Encounter Edu

# Ocean Plastics

Science | Ages 11 - 14

Teacher Book

Common Seas

A resource by Encounter Edu

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Encounter Edu would like to thank Jo Royle and Alice Beese from Common Seas


Sponsored by

**Common Seas**

Common Seas is on a mission to reduce the amount of plastic made and stop it polluting our people, economies and planet. The crisis is too big and complex to solve alone so we provide the right people with the right tools to tackle waste at source and deliver new ways to manage and re-use plastic.

With thanks to

**Association for Science Education**

# Contents



**Lessons**

# Welcome to the Ocean Plastics Academy

Common Seas

Marine plastic pollution is a visible and pervasive environmental issue affecting all oceans. Recent media coverage has raised awareness of the topic, encouraging politicians, businesses and the general public to take much-needed action.

Common Seas believes that education can be an important part of the solution to addressing marine plastic pollution. The recent popularity of the topic of marine plastics has meant that there is a wealth of information and ideas for action scattered across the internet and other media.

Common Seas uniquely provides teachers with a full suite of resources across science, geography, and design and technology across Key Stages 1 to 3, that are designed to fulfil the English National Curriculum teaching requirements. Providing teachers with off the shelf lesson plans, presentations and activities they can choose to deliver in their entirety or use sections as appropriate.

Supporting a more sustainable relationship with the environment is not a quick fix, but a multi-generational endeavour. This is why Common Seas works with a range of partners to move marine plastics education from an important side issue into the mainstream.

**Jo Royle**
Managing Director
Common Seas

# About the Ocean Plastics Academy

## What is the Ocean Plastics Academy?

Achieving the aim of plastic-free seas is likely to be a multi-generational endeavour. As with any environmental crisis, the important place to start is from a shared understanding of the problem and then move to solutions both in terms of individual behavioural change and advocating for changes at wider scales from the community-level upwards.

Literacy is the starting point for the education programme. A shared understanding of plastics across its entire life cycle including its impact on the marine environment is crucial in developing appropriate responses and informing action on a personal and community level. A plastics literate population will also be able to inform good governance, both as leaders and voters.

However you choose to address the issue of marine plastic pollution in your classroom, it can be hard to know what children should know. Common Seas has used the UNESCO Learning Objectives for the ocean[1] as a basis for creating a set of Ocean Plastics Learning Objectives to support educators in designing an appropriate set of learning opportunities for students. These learning objectives are listed in following section.

Literacy on its own is not enough and Common Seas will also be developing engagement tools that help to shift literacy into action, so do keep in touch!

## How do I use the Ocean Plastics Academy?

These resources have been designed to be an off-the-shelf teaching tool for your classroom. Of course, you know your students better than anyone and may want to adapt and change to suit your needs.

You will find a suite of supporting multimedia resources online, and these are referenced throughout the lesson plans. It is assumed that you have access to a digital projector or interactive white board to display these resources and accompanying slideshows. Students with individual devices can also view multimedia without needing an account.

If this is the first time that you are teaching an oceans-related unit to your students, consider using the Ocean for beginners resources (https://encounteredu.com/teachers/units/ocean-plastics-science-ages-11-14) to provide context.

## Is the Ocean Plastics Academy curriculum aligned?

Ocean Plastics Academy are aligned to the National Curriculum for England programmes of study for science, geography and design and technology. As the Ocean Plastics Academy develops, we will align the resources to additional curricula and standards.

[1] UNESCO Ocean literacy for all: a toolkit https://unesdoc.unesco.org/ark:/48223/pf0000260721 (see page 24)

# Learning objectives

Common Seas has worked with partners to create a set of universal Ocean Plastics Learning Objectives, utilising the frameworks developed by UNESCO and those working for Ocean Literacy. These learning objectives are listed below and are subscribed to by Common Seas Ocean Plastics Academy partners. We hope that these overarching learning objectives are useful to other individuals and organisations planning their own education programming to help a plastic waste free future.

## Ocean Plastics 11-14 Science

| Ocean Plastics learning objective | Lessons 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Cognitive learning objectives** | | | | | |
| • The learner understands the fundamental properties of plastics, including the use of additives. | ✓ | | | | |
| • The learner understands the scope and geographical scale of plastic use and plastic pollution historically as well as current predictions. | | | | | |
| • The learner understands the pathways through which plastics enter the ocean and marine life. | | | | ✓ | ✓ |
| • The learner understands the social, environmental and economic cost of plastics across its entire life cycle. | | ✓ | | ✓ | ✓ |
| • The learner can identify and evaluate ways to improve the sustainability of plastics at different stages of the product life cycle[1]. | | | | ✓ | |
| **Socio-emotional learning objectives** | | | | | |
| • The learner can reflect on their own use of plastics, and how this use might affect the marine environment. | | ✓ | ✓ | ✓ | |
| • The learner actively seeks alternative designs, behaviours and practices that reduce their contribution to plastic pollution. | | | | ✓ | |
| • The learner can communicate the societal and environmental impacts of plastic use, referring to the scientific evidence base. | | | ✓ | | |
| • The learner is able to influence the behaviours and practices of others in their community in terms of plastic use and management. | | | | | |
| • The learner can collaborate at a range of scales to campaign for the reduction of plastic pollution. | | | | | |
| **Behavioural learning objectives** | | | | | |
| • The learner is able to access and improve waste management systems in their local area. | | | | | |
| • The learner can plan and implement campaigns that lead to a reduction in plastic pollution at a range of scales. | | | | | |
| • The learner is able to evaluate media narratives about plastic pollution and present a balanced judgement to their peers. | | | | | |
| • The learner is able to make informed decisions as a consumer to reduce plastic pollution. | | | | | |
| • The learner is able to research different approaches to design, including circularity and biomimicry. | | | | | |

[1] Including improved design, alternative materials, waste management and individual behaviour.

# Applicable standards

## National Curriculum for England Key Stage 3

| KS3 Science<br>Element of the curriculum | Lessons<br>1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| **Materials** | | | | | |
| • Properties of polymers | ✓ | ✓ | ✓ | | |
| **Energy Changes** | | | | | |
| • Heating and thermal equilibrium: how a temperature difference between two objects leads to energy transfer from the hotter to the cooler one, through contact (conduction) or radiation, and how such transfers tend to reduce the temperature difference. Use of insulators. | | ✓ | | | |
| **Scientific working skills** | | | | | |
| • Make predictions using scientific knowledge and understanding. | | ✓ | | | |
| • To select, plan and carry out the most appropriate types of scientific enquiries to test predictions, including identifying independent, dependent and control variables, where appropriate. | | ✓ | | | |
| • To use appropriate techniques, apparatus, and materials during fieldwork and laboratory work, paying attention to health and safety. | | ✓ | | | |
| • To make and record observations and measurements using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements. | | ✓ | | | |
| • Presenting observations and other data using appropriate methods. | | | | | ✓ |
| • Translating data from one form to another. | | | | | ✓ |
| • Interpreting observations and other data, including identifying patterns and trends, making inferences and drawing conclusions. | | | | | ✓ |
| **Interactions and interdependencies** | | | | | |
| • How organisms affect, and are affected by, their environment, including the accumulation of toxic materials. | | | | ✓ | |
| **Genetics and evolution** | | | | | |
| • How changes in the environment may leave individuals within a species, and some entire species less well adapted to compete successfully and reproduce, which in turn may lead to extinction. | | | | ✓ | |
| **Knowledge** | | | | | |
| • How organisms affect, and are affected by their environment, including the accumulation of toxic materials. | | | | | ✓ |

# SCHEME OF WORK

## Lesson 1: How are plastics made?

### Overview

In this chemistry Key Stage 3 (KS3) lesson, students will learn how monomers and polymers dictate the properties of plastics. This lesson focuses on how plastics are made. Included are teacher resources for students to make their own polymer, using PVA and borax, to observe how changing the structure of a substance changes its properties.

### Learning outcomes

- State that plastics are made from oil
- Describe the steps involved in making oil
- State what a monomer and a polymer is
- Describe how changing a substance's structure can change its properties

### Resources

**Slideshow 1:**
How are plastics made?

**Activity Overview 1a:**
How to make slime

**Student Sheet 1a:**
Plastic production table

**Student Sheet 1b:**
Plastic card sort

**Student Sheet 1c:**
How to make slime

**Thinglink:**
Seven types of plastic

## Lesson 2: Why are plastics useful?

### Overview

In this chemistry Key Stage 3 (KS3) lesson, students investigate the different properties of plastics. In groups students design an investigation testing either thermal insulation or tensile strength. Included are teacher resources with an investigation template.

### Learning outcomes

- Describe how plastics can be both harmful and useful
- Identify independent, dependent, and control variables
- Develop investigation skills including control variables and repeats
- Evaluate results in a graph

### Resources

**Slideshow 2:**
Why are plastics useful?

**Activity Overview 2a:**
Plastics independent investigations

**Student Sheet 2a:**
Plastics independent investigations

## Lesson 3: What happens after you throw it away?

### Overview

In this chemistry Key Stage 3 (KS3) lesson, students investigate rates of decay. The lesson is focused on students designing their own investigation. Included are teacher resources allowing students to test how a conventional plastic bag decays compared to a compostable bag (using a potato as a substitute), in different conditions.

### Learning outcomes

- Recognise that most plastic ends up in either landfill or the sea.
- Order materials based on the time they take to degrade.
- Describe alternatives to using plastics
- Create an investigation on how to increase the speed of decay.

