BGE Science Level 3 Teaching Notes for Practical Activities

Rock cycle experiment (page 58)

Aim: To see how the rock cycle works

Equipment

- Fruit chew or similar chewy sweet
- Tripod
- Crucible

Instructions

1 Unwrap three sweets and observe their shape, colour and consistency.

2 Add pressure to form 'sedimentary rocks'. This can be done by hand – squash the three sweets together between your fingers or palms. The layers in the sweet rock are like those in sedimentary rocks.

3 Record observations of your sweet sedimentary rocks.

4 Add heat to create 'igneous rocks'. The squashed sweets should be placed in a crucible, on a tripod, above a Bunsen burner. The sweets should be heated until warm but not melted.

5 Record observations of your sweet igneous rocks.

6 Add extreme heat to produce 'metamorphic rocks'. Heat the crucible over a flame until the

7 Once cooled, record observations of your sweet metamorphic rocks.

Safety!

Risk of burns when heating sugar. Minimise risk by allowing plenty of cooling time before observation of final stage.

The heating stage could also be done as a demonstration.

Do not allow pupils to eat the sweets.

Experiment to make a dye (page 63)

Aim: To prove that plants can make useful products

Equipment

- Beakers
- Measuring cylinder
- Glass rods
- Tongs
- Bunsen burners, tripods, gauzes
- Filter funnels with filter paper
- Stands, bosses, clamps
- White fabric
- Beetroot
- Red onion

Instructions

1 Label two beakers: 'Beetroot' and 'Onion'.

2 Add the correct vegetable to each beaker.

3 Add 100#cm3 of water to each beaker.

4 Using a Bunsen burner, boil the vegetable and water for 15 minutes.

5 Allow the beaker to cool for a few minutes.

6 Filter the cooled liquid into clean beakers.

7 Using tongs, add your cotton to the dye bath and boil for 10 minutes, stirring regularly with a glass rod

8 Remove the material using tongs and allow to dry.

9 Record observations of differences between the dyed fabrics.

Safety!

There are risks associated with boiling water over a Bunsen.

Ensure proper Bunsen safety and allow cooling time before handling the glassware.

Investigation into starch production by plants (page 80)

Aim: To test a leaf for the presence of starch

Equipment

- Leaves
- 250 cm3 beaker
- Tweezers/forceps
- Glass rod
- Boiling tube
- Petri dish
- White tile
- Ethanol
- Kettle for boiling water
- Iodine solution

Instructions

1 Place a leaf in a beaker of hot water and leave for 1 minute.

2 Remove the hot leaf with tweezers and place it into boiling tube.

3 Cover the leaf with ethanol and place the boiling tube in a beaker of freshly boiled water.

4 Agitate the leaf with the tweezers and observe as the leaf start to lose its colour.

5 Once the leaf is colourless, remove it from the ethanol with tweezers and rinse it with cold water.

6 Place the leaf on the Petri dish, which is itself placed on top of the white tile.

7 Add a couple of drops of iodine to the leaf and observe. If a blue–black colour seen then starch is present.

Safety!

Ethanol is highly flammable. Never use an open flame in the vicinity of ethanol. In this experiment we use a kettle for boiling water rather than a Bunsen to reduce this risk

Iodine solution can stain the skin or clothing if spilled.

Design an experiment to investigate the rate of photosynthesis (page 81)

Aim: To investigate how the rate of photosynthesis is affected by the light intensity reaching the plant

Equipment

- Approx 7 cm long piece of Cabomba
- A boiling tube
- Lamp
- Ruler
- Stop clock

Instructions

1 Fill the boiling tube to halfway with water.

2 Place the cabomba leaf in the water with the cut end facing up but fully submerged.

3 Place the boiling tube in a rack.

4 Shine the lamp on the leaf and record the distance between the lamp and the leaf.

5 After a short period of time you should observe bubbles emerging from the cut end.

6 Start the stop clock and count the number of bubbles that appear from the cut stem over a set period of time.

7 Repeat this count for the lamp at different distances from the leaf.

Safety!

