7. Earth 1

LEARNING CONTEXT

AQA Big idea: 3.7 Earth

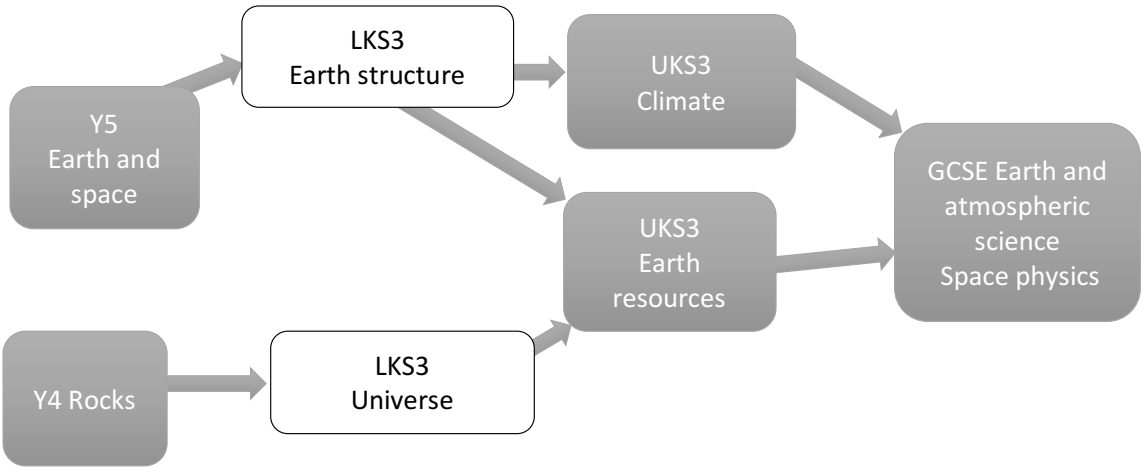
AQA Strand: 3.7.1 Earth structure 3.7.2 Universe

AQA Enquiry processes: 2.3 Draw conclusions 2.7 Critique claims

How this provides GCSE readiness: The concept of the structure of the Earth and the implications for this in terms of atmosphere and resources are important ideas in GCSE specifications. The ability to draw conclusions and critique claims made from experiments are fundamental aspects of working scientifically.

Focus of this task: Studying rocks to discover more about the planet Mars

Diagram showing connectedness of ideas



Key words

- Rock cycle
- Weathering
- Erosion
- Minerals
- Sedimentary rocks
- Igneous rocks
- Metamorphic rocks
- Strata
- Galaxy
- Light year
- Stars
- Orbit
- Exoplanet
- Secondary data
- Real difference
- Claim
- Evidence
- Reasoning

TEACHING TASK

The idea

The rock cycle is a long, slow process that links the rocks and sediments of the Earth together. Digging down on Earth is a little like going back in time. Things that happened long ago, like volcanic eruptions or extinctions, may have been covered over by later events. Only by digging into the surface can we see what the Earth was like billions of years ago. To find out these things on Mars, we could also use rock samples from deep down to see how the planet has changed during the 4.5 billion years of its life.

Eliciting students' ideas

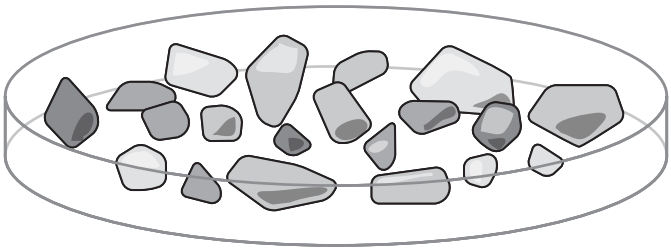
Ask students, how do scientists learn about the Earth from looking at the rocks? Lead this into a discussion about how we could find out about other planets by examining rocks – what could we find out? Discuss with students about some current ideas about Mars from astrobiology. Mars does not have any active plate tectonics, so there is no evidence of mountain building like the Earth, although there are signs of water erosion, so there was running water on the surface of Mars at some time in the past. Astrobiologists have identified three ages of Mars: cold and wet, snowball and hyper-arid (cold and dry).

