Rainfall Now and Then

Suitable for UK KS2 or ages 7-11

Notes for teachers

At a glance

This lesson is inspired by research at Oxford University into the climate during the Cretaceous period, 140 million years ago. As rocks formed, they used oxygen from rain, preserving it and the isotopes it was made of. Oxygen-18 is heavier than oxygen-16, and falls from the clouds first when it rains, leaving heavier isotopes of oxygen behind closer to the equator, and lighter isotopes closer to the poles.

In this lesson, students will follow Ricky, a researcher, to learn about how our planet's climate has changed over time and explore the features that make plants and animals well-adapted to their environment. They will study the experimental technique that Ricky uses to prepare samples and identify some challenges before performing similar experiments. They will compare measurements of the past climate to measurements of the weather and climate today, and build their own rain gauge. Students will be encouraged to answer open-ended questions and discuss their ideas with other students.

Learning Outcomes

Knowledge

- Learn about how the climate has changed between the Cretaceous period and today.
- Identify specific adaptions that make plants and animals well suited to their environments.

- Recognise that living things have changed over time.
- Understand more about the water cycle, evaporation, dissolution and condensation.

Laboratory skills

- Develop an understanding of the scientific method through comparing experiments done on the past and today, and identifying challenges.
- Ask questions, make predictions, and record observations and measurements.
- Develop good laboratory and scientific skills, including where to place a rain gauge to get reliable results.
- Develop links between fields such as biology, chemistry and geography, and understand how research is interlinked.

Each student will need

- A copy of the student worksheet
- Some powdered chalk
- Some sand
- A spoon
- A sample of weak acid (suggestions: 2 mol dm^{-3} HCl/vinegar)
- A plastic dropping pipette
- A tray, 2 x watch glasses, or 2 x petri dishes to perform the reaction on
- An empty 2 litre plastic bottle
- A funnel template (Appendix 1)
- Tape
- Scissors
- A graduated measuring cylinder about 20 cm tall

Possible Lesson Activities

1. **Starter activity**
    - Ask the students to read the first column of the worksheet and fill in the blanks as they watch the video, 'Using your science to reveal how much rain fell on the dinosaurs' (see web links).
    - Feedback answers as a class and go over the correct answers and how to do the sums.
      Answers are provided in Appendix 2.

2. **Main activity: Experimenting with rocks**
    - Ask the class to read through '**How does Ricky measure rainfall?'** on the worksheet and fill in the blanks.
      Answers are provided in Appendix 2.
    - Encourage the class to talk amongst themselves about what makes an experiment challenging and what they might find hard if they repeated Ricky's experiments.

      Hints:
      Where would you go to collect the samples?
      Is this a task you could do by yourself?
      What tools would you use to crush the samples?

What are the risks of working with acids?
Mass spectrometers are very sensitive machines. Can you think of any challenges using one?

- Move on to the section **'Experimenting with rocks'**. Before they can begin the experiment, they will need to make predictions about what will happen.
- Perform the experiment, ensuring the class are equipped with suitable PPE such as goggles and gloves for handling acid. Different acids can be used if the class are familiar with handling them.
- Invite the class to share their discoveries and talk about the experiments.
- To complete this activity, ensure the students have filled in their worksheets and read the final passages.

3. Main activity: Making a rain gauge

- Ask the class to read through **'Time-travelling'** on the worksheet and fill in the blanks.
  Answers are provided in Appendix 2.
- Write **meteorologists** and its definition up on the board.
- Ask the class to read through **'Making a rain gauge'** on the worksheet before starting the making.
- Encourage them to plan where they might place their finished rain gauge.

4. Plenary

- Ask the students what they already know about plant and animal **Adaption**.
- Introduce them to *Buccinatormyia magnifica* – a type of fly and discuss it as a class.