### Resources

**Slideshow 3:**
What happens to plastic when you throw it away

**Activity Overview 3a:**
Degradation test

**Student Sheet 3a:**
How long will it take to degrade?

**Student Sheet 3b:**
Biodegradable plastic bags academic paper

**Student Sheet 3c:**
Design a biodegrade test

**Student Sheet 3d:**
Dr Imogen Napper's study

**External Link:**
Inspiring Stories: Imogen Napper

## Lesson 4: How does plastic affect the environment?

### Overview

In this biology Key Stage 3 (KS3) lesson, students learn how plastics affect the marine environment. This lesson is focuses on the physical harm caused by plastics to marine organisms. Included are teacher resources that promote students to become advocates for reducing plastic waste to protect our oceans.

### Learning outcomes

- Order most common types of plastic waste
- Describe how plastic waste impacts the environment
- Predict how plastic waste impacts a variety of marine organisms
- Formulate solutions to plastic waste issues

### Resources

**Slideshow 4:**
How does plastic affect the environment?

**Student Sheet 4a:**
Sources of marine plastic

**Student Sheet 4b:**
Plastics in the ocean

**Student Sheet 4c:**
Marine life cards

**External Link:**
Sea turtle with a straw up its nostril

## Lesson 5: Plastics and bioaccumulation

### Overview

In this biology Key Stage 3 (KS3) lesson, students will learn about plastics and bioaccumulation. This lesson is focused on how chemical pollutants cause harm to marine organisms. Included are teacher resources to model bioaccumulation and an orca case study.

### Learning outcomes

- State that pollutants can enter an organism's body from the environment
- Describe how energy and pollutants are passed through a food chain / web
- Evaluate whether plastics contribute to bioaccumulation
- Analyse data to identify trends

### Resources

**Slideshow 5:**
Plastics and bioaccumulation

**Mark Scheme 5a:**
Plastics and bioaccumulation assessment

**Student Sheet 5a:**
Plastics and bioaccumulation assessment

**Subject Update:**
How to: improve students online research skills

# Teacher guidance

The Teacher Guidance for each lesson uses a set of icons as seen below to provide visual clues to support teachers:

## Lesson activities

**Explain**
teacher exposition using slides or script to support

**Demonstration / watch**
students watch a demonstration or video

**Student activity**
activity for students to complete individually such as questions on a Student Sheet

**Pair activity**
activity for students to complete in pairs

**Group work**
activity for students to complete in groups

**Whole class discussion**
teacher conducts a whole class discussion on a topic or as a plenary review

**Home learning**
home learning exercise for after school or alternatively, a lesson extension

## Teacher ideas and guidance

**Assessment and feedback**
guidance to get the most from AfL (Assessment for Learning)

**Guidance**
further information on how to run an activity or learning step

**Idea**
optional idea to extend or differentiate an activity or learning step

**Information**
background or further information to guide an activity or explanation

**Technical**
specific ICT or practical hints and tips

**Health and safety**
health and safety information on a specific activity

## Lesson 1:
## How are plastics made?

In this lesson, students be invited to learn how we make plastics. Students will gain on overview of all processes involved. Students will create their own polymer and observe first-hand how changing a chemical's structure changes its' properties.

### Resources in this book:


**Lesson Overview 1**


**Teacher Guidance 1**


**Activity Overview 1a:** How to make slime


**Student Sheet 1a:** Plastic production table

**Student Sheet 1b:** Plastic card sort

**Student Sheet 1c:** How to make slime

### Resources available online:


**Slideshow 1:** What can we do to reduce ocean plastic pollution?


**Thinglink:** Seven types of plastic

All resources can be downloaded from:
encounteredu.com/teachers/units/ocean-plastics-science-ages-11-14

# How are plastics made?

Age 11-14

60 minutes

## Curriculum links

- Investigate and understand how changing a substance's structure can change its properties
- Describe how plastics are made from crude oil

## Resources

**Slideshow 1:**
How are plastics made?

**Activity Overview 1a:**
How to make slime

**Student Sheet 1a:**
Plastic production table

**Student Sheet 1b:**
Plastic card sort

**Student Sheet 1c:**
How to make slime

**Thinglink:**
Seven types of plastic

## Extension or home learning

Students find a selection of products at home made of plastic. Photograph the symbols, printed or etched, on to the plastic. Bring an A4 sized sheet of the photographs. Add a key stating what these symbols mean. Students can be directed to an online resource as an exemplar - (https://encounteredu.com/discover/images/seven-types-of-plastic).

## Lesson overview

In this chemistry Key Stage 3 (KS3) lesson, students will learn how monomers and polymers dictate the properties of plastics. This lesson focuses on how plastics are made. Included are teacher resources for students to make their own polymer, using PVA and borax, to observe how changing the structure of a substance changes its properties.

| Lesson steps | Learning outcomes |
|---|---|
| **1. What can we do with oil? (5 mins)** To recap prior knowledge, students guess what can be done with oil. | • State that plastics are made from oil |
| **2. Plastic production carousel (15 mins)** Students are invited to discover how oil is made by moving to different stations around the room while they fill in Student Sheet 1a: Plastic production table. | • Describe the steps involved in making plastic |
| **3. Monomers and polymers (5 mins)** Students learn how the physical changes to the hydrocarbons happen through the process of polymerisation. | • State what a monomer and a polymer is |
| **4. Thermosetting vs thermoplastics (10 mins)** Students sort plastics by their properties into two categories: thermosetting and thermoplastics. | • Describe how changing a substance's structure can change its properties |
| **5. Making Slime (20 mins)** Students make their own polymer using PVA and borax. | • Describe how changing a substance's structure can change its properties |
| **6. Reflection: love, recycle, bin (5 mins)** Students reflect on the lesson. They state one thing they loved, one thing they would bin (had rather not have done), and one thing learned that they would like to recycle (needed for the next lesson). | |

# TEACHER GUIDANCE 1 (page 1 of 3)
# HOW ARE PLASTICS MADE?

| Step | Guidance | Resources |
|---|---|---|
| **1**<br>5<br>mins |  <br>Step 1 allows the teacher to assess student's prior knowledge of the topic through a settler activity.<br>· On slide 2, students list things that can be done, or made, with oil into their books.<br>· Collect this to understand where to pitch the introduction.<br>· Explain, if not elicited from students, that oil can be used to make plastics.<br>· Using slides 3-4, introduce the lesson and learning outcomes.<br>· Leading the students on to the next part of the lesson ask them to predict how oil is turned into plastic. This question is displayed on slide 4.<br>  <br>If you have not taught a marine or plastics focused lesson to your class before this lesson, consider using some of the activities and lessons from Oceans for beginners 11-14 to provide a broader context. This mini-unit can be accessed at https://encounteredu.com/teachers/units/oceans-for-beginners-11-14. | **Slideshow 1:**<br>Slides 1-4 |
| **2**<br>15<br>mins |  <br>In step 2, students will begin the journey of how oil is transformed into plastic through a carousel activity.<br>· Print slides 16-20 and place around the classroom. You may need 2 copies depending on class size.<br>· Students use Student Sheet 1a and move to different stations in the room to collect information, which they write into their table.<br>· Inform students to return to their seats once completed.<br>· Once several students have returned to their seats, call all students to return to their seats and review the steps, as a class, allowing students to fill in missing sections.<br>· Once reviewed you have opportunity for a mini-plenary. Referring to slide 6, ask a students to identify the image which represents the first step in the process. Ask them to describe what is involved in the process. Continue to direct questions at students to check understanding. This is a valuable opportunity to identify and correct misconceptions. | **Slideshow 1:**<br>Slides 5-6<br>**Student Sheet 1a:**<br>Plastic production table<br>**Print:**<br>Slides 16-20 |

| Step | Guidance | Resources |
|---|---|---|
| **3**<br>5<br>mins | In step 3, students consider the change in structure that the oil has undergone to become a plastic. Students are introduced to key terms, monomer, polymer, and polymerisation.<br>· Using slide 7, pose a whole class question, "What have we changed to make oil become plastic?" Remember to leave at least 5 seconds think time before taking a response.<br>· Referring to slide 8, inform students that the process changed the structure. The crude oil is extracted and separated. A type of oil is removed. It is broken down into a monomer. With that monomer we can make extremely long chains called polymers. This process is called polymerisation.<br>Note that monomer is a generic name for any small molecule. Polymer is generic name for any longer molecule made of repeating units. Polymerisation is the process where these units combine. In manufacturing and biologically this is often done in the presence of a catalyst.<br>Go further by modelling the process. Get students to line up and either the teacher or another student moves down encouraging them to hold hands. Be respectful of social, emotional, and religious beliefs. | **Slideshow 1:**<br>Slides 7-8 |
| **4**<br>10<br>mins | Students now have an appreciation of the steps involved in making plastics and key terms which describe their structure. Now students sort plastics by their properties into two categories: thermosetting plastics and thermoplastics.<br>· Ask students to look at the diagrams on the board. Ask a student to describe what they can see. Followed by asking another student, "What do you think the differences are between thermosetting and thermoplastics?"<br>· Inform students that thermosetting plastics are generally much harder and more brittle whereas thermoplastics are generally softer and more flexible. This is because of the presence of more cross links between polymer chains in the thermosetting plastics and fewer cross-links present between polymer chains in the thermoplastics.<br>· Hand out Student Sheet 1b.<br>· Using slide 10, direct students to sort out the plastics into two categories.<br>· Once students have placed each plastic in one of two categories, show slide 11 to share the answers. | **Slideshow 1:**<br>Slides 9-11<br>**Student Sheet 1b:**<br>Plastic card sort |

