RENEWABLES DON'T RUN OUT

A science investigation pack for teachers of 7-11 year olds

CENTRE *for* INDUSTRY EDUCATION COLLABORATION

Supported by the Gatsby Charitable Foundation

Contents

Introduction

AGE RANGE

The activities in this book provide practical opportunities for children in years 5 and 6 to consider the use of plant material (biomass) as a solution to some of our requirements for renewable energy, to address the problems that use of these materials can pose and to begin thinking about other applications for plant derivatives.

The concept of 'How Science Works' and the inclusion of a more detailed explanation of energy will provide an excellent opportunity to use the resource as a Year 6-7 transition unit.

The suggested activities can be adapted to suit the needs of the children, staff and the planning requirements of the school.

APPROXIMATE DURATION

The timings for each activity given are a guide, and will vary from class to class. They range in length from 1 to 2 hours.

CONTEXT

The activities are set in the context of a company that is considering its future needs for power. The children investigate the suitability of a number of different sources of biomass to fuel the boiler and also the implications of transporting bulky materials to the site. The same company also wishes to explore the use of biomass to replace some of the non-renewable ingredients in its products. This provides a further avenue for exploration by the children.

BACKGROUND INFORMATION

This resource introduces the concept of renewable resources from non-food crops. Renewable materials are made from crops, plants and animal sources rather than from fossil fuels or other diminishing non-renewable natural resources.

The activities can lead to discussions in other areas such as sustainability, fossil fuels, greenhouse gases, global warming, etc. which can be introduced during the activities or covered at a different time. Further information on renewables and other related topics can be found at the sister website to this resource http://www.plants4products.org.uk/ and also https://www.nnfcc.co.uk/

The websites provide teachers with ideas for managing discussion and questions to stimulate children's ideas.

Forging links with the local secondary school may be beneficial when carrying out some of the activities in this pack, e.g. Activity 2: Fuel from plants. The secondary school may be happy for the class to use their equipment and fume cupboards. The class could write to the science department requesting their help and advice and use the staff's expert knowledge of the equipment required. This would model the cooperative approach often used by scientists and industry.

ACTIVITIES

Activity 1 should be carried out prior to any of the other investigations as it sets the scene for the use of plant materials to solve a number of predicted shortages in coming years. It focuses on one solution to the ultimate scarcity of fossil fuels. The five investigative activities following Activity 1 provide a sequence that helps the children to explore the potential for using plants for non- food purposes. They introduce the children to a number of different problems each requiring enquiry skills, discussion and problem solving consistent with National Curriculum requirements.

In some activities detailed instructions have been provided to model a specific investigation process. Teachers may choose to provide children with these instructions following a preliminary discussion and to focus on practicing skills such as measuring, controlling factors, using simple equipment, observing, predicting, and data handling. As an alternative, or in later activities, the children may draw on these experiences to plan their own investigations.

The crop suggested as the source of biomass is the sunflower, which gives the children the opportunity to revise their knowledge of green plants and to consider the most appropriate uses for different parts of the plant. Other plants which bear oil rich seeds, such as maize, or oilseed rape can be used if they are more easily available.

The extraction of oil from the sunflower seeds is investigated, and the use of the oil as a fuel, lubricant or ingredient for a number of different products is explored.

The **literacy activity** is intended for use at any stage during the investigations. Ideally, the suggestions provided will be used alongside all of the activities to develop gradually the children's understanding of the scientific vocabulary they encounter.

The activity sheets provided in this pack are there to help children to organise their ideas but teachers should not feel constrained by them. They may be adapted or other methods, with which the children are already familiar, can be used. The activity sheets are available on the web site www.plants4products.org.uk and can be adapted to individual teacher's needs.

ADVANCE PREPARATION OF RESOURCES

Ideally, this unit will be carried out in the autumn term, using sunflowers grown in the summer term, which have been dried and stored. However, the activities can be carried out at other times of the year, using stored or purchased dried sunflower heads, and adapting the sequence of activities as appropriate.

We recommend that any plants to be used are planted in early May to be ready for the autumn term. Although dried sunflowers can be purchased, the cost may be prohibitive and alternatives may be required.

ACTIVITY SUMMARY

Title	Description	Timing
1. Crops for all purposes	The children are introduced to the idea that some crops are grown for non-food purposes. They review the parts of a plant and their function.	1.5 hours
2. Fuel from plants	Children observe how well different materials burn and if they can be compressed for transporting.	2 hours
3. Oil from seeds	Different techniques are used to extract oil from a variety of seeds and nuts.	2 hours
4. Separating oil and water	Methods of separating a mixture of oil and water are investigated.	1 hour
5. Oil as a fuel	Children use a variety of oils as fuels and compare results to find the best fuel.	1.5 hours
6. Oil as a lubricant	The children are challenged to find out which oil would be the best lubricant.	1 hour
7. Focus on vocabulary	Intended for use throughout Activities 1-6; suggestions are made for motivating the children to develop their use of relevant scientific vocabulary.	N/A

Resource requirements

Quantities are given per group of 4 children, unless otherwise stated:

ACTIVITY 1

Per group of 4

- 1 dried sunflower plant, or other plants that produce seed oils can be used e.g. maize, rape
- 3-4 clear food bags
- Sugar paper
- Adhesive labels
- A selection of photographs/images linking crops to their end products. A suitable selection can be downloaded and printed from the teachers section of www.plants4products.org.uk

ACTIVITY 2

Per class

- Bowl of each: straw, hay, wood shavings/chips, sunflower stalk 1 pair safety glasses or goggles
- Bag of sand/ bucket of water (emergency use)
- 3-4 metal baking trays/ roasting tins or similar
- Timer
- Safety lighter

Per group of 4

- Activity sheet 1
- Post-it note planning boards (optional, see Appendix 2)
- Cup of each: straw, hay, wood shavings/chips and sunflower stalk
- 4 plastic drinking cups/food cans
- 500g and 1kg weights
- Weighing scales
- String
- Plastic food bags
- Shallow trays

ACTIVITY 3

Per class

- Bottles of oil from a range of sources to include corn oil, groundnut (peanut) oil, almond oil, rapeseed oil, sunflower oil, sesame oil, olive oil, vegetable oil.
- A range of seeds, nuts and crops to include maize, peanuts, almonds, walnuts, sunflower seeds with and without outer casing, sesame seeds, pumpkin seeds.

Per group of 4

- Activity sheet 2
- Samples of the different seeds and nuts from the list above.
- 1 rolling pin
- 1 sealable clear bag per seed/nut sample
- 1 filter paper or sugar paper square (10cm x 10cm approx) per sample
- 1-2 teaspoons
- Bluetac or adhesive tape
- Camera (optional)

ACTIVITY 4

Per group of 4

- Small transparent plastic bottle (approx. 200-400 ml) containing equal amounts of water and a coloured oil, e.g. corn oil
- A range of separating equipment such as:
- Clean, empty, plastic sauce bottle with one way valve, e.g. shower gel, tomato sauce
- Clean, empty, transparent, plastic detergent bottle Funnel
- Tubing
- Flexible plastic drinking straw
- Small transparent pump action dispenser bottle Plastic cups
- 2-3 plastic pipettes
- Syringes
- Digiblue movie creator or similar software

ACTIVITY 5

Per class

- Safety lighter

Per group of 4

- Activity sheets 2-3
- Tidy tray containing sand
- Heating stand (available from TTS)
- 2 small metal containers, e.g. individual foil cake cases, empty tea light candle cases, metal screw cap lids (bottle lid)
- 1 sample per group of a selection of cooking oils, e.g. corn oil, groundnut (peanut) oil, almond oil, rapeseed oil, sunflower oil, sesame oil, olive oil, vegetable oil.
- Candle wick (available from craft stores) or cotton string and plasticine
- Thermometer
- Timer
- Tweezers
- Data logger (optional)

