

Living in a Material World

Looking at the materials that make up our world

Science Unit
Years 9/10

Living in a Material World

3/4 weeks

years 9/10

This unit explores different materials that we use everyday and how those discovered in the 20th century have made such a difference to our lives. This context is used to learn about chemical and material behaviour. Pupils will produce their own synthetic material (slime). They will also explore how new materials have made a difference in sport.

Key Questions

[What materials do you use everyday?](#)

[What are the different kinds of materials?](#)

[How can scientists make new materials?](#)

[Could you make a synthetic material?](#)

[How have new materials impacted on sport?](#)

Developing Pupils' Knowledge, Understanding and Skills	Links with other subjects
Develop creative and critical thinking in their approach to solving scientific problems. Research scientific information from a range of sources. Develop a range of practical skills, including the safe use of science equipment. Learn about: Chemical and material behaviour <ul style="list-style-type: none">• Atoms and chemical changes;• Structures, properties, uses of materials;• Elements, compounds and mixtures.	Technology & Design Art PE
Developing Pupils' Thinking Skills and Personal Capabilities	
<ul style="list-style-type: none">○ Identifying similarities and differences○ Exploring preconceptions and generalisations Thinking, Problem-Solving and Decision-Making <ul style="list-style-type: none">○ Observing closely○ Asking focused questions○ Structuring internet based research Managing Information <ul style="list-style-type: none">○ Taking time to be imaginative.○ Developing ideas Being Creative	

What materials do you use everyday?	
Learning Intentions Pupils are learning...	Possible Learning, Teaching and Assessment Activities
...about different materials.	<p>In groups pupils make a list of 20 kinds of materials. Remind pupils that in science and technology, materials refer to all substances, not just clothes.</p> <p>Pupils decide as a group which are the five most important materials to them. They could use Card Ranking* or Diamond Ranking* activities to help them do this. As part of this decision, they must include how it would make a difference to their everyday life if this material didn't exist.</p> <p><i>* see Active Learning and Teaching Methods booklet</i></p> <p>Group discussion and report back to class. Opportunity to develop/demonstrate/assess Communication</p>

What are the different kinds of materials?

Learning Intentions Pupils are learning...

... about similarities and differences.
... to explore their preconceptions and generalisations.

Thinking, Problem Solving, Decision Making.

...about natural and synthetic materials.

Possible Learning, Teaching and Assessment Activities

Using the original list of 20 materials, groups write the name of each material onto cards.

Define groupings for classification.

They then discuss how the materials could be grouped. How many different ways of classification can the class come up with? Examples of classification could include expensive/not expensive and necessary/not necessary.

One method of classifying materials is natural vs man-made/synthetic. Take opinions from class on the usefulness of this classification.

What are their feelings around the words 'man-made', 'synthetic' and 'natural'?

Pupils then classify their list of 20 materials into the categories of 'natural' and 'man-made'. Look at one example of each in more detail to clearly define the terms 'natural' and 'man-made'.

How can scientists make new materials?

Learning Intentions Pupils are learning...

...about the structure of everyday materials.

...about the terms: atom and molecules.

...about the relationship between atoms, molecules, elements and compounds.

... about polymers.

...to observe closely.

...to generate questions.

Managing Information

Possible Learning, Teaching and Assessment Activities

Teacher explains to pupils how materials are structured:

- atoms
- molecules
- chains of molecules forming polymers
- how polymers can have cross links (models may be useful).

Give examples of natural polymers such as hair, wool, linen, cotton, protein, starch and cellulose.

Give examples of man-made/synthetic polymers such as nylon, lycra and polythene,

Video 2nd watch activity

Pupils watch a 10 minute video extract showing the manufacturing process for a man-made material.

They discuss what questions they have as a result of this viewing. They view the same extract again and try to answer to some of the questions raised in the first viewing.

Pupils discuss possible follow ups to ideas raised in this video.