  How do we know what animals from the Cretaceous looked like?
  Dr Ricardo Pérez-de la Fuente is a palaeobiologist who looks at fossils, especially those of insects and arachnids preserved in amber. He is looking for signs of early defensive adaptions including camouflage – can you see any? He's also interested in which flowering plants were found in some of the same places as his fossilised insects – why do you think this is? This fly is carrying a lump of pollen.
  Source: González, Encarnación, et al. "Conocimiento de pediatras y padres andaluces sobre caries de aparición temprana." Anales de pediatría. Vol. 82. No. 1. Elsevier Doyma, 2015. https://www.sciencedirect.com/science/article/pii/S096098221500665X

- Ask the students to read through the rest of the **'Adaption'** section and label the plants and animals with specific adaptions that make them suited to their environments. Remind them of the differences between the Cretaceous period and today and encourage them to consider what adaptions might be necessary.

  e.g. for the Cretaceous period:
  Hot – animals would want to keep cool
  Forested wetlands and marshes – where would animals live?
  Few birds – invertebrates were often large
- A possible extension would be to create food chains for the Cretaceous period and today.

5. Optional Homework: Lab report

- Ask the class to use their rain gauge to record rainfall for 5 days, and write up their findings in a lab report. A good quality lab report should include:
  - An introduction, explaining what they wanted to find out and making a prediction.
  - A method, outlining the steps they performed when taking readings.
  - A drawing of the rain gauge.
  - A map of where the rain gauge was set up.
  - Results, presented clearly in tables and/or graphs.
  - A conclusion.
  - An evaluation, identifying sources of error and ways to improve the experiment.

Web links

Oxford Sparks video 'Using your science to reveal how much rain fell on the dinosaurs':
https://www.oxfordsparks.ox.ac.uk/content/using-your-science-reveal-how-much-rain-fell-dinosaurs

Image sources (public domain):
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https://en.wikipedia.org/wiki/Botanical_name#/media/File:English_Daisy_(Bellis_Perennis).jpg

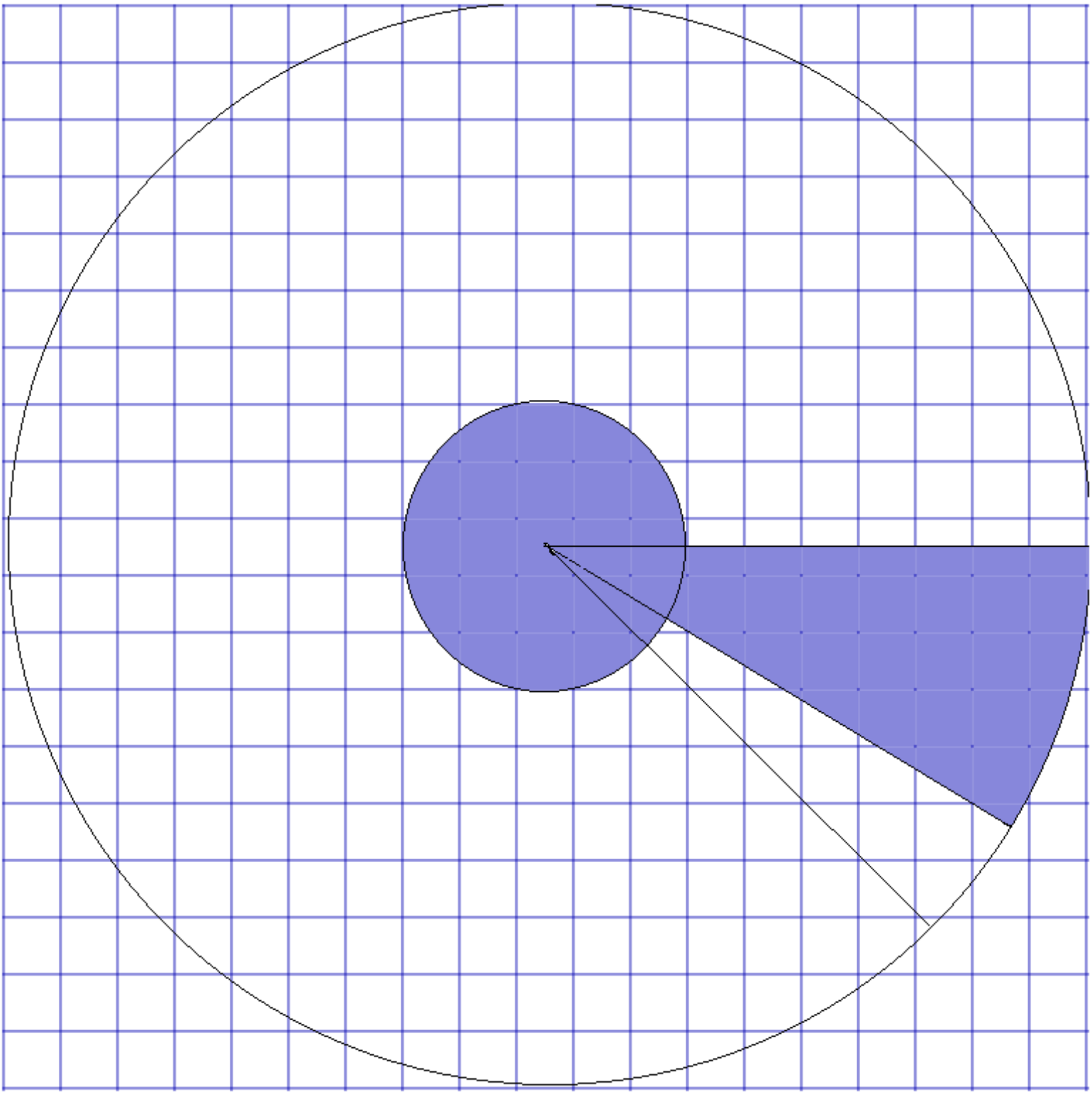
Image source (permissions granted):
https://oumnh.ox.ac.uk/people/ricardo-perez-de-la-fuente
Reconstruction by J. A. Peñas. Publication: Peñalver et al., 2015. Research by Dr Ricardo Pérez-de la Fuente.

