

●●○ MEDIUM

8 – 14

1 – 1½ HRS



1 Learn about the work of Robert Angus Smith

2 Analyse different water samples for acidity

3 Find out how acid rain can damage buildings and structures

STORIES IN CHEMISTRY

ACIDIC APRIL SHOWERS

Illustration: Robert Angus Smith



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INTRODUCTION

Robert Angus Smith was born in Glasgow. He started training to be a religious minister, but left before graduating. He was inspired to study chemistry instead, eventually being awarded a PhD.

Robert Angus Smith went to Manchester where he became interested in the environmental issues arising from air pollution.

At that time, Manchester was the world's first large industrial city and was powered by coal. Smith investigated the chemistry of rainwater in northern British cities. He deduced the rainwater was acidic as a consequence of burning of coal contaminated with sulphur. During his research, he discovered what came to be known as acid rain.



DID YOU KNOW?

Over time, acid rain can slowly react with stone and can erode the detail on sculptures. Famous buildings like the Sphynx, the Acropolis in Greece, the Taj Mahal, and even the iconic cathedral at York and Westminster Abbey have been damaged by acid rain.



SAFETY

- **Always wash hands after handling rainwater.**
- **Do not drink rainwater.**
- **Alternatives to red cabbage include beetroot, blueberries or plums.**
- **Red cabbage may stain fabrics and clothing.**
- **This activity should be supervised by an adult at all times.**

ACTIVITY

ANALYSE DIFFERENT WATER SAMPLES FOR ACIDITY

To commemorate Robert Angus Smith's discovery of acid rain, this activity will show you how to collect rainwater and to test for acid rain.

INSTRUCTIONS

ACTIVITY 1 – Make a rain gauge and red cabbage indicator

1. Place a clean, dry 2 litre plastic bottle on a chopping board, and remove the labels and lid. Using scissors, cut all the way around the bottle, about $\frac{2}{3}$ up, so that the smaller piece contains the neck of the bottle.
2. Turn the neck of the bottle upside down to form a funnel and place it inside the base of the bottle. This is now your rain gauge.
3. Place the finished rain gauge in an outdoor area and leave to collect rainwater.
4. Fill a 500ml measuring jug with small pieces of chopped or torn red cabbage and add hot water from the tap up to the 500ml mark. Leave for 15 minutes, until the water is dark purple coloured and has cooled. Filter through a tea strainer or sieve to remove all the lumps of cabbage.
5. Fill each of 3 jam jars about $\frac{1}{3}$ full of this red cabbage indicator. Add a teaspoon of vinegar which is acidic to one, leave the

other with nothing in it, and to the third jam jar add a teaspoon of bicarbonate of soda, which is alkaline. The indicator should turn red/pink when mixed with an acid, stay purple with nothing added, and turn blue when mixed with an alkali.

ACTIVITY 2 – Comparing different waters for acidity

1. Place four clean and dry jam jars, each a third full with red cabbage indicator, up against a window.
2. Add sparkling mineral water to one of the jam jars until the jar is $\frac{2}{3}$ full. Repeat with still mineral water in the second jam jar, tap water in the third jam jar and the rainwater collected in the rain gauge in the fourth jam jar. Observe the colours carefully. Which of the waters is the most acidic (pink/red), and which are the most alkaline (purple/blue)? How does your rainwater sample compare with the other types of water, is it acidic or alkaline?



YOU WILL NEED

- Empty 2 litre plastic bottle
- Scissors
- Chopping board
- Red cabbage
- 500ml measuring jug
- Tea strainer or sieve
- 4 clean jam jars
- Vinegar
- Bicarbonate of soda
- Small bottle sparkling mineral water
- Small bottle still mineral water
- Teaspoon



WHAT'S HAPPENING?

Burning fuels such as wood, coal, petrol and oil releases air pollution. When this air pollution mixes with tiny water droplets in the atmosphere, it dissolves. When this water falls to the ground as rain, snow or hail it is known as acid rain. In large cities during Victorian times lots of coal containing sulphur was burned in homes and factories; this caused acid rain which made bricks and buildings crumble.

Sparkling drinks are pumped full of carbon dioxide gas before they are sealed to make them 'fizzy'. As carbon dioxide gas dissolves in water, it becomes more acidic. Carbon dioxide is one of the air pollution gasses released by burning fuels like coal, which can cause rainwater to become acidic.