Could you make a synthetic material?	
Learning Intentions Pupils are learning...	Possible Learning, Teaching and Assessment Activities
<p>... how to work safely and appropriately in the lab.</p> <p>... to make new materials.</p> <p>...to follow instructions.</p>	<p><u>Practical Activity: Manufacturing a Polymer</u> Do not allow pupils to take slime or custard balls home – as there is a risk of these being eaten by younger siblings.</p> <p>Making Slime (eye protection necessary)</p> <ul style="list-style-type: none"> • Measure 50cm³ of PVA* solution into a beaker • Add 10cm³ of borax solution and stir vigorously <p>The solutions should be prepared before the lesson. The PVA* must be of a sufficiently high molecular mass for this recipe to work. Suitable PVA is available from Middlesex University Teaching Resources (www.mutr.co.uk) See attached resource sheets reproduced with kind permission of the Gatsby Science Enhancement Programme (www.sep.org.uk).</p> <p>These resource sheets contain instructions for making and testing slime. Teachers may choose simply to make the slime. The activity may be extended for more able pupils to testing the chemical properties.</p> <p>Making Bouncy Custard Balls (eye protection necessary)</p> <p>15 cm³ PVA* glue Borax Custard powder (No eating or tasting in the lab!)</p> <ol style="list-style-type: none"> 1. Make a solution of Borax (about 1 spatula to 10 cm³). 2. Measure 15 cm³ PVA glue into a beaker. 3. Stir in 2 spatula measures of custard powder and 1 of solid, powdered borax. 4. Add 0.5 cm³ of borax solution and stir thoroughly until the mixture is smooth. 5. Remove the mixture and rinse well with water before handling too much (borax is moderately alkaline). 6. Shape into a ball and knead it for 2 minutes. <p>Taken from 'The Salter's Chemistry Club'. Resource sheet attached.</p>

A useful support booklet for the activities above is available from www.sep.org.uk/downloads/flow_small.pdf. Videos, animations and more PDFs are available from the Gatsby Science Enhancement Programme ([SEP](http://www.sep.org.uk)).

How have new materials impacted on sport?

Learning Intentions Pupils are learning...

Possible Learning, Teaching and Assessment Activities

... to structure their research on the internet.

Managing Information

...to take time to develop imaginative ideas.

Being Creative

Each pupil, either individually or in a small group, chooses a topic about how man-made/synthetic material(s) have affected sport.

Possible topics include:

- How Lycra has radically changed sportswear? What materials were used in the past (for example, cycling jerseys used to be made from wool)?
- Impact of Astroturf.
- The ideal football boot.
- Materials that help you go faster, for example, in swimming and running.
- Lightweight materials in sport, for example, trainers, bicycles, golf clubs, tennis racquets.

Possible strategies:

- Using the Internet, pupils do a search on 'history of ...(material)' or '... (material) in sport'.
- Use the headings 'positives', 'negatives' and 'interesting' to structure the research and its presentation.

Opportunity to develop/demonstrate/assess Using ICT

Class Discussion

- What have you learned about materials?
- Compare and contrast natural with man-made/synthetic fibres.
- Are there environmental issues?
 - Which materials are biodegradable?
 - Which materials can be recycled?
- What kind of new materials do you think we still need?

Opportunity to develop/demonstrate/assess communication. (talking and listening)

MAKING AND TESTING SLIME

WHAT STUDENTS DO

Students make a sample of slime, then test its physical and chemical properties.

Intended age range: 11-14

Key teaching points and curriculum links

- There is a chemical reaction when borax solution is added to PVA solution.
- The new substance formed is 'slime', and it has very different physical properties from the two chemicals used to make it.
- The structure of the new substance is a giant molecular structure.
- Adding acid to slime makes it runny, because there is a reaction which breaks the hydrogen bonds between the particles which constitute the slime.
- This is a reversible reaction. (For a complete explanation, see the **Go with the Flow** booklet: this is also available as a pdf on the CD).

In general terms, this links to several aspects of Sc3, **Materials and their properties**. However, the chemistry behind the formation of slime and the effect on slime of acids or alkalis is not usually covered at this stage, but may be appreciated by more able students.

All students are likely to appreciate the actual results of these simple physical and chemical tests.

