Rocks and weathering

Where this unit fits in

This unit builds on:
- Unit 3D Rocks and soils in the key stage 2 scheme of work.
- The two units about Earth science draw on work about pH in unit 7E Acids and alkalis, work on evaporation in unit 7H Solutions, work on mixtures in unit 8F Compounds and mixtures and work on changes of state in unit 8I Heating and cooling.

Prior learning

To make good progress, pupils starting this unit need to understand:
- That there are rocks under the Earth’s surface
- Soil comes from rocks
- How the particles are arranged in solids, liquids and gases
- How to determine pH and relate this to acidity or alkalinity
- That dissolved solids are left behind when water evaporates and be able to name some examples and uses of rocks.

The concepts in this unit are:

- The characteristics of different rock textures
- Weathering, erosion, transportation and sedimentation.

This unit leads onto:

- Work on the rock cycle in unit 8H The rock cycle. Ideas about weathering are revisited in unit 9G Environmental chemistry. Together with unit 8H The rock cycle, this unit lays the foundation for work in key stage 4 on rock formation and deformation and on processes involving tectonic plates.

Expectations from the QCA Scheme of Work

At the end of this unit...

...most pupils will...

- Describe evidence for a sequence of geological events.
- Suggest a question to be investigated about the movement of sediment and, with help, identify an appropriate approach.
- Use ICT to make and record observations and explain these using scientific knowledge and understanding.

...some pupils will not have made so much progress and will...

- Describe changes in rocks or rock fragments over time.
- With help, identify a question about movement of sediment to be investigated and use ICT to make and record observations related to the question.

...some pupils will have progressed further and will...

- Use evidence from several sources to describe a sequence of geological events.

In terms of scientific enquiry NC Programme of Study Sc1 1a, b, c, 2a, c, d, e, f, g, h, i, j, k, l, m, n, o, p

- Describe rock specimens in terms of texture and relate this to properties such as porosity.
- Describe the physical and chemical processes by which rocks are weathered and transported and relate these to features of the environment.
- Describe and explain the processes by which layers of sediments are produced.

In terms of materials and their properties NC Programme of Study Sc3 1g, 2d, e, f, g

- Describe rock specimens and recognise that different rocks have different textures.
- With help, identify a question about movement of sediment to be investigated and use ICT to make and record observations related to the question.

Suggested lesson allocation (see individual lesson planning guides)

Direct route

- G1 Rock breaking
- G2 Disappearing rocks
- G3 Transporting rocks
- G4 Layers of sediment
- G5 Earth detectives – Think about explanations

Extra lessons (not in pupil book)

- G3 Investigate: Does particle size affect deposition?
- Review and assess progress (distributed appropriately)

Misconceptions

‘Rock only contains hard materials’ needs challenging. Teachers will need to be aware of the need to be sensitive to different religious beliefs when discussing fossil evidence.

Health and safety (see activity notes to inform risk assessment)

Risk assessments are needed for any hazardous activity. In this unit pupils plan and carry out an investigation into sedimentation.
### Learning objectives

- Rocks are usually made up of a mixture of minerals.
- Two main textures can be recognised: grains and crystals.
- Crystals are interlocking, grains are not and have spaces so water can go between them.
- How rocks are broken up by the effects of changing temperature, water and wind - physical weathering.

### Scientific enquiry

- Record observations. (Framework YTO Sc1 7d)
- Relate evidence about porosity to the way in which grains fit together. (Framework YTO Sc1 8f)

### Suggested alternative starter activities (5–10 minutes)

**Introduce the unit**
- Unit map for Rocks and weathering.

**Share learning objectives**
- Find out what rocks are made of
- Find out how rocks can be broken up by the weather
- Be able to record observations. (Sc1)

**Problem solving**
- Pupils sort samples of rocks into groups and explain the basis for their groupings.

**Brainstorming**
- Pupils make list of ways that rocks could be different from each other.

**Capture interest**
- Show photos of mountaineers.

### Suggested alternative main activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Learning objective see above</th>
<th>Description</th>
<th>Approx. timing</th>
<th>Target group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textbook G1</td>
<td>i, ii, iii and iv</td>
<td>Teacher-led explanation and questioning OR pupils work individually, in pairs or in small groups through the in-text questions and then onto the end-of-spread questions if time allows.</td>
<td>20 min</td>
<td>G R H E S</td>
</tr>
<tr>
<td>Activity G1a Practical</td>
<td>iii, iv, v, and vi</td>
<td>Rocks and porosity Pupils observe samples of granite and sandstone using hand lens. Then observe bubbles when put in water; weigh rocks before and after immersion.</td>
<td>30 min</td>
<td>✔</td>
</tr>
<tr>
<td>Activity G1b Practical</td>
<td>iv and v</td>
<td>Physical weathering Two demos to show how physical weathering can occur. Freezing bottle of water; plunging hot glass rod into water.</td>
<td>30 min</td>
<td>✔ ✔</td>
</tr>
<tr>
<td>Activity G1c Catalyst Interactive Presentations 2</td>
<td>iv and v</td>
<td>Support animation of two rock types, grain and crystal with porosity when water added.</td>
<td>10 min</td>
<td>✔</td>
</tr>
<tr>
<td>Activity G1d Catalyst Interactive Presentations 2</td>
<td>i, ii, iii, iv and vi</td>
<td>Support animation of water freezing in a rock sample and of a rock repeatedly heated and cooled.</td>
<td>10 min</td>
<td>✔</td>
</tr>
</tbody>
</table>

### Suggested alternative plenary activities (5–10 minutes)

**Review learning**
- Pupils work in groups of three to match words to their definitions.

**Group feedback**
- Pupils work in groups of four and use what they saw during Activity G1b to suggest why rocks break in cold weather.