ACTIVITY 6

Per group

- Activity sheets 2 and 4
- A range of oils and fats, e.g. maize, oil, groundnut (peanut) oil, almond oil, rapeseed oil, sunflower oil, sesame oil, olive oil, vegetable oil.
- Depending on the investigative methods chosen, some of: Ramp
- Foil
- Margarine tub filled with dried peas or marbles
- Timer
- Detergent and paper towels
- 3 elastic bands and force meter (1-10N scale)
- Metre stick/long ruler

1. Crops for all purposes

1.5 hours

The children are introduced to the idea that some crops are grown for non-food purposes. They review the parts of a plant and their function

OBJECTIVES

- Identify and describe the functions of different parts of flowering plants: roots, stem/trunk, leaves and flowers (Y3 Plants)
- To understand that plants are grown as crops for a number of different uses
- Recording findings using simple scientific language, drawings, labelled diagrams, keys, bar charts, and tables

RESOURCES

(Per group of 4 children unless otherwise stated)

- 1 dried sunflower plant, or other plants that produce seed oils can be used e.g. maize, rape
- 3-4 clear food bags
- Sugar paper
- Adhesive labels
- A selection of photographs/ images linking crops to their end products. A suitable selection can be downloaded and printed from the teachers section of www.plants4products.org.uk.

ADVANCE PREPARATION

We recommend that sunflowers are planted during the summer term (planting seeds in early May will produce mature plants by September) ready for this activity.

Note: Sunflower seeds will be found only in the matured plants. The use of dried flower heads therefore provides the best introduction to subsequent activities. See Appendix 1 for information on how to dry the heads and where to purchase pre-dried ones. The comparison of fresh and dried sunflowers using photographs or dried heads can overcome the problem of using pre-dried ones.

INTRODUCING THE ACTIVITY

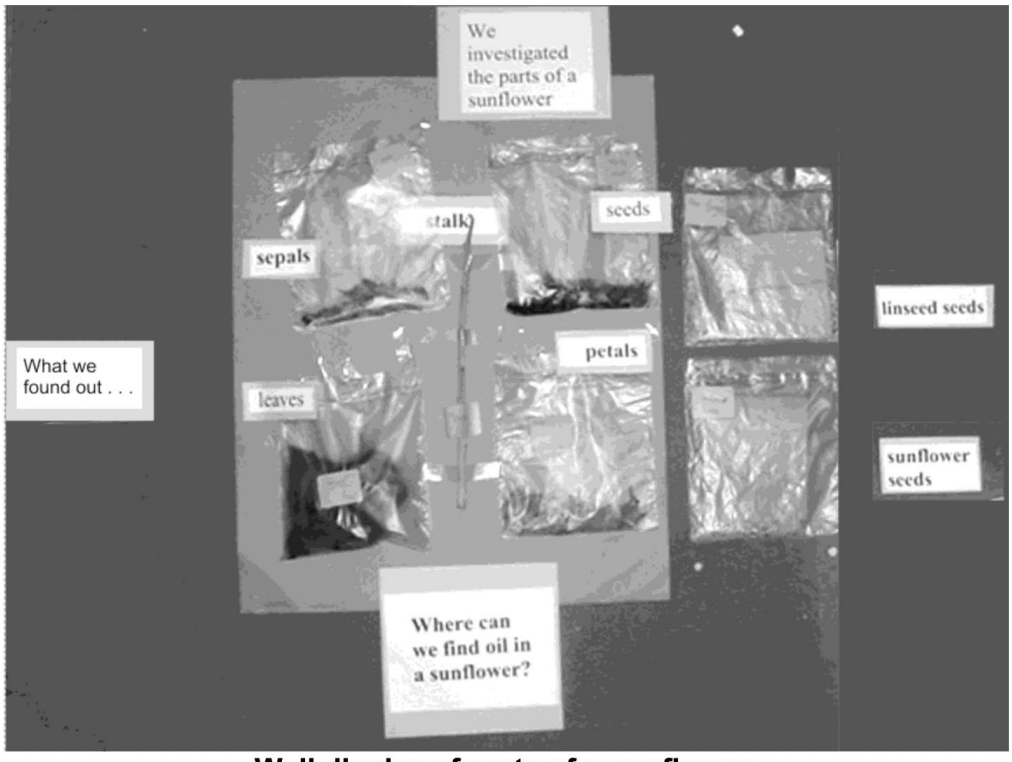
Each group of four children is provided with a set of images from the website. The groups are invited to sort the pictures using criteria of their choice. Once familiar with the pictures they are asked to record links between the photographs, matching the products to the plants that produced them.

Discuss the children's sorting criteria and consider other aspects of the pictures including:

- Do the pictures show living/non-living things?
- How many of the plants can be used for food?
- How many of the plants can be used for non-food purposes?
- Do any plants produce both food and non-food products? How many of the products does their family use; have they seen them in the shops?

MAIN ACTIVITY

Each group is given a sunflower plant to observe, separate into the different parts, label and display. They can include explanations about the function of the parts, e.g.'leaves use sunlight and water to make food for the plant to grow'. A plastic bag may be useful to collect the seeds from the dried flower, as well as other small parts of the plant. Work can be mounted by the children and displayed.



Wall display of parts of a sunflower.

Extension: Weigh the whole plant before separating. Each separate part can be weighed and the percentage of the whole can be calculated. The weight distribution of the plant can then be displayed in a bar chart or pie chart. Charts representing different specimens can be compared to see if distribution is always the same.

PLENARY

Each group presents their displayed findings and explains what each part of the plant does and what the different parts of the plant could be used for.

The discussion can extend to include all the plants in the photographs, focusing on how they are used to make different products and which parts of the plants are used, e.g. the branches of the willow are used for wicker baskets, the fibres from the seed of the cotton plant are used to produce cotton thread and the sunflower produces seeds and oil.

HOMEWORK

Children can be asked to research one or more of the plants in the photographs and their non-food uses.

2. Fuel from plants

2 hours

Children observe how well different materials burn and if they can be compressed for transporting.

OBJECTIVES

- Explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda (Y5 Properties and changes of materials)
- 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 class

- Bowl of each: straw, hay, wood shavings/chips, sunflower stalk 1 pair safety glasses or goggles
- Bag of sand/bucket of water (emergency use)
- 3-4 metal baking trays/roasting tins or similar
- Timer
- Safety lighter

Per group of 4

- Activity sheet 1
- Post-it note planning boards (optional, see Appendix 2)
- Cup of each: straw, hay, wood shavings/chips and sunflower stalk
- 4 plastic drinking cups/food cans
- 500g and 1kg weights
- Weighing scales
- String
- Plastic food bags
- Shallow trays

ADVANCE PREPARATION

The plant material needs to be completely dried.

If using the post-it planning method, activity sheets in Appendix 2 can be copied and laminated – one set per group is adequate for use at each relevant stage of this activity.

You may wish to carry out the burning investigation the day after planning, to allow time for equipment suggested by the children to be collected.

As this teacher-led practical activity involves burning a range of materials, the following safety precautions must be taken:

1. Carry out the activity in the open-air (middle schools may have a fume cupboard), or liaise with the local secondary school.
2. Have a bag of sand/bucket of water close by for use as an extinguisher, if necessary.
3. The teacher should wear safety goggles and have long hair tied back.
4. Children who have asthma should have ready access to their inhalers.

