PLASTICS PLAYTIME

Science and technology activities for 9-11 year olds

CENTRE for INDUSTRY EDUCATION COLLABORATION

BASF
We create chemistry

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Overview

- This package provides an opportunity for children to think about plastics, their diversity and their properties.
- The children first consider that many familiar objects are made from plastics. Density and elasticity are investigated to help identify four common plastics. Children go on to look at thermal insulation as a characteristic of plastics.
- The children design and build a package to protect a fragile object and investigate the effectiveness of their design.
- The number of activities and order in which they are done can be varied. A description of each activity and approximately how long it takes is given in the table on page 2.
- It is suggested that activities 1 and 1a are done first. Activities 2-5 can be done in any order, or by different groups of children who report their findings to the whole class. Activities 6-7 can also be done in any order but should follow the other activities.
- The material gives detailed teacher support and provides a framework for learning activities.
- The material is aimed at 9-11 year old children, though the activities can be readily modified for use by other age groups.

ACTIVITY SUMMARY

Title	Description	Timing
1 Sorting plastic items: How many things?	A collection of everyday items made from plastics will provide the focus for this activity. Children sort the items using given criteria or properties they have chosen themselves, giving reasons for their choices.	1 hour
1a Home survey of items made from plastics	Children could carry out a survey to list as many plastics items as possible found at home, school and outside. The information could be collated on a large table of results and used for further discussion of similarities and differences in use.	30 mins
2 Will it float?	Children investigate and identify four unknown plastics by testing samples for their floating or sinking properties.	45 mins
3 Will it crease?	Children test the flexibility of four unknown plastic samples and complete their identification by devising and using a simple classification key.	1 ½ hours
4 Keeping things warm or cold	Children set up their own investigation to compare the thermal insulating properties of polystyrene, expanded polystyrene and metal.	1 hour + 1 ½ hours
5 A fragile parcel	Children devise their own investigations to observe and measure the shock-absorbing properties of a variety of materials used in packaging.	1 ½ hours
6 Egg-spress Delivery	Children are challenged to this mini-enterprise activity to design packaging that will protect a fragile product.	2-3 hours
7 How does polystyrene expand?	Children observe how a physical process can be modelled to help explain the changes that have taken place from polystyrene beads to moulded polystyrene spheres.	2-3 hours

1. Sorting plastic items: How many things?

1 hour activity

A collection of everyday items made from plastics will provide the focus for this activity. Children sort the items using given criteria or properties they have chosen themselves, giving reasons for their choices.

OBJECTIVES

- Compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal), and response to magnet
- Recording data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graph

RESOURCES

(per group)

- Collection of plastic items
- Activity Sheets A1a and/or A1b
- P.E. hoops

A collection of everyday items made from plastics will provide the focus for this activity. Discuss classroom items and the materials from which they are made. Together the children and teacher could build up the collection by bringing plastic items from home. As wide a range of plastics as possible would help the children to realise the importance of the production and variety of uses of plastics in today's society. Appendix 1 lists items made from the four plastics used in activities 2 and 3. These are PVC (polyvinyl chloride), polythene and polystyrene (both ordinary and expanded). The teacher should ensure that the display includes several items from these categories.

CARRYING OUT THE ACTIVITY

Children sort the display items using criteria such as those below or criteria they have chosen themselves, giving reasons for their choices.

- Colour
- Use
- Flexibility
- Hardness (Scratch With Scissor Point, Nail Etc.)

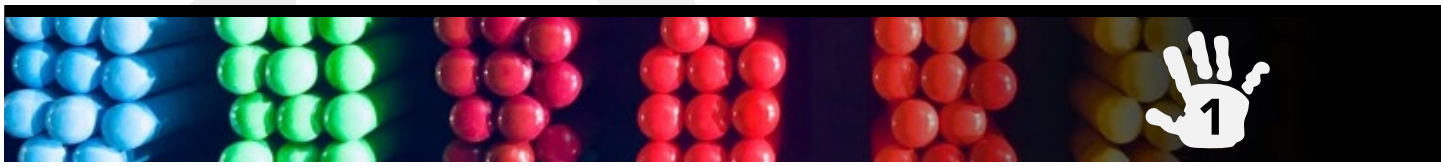
The children could place the objects into P.E. hoops or marked areas on the floor before completing Sheets A1a or A1b. These sheets can be a pictorial or written representation of the exercise.

