What on Earth?

A British Science Association activity pack for National Science and Engineering Week

For more information on National Science and Engineering Week or for further activity packs, please visit **www.nsew.org.uk**

National Science and Engineering Week is funded by the Department for Business Innovation and Skills

This 'What on Earth?' activity pack has been developed for **National Science and Engineering Week 2010**. It is intended to be a potential source of ideas for school or home activities. All activities are related to the theme in 2010 - 'Earth'. This is a broad theme and can include many topics in a wide variety of science and engineering subjects, for example, weather, gravity, plants, movement, energy and soil.

CREST ★ Awards

If you are using these activities for children and would like these to be accredited, all activities within this pack can count towards a CREST★ Investigator award. For details of this award scheme, please visit www.britishscienceassociation.org/ccaf. There are 3 Star and 4 SuperStar activities in the pack.

For the CREST Star activities (aimed at 5-7 year olds) children discuss, solve problems and share experiences. In CREST SuperStar activities (aimed at 7-11 year olds) children work independently, discuss ideas and how to test them, solve simple problems and decide how to share results.

The pack is split into two sections one with the 3 CREST Star accredited activities, one with the 4 CREST SuperStar accredited activities; indicated by the logos on those activity pages.

Star SuperStar

How to use this pack

For each activity in this pack, there is a page which can be handed out to the children, if appropriate, or used by the teacher/supervisor to guide them through the activity. For each activity there are also pages specifically for teachers/supervising adults; these pages contain background information, a list of the materials needed and any extra resources. Some activities take a while to set up and some take more than a week to complete. Also one is weather dependent. Make sure you read the activity pack well in advance of National Science and Engineering Week (12-21 March 2010) in order to ensure the activities can be done during that time if possible.

General information on how to use the pack:

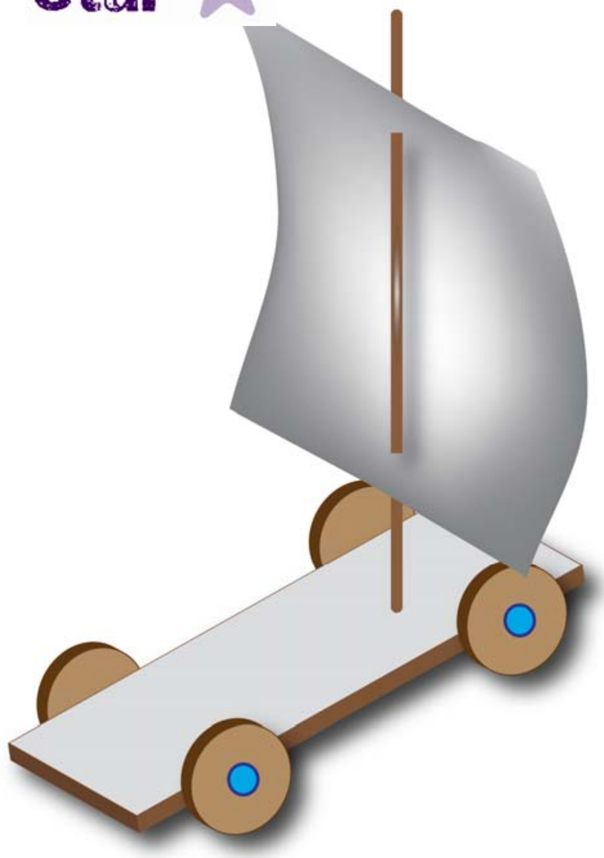
1. First familiarise yourself with the activity.
2. Check the resources list and make sure you make time to prepare anything you need. See the background information on each activity.
3. Make sure the children understand their task. You can give them the page describing their activity or use it to describe the task to them directly.
4. Give the children time to think about the activity. The idea is that they look at the problem and come up with potential solutions themselves. You can help with suggestions and tips.
5. Give them the equipment needed to do the activity.
6. Encourage them to discuss the results and why they saw what they did.

What on Earth – is weather?

The weather on our Earth is amazing and always changing. We get rain, snow, wind, sun, clouds, fog and everything in between! This activity is about one important aspect of the weather - wind.

Winds occur on Earth at different times, speeds and directions. Wind is a very useful aspect of the weather. We can use it to generate energy and travel great distances.

Imagine you are an engineer. You want to design some new sails for a land yacht and use the wind to travel across the country. You don't yet know what shape or size to use and so you are going to test this (your teacher/supervisor will give you some hints and tips).



Talk about:

- What is wind?
- How do you think sails work?
- What size and shape of sail would you like to make?
- What are you going to measure to test how well your sails work?

Here are some ideas to get you started:

Your teacher or supervisor will help by giving you some ideas. Once you have decided which sail you want to make, you can grab the materials and build it. When you are ready, and with help from your teacher/ supervisor, you can fix your sails to the land yacht base they have already provided for you.

How far and fast will your land yacht go? How will you measure this?

Sharing your ideas:

What results did you get? Which team's land yacht sailed the best? Why do you think this is?

Congratulations
You have completed a 'What on Earth' Challenge.

Here are some extra challenges:

When engineers design new things, many of their designs fail and they have to try again. You should try to improve on your last sail design. What do you think you could improve? Have another go and try to design a better one using what you have learnt!

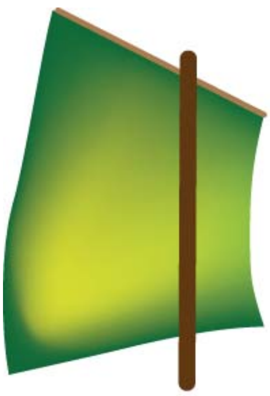
Organiser's notes

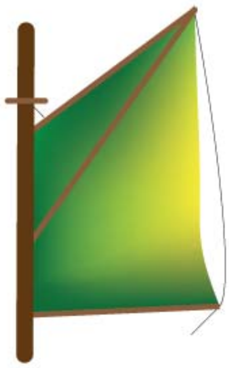
Suggested method:

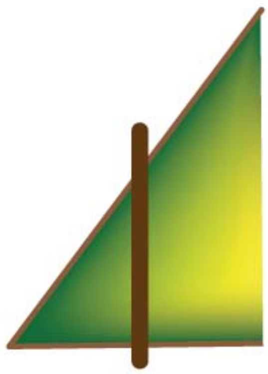
First talk about sailing and how boats and sail powered buggies work. How does the wind power these? Did you know that sails where first invented by people in the Middle East around 2,000 BC? They wanted to travel further on their boats and so they invented the sail.

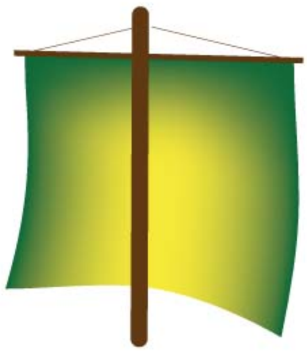
Land yachts like the one the children will be building convert the energy from the wind to movement. Like other early sailing ships the simple square sails can only sail downwind (with the wind).

