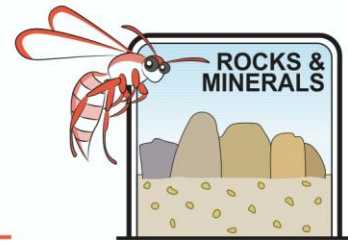
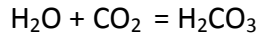


## Acid Rain - Teacher Notes

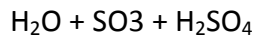


Acid rain is produced when carbon dioxide, sulphur trioxide and nitrogen dioxide are dissolved in water vapour in the atmosphere

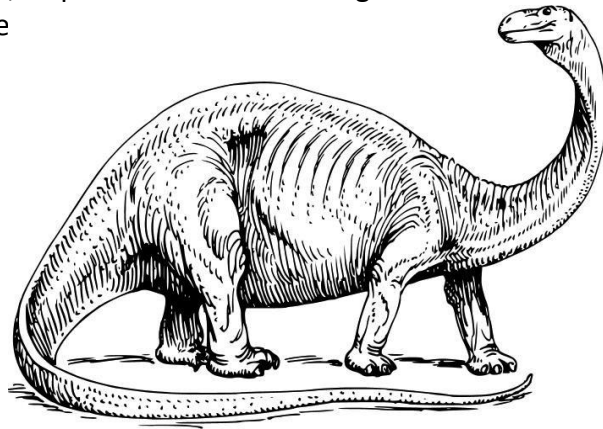
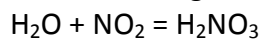
Water + Carbon dioxide = Carbonic acid



Water + Sulphur trioxide = Sulphuric acid



Water + Nitrogen dioxide = Nitric acid



### ***Interesting Geological Interpretation***

Many of Earth's major extinction events have been preceded by unusually widespread and long lasting volcanic outpourings termed flood basalts. It is thought that the resultant dust clouds reduced photosynthesis whilst acid rain produced from the noxious gasses reduced available food for larger life forms.

At least two major extinctions have shown evidence to follow this pattern:

- K-T extinction (65.5my) 75% species became extinct. Dinosaurs disappear, mammals and birds emerge
- The Great Dying (251my) Earth's greatest extinction. Over 90% of species die out.

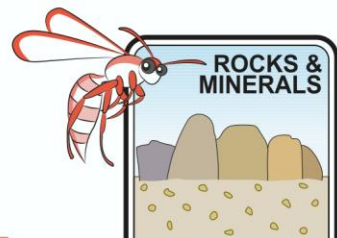
These extinction events have three distinct sequential phases covering tens of millions of years

1. Massive volcanic outpourings
2. Warmer climate and acidification of the seas
3. Rapid temperature rise perhaps driven by methane release

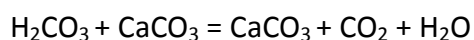
NB Although carbon dioxide has been demonized as a greenhouse gas causing a negative change in global climate, it was necessary to create the conditions to support life. Carbon dioxide in the atmosphere stops heat from the sun being instantly reflected back out into space leaving our planet a cold life-free place. When living things respire (use carbohydrates to create energy) carbon dioxide is a by-product. Carbon dioxide has always been present and essential however the rate of recent increase is certainly problematic. Most life is dependant on enzymes as catalysts for effective functioning. Enzyme function is affected by both heat and acidity.

Since the Industrial Revolution when people stopped relying on energy from themselves and from pack animals and changed to using fossil fuels, large quantities of carbon dioxide, sulphur dioxide and nitrogen oxide have been released into the atmosphere where they are dissolved in water and fall as acid rain. Acid rain has badly affected vegetation down wind from factories. Rocks, houses and masonry have been also been damaged.

## Acid Rain - Teacher Notes



Carbonic acid + carbonate (marble, limestone or chalk) = calcium salt + carbon dioxide + water



The following activities use carbonic acid because it is mild. Students need to know that:

An acid turns Universal indicator red

Neutral solutions turn Universal indicator green

Bases or alkalis turn Universal Indicator Blue

### Using CO<sub>2</sub> to create carbonic acid

I suggest that this activity is carried out as a competition between teams of 4 or 5 students. Each student has their own straw and can only blow for 1 minute before passing on to the next student (to prevent cases of hyperventilation) and overblowing. Splatter on the paper costs a 30 second handicap. The beakers of water are placed on white scrap paper or a light coloured bench top to more easily show colour change.

We can test that an acid is formed when we breathe out.

Materials required per student or group

- A small beaker or container with 100mL water
  - A drinking straw for each student
  - A dropper bottle with Universal Indicator
  - One sheet of white paper
1. Place the beaker of water on a white sheet of paper and add a few drops of Universal indicator until it turns green
  2. Students take turns to blow into the water for one minute. Any water splattered over the edge of the beaker incurs a penalty of waiting 30 seconds.
  3. The process continues until the liquid turns red indicating an acid has been produced

By the end of one minute the liquid should be turning yellowish, by the end of five becoming orange and by ten minutes a reddish tinge should be discernable if the glass is held against a white background. Students who play bagpipes or didgeridoos need to rein in their reverse cycle breathing.

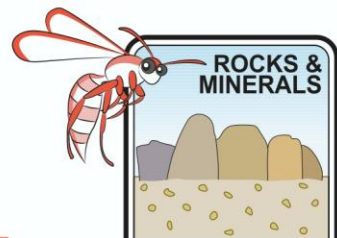
**Interesting Facts**      *The air we breathe in contains 0.39% carbon dioxide*

*The air we breathe out contains 4.0% carbon dioxide*

**Tourists are only permitted to visit the cave paintings at Lascaux for a few days each year because their breath has made the damp cave air acidic and the paintings are becoming affected**

NOTE in a chemical change **reactants** are mixed together to form a **product**

## Acid Rain - Teacher Notes



Answer the questions below

Which are the **reactants** (original materials)? **Water and carbon dioxide**

What is the **product**? **Carbonic acid**

What is the purpose of Universal Indicator? **To indicate if the liquid has changed from being neutral to being an acid**

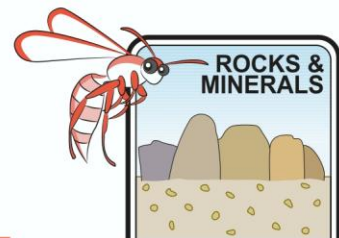
What colour was the water in the beaker immediately after adding Universal Indicator?  
**Green**

What happened to the colour of the water after blowing into it for ten minutes? **The water became pink or red.**

What did this change in colour indicate? **The water had changed from neutral to an acid**

Is this a chemical or physical change? Explain your answer. **A change of colour indicated that a new substance had been created, an acid. This is a chemical change.**

## Acid Rain - Teacher Notes



### Extra for experts

The major contributors to carbon dioxide in the atmosphere prior to the industrial revolution were volcanoes. When fossil fuels are burned, large amounts of sulphur dioxide and nitrogen oxide are released. These dissolve in water to form highly active sulphuric acid and nitric acid

### Extension: Kitchen Science

Students can create their own vegetable indicators by crushing colourful plants such as purple cabbage, nasturtium leaves and flowers and rose petals with a mortar and pestle with a little sand. Alternatively vegetable material can be placed into a blender with a little water and processed until liquid. Crushed purple cabbage can also be boiled. The spice turmeric can be boiled in water

The liquid produced can then be passed through kitchen cloth (Chux?) to remove lumps. The filtrate can be reserved in a bottle or jam jar for experiments.



Small amounts of foods, drinks, household cleaners and toiletries can be placed in a clean saucer and tested using these indicators.