# TEACHER GUIDANCE 1 (page 3 of 3)
# HOW ARE PLASTICS MADE?

| Step | Guidance | Resources |
|---|---|---|
| **5**<br>20<br>mins | Students work in groups to create their own slime. This demonstrates how changing the structure of a substance changes the properties.<br>· Inform students they will be making their own polymer using PVA and Borax.<br>· Hand out Student Sheet 1c.<br>· Demonstrate to students what they must do. This will vary depending on how you and your technician have set up the equipment.<br>· Remind students of safety precautions, including not to ingest the PVA-borax mixture.<br>· Once students have made the slime ask that they answer the summary questions.<br>· Review summary questions as a class.<br><br>The borax acts like a bridge connecting the individual PVA molecules. This increases the length of the molecules, changing the texture of the substance. This is like the change observed with the polymerisation of oil (a liquid) to form plastic (a solid).<br><br>Borax is toxic and should not be consumed or touched with bare hands. Ensure students do not ingest mixture and that they wash their hands if they have come into contact with borax.<br><br>Go further by explaining that slime is a non-Newtonian fluid. This means that under different conditions it can either act like a solid or a liquid. When under stress, from pulling sharply or hitting, the material becomes firm and breaks easily. When under low stress, from stirring smoothly, the material flows and can be stretched. | **Slideshow 1:**<br>Slides 12<br>**Activity Overview 1a:**<br>How to make slime<br>**Student Sheet 1c:**<br>How to make slime |
| **6**<br>5<br>mins | Students reflect on the lesson to practise metacognition.<br>· Students should state one thing that they liked; one thing they would bin (rather not have done); and one thing they will need to recycle (remember for next lesson). | **Slideshow 1:**<br>Slide 13 |
| **+**<br>20<br>mins | Challenge students to find a various products at home made from plastic. Ask students to photograph the symbols, printed or etched, on to the plastic. Explain that these symbols represent the type of plastic the product is made from. Students should bring an A4 sized sheet of photographs or drawings with 5 or more different products they have found. Students should include a key which identifies what plastic each symbol represents.<br><br>Diagram: Seven types of plastic can be used to complete this home learning. (https://encounteredu.com/discover/images/seven-types-of-plastic) | **Thinglink:**<br>Seven types of plastic |

# How to make slime

Age 11+
(adult supervision)

20 minutes

## Details

### What you need

- PVA glue
- Borax
- Cups
- Food colouring
- Stirrers
- Student Sheet 1c: How to make slime

## Safety and Guidance

### Precautions

Borax is toxic and should not be consume or touched with bare hands.

Ensure students do not ingest mixture and that they wash their hands if they have come in contact.

## Overview

In this activity students will discover how a change in the structure of a molecule can change the physical properties. Students will mix PVA (Polyvinyl Acetate) with borax. The borax creates cross links between the PVA molecules. This extends the PVA molecules and result in the new substance having a firmer texture.

## Preparation

For faster results ask technicians to add the raw ingredients to the cup with a stirrer. This allows students to simply stir and observe the changes.

## Running the activity

1. Add 125ml PVA to the beaker.
2. Add 2 teaspoons of borax.
3. Mix with a stirrer.
4. The mixture can become firm and hard, like the texture of fat. If the mixture becomes too thick, add up to two table spoons of water. This will give the desired slime texture, which can be stirred and poured easily.
5. Add food colouring (optional).

## Guidance for discussion

- Explain to students that they will be mixing PVA (a polymer) with borax (a smaller molecule).
- Ask students when doing the practical that they observe changes in the physical properties.
- Remind students that oil, a liquid, is converted to plastic, a solid. This happens through increasing the chain length through polymerisation. Then ask them to predict what might be happening to the length of the molecules in the PVA and borax mixture.

## Expected results

In this activity students create a polymer. They should observe that by adding borax to PVA the consistency changes. This is analogous to oil changing to plastic, as oil goes from being a liquid to being a solid. Students should recognise that by increasing the length of the molecule in both oil and our PVA-borax mixture we can change their properties.

STUDENT SHEET 1a

# Plastic production table


Go to each station in the room and write what happens at each step. Sketch a diagram to summarise each step.

| Location | What happens? | Sketch a diagram |
|---|---|---|
| Oil rig | | |
| Oil refinery | | |

## STUDENT SHEET 1a

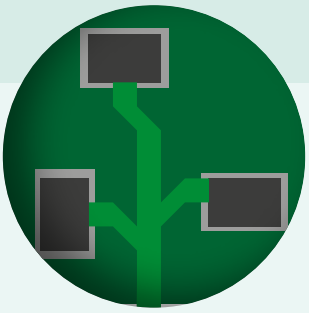
| Location | What happens? | Sketch a diagram |
|---|---|---|
| Chemical factory | | |
| Pellets | | |
| Moulding | | |

# Plastic card sort

## Thermosetting plastic or thermoplastic?

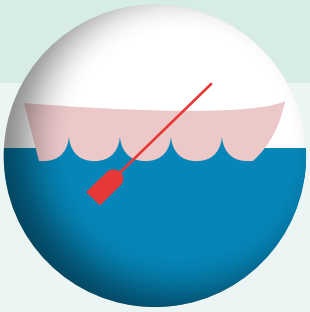
Cut out and arrange these cards into 2 categories:

| thermosetting plastics | thermoplastics |
|---|---|



**Epoxy resin (ER)**

This is used to make circuit boards because it is good insulator of electricity. Very Hard and brittle.



**Polyester resin (PR)**

Used to make the bodies of fast cars and boats. This is very stiff and brittle.

**Polyamide (Nylon)**

This is used to make clothes. It is hard wearing but flexible.

**Phenol formaldehyde (PF)**

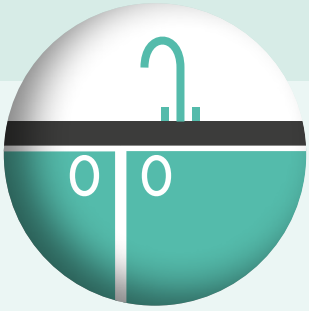
This is used in appliance fittings, such as handles of pans. Very hard.

**Polyethylene (PET)**

Most used plastic. This material makes bags and bottles. It is light weight and easily recyclable.

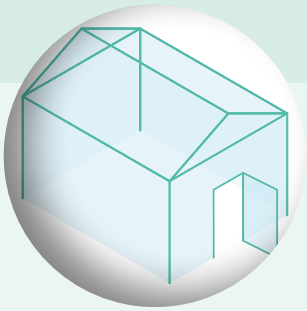
**Polypropylene (PP)**

Second most commonly used plastic. Used to make packaging. Light weight and flexible.



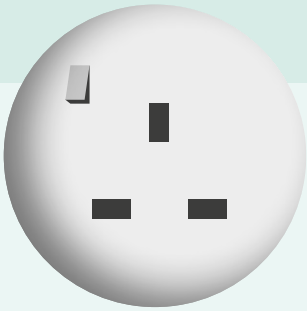
**Polycarbonate (PC)**

This is used to make kitchen work surfaces. Very strong and hard.



**Melamine Formaldehyde (PR)**

This material makes greenhouses. It is high impact resistant and transparent. Unusually strong for the group of plastics which it belongs to.



**Urea Formaldehyde (UF)**

This is used to make electrical components because it is a good insulator. Very hard and brittle.

**High Impact Polystyrene (HIP)**

This material makes sale signs and trays. Very rigid and strong for the group of plastics which it belongs.

# How to make slime

## Equipment

250ml beaker
125ml of PVA
2 tea spoons of Borax
2 table spoons of water
Food colouring (optional)

## Method

- Add PVA to the beaker.
- Add 2 tea spoons of borax.
- Mix with spatula.
- If the mixture is too thick, add up to 2 table spoons of water.
- Add food colouring.

## Summary Questions

1. What did you observe?

.....

.....

2. When we mix PVA with borax, the borax molecule binds the small chains of PVA together. This creates longer chains. Draw this as a diagram below.

3. Predict what would happen to the texture if we added more borax.

.....

.....

## Lesson 2:
## Why are plastics useful?

This lesson allows students to design and carry out an investigation to compare the properties of plastic with other materials.

### Resources in this book:


**Lesson Overview 2**


**Teacher Guidance 2**


**Activity Overview 2a:** Plastic independent investigations


**Student Sheet 2a:** Plastic independent investigations

### Resources available online:


**Slideshow 2:** Why should we recycle?

All resources can be downloaded from:
encounteredu.com/teachers/units/ocean-plastics-science-ages-11-14

# Why are plastics useful?

Age 11-14

60 minutes

## Curriculum links

- Investigate properties of materials
- Develop investigation skills including use of independent, dependent and control variables

## Resources

**Slideshow 2:**
Why are plastics useful?

**Activity Overview 2a:**
Plastics independent investigations

**Student Sheet 2a:**
Plastics independent investigations

## Extension or home learning

"On a hot day, would you rather drink from a cold single-use plastic bottle or a warm metal reusable bottle?" Write 200 words explaining the advantages and disadvantages. Give a conclusion.