You need to let the children use their imagination to think about what size and shape they want their sail to be. Ask them why they have chosen to do what they have. Below are some pictures of some basic sail shapes, which can be used as examples to get them started, but they can be as imaginative as they like – it doesn't matter if it fails. They should learn what works and what doesn't in the process. You can also add to the activity by geting them to think about what materials they should use. Have a wide selection of materials available (some less suitable than others).

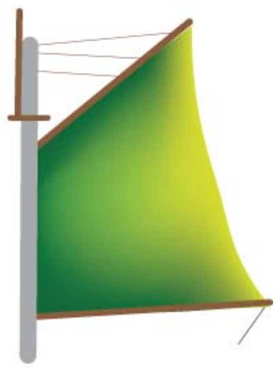

Lug sail


Spritsail


lateen sail


Square Sail

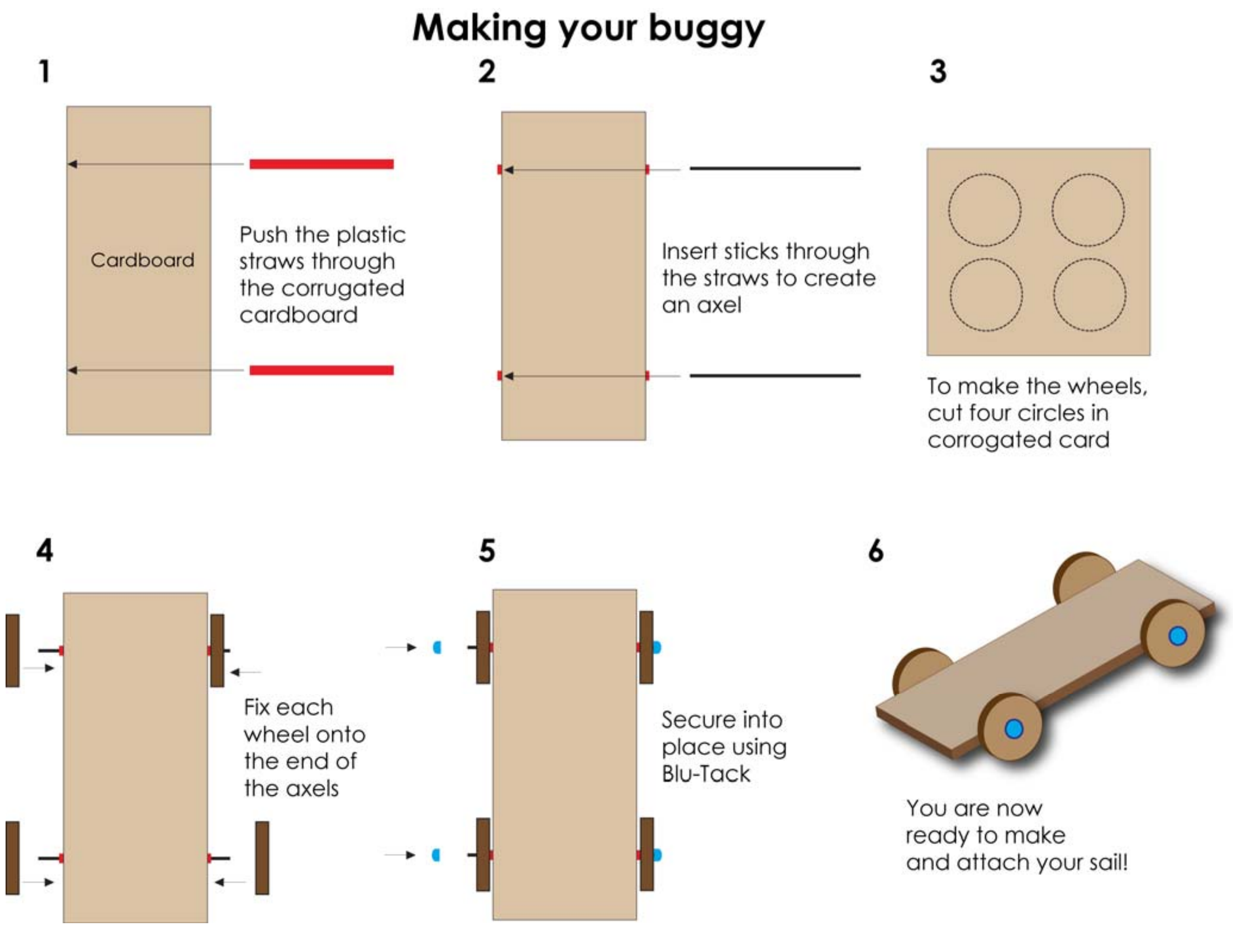

Bermuda Sail


Gaff Sail

You can either get the children to design a method of fixing the mast to the land yacht or you can standardise this and do it for them. Ideally the mast needs to be light, flexible and at a suitable height. To fix it to the base you can use modelling clay but this may not be strong enough to hold the mast in a 'bit of a blow'. We recommend using a piece of plastic tubing from a construction kit and attaching this to the base with a wood screw.

One other essential feature is rigging. It is ideal to have some mechanism that will stop the sail turning on the mast. You can again let the children first discover that for themselves or standardise it by providing the mast for them to attach their sail designs to.

To make it as fair a test as you can, make sure the buggy used is the same design for each group. Only the sail made by the children should vary. If the buggy is a different design then it will not be as fair. The buggy should be light weight, strong, stable and with wheels that turn easily. Alternatively you could get the children to attach their sails to a model boat (also stable and well built so that the boat does not disadvantage their designs). When testing the different sail designs, choose an area with a flat smooth surface so that the buggy can move across the surface easily. To create some wind you may want to use a hairdryer. For safety make sure you the teacher or supervisor uses this.



Advanced background information:

The Earth is unevenly heated by the sun, such that the poles receive less energy from the sun than the equator. This means that some areas of the Earth heat up more quickly than others. This heating effect causes wind by creating a global atmospheric convection system reaching from the Earth's surface to the stratosphere which acts as a virtual ceiling. Most of the energy stored in these wind movements can be found at high altitudes where continuous wind speeds of over 160 km/h (100 mph) occur.

Land sailing, also known as sand yachting or land yachting, is the act of moving across land in a wheeled vehicle powered by wind through the use of a sail. Recently the stunning 'Greenbird' Land Yacht shattered the world speed record for a vehicle powered solely by wind. Richard Jenkins, the designer and driver, brought the Greenbird up to speeds of 126.1 miles per hour on a desert cruise. He sailed past the previous record of 116 miles per hour.