Safety note

Ensure all bags have ventilation holes.

Children must not hold the bag during the test, to prevent a full bag falling on their feet.

INTRODUCING THE ACTIVITY

Activity sheet 1 is a letter which introduces the children to a fictitious company. This letter forms the introduction to several activities in this resource.

Tell the children that today they are going to plan a test to find out which plants are best for the company to burn in their boiler. Each group discusses what being 'best' means, e.g. burns for the longest, brightest flame. Post-it planning can be used at this stage, before collating ideas on the white board. Through class discussion, the best aspects of each group's plans are combined to provide the teacher demonstration.

Example of hay burning in a controlled manner.

The children can be involved in several aspects of the practical activity, such as:

- Measuring equal amounts of plant material.
- Emptying one bag of material at a time into a metal tray ready for testing.
- Measuring and recording the duration of burning.
- Photographing and/or filming the process.
- Recording a commentary.
- Making and recording close observations, including flame types, smoke produced.

Be aware of the weather conditions so that the children are not downwind of the activity and are out of any smoke produced or any material which may get blown about.

The ash and unburned material can be collected and once cool could be put into a clear plastic bag and used for display purposes.

Extension: The amount of ash and burnt material can be weighed and compared to the weight of the plant material at the start. Discuss why there may be a difference and what has happened to the plant material during the burning, i.e. an irreversible change.

Sample burning results

Material	Observations
Hay	takes time to ignite, smoulders rather than burns, produces a lot of smoke, and does not burn out completely.
Straw	burns readily, produces little smoke, quickly burns itself out, and leaves very little ash.
Wood shavings	ignite readily, produce little smoke, burn slowly but steadily and leaves ash.
Sunflower stalk	very slow to ignite and produces smoke.

DISCUSSION

After observing this demonstration, the children need to consider what the findings tell them. They should discuss the advantages and disadvantages of using renewable fuels and compare them to non-renewable fuels. Questions such as the following may be considered:

- What properties should the fuel heating the boiler have? (e.g. burn cleanly with no smoke, produce small amounts of ash and burn slowly.)
- Which properties would be a disadvantage?
- How do these materials compare to the most common fuels; gas, electricity, coal and oil?
- Can the waste products be used for other purposes? (e.g. ash can be used to manufacture concrete and be used as fertilizer.)

BACKGROUND INFORMATION FOR THE TEACHER

The most appropriate measure of energy produced in this activity would be to measure the heat produced by each plant source. To produce energy from sustainable sources the materials used as fuel need to be easily available in very large amounts. Oil, coal and gas are fossil fuels that have been created from plants over millions of years. They will be used up much more quickly than they can be replaced. Plant materials capture energy from the sun and carbon dioxide. They use up carbon dioxide and produce oxygen as they grow. This is why they are called renewable resources. Electricity can be produced using both fossil fuels and plants.

MAIN ACTIVITY

Each group is now given samples of the plant materials already used for the burning investigation to observe and handle. They discuss how each material would be stored and transported to the company; consider:

- Would they be easy to move?
- Are they heavy?
- What difficulties could there be in moving enough dried plant material to keep the furnace going?

The material takes up a lot of space, so would be inefficient to transport in its current state. Groups of children discuss how this could be changed, e.g. bundled up, packed in bags.

The children explore the effect of compressing the dried plant material, e.g. does it change the weight? Does it make it easier to transport? Would compressing the material make any difference to the burning and/or heat produced? Could the compressed material be used for anything else?

The following process provides one possible way to investigate the changes taking place and suggested method of collecting data:

1. Carry out the activity in shallow trays (to contain plant material).
2. Fill a plastic drinking cup with plant material.
3. Mark the level of the material and weigh the filled cup.
4. Compress the material using weights or by pushing down and mark the new level.
5. Re-weigh the cup (after removing the weights).
6. This process could be carried out once, compressing as much as possible, or, the level can be decreased by steps of 2cm, and weighed each time.

Extension: An explanation of density could be offered to extend the understanding of some children, as appropriate:

Density is how much mass is packed into the space taken up by an object. Something that is very heavy yet is small has a high density. When material is squashed to make it smaller, it weighs the same but becomes more dense. You may wish to link to literacy and create a class description of density.

PLENARY

From observations made during the introductory activity, the children can make recommendations as to which plant material makes the best fuel for the company (based on the amount of smoke produced, burning time, etc.). Each group can also report their findings on the compression of the dried plant materials, explaining what they have found out with respect to mass and volume, and possibly density.

Focusing again on the letter, discuss the idea that reducing the volume of the biomass (plant material) will reduce the number of vehicles required to transport it. By producing briquettes, small compressed packs of material, it is easier to handle and transport and will be in a form that can be used easily when adding to the furnace.

Materials also take up less space if air can be removed from between the pieces. Get the children to compare the space taken up by wood shavings or saw dust and the same weight of twigs or small wooden blocks.

Industry also grind up solid fuel so that it can be blown into the furnace. Ask the children why this might be a good idea, (the material will ignite more quickly).

Ask the children to discuss why it may be more convenient to convert fuel to electricity and supply it through a cable rather than burn the fuels on site.

Recommendations can be reported in the form of a letter or PowerPoint presentation.

Persind Products
Holme Lane
Greenton

Dear Science Consultants

Our company makes ingredients used in many different products, ranging from soap and body wash to kitchen cleaners. We want to ensure our products do as little damage to the environment as possible and would like your help with this matter.

We were wondering if we could burn dried plants instead of petroleum oil in our boiler to produce steam for heating and making electricity for use on our site.

Things we think we could burn, available from local companies, include straw, hay, wood shavings and sunflower stalks, but we are not sure which one would be best to use.

The oil we currently use is delivered to us by pipeline with little or no disruption. We are worried that we would need very large quantities of plant material and we don't have enough room to store it on site.

Also we would need many lorries every day to bring the plant materials on to our site. This will be very expensive and result in a lot of extra traffic on the roads.

We would like you to carry out some tests and provide us with evidence to help us make some difficult decisions. Any additional research you can do would also be gratefully received.

Yours faithfully

Susan Carlton

Susan Carlton

Environmental Manager

3. Oil from seeds

2 hours

Different techniques are used to extract oil from a variety of seeds and nuts.

OBJECTIVES

- To know that oils from seeds and nuts have a variety of uses
- Gathering, recording, classifying and presenting data in a variety of ways to help in answering questions

RESOURCES

Per class

- Bottles of oil from a range of sources to include corn oil, groundnut (peanut) oil, almond oil, rapeseed oil, sunflower oil, sesame oil, olive oil, vegetable oil.
- A range of seeds, nuts and crops to include maize, peanuts, almonds, walnuts, sunflower seeds with and without outer casing, sesame seeds, pumpkin seeds.

Per group of 4

- Activity sheet 2
- Samples of the different seeds and nuts from the list above.
- 1 rolling pin
- 1 seal-able clear bag per seed/nut sample
- 1 filter paper or sugar paper square (10cm x 10cm approx) per sample
- 1-2 teaspoons
- Bluetac or adhesive tape
- Camera (optional)

Safety note

Be careful not to include nut oils if involving children with nut related intolerance or allergies.

INTRODUCING THE ACTIVITY

Begin with a recap of previous activities with particular reference to non-renewable and renewable forms of energy.

Ask the children what is used to power most vehicles and where it comes from, i.e. products made from crude oil. Explain to the class that crude oil is found deep underground and was formed over millions of years. To access the oil, companies drill down under the earth or sea, pump it to the surface and send it by pipeline to oil refineries where it is separated into different parts and used for many different things.