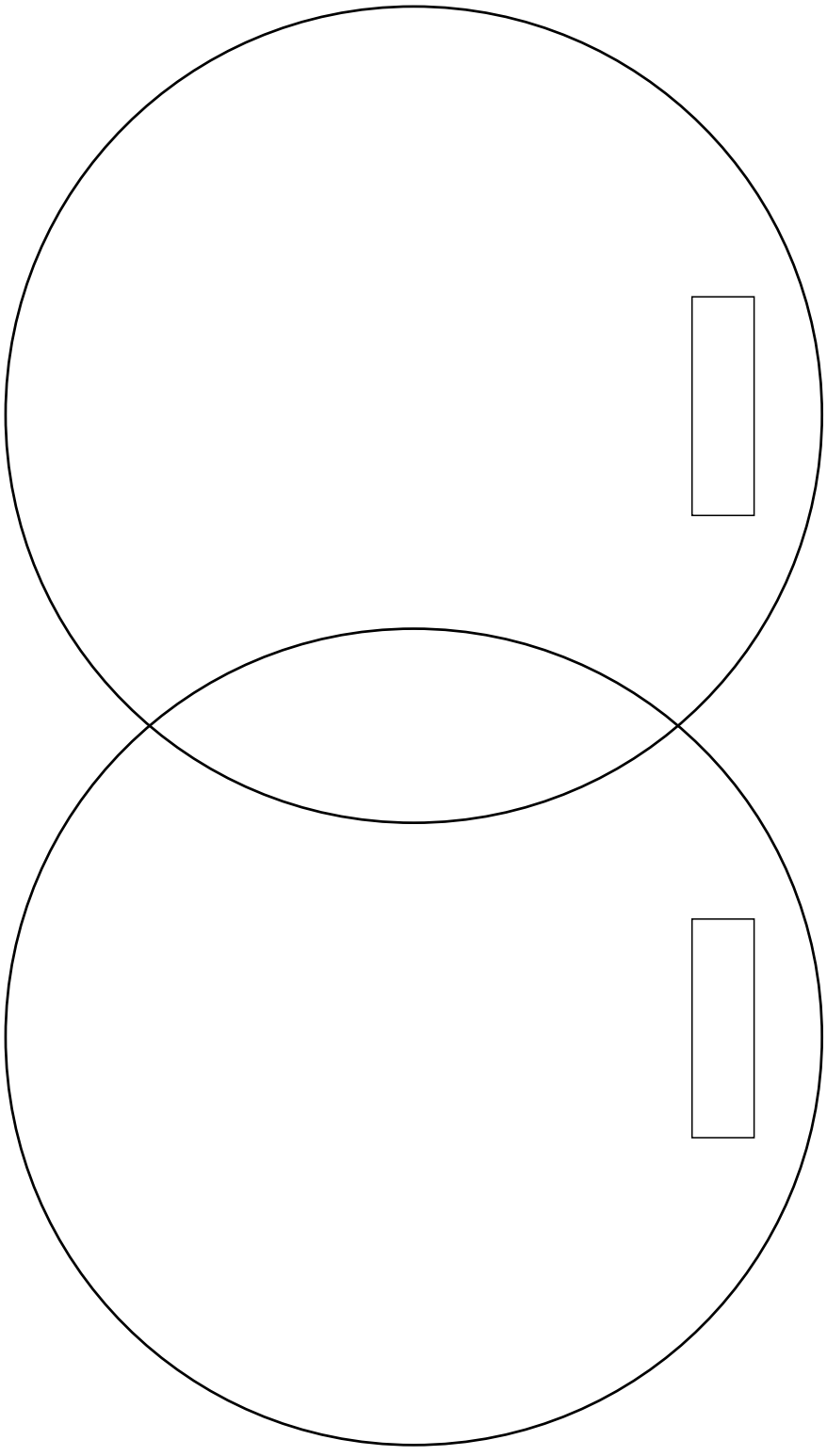
QUESTIONS FOR THINKING

- How can you tell plastics from other materials?
- Are all plastics the same?
- What similarities and differences have you noticed?
- Do you know the names of any plastics?
- If so, can you see anything made from these particular plastics?

Children may be familiar with names of plastics in specific contexts such as shopping with polythene bags or sitting on bean-bags filled with polystyrene beads. Using examples such as these might help them to identify items on the display that they think are made from the same plastics because of the colour or texture, etc. Some children may realise the difficulty in identifying plastics simply by appearance, and the idea of investigating different properties can be introduced.

Activity A1a: Venn sorting of our plastics collection

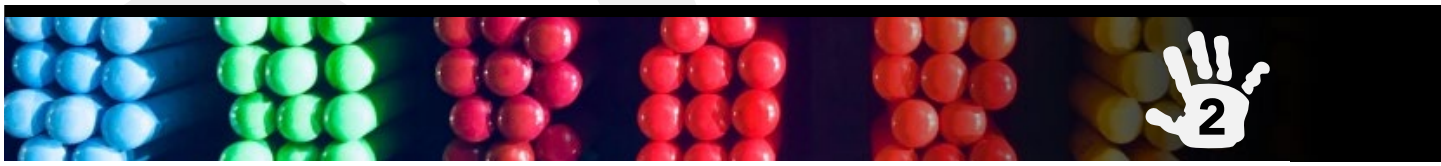




Choose 2 from below

opaque | transparent | hard | soft | flexible | rigid | home use | school use

Activity A1b: Carroll sorting of our plastics collection



opaque | transparent | hard | soft | flexible | rigid | home use | school use

1a. Home survey of items made from plastics

30 mins activity

Children could carry out a survey to list as many plastics items as possible found at home, school and outside.

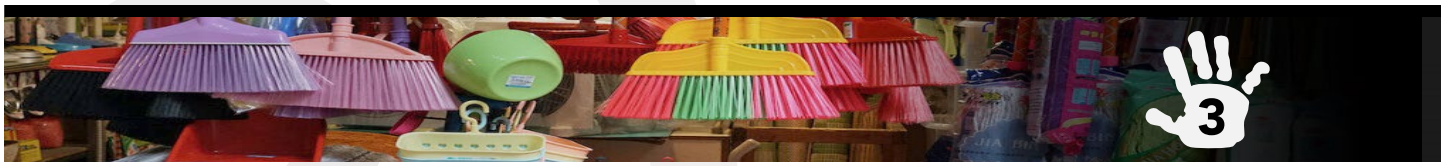
OBJECTIVES

- Compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal), and response to magnet
- Recording data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graph

CARRYING OUT THE ACTIVITY

Children could carry out a survey to list as many plastics items as possible found at home, school and outside. Activity Sheet A1c is provided for this purpose. The information could be collated on a large table of results and used for further discussion, e.g. similarities and differences in use.

Activity A1c: Plastics Survey



Things found at home	Things found at school	Things found outside
washing up bowl	ruler	some dustbins

2. Will it float?

45 mins activity

Children investigate and identify four unknown plastics by testing samples for their floating or sinking properties.