Suggested materials:

- Corrugated cardboard
- Straws
- BBQ Skewers/wooden sticks.
- Blue tac
- Hairdryer (to be used by adult)
- Light weight flexible mast and rigging securely fitted to the base. Suggest this is similar for each group
- A range of materials (some more suitable for sails than others)
- Scissors

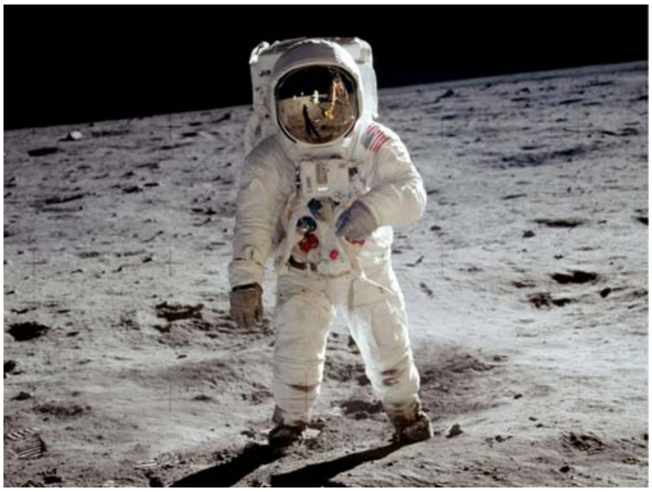
Developing the activity:

When engineers design new things, many of their designs fail and they have to try again. Get each team to try and improve on their last sail design. What have they learnt? What does this tell them they need to improve? Can they have another go and design a better one?

Do you want to build a proper model Land Yacht? There are many organisations and enthusiasts out there who can supply instructions on how to build proper models. For example you can get the instructions to build a land yacht here http://www.cornwallmodelboats.co.uk/acatalog/mar3009.html. You could build this to impress the children after they have tested their own sails. Maybe the winning group could win this as a prize or at least help build it?!

What on Earth – is gravity?

Gravity on Earth stops us from floating off into space. It also makes us the weight we are. How much do you weigh? You are this weight because of gravity on planet Earth. Your home planet!



Imagine you are an astronaut in the future. You are going to visit all the nine planets in our solar system; Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto.

You know that when you visit each planet your weight will change but you don't know by how much. How can you find out? (Your teacher or supervisor will help you).

Talk about:

- Have you heard of gravity before?
- Did you know that astronauts weigh more on Earth than they do on the moon?

Here are some ideas to get you started:

Your teacher or supervisor will tell you what the gravity on each of the planets is (on some it is stronger than on Earth and on others it is weaker). They will also show you how to calculate how your weight will change. Your challenge is to get your calculations right!

Congratulations
You have completed a 'What on Earth' Challenge.

Here are some extra challenges:

Do you know what doesn't change from planet to planet? Do you know what mass means?

Organiser's notes

Background:

What does heavy mean? It's the amount of 'pull' that the Earth, or any other planet you happen to be standing on, exerts on your body. The amount of pull between two objects is called gravity. While your mass (the amount of 'stuff' you are made from) stays the same wherever you are, your weight changes. As Jupiter is the largest planet in the solar system, you would feel heaviest if you could stand on Jupiter.

Suggested method:

Get the children to brainstorm about gravity. What does it mean to them? What do they think it is? It is quite a difficult science to understand but by doing this mathematic challenge this may help the children visualise how gravity can change. Although the specific concepts of gravity, mass and weight are not introduced until KS3 science, you can keep this activity simple and just introduce the concept that weight changes on different planets (astronauts weigh less on the moon).

You should introduce the children to this simple mathematical equation:

$$\frac{\text{Gravity on planet}}{\text{Gravity on Earth}} \times \text{Weight of an object on Earth} = \text{Weight of an object on the planet}$$

They need to use this equation to figure out the weight of an object on each planet in our solar system. First get them to discuss this equation – do they understand it. How will it help them figure out the weight of something on another planet? What information do they need to use it?

You can give them the gravity on each planet. This is listed below:

Mercury	3.7
Venus	8.9
Earth	9.8
Mars	3.7
Jupiter	23.1
Saturn	9.0
Uranus	8.7
Neptune	11.0
Pluto	0.7

You need to give them a water bottle as the 'object' and fill it with either water or sand or both. Get the children to measure the weight of this water bottle on Earth. Now they have this weight, get the children to use the information in the table to calculate how heavy the water bottle should be on other planets. It is simple maths but you can give them tips if they need help.

Once they have worked out how heavy the water bottle should be in each planet they need to get the 8 other empty water bottles and fill them with sand/water to the right weights. You should end up with 9 water bottles each a certain weight for each planet. The children should pick up each of the water bottles and realise how much effect gravity has.

Suggested materials:

- 9 water bottles
- Materials to decorate the bottles?

Developing the activity:

You could get the children to decorate the water bottles making them into astronauts. Each water bottle represents the weight of the same astronaut when he lands on each planet. You can get the children to feel the difference between the weight of each of the astronauts.

What on Earth... are plants?

Plants are living things which get their energy from sunlight. Do you know that humans first started growing plants for food a long time ago in prehistoric times (around 10,000 years ago)! Before that we didn't know how to plant things. We hunted and gathered food.

Imagine you are a prehistoric man or woman and you are learning to grow food for the very first time. You have found some seeds and have decided to try and grow them. You have seen plants growing in the wild, but you have never grown your own plant before and don't really know how to do it.

What do you think plants need? (Your teacher/supervisor will give you some hints and tips)

Talk about:

1. What do you think are all the different things plants need?
2. Can you think of ways to test out your ideas?

Here are some ideas to get you started:

Your teacher will give you some germinated seeds to use in your experiment.

How are you going to find out what plants need? What ideas will you test? (Your teacher/supervisor will help you)

Now you can start to test out your ideas.

Sharing your ideas:

What results did you get?
What does this tell you? Were you right?

Congratulations
You have completed a 'What on Earth' Challenge.

Here are some extra challenges:

Can you now look after plants better? Why don't you take the healthy seedlings home and keep looking after them until they are adult plants. Do you think you can remember how to look after them? Can you make them grow strong and tall?

Organiser's notes

This is a long term activity and will continue over a longer period than National Science and Engineering Week. It may take several weeks to grow plants from seed. However it will not only let children test out their ideas but will also teach them how to dedicate time each day to looking after growing things.

Suggested seeds to use – sunflowers.

The sunflower is a big beautiful flower and also a great vegetable; healthy, nutritious and attractive. People grow sunflowers in their gardens for their lovely flowers and to attract birds. Sunflowers are also grown for their seeds which are high in protein and to make cooking oil. Sunflower seeds are big and easy to handle and require minimal attention.

Suggested method:

Make the children think about what plants need. Can they think of anything? What have they missed? Try and get them to brainstorm and come up with all the eight things listed below. With your help they should then think about potential ways to test whether their ideas are right. For example, they may suggest that plants need sunlight. Get them to think about how they can test this. Are they really right? How will they prove it? You can give them some hints and tips, and guide them when necessary.

You may want to organise the children into groups and get them to focus on testing the first three things on the list below (i.e. light, water and room to grow). These are the easiest to test in the classroom or at home.

The sunflower seeds first need to be germinated before the experiment can begin. Three/four weeks before this activity you should germinate some sunflower seeds. Some seeds may fail to germinate so make sure you plant more than you need. You could do this as a class if you want to:

1. Use 7.5cm (3inch) pots (yoghurt pots would be ideal) and a good sowing compost.
2. Plant one seed per pot – about one inch deep. Add some water to the pot. Keep the soil in the pots moist, but not soggy, by watering when necessary and using drainable pots.
3. Cover with polythene to retain the heat and put in a bright place
4. Remove the cover when leaves appear
5. Re-pot in much larger containers when the plants are one or two inches high.