Take care when using water around electrical equipment, such as lamps and plug sockets

Fertiliser experiment (page 82)

Aim: To make nitrogen-rich fertiliser (ammonium sulfate)

Equipment

- Evaporating basin
- Gauze Tripod
- Bunsen burner
- 20 cm3 measuring cylinder
- Filter paper
- Filter funnel
- Conical flask (to stand funnel on)
- Glass rod
- Sulfuric acid 1 mol dm–1
- Ammonia solution 2 mol
- Full-range indicator paper

Instructions

1 Put 20ml sulfuric acid into and evaporating basin.

2 Add the ammonia solution a little at a time, with stirring, until a definite smell of ammonia is obtained

3 Check the pH is 7 or above with indicator paper.

4 Evaporate the solution to about one-fifth of its original volume. Take care – do not let the solution spit. Cool the concentrated solution.

5 Filter off the crystals and dry them.

6 Once the crystals are dry, they can be mixed with water and used to feed plants.

Safety!

Wear eye protection throughout the experiment.

Ammonia solution gives off ammonia which can irritate the eyes and respiratory system.

Sulfuric acid can cause chemical burns, so take care to not get it on the skin.

Health monitoring and screening (page 101)

Aim: To observe the effects of exercise on the human body

Equipment

- Stopwatch
- Pulse oximeter

Instructions

1 Check how much oxygen is in the bloodstream at rest and measure the heart rate using the pulse oximeter.

2 Exercise for a set period of time and then take new measurements.

3 Collate class results so that averages of the measurements both before and after exercise

can be measured.

Safety!

Ensure the style of exercise is safe for all students, preferably use a low impact exercise.

Ensure that any health issues are identified. Any students who should not take part could be time keepers.

Classroom challenge: Robert Hooke (pages 103–04)

Aim: To construct a small microscope to help students understand how they work

Equipment

- Two convex lenses
- Piece of paper with text on

Instructions

1 Take two magnifying glasses.

2 Hold one of them a short distance from a piece of paper with writing on.

3 Take the second magnifying glass and hold that between the first one and your eye.

4 Move the bottom magnifying glass up and down to bring the writing in and out of focus.

5 You have made a simple microscope!

Safety!

There is minimal risk with this experiment. However, ensure pupils aren't left with the magnifying glasses and a direct light source.

Looking at your own skin cells (page 105)

Equipment

- Microscope
- A clean cotton swab
- A microscope slide and cover slips
- Bromothymol blue stain
- Safety goggles

Instructions

1 Rub the cotton swab up and down on the inside of your cheek.

2 Rub the cell sample on the swab onto the centre of a microscopic slide.

3 Add a single drop of stain called bromothymol blue.

4 Place the cover slip down carefully. Your teacher will show you how to do this safely.

5 Set your microscope and see what your cells look like!

6 You should record the images in your notes by drawing. Remember that scientific diagrams need labels.

Safety!

Always wear safety goggles.

Bromothymol blue will stain skin and clothing, so avoid spills.

Make your own poo! (page 110)

Aim: To build a model for understanding the digestion process

Equipment

- Can of beans
- Can of hotdogs
- Chocolate biscuits
- Can opener
- Gloves
- Apron
- Three bowls (labelled mouth, small intestine and large intestine)
- Two buckets (labelled blood and toilet – put a little water in the toilet bucket)
- Potato masher (molars)
- Scissors (incisors)
- Sponge (villi)
- Leg of tights or stocking (small intestine)
- Wooden spoon (tongue)
- Two 'heavy duty' polypockets (stomach and large intestine)
- Six small bottles:
    - Enzymes (soap, water and red food colouring)
    - Stomach acid(vinegar)
    - Biles alts(soap)
    - Sodium bicarbonate
    - Bile(gravy powder)
    - Saliva (water)

Instructions

1 Place all the food in the 'mouth' and mash and slice with the 'teeth'. Add in the 'saliva' and the 'enzymes'. Use the 'tongue' to help food into the 'stomach'.

2 Add 'acid' and 'enzymes' and then churn the bag.

3 Cut a small hole in the corner of the bag and pass the food into the 'small intestine'.

4 Add 'enzymes', 'bile salts' and 'sodium bicarbonate' to the mix and pass the food along. Squeeze the nutrients into the appropriate bowl and then use the sponge to illustrate the absorption of the villi.

5 Transfer the mix to the 'large intestine'. Pour any remaining liquid into the blood bucket.

6 Cut a hole in the corner of the bag and transfer remains into the 'toilet'.

7 Take time to explain what is going on (and why) at each stage.

Safety!

Pupils should not eat any of the foods.