The children are asked to discuss what other things oil is used for, e.g. to make plastic products, for lubrication, to burn for heat and to make electricity.

Explain to the class that all of this type of oil will be used up at some time in the future; i.e. it is not renewable.

Introduce the email from the company (Activity sheet 2). The email thanks the children for their help, as requested in the initial letter. The email goes on to ask for help with some further investigations.

The focus of this activity is on the extraction of the oils, i.e. the company wants you to find out if oil can be separated or 'extracted' from a selection of seeds and nuts and then explore and compare the oil content obtained.

Show the class the bottles of oils and ask the children to look carefully at the appearance of the oils and the labels, paying close attention to the names, photographs, pictures, ingredients and other information provided on the label. Can they now suggest which seeds the oils have been extracted from? Explain that oils that are extracted from seeds and nuts are from renewable sources.

Next, show children some examples of different seed and nut crops, and ask them to match the oils to their seeds and explain their choices.

Note: Children may suggest that vegetable oils come from a vegetable source e.g. carrot or cabbage. Explain that vegetable oil is made from a blend of seed oils including rapeseed and sunflower oils.

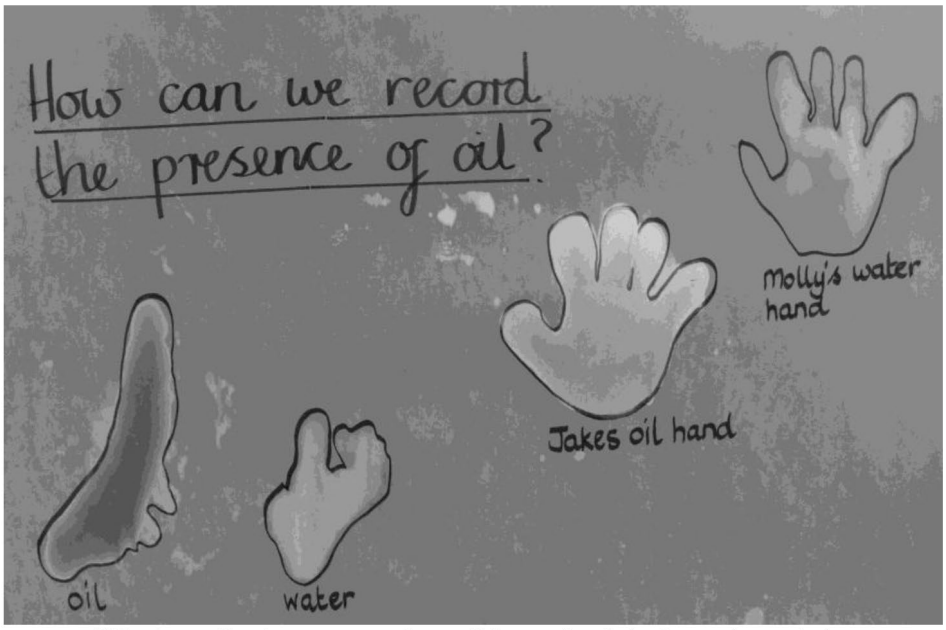
MAIN ACTIVITY

The children explore methods for separating or 'extracting' oil from the seeds and nuts and compare the oils obtained.

Begin by demonstrating how to show the presence of oil by smearing a small amount of vegetable oil across a piece of filter or sugar paper. The children should note that the paper is translucent when held up to the light. Smear a similar amount of water next to the oil and then display the sample on a window pane.

Ask the children what they think will happen when the paper dries. They may think that both samples will evaporate if left to dry. However, they will find that the oil can still be seen after the water evaporates.

Allow time for children to explore the translucency of other oils in comparison with water and make further window displays. Children can display and photograph oil and water hand prints on paper towels in the window.



Window display comparing oil based prints to water prints.

Ask the children how they think they can extract the oil from a seed, e.g. sesame or sunflower seed. Establish that the oil can be obtained by crushing the seed to leave an oily residue.

The children can use a wide range of resources, and request additional items. They can explore their own extraction ideas, or use those provided below if needed:

- Place a measured quantity of seeds/nuts on filter/sugar paper and crush with a rolling pin. This needs some force as larger nuts are more difficult to break down. A small plastic bag reduces the amount of mess created and collects the crushed material for display or to record results.
- Place the seeds/nuts into a mortar and crush with a pestle. Smear the crushed material onto a piece of filter/sugar paper. However, the results are not as clear as when crushed directly onto paper. Try using the mortar to crush the seed directly onto the paper.
- The seeds/nuts can be crushed in a mortar and then a small amount of water added and the mixture crushed again. The resulting mixture can then be filtered through filter paper and left to dry. Leave the paper overnight to allow remaining water to evaporate. This is a lengthy procedure.

Evidence can be displayed as oil marks beside relevant crushed and whole seeds/nuts. They could also be displayed in order of the amount of oil extracted. This makes a very effective window display.

PLENARY

Children share their findings with each other and discuss the merits and the weaknesses of the various methods they have used to extract oil. Encourage the children to talk about the quantity of oil extracted in each case, as well as the difficulty or ease with which each method was carried out. Children can begin to discuss how they think industry might extract oils from seeds.

Extension: Design a machine to carry out the extraction of seed/nut oils on a large scale. How would the machine be powered? How will the oil be collected?

BACKGROUND INFORMATION

A number of fruits yield oil from their flesh and these are exploited commercially for oil production, e.g. olives and avocados. Demonstration of the oil content of fruits is much more challenging. Olives are stored in brine, and therefore can be messy and it is difficult to get clear results.

Oils are extracted commercially by using a variety of techniques including drying the seed then crushing before extracting or boiling the seeds in water and then separating the oil from the water. Some of these techniques are not suitable for the classroom.

Oilseed rape is now the third most important crop in the UK after barley and wheat. It is very useful to us because the seed contains a lot of oil which is commonly used in many food products, e.g. cooking oil and margarine. Some parts of the oil can also be used in a range of cosmetic and cleaning products too. More recently, rapeseed oil has been used in the making of biodiesel for powering motor vehicles. The seeds from the plant contain the oil. The rest of the plant can be used as biofuel.

From: Susan Carlton [scarlton@persind.com]
Sent: 28 April 13:34
To: Science Consultants
Subject: Renewables

Dear Science Consultants,

Thank you for the information you have sent us so far. We have already started to make some important changes on site.

We are now thinking of other ways to make our company more environmentally friendly and we thought we might be able to use seed or nut oil as one of the ingredients in our products, rather than oils made from crude oil.

As we have no experience in extracting oil from seeds and nuts, we hoped you could investigate this process on our behalf and tell us how much oil different seeds and nuts produce.

We have also been told that we may be able to use any excess seed or nut oil in other ways that you may be able to investigate; could we

- burn any excess oil we make but don't use in our products?
- lubricate machines with seed or nut oil instead of using refined crude oil?

We look forward to hearing from you with your recommendations.

Kind Regards,

Susan Carlton

Susan Carlton
Environmental Manager

4. Separating oil and water

1 hours

Methods of separating a mixture of oil and water are investigated.

OBJECTIVES

- Use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating (Y5 Properties and changes of materials)
- Planning different types of scientific enquiries to answer questions

RESOURCES

Per group of 4

- Small transparent plastic bottle (approx. 200-400 ml) containing equal amounts of water and a coloured oil, e.g. corn oil
- A range of separating equipment such as:
- Clean, empty, plastic sauce bottle with one way valve, e.g. shower gel, tomato sauce
- Clean, empty, transparent, plastic detergent bottle Funnel
- Tubing
- Flexible plastic drinking straw
- Small transparent pump action dispenser bottle Plastic cups
- 2-3 plastic pipettes
- Syringes
- Digiblue movie creator or similar software

Safety note

Be careful not to include nut oils if involving children with nut related intolerance or allergies.