## Lesson overview

In this chemistry Key Stage 3 (KS3) lesson, students investigate the different properties of plastics. In groups students design an investigation testing either thermal insulation or tensile strength. Included are teacher resources with an investigation template.

| Lesson steps | Learning outcomes |
|---|---|
| **1. I couldn't disagree more because... (5 mins)**<br>Students use media-based knowledge on plastics to describe how they can be both harmful and useful. These ideas are put on the board. Students work in pairs to play 'I couldn't disagree more because'. | • Describe how plastics can be both harmful and useful |
| **2. Variables (5 mins)**<br>Teacher explains what independent, dependent, and control variables are. The teacher shows two examples of investigations into plastics with the variables identified. | • Identify independent, dependent, and control variables |
| **3. Designing a practical (35 mins)**<br>Students design and carry out their own investigation using Student Sheet 2a: Plastics independent investigations. | • Develop investigation skills including control variables and repeats |
| **4. Analyse Data (10 mins)**<br>Students must graph their data using the design your test worksheet. | • Evaluate results in a graph |
| **5. Reflection: love, recycle, bin (5 mins)**<br>Students reflect on the lesson. They state one thing they loved, one thing they would bin (had rather not done) and one thing learned that they would like to recycle (needed for the next lesson). | |

# TEACHER GUIDANCE 2 (page 1 of 3)
# WHY ARE PLASTICS USEFUL?

| Step | Guidance | Resources |
|---|---|---|
| 1<br>5<br>mins |  <br>Introduce the topic of plastics by discussing its advantages and disadvantages as a material.<br>· Introduce the lesson and the learning outcomes using slides 1-2.<br>· Using slide 3 as a prompt the teacher initiates a discussion on "Why are plastics harmful?" followed by "Why are plastics useful?"<br>· Students discuss why plastics can be harmful and useful.<br>· Collect ideas onto the class board so students can reference for the subsequent activity.<br>· Using slide 4, students work in pairs to play 'I couldn't disagree more because'. In pairs, one argues for and one argues against the use of plastic. Students must start every sentence with "I couldn't disagree more because..." | **Slideshow 2:**<br>Slides 1-4 |
| |  <br>"I couldn't disagree more because..." is designed to increase oracy in the classroom.<br>First of all a statement is given. For example, "Cheese is the best food." Students work in pairs, each taking opposing sides to an argument. Person A supporting the statement and person B opposing.<br>Person A could start by saying, "Cheese is fantastic because it makes everything taste great." To which person B responds, "I couldn't disagree more because most cheese smells like feet." Person A must then respond to person B's last comment, and the pair continue, always starting their sentence with "I couldn't disagree more because..." The person who argues the longest is the winner. | |
| |  <br>If you have not taught a marine or plastics focused lesson to your class before this lesson, consider using some of the activities and lessons from Oceans for beginners 11-14 to provide a broader context. This mini-unit can be accessed at https://encounteredu.com/teachers/units/oceans-for-beginners-11-14. | |

# TEACHER GUIDANCE 2 (page 2 of 3)
# WHY ARE PLASTICS USEFUL?

| Step | Guidance | Resources |
|---|---|---|
| **2**<br>5 mins | Step 2 involves students considering what makes a scientific investigation. They will be introduced to variables, which they will apply to their own investigation relating to plastics.<br>· Explain to students that they will be learning what makes a good scientific investigation.<br>· List the three types of variable: the independent (what we change); the dependent (what we measure); and the control (what we keep the same).<br>· Give context by posing a question, such as "How would I investigate if blue cars are faster than red cars?" Then either apply the variables to the question in your explanation or encourage a student to do so.<br>· Move to slide 6, allow students to work in pairs to read the scenario and identify the independent, dependent and control variables. Review these on slide 7.<br>· Move to slide 8, again allow students to work in pairs to read the scenario and identify the independent, dependent and control variables. Review these on slide 9. | **Slideshow 2:**<br>Slides 5-9 |
| **3**<br>35 mins | Students have the opportunity to work in small groups and create their own independent investigation, while applying knowledge from the lesson.<br>· Put students in small working groups.<br>· Hand out Student Sheet 2a.<br>· Direct students to Slide 10 to understand the sequence of activities.<br>· It would benefit students if they received their trays with equipment during planning, so that they design their investigation appropriately. Move to slide 8, again allow students to work in pairs to read the scenario and identify the independent, dependent and control variables. Review these on slide 9.<br>· If a significant number of students are struggling to draw a table, stop the group work and model how to do this on a white board for the whole class.<br>· After a set time period, invite groups to share their plan to model to other students what they will be doing during the practical.<br>· During step 4 students will work in small groups to carry out the investigation.<br>· Circulate the class coaching students through questioning such as, "Why are you keeping this the same?", or "How are you making your investigation repeatable?" | **Slideshow 2:**<br>Slide 10<br>**Student Sheet 2a:**<br>Plastic independent investigation |
| | Allow 15 minutes for designing the activity and 20 minutes for carrying it out | |

| Step | Guidance | Resources |
|---|---|---|
| | Remind students by demonstrating how to conduct the investigations safely. For those conducting the insulation investigation, do not give students water hotter than 43 degrees Celsius. This can be achieved by boiling water in advance and allowing it to cool to the appropriate temperature, or by asking technicians to bring the correct temperature water to the class when needed. | |
| **4**<br>10 mins | Once students have collected their data, they must present their findings in a graph.<br>· Direct students to return equipment and return to a seated position to allow them to concentrate on producing their graph.<br>· Continue to model how to draw a graph by demonstrating how to plot a single point from the two axes.<br>· Draw axis labels and remind students that these are essential for another person who was not part of the experiment, to understand the findings.<br>Note that students often struggle plotting the axes on graphs correctly. Remind students that each square has a value. They must go up in equal amounts (e.g. increasing by a value of 10 for every 10 squares means each square has the value of 1). | **Slideshow 2:**<br>Slide 10<br>**Student Sheet 2a:**<br>Plastic independent investigation |
| **5**<br>5 mins | Students reflect on the lesson to practise metacognition.<br>· Students should state one thing that they liked; one thing they would bin (rather not have done); and one thing they will need to recycle (remember for next lesson). | **Slideshow 2:**<br>Slide 11 |
| **+**<br>20 mins | Challenge students to respond to the following statement "On a hot day, would you rather drink from a cold single-use plastic bottle or a warm metal reusable bottle?" Ask students to write 200 words explaining the advantages and disadvantages. Remind them to give a conclusion. This evaluation challenge is brilliant for promoting structured answers to exam-style questions. Furthermore, it allows students to think critically about their attitude to sustainable issues. You can model this in class by taking a few opinions from students in class and constructing it into a comparative sentence. You can support students further by giving them appropriate connective words which they must include, such as "whereas", "however", "inversely" or "alternately". | |

# Plastics independent investigations

**Age 11+**
(adult supervision)

planning
**15 minutes**
investigation
**20 minutes**

## Details

**What you need per group**
**For insulation test:**

- 3 beakers (250ml)
- 2 or more different materials (paper and plastic)
- Scissors
- Sticky tape
- Thermometer
- Kettle
- Timer
- Student Sheet 2a: Plastic independent investigation

**For strength test:**

- Two different materials
- Sticky tape
- Scissors
- Scales / balance
- 10g weights

## Safety and Guidance

**Precautions**

Remind students by demonstrating how to conduct the investigations safely. For those conducting the insulation investigation, do not give students water hotter than 43 degrees Celsius. This can be achieved by boiling water in advance and allowing it to cool to the appropriate temperature, or by asking technicians to bring the correct temperature water to the class when needed.

## Overview

In this activity students will discover how to design and carry out their own investigation into the properties of plastics. Specifically, they will investigate the insulation properties and strength of plastic.

## Running the Activity

- Ask technicians to set up individual trays with equipment.
- Giving students the trays whilst they are planning their investigation ensures that they only plan a practical with the equipment available.
- For a class of 30 you may have ten groups. Therefore, request five trays with the insulation test and five trays with strength test.

## Expected results

Students will recognise that plastic is both a good insulator of heat and a strong material.

STUDENT SHEET 2a

# Plastics independent investigations

## Choose one of the following models for your investigation

A) Which material is the best insulator?
B) Which material is the strongest?

## Method A

1. Collect 3 250ml beakers
2. Wrap one in plastic, one in paper, and leave one uncovered
3. Add 100ml of hot water to each beaker
4. Measure the starting temperature
5. Measure the temperature every 2 minutes for 10 minutes
6. Calculate the change in temperature between the first and last reading

## Method B

1. Collect paper and plastic materials
2. Weigh the materials so you have the same mass of both (in grams)
3. Build two identical bridges between two tables
4. Fix the hook of the weight to the bridge
5. Add 10g at a time until the bridge collapses
6. Record the weight which causes the bridge to collapse

## Summary Questions

1. What is the **independent variable** (the thing that you are changing)?

.....

2. What is the **dependent variable** (the thing that you are measuring)?

.....

3. What is the **control variable** (the thing that you are keeping the same)?

.....

4. Draw and label a diagram of your practical in the box below.

5. Draw a table of your results.
   The dependent variable goes in the far-left column.

6. Draw a bar chart of your results.
   Remember the independent variable goes on the horizontal axis and the dependent variable on the vertical axis.

7. What do your results tell you?

.....

.....

8. Do you think your results are accurate? Explain why.

.....

.....

.....

9. How could you make your investigation more fair?
   (Identify more control variables.)

.....

.....

## Lesson 3:
## What happens to plastic when you throw it away?

This lesson is invites students to consider the journey plastic goes on after use. Students will explore both the distance in space and time plastic travels. To offer hope, students will consider biodegradable alternatives and experiment to see how factors effecting decay allow these to degrade much more easily compared to the plastic used mainstream today.

### Resources in this book:


**Lesson Overview 3**


**Teacher Guidance 3**


**Activity Overview 3a:** Design a biodegrade test


**Student Sheet 3a:** How long will it take to degrade?

**Student Sheet 3b:** Biodegradable plastic bags academic study

**Student Sheet 3c:** Design a biodegrade test

**Student Sheet 3d:** Dr Imogen Napper's study

### Resources available online:


**Slideshow 3:** What happens to plastics when you throw it away?


**Thinglink:** The top causes of ocean plastic pollution


**External Link:** Inspiring Stories: Imogen Napper

All resources can be downloaded from:
encounteredu.com/teachers/units/ocean-plastics-science-ages-11-14

LESSON 3

# What happens to plastic when you throw it away?

Age 11-14

60 minutes

## Curriculum links

- Investigate what happens to plastics when disposed
- Describe and understand alternatives to plastics
- Working scientifically to compare plastics to alternatives, through degradation tests

## Resources

**Slideshow 3:**
What happens to plastic when you throw it away?

**Activity Overview 3a:**
Design a biodegrade test

**Student Sheet 3a:**
How long will it take to degrade?

**Student Sheet 3b:**
Biodegradable plastic bags academic paper

**Student Sheet 3c:**
Design a biodegrade test

**Student Sheet 3d:**
Dr Imogen Napper's study

**External Link:**
Inspiring Stories: Imogen Napper

## Extension or home learning

Complete the home learning exercise on Student Sheet 3d: Dr Imogen Napper's study.