Experiment to extract DNA (page 119)

Aim: To extract DNA from living material

Equipment

- Beaker
- Test tube
- Wooden skewer
- Masher/blender
- Dish soap
- Pineapple juice
- Ethanol (ice cold, chilled in a freezer for at least 2 hours beforehand; 10cm3 for each sample)
- Soft fruit (banana or other source of DNA)
- Glass rod
- Ice bath
- Table salt

Instructions

1 Add the banana and a pinch of table salt to a beaker and mash until smooth.

2 Add 5 ml of liquid dish soap to the mashed banana and mix thoroughly. Try to avoid creating bubbles.

3 Add three drops of pineapple juice to the banana/soap solution.

4 Transfer the mixture to a test tube.

5 Very slowly, pour cold ethanol down the side of the test tube. This should be done at an angle to create a layer of ethanol on top of the banana/soap mixture.

6 Leave to stand for 5 minutes.

7 Observe a white substance that is suspended between the two liquid layers.

8 Very carefully, using the wooden skewer, hook out some of the white substance and transfer it to a microscope slide.

9 Observe the extracted DNA under the microscope.

Safety!

Always wear eye protection.

Avoid skin contact with ethanol. Wash off any spills with water

Microbe experiment (pages 124–25)

Aim: To prove that microbes are found in the classroom

Equipment

Nutrient agar plate

Pen (for labelling)

Cotton swab

Sticky tape

Disposal bin with bleach

Instructions

Prepared petri dishes should be refrigerated until used and always stored upside down (i.e media in upper dish, cover on bottom). This keeps condensation which forms in the lid from dropping onto and disrupting the bacteria growing surface.

When ready to use, let dishes come to room temperature (for about one hour) before taking samples.

1 Collect a nutrient agar plate and write your name and the date on one edge of the bottom.

2 Draw a cross along the bottom of your plate to make four separate sections.

3 Take four cotton swabs, to sample four different areas of the classroom. Before proceeding, discuss with your teacher which areas are acceptable for sampling and why. Next, use a swab to sample an area by wiping it on the area.

4 Lightly run the swab onto the surface of the nutrient agar and label that section of the plate with where the sample was taken.

5 Dispose of cotton swab immediately.

6 Using the remaining three cotton swabs, repeat the process for the three more areas of the classroom.

7 Place lid on agar plate.

8 Using two small pieces of sticky tape, secure the lid in place. **Do not** seal completely.

9 Return your labelled plates to your teacher for incubation.

10 Your teacher will place the plates into an incubator at a suitable temperature to grow bacteria. You will see the results in a day or two!

Make observations and keep records of what is growing in each dish. Make conclusions about which locations had the most bacteria.

Before disposing of dishes in the trash the bacteria should be destroyed. Pour a small amount of household bleach over the colonies while holding dish over sink.

Safety!

Do not allow bleach to touch your skin, eyes or clothes. It will burn!

Most bacteria collected from the environment will not be harmful. However, once they multiply into millions of colonies in a petri dish, they become more of a hazard. Be sure to protect open cuts with rubber gloves and never ingest or breathe in growing bacteria. Keep growing petri dishes taped closed until the experiment is complete. Then safely destroy the bacteria colonies using bleach.

Antibiotic ring experiment (demonstration) (page 126)

Aim: To investigate the effect of type of antibiotic on bacterial growth

Equipment

- Prepared petri dishes containing agar medium and nutrients
- Bacteria collected from doorknobs, bathroom fixtures, etc.
- Wax pencil for labelling dishes
- Masking tape
- Sterile swabs or inoculating loop
- Alcohol burner (source of flame to sterilise inoculating loop)
- Antibacterial agent (soaps, disinfectants, etc.)
- Sterile water
- Test tubes 12 × 75#mm
- Filter paper or paper towel
- Small containers in which to soak paper discs
- Hole punch
- Tweezers
- Ruler
- Bleach

Instructions

1 Prepared petri dishes should be refrigerated until used and always stored upside down (i.e. media in upper dish, cover on bottom). This keeps condensation which forms in the lid from dropping onto and disrupting the bacteria growing surface.

2 Let petri dishes come to room temperature (for about one hour) before taking samples.

3 Prepare sterilised water by boiling water and letting cool to room temperature.

4 Prepare antiseptic discs by using a hole punch to create paper discs out of a piece of filter paper or paper towel. Soak one disc in each antibacterial agent to be tested. Set aside until step 6.

5 Collect bacteria from each location using one swab for each new spot.

6 Fill a small test tube partly full of sterilised water. Dip bacteria laden swab into water. This will transfer some of the bacteria you collected into the water. Now, inoculate a petri dish by pouring the water into the dish so the entire surface is covered. Pour out excess water. Repeat for each bacteria sample using fresh water and clean test tube each time.

