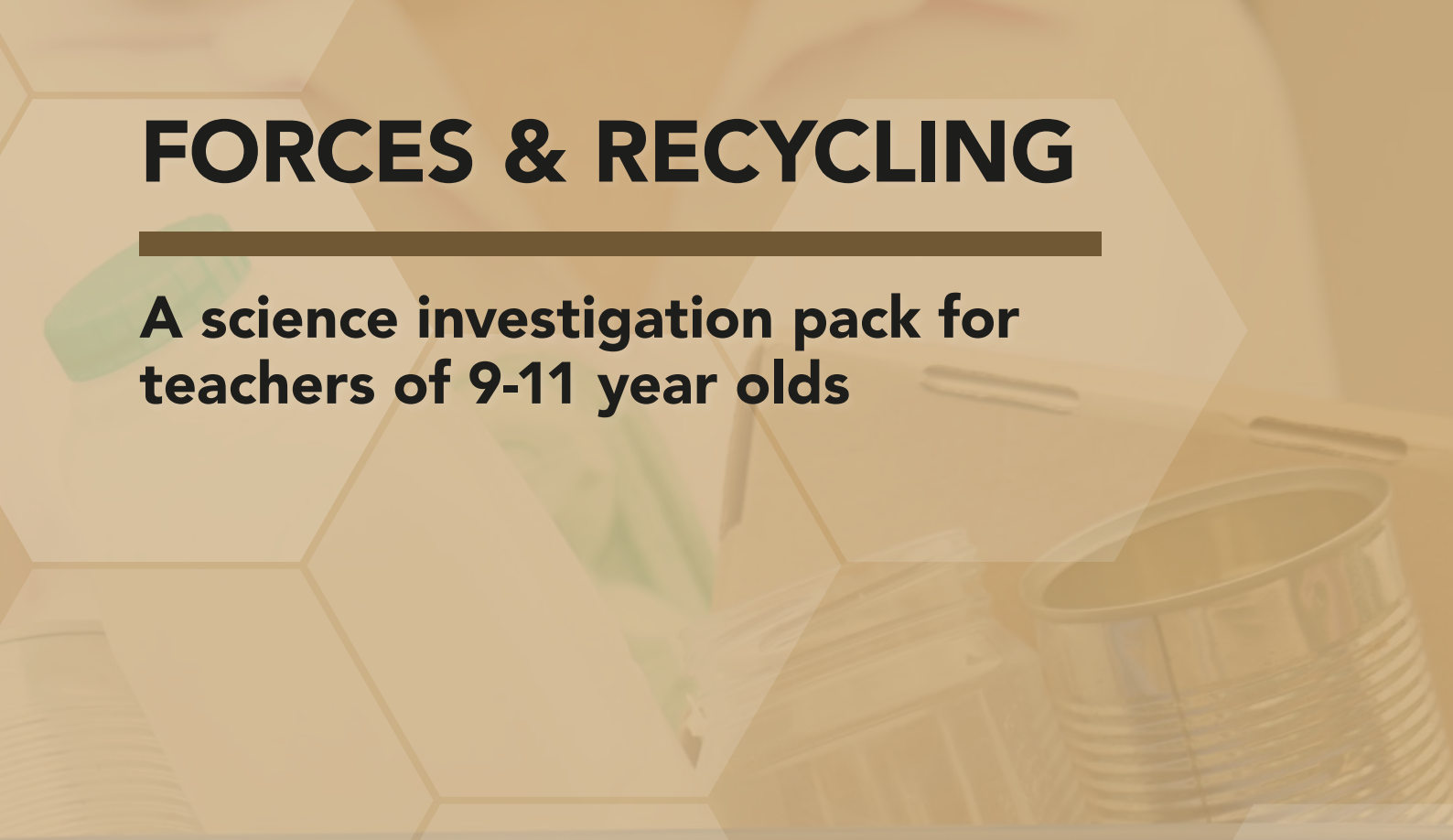
FORCES & RECYCLING

A science investigation pack for teachers of 9-11 year olds



CENTRE for INDUSTRY EDUCATION COLLABORATION

Supported by the Gatsby Charitable Foundation

Contents

Introduction

AGE RANGE

The activities in this book provide opportunities for children in Year 6 to revise their work on forces and to extend their understanding to the application of forces used in recycling. The unit links with and can replace some of the QCA scheme of work by (i) revising parts of units 2e Forces and Movement, 4e Friction and 6e Forces in Action, and (ii) addressing the environmental part of Unit 5/6e Enquiry in Environmental and Technical Contexts.

This material provides suggested activities that can be adapted to suit the needs of the children, staff and the planning requirements of the school.

CONTEXT

The key curriculum focus is not on materials and their properties as you would imagine for a recycling unit, but on the forces involved in the recycling process. It covers most of the necessary requirements of 'forces' in the National Curriculum.

The context if closely related to the recycling industry. Materials undergo the common processes of collection, sorting, shredding/crushing and separating. For most materials the final stage is melting and moulding or reshaping in some way. Paper and cardboard undergo the process of pressing and drying at this stage. There are many different types of plastic; some do not lend themselves to recycling and the sorting stage is very important. For more details and information about the products made with recycled materials, see Appendix 1.

The activities in this pack focus on common recycling processes. Therefore a specific material can be chosen as the focus (i.e. if it relates to a local industry or topic).

The table below shows which recyclable materials are covered by the activities in this pack.

Recyclable material	Activity Number
Aluminium	1,2,3,4
Steel	1,2,3,4
PVC	1,2,4,6
Polythene	1,2,4,6
Other plastic	1,2,4,6
Glass	1,2,4,6
Paper	1,2,3,4,5

ACTIVITIES

The introductory activity should be carried out prior to any of the other investigations, as it sets the scene for the problems faced by our consumer society.

The activities are timetabled for four sessions each of 1-2 hours duration, with optional preparatory and extension activities. The activities should be completed in the order given, as they build on each other in terms of the investigative process skills used, and lead from the identification of the problem to solutions. However, each activity can be adapted to suit the needs of the children or the school.

Optional and alternative activities are provided to allow you to choose which are relevant to your school depending on the needs of the class (children's ability and previous learning) and the planning and time constraints of the curriculum. As there is a skills progression throughout the activities, it is important that the order is maintained.

It is advised that children work in groups of 4. Some of the sessions (particularly activities 2 and 3) would benefit from additional adult support such as teaching assistants or parent helpers.

The activity sheets included provide an initial stimulus and guide children through the investigation process; planning, recording ideas, making observations and measurements, and drawing conclusions. Providing a suitable framework improves children's understanding of all that is involved in the investigation process, as well as increasing enjoyment of science by solving real life problems. The activity sheets are also intended to support differentiated teaching in the classroom and teachers are welcome to adapt these.

Reporting back can simulate a real situation in which to engage with a variety of communication skills in literacy.

ALTERNATIVE INDUSTRIAL LINKS

The fictional company in this pack is a materials treatment plant based on a variety of companies who recycle waste materials (e.g. aluminium, steel, glass, paper, plastic).

Other possible industrial links would be:-

A visit to a **recycling plant** where children could see the process first hand, from collection and sorting, through the treatment stages to a new product. Research and development into new and more efficient processes may be carried out on these sites and a visit to the laboratories would be an excellent opportunity to see scientists at work.

The **materials industry** supplying aluminium, plastic, paper, steel etc. to manufacturers, often process new materials alongside reclaiming and recycling. Manufacturers are increasingly looking for ways to ensure that their products or packaging will be easy to recycle after use. Children could visit manufacturers where these issues are addressed to compare the production process and the cost and efficiency of new against recycled.

Your **Local Council** waste management department will be a good source of information and may have an education officer who can come into school to provide expert information on the subject. Large recycling depots can also host visits where children can see first hand some of the forces used in the collection and sorting process.

ACTIVITY SUMMARY

Title	Description	Timing
Introductory activity	Children consider the first step of any recycling process: sorting and classifying materials, and investigate and sort waste in school.	1 hour
1. Marvellous magnets	Children look at the next stage in the recycling processes: removing steel or iron from waste materials. Children explore the characteristics of magnets and suggest ways to sort magnetic and non-magnetic household waste.	2 hours
2. Float and sort	Children investigate the force of up thrust in different liquids and link it to a recycling process where materials are sorted in flotation tanks containing liquids of various densities.	2 hours
3. Crush the can	In this activity, children look at the process of crushing and baling aluminium cans and investigate the most efficient way of crushing a cylinder.	2 hours
4. Fundamental friction	The children investigate the best materials to make conveyor belts to pass materials from one part of the recycling process to another.	2 hours
5. Pulp to paper (Optional/ alternative recycling link)	Children make recycled paper from newspaper by following the recycling process. They consider the forces involved and the efficiency.	1 hour
Class debate on recycling	Children consider issues surrounding the recycling of different materials and make a report of what they have found out.	1 hour

Resource requirements

Quantities are given per group of 4 children unless otherwise stated.

INTRODUCTORY ACTIVITY

- Activity sheets 1 - 4
- Collection of classroom waste for a week Protective gloves
- 5 hoops
- Calculator
- Paper for labels
- Bathroom or kitchen scales

Safety note

Check the waste does not contain sharp objects or kitchen waste.

ACTIVITY 1

- Activity sheet 5 - 7
- Selection of different types of magnets
- Collection of small non-metallic objects mixed with paper-clips and paper fasteners
- 20cm thread
- A4 paper
- Sellotape
- Scissors
- Stopwatch
- Iron filings in a sealed transparent file pocket

ACTIVITY 2

- Activity sheets 8 – 9
- A tank (transparent container) of water
- Three beakers (or other containers) containing equal quantities of liquid chosen from salt water, oil, bubble bath, golden syrup, washing up liquid and water
- Newton meter (with a scale of 0.5 N or less)
- Modelling material (plasticine)
- A selection of small objects with thread tied to attach to Newton meter (test objects to ensure a range of floating and sinking outcomes in different liquids)

ACTIVITY 3

- Activity sheets 5, 10 and 11
- Three empty fizzy drinks cans for the whole class
- Wooden board
- 3 cardboard tubes (3 pieces of A4 card to make into cylinders)
- 0-20 Push-meter (available from TTS) or collection of 100g weights – 10 per group of 4
- 1kg weight

ACTIVITY 4

- Activity sheets 5 and 12
- Newton meter (scale of 0.5 – 2N)
- Weighted object (e.g. a box containing 1kg weight)
- 3 samples of surface materials (e.g. vinyl flooring, carpet, polythene bag, etc.)