Each group will need the following to make the slime:

plastic 150 cm³ beaker

a stirring rod

a 50 cm³ measuring cylinder

a 10 cm³ measuring cylinder

PVA solution

Borax solution

Fluorescein solution or food dye (if the slime is to be coloured)

Eye protection for each student

Student Worksheet 1: Making and testing slime

Note:

Slime kits are available from Middlesex University Teaching Resources (MUTR), Unit 10, The IO Centre, Lea Road, Waltham Cross, Herts EN9 1AS
 Tel 01992 716052,
 Fax 01992 719474,
 Web www.mutr.co.uk

Preparation of materials:*PVA solution*

Add 40 g of PVA into 1 dm³ of water at 50 °C gradually, with stirring – this is best done using a magnetic stirrer and a hot plate. Heat the solution to 90 °C stirring continually but do not exceed this temperature. The solution should appear colourless and clear at this point, and there should be very little undissolved solid. Now cool the solution, covering the beaker (or flask) with aluminium foil and leave it to stand for 24 hours. The solution will keep for quite a long time if stored in plastic bottles.

Borax solution

Dissolve 10 g of borax (sodium tetraborate decahydrate) in 250 cm³ of water. Add a few drops of food colouring or fluorescein to the solution if you wish to make coloured slime.

Acid/alkali solutions (for testing slime)

These should be approximately 0.5 mol dm⁻³ solutions.

**SAFETY****Handling and disposal**

Although activities involving slime are not unduly hazardous, proper care should be taken when handling any chemical. Chemical resistant eye protection should be worn at all times. Sodium borate (borax) is toxic by ingestion – take care that this material is not placed in the mouth. Risk assessments should be made for the use of acids and alkalis for testing slime. It is unwise to dispose of unwanted slime, PVA and borax solution down the laboratory sink.

Resources required by students for testing slime:

Small dropper bottles of NaOH_(aq) and HCl_(aq), (0.5 mol dm⁻³ solutions)
 Plastic 150 cm³ beaker
 Stirring rod
 Ceramic tile
 Marble (or ball bearing)
 50 cm³ (or 100 cm³) measuring cylinder
 10 cm³ measuring cylinder

Student Worksheet 1: Making and testing slime

Making and testing Slime

Introduction

Ghostbusters slime or *Ectoplasm* is a popular toy available in many shops. In this activity you will make your own 'slime' and test it. Slime is a very unusual material because it is a bouncy solid that can also flow like a liquid – this type of substance is called a dilatant compound.

1 Making slime: What to do

- Wear eye protection.



Collect:

- a plastic 150 cm³ beaker
- a stirring rod
- a ceramic tile
- a marble or ball-bearing
- a 50 cm³ measuring cylinder
- a 10 cm³ measuring cylinder
- a small bottle of sodium hydroxide
- a small bottle of hydrochloric acid



1. Measure out 50 cm³ of PVA solution into a measuring cylinder, then pour into the beaker.
2. Measure out 10 cm³ of the borax solution into a measuring cylinder, then add it to the PVA solution. You can colour the borax solution with a few drops of fluorescein solution or food colouring.
3. Stir the mixture vigorously with the stirring rod until the slime has formed. The faster and longer you stir, the better the result will be.
4. Remove the slime from the beaker and knead it in your hands until most of the liquid that makes it wet has been squeezed out.
5. Place the slime on the tile and use portions of it for the tests that follow.

Making and testing Slime

2: Testing Slime

Testing physical properties: What to do

Use the results table below to describe what happened when you carried out each test.

There are two rows blank for you to try out your own tests. (Remember to check your plan with your teacher first).

Test	What happened?
Hold a portion of your slime gently between your thumb and forefinger. Hold it above the tile and watch it flow.	
Hold a similar sized portion of slime in both hands. Pull the slime apart quickly.	
Put the slime back in the beaker. Hold it firmly by the rim with one hand, and tap the bottom of the beaker very sharply with your other hand.	
Test the slime to see how bouncy it is. (This is a measure of its elasticity).	

Making and testing Slime

Chemical properties: information

Slime is made by joining PVA molecules together, a process called **cross-linking**. When borax solution is added to PVA solution, the borax forms special links between the PVA molecules – these links are called hydrogen bonds, which join the PVA individual molecules together to form giant molecules. It is this process which produces the slime. Jelly sets in a similar way, but here it's the water molecules that join gelatine molecules together as the jelly sets.

