0.1 M hydrochloric acid (pH = 1)
- 150 cm^3 1.0 M acetic acid (pH = 3)
- 150 cm^3 0.1 M acetic acid (pH = 5)
- 150 cm^3 distilled water (pH = 7)

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.

Substance	Hazard	First aid
0.1 M and 1.0 M hydrochloric acid	**not classed as hazardous** **it is advisable to wear eye protection**	**In the eye:** flood the eye with gently-running tap water for at least 10 minutes. **Swallowed:** wash out the mouth with water. Do not induce vomiting. **Spilt on the skin or clothing:** remove contaminated clothing and rinse it. Wash off the skin with plenty of water.
0.1 M and 1.0 M acetic acid	**not classed as hazardous** **it is advisable to wear eye protection**	**In the eye:** flood the eye with gently-running tap water for at least 10 minutes. **Swallowed:** wash out the mouth with water. Do not induce vomiting. **Spilt on the skin or clothing:** remove contaminated clothing and rinse it. Wash off the skin with plenty of water.

Experiment set-up

See experiment video on Resource Plus

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. Place the empty mollusc shells into an oven at least 1 day before the experiment to ensure they are completely dry.
2. Label five 100 cm^3 beakers with the pH 0, 1, 3, 5 and 7.
3. Use the measuring cylinder to measure 50 cm^3 of 1.0 M hydrochloric acid and carefully pour this into the beaker labelled “pH = 0”.
4. Use the measuring cylinder to measure 50 cm^3 of 0.1 M hydrochloric acid and carefully pour this into the beaker labelled “pH = 1”.
5. Use the measuring cylinder to measure 50 cm^3 of 1.0 M acetic acid and carefully pour this into the beaker labelled “pH = 3”.
6. Use the measuring cylinder to measure 50 cm^3 of 0.1 M acetic acid and carefully pour this into the beaker labelled “pH = 5”.
7. Use the measuring cylinder to measure 50 cm^3 of distilled water and carefully pour this into the beaker labelled “pH = 7”.
8. Record the total mass of three of the mollusc shells in your results table for pH = 0, and place these shells into the pH = 0 beaker.
9. Record the total mass of another three of the mollusc shells in your results table for pH = 1, and place these shell into the pH = 1 beaker.
10. Repeat with another three shells for each of the other beakers.
11. Leave the shells in the solutions for 24 hours.
12. The following day (or lesson) remove the dry shells and re-weigh them. Record the results in your results table.
13. Calculate the change in mass for each of the shells.

pH	Total mass of three mollusc shells / g		
	before	after	change
0			
1			
3			
5			
7			

Clean-up

After the experiment learners should:

- clean all glassware
- tidy up their work space
- ensure any spillages have been mopped up
- return all equipment and any unused chemicals 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 mollusc shell could be used such as snails, mussels, scallops, etc.
- Alternative solutions could be used with different pH's, as long as the solutions used give a range of pH's with at least some being acidic.
- If an oven is not available the shells could be left in a well ventilated warm sunny spot for a few days.

Alternative Lab lesson: Virtual experiment

Resources	• Resource plus Video: Designing Tables • Resource plus Video: Investigating the effect of pH on the loss of mass of empty mollusc shells • Copy of teacher method handout • Worksheet B: Example results table • Worksheet B Answers: Completed results table
Learning objectives	By the end of the lesson: • ***a***ll learners should record masses related to the video • most learners should be able to record sufficient data to be able to draw conclusions • some learners will be able to identify if there are any anomalies

Timings	Activity
25 minutes	**Starter/Introduction** Go through the teacher method handout with the learners and discuss the method. Learners construct a results table to record the data. See video: Designing tables to remind students if necessary,
20 minutes	**Main lesson** Watch the video in full detailing the process. Learners complete their results table by watching the video and completing results in their results tables.
15 minutes	**Plenary** 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 • Graph paper • Resource plus Video: Drawing Graphs
Learning objectives	By the end of the lesson: • all learners should produce a graph of their results • most learners should be able to produce a line graph of their results evaluate the reliability of their data • some learners will be able to suggest improvements to their method and how they might confirm their findings

Timings	Activity
10 mins	**Starter/Introduction** 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 15 minutes 15 minutes	**Main lesson** Watch the video: Drawing Graphs and discuss the most appropriate type of graph for the data they have collected. Learners process the data by line graphs using the data they have collected. 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** 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 an investigation into the effect of pH on the loss of mass of empty mollusc shells	x	
For use in *Alternative Lab lesson*:		
B: Results table	x	x

Worksheet A: Planning an investigation into the effect of pH on the loss of mass of empty mollusc shells

Use this worksheet with the planning lesson: Planning to investigate the effect of pH on the loss of mass of empty mollusc shells

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 pH on mass of mollusc shells the hypothesis should relate a change in pH of the solution to the change in mass of the empty mollusc shells, such as: 'The pH of a solution affects the rate of loss of mass of empty mollusc shells'.

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 change in mass of the empty shells.
  - How will you change the pH of the solutions?
- 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 pH will you use (maximum and minimum pH)?
  - How many different pH's will you test?
  - What will the intervals be between pH values?
  - Will you repeat the experiment for each pH?
- 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 preparing and containing the solutions
  - Equipment for recording mass of the shells
  - 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

pH	Total mass of three mollusc shells / g		
	Before	After	Change
0			
1			
3			
5			
7			

Worksheet B: Completed results table from video

pH	Total mass of three mollusc shells / g		
	Before	After	Change
0			
1			
3			
5			
7			

Cambridge Assessment International Education
1 Hills Road, Cambridge, CB1 2EU, United Kingdom
t: +44 1223 553554
e: info@cambridgeinternational.org www.cambridgeinternational.org