ACTIVITY 5

- Activity sheets 13 and 14 (each group to have a different activity sheet) Internet access
- Waste paper e.g. newspaper
- Water
- Wooden spoon and/or whisk Clean, absorbent kitchen cloths Food colouring
- Gauze sheeting
- Bucket or basin
- 2 wooden boards or baking trays Weights
- Aprons

CLASS DEBATE ON RECYCLING

- Activity sheets 14 - 18 (a different activity sheet for each group)
- Activity sheets 19 - 20

Introductory activity

1 hour

Children consider the first step of any recycling process: sorting and classifying materials, and investigate and sort waste in school.

OBJECTIVES

- To understand the importance of recycling.
- To predict the types of materials that can be recycled and the processes used.

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheets 1 - 4
- Collection of classroom waste for a week Protective gloves
- 5 hoops
- Calculator
- Paper for labels
- Bathroom or kitchen scales

ADVANCE PREPARATION

Collect non-food classroom waste for a week; a bag for each day.

INTRODUCING THE ACTIVITY

This activity introduces the children to the many issues involved in recycling waste. Read through the waste facts sheet (Activity sheet 1) with the class. Divide the class into 9 groups and provide each group with one of the facts cards. The group should then discuss alternatives to the creation of waste described on their card, or ways to promote more recycling or less consumption of a particular material.

MAIN ACTIVITY

Provide each group with a bag containing one day's classroom waste. The children sort and categorise waste into different materials. The hoops are then set out on the floor and labelled by the children. Each group sorts a different day's rubbish and separates each type of material into different hoops e.g. metal, glass, paper, card, plastic, other. It is unlikely that your classroom waste contains glass but it is worth mentioning and discussing the reasons for this and make a comparison with home waste.

They then find the mass of each type of material on the scales and record their results in the table on Activity sheet 3.

If the groups have worked independently, collect, total and share each group's results, so they can all fill in the table and find the total mass of class waste for the week. The whole class could share one set of hoops in which case the first column would be removed from the table.

The children then complete the final two columns of the table to estimate the amount of waste for their class in one year (multiply the mass of waste by the 39 weeks in the school year). They can then predict the total waste for their school in one year (multiply the mass of class waste by the number of classes in the school). The children can make a bar chart of the results using Activity sheet 4.

Discuss the magnitude of the amounts of waste by comparing with other masses they can visualise e.g. one bag of sugar is 1 kg, so the amount of waste produced each year is equivalent to X kg or X bags of sugar.

Discuss the accuracy of these predictions and what factors may change the statistics, e.g. each class is not going to produce the same amount of waste each week, or office or kitchen waste has not been considered, etc.

The children can then predict which items can be recycled and which can not.

Safety note

Children should wear protective gloves when handling rubbish

PLENARY

Revisit and discuss the list of different materials that can be recycled.

The children could produce a poster outlining the issues of recycling which would link to Literacy (discussion or persuasive texts).

Activity Sheet 1: Waste facts

- The UK produces more than 434 million tonnes of waste every year.
- Every year UK households throw away the equivalent weight of 31/2 million double-decker buses (almost 30 million tonnes).
- On average, each person in the UK, throws away seven times their body weight (about 500 kg) in rubbish every year.
- On average, every family in the UK consumes around 330 glass bottles and jars a year (British Glass).
- Recycling two bottles saves enough energy to boil water for five cups of tea.
- Every year in the UK, an estimated 10 billion plastic bags are given away by supermarkets. (167 per person)
- 1 litre of oil can pollute 1 million litres of fresh drinking water (Scottish Oil Care Campaign).
- About one fifth of the contents of household dustbins consists of paper and card, of which half is newspapers and magazines. This could easily be recycled.
- Babies' nappies make up about 2% of the average household rubbish. This is equivalent to the weight of nearly 70,000 double decker buses every year. If lined up front to end, the buses would stretch from London to Edinburgh.

Activity Sheet 2: UK waste facts cards

1 litre of oil can pollute 1 million litres of fresh drinking water. (Scottish Oil Care Campaign)

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Activity Sheet 3: Sorting and classifying classroom waste

Waste Material	Mass of waste for your group in one week (g)	Total mass of class waste for one week (g)	Total mass of class waste for the school year (x 39)	Total mass of school waste for the year (x the number of classes)
Metal				
Glass				
Paper				
Card				
Plastic				
Other				
TOTAL				

Activity Sheet 4

Graph to show the estimated waste produced by our school in a year

The amount of waste (kg)

Fill in y axis Scale

Metal		Glass		Paper		Card		Plastic		Other

Types of waste material

1. Marvellous magnets

2 hours

Children look at the next stage in the recycling processes: removing steel or iron from waste materials. Children explore the characteristics of magnets and suggest ways to sort magnetic and non-magnetic household waste.

OBJECTIVES

- Compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet and identify some magnetic materials
- Compare and group everyday materials on the basis of their properties including their response to magnets
- To understand that iron and steel are magnetic materials but other metals are not
- To sort household waste into different materials
- To sort metal cans into steel and aluminium

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheets 5 - 7
- Selection of different types of magnets
- Collection of small non-metallic objects mixed with paperclips and paper fasteners
- 20cm thread
- A4 paper
- Sellotape
- Scissors
- Stopwatch
- Iron filings in a sealed transparent file pocket

INTRODUCING THE ACTIVITY

Read the email from industry (Activity sheet 5) to the class to focus on the recycling of aluminium, and discuss ways to answer the problems.

Give the children samples of different types of metal and look for similarities and differences: colour, weight, hardness, magnetic/non-magnetic, etc.

Using Activity sheet 6 to record ideas, ask the children to think of any ways they can to separate some of the metals. Diagrams could show moving belts, tunnels, mechanical grabs, positioning of magnets and destination of separated materials. Collect ideas and discuss the pros and cons of each method. Ask if the children think that magnets could be used to separate some metals. They may think that all metals are magnetic.

- Which metals are magnetic?

Steel and iron are the only magnetic metals.

Explain that all food and drinks cans are either made of steel or aluminium and that magnets are used in the recycling process to separate steel and iron from other types of waste.

MAIN ACTIVITY

Tell the children they are going to explore different ways to use magnets to separate iron and steel from other materials. Some are fixed in position while the material passes under them (however some materials are missed because they are too far from the magnet). Others use electro-magnets to pick up and drop the magnetic waste.

- What are the problems that can arise with more than one magnet being used at the same time?

You may want to use the iron filings at this point to show the magnetic field. Lie magnets on a table and place the pocket over them. Tap gently and watch the iron filings form into lines following the magnetic field. Do this first with one magnet then two laid end to end. The children could complete the force diagrams on Activity sheet 7, showing the forces. Magnets can be put in different positions, e.g. pole to pole, (N-N and N-S) and side by side.

Provide each group with two magnets and challenge them to sort out any magnetic materials in the shortest time.

They could do **one** of the following:

1. Drop a magnet down to pick up the material.
2. Pass the magnets over the top of the materials.
3. Put magnets by the side of the materials.

Set the challenge of designing an automated system to do this sorting. This may involve suspending the magnets or attaching them to cardboard side walls, etc.

Children draw design ideas for machines for a magnetic sorting process. Ask them to add arrows to show the directions of different forces. Allow the children time to try out their ideas.

Remind the children to carry out their investigation using fair test conditions. Ask them to record what these conditions should be (e.g. equal strength and quantity of magnets and the same mixture of material).

Each group use their own automated method to remove as many paperclips from the waste mix as they can in 30 seconds. They can use Activity sheet 7 to record their results.

PLENARY

Gather the children's results on the board, and discuss the various methods. Ask questions such as:

- Which forces helped to separate the materials?
- What difficulties could they envisage in this part of the process?

E.g. The variety in the size and shape of the materials will make attraction by magnets erratic. Objects made from other metals will be left behind and items made from more than one material are difficult to sort.

Ask the children to suggest ways to deal with plastic coating/ink/other impurities as magnetic forces work through other materials. Explain that when aluminium cans are recycled, unwanted materials are removed by passing the waste through intense heat to vaporise the inks and plastic.

Look at the beginning of the process on the Novelis Alcan website (https://thinkcans.net/)

EXTENSION ACTIVITY

Children could make an electro-magnet.

They need a large iron nail (8 cm approx.), thinly coated copper wire (1 m approx.), D size battery, some paper clips.

Wrap the wire around the nail, leaving about 20 cm of wire free at either end. With wire strippers remove 2 cm of the plastic coating from both ends of the wire. Attach one end of the wire to a battery terminal and the other end to a paper clip.

The nail will become magnetic when the paper clip is used to connect the other terminal.

Discuss the advantages of using an electro-magnet in the separation process to turn on and off to pick up and drop.

Connecting up the electro-magnet and allowing the current to run may result in the nail becoming magnetised. This will make it more difficult to turn the magnet off.

Safety note

Warning: the wire can get very hot.

From: IMGreen@renewplc.com
To: research@greengrp.co.uk
Subject: Sorting and Recycling

Dear Research Group,

We are a recycling facility who separate and sort household and industrial waste materials before crushing them and sending them to treatment plants to be processed and recycled. The materials we sort are: aluminium, steel, glass, plastic, paper and card and mixed materials (e.g. some vehicle parts or circuit boards).

We have problems sorting so much waste by hand. We would like your help to improve the following recycling processes:

- Separating aluminium and steel cans. These are sorted using magnets, but we need to find a more efficient way to use the magnets.
- Crushing cans for transport.
- Efficient movement of materials from one area of the site to another.