**Word game**
- Word splat' using key words from the lesson.

**Looking ahead**
- Show an animation of plants growing in cracks in rocks and causing them to break up. Catalyst Interactive Presentations 2

### Learning outcomes

**Most pupils will ...**
- describe rock specimens in terms of texture.
- relate this to properties such as porosity.
- describe physical weathering processes – including the weathering of rocks by rain-ice and temperature and relate these to features of the environment.

**Some pupils, making less progress will ...**
- describe rock specimens.
- recognise that different rocks have different features.
- describe some effects of physical weathering.

**Some pupils, making more progress will ...**
- relate density of rocks to their mineral content and how closely packed the particles are in the mineral.
- discuss weathering by the wind.
- define biological weathering.

### Key words
- crystals, granite, sandstone, weathering, minerals, grains, texture, interlocking, non-interlocking, porous, physical weathering, red only:
- freeze–thaw weathering, biological weathering

### Out-of-lesson learning

**Homework G1**
- Textbook G1 end-of-spread questions
- Read newspaper articles about weather conditions
Lesson planning guide

Disappearing rocks

Learning objectives

i. Chemical weathering is caused by reactions between acidic rainwater and minerals in the rock.

Scientific enquiry

iii. Record results in a suitable manner. (Framework YTO Sc1 7d)

iv. Draw conclusions about weathering from data obtained by experiment. (Framework YTO Sc1 8f)

v. Use secondary sources to collect, store and present information about weathering. (Framework YTO Sc1 8d)

Suggested alternative starter activities (5–10 minutes)

Recap last lesson

True/false statements about physical weathering.

Brainstorming in groups ‘What chemicals might cause the breaking up of rocks?’

Capture interest (1)

Demonstration of dropping a piece of marble into hydrochloric acid so pupils can observe the reaction.

Capture interest (2)

Show photos of rocks/buildings that have been weathered.

Catalyst Interactive Presentations 2

Suggested alternative main activities

Activity Textbook G2

i and ii  Teacher-led explanation and questioning OR pupils work individually, in pairs or in small groups through the in-text questions and then onto the end-of-spread questions if time allows.

Chemical weathering

Pupils investigate chemical weathering of limestone and granite.

Where weathering happens

Pupils use a map showing rainfall and temperature and suggest regions where extensive weathering might occur.

A sequence showing weathering using oxygen-rich acid conditions.

Approx. timing 20 min 30 min 15 min 10 min

Target group ✔✔ ✔ ✔

Key words chemical weathering, limestone, topsoil, humus

Suggested alternative plenary activities (5–10 minutes)

Review learning

Show photos of scree slopes and ask how they were formed.

Catalyst Interactive Presentations 2

Pupils use the evidence from Activity G2a to write a letter suggesting which type of rock should be used to build a new cathedral.

Pupils use the evidence from Activity G2b to decide which parts of UK are likely to have the most weathering of rocks.

Check progress by pupils writing a poem about weathering of rocks.

Pupils suggest what happens to the rock fragments formed by weathering.

Learning outcomes

Most pupils will...

• describe the chemical processes by which rocks are weathered and transported and relate these to features of the environment.

Some pupils, making less progress will ...

• describe some effects of chemical weathering.

Some pupils, making more progress will ...

• explain why granite is weathered more slowly by the rain than limestone.

• compare granite and limestone as building materials.

Key words chemical weathering, limestone, topsoil, humus

Out-of-lesson learning

Homework G2 Textbook G2 end-of-spread questions Activity G2b

Read relevant newspaper articles/watch TV documentaries

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Learning objectives

i. Erosion happens when rocks are transported away from where they are weathered and worn away further as they are moved.

ii. Fast moving wind and water can carry larger pieces of rock than slow moving wind or water.

iii. Deposition happens when pieces of rock that have been transported settle again on the Earth’s surface.