INTRODUCING THE ACTIVITY

Explain that, in industry, oil is often extracted from plants and seeds by boiling them in water after they have been crushed. Show the class a transparent plastic bottle with equal volumes of oil and water, explaining that it is similar to that produced from an industrial extraction. Ask them what will happen when you shake the container? Following the discussion, give each group their own bottle of oil and water to observe, shake, keep stationery, shake again, etc.

MAIN ACTIVITY

Once the children's observations have been discussed, and possibly drawn or photographed, the groups are challenged to create a 'separator' to collect both the oil and water separately.

Demonstrate that the oil can be poured off the top of the water but as the amount of oil reduces, it gets very difficult to complete the separation.

The focus of this activity is exploration, rather than planning, measuring, recording, etc. Each group is given the full selection of equipment, and given plenty of exploration time to try different methods. Possible methods include:

- Removing oil from the surface of the water with a pipette.
- Pouring the mixture into a funnel where the flow of liquid is controlled by either a finger or a blu-tac/plasticine stopper.
- Putting the mixture in a sauce bottle with a one-way valve.
- Putting the mixture into a syringe and gently emptying.
- Adding to a pump dispenser.
- Creating a unique piece of equipment.

Note: To prevent spillage of the oil and water working in shallow trays will help contain the liquids.

PLENARY

Each group demonstrates their preferred method to the rest of the class, and explain what makes it superior to the other methods they have tried. Each group could video-record their demonstration to play to the rest of the class.

5. Oil as a fuel

1.5 hours

Children use a variety of oils as fuels and compare results to find the best fuel.

OBJECTIVES

- Use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating (Y5 Properties and changes of materials)
- Planning different types of scientific enquiries to answer questions

RESOURCES

Per class

- Safety lighter

Per group of 4

- Activity sheets 2-3
- Tidy tray containing sand
- Heating stand (available from TTS)
- 2 small metal containers e.g. individual foil cake cases, empty tea light candle cases, metal screw cap lids (bottle lid)
- 1 sample per group of a selection of cooking oils e.g. corn oil, groundnut (peanut) oil, almond oil, rapeseed oil, sunflower oil, sesame oil, olive oil, vegetable oil.
- Candle wick (available from craft stores) or cotton string and plasticine
- Thermometer
- Timer
- Tweezers
- Data logger (optional)

INTRODUCING THE ACTIVITY

Read the email from the company (Activity sheet 2). With ideas from the class, create a list of examples of oils being used as fuels, e.g. heating our homes, schools and offices, fuel for transport etc, energy for industrial sites and steel making.

MAIN ACTIVITY

The planning and design of this investigation has been provided, due to the heath and safety aspects that need to be considered. The children can discuss the elements of fair testing, controlling variables, what to change, and what to measure. The development of children's measurement skills provides the investigative focus. Activity sheet 3 provides a table for them to record their results if required.

Each group collects their equipment to test one of the oil samples, and carries out the test, setting up the equipment as shown in the photograph:

Photograph showing an oil burner heating water on a heating stand. The sand tray provides a safe area for this kind of activity.

Note: To establish whether the oil is needed to keep the flame alight, a small piece of wick can be lit in the foil tray before adding the oil. The wick could also be placed in a non-flammable liquid (water) to show that the flame does not then stay alight.

The following is an example of how to carry out the activity.

1. Place a wick in the metal container and secure it with plasticine. Add a measured amount of oil to the container. Make sure the plasticine is below the oil's surface.
2. Fill a second metal container with a measured amount of water and place it on top of the heating stand. Measure the temperature of the water and record it. Light the wick in the lower container and start the timer.
   Note: If the wick has fallen into the oil, use tweezers to hold up a section prior to lighting.
3. After a set period of time (typically 5 minutes), record the temperature of the water and compare it to the start temperature to find the difference.
4. Extinguish the oil burner and leave it to cool before clearing away.

Extension: The temperature can be taken at regular intervals over a specific time period. The data can then be used to produce a graph illustrating the rise in temperature for each oil. Alternatively a data logger with a heat sensor probe can be used to produce a graph illustrating the increase in temperature.

PLENARY

All the groups' data are collated and compared. The children suggest which oil would be the best to use as a fuel and why (the maximum temperature change per unit mass of water). Some discussion of where the crop is grown, the necessary energy investment and how much the crop costs to produce can be introduced here. An email can be created, with attachments showing the experimental design and resulting tables/graphs. A willing governor or other adult may be prepared to receive the data and respond.

BACKGROUND INFORMATION

The best application for each type of oil depends on its properties. For example an ideal lubricant would not burn and would be in-volatile whereas a fuel oil would burn easily and be volatile.

Oils also have different freezing/melting points which can make them difficult to use in certain circumstances. Palm oil, grown in tropical climates, can be solid at room temperature in Britain which means it could be difficult to use during our winter. Oils from other crops may have similar properties but have a lower freezing point. A table of softening (melting) and boiling points can be found in Appendix 3.

Diesel oil used in vehicles was once susceptible to freezing in winter months. In some cold climates fuel tanks have an independent heating system to warm fuel. Improved refining methods have been able to remove more impurities from the oil lowering the freezing temperature. The impurities were fractions of oil that became solid at temperatures just below 0˚C.

Activity Sheet 3: Oil as a Fuel

Comments						
Temperature after _____ minutes (°C)						
Temperature at the start (°C)						
Oil type						

6. Oil as a lubricant

1 hour

The children are challenged to find out which oil would be the best lubricant.

OBJECTIVES

- Identify the effects of air resistance, water resistance and friction, that act between moving surfaces (Y5 Forces)
- 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

- Activity sheets 2 and 4
- A range of oils and fats, e.g. corn oil, groundnut (peanut) oil, almond oil, rapeseed oil, sunflower oil, sesame oil, olive oil, vegetable oil.
- Depending on the investigative methods chosen, some of: Ramp
- Foil
- Margarine tub filled with dried peas or marbles
- Timer
- Detergent and paper towels
- 3 Elastic bands and force meter (1-10N scale)
- Metre stick/long ruler

Safety note

Be careful not to include nut oils if involving children with nut related intolerance or allergies.

INTRODUCING THE ACTIVITY

Reread the e-mail from the company (Activity sheet 2).

Ask the class "What is a lubricant?". Discuss occasions when they have used oil as lubricants, or seen others using them, e.g. oiling a squeaky hinge, oiling a bicycle chain, etc. What does the oil do in each of these examples? Children's understanding of lubricants may be expressed in terms of reducing noise, rubbing, grinding, and friction. You may wish to link to literacy and create a class description of lubricant, e.g. "A type of liquid that is spread over two touching surfaces to help them move freely over each other and therefore reduce the friction."