The task

The Mars Rover has collected samples of the Mars rocks for analysis. As a student researcher, you have been given a simulated mixture based on the Rover's preliminary work.

Some of the sample is from deep below the surface as it is near where a meteor struck.

You will need to study the sample carefully to identify the geological processes that formed the substances and how these compare to Earth.



Equipment required:

- basin of Mars crustal material (mixture of coarse/fine sand, rounded pea gravel, rock salt, granite chips, pumice (or vermiculite), broken shells, marble chips)
- petri dishes for student samples
- forceps
- hand lens
- toothpicks (for separating out sample)
- labelled rock samples of sedimentary, igneous and metamorphic for comparison
- A3 paper (per student)

QUESTIONS AND ACTIVITIES

KNOW

- What are the different types of substance in your sample?
- Can you group the different substances in your petri dish into collections of your own? Draw circles on your A3 paper and place each of the samples into a circle.
- Label each circle with the key characteristics for the group.
- Compare your groups with the labelled rock samples. Are there any similarities?
- How are different rocks types formed on Earth?
- Describe where you might find some of the substances on Earth.
- Describe how they may have been formed on Earth.
- Is there enough evidence in the sample to be sure about the geological processes on Mars?
- Explain logically how each piece of evidence supports your opinion about the processes on Mars.
- Is all the evidence relevant?

APPLY

- Why have you chosen to group the substances as you have?
- Explain the features of the different substances and how they relate to the labelled rock samples.
- Describe what weathering and erosion process might have formed some of your sample.
- Decide how your sample could be linked to model a cycle (similar to the rock cycle on Earth) and rearrange the groups so the links become clear. Label an arrow between each group with the process involved in the transformation.

- Decide how some of the less obvious substances could be linked into the rock cycle you have created.
- Use the observations you have made to suggest what the Martian planetary conditions might have been in the past. Explain why you have made these suggestions.
- How could you check your suggestions?

EXTEND

- Extend your ideas by suggesting reasons for conditions on Mars being different from Earth.
- Give some suggestions to the timescales for each of the processes you have observed.
- Evaluate how realistic the sample has been in simulating Martian rock.
- How could the sample have been improved to make it more realistic?

INTERPRETING STUDENT RESPONSES AND PROBING UNDERSTANDING

Where previous questions have helped to explore students' knowledge, these bullet points outline only what is required for mastery of the topic and extension of that knowledge, so it is easy to assess progress throughout the activity.

Research shows that some students hold misconceptions in this area, including:

- Rocks must be heavy.
- Any crystal that scratches glass is a diamond.
- All rocks are the same, and it is hard to tell how they originated.
- Rocks and minerals are the same thing; distinguishing them is not important.
- Dinosaurs and cavemen lived at the same time.
- Continents do not move.
- Belief in the stability of the Earth surfaces so that when changes happen, they must be catastrophic.
- The Earth is 6–20 thousand years old.
- Earth is molten, except for its crust.
- The Earth's revolution around the Sun causes night and day.
- Winter is colder than summer because the Earth is farther from the Sun in winter.
- The Sun does not rotate.
- The Sun rises exactly in the east and sets exactly in the west every day.
- The phases of the Moon are caused by shadows cast on its surface by other objects in the solar system.
- The solar system contains only the Sun, planets and the Moon.
- Meteors are falling stars.
- Stars are evenly distributed throughout the galaxy.
- Gravity is selective; it acts differently, or not at all, on some matter.
- Gravity increases with height.
- Gravity requires a medium to act through.

KNOW

- Can the students classify the substances into organic and inorganic groups?
- Can they recognise the different types of rock samples?
- Can they describe how igneous rocks are formed?
- Can they describe how sedimentary rocks are formed?

APPLY

- Can the students relate the characteristics of the sample to different processes (for example, rounded is evidence for water transport)
- Can students model Earth's rock cycle using their sample?
- Can they suggest how the salt crystals and shells may be linked to the cycle (with sedimentary rocks)?
- Can they use their model rock cycle to demonstrate how processes may be similar between Mars and Earth?