Each group or child (depending on how you want to organise it) should have 2 or 3 germinated sunflower seeds to work with. It may be the most practical to get each group to choose what to test; either light, water or room to grow. Note: For each tested condition, all the other variables have to be constant. For example, when testing sunlight – all the seedlings should receive everything else they require i.e. water, plenty of room to grow, suitable temperatures, no disease etc. This makes it a fair test. When working with three seedlings here is a suggested method for each:

- To test sunlight, put one seedling in complete darkness (in a cupboard), one away from direct sunlight in a dull area of the classroom and one seedling in bright area where it will get plenty of direct sunlight.

- To test water, you should vary how much water the three seedlings get. One the ideal amount of water (the soil is always moist to touch and is never allowed to dry out – use well drained pots to avoid over watering), one gets water but less than the ideal (say only watered a little), and the last seedling gets no water at all.
- To test room to grow, give the three seedlings variable amount of room. One has plenty of room and is planted in a large pot, one is planted in a small sized pot and one has a tiny pot with hardly any or no soil.

Students should observe and measure their plants every few days, recording their measurements. They should record the differences between their own plants. After 1-2 weeks you can get students to discuss their findings and the findings of other groups.

Background information:

All plants need these eight things to grow well, they are listed below:

Room to grow: All plants like to have room to grow. The above ground portions of the plant need space so leaves can expand and carry out the job of making food. Roots also need room to grow. Plants growing in small spaces will have their roots crowded, and that results in smaller amounts of growth.

Temperature: Most plants like temperatures that most humans like. Some may like warmer temperatures while others may prefer cooler temperatures for best growth. It is always good to know where plants come from so you can make them feel at home. Most plants like to have cooler temperatures at night and don't like to be in a drafty spot.

Light: Plants grown indoors like bright light. Windows facing the south or west have the best light. Try to place the plants close to the window to take advantage of all the light. The further away from the window, the darker it becomes. A plant will tell you when it isn't getting enough light, because its stems will be thin and it will lean toward the light.

Water: Water is important in the plant's ability to make and move nutrients. Without water or with too much water, a plant dies. For this reason, watering is an important part of plant care. Most plants like to be watered when the soil is slightly dry to the touch. When watering, moisten the soil by using enough water so that it starts to come out of the hole in the bottom of the container. (This is why it is important to use containers with drainage holes.) How often you water depends on a lot of things. Plant size, time of the year, and type of plant are a few. Your best guide, though, is to feel the soil. If you stick your finger one inch into the soil and it is dry, then water your plant.

Air: Plants use carbon dioxide in the air and return oxygen. Smoke, gases, and other air pollutants can damage plants

Nutrients: Most of the nutrients a plant needs are dissolved in water and then taken up by its roots. Fertilizers will help to keep the soil supplied with nutrients a plant needs. Don't apply too much too often. Fertilizer won't solve all of your plant problems, so make sure your plants have good light, good soil, and good drainage. The three most important nutrients are nitrogen, phosphorous, and potassium. Nitrogen is used for above ground growth. This is what gives plants a dark green colour. Phosphorous helps plant cell division. It aids in flower and seed production and in the development of a strong root system. Potassium helps fight off disease and aids the growth of strong stems.

Time: It takes time to grow and care for plants. Some plants require more time to grow than others. Getting plants to flower or fruit at a certain time can be challenging. Plants that normally grow outdoors need a certain number of days to flower or fruit. You can time plants to flower or fruit on a certain date. This is a good lesson in both plant science and maths.

Lack of disease or pests/over grazing: As with all living things plants suffer from disease. In almost all cases of infection, the health and growth of the plant is affected and in some cases the plant can die. Many creatures, from tiny insects to large animals feed on plants. If too much of the plant is eaten then it will not survive.

Suggested materials:

1) Seeds – this could be anything but sunflowers are fun and easy to measure.
2) Suitable pots
3) Tape measure

Developing the activity:

You could make this into a sunflower competition. This is a great activity for children. It will mean they get to use the information they have discovered in this activity. Sunflowers are good for growing competitions as they grow so tall and fast, have impressive sized flowers and are easy to look after compared with other plants.

What on Earth – is movement?

There is lots of movement on our Earth. To move, things need energy. Rockets are one of the most impressive things that move, launching themselves right out into space.

Imagine you are an engineer and your job is to help build a rocket. As part of your job you have been asked to improve the fins of one of NASA's model rockets. (Engineers use models to help them test and build the real thing!)

With help from your teacher or supervisor you can build you own model water rocket and use this to test out different fins to see which work best.

You need to get your teacher or supervisor to show you how to launch it and you will need to follow the safety instructions.

Talk about:

1. What do you think the rocket fins do?
2. What materials will be good to make rocket fins? For example, do the materials need to be light or heavy, strong or easily breakable, waterproof or absorbent? Your teacher/supervisor will provide a selection of materials for you to use.
3. What shapes do you think the fins should be? Decide on your favourite design.

Here are some ideas to get you started:

You must decide what materials you will use for the fins and their shape. You need to have four fins on your rocket. Each fin also needs to be exactly the same so that the rocket is symmetrical. This helps it fly through the air.

Once you have decided what materials you are using for your fins and what shape they should be, you can make your water rocket – and don't forget to give it a name!

How will you test how well your fins work? What do you think you will measure when you launch your rocket?

Now get ready to fly your water rockets in a safe place! (Your teacher/supervisor will do this)

Congratulations
You have completed a 'What on Earth' Challenge.

Here are some extra challenges:

When engineers design and test new things, many of their designs fail and they have to try again. You should try to improve on your last rocket fin design. What do you think you could improve? Have another go and try to design a better one using what you have learnt!

Organiser's notes

Safety

Warning:
Water Rocketeering is potentially dangerous. Any individuals following the instructions below do so at their own risk.

Safety

1. Make sure that you use a very large open space to test the rockets. It is important to keep a safe distance (~10 meters) away from the launch pad and to have a large space free of people in front of the launch pad (around 50 meters squared). Be aware that water rockets can travel really impressive distances, reaching 30 or 40 metres. As the children will be designing the fins of the rockets, this may also make the rockets fly a little wonky (although less likely when they are symmetrical). Therefore to avoid people being hit by rockets, it's very important to have plenty of room.

2. Do NOT use 2 litre bottles that have contained still water or juice. Make sure you use FIZZY drinks bottles. These bottles are designed to withstand the high pressure needed for the rockets.

3. Launching a rocket straight up in the air can increase the chance of people being hit. This is because the rocket may go straight down and land on people's heads. The easiest way to safely launch your water rocket is to launch it at an angle away from the crowd. Use a launch pad.

Suggested method

A water rocket is just an upside down fizzy drinks bottle. Added to this is a 'nose' cone and some fins. The job of the nose cone is to make the fizzy drinks bottle more aerodynamic. The fins ensure that the rocket flies smoothly and this is what the children will design and test.