We need you to:

1. Find out how to separate the different materials, in particular steel and aluminium.
2. Explain the most efficient way to crush the cans/containers (taking their shape into account).
3. Investigate suitable material for our conveyor belt to move waste from one process to the next.
4. Find out more about what happens to materials when they go from us to the treatment site to be recycled (e.g. paper).
5. Design a poster to make the public aware of the benefits of recycling or disadvantages of not recycling.

We look forward to hearing from you with your results.

Isla Green

Research manager – Renew plc

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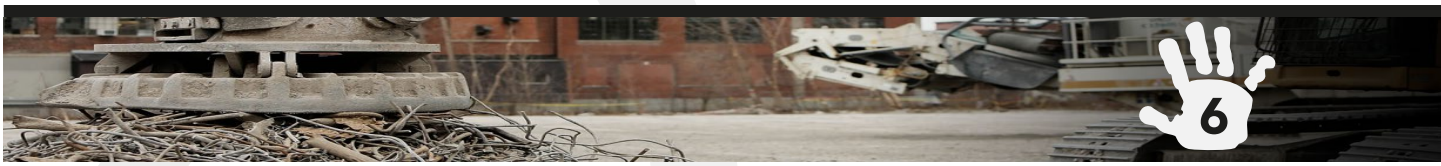
Disclaimer

This email transmission is confidential and intended solely for the organisation to whom it is addressed.

Activity Sheet 6: Magnets in the recycling process



Which types of metals do magnets attract?

Challenge

To separate as much magnetic waste as possible in 30 seconds.

You need

- A pile of mixed waste (paper clips and other materials)
- Two magnets
- Other useful equipment (thread, paper, sellotape, scissors etc.)

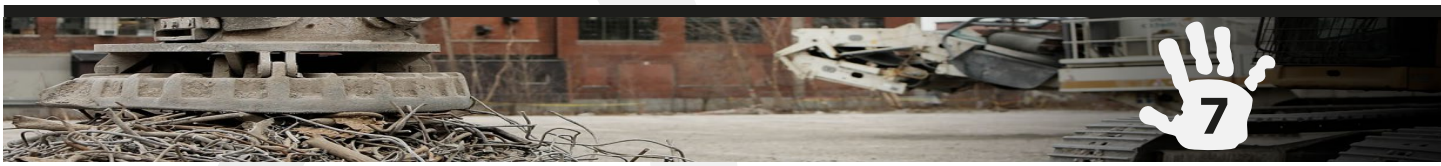
Plan

In your group decide the best way to separate the steel or iron from the other waste.

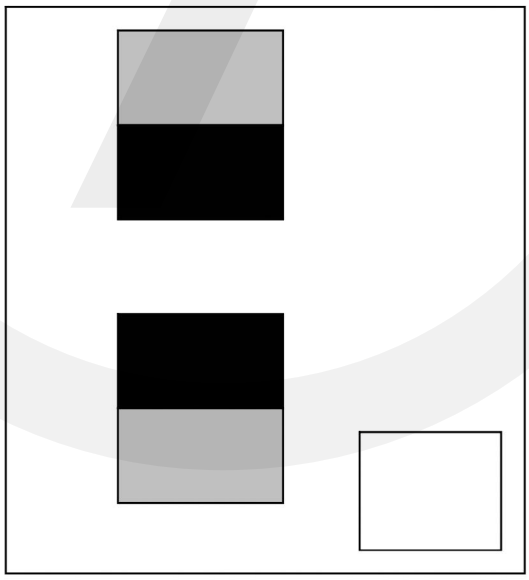
Diagram

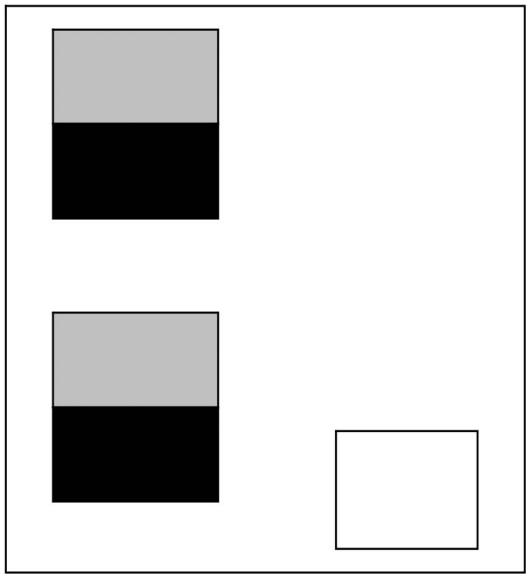
Add arrows to show the direction of the forces and label them (magnetic force and gravitational force).

Activity Sheet 7: Magnets in the recycling process part 2



Draw arrows on the force diagrams to show the directions of the magnetic forces.





Tick the diagram where the magnets are working together and cross the diagram where the magnets are working against each other.

Results	Number of paperclips
My Group	
The highest number	

Record you results from magnetic sorting here.

What did the best group do to separate more paper clips?
What problems could arise if you use more than one magnet in the same separating machine?

2. Float and sort

2 hours

Children investigate the force of up thrust in different liquids and link it to a recycling process where materials are sorted in flotation tanks containing liquids of various densities.

OBJECTIVES

- Taking measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when necessary
- Identify the effects of air resistance, water resistance and friction that act between moving surfaces.
- To understand that submerged objects experience up thrust.
- To use a force meter to measure up thrust in different liquids.
- To investigate the use of different density liquids to sort plastic waste.

RESOURCES

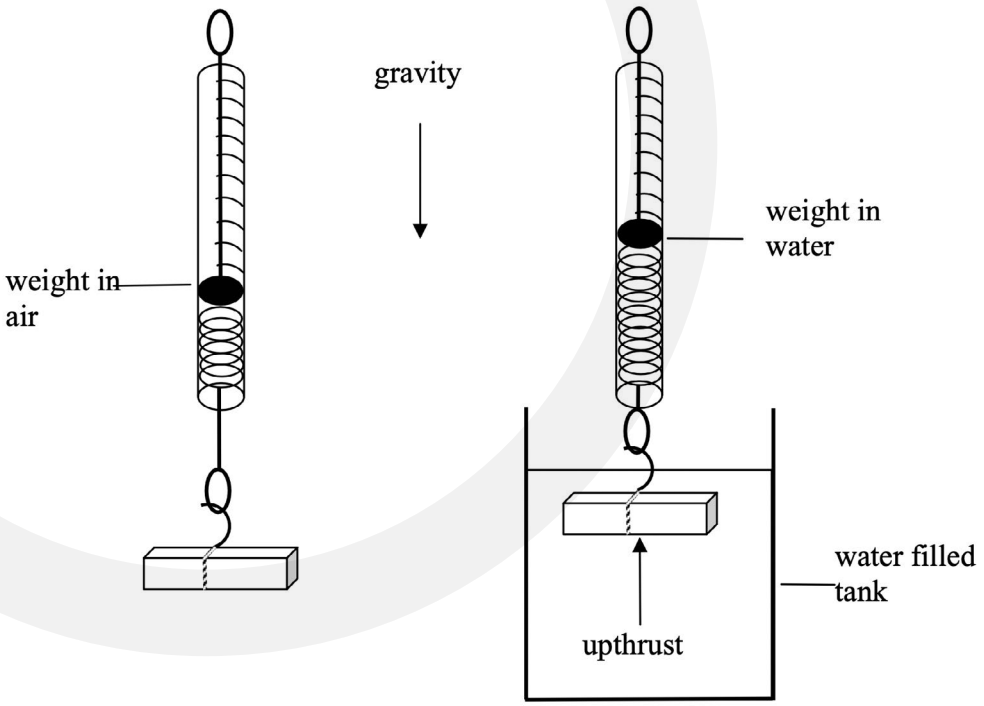
(Per group of 4 children unless otherwise stated)

- Activity sheets 8 - 9
- A tank (transparent container) of water
- Three beakers (or other containers) containing equal quantities of liquid; choose from water, salt water, oil, bubble bath, washing up liquid or golden syrup.
- Newton meter (with a scale of 0.5 N or less)
- Modelling material (plasticine)
- A selection of small objects with thread tied to attach to Newton meter (test the objects to ensure a range of floating and sinking outcomes in different liquids)

INTRODUCING THE ACTIVITY

Ask the children to predict which of the objects will float and which will sink in water. Test their ideas for some of the objects in the water tank. Use the phrase up thrust to describe the force pushing up in water.

Explain and demonstrate how to measure the up thrust for different materials by measuring the weight in air and then in water using a Newton metre, and finding the difference. If the object floats on the surface, the up thrust equals the weight in air.



Weighing an object to find the effect of up thrust in water.

First suspend the object from the Newton meter and record the weight in air. Then re-suspend lowering the object into the water tank. The object should be pushed below the surface and allowed to float back to the top. This prevents the surface tension of the water from affecting the result. The resulting weight in water will be affected by the up thrust of the water on the object, see diagram above.

MAIN ACTIVITY

Set the children the investigation question:

- Can we use floating and sinking to separate materials?

A supplementary question could be,

- Do things float in the same way in different liquids e.g. salty water, cooking oil, golden syrup?

The objects chosen for this should have been selected to ensure that some will sink in all liquids, some float in all liquids and others float only in the thicker (more dense) liquids.

When planning, children need to consider which factors would affect fair testing. The volume of liquid does not change the up thrust of that liquid on an object. This can be demonstrated by weighing the same object in a large and a small volume of water.

Provided that each object is pushed below the surface of the water, the shape and size of the object will not affect the up thrust. The difference in up thrust is a result of the density of the material from which the objects are made. Materials which would not normally float in water can be made to do so by adding air e.g. the air inside an inflatable or the air inside a boat.

The children can now investigate the up thrust of the liquids by measuring the weight of each of the objects in air and in the liquids.

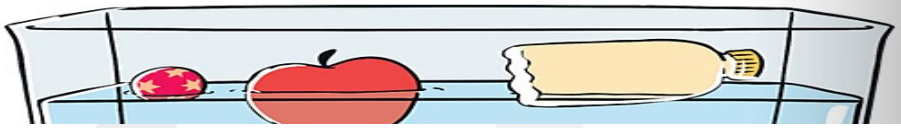
Provide the children with the three containers of different liquids and a selection of objects. The results can be recorded on Activity sheet 8. Once a pattern for the liquids has been established with one object, they should test the theory using other objects. Activity sheet 9 is designed to help children to construct an identification chart. Ask the children how useful this would be to a recycling company.

