MUSEUM OF SCIENCE & INDUSTRY

Brownie Science Investigator Badge

1. Carry out the following investigations

❖ Make an acid indicator using red cabbage

Make an acid indicator using red cabbage. Test the following to see if they are acidic or alkaline and record your results.

You need

Equipment	Things to test
▪ Half a small red cabbage ▪ Hot water ▪ Bowl ▪ Knife ▪ Chopping board ▪ Sieve ▪ Jug ▪ 10 small glasses or jars ▪ 10 sticky labels ▪ Teaspoon	▪ Sugar ▪ Lemonade ▪ Orange juice ▪ Clear vinegar ▪ Flour ▪ Toothpaste ▪ Apple juice ▪ Yoghurt ▪ Baking powder (sodium bicarbonate)

What to do

1. Carefully chop the cabbage into small pieces and put it in a bowl. Boil some water, pour it over the cabbage and leave it to soak for half an hour until the water turns purple.
2. Pour the cabbage water through the sieve into the jug, so that the cabbage stays in the sieve.
3. Pour a little of the purple liquid into a jar and label it 'Control'. Keep this one aside to compare all your results against.
4. Pour cabbage water into the other jars.
5. Add a small amount of a different test substance to each one. Label each one so you know what is in it. Be careful not to stain anything with the purple water!

What happens to the purple water? Get the girls to compare each of the jars with the test substances to the control jar with the pure cabbage water.

If the purple cabbage water turns red or pink, the substance you have tested is **acidic**.
If the purple cabbage water turns blue or green, the substance you have tested is **alkaline**.

Why not? – Extension Ideas

You can use your red cabbage water to pretend to be a master magician. In one glass, dissolve some baking powder in water. Pour some clear vinegar into another glass. Don't forget to label them. Take the jar of cabbage water and tell the girls that you are going to use it to make some magic water that changes colour. Say you are going to ask your magic liquid to change the colour – what about a nice pink colour? Abracadabra! Pour the vinegar into the cabbage water and it will go pink. But can you change it back again? Pour the baking powder solution into the water and it will go blue. This shows that the liquid is no longer acid but alkaline.

You can also write invisible messages with vinegar or lemon juice, allow them to dry and reveal them by spraying lightly with the cabbage water indicator!

How it works

Some dyes from plants change colour in liquids of different acidity. The colour change is a result of how the dye in the cabbage changes when it is mixed with acids and alkalis. Acids (e.g. vinegar) turn it pink and alkalis (e.g. sodium bicarbonate) turn it blue. The changing dye in the red cabbage is the pigment *anthocyanin*. Therefore, the cabbage dye works as an indicator and can be used to tell you whether something is an acid or an alkali.

The **pH scale** is how we measure how acidic or alkaline something is. The red cabbage pH indicator colours relate to the following pH levels:

pH 2	pH 4	pH 6	pH 7	pH 8	pH 10	pH12
red	purple	violet	blue		blue/green	green
acid			**neutral**	**alkali**		

Human skin is slightly acidic. This is probably to protect the skin as acidity kills bacteria. Therefore it is important that cosmetics also have a slightly acidic pH value in order not to destroy the skin's own pH value. Look for the pH value on the back of the shampoo bottle. As human skin is slight acidity, this is why you are not allowed to touch certain objects in museums without wearing gloves. The acidity would destroy the objects over a longer period of time.

❖ Grow two broad beans

Do plants grow better in different light? Grow two broad beans: one in the light and one in the dark. Ask the girls to observe them for two weeks and to complete a record sheet.

You need
- 2 pots (Styrofoam or waxed paper cups are OK).
- 2 saucers.
- Soil.
- 2 broad beans.

What to do
1. Make sure the pots have drainage holes at the bottom. If not pierce with scissors.
2. Put the soil in the pots. Moisten the soil and let the excess water drain away. Put the pots on the saucers.
3. Put one of the broad beans in each pot. Press them into the soil, so that they are just covered. Water again, but very lightly.
4. Place the two pots in different locations:
   a) one at a window that has some sun.
   b) one at a dark place.
5. Water very lightly every day.
6. Record what each is like after the first and second week. Are there differences in the size, colour, leaves and form of the plant? If you like you can draw the plants on your record sheet. Review what you see as the conclusions to the experiment.

Why not? – Extension Ideas
Instead of two beans grow five, each in a different location:
- Window that has some sunlight.
- Outdoors in the shade.
- Outdoors in the sunlight.
- In a well lit room but with no direct sunlight.
- In a room that is not well lit.

How it works
A plant needs certain elements and sunlight to make its own food while taking in carbon dioxide and giving off oxygen. This process is called photosynthesis. “Photo” means “light” and “synthesis” means “putting together”. When water, air, chlorophyll (which causes the green colouring), and sunlight are put together in a certain way by the plant, it makes its own food. The food is actually a form of sugar that is eventually turned into starch. If any one of these elements are missing, a plant cannot live.