Safety disclaimer: The practical work suggestions given here have not been tested by us for safety. While the suggested practical work is based on existing laboratory experiments, you should always carry out your own risk assessment, especially before using or making a hazardous procedure, chemical or material. All practical work should be supervised by a qualified science teacher with suitable knowledge of the equipment used and carried out in a properly equipped and maintained laboratory. For more information, refer to www.cleapss.org.uk/.

Appendix 1. Funnel template

The class should cut out the cone , chopping out and discarding the shaded section. The addition segment provides a guide of how much to overlap the edge as the cone is formed.

Printed **this size** on A4 paper, the funnel will be 18 cm diameter, once formed. To achieve 20.3 cm, print to 23.2 cm wide.



Appendix 2. Answers

Starter activity: watch the video carefully and fill in the blanks in the table below:

	Units	Now	Then	
Carbon dioxide levels	parts per million	400	1000	How many times higher? 1000/400 = 2.5
Ocean surface temperature	°C	17	30	How many degrees hotter? 30-17 = 13 °C
Annual rainfall	mm	650	1000	Was it wetter or drier in the past? Wetter

How does Ricky measure rainfall?

1. Ricky collects **carbonate** minerals. Her favourite mineral is called **siderite**.
2. She **crushes** them up.
3. She **dissolves** them in acids.
4. She puts her samples into a **mass spectrometer**.
5. The result she gets is a **ratio** of oxygen-16 to oxygen-18.
6. She **calculates** how much rainfall there was in the Early Cretaceous period.

Challenges of Ricky's experiments:

1. Finding good sample sites
2. Digging up samples
3. Crushing rocks
4. Handling acid/dissolving samples
5. Using the machine correctly/same way each time

Any other sensible answers.

Experimenting with rocks

Observations with (a) sand: No reaction
Observations with (b) chalk: Fizzing

Time-travelling

Carbon dioxide sensor, thermometer, rain gauge.