PLENARY

Discuss the differences between the forces of up thrust in the different liquids. As the density of the liquid increases, the object will appear to be lighter. Discuss the relationship between the forces when objects float. (When the forces of up thrust and gravity are equal or balanced, the object will float and weigh nothing).

Visit the European Metal Recycling website (https://uk.emrgroup.com/) to show a flotation tank animation. Click on 'Quick links' menu, scroll for 'Dense Media Separation', and click on 'view presentation'. This can be used to stimulate discussion of the use of liquids in recycling.

Activity Sheet 8: Up thrust forces in water

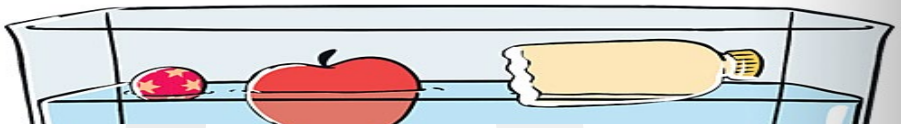


Use the same object in all liquids.

Liquid	Weight of object in air (N)	Weight of object in liquid (N)	The force of up thrust in the liquid (N)

Which liquid has the lowest upthrust?	
Which liquid has the highest upthrust?	
Why do you think this is?	
Draw a force diagram to show the forces on an object suspended in liquid.	Which liquid will more materials float in? Why?
	How could this be used to sort different materials before they are recycled?

Activity Sheet 9



Flow chart to sort materials by floating and sinking

Fill in the chart with the liquids in order of thickness. Put the runniest liquid at the top.

Does it float in _____?

Yes

No

Does it float in _____?

Yes

No

Does it float in _____?

Yes

No

3. Crush the can

2 hours

Children investigate the force of up thrust in different liquids and link it to a recycling process where materials are sorted in flotation tanks containing liquids of various densities.

OBJECTIVES

- To understand that different shapes affect the strength of an object
- To devise and carry out an investigation to test the most efficient way of crushing a can
- Planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary
- Recording data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheets 5 , 10 and 11
- Three empty fizzy drinks cans for the whole class
- Wooden board
- 3 cardboard tubes (made from 3 pieces of A4 strong enough to support 40g.
- 0-20 Newton Push-meter (available from TTS) or 10 x 100g weights.)

INTRODUCING THE ACTIVITY

Look back at the e-mail (Activity sheet 5) and explain that once sorted, the waste needs to be crushed and baled ready to be transported to the recycling plant. The aim of this activity is to find an efficient way to crush cans. Ask the children to discuss what might affect the efficiency of crushing cans (e.g. the amount of force on the can, or the position and direction of the force used).

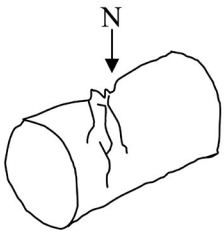
In this activity the children will test the strength of the cylindrical shape using card.

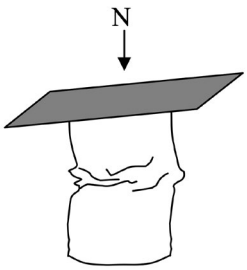
MAIN ACTIVITY

Ask the children to create three identical open-ended cylinders out of A4 card (to represent the cans). Alternatively, they could use the cardboard cylinders from the inside of kitchen rolls.

Each group begins by thinking about the question they are trying to answer. Examples of this could be:

- Is it easier to crush a can from the top or from the sides?
- Does applying a force in two places cause the can to crush more easily?
- Do we need more force to crush the cylinder from the sides or from the top?





The chosen question is then added to Activity sheet 10 and the process of planning the investigation is recorded so that the children think carefully about what they are going to do and why. Any diagrams required can be drawn on the reverse of the sheet.

A prediction is made before the investigation is carried out. The children suggest the most likely answer to the question that they have posed and give reasons to support their claims.

Each group investigates the force needed to crush the cylinder from the top by standing it upright, placing a piece of card on the top and applying a force using the push-meter, or by adding 100g weights one at a time. Each 100g weight applies a force of 1N. The force needed to crush the cylinder can be read just before the cylinder collapses. (One child reading the values out loud until the collapse point will enable the correct reading to be identified.) The children record their results in the table on Activity sheet 11.

They repeat the investigation on the side of the cylinder and record their results.

They could repeat the investigation a final time, but this time applying a force on the top and the sides simultaneously. One child could place the weights on top while the other pushes in at the sides using the push meter.

Collect each group's results in a table on the board and find the mean average. Discuss the fact that collecting repeated results makes the investigation more reliable.

The children could draw a series of force diagrams to show the direction of forces they applied to the cylinders, representing the magnitude by the size of the arrows.

Safety note

Care should be taken that the weights do not fall onto children's hands.

PLENARY

Discuss the findings. Ask questions such as:

- Which direction of force will crush the shape best?
- Where would you apply the force to crush cans or plastic bottles?

Demonstrate an experiment which applies their findings. Use three empty fizzy drinks cans. Place a wooden board on top of each can in turn (balanced or propped up by a volunteer) and begin to add weights. Find out the direction of the force which crushes the can most easily (vertical, horizontal and vertical with additional force on the sides).

Ask:

- Does it match the results of the cardboard cylinder experiment?
- What difference does having top and bottom ends to the can make?

Compare empty fizzy drinks cans with empty food cans: fizzy drinks cans are thinner and more flexible/crushable, whereas food cans are more rigid and stronger. You may want to discuss the reasons for the differences, their comparable costs, their implications for recycling and the forces needed to crush the cans. Food cans are often made of steel and use more material , which will affect cost of production, but also the force needed to crush them. They are more rigid than drinks cans and therefore can be stacked for storage.

Drinks cans can also be stacked for storage.

Ask the children:

- Where do the drinks cans get their added strength from?

The gas inside pushes outwards, making the cans more rigid.

You could ask the children to draw force diagrams showing the forces in a pile of drinks cans and a pile of food cans. Explain the dangers of testing the strengths of full fizzy cans. The pressure of carbon dioxide gas being exerted on the can from the inside could cause an explosion if the can was put under external pressure.

Safety note

Cans containing fizzy drinks are pressurised and may explode.

EXTENSION ACTIVITIES

The children could visit the Novelis Alcan website (https://thinkcans.net/) to explore the next part of the process: shredding and purification. They could visit the SCRIB website (http://www.scrib.org.uk/) to find out about the recycling of steel cans.

Activity Sheet 10: Crushing the can

Investigation planning sheet

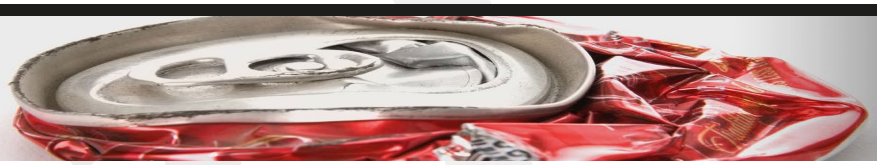
Our question is:

Plan	
We will change because	We will measure using

Fair Test
We will keep these things the same:

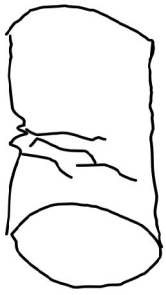
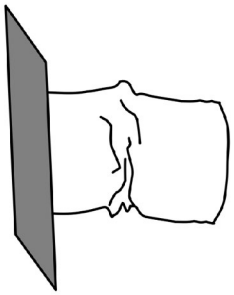
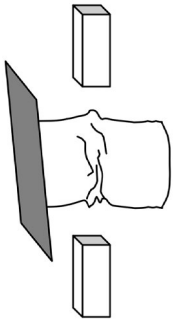
Prediction
I think because . . .

Activity Sheet 11: Crushing the can



11

Results table

Where the force was applied	Force needed to crush the can Choose the correct units (Newtons or grams)			Mean/Average Force
To the sides 				
To the top 				
To both 				

4. Fundamental friction

2 hours

The children investigate the best materials to make conveyor belts to pass materials from one part of the recycling process to another.

OBJECTIVES

- Compare how things move on different surfaces
- Identify the effects of air resistance, water resistance and friction that act between moving surfaces
- Planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheets 5 and 12
- Newton meter (scale of 0.5 – 2N)
- Weighted object (e.g. a box containing 1kg weight)
- 3 samples of surface materials (e.g. vinyl flooring, carpet, polythene bag, etc.)

INTRODUCING THE ACTIVITY

Read the part of the e-mail (Activity sheet 5) that asks about suitable materials for the conveyor belt.

Explain to the children that a conveyor is a series of rollers, which move the belt along; see diagrams on Activity sheet 12. Remind the children that a surface with high friction has good grip. If the surface of the underside of the belt is too smooth, the rollers will not grip and move the belt, they will just turn around.

Ask the children to suggest surfaces with high and low friction, e.g. tyres on cars and bicycles have high friction to grip the road. A child's slide has low friction so that children slip smoothly down, but the clothes and shoes that they wear will affect the speed. Show the children how friction can be measured by pulling a heavy object over the surface using a force meter. The reading should be taken just as the object begins to move. The units used are Newtons.

MAIN ACTIVITY

Show the children a selection of different flexible surface materials, e.g. polythene (bin bag), both sides of carpet, vinyl tiles, etc. They could predict which they think has the highest and which has the lowest surface friction.

Each group could test a different surface and compare results at the end, or they could test all three.

Use Activity sheet 12 as a guide through the investigation; measuring the surface friction of each material to find which has the highest. Do this by dragging an object (e.g. a box containing a 1kg weight) using a force meter and recording the force. As one child pulls on the force meter attached to the object, a second child reads out the scale as it increases. A third child carefully watches the object to indicate when it first starts to move. The fourth child in the group listens to the scale readings to record the correct reading when the object started to move.

The children then draw a force diagram to show their box being dragged over different surfaces.