❖ Make a carbon dioxide fire extinguisher

What happens when something is on fire? How does a fire extinguisher do it's job? Make a carbon dioxide fire extinguisher to put out a candle flame. Explain how it works.

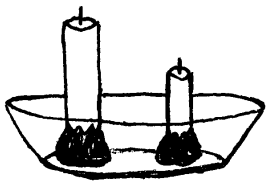
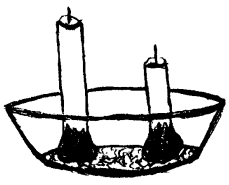
This experiment is probably better used as a demonstration as it involves lighting candles.

You need

- 2 candles of different heights.
- 2 balls of clay.
- Small dish (not plastic).
- Large bowl (not plastic).
- Baking soda.
- Vinegar.
- Teaspoon.
- Matches.

What to do

1. Place a short candle and a slightly longer candle into the two balls of clay.
2. Place the candles on the small dish, then cover the bottom of the dish with one teaspoon of baking soda.
3. Place the dish with the candles and baking soda into the bottom of the larger bowl.
4. Carefully light the candles.
5. Slowly pour the vinegar down into the dish of baking soda, being careful not to pour the vinegar on the wick of the candles.
6. Ask the girls, what do they think will happen to the candles? Watch what happens as the candles burn and the baking soda fizzes. You may have to add a little more vinegar to keep the fizzing going.
7. What happened to the candles when you added vinegar to the baking soda? Which candle goes out first - the shorter one or the taller one?
8. If the candle goes out, try to relight it. Can you? If not, why?

1. Put the candles in a lump of clay in a small dish 	2. Cover the bottom of the small dish with one teaspoon of baking soda 	 3. Place the dish in a large bowl which needs to be higher than the candles

Why not? – Extension Ideas

Place a candle in a glass and cover it with a saucer in order to show that a fire needs oxygen to burn.**{**PRIVATE "TYPE=PICT;ALT=CO2 equation"**}**

How it works
When vinegar is combined with baking soda, the two react and produce carbon dioxide gas. The carbon dioxide gas is heavier than the surrounding air so it sinks into the bottom of the bowl. As the reaction continues, more and more carbon dioxide gas is produced which slowly begins to fill up the bowl. When the level of carbon dioxide has risen to the level of the flame, the flame will go out from lack of air (oxygen). Oxygen in the air is necessary for a fire, and when this oxygen is removed, the fire goes out.

Humans use carbon dioxide in many different ways. The most familiar example is its use in **soft drinks**, to make them fizzy. It is also released by **baking powder or yeast** to make cakes or batter rise.

❖ A xylophone from glass bottles

Why do things make sounds? How are sounds made? Fill some glass bottles with water and play a tune on your self-made xylophone!

You need
- Several glass bottles the same size.
- Water.
- Food colouring or ink.
- Metal spoon.

What to do
1. Stand the bottles in a row. Pour water into them, so that each bottle contains a little more water than the one before.
2. To make the xylophone look prettier, add a few drops of food colouring to each bottle of water and stir it in.
3. Tap each bottle in turn with the spoon to see what note it makes.

Why not? – Extension Ideas
Instead of tapping the bottles with a spoon you can also try blowing them. Hold the bottles to your mouth so that you can blow across the tops of them – like a flute.

If you adjust the amount of water in the bottles, you should find that you can play part of a musical scale. Try to play some Brownie songs on your xylophone.

Why not make some more instruments and create your own band?

Pan Pipes – With 8 plastic drinking straws, 2 strips of card (14cm by 2.5 cm), a glue stick and scissors you can make a Pan Pipe. Spread glue along one strip of card. Glue the eight straws to the card at equal distances, with the tops of the straws in line. Glue the second strip of card over the top of the straws. Trim the straws so that each one is shorter than the one before.

Rubber Band Harp – Stretch eight elastic bands around a baking tin or a plastic box, so that they are all the same distance apart. To give the elastic bands different notes, tighten each one by pulling it and catching it on the edge of the tin. Try tuning the elastic bands so that you can play a scale.

How it works
Sound is produced by vibrating objects such as musical instruments and the vocal cords which produce the human voice. All sounds are carried by the air around you. When you play a musical instrument, it makes the air around it vibrate. The air carries this vibration to your ears. Your eardrums vibrate and you hear the sound made by the instrument.

The more water there is in the bottle, the shorter the column of air that vibrates in the bottle and the higher the sound it makes. The shorter the straws are, the higher the notes they make. The tighter each elastic band is pulled across the box, the higher the notes it makes when you pluck it.