## Lesson overview

In this chemistry Key Stage 3 (KS3) lesson, students investigate rates of decay. The lesson is focused on students designing their own investigation. Included are teacher resources allowing students to test how a conventional plastic bag decays compared to a compostable bag (using a potato as a substitute), in different conditions.

| Lesson steps | Learning outcomes |
|---|---|
| **1. How many questions can you think of? (5 mins)** Students are shown a picture of a plastic bag in the ocean. They must try and generate as many of their own questions about this image as they can. | • Recognise that most plastic ends up in either landfill or the sea |
| **2. Where does it go? (5 mins)** Students learn the possible journey plastic can take using a flow diagram. | • Recognise that most plastic ends up in either landfill or the sea |
| **3. Sources of plastic pollution (5 mins)** Students are introduced to sources of plastic pollution using an infographic. Students are challenged to redraw the image from memory. | • Recognise that most plastic ends up in either landfill or the sea |
| **4. Timeline (10 mins)** Students order objects in order of the length of time it takes them to decay. | • Order materials based on the time they take to degrade |
| **5. What are the alternatives? Academic paper (10 mins)** Students analyse an academic paper to find alternatives to oil-based plastic. | • Describe alternatives to using plastics |
| **6. Biodegrade test (20 mins)** Students investigate what factors increase decay. | • Create an investigation on how to increase the speed of decay |
| **7. Unintended consequences? (5 mins)** Students evaluate the alternatives to plastics and balance the advantages with disadvantages. | • Describe alternatives to using plastics |

# TEACHER GUIDANCE 3 (page 1 of 4)
# WHAT HAPPENS TO PLASTIC WHEN YOU THROW IT AWAY?

| Step | Guidance | Resources |
|---|---|---|
| **1**<br>5<br>mins | Step 1 invites students to generate their own line of enquiry about plastic in the ocean.<br>· On slide 2, students are shown a picture of a plastic bag in the ocean. As a settler activity they write as many questions as they can think of into their book.<br>· Coordinate the sharing of students' questions.<br>· At this point you will notice some common themes and can inform students about the lesson journey and which questions we will seek to answer in more detail during the lesson.<br>· Follow on by sharing the learning outcomes, linking these to the questions previously raised. | **Slideshow 3:**<br>Slides 1-3 |
| **2**<br>5<br>mins | Most students will have recently drunk from a plastic bottle. Step 2 informs students about the end life of this everyday commodity.<br>· Show the diagram on slide 4 detailing where manufactured plastics go.<br>· Students may need you to remind them what kilotonne (kt) is. Break down the word kilo meaning thousand and tonne being a unit of measurement. A common misconception is scales of magnitude. You can make this data more relatable by letting them know that a small car weighs approximately 1 tonne.<br>· You may want to ask students "what does this diagram tell us?" and "Are you surprised? How do you feel about this information?" | **Slideshow 3:**<br>Slide 4 |
| **3**<br>5<br>mins | Students have an appreciation for where most plastics end up. In this step, students identify what are the main sources of this plastic waste through the 'flash diagram activity'.<br>· Print off a copy of slide 5. Remember not to show this slide on the board as this will reveal the 'sources of waste diagram' that students need to draw in this 'flash diagram' activity.<br>· The 'flash diagram activity' is where students work in groups to reconstruct a picture from memory.<br>· Put the students into groups and give each group a few blank sheets of A4 paper.<br>· Explain the activity to students. As a group, students will be re-drawing a diagram on their sheet of paper. All the students in a group will get to see the diagram, but there are some catches.<br>1. Only one group member is allowed to see the diagram at a time.<br>2. Students cannot write or draw anything while they look at the diagram. | **Slideshow 3:**<br>Slide 5<br>**Print:**<br>Slide 5 |

| Step | Guidance | Resources |
|---|---|---|
| | 3. Each group member is only allowed to see the diagram for a short period of time, and this time will get shorter after each viewing.<br><br>Station yourself so that class cannot see the diagram, but there is room behind you where students can stand and "view" the diagram. | |
| **4**<br>10 mins | Having looked at where plastics go, students now consider how long they persist there through predicting how long it takes different objects to degrade.<br>· Either hand out Student Sheet 3a or advise students to draw timeline in their books.<br>· Students must predict how long we estimate different materials take to degrade.<br>· After most students have committed their answers, reveal the answers and ask students to correct their timeline using a different coloured pen.<br><br>Note that these values given are estimates. As many of these materials are relatively new, it is impossible to know accurately how long they will take to degrade, given different conditions. | **Slideshow 3:**<br>Slides 6-7<br>**Student Sheet 3a:**<br>How long will it take to degrade? |
| **5**<br>10 mins | Students now recognise how plastics enter the wider environment and the time taken for different materials to degrade. Now students explore alternative materials to synthetic plastics.<br>· Using slide 8, pose the question "Plastic persists in the environment. If we want products that degrade quicker, what material would you use?" If this does not elicit a desirable response, ask students "What sorts of things, that you can find at home, degrade quickly?" Students ought to recognise that perishable foods degrade quickly.<br>· Next, direct students to find out what scientists are doing by completing Student Sheet 3b, supported by slide 9.<br>· Review Student Sheet 3b comprehension questions using slide 10.<br>· Many students will have misconceptions about the differences in how plastics and bioplastics degrade. Address this common misconception on slide 11. | **Slideshow 3:**<br>Slides 8-11<br>**Activity Overview 3a:**<br>Degradation test<br>**Student Sheet 3b:**<br>Biodegradable plastic bags academic paper |

| Step | Guidance | Resources |
|---|---|---|
| | Go further by making it physical. Hand post-it notes to students. Challenge them to tear them into the smallest pieces possible. Explain that this is what happens to plastic. The post-it has not changed chemically - it has just become smaller. In contrast, natural polymers – such as starch - can be biodegraded by living decomposers, such as fungi and bacteria, which chemically change them into a new substance with different properties. | |
| **6**<br>20<br>mins | Students recognise that there are alternatives. Step 6 introduces students to Dr Imogen Napper and her work on investigating how fast materials degrade. Students will then replicate this research themselves.<br>· Using slides 12 and 13, introduce Dr Imogen Napper by asking a student to read her comments.<br>· Hand out Student Sheet 3c.<br>· Explain that students will have to compare how plastic and a potato (proxy for bioplastic) decompose in different conditions.<br>· Slide 14 has a graphic which explains factors affecting rate of decomposition. Depending on the class, you may want to talk through this in detail, or just direct them to the graphic to help them with their investigation.<br>· Students will need to leave their samples for a week or more to see substantial results. Once they have prepared their samples get students to return to their seats and ask them to predict what might degrade most. The plastic or the potato?<br>· Get students to vote with a 'hands-up': "which materials, plastic or bioplastic, is better for the environment? Hand up for plastic...Hands up for bioplastic?" | **Slideshow 3:**<br>Slides 12-14<br>**Student Sheet 3c:**<br>Design a biodegrade test<br>**Video:**<br>Inspiring stories: Imogen Napper |
| | This video is hosted on YouTube and you may need to unblock this service, liaising with your IT department.<br><br>The link for the video is:<br>Inspiring Stories: Imogen Napper<br>https://youtu.be/8D0nBs9TiyI | |

# TEACHER GUIDANCE 3 (page 4 of 4)
# WHAT HAPPENS TO PLASTIC WHEN YOU THROW IT AWAY?

| Step | Guidance | Resources |
|---|---|---|
| **7**<br>5<br>mins |  <br>Students should conclude that bioplastics are the better alternative. However, step 7 challenges students to consider unintended consequences of using the technology.<br>· Direct students to the opinion on slide 15. It reads: "Bioplastics need lots of starch from plants. This takes up way too much land, which may result in forests being cleared for farming. It is also unethical because many people go without food."<br>· Ask students whether they agree or disagree with this opinion. The teacher can then chair a small debate on students' opinions.<br>· A useful debate model is ABC (Agree, build, challenge), where students must respond with either: "I Agree" "I want to build on that" or "I want to challenge that"<br>  <br>The statement on slide 15 is deliberately provocative. A switch to bioplastics does not necessarily mean deforestation and famine, but the increased use of any natural resource will place pressure on habitats and supply chains. | **Slideshow 3:**<br>Slide 15 |
| **+**<br>20<br>mins |  <br>Complete the homework sheet on Dr Imogen Napper's study | **Student Sheet 3d:**<br>Dr Imogen Napper's study |

# Design a biodegrade test

Age 11+
(adult supervision)

20 minutes

## Details

### What you need per group

- Half a potato
- Part of a plastic carrier bag
- Cork borer
- Knife
- Cutting tile
- Ruler
- 4x Petri dishes
- Pen to label dishes
- Balance (to share)
- Student Sheet 3c

### Equipment to change conditions:

- Soil
- Salt water
- Oil

## Safety and Guidance

### Precautions

Students may cause injury with knives and cork borers. Remind students and demonstrate how to conduct investigation safely.

Count the knives and borers handed out and count the knives and borers returned.

Students should be careful not to ingest rotten potato. Encourage students to wash their hands after handling.

Rotting potato has the potential to breed fungus and bacteria. Ensure that samples are disposed of at the end of the activity

## Overview

In this activity students will compare how plastic and potato (a proxy for starch-based bioplastic) degrade in different conditions. Note that results cannot be gathered in the same lesson.