Scientific enquiry

iv. Record observations from experiments investigating erosion. (Framework YTO Sc1 7d)

v. Draw conclusions about the cause of erosion of rock fragments. (Framework YTO Sc1 8f)

Suggested alternative starter activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Recap last lesson</th>
<th>Share learning objectives</th>
<th>Problem solving</th>
<th>Capture interest (1)</th>
<th>Capture interest (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workboard of terms connected with the weathering of rocks.</td>
<td>i, ii and iii</td>
<td>Teacher-led explanation and questioning OR pupils work individually, in pairs or in small groups through the in-text questions and then onto the end-of-spread questions if time allows.</td>
<td>Video-clips of water flow in different parts of a river course from fast mountain stream, to slow near mouth. Catalyst Interactive Presentations 2</td>
<td>Show photos of floods causing massive erosion including earth slips, sweeping away buildings and depositing mud after floods have abated. Catalyst Interactive Presentations 2</td>
</tr>
</tbody>
</table>

Suggested alternative main activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Learning objective(s)</th>
<th>Description</th>
<th>Approx. timing</th>
<th>Target group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Textbook G3</td>
<td>Textbook G3</td>
<td>Teacher-led explanation and questioning OR pupils work individually, in pairs or in small groups through the in-text questions and then onto the end-of-spread questions if time allows.</td>
<td>20 min</td>
<td>R O G R S</td>
</tr>
<tr>
<td>Activity G3a Practical</td>
<td>i and iv</td>
<td>Pupils carry out an investigation into how do sediments move? Pupils test at the way water carries sediments and how the sediments are deposited.</td>
<td>30 min</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>Activity G3b Practical</td>
<td>i, iv and v</td>
<td>Erosion Pupils model the process of erosion.</td>
<td>40 min</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>Activity G3c Paper</td>
<td>v</td>
<td>Looking at rivers Pupils look at a diagram of a river basin and explain what happens at various points along the way.</td>
<td>30 min</td>
<td>✓</td>
</tr>
</tbody>
</table>

Suggested alternative plenary activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Review learning</th>
<th>Sharing responses</th>
<th>Group feedback</th>
<th>Word game</th>
<th>Looking ahead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Show photos of layers of rock exposed on cliff faces. Catalyst Interactive Presentations 2</td>
<td>Pupils use evidence from Activity G3a to write questions to given answers about the way that rock fragments are carried in rivers.</td>
<td>Pupils use evidence from Activity G3c to write five sentences that describe how the smooth round pebbles on a streambed got there.</td>
<td>True/false quiz about the way that rock fragments are carried in rivers.</td>
<td>Show video-clips of sandstorm and rocks shaped by wind erosion; glacier and large rocks carried down by glacial action. Catalyst Interactive Presentations 2</td>
</tr>
</tbody>
</table>

Learning outcomes

Most pupils will ...

• explain how rock fragments called sediment can be transported by flowing water or wind
• recognise that fast moving water or wind can carry larger pieces of rock than slow moving water or wind
• state that deposition happens when pieces of rock that were transported settle.

Some pupils, making less progress will ...

• state the difference between weathering and erosion
• begin to relate particle size and water flow to how sediment is transported and deposited.

Some pupils, making more progress will ...

• suggest what effects a flash flood might have
• describe how glaciers transport rocks
• relate the deposition of different sized particles to rate of flow.

Key words

erosion, deposition, delta, sediment, red only: glacier, estuary

Out-of-lesson learning

Homework G3

Textbook G3 end-of-spread questions

Activity G3c

Visit museums
Investigate: Does particle size affect deposition?

Learning objectives

i Identify and carry out a strategy for investigating a question.

Scientific enquiry

ii Suggest a question to be investigated about the movement of sediment. (Framework YTO Sc1 7b, 8b)

iii Draw conclusions and describe how they are consistent with the data obtained. (Framework YTO Sc1 8f)

iv Consider how the design of an investigation could be improved. (Framework YTO Sc1 8g)

Suggested alternative starter activities (5–10 minutes)

Setting the context

Demonstration of different sized marbles falling through water in a large measuring cylinder.

Introduce the apparatus

Place the apparatus for this activity on a tray in the classroom so pupils can decide how it could be used in the investigation.

Safety

Pupils work in groups to list the possible hazards and suggest safe working methods to avoid these.

Brainstorming (1)

Pupils work in groups to brainstorm the question ‘What has an effect on the way that water carries rock fragments?’

Brainstorming (2)

Pupils work in groups to brainstorm the question ‘How can we measure the rate at which different fragments settle?’

Investigation

Activity

Activity G3d Practical

Learning objective

i – iv

Description

Core: Pupils are shown the apparatus and work in pairs to plan the activity. They carry out the activity using their plan and make repeat measurements. They use results and relate this to ‘real life’ situations of deposition.

Help: Pupils are given a method to follow.

Extension: Pupils are prompted to think of several ways of investigating the question and then evaluate which is the best one to use.

Approx. timing

50 min

Target group

C H E S ✔✔ ✔

Suggested alternative plenary activities (5–10 minutes)

Review learning

Groups report their results to the class.

Group feedback

Teacher-led review of how a sample set of results can be used to answer the question posed by the investigation.

Analysing

Group discussions followed by feedback and class evaluation of the investigation.

Evaluating


Learning outcomes

Most pupils will ...

Some pupils, making less progress will ...

Some pupils, making more progress will ...

• Identify a strategy for investigating a question

• Suggest ways that the method of investigation could be improved.

• Draw conclusions from their data

• Use a prompt to draw conclusions from their data.

• Choose results from a list in a way that the method could be improved.

• Identify several strategies and choose the best

• Draw conclusions from their data and use scientific ideas to explain them.