❖ Magnets

Magnets have strange powers and can draw some things to them as if by magic. You cannot see how a magnet works, but you can find out more about it by experimenting with it.

You need

- Magnets (You can buy magnets at hardware or toy shops).
- Selection of magnetic objects ie. made of metal (eg. paperclips, kitchen foil, coins, cans of drink, teaspoons, etc.)
- Selection of non-magnetic objects ie. not made of metal (eg. wooden ruler, handkerchief, plastic bottle cap, piece of cardboard or paper, etc.)

What to do

1. Test your magnet on the objects you have collected.
2. Which things does it pick up? Sort the objects into two piles – magnetic and non-magnetic. What do magnetic objects have in common?
3. How strong is your magnet? How many paper clips can it pick up? Can you pick them up by holding the magnet above them?
4. Does your magnet work through materials, e.g. wood, paper?

Why not? – Extension Ideas

Making a compass - turn a darning needle into a magnet. Just stroke it about twenty times in the same direction with one end of your magnet. Float a small piece of paper on water in a glass and lay the needle on top of it. The piece of paper turns until one end of the needle points North and the other end South. The Earth is like a giant magnet and the magnetised needle acts like a compass needle.

Draw a maze on a piece of cardboard. Can you guide a paper-clip through the maze?

How it works

The ability to attract iron and steel is called magnetism and materials which have this property are called **magnetic**. The regions near the ends of a magnet are called its poles. If a bar magnet is hung by thread, it will rotate until it is pointing in a north-south direction. The end which points south is called the south pole. The end which points north is called the north pole. If two north or two south poles are brought towards each other, they will push away, or repel, each other. If one north pole and one south pole of two magnets are brought together, they will pull towards, or attract, each other. That demonstrates the law of magnetism.

A magnet is surrounded by an area called its magnetic field. Magnetic objects entering this field are affected by the magnet's forces of attraction and repulsion.

2. Choose and do two of the following

❖ Insulators

Investigate how well newspaper, silver foil and polystyrene act as insulators. Which one keeps an ice-cube frozen for the longest time?

You need

- Newspaper.
- Kitchen foil/ Aluminium foil.
- Polystyrene.
- Eiderdown blanket or woollen jumper.
- 4 ice cubes.
- Stopwatch.

What to do

1. Wrap an ice cube in a newspaper and one in kitchen foil. Put another one in polystyrene and the last one in a thin plastic bag and then in an eiderdown blanket or woollen jumper.
2. Use the stopwatch to measure the time each ice cube takes to thaw into water.
3. Which material keeps the ice cube frozen for the longest time? Why?

How it works

Substances which conduct heat or cold slowly, such as wood and water, are called **insulators**. Air is one of the best insulators of heat. Therefore, materials which trap air inside them, such as cork, polystyrene and wool, are good insulators. Insulating materials have a variety of uses:

- a thermos bottle keeps your tea hot.
- fibre-glass, polystyrene or double glazing are used for house insulation.
- woollen or fleece clothing prevents heat leaving the human body.

❖ Transporting a small load

Build something to transport a small load (eg. a stock cube) from point A to point B.

You need

- Stock cube (or another small item).
- Materials for building (eg. paper, small cardboard boxes, string, pipe cleaners or drinking straws, cotton reels).
- Tools for building (eg. scissors, stapler, glue, sticky tape).
- Materials for decorating (eg. coloured paper, stickers, felt pens).
- Carpeted floor (or a piece of carpet) and a wooden floor.

What to do

1. Work in pairs or individually to make a vehicle to transport a stock cube using the materials available.
2. Measure and mark 2 metres on a wooden floor and on a carpeted floor.
3. Mark one end ‘A’ and the other ‘B’ on both floors.
4. Construct your vehicle using the materials available. Remember it has to move the stock cube from point A to point B. Will you push it or perhaps pull it on string?
5. Use your vehicle to move the stock cube between the two points on first the wooden floor and then the carpeted floor.
6. Compare your results. Which was easiest?

How it works

If you want to move an object you have to apply a **force**. A force can be a push or a pull. It affects the motion of an object by changing its speed or direction. A force, which acts between any two masses, attracting them toward each other, is called **gravity**. In our case the stock cube is attracted by the Earth. Weight is a measure of a planet’s gravitational pull on an object. So, if you want to lift the stock cube you need to pull its weight upwards against the force of gravity.

Another force is called **friction**. Friction is the force between two surfaces rubbing together (eg. between the wheels on your vehicle and the floor surface). When two smooth surfaces rub together there is very little friction. When two rough surfaces rub together there is more friction. Friction can be a good thing. The rough surfaces on our shoes and on our car tyres keep us on the ground! Both need good grip so their surfaces are rough. If your carpeted floor is rougher than your wooden floor, you might have found it was easier to move your vehicle on the wooden floor because there was less friction.