Instructions for building the rocket:

Materials:

- A two litre fizzy drinks bottle for the main body of the rocket. Make sure it's a FIZZY drink bottle – a bottle that contained still drinks will NOT be strong enough. DO NOT USE IT!
- A tennis ball for the nose cone
- Some different materials for the children to choose from for the fins. Include corrugated cardboard and corrugated plastic in their choices (these tend to work well).
- Strong tape to hold it all together
- Scissors (under adult supervision)

Instructions:

Each team of children will choose the material they use for the fins and the shape of them. All other variables other than the fins will remain the same for each rocket.

1. Make sure the fizzy drink bottle is empty, clear of stickers and clean.
2. The nose cone needs to be slightly pointed and provide a little bit of weight towards the front of the rocket. You can achieve these aims by taping a tennis ball to the end of the bottle.
3. Attach the fins as designed by the children with strong tape. Make sure there are four fins and that they are attached in a symmetrical way. Make sure any sharp edges are taped

up if the children have used potentially sharp materials. They need to be reasonably firmly attached to prevent them being ripped off during launch. They will almost certainly be damaged on landing but then they will not be too hard to repair if you want to do another run.

4. Decorate each rocket and give it a team name!

Instructions for building the launcher (to be done by an adult)

Launchers are much more complicated to build than the rockets and so an adult with suitable DIY experience needs to build the launcher. You must build the launcher and safety test it before the children get involved and build their rockets. There are various different methods available – we suggest using the method suggested by the National Physical Laboratory in their Water Rocket Challenge guide (see http://www.npl.co.uk/educate-explore/water-rocket-challenge/). If you would like more information on different launcher designs – go to the various websites listed under 'Developing the activity'.

You can also buy the launcher and equipment to make water rockets if you can not build your own launcher. See the example website: http://www.mutr.co.uk

Background:

Requirements for the fins:

1. Whatever fin design the children go with, they should make four fins and they should be the same as each other
2. The fins should be positioned towards the back of the rocket
3. They should be arranged symmetrically around the rocket (every 90° if you have four)
4. They should be thin when viewed 'head on'
5. Any shape and material can be used. Have a selection available for the children to use.

Developing the activity:

In the US, building water rockets is very popular. There is a website dedicated to water rockets for schools. This is full of very useful information and advice. Click here http://www.water-rockets.com for more information.

If the rockets worked well (or even if they didn't), why not take part in the annual Water Rocket Challenge organised by the National Physical Laboratory. It usually happens July each year. For more information go to http://www.npl.co.uk/educate-explore/water-rocket-challenge/. There is a much more detailed pack of information available on this website than is given here.

Also take a look at the world record holders - www.gottalaunch.com

What on Earth – is energy?

Each day, the sun bathes the Earth in very large amounts of solar energy. At the Earth's surface this energy is absorbed and can be converted into heat.

Imagine you are a scientist and have been asked to help build and test a solar cooker. Solar cookers are very useful across the world – they allow people to cook in an environmentally friendly way and for free!

Can you cook an egg just using the power of the sun? To do this you need to help build and test a solar energy cooker.

Talk about:

What is solar energy?
How do you think the solar cooker might work?
Do you think you can cook an egg?
What might stop you?

Here are some ideas to get you started:

Your teacher or supervisor will help you build a solar cooker. Your aim is to try and cook an egg and measure the temperature your solar cooker reaches. How high a temperature can you get?

You need to think about the following:

1. Where will you put your cooker? Your teacher or supervisor will suggest safe places to put your cooker. You need to find somewhere as sunny and draft free as possible.
2. What direction will you face your solar cooker?
3. When will you begin your test? In the morning, at midday or in the afternoon?

Your teacher will supply you with a thermometer so you can see how hot the cooker becomes. Be careful not to touch the cooker when hot. Your teacher/supervisor will handle the cooker at all times.

If you reach high enough temperatures you should be able to cook food – but this will depend on the weather so don't worry if you don't succeed. You can have another go on a sunnier day!

Did you manage to cook an egg? What temperature did your solar cooker get to?

Congratulations
You have completed a 'What on Earth' Challenge.

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Here are some extra challenges:

What happens when you paint the foil cake tin different colours? Does using white or coloured paint make the cooker more or less efficient?

Organiser's notes

Safety

Warning:
Using solar energy is potentially dangerous. Any individuals following the instructions below do so at their own risk.

Make sure the children do not touch the cooker when it's hot!

Background:

A solar cooker uses sunlight as its energy source. They use no fuel and they cost nothing to run. This means that humanitarian organisations across the world are promoting their use to help slow deforestation and desertification caused by using wood as fuel for cooking.

Solar cookers do three things which together create temperatures sufficient for cooking:

1. Concentrate sunlight. This is usually done by using a mirror or some type of reflective metal. The light and heat from the sun is concentrated into a small cooking area, making the energy more potent.
2. Convert light to heat. Any black on the inside of a solar cooker improves the effectiveness of turning light into heat. A black pan absorbs almost all of the sun's light and turns it into heat.
3. Traps heat. Isolating the air inside the cooker from the air outside makes an important difference. Using a clear lid, like a plastic bag or a glass cover, will allow light to enter, but once inside the light is absorbed and converted to heat. This makes it possible to reach similar temperatures on cold and windy days as on hot days.

Facts about solar cookers:

1. Solar cookers should be turned towards the sun. It will take a longer period of time to cook food in a solar cooker than an oven or over a fire. People who use solar cookers will leave them for hours until the food is cooked.
2. Unlike cooking on a stove or over a fire, food in a solar cooker is generally not stirred or turned over, both because it is unnecessary and because opening the solar cooker allows the trapped heat to escape and thereby slows the cooking process.
3. People will check solar ovens and turn them to face the sun more precisely over the day. They also check to ensure that shadows from nearby buildings or plants have not blocked the sunlight.
4. How long food takes to cook in solar ovens depends primarily on the equipment being used, the amount of sunlight at the time, and the quantity of food that needs to be cooked. Air temperature, wind, and latitude also affects performance.
5. Food cooks faster in the two hours before and after the local solar noon than it does in either the early morning or the late afternoon.
6. Larger quantities of food, and food in larger pieces, take longer to cook.
7. It is difficult to burn food in a solar cooker. Food that has been cooked even an hour longer than necessary is usually indistinguishable from minimally cooked food.
8. For most foods, such as rice, the typical person would be unable to tell how it was cooked from looking at the final product. There are some differences, however: Bread and cakes brown on their tops instead of on bottom. Compared to cooking over a fire, the food does not have a smoky flavour.
9. If solar cookers reach 100 degrees C, they can be used for heating foods. If they get to temperatures of 175 degrees or higher, you can use it for baking. Make sure the children do not get to close to the solar oven or touch it while it is hot!

The aim of this activity is to test how high a temperature can be produced in a solar cooker on any given day and whether it is high enough to cook an egg. Get the children to leave the egg and the solar cooker for at least one hour (but longer if possible). Ideally the solar cooker should be placed somewhere safe, where it's directed towards the sun and will not be blown over, rained on or tripped over etc.

After ~ one hour the children can return and record the temperature in the solar oven by reading the thermometer (at a safe distance). You (as supervisor) can then remove the eggs and crack them to see if they have cooked and to what degree.