OBJECTIVES

- Compare, identify and name everyday materials on the basis of their properties, including floating and sinking
- Pupils should use and develop keys and other information records to identify, classify and describe materials

RESOURCES

(per group)

- 1-litre measuring jug, or bowl of similar capacity Salt
- Teaspoon
- Plastic pieces (see below)
- Activity sheet A2a and A2b

Pieces of PVC, polythene, polystyrene and expanded polystyrene should be cut to approximately 8cm x 1cm (see Appendix 1 for items made from these plastics). The strips are then numbered 1 to 4 with a permanent marker. To put the plastics pieces in a context, allow the children to see the items which have been cut up. Transparent pieces are partially coloured with a permanent marker, as they are very difficult to see when added to the solution.

Alternatively, a selection of coloured plastics are shown in the table below.

Container	Colour	Plastics type
Fabric conditioner bottle	Blue or pink	Polythene
Shampoo bottle	Green	PVC
Yogurt pot	White	Polystyrene
Lemon juice bottle	Yellow	Polythene
Burger box	Gold	Expanded polystyrene

N.B. Items that can be used in a microwave oven or freezer will not be made from polystyrene.

If children associate the colour of plastics with density, carry out a second test with plastics pieces all the same colour, either white or transparent, to show that this is not the case.

As it is not certain that an object is made from a specific plastic it is important that the teacher checks the identity of the selected items before presenting the activity to the children.

CARRYING OUT THE ACTIVITY

Children half fill the jug with water and place each sample piece under the water before letting it go. The contents are stirred. The pieces of polythene and expanded polystyrene will float as they are less dense than water.

Salt is added to the water a teaspoon at a time, stirring after each addition. The piece of polystyrene will begin to rise and will float after 2-3 teaspoons of salt have been added. The piece of PVC will stay at the bottom.

QUESTIONS FOR THINKING

- Are pieces floating if they are in the middle of the water?
- Why did some pieces float and others sink?
- Why did one piece at the bottom float when the salt was added?

BACKGROUND INFORMATION

The table below shows the density range for the four plastics types. The density of water is 1.00 g/ml[1]. The piece of expanded polystyrene will float as the density is far less than that of water. Polythene also floats.

As salt is added the density of the solution increases. When the solution's density is greater than the density of polystyrene it will float (the polystyrene will be suspended when the density of the salt solution is the same as that of the polystyrene).

This effect is similar to that of a person floating higher in the denser water of the Dead Sea than other seas. The teacher might like to ask the children if they know about this effect.

Plastics type	Density in g/ml*
Expanded polystyrene	0.02-0.06
Polythene	0.91-0.96
Polystyrene	1.04-1.11
PVC	1.20-1.55

Density = mass/volume

EXTENSION

The children investigate the effects of adding other substances to the water (such as sugar, sand, etc.) to find out the effect of this on the floating/sinking of the plastics samples. This will help reinforce the concepts of dissolving and density, if the teacher wishes to emphasise these ideas.

1 Throughout these notes millilitres (ml) have been used rather than cubic centimetres (cm3). The two units have the same numerical value.

Activity A2a: Will it float?

Before the test, **predict** which will float

Floaters: _____

Sinkers: _____

Why do you think these pieces will **float**? _____

_____

_____

Why do you think these pieces will **sink**? _____

_____

_____

TESTING THE PIECES

1. Half fill a jug with water.
2. Put all the pieces beneath the water, let go, and record which float and sink.

Pieces that float	Pieces that sink

3. Add a teaspoonful of salt to the water and stir until the salt dissolves.
4. Keep adding a teaspoonful of salt and stirring until one piece of plastic rises.

Activity A2b: Our Results

Draw or stick each piece of plastic on this picture in their positions at the end of the test.

Expanded polystyrene floats.

Polythene floats.

Polystyrene floats in a water and salt mixture.

PVC sinks.

You can now name 2 of the 4 plastics. Which ones are they?

Write the names in **two** of the spaces below:

1 is _____

2 is _____

3 is _____

4 is _____

3. Will it crease?

1½ hours activity

Children test the flexibility of four unknown plastic samples and complete their identification by devising and using a simple classification key.

OBJECTIVES

- Compare, identify and name everyday materials on the basis of their properties, including flexibility
- Pupils should use and develop keys and other information records to identify, classify and describe materials

RESOURCES

(per group)

- Plastics pieces (as in previous activity)
- Activity Sheet A3a
- Activity Sheet A3b (optional)
- Safety glasses
- Gloves

Safety note

Safety glasses should be worn during testing, as small pieces may splinter off the plastics when under stress. Wearing gloves would prevent cuts from sharp edges.

CARRYING OUT THE ACTIVITY

Before carrying out the test ensure the children can recognise stress whitening. It can be seen on yogurt pots and clear egg cartons after creasing (allow children to discover this for themselves). The plastics affected become white along the line of stress where the material structure is altered.

Children attempt to put a crease in each of the four plastics pieces. The results are recorded on Sheet A3a. Using the classifications given on Sheet A3a and results from activity 2, children should now be able to identify the four plastics. The classifications shown on Sheet A3a are;

- Snaps - thick PVC, expanded polystyrene
- Crease - polythene
- Creases with stress whitening - polystyrene, thin PVC and some polythene

One use of stress whitening is the labelling gun (Dymo) where the letters stand out on a coloured background due to the whitening when a force is applied. The children are asked if they can think of any uses for the stress whitening. To assist them, each child is given a piece of unused Dymo tape and asked to crease it. The

tape will then show stress whitening and if the children still need help, the children place the tape in the Dymo gun and press in some letters. The children could press in their own names and attach it to their work. They then write an explanation of how the tape has been altered.

The children devise a classification key to identify the four plastics. It may look like this:

For some children this may be a paper and pencil exercise using key questions provided by the teacher, others may find it useful to have the questions, answers and YES/NO arrows presented on cards to be correctly arranged. Activity Sheet A3b could be used for making these cards.

N.B. Three copies of the YES and NO arrows will be required. Groups of children could test the key on other children in the class to make sure that it gives the correct answers.

Activity A3a: Did it crease?