7 Place a pretreated antiseptic disc in each inoculated petri dish.

8 Replace cover on dish, tape closed, store upside down. Be sure to label each petri dish with a name or number.

9 Let grow in undisturbed warm location, ideally in an environment around 100°#F (37°#C) – not in sunlight or on a heater.

Antibiotic ring experiment (demonstration) (page 126)

10 You should see growth within a couple of days. You should also see a 'halo' around each disc indicating a no growth zone. Measure and compare the size of the kill zone to determine effectiveness of each antibacterial agent.

11 Before disposing of dishes, the bacteria should be destroyed. Pour a small amount of household bleach over the colonies while holding dish over sink.

Safety!

Caution – do not allow bleach to touch skin, eyes or clothes. It will burn!

Most bacteria collected from the environment will not be harmful. However, once they multiply into millions of colonies in a petri dish they become more of a hazard. Be sure to protect open cuts with rubber gloves and never ingest or breathe in growing bacteria. Keep growing petri dishes taped closed until the experiment is complete. Safely destroy the bacteria colonies using bleach.

[C HEAD] Example of results

You can print the image at this link as a handout for this activity.

Neutralisation experiment (page 132)

Aim: to find out what happens when an acid and an alkali are added together

Acids and alkalis react with each other. The alkali cancels out the acid in the reaction. This is called neutralisation. A salt is made. The salt contains the metal atom from the alkali, and part of the acid molecule. The salt depends on the acid and alkali used.

Instructions

1 Place 20 drops of hydrochloric acid into a test tube.

2 Add one drop of Universal Indicator.

3 Notice the colour of the liquid.

4 Now keep adding drops of sodium hydroxide.

5 Count the number of drops until the solution turns green (pH7).

Safety!

Students should wear safety goggles at all times while acids and alkalis are being handled

If any acids or alkali are spilt onto skin, wash thoroughly with water.

An eye bath kit should always be available in case of chemicals coming in contact with eyes.

Test tube rainbow (page 132)

Aim: to investigate the colour changes associated with universal indicator.

A long glass tube is filled with a neutral solution of Universal indicator. Hydrochloric acid is added to one end and sodium hydroxide solution to the other. The tube is inverted a few times to mix the solutions and the 'rainbow' of Universal indicator colours appears.

Equipment

- Safety goggles
- Glass tube and bungs to fit each end
- 100 cm3 beaker
- Three pipette droppers
- Clamp stand and clamp
- Water
- 0.1 Ml hydrochloric acid
- 0.1 Ml sodium hydroxide solution
- Universal indicator solution

Instructions

1 Add sufficient Universal indicator to about 60#cm3 of deionised or tap water in a beaker, to give a solution with a visible green colour.

2 Ensure that one end of the glass tube is firmly stoppered with a rubber bung.

3 Fill the tube to about 2 cm from the top with the Universal indicator solution. Then clamp the tube vertically. It is important to leave a space above the liquid in the tube so that there is an air bubble – this helps the step mixing.

4 Add 3–4 drops of the hydrochloric acid solution. The top few centimetres of the liquid should turn red.

5 Stopper the upper end of the tube, remove it from the clamp, carefully invert it and then clamp it vertically again.

6 Remove what is now the top stopper. Add 3–4 drops of the sodium hydroxide solution. The top few centimetres of the liquid should turn purple.

7 Stopper the tube. Both ends of the tube should now be firmly stoppered.

8 Remove the tube from the clamp and carefully invert it 2 or 3 times. The movement of the air bubble will mix the contents and produce a 'rainbow' in the tube, showing all the colours of Universal indicator from red through orange, yellow, green, blue and purple.

Safety!

Wear eye protection throughout.

Hydrochloric acid, HCl (aq) – (IRRITANT at concentration used) Sodium hydroxide, NaOH (aq), (IRRITANT at concentration used) Universal indicator solution (HIGHLY FLAMMABLE)

Measuring forces (page 135)

Aim: To measure the force to lift or pull an object along a surface

Equipment

- A range of Newton balances of different maximum forces
- Objects that can be hooked onto with the newton balances

Instructions

1 Pupils should first identify an object that would be appropriate to either lift or pull along a surface.

2 The pupil should then select a newton balance with an appropriate scale to measure either the lifting or pulling force on that object. This might require some trial and error at first.

3 When pulling an object along a surface the pupil should pull the object with the newton balance at a steady speed to allow an accurate attempt at reading the scale.