The success of this exercise will depend largely on the weather. The UK climate is not ideal so do not let the children feel disappointed if their egg did not cook. We suggest building the solar cooker with the children and then making them wait to do the experiment on the sunniest day over that week. They can choose the day as a class to do the test. Show them how to read or listen to the weather forecasts and get them to decide as a class which day to use their solar ovens. Tell them the UK has a colder climate than most countries and so only small temperature rises may occur in their solar ovens but it may be possible to cook an egg if they are lucky!

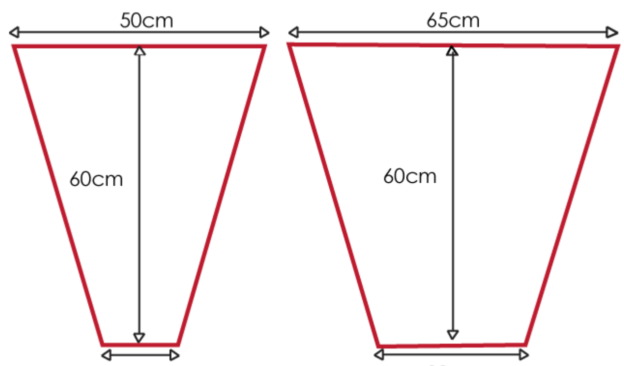
Suggested method:

Making the solar energy cooker:

Tools and Materials

- Corrugated cardboard (large flat sheets)
- Duct tape
- Black paint, white paint, one other colour – maybe red.
- Glue
- Plastic container, approximately 500 ml
- Oven thermometer
- Aluminum foil (45.7 cm by 7.6 m roll)
- 3 large aluminum foil cake tin (15 cm by 30 cm by 8 cm deep)
- 1 large (turkey-sized) transparent oven bag
- Shredded paper (for insulation)
- Cardboard box (with flaps, approximately 25 cm by 35 cm by 16 cm deep)
- Plastic spoon
- Utility knife
- Meter stick or metric tape measure
- Felt tip marker
- Sunglasses
- Paint brush
- Oven gloves

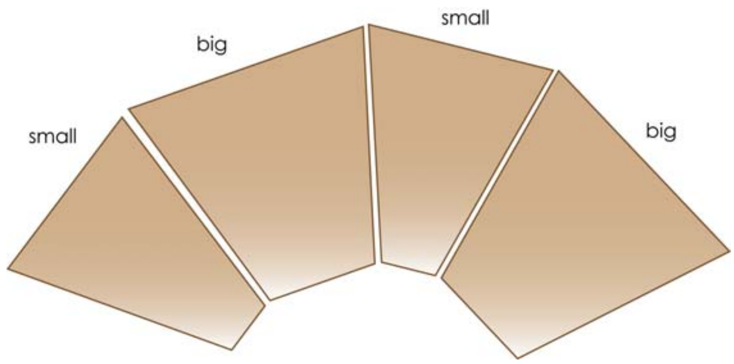
Solar Oven Reflector Plan



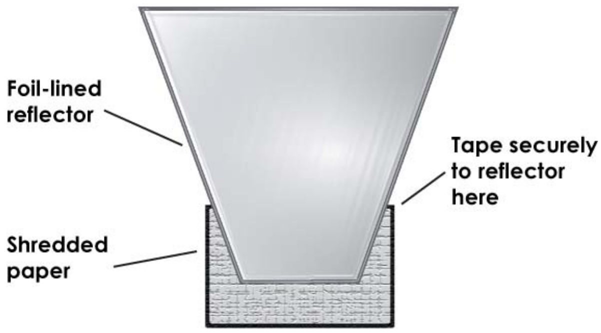
Cut two of each of these panels

You will need a large tabletop to work on. It is very helpful to have a sink nearby for cleaning up.

- Draw the outlines of the reflector segments on your cardboard. Use the measurements above.
- Cut out the 4 cardboard segments.
- Measure out enough aluminium foil to cover each section. If the cardboard is wider than the foil, use two pieces of foil and plan to join them near the middle.
- Using the paintbrush, apply a thin layer of white glue over the entire surface of the cardboard and glue down the aluminium. Keep the foil as smooth and flat as possible. Wrinkles and creases in the foil will reduce the efficiency of the reflector.
- Trim the foil so that it is flush with the edge of the cardboard sections. Set the panels aside to dry.



- Arrange the segments as shown, foil side down, wide sections alternating with narrow ones.
- Join the panels to each other with strips of duct tape over the joint between the panels. Press it onto the joint, being sure it sticks securely to both panels over its full length.
- Flip the joined panels over on the table. This may require two people. Reinforce the joint between each panel using another strip of duct tape.
- Stand your reflector up (foil side in), bringing the edges of the outer two panels together. Have someone hold the reflector in position while you add the last piece of duct tape.



- Using duct tape, fasten the cardboard box securely to the bottom of the reflector by its flaps.
- Shred some newspaper by tearing it lengthwise into thin strips. Stuff shredded paper into the gaps between the box and the reflector. Leave a little of the paper on the bottom of the box, as shown in the illustration.

- Apply black paint evenly over the inside of an aluminium foil loaf tin. Set this aside to dry. It may be necessary to apply two coats of the paint to ensure full coverage of the aluminium.

Developing the activity:

Solar cookers are used in developing countries to provide environmentally friendly and free means of preparing food and making water safe. One organisation involved with their promotion is Solar Cookers International. See their website http://solarcookers.org/.

You could use this example as a means to introduce to the children the importance of solar energy and how we are using it across the world.

This activity has been adapted from re-energy.ca website where there are many other fantastic activities to choose from. Go to www.re-energy.ca

What on Earth... is soil?

One of the most important natural resources on the Earth is soil. Most life on Earth depends upon the soil for food as plants obtain nutrients from it and many animals then eat the plants.

Farmers have a very important job growing the food for the world. If we did not have farmers, we would have to grow all of our own food. Farmers must take good care of soil so that they can grow enough food to feed everyone. To do this, farmers need to know what type of soil they have. Did you know there are different soil types?

Imagine you are a farmer. Your important challenge is to find out the type of soil you have been given. How are you going to find this out? What tests do you need to do? (Your teacher will give you some hints and tips)

Talk about:

1. What different types of soil can you think of?
2. What makes them different from each other? Think about the following characteristics:
    a. How do different soil types feel? Slimy and sticky or dry and grainy? (Texture)
    b. Is it lumpy or smooth? Are there lots of different sized bits? (Particle size)
    c. Are all soils the same colour?
    d. If you pour water on it how fast does the water disappear through the soil? (Porosity)
3. Test each of these differences and from the results find out your soil type. Your teacher/supervisor will help you.

Here are some ideas to get you started:

Your teacher/supervisor will help you collect some sample soils for you to test and compare.

Now you can start to test your soils.

Sharing your ideas:

What results did you get?
What types of soil do you think you have?

Congratulations
You have completed a 'What on Earth' Challenge.

Here are some extra challenges:

In addition to type, soil has another characteristic called pH. Have you heard of this before? This is a measurement of whether something is acid, neutral or alkaline. Farmers need to know the pH of their soil in order to make sure their crops are healthy. How do farmers test pH? Do you have any ideas? Your teacher/supervisor can help show you.