• Suggest ways that the method of investigation could be improved and explain anomalous results.
Layers of sediment

Learning objectives
i. Sediments settle to form layers that eventually build up.
ii. Parts of sea creatures that are preserved in sedimentary rocks are called fossils.
iii. The oldest rocks are the bottom layers.

Scientific enquiry
iv. The relationship between the fossils found in a rock and the age of the rock.
v. Collect, store and present information about sedimentation in a suitable way. (Framework YTO Sc1 B8)

Suggested alternative starter activities (5–10 minutes)

Recap last lesson
• Find out what happens to the sediment carried by rivers after millions of years.
• Find out about fossils.

Problem solving
Pupils look at samples of fossils and/or slides of fossils and discuss ‘What are fossils?’

Capture interest
• Show a photo of limestone quarry showing: strata in the rock; fossils found in the limestone.

Catalyst Interactive Presentations 2
• Show an animation of dinosaur dying and being turned into a fossil.

Suggested alternative main activities

Activity
Textbook G4
Activity G4a
Activity G4b
Activity G4c

Learning objective
i, ii, iii and iv
i and v
i and v
ii

Description
Teacher-led explanation and questioning OR pupils work individually, in pairs or in small groups through the in-text questions and then onto the end-of-spread questions if time allows.
Swirling sediments Pupils use smaller beakers to swirl a mixture of clay, sand and gravel and allow to settle.
Evaporating sea water Pupils evaporate ‘sea’ water to obtain a layer of salt.
Support animation to show formation of fossils and of fossil fuels, e.g. oil.

Approx. timing
20 min
20 min
30 min

Target group
CHESS
R/G GR S
✔✔
✔

Suggested alternative plenary activities (5–10 minutes)

Review learning
Pupils match words to definitions.

Sharing responses
Show a photo of a cliff face with several layers visible.

Group feedback
Pupils consider what a layer of rock can tell you about the way it was formed using information gained from Activity G4a.

Brainstorming
Sequencing activity using statements about fossil formation.

Looking back
Pupils revise and consolidate knowledge from the unit.

Learning outcomes

Most pupils will …
• describe and explain the processes by which layers of sediments are produced
• state that the bottom layers are the oldest
• explain that the parts of dead sea creatures preserved in sedimentary rocks are called fossils
• relate the fossils found to the age of the rock.

Some pupils, making less progress will …
• recognise sedimentary layers and begin to describe the processes by which they were formed
• state that fossils are the preserved remains of sea creatures in sedimentary rocks.

Some pupils, making more progress will …
• relate sedimentary layers to the processes by which they were produced
• recognise the significance of William Smith’s use of fossil evidence to draw maps showing where the older and younger rocks are.

Key words
sedimentary layers, fossils, geologists

Out-of-lesson learning
Homework G4
Textbook G4 end-of-spread questions
Internet search: William Smith

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Learning objectives
i Mary Anning is famous for piecing together dinosaurs from fossils found on the seashore.
ii There are different ways of thinking.
iii The value of lateral thinking to explain puzzling observations such as fossils on the seashore.

The structure of this lesson is based around the CASE approach. The starter activities give concrete preparation. The main activities move away from the concrete towards a challenging situation, where pupils need to think. The extended plenary gives pupils time to discuss what they have learnt, to negotiate a method to commit to paper and express their ideas verbally to the rest of the class.

Suggested alternative starter activities (5–10 minutes)

Bridging to the unit
Demonstration of different coloured samples of sand each swirling in water and added to a large measuring cylinder one at a time to build up into a series of layers.

Setting the context
Show a photo of a number of rock layers in a cliff with embedded fossils for pupils to age.

Concrete preparation
Pupils use two diagrams of rock layers with embedded fossils and use them to work out the age of the fossils.

Suggested main activities

Activity | Learning objective | Description | Approx. timing | Target group
--- | --- | --- | --- | ---
Textbook G5 | i, ii, iii and iv | Teacher-led explanation and questioning OR pupils work individually in pairs or in small groups through the in-text questions and then onto the end-of-spread questions if time allows. | 20 min | G, G, G, S
Activity G5a | iv | Books and lessons pupils look at a pile of books at front of classroom and discuss lessons the teacher was teaching. | 20 min | ✔

Suggested alternative plenary activities (5–10 minutes)

Group feedback
Pupils use a series of written statements and put the statements in the correct order to describe the thinking that led them to the conclusion that Earth movements explained the fossil problem.

Bridging to other topics
I introduce the idea of evolution for class discussion and how a fossil record is evidence for evolution.

Learning outcomes

Most pupils will ... Some pupils, making less progress will ... Some pupils, making more progress will ...
- apply the concept of Edward de Bono’s ‘Six Thinking Hats’ to decision making and problem solving.
- reflect upon the idea of the oldest rocks containing fossils of organisms that lived longest ago
- analyse a problem to see how lateral thinking can lead to a solution.
- discuss different ways of thinking
- begin to understand the idea of lateral thinking
- with help analyse a problem to see how lateral thinking can lead to a solution.
- resolve cognitive conflict arising from a fossil fish that lived 350 million years ago being found above sea level
- discuss the merits of lateral thinking
- identify evidence from quotations to suggest that Mary Anning was capable of lateral thinking.