Testing chemical properties: What to do

Place small samples of jelly and slime into separate test tubes.

1. Add about 2 cm³ of sodium hydroxide (alkali) to one sample of slime
 2. Add about 2 cm³ of hydrochloric acid (acid) to the other slime sample.
- Repeat steps 1 and 2 with your jelly samples.

SAFETY

Take great care!

Acids and alkalis are corrosive substances.

Always wear your eye protection.

If you spill any chemical on your skin wash it under running water and report it immediately.



Write down what you observe in the table below and then answer the questions that follow.

	Tests on slime	Tests on jelly
Effect of adding alkali		
Effect of adding acid		

Making and testing Slime

Questions

1. Which chemicals seem to affect the slime and the jelly?
2. Complete the passage below, choosing the correct words from the box. You might need to use a word more than once and some words might not be used at all.

liquid bonds molecules solid acid alkali gel

When was added to the PVA slime, it destroyed its properties. The material became runny and flowed easily. This is because attacks the that hold the PVA molecules together. When the molecules move apart they can slide over each other and the gel turns into a

3. What do you think might happen if you added alkali to slime that has already been treated with acid?
4. Write down your reasons for thinking that slime should be called a solid.
5. Write down your reasons for thinking that slime should be called a liquid.

3: Bouncing Custard Balls

Using a simple cross-linking reaction between two polymers, a bouncy ball can be made.



eye protection
must be worn

What you will need

15 cm³ PVA glue
measuring cylinder
borax (sodium tetraborate Na₂B₄O₇·10H₂O)
custard powder
test tube
test tube rack
100 cm³ beaker
glass stirring rod
spatula

eye protection

What you do

- 1 Make up a borax solution by adding a spatula of borax to a test tube containing 10 cm³ water.
- 2 Pour 15 cm³ PVA glue into the beaker.
- 3 Add 2 spatulas of custard powder and 1 spatula dry borax.
- 4 Add 0.5 cm³ of the borax solution and stir vigorously. Keep stirring until the mixture is smooth.
- 5 Remove the mixture from the beaker, shape it into a ball and work it between your hands for about 2 minutes. You should feel the ball gradually becoming more elastic.
- 6 Test the ball to see how well it bounces.

Wash your hands afterwards.

Troubleshooting:

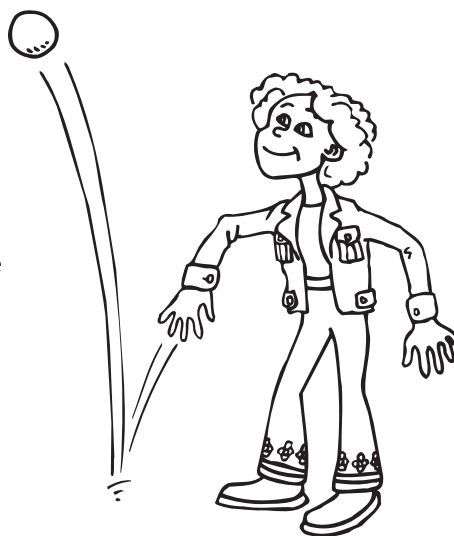
If the ball is brittle, you have used too much borax.

If the ball is too soft and not elastic, you have not used enough borax.

Note:

Your custard balls will dry out and lose their bounce unless you keep them in a plastic bag.

Eye protection must be worn.



Development of Learning Outcomes	
<ul style="list-style-type: none"> • demonstrate a range of practical skills in undertaking experiments, including the safe use of scientific equipment • research and manage information effectively, Using ICT where appropriate • show deeper scientific understanding by thinking critically and flexibly • demonstrate creativity and initiative when developing ideas • work effectively with others • demonstrate self management by working systematically, persisting with tasks, evaluating and improving own performance • communicate effectively in oral and written formats, showing clear awareness of audience and purpose 	
Links with Key Elements	Links with Learning for Life and Work
Cultural Understanding	Employability
Economic Awareness	
Education for Sustainable Development	