PLENARY

Collate the results on the board and discuss them. Draw a class conclusion about the best surface for the conveyor belt. Tell the children that many conveyor belts are made out of rubber sheeting. Discuss why this is a suitable material for a conveyor belt. It is durable, flexible and has high surface friction.

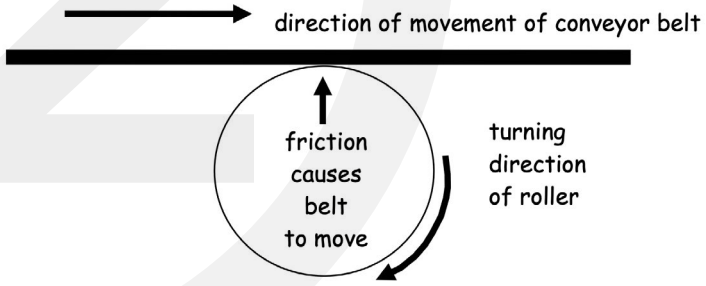
Ask the children to think of possible ways to increase the friction of the rollers (e.g. adding bumps or ridges).

Discuss the upper surface of the belt. Does this need to have high friction? A very slippery belt may cause items to slide when it stops moving. Ways of treating the surface to stop this from happening could be investigated as a possible extension.

Activity Sheet 12: Surface friction investigation

Investigation Question

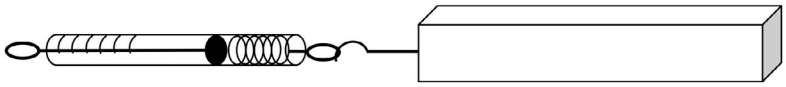
Which surface has the highest friction?



Predict

Which surface do you think would be best for the underside of the belt?

Draw 3 forces acting on the block, when the Newton meter is pulled.



Measure the friction of the materials you choose.

Results

Repeat your investigation three times to get reliable results.

Surface	Force to pull (N)			
	1	2	3	Average

Conclusion

Which surface has the highest friction?

Was your prediction correct?

Would this be suitable material for a conveyor belt in a recycling plant?

Why/why not?

What ways could you increase the surface friction?

5. Pulp to paper

2 hours

Children make recycled paper from newspaper by following the recycling process. They consider the forces involved and the efficiency.

OBJECTIVES

- To make recycled paper out of waste paper.
- To investigate forces involved in paper recycling.

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheets 13 – 14 (each group to have a different activity sheet)
- Waste paper e.g. newspaper
- Water
- Wooden spoon and/or whisk
- Food colouring
- Kitchen cloth, clean and absorbent Gauze sheeting
- Bucket or basin
- 2 wooden boards or baking trays Weights
- Aprons

ADVANCE PREPARATION

The process of breaking apart the fibres will be much more successful if the shredded paper is allowed to soak overnight.

INTRODUCING THE ACTIVITY

Look at Activity sheet 14 and talk through the process of recycling paper. Highlight the fact that similar processes are used in the recycling of many different materials. i.e. sorting – shredding – processing – finishing. Look at www.recyclenow.com/fun_stuff for video of the paper recycling process.

MAIN ACTIVITY

Provide Activity sheet 13 and the other materials. In groups, the children follow the instructions to recycle newspaper.

Ask the children to think about the different stages of the recycling process and the forces involved while they are making the paper, e.g. the separating of impurities, magnetism, the shredding, beating, removal, pressing, etc.

Explain that colour is added to cover the ink and also that some recycling plants clean off the ink or use bleach to remove it. Further steps would then be taken to recover the bleach and prevent it from becoming a pollutant.

PLENARY

Collect children's feedback about the recycling paper activity. Discuss any problems in the process.

Ask questions like:

- Did the paper break down enough to form a pulp?

If the paper being recycled is not shredded very finely there will be less chance of a uniform pulp being created.

- Did some parts of the process take longer than others?
- How might this affect the recycling on an industrial scale?

The materials would mount up at various stages. Design of the process may allow for larger quantities to be processed at some stages or storage may be needed. Sometimes there is more waste than sites can deal with, thus creating a waste mountain.

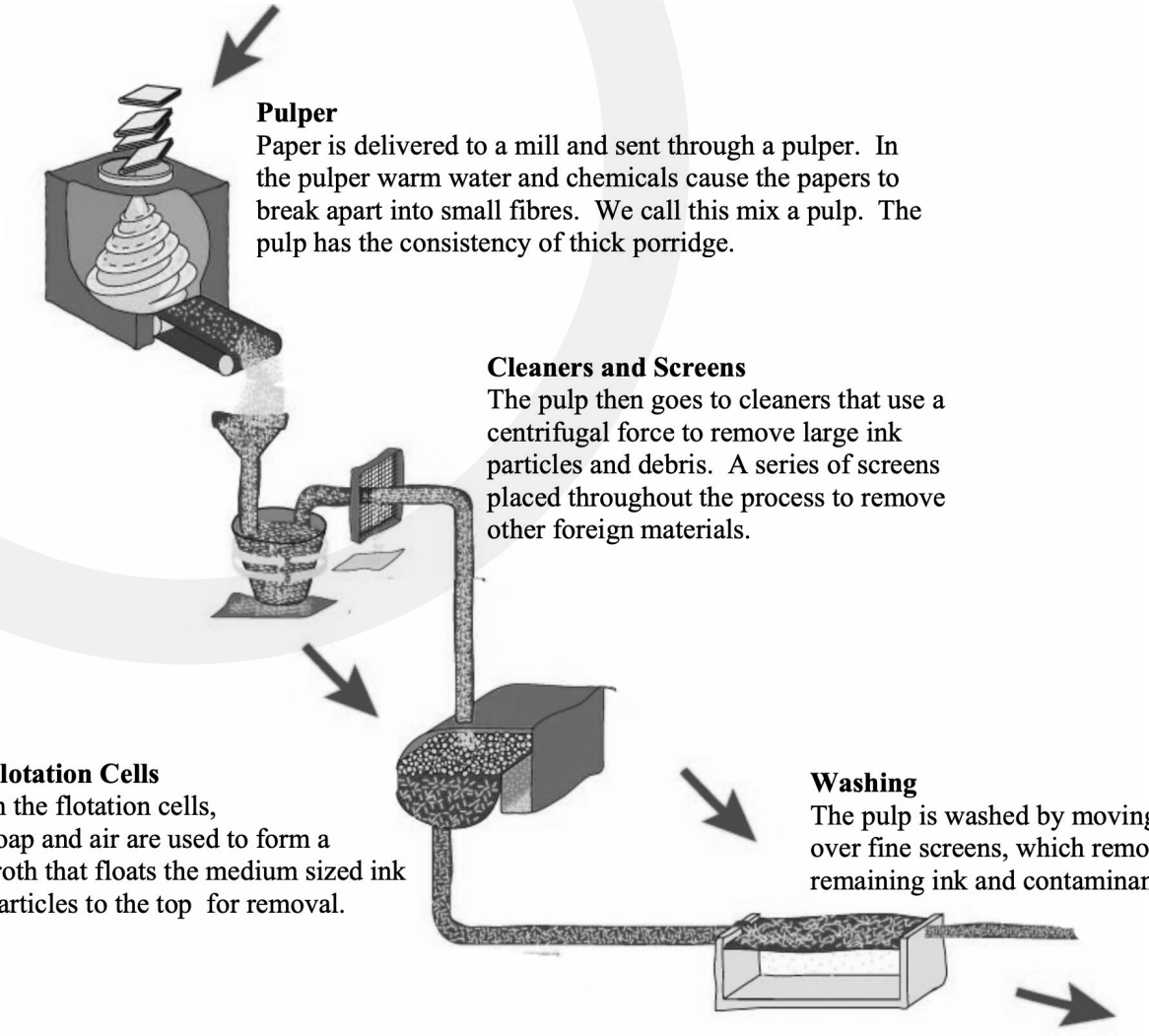
Give the children the opportunity to look at the listed websites in Appendix 2, showing the recycling processes of glass, steel aluminium and plastic. This could be an independent or whole class activity. Compare these processes to the recycling of paper.

EXTENSION ACTIVITY

Create a paper recycling treatment plant. Each group takes on the role of a different stage in the recycling process:

- Sorting
- Shredding
- Extracting steel/iron with magnets (this may not be a major task in your classroom simulation)
- Pulping
- Dyeing
- Extracting the water

The diagram below shows part of the recycling process taken from the poster Paper Recycling Works which can be found at http://www.paperretriever.com/.



Pulper
Paper is delivered to a mill and sent through a pulper. In the pulper warm water and chemicals cause the papers to break apart into small fibres. We call this mix a pulp. The pulp has the consistency of thick porridge.

Cleaners and Screens
The pulp then goes to cleaners that use a centrifugal force to remove large ink particles and debris. A series of screens placed throughout the process to remove other foreign materials.

Flotation Cells
In the flotation cells, soap and air are used to form a froth that floats the medium sized ink particles to the top for removal.

Washing
The pulp is washed by moving it over fine screens, which remove the remaining ink and contaminants.

Activity Sheet 13: Recycling Paper

You will need

Newspapers, a bucket, water, a wooden spoon, a tray or pan, thin mesh or netting, a flat piece of wood, weights, clean absorbent kitchen cloths, ink (optional), aprons.

What to do

1. Shred two or three sheets of newspaper into very small pieces. Put them in the bucket, cover them with water and leave them to soak (preferably overnight).
2. Stir and mush it up to make a pulp. It may help to beat or whisk the mixture.
3. You could add ink at this point to dye the paper.
4. Put the mesh or netting on the tray or pan. Cover with water.
5. Spread some of the pulp evenly over the mesh or netting.
6. Lift the mesh off the tray and place on top of kitchen cloths to absorb the water.
7. Cover it with more kitchen cloths, newspaper or a plastic bag and carefully turn it over.
8. Place a wooden block or heavy weight onto the paper and push or weigh it down to squeeze the water out.
9. Remove the top piece of newspaper or plastic and the mesh or netting.
10. Leave the pulp to dry for at least 24 hours. You have made recycled paper.