Key words
lateral thinking

Out-of-lesson learning
Textbook G5 end-of-spread questions
Visit to the seashore, river estuary, hills or cliffs.
Copy the unit map and use these words to help you complete it.
You may add words of your own too.

- biological weathering
- contract
- cooling
- crystals
- delta
- expand
- geologists
- grains
- glacier
- fossils
- freeze-thaw
- granite
- heating
- interlocking

- layers
- limestone
- minerals
- non-interlocking
- non-porous
- porous
- rain
- river
- sediment
- sedimentary layers
- sulphuric acid
- texture
- wind
**Suggested alternative starter activities (5–10 minutes)**

<table>
<thead>
<tr>
<th>Introduce the unit</th>
<th>Share learning objectives</th>
<th>Problem solving</th>
<th>Brainstorming</th>
<th>Capture interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit map for Rocks and weathering.</td>
<td>Find out what rocks are made of.</td>
<td>Pupils sort samples of rocks into groups and explain the basis for their groupings.</td>
<td>Pupils make lists of ways that rocks could be different from each other.</td>
<td>Show photos of mountaineers. Catalyst Interactive Presentations 2</td>
</tr>
</tbody>
</table>

**Introduce the unit**
- **Either** draw the outline of the unit map on the board then ask pupils to give you words to add, saying where to add them. Suggest some words yourself when necessary to keep pupils on the right track.
- **Or** give out the unit map and ask pupils to work in groups deciding how to add the listed words to the diagram. Then go through it on the board as each group gives suggestions.

**Share learning objectives**
- Ask pupils to write a list of FAQs they would put on a website telling people about rocks and physical weathering. Collect suggestions as a whole-class activity, steering pupils towards those related to the objectives. Conclude by highlighting the questions you want them to be able to answer at the end of the lesson.

**Problem solving**
- In groups or pairs, pupils are given samples of rocks to sort into groups.
- Pupil groups report their rock groupings to the class, and explain the reasoning behind their groupings.

**Brainstorming**
- Pupils work in groups to brainstorm the question “How many ways can rocks be different from each other?”
- Groups report back to the class and differences are listed on the board.

**Capture interest**
- Show pupils photos of mountaineers climbing high mountains, eg Alps or Himalayas.
- Pupils answer the questions on the pupil sheet and then discuss the answers as a class.

**Equipment**
For each group: one piece of each of several rocks (eg limestone, sandstone, chalk, mudstone, granite, basalt, gneiss, marble, slate), hand lens. If possible provide several different types of rocks such as limestone and sandstone. These are likely to have different colours and/or grain sizes but otherwise be similar.

**Answers**
1. They will cool causing outside of rocks to contract more quickly than inside and any melted water in cracks to freeze.
2. They will heat up causing outside of rocks to expand more quickly than inside and any melted water in cracks to thaw.
3. As the rocks heat up they will crumble, making climbing dangerous. There is also a greater risk of avalanches as snow begins to melt.
4. He/she may fall.
Capture interest

Look at the photo, then answer the following questions.

1. What might happen to the mountain faces during the night?
2. What might happen to the mountain faces during the day?
3. Mountaineers climbing in high mountains start early in the morning and try to complete their climbing on mountain faces by midday. Why?
4. What could happen to a mountain climber who was still climbing on a high mountain face in the afternoon or evening?
### G2 Disappearing rocks

#### Recap last lesson
- Give pupils a list of statements about physical weathering.
- They work in groups of three or four to discuss the statements and decide whether each statement is true or false.
- Each group reports back to the class on one statement, giving reasons for their choice.

#### Share learning objectives
- Ask pupils to write a list of FAQs they would put on a website telling people about rocks and chemical weathering. Collect suggestions as a whole-class activity, steering pupils towards those related to the objectives. Conclude by highlighting the questions you want them to be able to answer at the end of the lesson.

#### Brainstorming
- Pupils work in groups of four to brainstorm the question ‘What chemicals might cause the breaking up of rocks?’
- Each group reports back their ideas to the whole class.
- List suggestions on the board.
- Each suggestion is considered on the basis of ‘Where would the chemicals come from?’ and/or ‘How would it get onto the rocks?’ Implausible suggestions are removed from the list.
- The list should eventually be whittled down to acids, and principally carbon dioxide making rain water acidic (forming carbonic acid).

#### Capture interest (1)
- Show pupils the appearance of a few marble chippings.
- Pupils watch as the marble chippings are dropped into hydrochloric acid in a beaker.
- Pupils observe the bubbles produced.
- After a few minutes the chippings are filtered off and washed.
- Pupils observe that the chippings have decreased in size.

#### Capture interest (2)
- Show pupils slides or photographs of buildings, etc. that show evidence of chemical weathering.
- If you are able to, include some local buildings: cathedrals, churches, grave stones and statues are particularly suitable and you may find some ‘before and after’ photographs.
- Ask pupils to suggest what has happened to the buildings and how long this may have taken.

