



# KNYSNA BASIN PROJECT

## CLIMATE CHANGE SCIENCE EXPERIMENTS

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## What is climate change?

Climate change refers to the change in regional or global climate patterns which include changes in average temperature, humidity, and rainfall patterns over a long period of time. Climate change is mainly associated with global warming which is the rise in average global temperatures due to the greenhouse effect (increased amounts of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), water vapour (H<sub>2</sub>O) and ozone (O<sub>3</sub>) in the atmosphere).

Listed below are some of the effects of climate change:

- Increased temperatures may lead to increased evaporation resulting in increased extreme events such as droughts, heat waves and wildfires in certain areas. Increased precipitation may lead to events such as floods, hurricanes and thunderstorms.
- Melting ice caps results in sea level rise and can cause related habitat degradation.
- Increased ocean acidity due to an increase in CO<sub>2</sub> levels in the ocean.
- Species extinction seeing that some species may not be able to adapt to the rate of environmental change.
- Warmer temperatures may expand the range of many disease-causing pathogens, therefore exposing more animals to diseases that were otherwise confined to a certain area.
- Degradation of agricultural systems because of increased droughts and extreme weather.

However, through conservation and education we can reduce the effect of climate change. Through this guide we hope to provide relevant information of what climate change is and what impact it can have on our environment and lives. It provides step by step instructions on how to conduct climate change related experiments as a tool to teach learners about climate change. It also provides solutions on how to reduce the effect of climate change. Each experiment is linked to the Curriculum Assessment Policy Statement (CAPS) document.

## Experiment 1: Acidification of the Oceans

An increase of CO<sub>2</sub> in the atmosphere can lead to ocean acidification. CO<sub>2</sub> (excess) in the ocean turns the water acidic.

### Needs:

1. Universal indicator or red cabbage
2. Four see-through containers
3. Straw
4. Carbon dioxide (CO<sub>2</sub>) through breathing into the container
5. Vinegar
6. Bleach

### Method:

1. Boil the cabbage, filter out the leaves and discard whilst keeping the red liquid,
2. Pour the red cabbage water into four see-through containers,
3. Add bleach (base) in one of the containers and the vinegar (acid) into the other. The bleached cabbage water will change into a green(ish) colour whilst the vinegar will turn the cabbage water a pink(ish) colour. This should give the learners an indication of what colour an acid or basic solution will produce,
4. Using a straw (metal), blow through one of the untouched containers to create bubbles,
5. CO<sub>2</sub> generated through breathing into the container will react with the water to form carbonic acid, changing the red cabbage water to a pink(ish) colour. The cabbage juice acts as an indicator and will change colour as CO<sub>2</sub> is bubbled into the water and as the solution changes from a neutral solution to an acidic solution.

## Chemical Reactions:



## Discussion points:

Ocean acidification is the decrease in pH of ocean water caused by an increase in the amount of  $\text{CO}_2$  in water which may lead to the water becoming acidic. Increased burning of fossil fuels and cutting down of trees (deforestation) increases the amount of  $\text{CO}_2$  in the atmosphere and therefore the amount absorbed by the ocean. This has a negative effect on marine animals especially animals with calcium carbonate shells. These shells will dissolve in an acidic solution. As a result of this, species with shells may die out which may then have an effect on the animals and humans that feed on these animals, ultimately, affecting the whole food chain. To try and alleviate ocean acidification we can plant more trees as  $\text{CO}_2$  is needed and used by plants for photosynthesis. Plants can no longer provide this service as they are cut down for development. We can also reduce the amount of fossil fuels we use by reducing our electricity consumption and using more energy efficient transport systems such as lift clubs or busses.