## Preparation

- Ask technicians to supply you with individual trays containing the essential equipment.
- In separate trays, or on top of the technician trolley, have a selection of optional equipment for students to choose from.

## Running the activity

1. Use the borer to remove 4 cylinders of potato.
2. Cut all 4 pieces of potato into the same length.
4. Place each potato cylinder into a petri dish.
5. Cut out 4 squares of plastic carrier bag to the same size.
6. Add a plastic carrier bag square to each of the 4 petri dishes.
7. Change the environment for each petri dish (temperature, oxygen availability).
8. Leave your samples for a fixed time.

## Expected results

Students are likely to predict that the potato (naturally polymer made of starch) will biodegrade more easily than the conventional plastic bag (man made polymer made of hydrocarbons derived from oil). Students will notice that by adjusting availability of microbes, oxygen, or changing the temperature, they can increase the appearance of decay in the potato.

# How long will it take to degrade?

## Put these objects in order of the time it takes for them to degrade


Aluminium Can


Fishing Line


Plastic Bottle


Polystyrene Cup


Nappy / Diaper


Cigarette butt


Rubber boot sole


Sanitary pad


Plastic straw

0 years

800 years

STUDENT SHEET 3b

# Biodegradable plastic bags academic paper

Scientists put their findings in writing to share. These are called publications or academic papers. Below is a group of scientists who share their ideas on a possible solution to the plastic problem. Read the extract and answer the comprehension questions.

## Starch based bio-plastics as alternative packaging materials

Due to the negative environmental impacts of synthetic plastics, the development of biodegradable plastics for both industrial and commercial applications is essential today. Researchers have developed various starch-based composites [bioplastics] for different applications.

The present work investigates the corn and rice starch-based bioplastics for packaging applications. Various samples of bioplastics are produced, with different compositions of corn and rice starch, glycerol, citric acid, and gelatin. The tensile [strength] properties were improved after adding rice starch. However, water absorption and water solubility were reduced.

On the basis of these results, the best sample was analysed for thickness testing, biodegradability properties, SEM, hydrophilicity, thermogravimetric analysis, and sealing properties [visual inspection under a microscope, strength, and ability to make a seal] of bioplastic. The results show the suitability of rice and corn-based thermoplastic starch for packaging applications.

Marichelvam et al. (2019)
Corn and Rice Starch-Based Bio-Plastics as Alternative Packaging Materials, Fibers 2019, 7(4), 32; https://doi.org/10.3390/fib7040032

## Comprehension Questions

1. What is meant by synthetic plastics?

2. Name the natural polymer they are using in their bioplastic.

3. Which two foods do they obtain the starch from?

4. Overall, does the text suggest that bioplastics are useful? Explain why.

STUDENT SHEET 3c

# Design a biodegrade test

## How to make the most disgusting potato

| Essential Equipment | Optional Equipment |
|---|---|
| • Potato | • Soil |
| • Plastic carrier bags | • Salt water |
| • Cork borer | • Oil |
| • Knife | |
| • Cutting tile | |
| • Ruler | |
| • Petri dishes | |

### Method

1. Use the borer to remove 4 cylinders of potato.
2. Cut all 4 pieces of potato into the same length.
3. Place each potato cylinder into a petri dish.
4. Cut out 4 squares of plastic carrier bag to the same size.
5. Add a plastic carrier bag square to each of the 4 petri dishes.
6. Change the environment for each petri dish (temperature, oxygen availability).
7. Leave your samples for a fixed time .

| Potato & plastic sample | How have you changed the conditions? |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |

| Samples | Observations |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |

## Summary Questions

1. What factors increase the rate of degradation?

.....

.....

2. From your investigation, which factor(s) caused the most degradation?

.....

.....

3. Explain why this might have happened?

.....

.....

4. Would you recommend using starch-based (bio) plastics? Explain why.

.....

.....

# Dr Imogen Napper's study

## Deterioration of compostable versus conventional carrier bags

Dr Imogen Napper studies ocean plastics at The University of Plymouth. Imogen has compared lots of different types of plastic to see in what conditions they break down best. Her findings will help us reduce the time plastics persist in the environment.

Imogen has tested compostable and conventional plastic carrier bags. These materials were exposed to open air, buried in soil, and submerged in seawater. One was kept in laboratory conditions as a control.

Imogen removed the bags after 3 years. She cut them into equal sized squares. Then Imogen hung a weight from the plastic and measured how much they stretched. The more the plastic stretched the more they had degraded.

1. What was Imogen's independent variable (what did she change)?

.....

2. What was Imogen's dependent variable (what did she measure)?

.....

3. What was Imogen's control variable (what did she keep the same)?

.....

| Environment | How much the bags stretched with 60g weight | |
|---|---|---|
| | Compostable bag | Conventional bag |
| Open air | 120mm | 100mm |
| Buried in soil | 240mm | 60mm |
| Submerged in sea water | 120mm | 100mm |
| Lab conditions | 100mm | 90mm |

4. Which bag showed the most degradation?

.....

5. Which environment degraded the bags the most for compostable and conventional bags?

.....

.....

6. How could you improve this investigation?

.....

.....

.....

## Lesson 4:
## How does plastic affect the environment?

Students identify the biggest contributors to plastic pollution in oceans and the impact that these have on the marine environment.

### Resources in this book:


**Lesson Overview 4**


**Teacher Guidance 4**


**Student Sheet 4a:** Common plastic waste

**Student Sheet 4b:** Plastic in the ocean

**Student Sheet 4c:** Marine life cards

### Resources available online:


**Slideshow 4:** How does plastic affect the environment?


**External Link:** Sea turtle with straw up its nostril

All resources can be downloaded from:
encounteredu.com/teachers/units/ocean-plastics-science-ages-11-14

LESSON 4

# How does plastic affect the environment?

Age 11-14

60 minutes

## Curriculum links

- Investigate how human pollution impacts the environment
- Understand how plastic pollution affects marine organisms

## Resources

**Slideshow 4:**
How does plastic affect the environment?

**Student Sheet 4a:**
Common plastic waste

**Student Sheet 4b:**
Plastics in the ocean

**Student Sheet 4c:**
Marine life cards

**External Link:**
Sea turtle with a straw up its nostril

## Extension or home learning

Completing the "Plastic advocacy" task. This will involve redrafting the letter or poster to a professional standard. Where possible, to be completed on a computer and printed out.

## Lesson overview

In this biology Key Stage 3 (KS3) lesson, students learn how plastics affect the marine environment. This lesson is focussed on the physical harm caused by plastics to marine organisms. Included are teacher resources that promote students to become advocates for reducing plastic waste to protect our oceans.

| Lesson steps | Learning outcomes |
|---|---|
| **1. What is the most common trash? (10 mins)** Students order the types of waste found washed on beaches from the most to least common. | • Order most common types of plastic waste |
| **2. How does plastic affect the environment? (15 mins)** Students move around the classroom to investigate how different types of plastics waste impact the environment. | • Describe how plastic waste impacts the environment |
| **3. Marine life cards (10 mins)** Students have a set of marine animal cards. They are presented with information and must decide which animal is going to be most and least effected. | • Predict how plastic waste impacts a variety of marine organisms |
| **4. Plastics advocacy (20 mins)** Students apply what they have learned by choosing one of two activities. Either making a poster or writing a letter. | • Formulate solutions to plastic waste issues |
| **5. Marine animal reflection (5 mins)** Students write a reflection on what they have learned in the lesson from the perspective of a marine animal. | • Predict how plastic waste impacts a variety of marine organisms |

# TEACHER GUIDANCE 4 (page 1 of 3)
# HOW DOES PLASTIC AFFECT THE ENVIRONMENT?

| Step | Guidance | Resources |
|---|---|---|
| **1**<br>10 mins | Students are introduced to the topic by first considering what everyday products are most commonly found in our oceans.<br>· Using slide 2 alone, ask students to order these everyday items from most to least commonly found in the ocean.<br>· Note that, depending on your class, this can be done with or without Student Sheet 4a.<br>· Reveal the answers to students, as shown on slide 3,<br>· Using slide 4, introduce the topic and learning objectives. | **Slideshow 4:**<br>Slides 1-4<br>**Student Sheet 4a:**<br>Common plastic waste |
| **2**<br>15 mins | Students now have an appreciation of the abundance of different materials. Next, they move to different stations around the room and discover how different objects can affect the environment.<br>· Print out slides 21-26 and place around the room. For larger classes print two copies.<br>· Hand out Student Sheet 4b.<br>· Students move to each station filling in two sections of the table titled, 'Impact on the environment', and 'How can we prevent this?'<br>· Once several students have completed and returned to their seats, ask all students to return. Review the sections allowing all students to fill in missing sections. | **Slideshow 4:**<br>Slide 5<br>**Student Sheet 4b:**<br>Plastics in the ocean<br>**Print:**<br>Slides 21-26 |
| **3**<br>10 mins | In step 3, students must consider how different factors will affect marine organisms. They must use knowledge acquired in step 2 to make predictions.<br>· An optional starter to this activity is described overleaf. Use slide 6 to introduce this or delete if not using.<br>· Using slide 7, introduce the task to students. Explain that they will be predicting how different statements will effect the marine organisms shown on the board.<br>· Note that, depending on the class, you can either do this activity from the board or using Student Sheet 4c.<br>· Reveal statement 1 on slide 8. Allow students to discuss, in pairs or groups, and rank which organisms are affected most to least. Review choices made by groups as a whole class discussion.<br>· Repeat for statements 2 and 3, respectively shown on slides 9 and 10. | **Slideshow 4:**<br>Slides 6-10<br>**Student Sheet 4c:**<br>Marine life cards<br>**Video:**<br>Sea turtle with straw up its nostril |