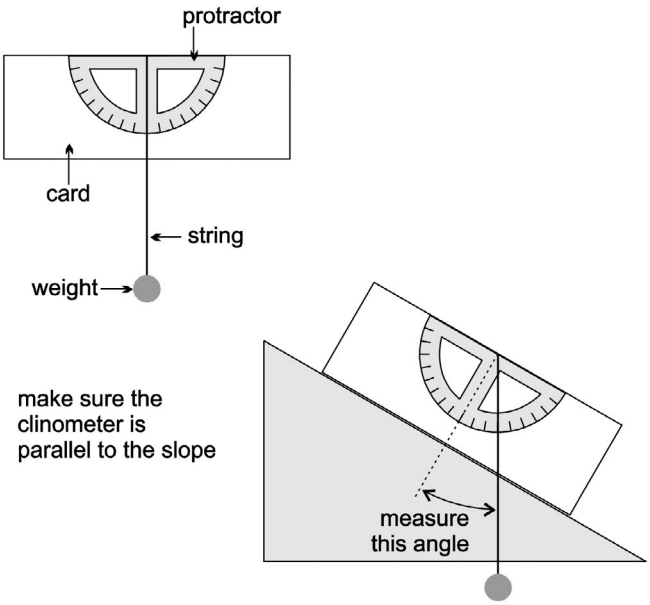
MAIN ACTIVITY

The children can design an investigation to find the best lubricant, or use one of the methods below, depending on the investigative focus of the lesson.

Method One

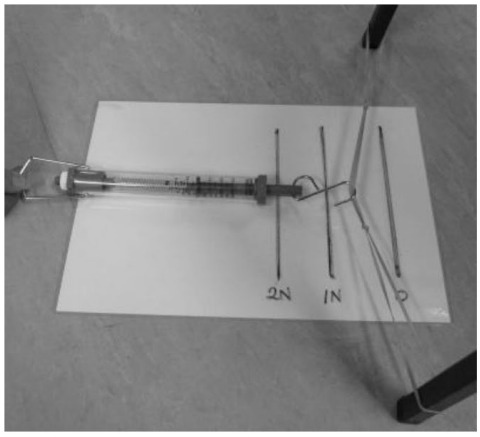
1. Cover a board with foil or use a non-stick baking tray and smear with oil.
2. Fill a margarine tub with the marbles or dried peas to add weight.
3. Smear the base of the margarine tub with the same oil.
4. Place the margarine tub on the end of the board and slowly lift until the tub starts to slide.
5. Either measure the height of the end of the board or the angle that the board makes with the floor when the tub starts to slide. Take repeat readings and calculate an average for each oil under test.
6. Clean and dry the base of the tub and the foil thoroughly before testing the next oil.
7. Tabulate results (Activity sheet 4) and represent them graphically to report back to the company.

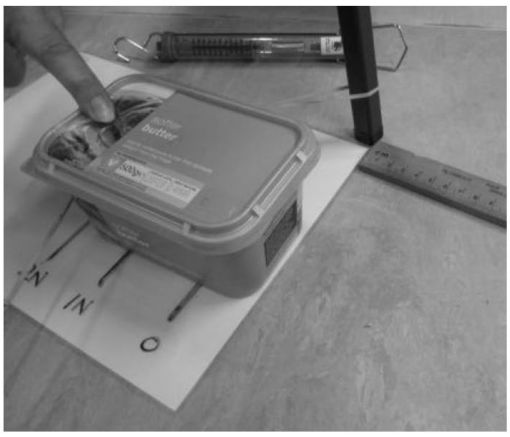
Extension: Children make a clinometer to measure the angle.



Method Two

Using an elastic band launcher along the board or across a table. The force can be controlled by making a scale for the launcher using a force meter, and marking lines for each 1 or 2N. The tub is then pulled back a designated force each time.





Method Three

Use a ramp at a set angle and measure the time taken for the tub to travel a fixed distance down the ramp.

PLENARY

The class share the results and conclusions they have drawn from the investigation. Discuss which of the oils would be the best lubricant for the machinery and why. What are the advantages and disadvantages of using vegetable oils or petrochemical oils, e.g. vegetable oils come from a sustainable source and decompose more easily but may smell strongly. Petrochemical oils are a finite resource which are being used faster than they can be made, they have to be processed and refined before they can be used, and they decompose more slowly.

This is also an opportunity to evaluate the success of the different investigative methods.

Extension: Children can investigate the effect of heat on a lubricant (the viscosity of the oil will change). Does this make a difference to the efficiency of the lubricant?

7. Focus on vocabulary

N/A

Intended for use throughout Activities 1-6; suggestions are made for motivating the children to develop their use of relevant scientific vocabulary.

OBJECTIVES

- Pupils should use relevant scientific language and illustrations to discuss, communicate and justify their scientific ideas

INTRODUCTION

The following activities can be used as stand alone activities, as lesson starters or be used as part of any of the activities in this resource. It is important to identify vocabulary to be used during the activities and to make sure that children are familiar with the words and can use them in the correct context.

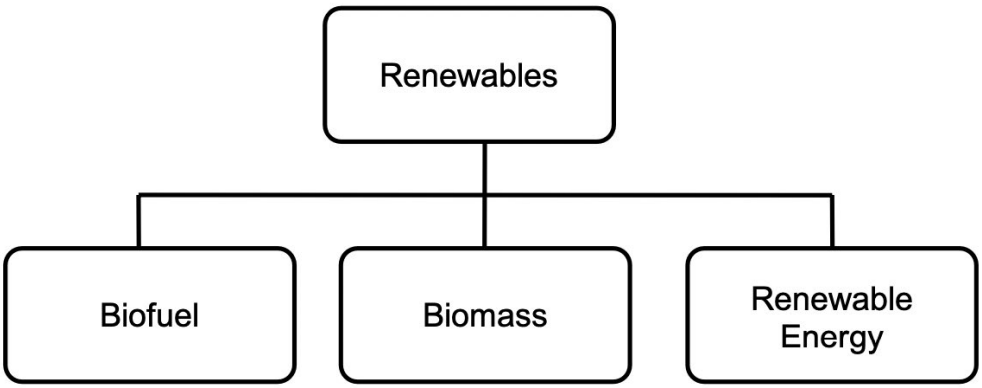
The children need to be aware that some scientific words have everyday meanings as well as scientific meanings. Reinforcement of these terms is important to ensure correct usage.

There are many different ways to develop literacy in science: the ideas below are suggestions and are not the only strategies that can be used. You may be able to think of many more providing the children with a varied and stimulating experience.

WORD BANKS DISPLAYS, AND MOBILES

Creating word banks and displays around the classroom will increase the correct use of vocabulary. By reminding the children to use the targeted words during investigations, the vocabulary will be reinforced.

Word mobiles can be produced in ways which will create links with their meanings and associated words. The words cascade from the topic down through related areas to possible vocabulary.



ILLUSTRATED WORDS

Ask the children to find ways of illustrating words that demonstrates their meaning, e.g.

WORD SHIRTS

The children bring a plain white shirt to school at the start of the year. They choose an area of the shirt, e.g. right front or a sleeve, to group words relating to a specific topic and they are written on the shirt in permanent ink. The shirts are worn for science practical work. The children are allowed to add a word to their shirts when they can demonstrate to the teacher that they understand what the word means. By the end of the year, each shirt should be a colourful array of scientific vocabulary!

SPLAT

This is a game to identify word meanings. Each group has a number of words each written on post-it notes. Around the classroom are posters containing the definitions. At a signal one member of each group takes a word and 'splats' it on the definition poster. The group can agree on the definition before the group member leaves. Each child takes it in turn to 'splat' the word. The winning team will have posted all their words the quickest.

'TABOO'

A group of children are given a set of cards which are placed face down in the middle of the group. Each child takes it in turn to take the top card. On each card there is a word which the child has to describe to the rest of the group. There are also 'taboo' words indicated on the card which cannot be used in the description. The rest of the group have to guess the word from the description.