**Figure 1: Red cabbage water used as an indicator at different pH values showing how the colour changes from an acidic solution (pH 2) towards a basic solution (pH 11)**

## Experiment 2: Corrosion of sea animal shells as a consequence of ocean acidification

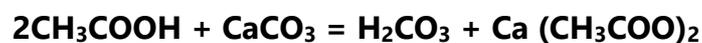
### Needs:

1. Two seashells – mussel shells work well
2. Vinegar
3. Ocean water
4. Two see-through bowls (containers)

### Method:

1. Fill one container with vinegar and the other with ocean water,
2. Place one seashell in the container with vinegar and the other in the container with sea water. It will take weeks for the seashell to start corroding.
3. Observe as the vinegar (acid) corrodes the seashell

### Chemical reaction:



### Discussion points:

Discuss the growing problem of ocean acidification which causes the corrosion of calcium carbonate shells. These organisms can be important links in the marine food chain. The increase in ocean acidification could significantly reduce the ability of these creatures to build their casings. See above discussion.



Figure 2: Acid corrosion of shells over time.

Experiment 1 & 2 can be linked to the following topics in the Natural and Physical Sciences CAPS document:

<b>Grade</b>	<b>Topic</b>	<b>Link</b>
Grade 4 Term 4	Planet Earth: Most of the surface of the Earth is covered in water (oceans and seas).	Experiments 1 and 2 show how climate change (increased CO <sub>2</sub> levels) affect the quality of water. It makes it more acidic which in turn influences marine animals, specifically those with calcium carbonate shells. This then has an even greater effect on the marine food chain as animals and humans that feed on them may not have food.
Grade 5 Term 1	Plants and animals on Earth: Interdependence	Most things on earth depend on each other and experiment 2 shows how an increase in CO <sub>2</sub> in the water affects marine animals and the food chain.
Grade 6 Term 1	Ecosystems and food webs: Non-living and living things in ecosystems	Explore the relationship between living (animals) and non-living things (water), how they impact each other.
Grade 6 Term 2	Mixtures and water resources: Water pollution	These experiments show exactly how human activities through burning of fossil fuels and deforestation can lead to an increase in CO <sub>2</sub> , therefore, turning the water more acidic.
Grade 7 Term 2	Acid-base indicators	Experiment 1 distinguishes between acids and bases.
Grade 9 Term 2	Acids, bases & pH	Experiment 1 distinguishes between acids and bases and explains what pH is.
Grade 10 Term 3	Reactions in aqueous solution: Acid-base reactions	Experiment 1 shows the effect of a base and an acid and explains what each one is.
Grade 11 Term 3	Energy and chemical change: Type of reactions- acid-base reactions	Use experiments to show what indicators are.

## Experiment 3: Global warming (melting of ice caps)

### Needs:

1. Two blocks of ice
2. Two towels (1 warm and 1 cold)
3. Stopwatch

### Method:

1. Cover the blocks of ice with the towels,
2. Time how long each block of ice took to melt.

### Discussion points:

Discuss greenhouse gasses. The primary greenhouse gases in earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide and ozone. Without greenhouse gases, the average temperature of earth's surface would be about  $-18\text{ }^{\circ}\text{C}$ , rather than the present average of  $15\text{ }^{\circ}\text{C}$ .

The greenhouse effect occurs when certain gases in the earth's atmosphere traps infrared radiation (blanket effect demonstrated with the towels). This makes the planet become warmer, similar to the way it makes a greenhouse become warmer. Humans increase greenhouse gasses by:

- Burning fossil fuels for oil and energy production, manufacturing, transportation.
- Agriculture and the use of fertilizers increases the emission of nitrous oxide.
- Deforestation leads to trees being cut down and the carbon stored in the decomposing or burnt tree escapes into the atmosphere.
- Decomposition of waste at landfill sites gives off a gas called methane.

We can reduce the amount of greenhouse gases by reducing our electricity usage, using more fuel-efficient transportation, planting trees, reduce water waste, using more sustainable agricultural methods and recycling.

## Experiment 4: Sea level rise due to global warming

### Needs:

1. Power source
2. Hair dryer
3. Block of ice
4. Container with a small model city

### Method:

1. Place the ice block in the container with the small city model,
2. Using a hairdryer, melt the ice,
3. As the ice melts, it will flood the city.