# TEACHER GUIDANCE 4 (page 2 of 3)
# HOW DOES PLASTIC AFFECT THE ENVIRONMENT?

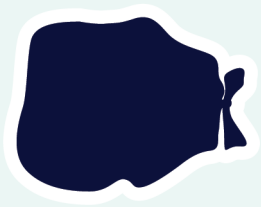
| Step | Guidance | Resources |
|---|---|---|
| | Recently footage of a turtle having a plastic straw removed from it's nostril became hugely popular on social media. The footage was taken by Christine Figgener, marine biologist at Texas A&M University. Initially they assumed it was a barnacle or worm. You may want to introduce step 3 with the video. Pose students the question: "Can you guess what has got stuck in the turtle's nostril?" This video is 8 minutes long so you may wish to use just a short excerpt.<br><br>This video is hosted on YouTube and you may need to unblock this service, liaising with your IT department.<br><br>The link for the video is:<br>Sea Turtle with Straw up its Nostril *NO* TO PLASTIC STRAWS<br>https://youtu.be/4wH878t78bw<br><br>Watch the video before presenting it to the class. Depending on the age of your class, consider whether it is too graphic. This video contains inappropriate / strong language. | |
| **4**<br>20<br>mins | Students now understand how plastics harm marine organisms. In this step, students attempt to find solutions to the problem. They are introduced to advocacy and create their own campaign material.<br><br>· Using slide 11, introduce students to scales of change.<br><br>· Using slide 12, students consider what changes individuals can make to reduce physical harm caused by plastic. Hand out post-it notes. Ask students to work in pairs or groups and write their ideas on to a post it note. Facilitate students to share their ideas in a whole class discussion.<br><br>· Using slide 13, the teacher highlights more changes individuals can make to reduce physical harm caused by plastic.<br><br>· Directing students to slide 14, explain what an individual can do to create a bigger change.<br><br>· Introducing the plastic advocacy task, show slide 14. Ask students to choose either option 1 or option 2. Students can either write a letter to their local government or create a poster for their community.<br><br>· Ensuring students progress, show students slides 16 and 17 to co-create a success criteria. Facilitate a discussion on:<br><br>1. "What makes a good campaign poster?"<br>2. "What makes a good letter?"<br><br>· Ask one student to stand by the class board and list the classes' shared success criteria.<br><br>· Ask students to begin Plastic Advocacy task. Circulate to offer fast feedback. | **Slideshow 4:**<br>Slides 11-17 |

# TEACHER GUIDANCE 4 (page 3 of 3)
# HOW DOES PLASTIC AFFECT THE ENVIRONMENT?

| Step | Guidance | Resources |
|---|---|---|
| **5**<br>5<br>mins | Students reflect on the lesson from different perspectives.<br>· Using slide 18, ask students, "Describe what you would think of this lesson if you were..."<br>1. A turtle.<br>2. A drinks manufacturer.<br>3. A fisherman.<br>· Collect student's response. | **Slideshow 4:**<br>Slide 18-19 |
| **+**<br>20<br>mins | As there is limited time in the lesson, ask students to complete their plastic advocacy task. This will involve either redrafting their letter or poster to a professional standard. Where possible, completing on a computer. | |

# Common plastic waste

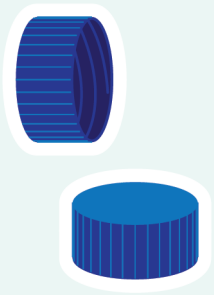
These items are often found washed up on beaches. Order them from the most to least commonly found.



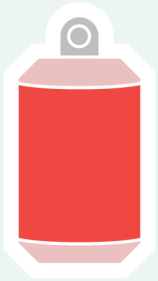
Other plastic bags

Plastic Grocery bags

Plastic bottle caps

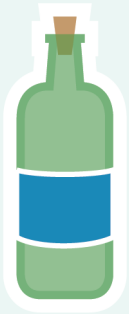


Aluminium cans



Plastic straws

Glass beverage bottles



Plastic cups and plates

Plastic bottle

Food wrappers

Cigarette butts

STUDENT SHEET 4b

# Plastic in the ocean

Plastics in the oceans can cause harm to the environment. Move to each station, write down the impact on the environment, and think of a way how we can prevent it.

| Source | Impact on the environment | How we can prevent it |
|---|---|---|
| Cigarette butts | | |
| Beverage bottles and caps | | |
| Plastic straws | | |
| Plastic bags | | |
| Fishing line and nets | | |
| Microplastics | | |

# Marine life cards

**Sperm whale**

The sperm whale is the largest toothed whale on the planet, living in ice-free oceans around the world. They often hunt at depth and eat larger prey such as squid.

**Mussel**

Mussels are a type of shellfish. They live in coastal waters, mostly in temperate oceans. They feed by filtering the seawater for plankton, small sea creatures floating in the water.

**Lanternfish**

Lanternfish live in all the world's oceans. They live at depths of between 300m and 1,500m, rising towards the surface to feed at night. They feed on plankton, small animals drifting on the ocean currents.

**Albatross**

Albatross live across the southern oceans of the world and in the North Pacific. They return to land to breed and nest. They eat a range of marine life including squid and fish.

**Green turtle**

Green turtles live across tropical and subtropical oceans worldwide. They nest on beaches and can be found near human settlements. Turtles eat many different foods including jellyfish.

## Lesson 5:
## Plastics and bioaccumulation

This lesson focusses on how pollutants from plastics, accumulate in the food chain. Students model how theses plastic pollutants move in the food chain and complete an Orca case study.

### Resources in this book:


**Lesson Overview 5**


**Teacher Guidance 5**


**Mark Scheme 5a:** Plastics and bioaccumulation assessment


**Student Sheet 5a:** Plastics and bioaccumulation assessment

### Resources available online:


**Slideshow 5:** Plastics and bioaccumulation


**Subject Update:** Improve student's online research skills

All resources can be downloaded from:
encounteredu.com/teachers/units/ocean-plastics-science-ages-11-14

LESSON 5

# Plastics and bioaccumulation

Age 11-14

60 minutes

## Curriculum links

- Investigate how pollutants, accumulate in organisms, through the food chain
- Evaluate the impact of microplastics on bioaccumulation

## Resources

**Slideshow 5:** Plastics and bioaccumulation

**Mark Scheme 5a:** Plastics and bioaccumulation assessment

**Student Sheet 5a:** Plastics and bioaccumulation assessment

**Subject Update:** How to: improve students online research skills

## Extension or home learning

Find out about at least 5 other harmful chemicals found in plastics. Provide the name of the chemical, how it is produced, and potential harm it can cause.

## Lesson overview

In this biology Key Stage 3 (KS3) lesson, students will learn about plastics and bioaccumulation. This lesson is focused on how chemical pollutants cause harm to marine organisms. Included are teacher resources to model bioaccumulation and an orca case study.

| Lesson steps | Learning outcomes |
|---|---|
| **1. How do our surroundings affect us? (10 mins)** Students are shown two images and predict how the environment can change the health of a person. Students are then introduced to the lesson and learning outcomes. | • State that pollutants can enter an organism's body from the environment |
| **2. How does this affect the ecosystem as a whole? (10 mins)** Students create their own food chain and food web using Artic animals. | • Describe how energy and pollutants are passed through a food chain / web |
| **3. Modelling bioaccumulation (15 mins)** Students use marbles or counters to model the bioaccumulation of pollutants. | • Describe how energy and pollutants are passed through a food chain / web |
| **4. Plastics bioaccumulation assessment (20 mins)** Students complete a case study on PCBs in orcas. | • Evaluate whether plastics contribute to bioaccumulation<br>• Analyse data to identify trends |
| **5. Review (5 mins)** Students discuss how the image can be an analogy for the lesson. | |

# TEACHER GUIDANCE 5 (page 1 of 4)
# PLASTICS AND BIOACCUMULATION

| Step | Guidance | Resources |
|---|---|---|
| **1**<br>10 mins | Students are introduced to the topic of bioaccumulation by first considering how the environment impacts the individual. Students will relate both prior learning and their vicarious experiences.<br>· When students enter the classroom direct them to slide 1 as a settler activity. Students write the answers into their class book.<br>· Once most students have settled and responded to the task open a discussion. Students share their ideas with the whole class.<br>· Using slide 2, explain how chemicals from the environment can pass into people.<br>· Using slides 3 to 4, introduce today's lesson title and learning outcomes.<br>· Using slide 5, students are introduced to some of the pollutants that can be found in the ocean. Pollutants which come from plastics are highlighted (appear bold on the board).<br>· Using slide 6, ask the class: "What harm do these plastic related chemicals cause in the ocean?"<br>· Students ought to recognise the impact on the health of marine life. | **Slideshow 5:**<br>Slides 1-6 |
| **2**<br>10 mins | Students now understand that the chemical pollutants in the oceans can cause harm to individual marine organisms. For the next step students must think how organisms are connected.<br>· Directing students to slide 7, explain that pollutants in the water can accumulate in marine organisms.<br>· Using slide 8, students follow the instructions on the board.<br>· Ask students to draw a food chain and food web using arrows.<br>· For younger students it may be important to model this on the board.<br>· Remind students to use arrows to show the direction of how energy is passed.<br>· If students finish ahead of time, ask them to respond to the extension, 'why might food webs be more useful than food chains?'<br>· Once most students have completed, conduct a mini plenary.<br>· Invite a student up to draw their food chain or web on the board and ask other students in the class to provide feedback.<br>· Reveal possible answers on slide 9-10 to ensure all students see correct way to display the diagrams. | **Slideshow 5:**<br>Slides 7-10 |