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**Suggested alternative starter activities (5–10 minutes)**

<table>
<thead>
<tr>
<th>Recap last lesson</th>
<th>Share learning objectives</th>
<th>Brainstorming</th>
<th>Capture interest (1)</th>
<th>Capture interest (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>True/false statements about physical weathering</td>
<td>Find out about chemical weathering</td>
<td>Brainstorming in groups ‘What chemicals might cause the breaking up of rocks?’</td>
<td>Demonstration of dropping a piece of marble into hydrochloric acid so pupils can observe the reaction</td>
<td>Show photos of rocks/buildings that have been weathered. Catalyst Interactive Presentations 2</td>
</tr>
</tbody>
</table>

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Disappearing rocks

Recap last lesson

Decide if these statements are true or false.
Discuss each statement in your group and decide.
You may be asked to give reasons for your choice.

1. Scientists who study rocks are called geologists.
2. When a rock is heated the inside heats up quicker than the outside.
3. Rocks with interlocking crystals are less porous than rocks with non-interlocking crystals.
4. Fossils are made of bone.
5. Acidic rain water contains dissolved carbon dioxide.
6. Freeze–thaw is a type of physical weathering.
7. Water contracts as it turns to ice.
8. Limestone is affected more by weathering than granite.
9. Sandstone is a non-porous rock.
10. Acidic rain water is a cause of chemical weathering of rocks.
Disappearing rocks

Recap last lesson

Teacher sheet

Statement

1. Scientists who study rocks are called geologists. [True]
2. When a rock is heated the inside heats up quicker than the outside. [False]
3. Rocks with interlocking crystals are less porous than rocks with non-interlocking crystals. [True]
4. Fossils are made of bone. [False]
5. Acidic rain water contains dissolved carbon dioxide. [True]
6. Freeze-thaw is a type of physical weathering. [True]
7. Water contracts as it turns to ice. [False]
8. Limestone is affected more by weathering than granite. [True]
9. Sandstone is a non-porous rock. [False]
10. Acidic rain water is a cause of chemical weathering of rocks. [True]

Capture interest (1)

Teacher sheet

1. Show pupils a few marble chippings (they could be placed in a Petri dish and passed round the class). Ask pupils to note their shape and size.
2. Drop the marble chippings into a 400 cm³ beaker half filled with dilute hydrochloric acid. (This should be performed with a safety screen between the apparatus and pupils. The teacher should wear eye protection.)
3. Allow pupils to observe the marble chippings producing bubbles of carbon dioxide as they react with the acid. Ask pupils what they can observe.
4. After about five minutes filter the acid and chippings and wash the chippings with a little water.
5. Place the ‘weathered’ marble chippings in a Petri dish and pass round the class. Ask pupils to note any changes that have taken place.

Note: although acidic rain water is a solution of carbon dioxide in water (carbonic acid), this is a weak acid and does not give such a good reaction in this experiment. Pupils could simply be told that the beaker contains acid similar to that in acidic rain water, rather than hydrochloric acid, to avoid confusion.
Suggested alternative starter activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Recap last lesson</th>
<th>Share learning objectives</th>
<th>Problem solving</th>
<th>Capture interest (1)</th>
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<tr>
<td>Recap last lesson</td>
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<td>Capture interest (1)</td>
<td>Capture interest (2)</td>
</tr>
<tr>
<td>Wordsearch of terms connected with the weathering of rocks.</td>
<td>• Find out what happens to the bits of rock that have been weathered away. • Be able to draw conclusions from data. (Sc1)</td>
<td>Pupils match different sized particles of rock with water speeds.</td>
<td>Video-clips of water flow in different parts of a river course from fast mountain stream, to slow near mouth. Catalyst Interactive Presentations 2</td>
<td>Show photos of floods causing massive erosion including earth slips, sweeping away buildings and depositing mud after floods have abated. Catalyst Interactive Presentations 2</td>
</tr>
</tbody>
</table>

Recap last lesson

- Pupils complete a wordsearch containing words associated with the weathering of rocks.
- Ring the words on a copy of the pupil sheet and show it as an OHT for them to check their answers. Use the words on it to introduce the lesson.

Share learning objectives

- Ask pupils to write a list of FAQs they would put on a website telling people about erosion and deposition. Collect suggestions as a whole-class activity, steering pupils towards those related to the objectives. Conclude by highlighting the questions you want them to be able to answer at the end of the lesson.

Problem solving

- Pupils work in groups to match different sized particles with the speed of moving water where they are deposited.
- Each group reports to the class on one of their matches, with reasons for their choice.
- Errors are discussed and corrected.

Capture interest (1)

- Show video-clips of water flowing in different parts of a river.
- Ask pupils to suggest which part of the river each video-clip is showing: mountain stream, fast-flowing river near the mountains, slower-flowing river in the middle of its course, very slow-flowing river near its mouth.
- Pupils suggest what sort of rock fragments each flow of water might be able to carry.