Number	Y = yes N = no SW = stress whitening
1	
2	
3	
4	

Snaps	- expanded polystyrene + thick PVC
Creases	- polythene
Stress whitening	- polystyrene, thin PVC + some polythene

Stick your plastics pieces in the table below. Use the results of the floating **and** creasing tests to write the name beside each piece.

Number	piece of plastic	name of plastic
1		
2		
3		
4		

Activity A3b: Plastics Key Cards

Polythene

Expanded polystyrene

Polystyrene

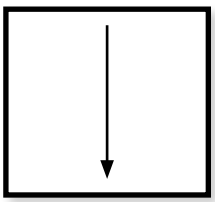
PVC

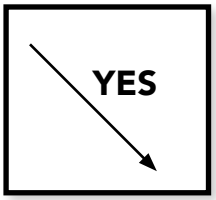
Does the plastic float?

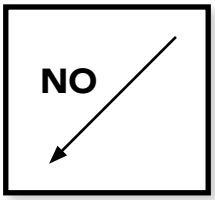
Does the plastic crease?

Does it rise when a little salt is dissolved?

START







4. Keeping things warm or cold

1½ hours activity

Children set up their own investigation to compare the thermal insulating properties of polystyrene, expanded polystyrene and metal.

OBJECTIVES

- Compare and group together everyday materials on the basis of their properties, including their thermal conductivity
- Give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic
- Planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary

RESOURCES

(per group)

- Activity Sheet A4a or A4b/c[1]
- Activity Sheet A4d/e
- Activity Sheet A4f or A4h[2]
- Metal can, (with lid safely removed)
- Expanded polystyrene cup
- Polystyrene cup
- Milkshake or drinks lids with '+' cut for a straw (or card discs to fit the cups with a hole for the thermometer)
- 3 thermometers
- Stop-watch or 2- and 5-minute egg timers
- Source of hot water
- 2-litre plastic bottle

Prior to the cold water activity the teacher will need to half-fill a 2-litre plastic bottle with water and leave in a freezer overnight. The bottle is taken out of the freezer about 1-2 hours before the lesson begins and filled up with water. The bottle is left to stand so that the temperature of the water falls to about 3 °C. The water is then ready for use.

1 This will depend on whether an open-ended or more structured approach is used.
2 This will depend on the choice of bar graph the child is to produce.

CARRYING OUT THE ACTIVITY

Sheet A4a provides the stimulus for discussion on fair testing if the teacher wants to adopt an open-ended approach to the activity. This sheet shows unfair test situations using containers of different sizes as well as differing amounts of water and ice-cubes. Guess-work has been used rather than measuring the temperature of the water or the time passed.

The children then plan their own investigation, and are encouraged to think about which factors to keep the same and what to measure. They can control the size of the container (as closely as possible) and the amount of water. They can measure the temperature of each cup of water and use the same time intervals between each measurement.

Alternatively, Activity Sheet A4b provides a structured method for carrying out the test, applying the above criteria of measurement and fair testing. The equipment is set up as shown here.

The children can organise most of the activity but **the teacher must pour the hot water into each container.** The water should be no hotter than 60 °C. 100 ml is a suitable quantity of water.

N.B. Ensure that the start temperatures in each cup are as close together as possible. Regulate temperatures by mixing hot and cold water together.

As the temperature of the water is taken every two minutes, children work in groups of three (see Appendix 2 for a sample set of results). Each child is then responsible for reading and recording the temperature from one thermometer. *They should allow a few seconds for the thermometer reading to adjust to the water temperature before reading the scale.*

The children could be challenged to estimate the next thermometer reading (whilst waiting for the end of a time interval) and attempt to become more accurate with each estimate they make.

Safety note

The thermometer should be removed between readings to minimise the possibility of the cups being knocked over.

The results are recorded on Activity Sheet A4d, and each child could then complete a graph (once the temperature measurement is completed) using Activity Sheet A4f or A4h. For sheet A4f, children mark and colour in the bar for that temperature. The extension of this is to only plot temperature points on each thermometer template and then join these to produce a line graph. Different coloured lines could be drawn for easy comparison on the same graph.

To obtain the results for the cold water experiment the children can repeat the procedure. This time they use 100 ml of iced water from the 2-litre plastic bottle. These results are recorded on Sheet A4e. Alternatively the class could be split into two, half the groups using hot water and the others using cold.

If a clock or watch with an alarm is available the children could continue with other work (e.g. the temperature graph) during the 5 minute intervals.

N.B. The bar chart sheets will need adapting for the different time scales used in this test.

The teacher encourages the children to offer explanations of their results during discussion. The children are asked to think about the way in which materials reduce the movement of heat (heat transfer). They should understand that the insulator prevents the heat energy escaping. The teacher should discourage the idea that 'cold' is entering the cup, as this is incorrect.

QUESTIONS FOR THINKING

- Can we use the final temperatures of the water to find out which cup was the best insulator?
- Were the plastics better insulators than the metal?
- Which plastic was the best insulator?
- Why is there a difference between the insulating properties of the two plastics?

