

The Greenhouse Effect

Student Worksheet

Name: _____
Class: _____
Date: _____

Aim

The aim of this experiment is to model two environments to investigate the greenhouse effect and nutrient cycling.

Background Information

The greenhouse effect is a natural process that keeps Earth at a mild, stable temperature that is suitable for life. Greenhouse gases play a vital role of trapping heat in the atmosphere. The most common greenhouse gases are water vapour, carbon dioxide, methane and ozone.

Short-wave radiation from the Sun bombards the Earth. Some of the radiation is immediately reflected back into space or absorbed by the atmosphere. The rest reaches Earth's surface, before being reflected as long-wave radiation (heat). The long-wave radiation has difficulty getting back through the atmosphere and into space. This is because greenhouse gases absorb it or reflect it back towards the surface of the Earth.

The glass walls of a greenhouse work in a similar way to the atmosphere. Short-wave radiation from the Sun passes through the walls and roof of the greenhouse. The ground reflects long-wave radiation (heat), which rises and is contained by the glass walls and roof. This is how the glass walls trap heat inside a greenhouse. Mini-greenhouses, like terrariums, can be used to model the greenhouse effect because they trap heat in a similar way to the atmosphere. A terrarium is a small, self-sufficient environment in which plants can be grown. The container can be sealed or unsealed, depending on the type of environment being replicated.

Sealed (closed) terrariums are excellent recyclers. The air inside a terrarium is heated as sunlight that passes through the walls and roof. The warm air rises and cannot escape, which increases the temperature inside the terrarium. As the environment gets warmer, any water inside the terrarium evaporates and rises. However, the water vapour cannot rise beyond the roof of the terrarium and so it condenses, creating a miniature water cycle.

As organisms start to decay and bacteria works in the soil, carbon dioxide (CO_2) is released into the air inside the terrarium. The CO_2 builds up and is absorbed by plants during photosynthesis. The plants release oxygen (O_2) as a by-product of photosynthesis. However, during the night, plants are not able to photosynthesise. Over the night, they consume large amounts of O_2 during respiration to create usable energy. This process also creates CO_2 as a by-product, which is released back into the air inside the terrarium.

The Carboniferous Period (359 - 299 million years ago) is well known for having the highest concentrations of atmospheric oxygen ever experienced on Earth. The climate was more hot and humid than it is today, and the Earth was covered in vast amounts of vegetation. Plants thrived during the Carboniferous, since the elevated oxygen levels promoted more efficient rates of respiration. As a result, Carboniferous plants grew rapidly and reached sizes beyond anything recorded today.

Pre-Practical Questions

1) Why is the greenhouse effect important for life on Earth?

2) Name two greenhouse gases.

3) How do greenhouses capture heat?

4) Where does the water come from in a closed terrarium?

5) Where does the CO₂ come from in a closed terrarium?

6) Where does the O₂ come from in a closed terrarium?

Practical

This is a long term experiment. Measurements and observations will be conducted over a period of one month.

Terrarium Materials

Two terrariums - a desert and a rainforest - will be made to model and investigate the greenhouse effect. These preparations need to be made well ahead of time so the terrariums can settle and begin to replicate their natural environment.

- A large plastic bottle or glass jar with a lid for the rainforest environment
- A large serving bowl, china dish or bottle with no lid for the desert environment
- Activated charcoal
- Gravel or small rocks
- Water spray bottle
- Sterilised potting mix for tropical plants
- Potting mix for succulents
- Sphagnum moss or netting
- A number of plants that thrive in damp environments for the rainforest terrarium and some succulents for the desert terrarium

Building a Rainforest Terrarium

Ensure the materials only take up 1/3 of the space in the container.

1. Place 1 - 2 inches of gravel into the base of the container.
2. Apply a thin layer of activated charcoal over the gravel.
3. Cover the charcoal with sphagnum moss or netting.
4. Place a layer of sterilised potting mix on top of the moss or netting, deep enough that plants will have enough room to grow.
5. Add a few plants suitable for a damp environment. Do not crowd the container.
6. Give the container a spray of water.
7. Put the lid on.
8. Place the container in a well-lit position, but not in direct sunlight.

Building a Desert Terrarium

1. Place 1 - 2 inches of gravel into the base of the container.
2. Cover the gravel in succulent potting mix. This layer should be deep enough to allow the succulents to grow (about 2 inches deep).
3. Add a few succulents to the container and give a light spray of water. Don't crowd the container with plants.
4. Place the container in a well-lit area and leave to settle.

Experiment Materials

- Prepared terrariums
- Thermometer or Temperature Sensor
- Carbon Dioxide Sensor
- Relative Humidity Sensor

Experiment Method

1. Use the sensors to take daily measurements of temperature, humidity and CO₂ in both terrariums.
2. Record the measurements in a table.
3. Consider additional observations to be taken. These might include airflow, soil characteristics, light intensity, leaf structures, plant growth, plant characteristics, root structures, plant adaptations, leaf growth and leaf colour. These observations can be conducted in any way, as long as they are kept consistent throughout the experiment.
4. Record the additional observations in table.
5. Continue to take measurements and record observations for a month.

Results

You can create a table to record your measurements and observations in the space below.

Title: _____

Results Questions

Answer the following questions on a separate piece of paper.

- 1) What happened to the temperature of the rainforest environment?
- 2) What happened to the temperature of the desert environment?
- 3) What happened to the humidity of the rainforest environment?
- 4) What happened to the humidity of the desert environment?
- 5) What happened to the CO₂ levels of the rainforest environment?
- 6) What happened to the CO₂ levels of the desert environment?

Discussion Questions

Answer the following questions on a separate piece of paper.

- 1) What happened to the temperature in the terrariums? Why do you think this happened?
- 2) Was there a change in humidity in both environments? Why do you think this happened?
- 3) In a closed environment, where no CO₂ is added, where does the required CO₂ come from?
- 4) Explain how the rainforest terrarium survived even though nothing was added to the ecosystem over time.
- 5) How does the greenhouse effect work? What affect does this have on vegetation? Using this knowledge, predict what you think might happen on Earth as the temperature and CO₂ levels continue to rise.

Extra for Experts

Answer the following question on a separate piece of paper.

- 1) Imagine you have a salt water aquarium set up with a few different types of marine plants, however the plants aren't doing well. You decide you want to see what will happen to the aquarium if you alter aspects of the environment. You place a lamp over your aquarium and increase the amount of light received each day. You also decide to pump additional carbon dioxide into the water. What do you think will happen to the plants in your aquarium?