Capture interest (2)

- Show photos of floods and the erosion caused by flooding, including earth slips and buildings being carried away.
- Ask pupils to explain why flooding causes erosion.
- Show photos of the mud left behind in streets and houses after flooding has subsided.
- Ask pupils to explain why mud is left behind after flooding.
Transporting rock

Recap last lesson

All these words are connected with the weathering of rocks. See how many of them you can find in the wordsearch.

acid  chemical  contract  crumble  expand
freeze  physical  porous  scree  thaw  weathering

I  A  J  W  N  Y  B  L  G  A  C  I  D
H  K  M  A  H  F  S  A  Y  R  C  A  H
E  N  L  H  V  R  C  C  L  B  J  E  W
W  E  A  T  H  E  R  I  N  G  O  X  E
A  X  C  L  D  E  B  S  G  F  P  U  E
W  P  I  Q  C  Z  Z  Y  R  Q  T  D  R
K  A  M  V  U  E  O  H  X  F  E  D  C
E  N  E  I  Z  M  P  P  O  R  O  U  S
F  D  H  G  J  Q  C  R  U  M  B  L  E
D  L  C  O  N  T  R  A  C  T  K  C  E
Problem solving

The moving water in streams and rivers carries rock fragments along with it. These fragments are deposited when the water is no longer moving fast enough to carry them.

Draw a line to match each of the rock fragments on the left with the place you would expect to find these fragments deposited on a riverbed or streambed.

A: small pebbles

1. A smooth-flowing river.

B: coarse sand

2. A very fast-flowing mountain river.

C: fine sand

3. A mountain stream gushing over waterfalls.

D: gravel

4. A fast-flowing river.

E: large pebbles

5. A slow-moving river near its mouth.
Starters

Investigate: Does particle size affect deposition?

Suggested alternative starter activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Setting the context</th>
<th>Introduce the apparatus</th>
<th>Safety</th>
<th>Brainstorming (1)</th>
<th>Brainstorming (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstrate different sized marbles falling through water in a large measuring cylinder.</td>
<td>Place the apparatus for this activity on a tray in the classroom so pupils can decide how it could be used in the investigation.</td>
<td>Pupils work in groups to list the possible hazards and suggest safe working methods to avoid these.</td>
<td>Pupils work in groups to brainstorm the question “What has an effect on the way that water carries rock fragments?”</td>
<td></td>
</tr>
</tbody>
</table>

Setting the context

- Demonstrate different sized marbles falling through water in a measuring cylinder.
- Ask pupils what was different about the way that the marbles fell through the water to the bottom of the measuring cylinder.
- Ask pupils to suggest how this is similar to the deposition of sediments onto a riverbed or seabed. If necessary, help pupils understand that the faster particles settle in still water, the less far they will be carried by moving water and vice versa.

Introduce the apparatus

- Place a tray of the apparatus on the list for this investigation at the front of the laboratory for pupils to look at.
- Pupils work in groups to decide how they could use that apparatus to find the effect of particle size on deposition.
- In turn, groups report back their ideas to the class.

Safety

- Ask pupils to work in pairs to list the hazards involved in this investigation.
- Pupils decide how to minimise the danger presented by each hazard.
- Pairs report back to a class discussion during which a final set of safety procedures is listed on the board.

Brainstorming (1)

- Ask pupils to brainstorm the question “What has an effect on the way that water carries rock fragments?” and to discuss in groups what the variables are in the investigation.
- Ask them to decide what variable should be changed (input variable) and what should be measured during the investigation (outcome variable).
- Ask individual pupils for their ideas. Use class discussion to finalise details of the two dependent variables.

Brainstorming (2)

- Pupils work in groups to brainstorm the question “How can we measure the speed that different fragments settle?”
- Each group reports their ideas back to the class for discussion.
- If it does not arise from pupils’ suggestions, suggest timing how long it takes for a cross to reappear as the material deposits.
- Answers from individual pupils can also be used to initiate class discussion about fair testing and reliability of results.

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Investigate: Does particle size affect deposition?

Setting the context

Teacher sheet

- Pour water into a 1000 cm$^3$ measuring cylinder until up to the top mark.
- Drop a small marble into the water and allow pupils to watch it settle to the bottom.
- Drop a large marble into the cylinder and again allow pupils to watch it settle.
- Ask pupils what difference there was between the ways that these two marbles settled to the bottom.
- Try adding several different sized marbles at the same time so that pupils can observe the different speeds of settling.
- If further proof is required by pupils, individual marbles can be timed from the top to hitting the bottom.
Layers of sediment

Suggested alternative starter activities (5–10 minutes)

Recap last lesson
- Show a series of slides or photographs showing large boulders in a moraine, mud in an estuary, pebbles on a riverbed, sand dunes in a desert.
- Pupils work in groups to decide how each of these materials got to the place where it is.
- In turn, groups report back their ideas for class discussion.

Share learning objectives
- Ask pupils to write a list of FAQs they would put on a website telling people about sediments. Collect suggestions as a whole-class activity, steering pupils towards those related to the objectives. Conclude by highlighting the questions you want them to be able to answer at the end of the lesson.

Problem solving
- Pupils look at fossil samples or slides/photographs of fossils.
- Pupils work in groups of four to brainstorm the question ‘What are fossils?’
- In turn, groups report back their ideas for class discussion.
- Collect ideas on the board and dispel misconceptions such as ‘fossils are very old bones’.