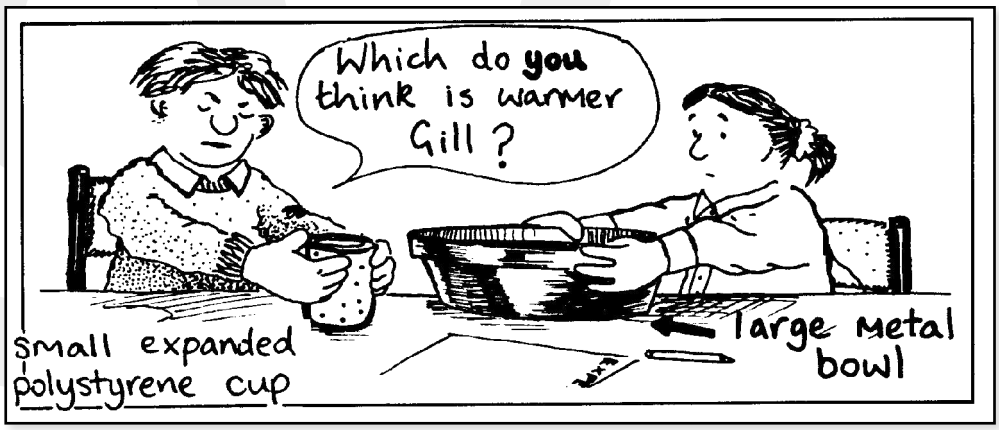
BACKGROUND INFORMATION

The change in temperature can be calculated by subtracting the final temperature from the start temperature. The change in temperature can be thought of as an indication of the amount of heat that has 'moved' from the water. A simplified explanation is that the heat moves from the water through the cup and to the cooler surrounding air. Similarly with the cold water, the heat moves from the warmer surrounding air, through the cup and into the water.

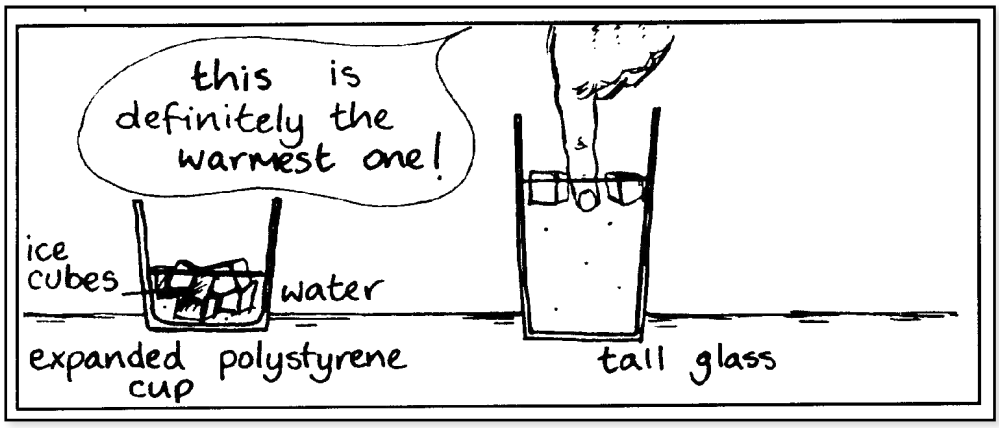
Air is trapped inside expanded polystyrene. A simplified explanation for air being a very good insulator is that the particles in air are far apart and the heat is not readily passed from one particle to another. Therefore its presence in the expanded polystyrene gives it greater insulating properties than the unexpanded variety. Similarly, metals are poor insulators as the particles in them are close together and the heat is readily passed from one particle to another.

Activity A4a: Can expanded polystyrene keep hot water warm and cold water cool?

Do you think this is a **fair** way to find out if expanded polystyrene can keep hot water warm?



Do you think this is a **fair** way to find out if expanded polystyrene keeps cold water cool?



Use this space to show your own **fair** test.

Activity A4b: Does expanded polystyrene keep things warm?

I predict that the_____ cup will keep the water warmest.

You will need:

- 3 thermometers
- stop-watch or egg timer
- some hot water

metal	polystyrene	expanded polystyrene

Fill each container with the same amount of water.

Measure the temperature in each container every two minutes.

Use the sheet provided to record the temperatures.

In which cup did the water stay warmest?_____

Why do you think this is?_____

_____

Activity A4c: Do plastics keep things cold?

I predict that the_____ cup will keep the water coolest.

You will need:

- 3 thermometers
- stop-watch or egg timer
- ice-cubes

metal	polystyrene	expanded polystyrene

Fill each container with the same amount of water.

Measure the temperature in each container every two minutes.

Use the sheet provided to record the temperatures.

In which cup did the water stay warmest?_____

Why do you think this is?_____

_____

Activity A4d: Keeping water warm

Temperature in °C taken every 2 minutes											
Cup	Start	2	4	6	8	10	12	14	16	18	20
Metal											
Polystyrene											
Expanded polystyrene											

Which cup kept the water warmest?_____

Why?_____

_____

_____

_____

Activity A4e: Keeping water cold

Temperature in °C taken every 5 minutes										
Cup	Start	5	10	15	20	25	30	35	40	45
Metal										
Polystyrene										
Expanded polystyrene										