Organiser's notes

Ideal method:

Make the children think about different soils. What is different about them? Why do they think soil is important? Do they understand why farmers need to test their soils? Try and get them to brainstorm about different soil types. Have different soil types collected and in pots to help prompt them. For example they may immediately see the difference between sandy and peaty soils but not clearly see differences such as porosity, texture, particle and colour. You could choose to introduce these words by demonstrating what they mean.

Once they understand how different soils vary get them to brainstorm how they could test what soil they have in their 'mystery pot'. This should be a pot of soil you have hidden until now. From what they have learnt can they identify the soil in this pot? Get them to brainstorm ideas about how to test this soil and give them tips.

The ideal method of testing each characteristic is below:

Porosity:
Water an area of soil with a watering can. Surface water disappears quickly on sandy or gravelly soils, but remains on the surface for longer on clay soils.

Texture:
Take a handful of soil and gently squeeze. If it feels slimy and sticky when you release the pressure the lump stays in shape - it is clay soil. Sandy or gravelly soils feel gritty and the lump crumbles apart. Peaty soil feels spongy. Loamy and silt feel smooth and retain their shape for longer than sandy soil, but not as rigidly as clay.

Particle size:
Add half a handful of soil to a large glass jar. Fill with water. Stir well. Leave to settle for two hours. Sandy/gravelly: Most of the sandy particles sink and form a layer at the bottom and the water looks fairly clear. Clay/silty - the water is cloudy with a thin layer of particles at the bottom. The tiny clay particles take ages to settle. Peaty - lots of bits floating on the top, the water is a bit cloudy and there's a small amount of sediment sitting at the bottom. Chalky: there are white gritty fragments at the bottom and the water is pale greyish in colour. Loamy: fairly clear water with a layered sedimentation at the bottom with finest particles at the top.

Colour:
The colour of the soil can help suggest the soil type. For example very sandy soils are likely to be lighter in colour, chalky soils will have a grey appearance or have visual flecks of white where the chalk is visible, peaty soils with a high percentage of organic matter will be very dark. However alone this is not enough to conclude your soil type as the colour mostly depends on the amount of organic matter in the soil.

Example method for testing acidity:

You may want to extend this activity and introduce the children to pH. To do this you may want to show them how to test the pH of their mystery pot. Do they know what pH is?

Usually if your area has soft water you have acid soil, if you have hard water (there is always scum around the bath) the local soil is alkaline. However, to be sure you need a soil test kit (available cheaply from all good garden centres) some de-ionised water and a soil sample.

1) Dig several 'soil cores' from various beds
2) Discard the top 3cm of soil then mix it all together

3) Dry on a radiator
4) Follow the test kit instructions

Advanced background information:

Soil is made up of four parts: air, water, minerals, and organic material. Air and water provide nutrients to plants so they can make food for themselves. Organic matter, also known as humus, is made of plant and animal remains in various stages of decay. Minerals are the clay, sand, and silt particles. The mineral content determines the soil type.

- Sandy soil has mostly sand and no organic matter. Sand is the largest of the soil particles, feels gritty, is the heaviest, and allows water and air to move easily through it.
- Clay soil has mostly clay, a little organic matter, and sand. Clay particles are very fine and are the smallest of the three soil particles. Clay is sticky when wet and hard and brick-like when dry.
- Silt is the soil particle that falls between sand and clay in texture. It is considered a medium-sized soil particle.

In addition to type, soil has another characteristic called pH. This is a measurement of whether it is acid, neutral or alkaline. The normal pH of British soils is between 4.0-8.5. Acid or 'ericaceous' soils have a pH between 1-7, for example peaty soils. Neutral soils have a pH of exactly 7, for example some clay soils. Alkaline or 'limey' soils have a pH between 7-14, for example chalk soil.

The pH of soil has a huge influence on what plants will grow. Most plants prefer a pH range of 6.5-7. This is the point where nutrients are most easily available. Some need acid soil, for example most rhododendrons, or an alkaline soil, for example saxifrages.

Suggested materials:

1) Different soil samples
2) Water
3) Soil pH test kit (optional)

Developing the activity:

You may want to develop this activity further. There are many resources for schools out there connected with planting, organic farming and healthy food. For example;

1) The Woodland Trust is giving away a free pack of 30 native trees (enough for a small grove or short length of hedge) to all schools which come with guidance on planting and maintenance plus curriculum-linked activities. There is more information on their website www.treeforall.org.uk
2) The Department for Children, Schools and Families has a Growing Schools website which has been designed to support teachers in using the "outdoor classroom" as a resource across the curriculum for pupils of all ages. www.growingschools.org.uk.
3) Think Food and Farming is the exciting legacy project building on the successes of the Year of Food and Farming. It will promote healthy living by offering children and young people direct experience of the countryside, farming and food through growing and cooking activities, and visits to farms. There is a large amount of information and links to resources on this website. www.thinkfoodandfarming.org.uk

What on Earth… are fossils?

Fossilised remains of creatures from the past are buried all over the world. From complete skeletons of huge carnivorous dinosaurs to sharks teeth in your very own back garden, fossils give us clues about what life was like on Planet Earth millions of years ago.

Palaeontologists have a very important job unearthing fossilised remains and carefully inspecting what they see to tell us how creatures evolved on Earth, and even how we as humans came to be. To do this they need to piece together the remains to build a complete skeleton, but sometimes incomplete fossils mean they need to base their recreations on what they already know from the past.

Imagine you are a paleantologist and you are given a bag of bones to piece together. Can you solve the mystery and predict what this animal was?

Talk about:

1. How fossils are made
2. Why might palaentologists get an incomplete set of bones to piece together?
3. What sort of creature do you think you are piecing together?

Here are some ideas to get you started:

Your teacher will show you some pictures of fossilised skeletons that have already been identified using the process of science. Does your skeleton resemble anything you can see there?

Talk about:

1. What you already know about skeletons to decide what bones go where
2. How you can build a more accurate picture of the skeleton based on other creatures from the past
3. Do you need to use all the bones in the bag – are some from other creatures?

Sharing your ideas:

What skeleton did you piece together?
How different is it to other skeletons in the class?
What creature do you think it is?

Congratulations
You have completed a 'What on Earth' Challenge.

Here are some extra challenges:
We have skeletons just like dinosaurs did. Look at pictures of the skeletons of different dinosaurs and think about what they might have eaten. Some dinosaurs were carnivores while others were herbivores. Can you tell which is which?

Organisers notes

This is a short activity that can be used to demonstrate the scientific method and evidence-based learning – scientists have to know how to ask questions before they can answer them.

The aim is to get the children to think about fitting evidence in with what is already known, and starting to think about discarding certain pieces of evidence if they don't fit. It will give them the understanding that there is often more than one solution to a problem and that science is not about right answers.

Ideally, the activity can be done in pairs or small groups so each group can feed back to the rest of the class about what they have created.

Method:
Talk to the class about fossils, why fossils are important to palaeontologists, and how they can build up a more accurate picture of evidence as they collect more data.