4 When a pupil is lifting an object they should attempt to hold the object with the newton balance as still as possible.

Safety!

Ensure students are safe when moving around the room

Remind students to only lift or pull appropriate objects making sure not to overload the newton balance they are using.

Water filtration experiment (page 149–150)

Aim: To make your own water filtration system

Equipment

- A plastic bottle, cut in half and with cap still attached
- Gravel
- Activated charcoal
- Filter paper
- Clean sand
- Cotton wool
- Dirty water

Instructions

1 Take the top half of the bottle and place it upside down into the bottom part of the bottle, as shown in the picture.

2 Place cotton wool in the neck of the upturned bottle (closest to the cap) and place the filter paper on top.

3 Add the activated charcoal on top of the filter paper.

4 Then add a layer of gravel.

5 The sand is added next. The sand layer should be about the same depth as the initial layers combined.

6 Finish off with another layer of gravel.

7 Take the filtration system out of the bottom part of the bottle and remove the cap.

8 Replace the filter set-up in the bottom part of the bottle. Add dirty water to the top.

9 Record your observations of the water that has passed through the filtration system.

Safety!

Remind students not to drink the water as the filter will not be effective at removing bacteria.

Dilute to taste (page 153)

Everyone likes their juice solutions at different concentrations. What concentration do you prefer?

Instructions

1 Using clean droppers and measuring cylinders, make different concentrations of diluting juice. Make the juice solutions carefully using the volumes set out in Table 20.

Table 20 Diluting juice concentrations

Volume of juice (ml)	Volume of water (ml)	Total volume (ml)
0	10	10
2	8	10
4	6	10
6	4	10
8	2	10
10	0	10

2 Add the drinks of different strengths to labelled plastic cups.

3 Take a sip of the most dilute sample first. Allow it to sit on your tongue and think about the flavour.

4 Once you have swallowed it, take a sip of pure water.

5 Repeat this process with all the dilutions of juice, finishing with the most concentrated.

6 Which concentration of juice do you prefer?

Safety!

This experiment could most safely be carried out in Home Economics classroom rather than the lab, but it could easily and safely be done in your own classroom by discussing the reasons behind the use of plastic cups, and new disposable droppers and cleaned sterilized measuring cylinders.

Solvent experiment (page 153–154)

Aim: To find out which solvent works as a nail varnish remover

Equipment

- Glass rods with approximately 2 cm at one end painted with nail varnish
- Four small beakers
- 25 ml each of: water, 0.1 M hydrochloric acid, 0.1 M sodium hydroxide, acetone
- Paper towels

Instructions

1 Label the four beakers, each with the name of one of the solvents.

2 Place 25 ml of a solvent in each beaker.

3 Place a glass rod with nail varnish on the end into the solvent, ensuring the nail varnish is submerged in the liquid.

4 Leave for 5 minutes.

5 Remove the glass rods and place on a paper towel.

6 Record your observations.

Safety!

Solvents are harmful if ingested or can irritate eyes and skin. Ensure students wear eye protection throughout the activity.

How to use a Bunsen burner for heating water (page 163 –164)

Equipment

- Container for heating water
- Distilled water (not tap or spring water)
- Thermometer (with at least 1 degree intervals)
- Heat source (Bunsen burner, hot plate, etc.)

Instructions

1 Decide, as a class, the volume of water (in mL) that will be used for the experiment and record on your data sheet. You can use any volume of water between 250–750 mL. All students in the same class must use the same exact volume of water. Different classes may use different volumes of water (example: all students in Period 2 class use 475 mL of water and all students in Period 7 class use 550 mL of water).

2 Decide, as a class, the heating device that will be used for the experiment and record on your data sheet. All students in the same class must use the same type of heating device. Different classes may use different heating devices (example: all students in Period 2 class use a hot plate and all students in Period 7 class use a Bunsen burner).

3 Decide, as a class, the elevation of your classroom (in metres) and record on your data sheet. If possible, try to find the exact elevation of your school (might be on school blueprints or a local topographic map). If you have access to a GPS unit, you can find the exact elevation of your classroom. If this information is not readily available, use the elevation for your city or town.

4 Calibrate each of the thermometers that you will be using for the experiment. Record the results on your data sheet.

5 Measure the air temperature in the room (in Celsius) and record on your data sheet. Be sure to include any calibration corrections.