Which cup kept the water coolest?_____

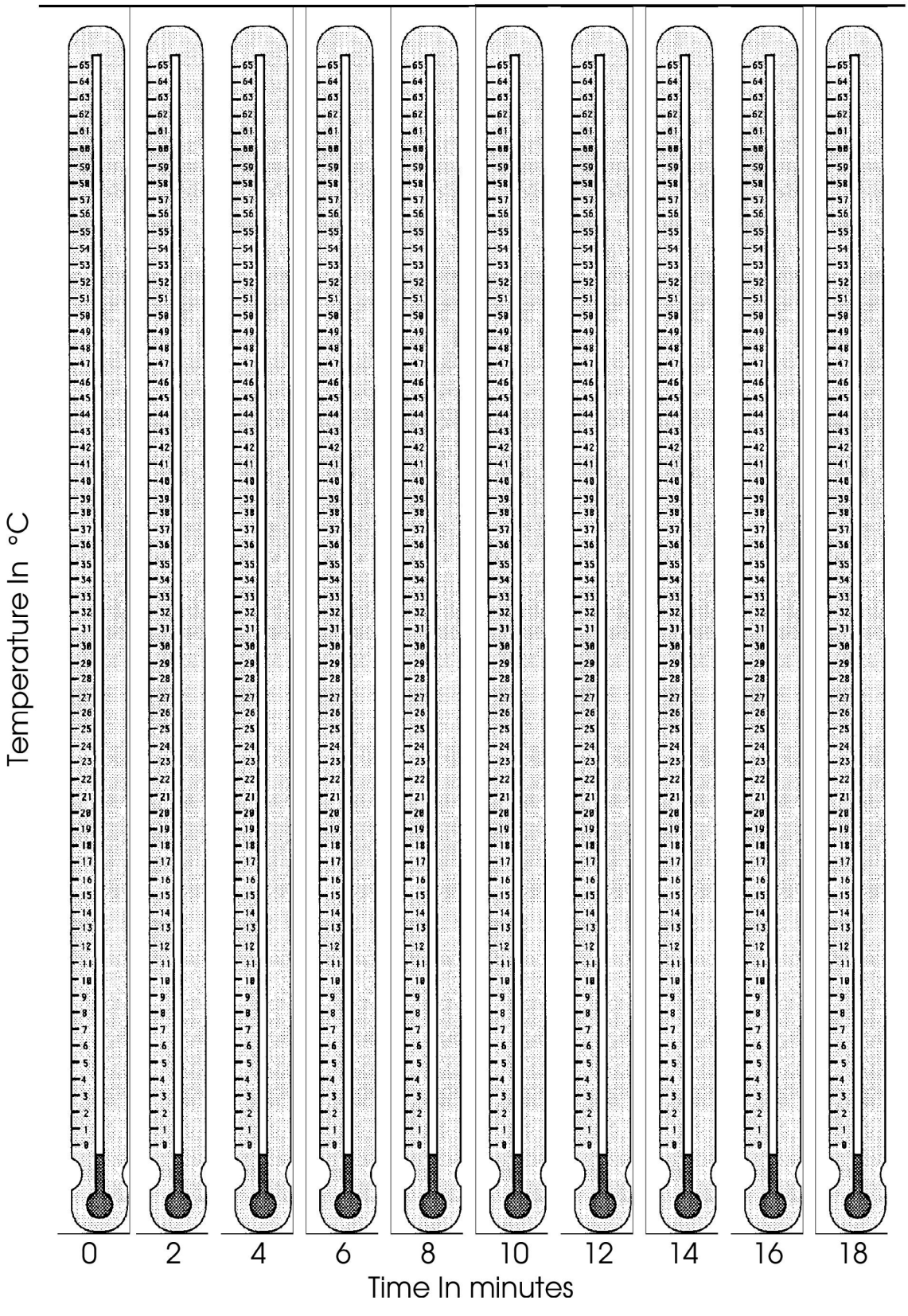
Why?_____

_____

_____

_____

Activity A4f: Temperature graph for _____ cup



Activity A4h: Temperature graph for _____ cup

Temperature in °C

65
60
55
50
45
40
35
30
25
20
15
10
5
0

2 4 6 8 10 12 14 16 18 20

Time In minutes

5. A fragile parcel

1½ hours activity

Children devise their own investigations to observe and measure the shock-absorbing properties of a variety of materials used in packaging.

OBJECTIVES

- Compare, sort and group everyday materials on the basis of their properties, including shock absorbtion
- Give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic
- Planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary

RESOURCES

(per group)

- A packaging display is required and could include:
  - Jiffy bag - postal
  - Expanded polystyrene packaging - for televisions, video-players, etc.
  - Card, polystyrene and expanded polystyrene egg boxes
  - Bubble packing
  - Tissue paper
  - Easter egg and chocolate boxes
  - Blister packaging - as seen when moulded over items
  - Expanded polystyrene pellets (not the small variety, in case children inhale them) Shredded or whole newspaper
  - Sawdust or wood shavings
  - Cotton-wool
  - Hay or straw
- Food bags and ties
- Metre rulers
- Fragile items (crisps, meringues, etc.), up to 3 will be needed. Activity Sheet A5
- List of Royal Mail parcel charges
- Activity sheet A5

DISPLAY DISCUSSION QUESTIONS

- What types of things would be wrapped or put into each packaging? (E.g. eggs, television, etc.)
- Can you think of some words that describe what the packaging is like? (E.g. soft, spongy, specially shaped or formed, air inside, etc.)
- Can the packaging be used for only one thing or lots of things? Why? (E.g. some packaging will be moulded for a specific purpose and others will be produced for more general use.)

CARRYING OUT THE ACTIVITY

Three of the packaging types are chosen from the display to investigate their effectiveness at protecting fragile objects. Children can be asked to choose one material they think will be very good, one material that will be average, and one material they think will be poor. They are asked to give give reasons for their choices (see activity sheet A5).

The 'fragile parcel' could be a meringue, popadoms, stacker crisps, a blown egg, or an item of the children's choice. Children should check their choice with the teacher before starting their investigation.

Children should decide on the best way of testing the materials, e.g. dropping the parcel from increasing heights, dropping an increasingly large mass on the parcel, dropping the same mass from increasing heights on the parcel, etc.

Fair testing may be discussed, e.g. thickness, weight, volume and number of layers of wrapping; the heights and/or masses used.

The fragile item is wrapped in each type of packaging and can be held together in a plastic food bag and tied before carrying out the chosen test. The fragile item is then carefully checked for any signs of damage. The height or mass is increased in even steps until damage occurs or a specified maximum height or weight is reached. The results can be recorded on activity sheet A5.

BACKGROUND

The ability for a material to absorb shock can be explained as its 'squashiness'. Shock travels through a material and some of the energy from impact is absorbed on its journey through the material. Good shock-absorbers absorb much of the impact energy so it does not get transmitted to the other side. This energy is used in the collapsing of the structure of the material and/or in the compressing of air present in the material. In the case of expanded polystyrene both of these things occur. Thus it is a good shock-absorber.