### Discussion points:

Discuss the melting rate of the polar ice caps that contributes to sea level rise and indirectly flooding. Higher global temperatures melt glaciers, which flow into the oceans, adding to the amount of seawater. A large rise (on the order of several meters) in global sea level poses many threats to both animals and humans. Habitats may be submerged by the high-water levels, destroying some ecosystems. Saline water intruding on freshwater will have an impact on species that are adapted to freshwater environments. Birds that nest on certain islands may also be vulnerable due to flooding and intense storm surges. Humans who live near the coast especially on small islands, are at risk of property damage and economic loss as some depend on commercial fishing for income.



**Figure 3: Sea level rise due to melting icecaps (or ice-cubes) experiments.**

## Experiment 5: Heat Capacity of water contributing sea-level rise

### Needs:

1. Two balloons
2. Lighter
3. Water

### Methods:

1. Fill one balloon with water,
2. Fill one balloon with air,
3. Light the balloon with air (it will pop because air has a low heat capacity),
4. Then light the balloon filled with water.

### Discussion points:

Discuss the high heat capacity of water and particularly its expansion when heated which will also contribute to sea-level rise. Between 80-90% of the heat in the earth is absorbed by the ocean.



Figure 4: Heat resilient balloon due to heat capacity of water

Experiment 3, 4 & 5 can be linked to the following topics in the Natural and Physical Sciences CAPS document:

<b>Grade</b>	<b>Topic</b>	<b>Link to CAPS document</b>
Grade 9 Term 4	Atmosphere	This experiment shows how global warming leads to an increase in sea level rise.
Grade 10 Term 1	Three states of matter	This experiment can be used to show how water stored in glaciers (ice) melts to become liquid, therefore leading to sea level rise.
Grade 10 Term 2	Physical and chemical change: Separation of particles in physical and chemical change	Show how ice, which is a solid is heated to liquid.
Grade 11 Term 1	Intermolecular forces: How hydrogen bonds and density affect water.	Explain how hydrogen bonds formed by water enable water to absorb heat from the sun and how that affects the earth's climate. Also, explain how density affects water.

## Experiment 6: Soil erosion

### Needs:

1. Three 2 litre containers cut across in half
  - 1 – Pack with just soil
  - 2- Pack with soil and dead leaves/rocks
  - 3 – Soil with grass planted on top
2. Three bottoms of 2 litre containers
3. Strings
4. Punch
5. Water

### Method:

1. Pour the same volume of water on top of the three different types of bottles,
2. Pour enough water that it overflows out of the mouths of the containers and into the collection containers,
3. Observe the clarity of the water exiting the mouth of the 2L bottles into the collection cups,
4. The bottle with just soil will erode the most. This will be visible as the water will leave with soil into the collection cup while the container with plants in it will not erode at all.

### Discussion points:

During deforestation large areas of bare sediment are left, without any vegetation to secure the sediment. In addition, water is not absorbed into the soil as there are no trees to take up the water through their roots. During heavy rains the water runs off causing erosion. Plants are important in reducing erosion because they absorb and store rainwater which reduces runoff and sediment deposit and play an important part in limiting the impact from flooding.



Figure 5: Soil erosion demonstration using bare, partially covered and fully cover soil.

Experiment 6 can be linked to the following topics in the CAPS document:

Subject & Grade	Topic	Link
Natural Sciences: Grade 5 Term 4	Surface of the Earth: Rocks, soils	The role of soil and plants in climate change.
Geography: Grade 9 Term 3	The impact of people on soil erosion	During flooding events plants reduce erosion by protecting the soil against the impact of the flood. Therefore, planting more reduces soil erosion.
Geography: Grade 11 Term 4	Resources and Sustainability: Soil and erosion	Soil as a resource and the effects of erosion on the environment.