6 Measure out the exact volume of **distilled** water that your class decided on and pour into your container.

Note: **It is very important that you use distilled water and not tap or spring water.** Depending on the minerals that are present in your tap or spring water, the boiling point could be off by as much as 2 or 3 degrees!

7 Place a thermometer in the water so that the bulb is several centimetres above the bottom of the container. Do not let the bulb of the thermometer rest on the bottom of the container and do not hold the thermometer in place. You can clamp the thermometer in place or use a rubber band to secure it to a piece of wood that you can place in the water.

8 Begin to heat the water. Take temperature readings every 30 seconds and record on your data sheet.

9 Continue recording temperature until it remains constant for **at least 5 minutes**. This is the boiling point. Record the boiling point on your data sheet (Celsius). Be sure to include any calibration corrections.

10 Do this experiment on three different days (preferably 3 days in a row) to account for any differences in atmospheric conditions. Please use the same type of heating device and the same volume of water that each class had used previously. Record the room temperature and boiling point temperature on your data sheet each day.

How to use a Bunsen burner for heating water (page 163 –164)

11 Determine the average room temperature and average boiling point temperature for the 3 days and record on your data sheet.

12 Determine the average boiling point based on results from the **entire class** over the 3 day period. Also determine the class average room temperature for the 3 day period.

Safety!

Care should be taken when handling hot water in containers. Allow any hot water to cool down before attempting to move the container

Place the Bunsen burner away from any overhead shelving, equipment or light fixtures by at least 30 cm.

Remove all papers, notebooks, combustible materials and excess chemicals from the area.

Tie back any long hair, remove dangling jewellery, or loose clothing.

Have the sparker/lighter available before turning on the gas.

Adjust the flame by turning the collar to regulate air flow and produce an appropriate flame for the experiment (typically a medium blue flame).

Do not leave open flames unattended and never leave the laboratory while the burner is on. Shut off gas when its use is complete.

Allow the burner to cool before handling. Ensure that the main gas valve is off before leaving the laboratory.

Experiment to investigate conduction (page 164–165)

Aim: To compare conductive properties of different materials

Equipment

- Large beaker
- Kettle
- Rods of various materials
- Butter
- Tacs

Instructions

1 Place the ends of some different materials like wood, metal, plastic (preferably materials of roughly the same dimensions) into a beaker of warm water.

2 Carefully place small lumps of butter on the other ends of each of the materials.

3 Observe which lump of butter melts first. Draw a table to record your findings.

Safety!

Care should be taken when handling warm or hot water

Convection experiment (page 166)

Aim: To observe convection currents in water

Equipment

- water
- potassium manganate
- beaker
- Bunsen burner, tripod, gauze, heatproof mat

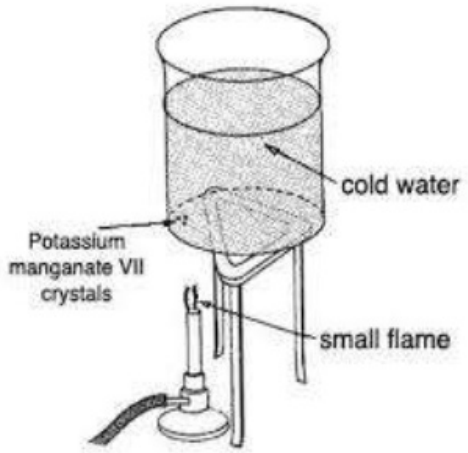
Instructions

1 Set up the experiment as shown in the diagram.

2 Wait a short time to allow the cold water to settle, then add a single crystal of potassium manganate.

3 Gently heat the water.

4 Observe how the dye moves with the movement of the water particles as they rise and fall due to convection. Draw a diagram of your results.



Safety!

Care should be taken when handling hot water.

Burning hydrocarbon demonstration (page 171)

Aim: To investigate the products of hydrocarbon combustion

In this demonstration a solid hydrocarbon burns and a pump is used to draw the gaseous combustion products over a piece of cobalt chloride paper and through limewater to show the presence of water and carbon dioxide respectively.

Equipment

- Eye protection
- Glass funnel
- 6 cm diameter boiling tubes
- Two, two-holed rubber bungs to fit the boiling tubes, and fitted with one long and one short piece of glass tubing
- Glass or plastic tubing for connections
- Filtering pump
- Tea light, night light or candle
- Piece of blue cobalt chloride paper (TOXIC)
- Limewater (treat as IRRITANT)

Instructions

With this demonstration, the apparatus can be left running for some time and students can file past in small groups to see it more closely. Alternatively, a flexicamera can be used – linked to a projector. If students are not familiar with the cobalt chloride paper and limewater tests, either demonstrate these separately or allow students to try the tests themselves. Assuming everything is already set up this demonstration takes only a few minutes.