The results may show that heavy packaging such as cotton-wool is as good at absorbing shock as bubble-packing. Discussion could include the importance of packaging being lightweight as well as shock absorbant, so as to reduce transportation charges. The air in the bubble packing and the expanded polystyrene helps make these packaging materials effectively lighter and shock-absorbing, so both are ideal for protecting fragile items in transit. Adding air to a material does not make it lighter but less dense, allowing less material to be required to protect the contents of a parcel.

EXTENSION

The children could investigate the weights of the packaging if this has not been chosen as a criterion for fair testing. A food bag of newspaper or cotton-wool weighs approximately 4 or 5 times more than the same volume of bubble packing or expanded polystyrene pellets. Children could record the weight of the packaging in grams, or roll balls of plasticine the same weight as each package for a visual comparison.

Discussing transportation of parcels would link this activity with the mini-enterprise to follow. The teacher could ask which packing the children might choose for sending a thousand fragile parcels by road on a long journey. A very heavy load will increase the amount of fuel needed for transport and therefore increase costs. If the transportation costs are increased then the cost of the product will also be increased. Using a list of Royal Mail parcel charges, the link between cost and weight can be shown and some maths work carried out using this relationship.

Activity A5: A fragile parcel

Predict which packaging you think will protect the fragile item best, in the middle, and worst.

_____ will be the **best** material because _____

_____

_____ will be in the **middle** because _____

_____

_____ will be the **worst** material because _____

_____

Type of packaging			
	1	2	3

What did you find out?

_____

_____

6. Egg-spress delivery

2-3 hours activity

Children are challenged to this mini-enterprise activity to design packaging that will protect a fragile product.

OBJECTIVES

- Compare, sort and group everyday materials on the basis of their properties, including shock absorbtion
- Pupils should use relevant scientific language and illustrations to discuss, communicate and justify their scientific ideas

RESOURCES

(per group)

- A selection of packing materials (see previous activity) Adhesives e.g. Sellotape or glue
- Plastic money (maths equipment)
- Fragile item
- Activity Sheet A6a and A6b and A6c for the certificate
- Calculators (optional)
- List of Royal Mail parcel charges
- Weighing scales and weights
- Postage stamps (or a trip to the Post Office to post the parcels)

CARRYING OUT THE ACTIVITY

To extend the previous activity a mini-enterprise challenge is set. The challenge is to design a package that would carry a fragile item through the Royal Mail system without being damaged. Activity Sheet A6a provides the children with a letter from "Eggcellent Eggs Ltd." who are asking for tenders to provide such a packaging.

Groups of children could set themselves up as companies to put in a tender. Each 'company' is given a fixed budget in plastic money from the maths equipment and they then have to buy packaging materials and adhesives from a 'supplier'. The supplier could be the teacher or a group of children in the class. Prices will need to be allocated to each item and sold in units of length, area, volume or weight as appropriate. If time allows, choosing these units of sale provides an extra activity.

Each group can record its expenditure on the budget sheet provided on Activity Sheet A6b. Children are given the option of using a calculator to complete their budget sheet. Before each group begins, the teacher leads a class exercise showing how to fill in this sheet. An example is given overleaf.

Money allocated	Material bought	No. of units	Cost per unit	Total cost	Money remaining
150p	Cotton-wool (unit=100g)	1	10p	10p	140p
	Bubble packing (unit=100 cm2)	3	10p	30p	110p
	Sellotape (unit=1metre)	1	5p	5p	105p
	Thin card (unit=100 cm2)	4	8p	32p	73p
	Postage stamps			68p	5p

The children will need to be aware of the weight of their package as the cost of postage stamps will be included in their expenditure. The children could refer to the list of Royal Mail charges during the making of their package. The teacher should point out that a weight change of 10 grams can increase or decrease the price of postage substantially if near the weight limits of any price band.

Total cost of material	=	77p
Cost of posting package	=	68p
Total expenditure	**=**	**145p**

To test the products each group addresses the parcel, containing their fragile item, to themselves at school and posts it!

Whilst waiting for their parcels to return, the children could spend a lesson taking part in role- play, simulating the journey of the parcels from the Post Office back to the school.

On return delivery the packages are opened and the groups evaluate and describe the state of their eggs. The groups report their findings to the rest of the class.

The group with no damage to their egg would win the contract certificate on Activity Sheet A6c. If several groups have no damage to their eggs, the one with the cheapest production costs would win the contract. In the case of all the eggs having some damage, the group with minimum damage could be chosen to win the contract with suggested modifications to their design.

At this stage the whole class could be involved in brain-storming modifications to design one class 'super-package' that can be made and posted for testing, if time permits.

EGGCELLENT EGGS LIMITED

58 Smash Road
Eggleston
Yorkshire
YO1 LK8

Dear Packaging Manufacturer,

We are looking for a company that will produce a form of packaging for our eggs. Packages will be sent to our customers "eggspress delivery" through the Royal Mail. The package must:

1. Protect the egg from damage.
2. Be light to post.
3. Be produced at a competitive price.
4. Look attractive to our customers.

We look forward to receiving your bid for our contract.

Yours faithfully,

Shelley White

Shelley White
Managing Director

Activity A6b: Budget Sheet

Money to spend	Material bought	No. of units	Cost per unit	Total cost	Money remaining

Total cost of materials = _____

Cost of posting package = _____

Total expenditure = _____

EGGCELLENT EGGS LIMITED

Congratulations to

_____

of

_____

(company)

You have won the contract to produce egg packaging for Eggcellent Eggs Limited.

We thought your packaging met all our needs, including its appeal to our customers.

Your company is clearly going to do well in the future.

Signed

_____

Managing Director

7. How does polystyrene expand?

2-3 hours activity

Children observe how a physical process can be modelled to help explain the changes that have taken place from polystyrene beads to moulded polystyrene spheres.