| Step | Guidance | Resources |
|---|---|---|
| | If you want to make the learning more physical, you can put students in groups with some string, scissors, and post-it notes. Give them 3 minutes to make a food chain using the examples on the board. Stop to review each group's work. This may also involve reviewing attitude towards learning as well as learning, through a question like 'what went well, and what did we find challenging?'. Then give students a further 3 minutes to create a food web. | |
| **3**<br>10<br>mins | The teacher invites students to now link organism's absorption of chemicals from the environment with predator-prey relationships.<br>· Using slide 11, invite seven students to the front of the class.<br>· Give the seven students roles. One will be an orca, two seals, and four artic cod.<br>· Give each a cup.<br>· Tell the rest of the class, sat in their seats, that they will be copepods (small marine invertebrates).<br>· Showing slide 12, pass a marble or counter to each copepod. Explain that this is a chemical pollutant they have ingested into their bodies from the environment.<br>· Showing slide 13, send artic cod to eat the copepods. They must decant the marbles / counters into their cups.<br>· Showing slide 14, send the seals to eat the artic cod. They must decant the artic cods' marbles / counters into their cup.<br>· Showing slide 15, send the orcas to eat the seals. They must decant the seals' marbles / counters into their cup.<br>· Stop the activity and begin to ask students to describe what has happened. Students should be able to explain that the chemical has passed up the food chain.<br>· Using slide 16, introduce students to the idea of bioaccumulation. This word may need breaking down (bio = living; accumulating = gather / build).<br>· Using slide 17, the teacher shows an infographic on biomagnification. Explain that the concentration of chemicals in organisms increase up the food chain. The food chain is shown here as a pyramid of biomass. | **Slideshow 5:**<br>Slide 11-17 |

| Step | Guidance | Resources |
|---|---|---|
| | Biomagnification is a conceptually difficult topic. Only do this with able students and if you have the time to address any misconceptions.<br><br>Biomagnification relies on students understanding the pyramid of biomass. As you go up the food chain, or pyramid, the biomass decreases. Yet, the number of pollutant molecules remains the same. This means that organisms higher up the food chain have a higher concentration of pollutants. This can also be framed as, for the same mass of living matter (flesh), there are more pollutant molecules.<br><br>To make the concept visual you can tell students you are going to cut 1g of blubber from an orca. Then, you will collect 1g of Plankton. Explain that the orca's flesh will have more molecules per gram than the plankton. | |
| **4**<br>20 mins | In step 4, students consider the real-world impact of bioaccumulation by looking at a case study.<br>· Using slide 18, introduce students to Polychlorinated Biphenyls (PCBs).<br>· Hand out Student Sheet 5a.<br>· Hand out graph paper.<br>· Using slide 19, direct students to complete the case study.<br>· Allow students time to complete task independently, circulating for support.<br>· Before students attempt to draw their graph, stop students and regain their attention. Model how to draw the graph. Inform students that one data set is continuous (numerical) and the other distinct (categories). Therefore, a bar chart is needed. Continue to model by showing them how to draw and label the axes.<br>· Once students are complete, use the Mark Scheme 5a to review the answers. | **Slideshow 5:**<br>Slide 18-19<br><br>**Student Sheet 5a:**<br>Plastics and bioaccumulation assessment<br><br>**Mark Scheme 5a:**<br>Plastics and bioaccumulation assessment<br><br>**Graph Paper** |

| Step | Guidance | Resources |
|---|---|---|
| |  PCBs are a group of synthetic (man-made) organic chemicals consisting of carbon, hydrogen and chlorine atoms. PCBs were used in plasticizers in paints, plastics and rubber products. They were banned in the in 1979 in the USA and 1981 in the UK.<br><br>However, they are called Persistent Organic Pollutants (POPs), because they do not degrade easily. This means they keep their structure and damaging chemical properties. As a result, today they can still be found in living marine organisms.<br><br>In animal tests, they have been found to:<br>· Increase risk of certain cancers.<br>· Cause problems with reproduction.<br>· Decrease immune response.<br><br>  Many exam style questions ask students to remove an anomaly from a table with 3 sample values. However, as scientists we know that three repeats are too few to discern which values are anomalous. It may be worth discussing with your class the importance taking as many repeats as possible. | |
| **5**<br>5<br>mins |  In step 5, students reflect on the lesson. Students are shown an image of a whale made of plastic and asked to explain how the image could be an analogy for the topic. If timing allows go further by asking students to create their own analogy of bioaccumulation. | **Slideshow 5:**<br>Slide 20 |
| **+**<br>20<br>mins |  This lesson students have learnt about some of the harmful chemicals associated with plastics. However, there are many. Task students with finding out about at least 5 other harmful chemicals found in plastics.<br><br>They must provide:<br><br>• The name of the chemical.<br>• How it is produced.<br>• Potential harm it can cause. | **Subject Update:**<br>How to: improve students online research skills |

# Plastics and bioaccumulation assessment

## Table calculations

Should be completed as following.

**Table 1**

| Mean of samples | Rank of mean concentration |
|---|---|
| **102** | **5** |
| **111** | **4** |
| **174** | **3** |
| **235** | **2** |
| **341** | **1** |

## Graphing exercise

1. Drawn a bar chart.
2. The 'Location' should be on the horizontal axis.
3. 'Mean concentration of PCB in blubber (mg/kg)' on the vertical axis.
4. Axes plotted correctly.
5. Axes labelled correctly.
6. Title included.

| Question | Answer |
|---|---|
| **1** | Bioaccumulation is when chemicals accumulate in living things. They accumulate in higher concentrations the higher you go in the food chain. |
| **2** | PCBs have been banned in the USA and UK for a long time. However, they are still present in the environment and wildlife. |
| **3** | Orcas in Gibraltar have the highest concentration of PCBs in their blubber. Therefore, I think Gibraltar has the most pollution of PCBs. |

STUDENT SHEET 5a

# Plastics and bioaccumulation assessment

## Background

Orcas are under threat from water contamination. Polluted water can contain many different chemicals which pass directly from the water to the animal.

Orcas are apex (top) predators. As a result, chemicals can pass up the food chain accumulating in greater concentrations in these animals. This process is called bioaccumulation.

Polychlorinated biphenyls (PCBs) are industrial chemicals used to make lots of products. They are so dangerous to humans and the environment that they were banned in the in 1979 in the USA and 1981 in the UK. However, they persist in the oceans today.

Orcas with high levels of PCBs often become ill. The chemical can cause cancer, suppress immune system, and impair reproduction. One orca was in the news in 2018 as she was carrying a dead calf for 17 days. The calf died, in part, as it received PCBs from the mother's milk.

## The study

Scientists have speared orcas in these locations, removing some of their blubber (fat). Their fat was tested for concentrations of PCBs.

1. Calculate the mean concentration (add all 3 values and divide by 3).
2. Remove anomalies (sample values which do not match others).
3. Using graph paper, draw a bar chart showing how the mean PCB concentration in orcas change with location.

**Table 1: PCB concentration in orcas**

| Location | Sample concentrations of PCB in blubber (mg/kg) 1 | 2 | 3 | Mean of samples | Rank of mean concentration (1 - highest) |
|---|---|---|---|---|---|
| UK | 101 | 103 | 300 | | |
| Portugal | 110 | 111 | 112 | | |
| Slovenia | 170 | 177 | 174 | | |
| Spain | 230 | 241 | 235 | | |
| Gibraltar | 320 | 360 | 344 | | |

## Summary Questions

1. What is bioaccumulation?

.....

.....

.....

2. A scientist called PCB chemicals a 'persistent organic pollutant (POP)'. Why do you think she called them persistent?

.....

.....

.....

3. Which areas are most polluted with PCBs?

.....

.....

.....

Jepson et al. (2016)
PCB pollution continues to impact populations of orcas and other dolphins in European waters.

This book and associated resources can be accessed from encounteredu.com/teachers/units/ocean-plastics-science-ages-11-14


- Videos and interactive diagrams
- Individual lesson and resource downloads
- Live broadcasts with scientists and innovators
- Subject Updates and training courses

## Other books in this series


Ocean Plastics X-Curric 5-7


Ocean Plastics X-Curric 7-11


Ocean Plastics Geography 11-14


Ocean Plastics D&T 11-14

## Photo credits

| | |
|---|---|
| Cover | Plastic beach: Muntaka Chasant<br>Plastic waste: Bigstock |
| Student Sheet 1b | Plastic pellets: Feiern1 |
| Student Sheet 1c | Slime: Nevit |
| Student Sheet 2a | Polystyrene: JensRS |
| Student Sheet 3b | Landfill: Prylarer |
| Student Sheet 3c | Rotting potatoes: Steve Theaker |
| Student Sheet 4b | Plastic river: Horia Varlan |
| Student Sheet 4c | Mussel: Marina32<br>Albatross: JJ Harrison<br>Sperm whale: Gabriel Barathieu<br>Lanternfish: Francesco Costa<br>Green turtle: Bill C |
| Student Sheet 5a | Orca: Skeeze |
| All other photos | Encounter Edu |

Ocean Plastics Science is a Key Stage 3 (KS3) resource combining both biology and chemistry. Students are taken on the journey of plastic. Exploring how plastics are manufactured, used, and disposed into the ocean. Students will learn the science behind what makes plastics both brilliant for everyday purposes and devastating to our oceans and marine life.

Included in this topic are teacher resources that promote students to conduct authentic research, emulating research conducted by The University of Plymouth. Students will test the properties of plastics, investigate compostable alternatives, and analyse case studies to discover how plastics can physically and chemically harm marine life.

**Where Learning Meets The World**

**www.encounteredu.com**

Encounter Edu designs and runs STEM and Global Citizenship education programmes, which make use of virtual exchange, live broadcast and virtual reality. These technologies create classroom encounters that widen young people's world view. Learning is further underpinned by an online library of teacher resources and training. Combined, these provide children with the experience and knowledge to develop as engaged citizens and critical thinkers for the 21st Century.