Tell them to imagine that they are palaeontologists who have to reconstruct the skeleton of an animal. Give each pair a bag of bones (from worksheet) and ask them to piece them together into the type of creature they think it might be.

When they have finished ask them to present their construction to the rest of the class, and they will see that other pairs have created different creatures – this shows that there is more than one interpretation for the way that a skeleton can be constructed.

You could encourage the group to discuss what factors have led to their interpretation – are there bones missing? Are all the bones in the bag from the same dinosaur? This particular dinosaur is an Iguanodon, which has been subject to lots of different interpretations over time.

Suggested materials:

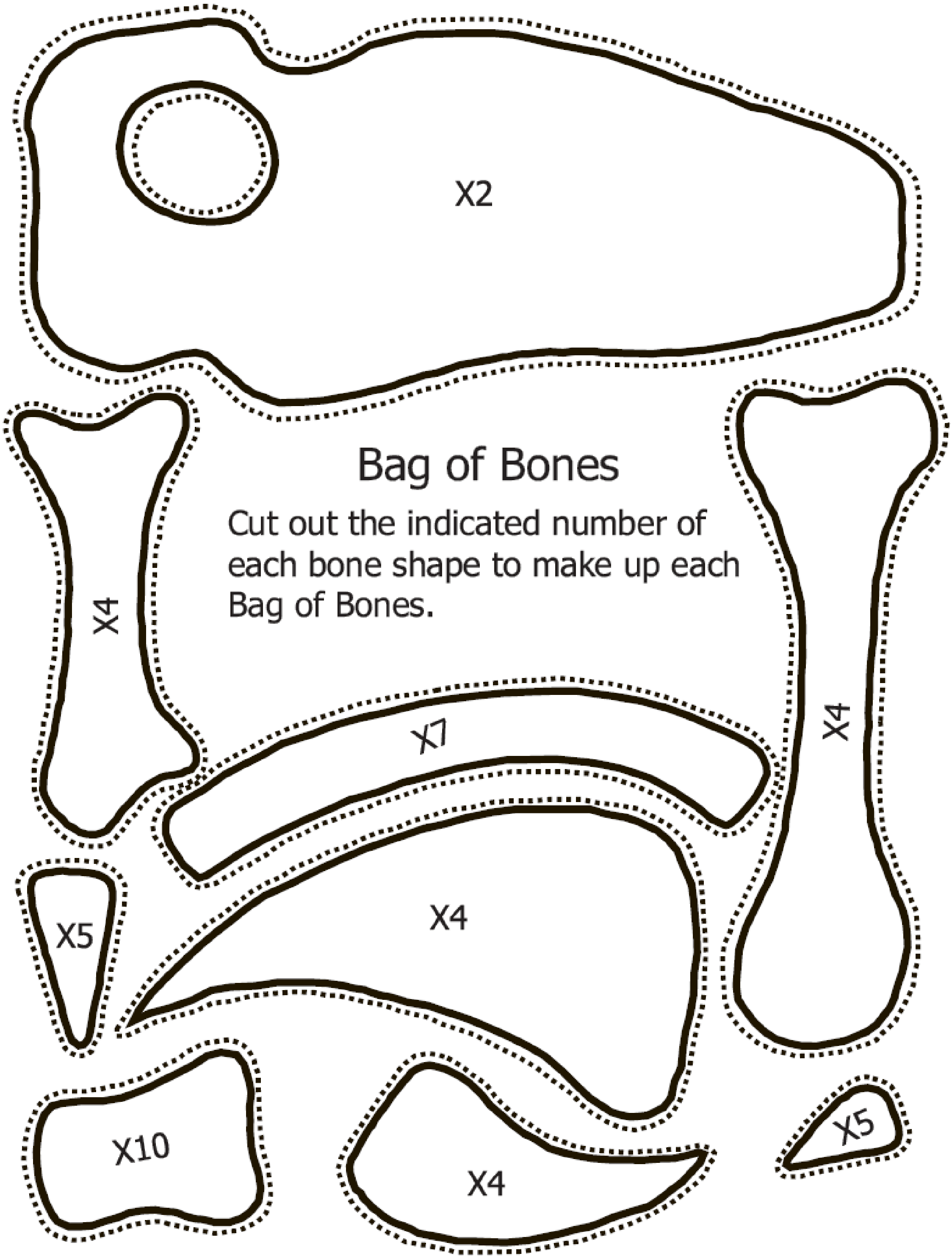
- Some small bags
- Photocopied cutouts of bones (see next page)
- Picture of dinosaurs and the Iguanodon

Developing the activity further:

- Show them some pictures of dinosaurs from the internet and explain that a lot of what we know about dinosaurs is based on piecing together bits of evidence from lots of different parts of the world.
- Explain that fossils are formed when organisms are buried as sedimentary rocks are formed under particular conditions. Geologists categorise fossils into trace fossils, where a trace of the activity of an organism is preserved, and body fossils, where part of the organism itself is fossilised. Give pupils a list of present-day organisms (eg ones you might find in your garden…worms, snails, slugs, ladybirds, frogs, birds, cats, mice) and ask them which ones they think would be most likely to become fossils if the conditions were right, and which parts they would be most likely to see? (Geologists often use comparison with the present day to help them understand what might have happened in the past).
- Set up your own geology club – see www.fossil-facts-and-finds.com
- Check out http://www.jurassiccoast.com, http://www.sedgwickmuseum.org/ and www.fossil-facts-and-finds.com for more information

Bag of Bones

Cut out the indicated number of each bone shape to make up each Bag of Bones.



Courtesy of the Sedgewick Museum

Thank you for using What on Earth?

We hope you enjoyed the activities within this pack. To help us to continue to provide new activity packs, we'd like to ask you to tell us a little about what you did for National Science & Engineering Week.

Please take a few minutes to fill in this form. If you used this activity pack for NSEW, send in this completed form and we will send you a National Science and Engineering Week Certificate.

Organisation: ______________________________

Address: ______________________________

____

Postcode: ______________________________

Tel: ______________________________

Fax: ______________________________

Email: ______________________________

Which dates did you do National Science and Engineering Week activities on? __________

What did you do?

Please make any comments about this activity pack, National Science & Engineering Week and/or other possible topics for future packs.

☐ **Tick this box** to be added to our mailing list. This will keep you up to date with NSEW, including grants, resources and activities. Your contact details will not be passed onto third parties.

Please return to:
Fax: 0870 770 7102
Post: National Science & Engineering Week
FREEPOST LON 20848
London
SW7 5BR

Do you want more?

If you enjoyed these activities and would like to do more then why not register for CREST ★ Investigators and receive a pack of further activities and investigations?

CREST ★ Investigators is a UK-wide award scheme that enables children to solve scientific problems through practical investigation. The activities focus on thinking about, talking about, and doing science. The activities develop children's scientific enquiry skills in an enjoyable context with links to the National Curriculum where appropriate.

To start you off, all of the activities within this pack will count towards an award at either Star or SuperStar level.

For more information on how to register and receive your Crest ★ Investigator packs, visit our website at www.britishscienceassociation.org/creststar or call 020 7019 4943.