Activity Sheet 14: The Paper/Card Recycling Process

14

Material
Waste paper and card including newspaper.

1: Collecting and sorting
Kerbside collection schemes or paper/card banks. They are sorted, baled and transported to the treatment plants.

2: Shredding/crushing
The waste paper is shredded into very small pieces.

3: Pulping
It is soaked in water and stirred to release the fibres; turning them into pulp.

4: Separating
Ink is removed using different chemicals or air is passed through it to make an inky foam which is skimmed off.

5: Pressing/Drying
The pulp is pressed into sheets and dried to make paper.

Product:
Recycled paper as well as other products such as confetti, wall insulation and even furniture.

Key Facts:
Paper can only be recycled up to 4-6 times as the fibres get shorter each time. New pulp is often mixed with recycled pulp to improve the quality of the paper.

6. Class debate on recycling

1 hour

Children make recycled paper from newspaper by following the recycling process. They consider the forces involved and the efficiency.

OBJECTIVES

- Reporting and presenting findings from enquiries, including conclusions, causal relationships and explanations of and a degree of trust in results, in oral and written forms such as displays and other presentations

RESOURCES

(Per group of 4 children unless otherwise stated)

- Activity sheets 14 - 18, one copy per class
- Activity sheets 19 - 20

ADVANCE PREPARATION

Activity sheets 19 - 20 can be prepared as cards and laminated.

INTRODUCING THE ACTIVITY

Provide each group with a copy of a different material recycling process outline (Activity sheet 14 - 18).

Allow the children time to read through the information, discuss the recycling processes of different materials with their group, and think about how it links to what they have done so far in this topic.

Children briefly feed back to the class to outline key parts of the recycling process for their material.

Discuss the similarities and differences between the processes in the recycling procedure: e.g. sorting, crushing, baling, shredding, cleaning, purifying, breaking down, melting, remoulding, etc. Identify processes that may be unique to recycling a particular material.

MAIN ACTIVITY

Explain that some materials can be recycled over and over and others can only be recycled a limited number of times.

Provide children with the cards from Activity sheets 19 - 20, or ask them to cut them out. Children then match the correct statements to the correct material (some statements are written more than once because they may apply to more than one material).

The children then rank the materials in order from those most suitable to those least suitable for recycling. In discussion, ask each group to put forward reasons for their choices, e.g. aluminium, steel and glass are very good for recycling because they are 100% recyclable with little loss of quality and much cheaper than producing them from raw materials (aluminium 95%, steel 75%). Steel is one of the easiest materials to separate from its impurities.

Paper is easy to recyle but the quality reduces each time it gets recycled (the fibres are shortened in the recycling process). Plastics are harder to recycle, often requiring processes that may be inefficient, expensive, damaging to the environment and produce material of a lower quality.

For the debate, organise groups according to the children's views on the benefits and drawbacks of recycling particular types of materials. The outcome of the debate should be agreement on which materials are the most important to recycle. A presentation from each group could be followed by either an individual or a group vote.

Re-read the e-mail from the company (Activity sheet 5). Discuss the findings from all the activities.

Ask the children:

- Have the company's queries been answered?
- Why do we need to recycle?
- What affect does waste have on the environment? Why is efficiency important?

Discuss different ways in which the information could be reported back.

The children reply to the company e-mail (Activity sheet 5), answering the questions and explaining what they have discovered in one of the following ways:

- powerpoint presentation
- writing a letter or e-mail
- a written report
- an individual or group poster
- a cartoon strip
- a video or audio presentation
- a public awareness poster

Depending on the class, they could be given the freedom to choose one of the above methods, or the choice could be limited. This provides an ideal opportunity for assessment.

FURTHER DEVELOPMENT

The children compile a list of questions that they would like to find out about recycling plants and the role of scientists in these companies.

A site visit could be arranged to a recycling plant or a packaging manufacturer (e.g. producer of cans, cartons, bottles, plastic packaging, etc.). Here the children could observe the recycling process, find out what the scientists do in the company, and compare these to the investigations they set up and carried out in the classroom. Some of the children's work could be passed on to the company. The children could try and find the answers to any questions. Or, if this is not possible, a representative from a recycling plant or the council could visit the school to describe the roles of scientists and how they recycle products.

If a link with industry is not possible, the children could research answers to their questions on the internet or in the library.

EXTENSION ACTIVITY

The children could investigate how much waste is recycled in Britain compared to other countries. They could find out reasons why there is not more recycling when the technology is available. (E.g. It is expensive to change processes; some recycling processes use lots of energy and it may be cheaper to make products from raw materials; some recycling requires chemicals that are more damaging to the environment, recycling may produce material that is of lower quality than newly made). Explore what are the forces that are driving the move to recycle more (Pressure groups, National government targets through legislation and taxation, European Union targets, International targets, etc.). With more focus and impetus the technology will get better, and recycling will produce better quality products. In addition awareness should be raised so people know what they can do to help (e.g. kerbside schemes, use recycle banks more; sorting carefully, buying recycled materials more and buying products with recyclable or less packaging).

Prepare and hold a school debate

Give children time to formulate ideas as recycling pressure groups. Have some groups representing different target groups, suggestions could include, large companies using lots of packaging, supermarkets that multi-wrap products, advertising companies that distribute junk mail. Allow them time to create a campaign poster and/or a speech. Children can use prompt cards from Activity sheet 20.

Activity Sheet 15: The Steel Recycling Process

Material

Scrap: factory waste,
steel food cans,
white goods parts,
vehicles and parts, etc.

1: Collecting and sorting

Kerbside collection and can banks. Steel is separated from other waste using magnets. It is then crushed and baled and sent to a treatment plant.

2: Shredding/crushing

Large items are crushed. The waste is shredded into small pieces.

3: Separating

Magnets, water, and blasts of air are used to separate high quality steel from other materials. It is also passed through liquids with different thickness where floating items are removed and heavy metals like steel remain.

4: Melting

The separated steel is then melted in a furnace

5: Moulding

The steel is moulded to the customers' requirement and sent to different manufacturing industries

Product:

Cars, bikes,
drinks/food/pet food cans, aerosol cans and other household and industrial products.

Key Facts:

It takes less energy to recycle steel than to produce it from raw materials. Steel can be recycled over and over, keeping the same quality. It is 100% recyclable. The production of steel from scrap saves 75% of the energy required to produce it from raw materials.

Activity Sheet 16: The Glass Recycling Process

16

Material
Glass bottles, jars and other glass containers.

1: Collecting and sorting
Kerbside collection schemes and bottle banks (sorted by colour). The materials are then transported to the treatment plant.

2: Shredding/crushing
All bottles and jars are crushed.

3: Separating
Giant magnets, vacuum cleaners and lasers are used to remove metal, ceramics and paper, etc.

4: Melting
The glass is heated in a furnace to 1500 C. It is then cut into pieces called gobs.

5: Moulding
The gobs are dropped into moulds and blown into the shapes of bottles or jars. They then cool slowly for strength.

Product:
All glass packaging e.g. bottles and jars.

Key Facts:
Glass is 100% recyclable and can be recycled over and over at the same quality.
Recycled glass is as pure and clean as newly made glass.
The energy needed to recycle glass is less than is needed to produce glass from raw products.
It is important that the colours of glass are separated before recycling to prevent dark coloured glass from contaminating the lighter colours.

Activity Sheet 17: The Aluminium Recycling Process

17

Material
Scrap: Factory waste, engine parts, aluminium window frames, old household appliances

1: Collecting and sorting
Kerbside collection/can banks. Crushed, baled and taken to treatment plant.

2: Shredding/crushing
Aluminium waste is then put in the shredder and shredded into 10p sized pieces.

3: Separating
The pieces are sieved and passed through a magnet drum to remove steel. Plastic coating/paint removed in a de-coater at 500 C.

4: Melting
Shreds melted at 700 C and 'impurities' are removed.

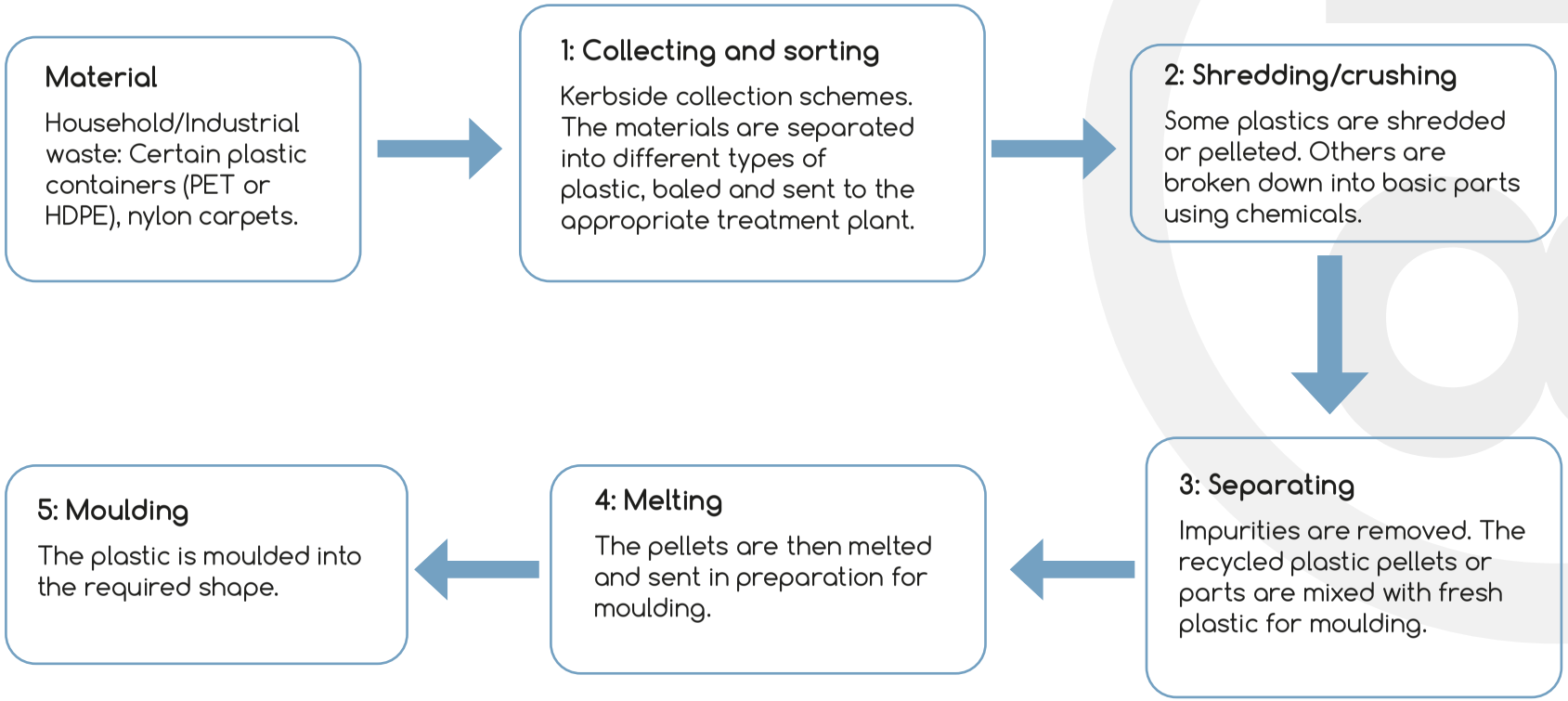
5: Moulding
Liquid aluminium is poured into moulds which are cooled by jets of water.