❖ Electric circuits

Make an electric circuit that could be used as a torch.

You need

- 1.5 volt battery.
- 1.5 volt bulb.
- Bulb holder.
- Battery holder.
- 2 wires.
- 4 crocodile clips.

What to do

1. Put the 4 crocodile clips into the 4 end of the wires.
2. Attach one end of the wire to the bulb in the bulb holder. Attach the other end of the same wire to the battery in the battery holder.
3. Now repeat using the last wire to complete the circuit.

Why not? – Extension Ideas

Put a switch in the circuit in order to switch the bulb on and off. For that you need a switch and an extra piece of wire.

With a balloon and a woollen or nylon sweater you can experience electricity in a very simple way:

1. Take the blown up balloon and rub it vigorously against your sweater about ten times.
2. Now hold the balloon against your sweater or hair for a minute.
3. Let go of the balloon. What happens? Did it stick? Can you stick it on the ceiling?

How it works

With a simple circuit the light goes on when everything is joined together to make a complete circuit. Electricity runs from the battery to the bulb, then back to the battery. If you unhook a wire from the battery, the circuit is broken and the light goes out, the switch works in the same way.

Electricity runs the lights in our homes and many everyday household machines but it also occurs naturally in the form of lightning and static electricity. When a balloon and a jumper (or hair) are rubbed together; each will gain a different type of electrical charge. The balloon becomes a negative charge and the jumper becomes a positive charge. Opposite charges attract each other. That is why the balloon sticks on the sweater or your hair stands on end.

❖ Supporting loads

Make a tower from either rolled-up newspaper or drinking straws. Find out what load it will support.

You need

- Newspaper.
- Drinking straws.
- A load, eg. an apple.

What to do

1. Roll up a whole newspaper and hold it upright. Put the load on top of it. Does the newspaper support the load?
2. Take some pages off and roll up the newspaper again. Does it still support the load?
3. How thin can the newspaper be and still support the load?
4. Take a handful drinking straws, hold them upright and put a load on top of it. Remove some of the drinking straws. What is the least number of drinking straws you need to support your load?
5. Discuss which materials you think are best at supporting loads.

How it works

The force which pulls an object down to earth is called gravity. If you want to support an object you need to push against the force of gravity. For that you need a material which is strong enough to support the weight of an object.

3. Do one of the following and talk with the tester about it

Visit a museum or exhibition that specialises in science

The Museum of Science and Industry in Manchester welcomes Brownie groups. Situated in the oldest surviving passenger railway station, the Museum tells the story of the science, history and industry of Manchester - the world's first industrial city. The five large buildings are packed with colourful exhibitions for you to explore.

Visit *Xperiment*, our interactive science centre, or view *Underground Manchester* - a reconstructed Victorian sewer complete with sounds and smells! Marvel at fabulous flying machines, and find out about space in our *Air and Space Hall*. Watch the largest collection of working steam mill engines in the world in our *Power Hall*.

All permanent galleries are free of charge. A group booking form can be downloaded from our web site in the Education and Learning/Group Visits section.

Find out about the discoveries of two famous scientists and how their work has affected our lives

The Manchester Science Gallery on the first floor of Building One features four famous scientists from Manchester. A group leader guide to the gallery, a suggested activity sheet plus resource sheets are provided as separate downloadable files to help you and your girls learn about these famous scientists and how their work has affected our lives.

The Learning Centre, Museum of Science and Industry, Liverpool Road, Castlefield, ManchesterM3 4FP
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More Science Experiments?

Tips & Ideas

For additional support with these experiments, ideas for other activities and general background information – have a look at the following websites:

www.kids-science-experiments.com
A lot of simple experiment instructions over a wide range of science.

www.planet-science.com
click: sci-teach (Resources for Teacher) click: The little Books of Experiments (www.planet-science.com/sciteach/index.html) This book is available as a pdf-document.

www.ratlab.co.uk/
RATLAB is a non-profit website aimed at spreading a little science love to anyone who will listen, whether you are considering a career in science or are simply curious about the world around you. It also includes experiment instructions.

www.spartechsoftware.com/reeko
Reeko's Mad Scientist Lab is a source of free science projects and experiments for parents, teachers, and children of all ages.

www.physics.org/cartoons/cartoons.asp
Every month find out about a new and easy experiment through the medium of cartoons.

www.npl.co.uk/thelearningroom
The National Physical Laboratory's educational website dedicated to helping physics teachers and their students. The learning room is packed full of ideas, resources, experiments and events that can help support the education of physics and science.

www.discoverycube.org/kids/index.htm
On this Kids Site of a Discovery Science Center in California you will find a lot of useful experiment instructions.

Suppliers of suitable equipment for some of the experiments include:

www.tts-group.co.uk

www.glsed.co.uk

www.economatics-education.co.uk

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