1 Care should be taken with the right-angle bend connected to the funnel. If this is made of flexible tubing, it can get hot and melt. Ideally, the glass stem of the funnel should be bent into a right-angle. Alternatively, join a standard funnel onto a right-angled piece of glass tubing using epoxy resin. A more temporary arrangement is to slide one arm of a right-angled piece of glass tubing inside the stem of the funnel and seal the join on the outside with a piece of flexible tubing (see diagram).

2 Filter paper: Information about the type and use of various grades of filter papers can be found in section 9.11.4 of the CLEAPSS Laboratory Handbook. Filter pumps: The use of traditional water-operated filter pumps for vacuum filtration and for drawing air through solutions is covered in section 10.6.4 of the CLEAPSS Laboratory Handbook. It is strongly recommended that this is referred to before purchasing or using such pumps – it may not be possible or appropriate to use this type of equipment in your school or college. Alternative means of carrying out vacuum filtration and drawing air through solutions are suggested in this section of the Laboratory Handbook.

Burning hydrocarbon demonstration (page 171)

Before the demonstration, assemble the apparatus as shown in first diagram. Ensure that the connections to the boiling tubes are the correct way round.

Place a piece of blue cobalt chloride paper into the first boiling tube and half-fill the second boiling tube with limewater.

At the start of the demonstration, turn on the pump so that a gentle stream of air is drawn through the apparatus.

Light the tea light and leave for a few minutes until the cobalt chloride paper turns pink (from blue)

and the limewater goes milky (produces a white precipitate). This indicates the presence of water and carbon dioxide respectively.

Teaching notes: Some students will know that air contains both water vapour and carbon dioxide. To show that the changes observed are not due to these alone, repeat the experiment without the tea light and note how much longer it takes for any changes to be observed. Understanding the process of burning is important at all levels of chemistry. Emphasis that burning in air is a reaction with oxygen. The elements hydrogen and carbon are present in hydrocarbons, such as candle wax. Students will quite readily appreciate that carbon reacts with oxygen to form carbon dioxide, but often need help to grasp that hydrogen combines with oxygen to form water. The production of carbon dioxide could lead to discussion of the role of this gas in the greenhouse effect. The experiment could be extended to burning alcohols with a spirit burner.

Safety!

Wear eye protection. Cobalt chloride/cobalt chloride paper is TOXIC and DANGEROUS TO THE ENVIRONMENT. Cobalt chloride paper can be stored in a desiccator. Minimise handling of cobalt chloride paper (sensitiser) and wash hands after use (cobalt chloride is a category 2 carcinogen).

Preparing and using cobalt chloride indicator papers. Calcium hydroxide solution, ‘limewater’ – Ca(OH)2 (aq), (treat as IRRITANT) – ideally, the limewater should be made fresh on the day.

Chemical cell experiment (page 178-79)

Aim: To make your own chemical cell to produce a voltage

Student worksheet: Electricity from chemicals

Introduction

Reactive metals form ions more readily than less reactive metals. This experiment illustrates the tendency of various metals to form ions. Two different metals and an electrolyte form a cell. The more reactive metal becomes the negative pole from which electrons flow.

What to record

Using the example table of results on page 179, pupils should copy the table into their own write up and where possible leave the voltage column blank. Complete the voltage column in the results table.

What to do

1 Set up the apparatus as shown.

2 Record the voltage.

3 Try all the combinations of metals.

4 Wash hands after handling lead.

Safety!

Metal strips can have sharp edges, please ensure pupils are aware of what to do if they cut their skin.

Metals used

Which metal forms the positive terminal (+ve)?

Which metal forms the negative terminal (-ve)?

Conclusion

1. Place zinc, magnesium, copper, lead, and iron in order of reactivity

Building series circuits (pages 181–82)

Aim: Use voltmeters and ammeters to measure current and voltages in series and parallel circuits

Equipment

For each student group

- Cells, 1.5 V, with holders, 2
- Lamps with holders, 3
- Ammeter (0–1 amp), DC, preferably moving-coil
- Leads, 4 mm, 6
- Digital and analogue ammeters with varying ranges (OPTIONAL)
- Digital multimeter with multiple current ranges (OPTIONAL)

Safety!