DEFINITION DOMINOES

A set of cards, which are similar to a set of dominoes, are used in this game. On one end of the card there is a description of a word whilst on the other end is a word. The children have to match up the words and meanings by placing them down on the table, matching the cards until all the cards have been put down.

LOOP CARD GAME

This is a similar idea to definition dominoes. In this game, all the descriptions and words follow on from each other so they form a loop. Although the cards follow a specific order, the loop can be started anywhere. The first child reads out the definition, the child who has the word described on their card calls it out and then reads out the definition for the next word. When the game is first introduced the children can link the words to their meanings at their own pace. Once the group is accustomed to playing the game, it could be timed. The group could be given a specific time to complete or could try to beat their previous time. See Appendix 4 for a set of cards to be used for this game.

SPINNER GAME

A spinner is used to choose a strategy to describe a word chosen from the word bank. This strategy is then used by one child while the other children try to identify the word. See Appendix 5 for an example of a spinner. Alternatively a die can be made using the different strategies on the different faces.

CONNECT 4

This is a game for two players or two groups. The children start by drawing a grid on a white board; this can be either a 4x4 or a 5x5 grid. The children suggest a word from the scientific vocabulary they have been using in their work and if they can correctly explain the meaning they can write it into one of the grid squares. Two colours are used so the two sides can identify their own words. The aim of the game is to connect 4 words together in a row, column or diagonal. Grids and word cards could be made up ready for the children to use if there is certain vocabulary the teacher wants to cover. The words and meanings contained in Appendix 4 could be used for this activity.

WORD COMPLETION EXERCISES

This includes activities such as crosswords and word searches. There are many software packages available to produce these.

SCIENCE DICTIONARY

Once the children can confidently use a set of vocabulary, they can include it in their own science dictionary. A blank exercise book is divided into letters of the alphabet, e.g. 2-3 pages for 'A' and 1 page for 'XYZ'. When a child is confident of a word's meaning, he/she adds the word along with its definition, examples of use, and illustrations. This dictionary can then be used to identify areas which have been learned and understood.

Appendix 1: Sourcing dried sunflowers

Dried sunflower head bird feeders can be purchased from some garden centres or via the internet from sites such as www.franceshilary.com

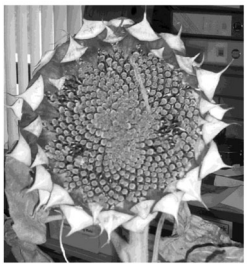
Drying Sunflowers

Outlined below are two different ways to dry sunflowers. Harvest the sunflowers when their heads become brown and dry and most of the leaves have fallen off the stem (the plant will look wilted).

Method 1 – In the garden

The first method is to dry the head and the stem naturally. When the back of the flower's head turns yellow and the petals have fallen off, cover it with a brown paper bag. This prevents the seeds falling to the ground and it will also protect it from birds, squirrels and other animals. The bag allows the plant to 'breathe' and prevents moisture from building up which could cause the seeds to becoming mouldy. If it rains and the bag becomes soggy, it may need replacing. If just the flower head is needed it can be removed from the plant once the head has turned brown about 30cm down the stem, making sure the bag does not fall off in the process. If the whole plant is required, the plant can be removed from the garden at this stage and stored somewhere dry.

Method 2 – Drying indoors



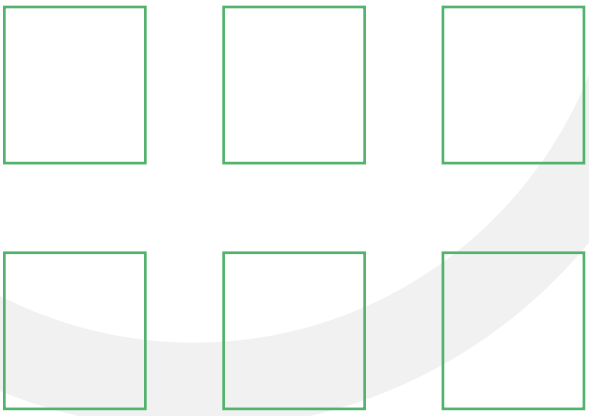
The sunflower head can be dried away from the plant if there is a strong risk of losing the seeds to wildlife. When the flower head starts to yellow and the petals have died away, harvest the head approximately 30cm down the stem. The head can be dried in any location which is warm, dry and has good ventilation to prevent the seed head becoming mouldy. As with the natural method, a brown bag can be placed over the seed head to prevent losing any seeds, and will protect against wildlife attack.

Further information regarding sunflowers can be obtained from www.sunflowerguide.com

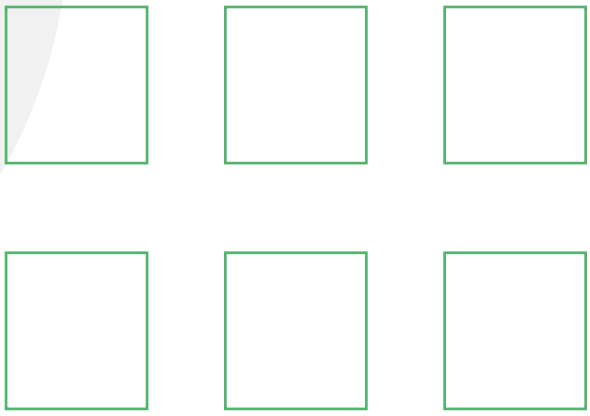
Appendix 2: Planning

We are investigating.....

We could change



We could measure/observe



We will change

We will measure/observe

Our investigation question is.....

We will keep these the same...

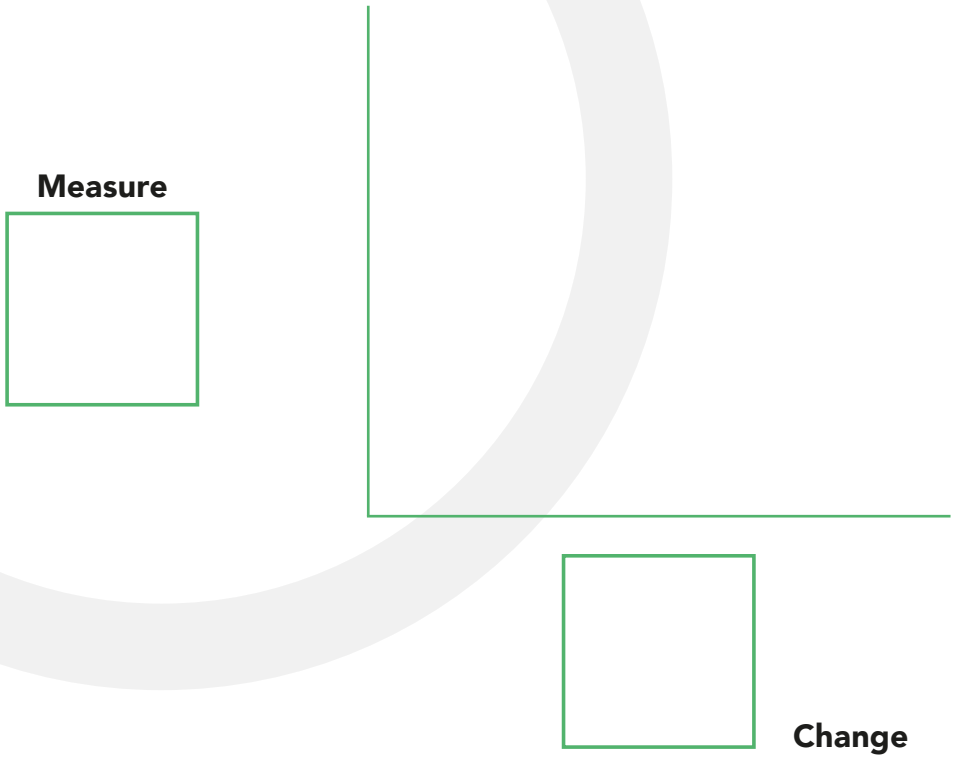
When we change

What will happen to...?