Product:
Car engine parts
Fizzy drinks cans

Key Facts:
Aluminium is the only material that can be recycled without additional energy costs because the energy needed to recycle is only 5% of that required to make it from raw materials.

It is much cheaper to recycle aluminium than produce it from raw materials.

It can be recycled over and over again with the same quality.



Product:

Some recycled plastic makes carpets. Other types make different packaging.

Key Facts:

There are lots of different types of plastic that are recycled in different ways. Only certain types of plastics can be recycled.

Plastics cannot be recycled over and over and lose quality each time they are.

New plastic is often cheaper to produce and better quality than recycled plastic.

Activity Sheet 19: Recycle cards

19

You may wish to enlarge these using the photocopier.

Cut out the cards on this page and the next. Match the statements on the other page to the material headings on this page.

Steel

Aluminium

Glass

Plastic

Paper

Card

Activity Sheet 20: Recycle fact cards

20

The recycled product is worth more than the cost of recycling it.

It loses quality each time it is recycled.

It takes 95% less energy to recycle than to make out of raw materials.

It takes 25% of the energy to recycle than to make out of raw materials.

It can be recycled forever without losing quality.

It needs to be mixed with freshly produced material to keep the quality high.

The fibres get shorter each time it is recycled.

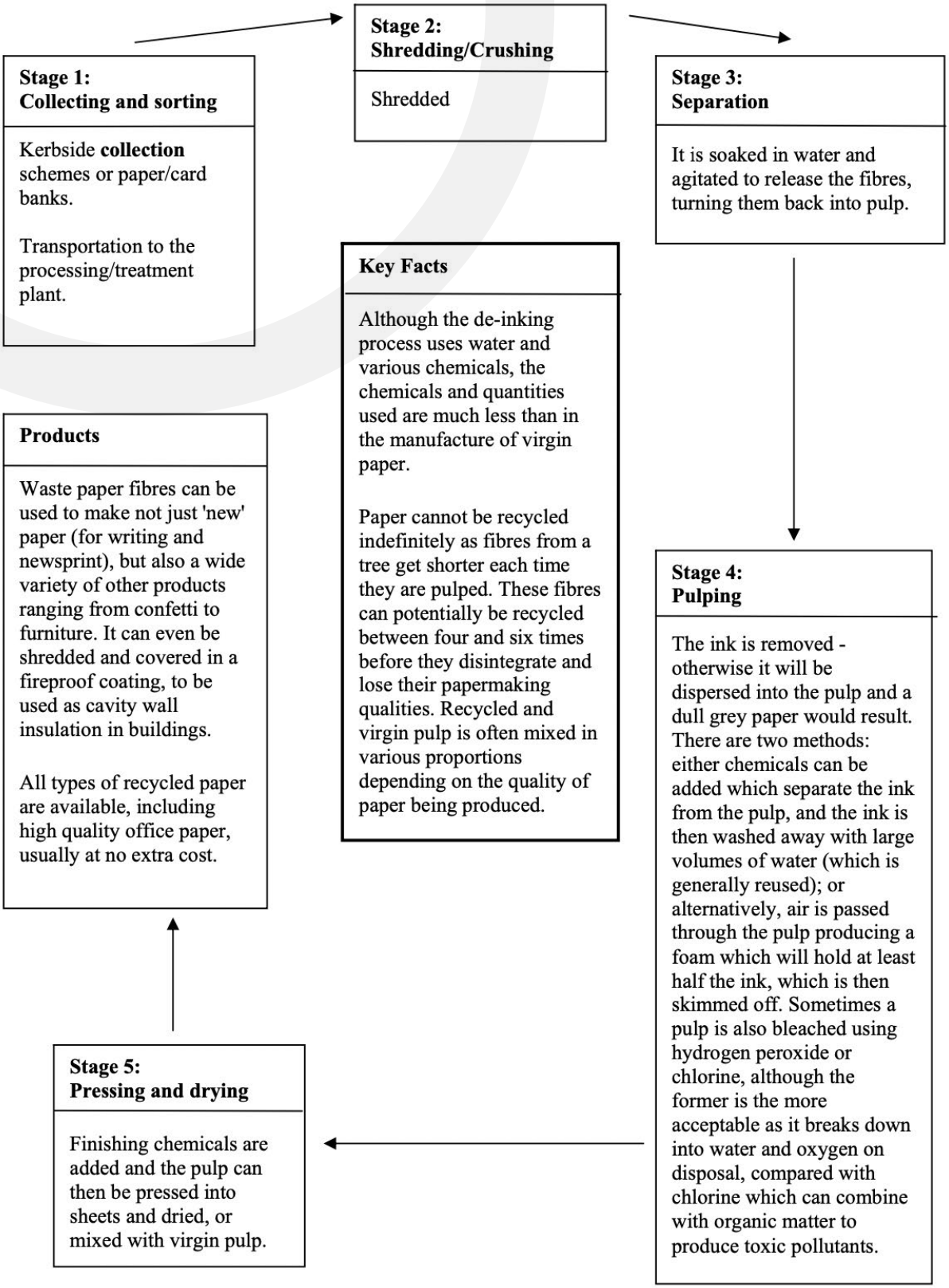
It is 100% recyclable.

The colours need to be separated before recycling.

It takes more energy to recycle than it does to produce new.

Appendix 1

PAPER/CARD



Stage 1: Collecting and sorting

Kerbside collection schemes or can banks

Some areas operate Energy from Waste plants which recover energy through controlled burning of domestic waste. Steel cans do not burn, and so can be recovered magnetically, baled and sent on to the steel industry for recycling.

Other areas operate a system where the waste is spread on a conveyor belt, and steel cans are retrieved with a simple magnet before being sent for de-tinning, and eventually back to the steel industry. This process is called magnetic extraction.

Steel is recovered from much waste in most waste treatment facilities.

Transportation to the processing/treatment plant.

Stage 2: Shredding/Crushing

Oversize items such as light iron, vehicles and white goods and recovered clean pieces of steel.

They are crushed and the different constituent materials are separated (See Stage 3).

Stage 3: Separation

Because of its magnetic properties, steel can be pulled out of domestic waste using simple electro-magnets.
Either fixed or mobile balers have shears that convert loose new production cuttings into clean, dense, furnace-ready material.
Air cyclones, magnets and eddy-current separators are used to recover high-quality steel for smelters and mixed heavy materials for further separation.

Mixed heavy materials (produced by shredders) can be processed to recover mixed aggregates, aluminium and other metals.
This is done by passing it through a floatation tank containing a thick liquid where very heavy items fall to the bottom. The items that float are removed (magnesium, rubber and plastic float).

The items that sink are passed through an even thicker liquid and the floating items are removed (aluminium, glass and stones).

The rest is separated by hand or by computer.

Many of these items are sent to other recycling facilities. The main component, steel, continues on through the process.

Key Facts

The energy required to recycle is approximately 25% that of primary production. Studies show that, in such a situation, the production of steel from scrap steel saves up to 75% of the energy required to produce if from the virgin materials. The production of steel for can making now requires only about 60% of the energy which would have been required just ten years ago. The steel industry continues to make great advances in energy efficiency ensuring that the manufacture of steel cans is environmentally sound.
Each steel can is 100% recyclable and can be recycled over and over.

Stage 4: Melting

The cans are baled and put into the furnace. Molten iron is added and oxygen blasted through the furnace which heats up to around 1700ºC. The molten steel is formed into big slabs and then rolled into coils.

Stage 5: Moulding

Constructional and lighter gauge steels are cut to standard sizes or to customers' requirements.

Products

Cars
Bikes
Drinks cans
Food cans
Paint cans
Aerosols and containers of many other household and industrial products

Stage 1:
Collecting and sorting

Kerbside collection schemes or bottle banks. Sorted by colour: colourless, brown and blue, green.

Transportation to the processing/treatment plant.

Stage 2:
Shredding/Crushing

At the glass treatment centre all the bottles and jars are **crushed**.

Stage 3:
Separation

Magnets, giant vacuum cleaners and even lasers go over the glass to extract metal, ceramics and light materials like paper and plastics. Pieces of metal, plastics and stones can spoil the recipe for glass, so they must be removed.

Key Facts

Glass is 100% recyclable, without any loss in quality, no matter how many times it is recycled. After re-melting and forming, containers are as pure and clean as those made from virgin raw materials. It can be recycled forever.
Glass packaging recycling saves energy. The amount of energy needed to melt recycled glass is significantly less than that which is needed to melt virgin raw materials to make new glass containers.

Products

Recycled glass packaging is used in all market sectors, from wine and beer to spirits and foods. Glass can be recycled infinitely without any loss of quality.