OBJECTIVES

- Explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible
- Pupils should make their own decisions about what observations to make

RESOURCES

(per class)

- Activity sheet A7
- Sample A Polystyrene beads in a transparent, sealed container.
- Sample B 1 cubic centimetre of polystyrene beads (the amount needed to make one sphere) Expanded polystyrene spheres
- Flour (about 750g)
- Dried yeast (1 sachet)
- Mixing bowl
- Weighing scales
- 2-3 baking trays (used for fairy cakes, jam tarts, etc.)
- Tea-towel
- Oven and hob
- Unblown popcorn (optional)
- Glass pan with lid (optional

Safety note

Do not allow the children to hold the loose polystyrene beads as they are small and light enough to be inhaled.

CARRYING OUT THE ACTIVITY

Show the children Sample A of polystyrene beads.

Show the children some expanded polystyrene spheres and ask them to look for similarities and differences between the two examples. Explain to the children that the beads are used to make the spheres. Let the children observe the spheres through hand lenses and ask what they can see (e.g. the misshapen outline of the original beads)

Show them Sample B of beads and tell them that this is the amount needed to make one sphere. Ask the children to think of ideas about how the spheres might be made from the beads.

To extend these ideas, the following activity of bread-making provides a simple analogy of the process. Dough is made by following any recipe for bread. Before the dough is left to rise, divide it equally between all the children. Each child then rolls small 'beads' of dough (about the size of marbles) and piles them in one compartment of the baking tray. When each child has done this they record (pictorially and/or in writing) on Sheet A7 what the dough looks like. Tea-towels are placed over the baking trays and the dough left in a warm place to rise for 45-60 minutes. The children observe the dough again. They can record what it looks like and comment on changes that have taken place. The buns can be cooked and eaten! A discussion of the changes that have taken place is linked to the changes in the polystyrene spheres.

ALTERNATIVE ACTIVITY

Unblown popcorn could be expanded in a glass pan (or popcorn for the microwave could be used) for the children to observe this expansion. In this example the corn expands but does not stick together.

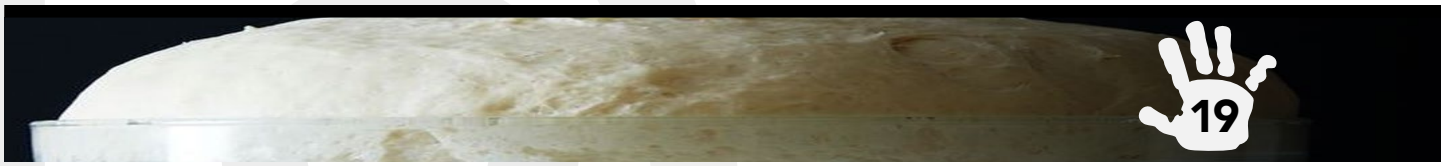
BACKGROUND INFORMATION

Expanding polystyrene. The process involves expanding the polystyrene beads in a pan of boiling water.[1] The expanded beads are cooled and placed in a spherical mould and the mould is added to a pan of boiling water to complete the expansion and compress the beads together. To obtain packaging for televisions, etc. the mould is in the appropriate shape for the consumer item. The beads used in this process have a chemical inside them to enable air to be drawn into their structure. As the air is heated in the boiling water it pushes the polystyrene structure outwards causing expansion.

Expanding dough. When dough is left to rise in a warm place the yeast ferments and this releases carbon dioxide gas. The gas is 'trapped' in the dough in small bubbles and this causes the volume of the dough to increase. In this activity, as the dough rises and expands, thebeads stick together. The appearance of the resulting 'bun' is lumpy, as the misshapen beads can still be seen. Unlike the polystyrene beads, the dough beads are not forced to sticktogether under pressure but by the consistency of the mixture.

1 The beads available from craft shops have been through this stage of expansion. Prior to this the beads are much harder and smaller.

Activity A7: Expanding dough



1. A drawing of my dough before leaving it in a warm place

2. A drawing of my dough after leaving it in a warm place

The dough is different In the second picture because

Appendix One

SOURCES OF PLASTICS

The following objects may be made of the plastics indicated.

Polythene - high density	Expanded polystyrene
bowls, buckets, beakers	ceiling tiles
piping e.g. water pipes	non-fibrous loft insulation
large cases	fast food packaging
milk crates	meat and food trays
dustbins	packaging (especially delicate instruments)
bleach bottles	head protection (e.g. cycling helmet)
doll's bodies	disposable cups for hot liquids
large toys	foamed material (sponges)
pressure pipes	egg boxes
kitchenware	

PVC	Polythene - low density
drainpipes	squeezy bottles/tubes
gramophone records	cable insulation
wellington boots	film for bags and packaging
wallpaper (washable vinyl)	back of carpets(e.g. car carpets)
table cloths	ink tubes in ball-point pens
shower curtains	food storage containers
baby pants	**Polystyrene**
macs	clear storage containers/jugs in kitchens
artificial leather	food containers, e.g. yoghurt cartons, clear
flooring e.g. kitchen	egg boxes
DIY blister packs	model kits e.g. Airfix
hosepipes	ball-point pen and fountain pen cases
plastic cutlery	plastic coat hangers
watch straps	

Appendix Two

Example Temperature Record Sheet

Keeping water warm

Temperature in °C taken every 2 minutes										
Cup	Start	2	4	6	8	10	12	16	18	20
Metal	63	60	57	55	53	50	48	45	44	43
Polystyrene	64	60	58	55	53	52	52	48	47	45
Expanded polystyrene	65	63	61	59	58	56	55	53	51	50

Which cup kept the water warmest? expanded polystyrene

Keeping water cold

Temperature in °C taken every 5 minutes										
Cup	Start	5	10	15	20	25	30	35	40	45
Metal	3	5	6	7	8	9	10	10	11	12
Polystyrene	3	4	5	7	7	8	9	10	11	12
Expanded polystyrene	3	4	4	5	5	6	7	7	8	9

Which cup kept the water coolest? expanded polystyrene

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