Why?

APPENDIX 2: OBTAINING EVIDENCE

Change	Measure/observe



When we changed . . .	What happened to . . .

Was our prediction correct?

How could we improve what we did?

Appendix 3: The effect of temperature change on oils and fats

The following table lists the softening (melting) and boiling points for commonly used oils and fats. It is not a definitive list and there may be slight variances depending on the purity of the oil. Because of the impurities, the change to a liquid takes place over a temperature range when the solid will soften.

Oil	Softening (melting) point ˚C	Boiling point ˚C
Linseed (Flax seed)	-24	316
Olive	-6	191
Peanut	3	227
Rapeseed	-10	200
Sunflower	-17	230
Palm Kernel	24	350
Palm	35	n/a
Grapeseed	10	230
Coconut	25	177
Hempseed	-8	166
Corn	-20	246
Sesame	-6	216
Lard	33	n/a
Butter	35	n/a

Palm oil, lard and butter do not have a specific boiling point. These fats are likely to break down before they change to a gas state. Oils and fats are the same chemical composition but they are described as fats when solid at room temperature.

Appendix 4: Game cards for dominoes and loop game

Organic material which can be used to produce energy.	**Liquid**
A state of matter. It can be poured and take on the shape of the container.	**Evaporation**
The process of change from a liquid into a gas.	**Melting**

The process of changing a solid to a liquid.	**Biofuels**
A source of fuels which comes from plants or animals.	**Fuel**
A source of energy, e.g. wood, gas, coal.	**Volume**

The space taken up by a substance.	**Burning**
To be in flames, a change that is irreversible which involves fuel, oxygen and a flame.	**Heating**
The process of increasing the temperature of an object.	**Reversible change**

A change that can be easily reversed e.g. freezing water to make ice.	**Irreversible change**
A change that cannot easily be reversed e.g. burning.	**Renewable energy**
A source of energy that does not involve the burning of fossil fuels and won't run out.	**Weight**

The downward force on an object caused by gravity.	**Friction**
A force affecting movement between two materials.	**Lubrication**
The method to reduce the friction between two surfaces.	**Filtration**

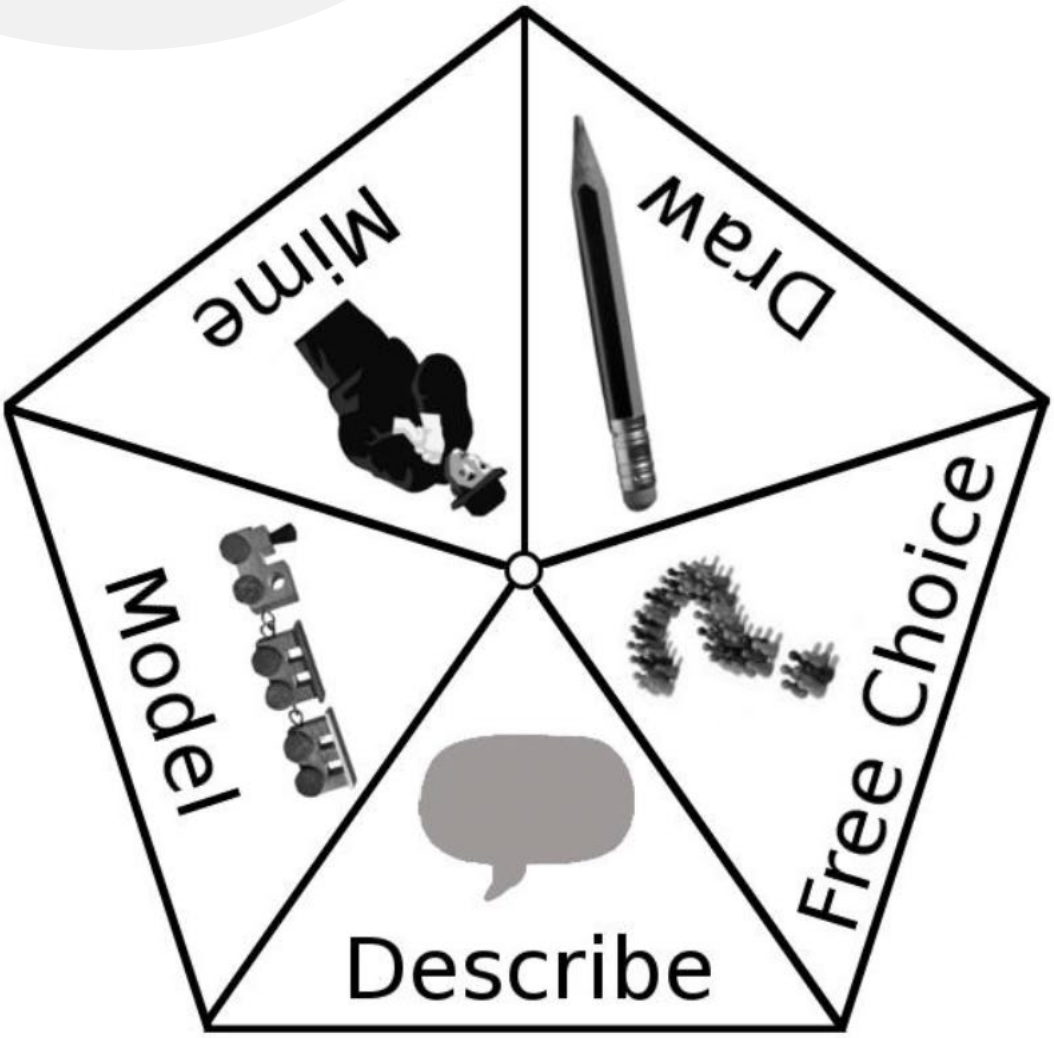
The process of separating a solid from a liquid.	**Biomass**

Game card solutions and glossary

Organic material which can be used to produce energy.	Biomass
A state of matter. It can be poured and take on the shape of the container.	Liquid
The process of change from a liquid into a gas.	Evaporation
The process of changing a solid to a liquid.	Melting
A source of fuels which comes from plants or animals.	Biofuels
A source of energy, e.g. wood, gas, coal.	Fuel
The space taken up by a substance.	Volume
To be in flames, a change that is irreversible which involves fuel, oxygen and a flame.	Burning
The process of increasing the temperature of an object.	Heating
A change that can be easily reversed e.g. freezing water to make ice.	Reversible change
A change that cannot easily be reversed e.g. burning.	Irreversible changes
A source of energy that does not involve the burning of fossil fuels and won't run out.	Renewable energy
The downward force on an object caused by gravity.	Weight
A force affecting movement between two materials.	Friction
The method to reduce the friction between two surfaces.	Lubrication
The process of separating a solid from a liquid.	Filtration

Appendix 5: Spinner

- Cut out the spinner and paste on to a piece of card. Place a paper clip to the centre of spinner.
- Put the point of a pencil in the middle of the spinner through the paper clip.
- Spin the paper clip round.
- Where the paper clip stops indicates how the word should be represented.



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The unit was funded by the Gatsby Charitable Foundation.

First Published 2009

Revised 2021

ISBN: 978 1 85342 5943

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Editor – Joy Parvin, Gayle Pook

Design by Abdullah and Design Solutions.