EXTEND

- Can students evaluate how good the sample is as a representation of Mars?
- Can they relate the presence of marble chips and shells as evidence for complex life?
- Can they suggest how to improve the sample (for example, removing limestone/shells and replacing with iron oxide/lodestone/similar)?
- Can they give some suggestions to how Mars has transformed from wet, to cold, to dry over the last 4.5 billion years?

FURTHER IDEAS FOR INTERVENTION TASKS

It is important to recognise ideas that have been mastered and to consider the next steps in learning. The area of mastery (e.g. apply) provides a useful stem for giving feedback to students. Depending on the profile of progress, it might be appropriate to organise some further intervention. Examples of this might include:

- Give students a variety of geological samples (including gravel, sand and mineral crystals) and ask them to sort them into rock, mineral, crystal, stone, or other.
- Give students an opportunity to see how the weight of a whole biscuit compares to the biscuit broken into pieces to enhance ideas about conservation of matter and link to the weathering of rocks.
- Ask students to explain where sand on a beach comes from, enhancing ideas about weathering, erosion, and deposition.
- Link rock and mineral formation with observable properties by showing students video footage of a bubbling lava flow hardening and linking this to the tiny holes in pumice and basalt. Microscopic images of chalk can also illustrate the calcium carbonate shells that have formed it.

APPENDIX: AQA syllabus statements covered in this task

This is a full list of the AQA syllabus statements that this task covers

a) Earth structure

Area of mastery	**Model the processes that are responsible for rock formation and link these to the rock features**
Know	Sedimentary, igneous and metamorphic rocks can be inter converted over millions of years through weathering and erosion, heat and pressure, and melting and cooling. The three rock layers inside the Earth are the crust, the mantle and the core.
Apply	Explain why a rock has a particular property based on how it was formed. Identify the causes of weathering and erosion and describe how they occur. Construct a labelled diagram to identify the processes of the rock cycle.
Extend	Identify circumstances that indicate fast processes of change on Earth and those that indicate slower processes. Predict planetary conditions from descriptions of rocks on other planets. Describe similarities and differences between the rock cycle and everyday physical and chemical processes. Suggest how ceramics might be similar to some types of rock.

b) Universe

Area of mastery	Relate observations of changing day length to an appropriate model of the solar system
Know	The solar system can be modelled as planets rotating on tilted axes while orbiting the Sun, moons orbiting planets and sunlight spreading out and being reflected. This explains day and year length, seasons and the visibility of objects from Earth. Our solar system is a tiny part of a galaxy, one of many billions in the Universe. Light takes minutes to reach Earth from the Sun, four years from our nearest star and billions of years from other galaxies.
Apply	Describe the appearance of planets or moons from diagrams showing their position in relation to the Earth and Sun. Explain why places on the Earth experience different daylight hours and amounts of sunlight during the year. Describe how space exploration and observations of stars are affected by the scale of the universe. Explain the choice of particular units for measuring distance.
Extend	Predict patterns in day length, the Sun's intensity or an object's shadow at different latitudes. Make deductions from observation data of planets, stars and galaxies. Compare explanations from different periods in history about the motion of objects and structure of the Universe.

c) Working scientifically

Area of mastery	Draw conclusions
Know: individual skills	Suggest a scientific reason for your findings. Quote any secondary data you have which led to the same conclusion.
Know: integration	Make conclusion and explain it. Judge whether the conclusion is supported by the data.
Apply: understand principles	Make a conclusion and explain it. Judge whether the conclusion is supported by the data. Identify further questions arising from the investigation.

Area of mastery	Critique claims
Know: individual skills	Identify the claim. Comment on whether the claim is clearly stated. Identify all the evidence that is used. Comment on whether the evidence is scientifically accurate and relevant to the claim. Identify the reasoning that links the evidence to the claim. Comment on whether the reasoning follows logically from the evidence.
Know: integration	Check the claim. Check the evidence. Check the reasoning.
Apply: understand principles	Explain how believable you think the claim is, by presenting all your evidence and reasoning.