Stage 4:
Melting

The recycled glass is now called cullet and is taken to a glass bottle making factory.
It is heated in a furnace at a temperature of 1500ºC. Molten glass is then drawn from the furnace, cut into pieces called gobs, dropped into a mould and blown into the shape of a bottle or jar. This is carried out by complex machines, controlled by computers.

Stage 5:
Moulding

The new glass bottles move on a conveyor belt into a long oven which reheats them and then lets them cool slowly. This is called annealing and makes sure that the bottles stay strong in everyday use. Machines check the bottles to make sure they are all perfect. The bottles are then packed and taken to food and drinks manufacturers to be filled.

ALUMINIUM

New Scrap

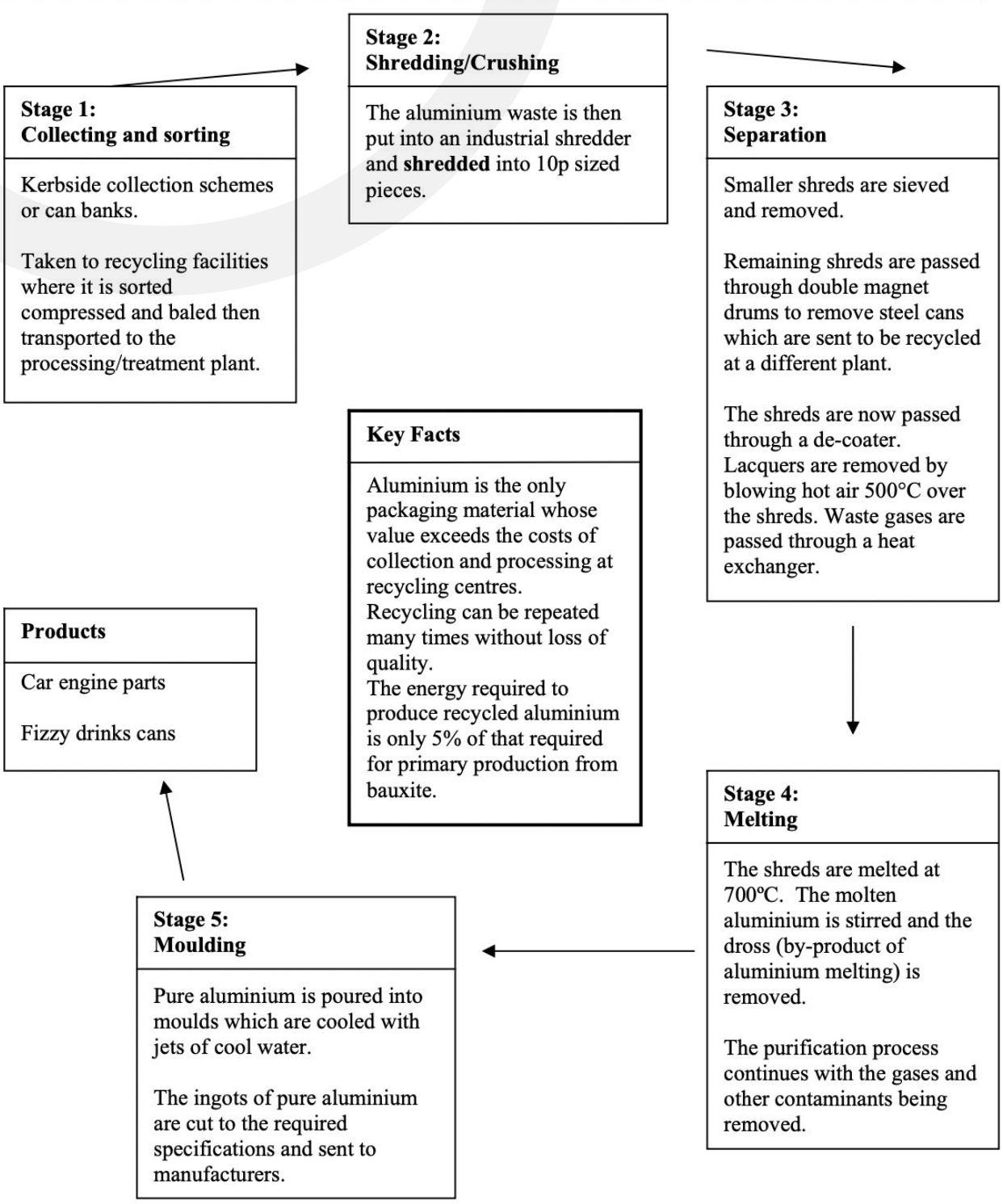
Waste aluminium from aluminium alloy making process.

Old Scrap

Aluminium vehicle engine parts, aluminium window frames or old electrical conductors, or household appliances.

Household waste

Aluminium cans, aluminium foil, aluminium foil laminates (found in between layers of food packaging).



Stage 1:
Collecting and sorting

Most recycling of plastics in the UK is 'process scrap' from kerbside and industry collections schemes.

Collection must be efficient but plastics can be lightweight and bulky. It is therefore uneconomical to transport unless crushed.

Plastics for home use are often of mixed types and impure. This makes recycling more expensive.

In the UK only some types of plastic are collected for recycling.

Sorting is often done by hand. As well as separating types of plastic, strong colours need to be separated from white.

Stage 2:
Shredding/Crushing

After sorting, baling machines compact the plastics. In the reprocessing factory bottles are cut into granules for reuse.

Mixed waste plastics can be broken down chemically to produce gases. 80-90% hydrocarbons are for reuse in plastics manufacture and 10-20% as fuel gas.

This way of recycling plastic packaging is predicted to increase in the UK.

Stage 3:
Separation

The granules are washed and dried (water used is filtered and reused). Sorting by density sometimes takes place at this stage.

The granules are passed under metal detectors and through de dusting units to remove further contaminants (lighter particles).

Stage 4:
Melting

Dry plastic granules or flakes are fed into an extruder where heat and pressure melt the plastic. Different plastics melt at different temperatures.

The molten plastic is forced through a fine screen to remove any contaminants that may have been missed.

It is then forced through a grid to make strands which are cooled in cold water and chopped into pellets.

Stage 5:
Moulding

Recycled pellets can be melted down and reshaped by blow moulding, extrusion, injection moulding, compression moulding and a variety of other technical operations.

Recycled pellets can be used on their own or mixed with new plastics.

Recycled plastic is often produced in dark colours to mask the colour from the original plastic.

Products

Recycled plastics cannot be used in some products, for example those for food or medical use.

The range of products is very extensive including carpets, garden furniture, engineering components.

The range of products that can be produced from chemically recycled plastic is even greater.

Key Facts

Not all plastics lend themselves to recycling and the need to sort the plastics makes processing complicated and expensive.

Contamination with another product such as paper can make a seriously inferior product.

The resale value of recycled plastics fluctuates with the price of oil and therefore the cost of the raw materials for new plastics.

There are no subsidies currently being offered in the UK for plastics recycling, unlike many other European countries.

Appendix 2

The table below shows useful websites with information relevant to the unit.

Website	Details
https://uk.emrgroup.com/	The European Metal Recycling website has animations of the processes of shredding, flotation (to separate materials) and dismantling and recycling a fridge.
http://www.scrib.org.uk/	This is the Steel Can Recycling Information Bureau website. It contains information for teachers as well as activities for children. Free posters and videos are available for schools.
https://www.sustain-education.org/	Although aimed at secondary school use this CIEC website contains useful information about the recycling of different materials and provides other links.
https://thinkcans.net/	This Novelis aluminium recycling education website contains information, interactive games, activity sheets and teachers' activity ideas.
https://www.wastecare.co.uk/	This is a website encouraging more recycling and gives information about all types of recycling.
https://www.recycle-more.co.uk/	This is another website encouraging recycling with other activity ideas and games.
https://wrap.org.uk/	Useful research site.

LO	Level 1	Level 2	Level 3	Level 4	Level 5
Planning & Predicting		Can suggest ways to explore the weights of different objects in air and the liquids. Describes what they think will happen when the objects are lowered into the liquids *'I think it will float in all of them.'*	Able to make simple predictions about how the liquids will be different, based on some scientific knowledge. *'The oil is thicker so it might sink slower.'* **Think about how to collect evidence.** *'We could measure using a forcemeter.'*	Able to make predictions based on scientific knowledge. *'There will be less force downwards if the liquid is making the object float because of the upthrust.'* **Plans to test each liquid with the same object and then use a new object to test again.**	Can make predictions based on scientific knowledge and understanding and explain choices. *'We are going to test each liquid to put them in order. Then we will test with a different object to see if the liquids come out in the same order as before.'*
Obtaining Evidence	Can state that some things float in water and others sink.	Can makes observations related to the suggested method. Can record in a chart provided, which ones float and which ones sink. *' The pencil sharpner sinks in the water but floats in the syrup.'*	Can make relevant observations and record readings from the force meter. Knows that items that float will give lower readings in the liquid because of the upthrust. *'This one floats in oil so the force meter will show less force in oil.'*	Makes a series of repeat measurements with attention to fair testing and accuracy. *'I think we need to do them more than once just to check. The reading for the same object in the same liquid should be the same.'*	Can make a series of repeat tests and recordings and understand how this data can be used to predict for other items in the same tests. *'We need to collect results for one item in all liquids first and then decide what to change in the next test.'* *Can produce diagrams showing all forces acting and balanced forces.*
Considering Evidence	Can identify differences. *'The cooking oil is runnier than the syrup.'*	Can make simple comparisons. *'It will float in oil but it just sinks in the water.'* *Can record with drawings or fill in the data table provided.*	Is able to identify simple patterns in observations. *'I think more things float in the thick liquids.'* **Can decide which data to record.**	Can relate conclusions to scientific knowledge and identify patterns in their own observations. *'The thicker the liquid the less the force pulling the object down is. There is more upthrust in thicker liquids.'* *Can produce diagrams showing direction of forces.*	Can explain their findings in scientific language and state the relevance of their conclusions. *'The force on the object hanging on the force meter is made less by the opposite force of upthrust from the liquid.'* *Can explain which liquids have enough upthrust to stop some, but not all materials from sinking. 'We can sort materials by finding which liquid they float in.'*

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www.ciec.org.uk

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