Modern dry cell construction uses a steel can connected to the positive (raised) contact. The negative connection is the centre of the base with an annular ring of insulator between it and the can. Some cell holders have clips which can bridge the insulator causing a 'short circuit'. This discharges the cell rapidly and can make it explode. The risk is reduced by using 'low power' zinc chloride cells not 'high power' alkaline manganese ones.

Instructions

1 Set up a circuit in which a cell, a lamp and an ammeter are connected in series.

2 To record what you observe, draw a circuit diagram. Beside the lamp, note its brightness. Beside the ammeter, note its reading.

3 Set up a second circuit with two lamps connected in series with the cell and ammeter. Record your observations.

4 Repeat this with the two lamps connected in parallel with each other (side-to-side).

5 Repeat these observations using two cells in place of one.

6 How does the reading on the ammeter relate to the brightness of the lamps?

7 Investigate how the reading on the ammeter depends on its position in the circuit.

Building series circuits (pages 181–82)

Using voltmeters

Equipment

For each student group

- Cells, 1.5 V, with holders, 3
- Lamps with holders, 3
- Leads, 4 mm, 8
- Demonstration voltmeter (0–5 V)
- Digital multimeter with multiple voltage ranges (OPTIONAL)
- Digital and analogue voltmeters with varying ranges (OPTIONAL)

Instructions

1 Connect three cells in series. (Don't complete the circuit.)

2 Attach two leads to the demonstration voltmeter of a different, distinctive colour, e.g. green.

3 Connect the meter, reading 0–5 volts, first across one cell, then across two, then across three. Show that the meter reading increases in equal steps – the meter is 'counting the cells'. (You might wish to mark the meter face to indicate '1 cell', '2 cells', '3 cells'.)

4 Now connect three lamps in series. Connect one cell across the three lamps – the demonstration meter should read approximately '1 cell'. Repeat with two and three cells.

5 Finally, with three cells and three lamps, make readings across one, two and then three lamps to show how the voltage of the cells is shared between the lamps when they are in series.

Catalyst experiment (page 186)

Aim: To compare reaction speed with and without a catalyst

Equipment

- 2 boiling tubes
- Test tube rack
- Spatula
- A large tray to catch any foam that spills over the top of the cylinders
- 75#cm3 of 100 volume hydrogen peroxide solution
- About 0.5#g of powdered manganese(IV) oxide (manganese dioxide, MnO2)

Instructions

1 Take two labelled test tubes and half-fill one with water and one with hydrogen peroxide.

2 Make an observation of each liquid and record what they look like in your table of results.

3 Add a small spatula of manganese dioxide into both test tubes.

4 Make another observation of both test tubes and record what they look like into your results table.

[C HEAD] Safety!

Hydrogen peroxide solution, 100 vol H2O2 (aq) is corrosive.

Wear splash-proof goggles.

Manganese(IV) oxide, MnO2 (s) is harmful if swallowed or inhaled.

Experimental tests (page 189)

Aim: To explore energy changes during chemical reactions

Equipment

- Vinegar
- Baking soda
- Water
- Thermometer
- 4 small clear plastic cups
- 1 cup measuring cup
- Measuring spoons (1 tablespoon, 1⁄2 teaspoon)

Instructions

1 After students explore one example of an endothermic change and one example of an exothermic change, they are then asked to explore the connection between energy changes and chemical reactions. To do this, students may need some guidance to arrive at the idea that temperature changes may also accompany dissolving.

2 Students will have an easier time devising a fair test if they are well versed in the definitions of physical changes and chemical changes. Students should propose an experiment to you before they test their hypothesis. To observe a temperature change during a physical change, students should devise a procedure such as:

3 Add 10#mL of water to a small plastic cup and place a thermometer in the water. Record the initial temperature (Ti).

4 Add 1⁄2 teaspoon of calcium chloride to the water and swirl the cup. After it has stopped changing, record the final temperature (Tf).

Safety!

Be sure you and the students wear properly fitting goggles.

Acetic acid (vinegar) vapours can be irritating. Work in a well-ventilated area. In the event of eye contact, flush with water. The concentration of acetic acid in this experiment does not present any significant hazards.

Calcium chloride can be an irritant to body tissues. In the event of contact, wash affected areas with water. Dispose of calcium chloride solutions according to local regulations.

Note; Burning Methane should be done as a demonstration. Gas from the gas taps should be bubbled through a water and detergent solution and a lit splint should be used to set the bubbles alight.