Capture interest (1)
- Show a video-clip of a limestone quarry, featuring rock strata and fossils in the limestone.
- Ask pupils to suggest the answers to the questions opposite.

Capture interest (2)
- Show the animation of a dinosaur dying and being turned into a fossil.
- Tell pupils that dinosaur fossils are quite rare and ask them to suggest why we do not find more dinosaur fossils.

Questions
- Why is the limestone found in layers?
- How did fossils come to be in the limestone?
- Why are there more fossils in some layers of the limestone than others?

Equipment
- a variety of different fossils or photos of fossils

Teacher sheet
- Catalyst Interactive Presentations 2

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Layers of sediment

Capture interest (1)

Teacher sheet

Answers

Each year different amounts and types of shells and marine animal bones were deposited on the seabed, forming layers of different thickness and content. Pressure of layers above over millions of years turned the shells and bones into limestone. Shells and bones in the deposited layers were turned into rock, forming fossils. The types of shells and bones deposited each year were different. Some years they were of types that more easily formed fossils than others.

Capture interest (2)

Teacher sheet

Answer

Most dead dinosaurs rotted away and/or were eaten by other animals. Only on rare occasions, e.g., a flash flood or landslide, were the bodies covered up before this could happen. Also, many dinosaur fossils remain undiscovered, buried under metres of rock. The ones found are those brought to, or near to, the surface by rock movements or erosion.
**Earth detectives - Think about**

### Bridging to the unit
- Pupils watch a demonstration of different coloured samples of sand in turn swirled in a beaker of water and poured into a large measuring cylinder.
- They note the layers of sand that build up at the bottom of the beaker.
- Show pupils another large measuring cylinder with the same coloured sand layers but in a different order (prepared earlier) and ask them to describe how this was prepared.

### Setting the context
- Show pupils a photo of a cliff face with a number of rock layers visible (some with embedded fossils).
- Ask pupils to suggest which layer is the oldest and which is the youngest.
- Reinforce the idea that layers are usually laid down sequentially, so that the lower down the layer is, the older it is.

### Concrete preparation
- Show pupils an OHT of Diagram 1 of rock strata with fossils embedded in three different layers.
- Discuss the age of the fossils shown on the diagram.
- Ask pupils to suggest ages for the fish fossils, based on their position in the sequence of layers.

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Bridging to the unit

**Teacher sheet**

1. Measure out about 100 cm³ of coloured sand in a 400 cm³ beaker.
2. Add water up to the 300 cm³ mark.
3. Stir the sand and water with a glass rod.
4. Swirl the sand and water then quickly pour the mixture into a 1000 cm³ measuring cylinder.
5. Allow the sand to settle, then repeat the procedure using sand of a different colour.
6. Continue until there are five layers of sand in the measuring cylinder.
7. Show pupils another measuring cylinder prepared earlier with the same coloured sand layers but in a different order.
8. Ask pupils to suggest how this second measuring cylinder was prepared.

**Technician sheet**

For preparation before the lesson:
- sand of five different colours, about 100 cm³ of each
- 400 cm³ beaker
- stirring rod
- 1000 cm³ measuring cylinder

For the demonstration:
- sand of five different colours, about 100 cm³ of each
- 400 cm³ beaker
- stirring rod
- 1000 cm³ measuring cylinder

Different coloured sand is available from aquarium retailers.
G5 Earth detectives

Concrete preparation

Diagram 1

- Basalt
- Sandstone with plant fossils, age 30 million years
- Limestone with shell fossils, age 50 million years
- Mudstone with dinosaur fossils, age 100 million years
- Granite

Diagram 2

- Sandstone with plant fossils, age 30 million years
- Limestone with fish fossils
- Mudstone with dinosaur fossils, age 100 million years
Rocks and porosity

Running the activity
Pupils use hand lenses to look at the surface texture of samples of different types of rock and record a description and a diagram of the appearance of the grains or crystals on the surface of each type of rock in a table.

They use a balance to find the mass of a sample of rock both before and after soaking in water. Results are recorded in a table.

A demonstration of a sponge being dipped into water may be used to introduce the porosity part of the activity.

Expected outcomes
Pupils should be able to make a distinction between the more open-textured porous sedimentary rocks that have grains with space between them; the less porous metamorphic rocks that have a less open crystalline structure and the non-porous igneous rocks that have a very closely packed crystalline structure.

Pitfalls
Show pupils the correct way to use a hand lens before the practical commences. The hand lens should be held just in front of the eye, and the head lowered until the surface of the rock is in focus. Most pupils will need some guidance on what to look for, and how to draw the arrangement of grains found in a small part of the surface.

For the porosity part of the activity, warn pupils of the danger of spilt water on the floor and of the possibility of cracking the beaker if the rock is dropped into it. Instructions about the use of paper towels to blot dry the rock may avoid spilt water. The surface of the rock should be as dry as possible before re-weighing.

The number and range of rocks tested will depend on the time available, but at least one each of the sedimentary, metamorphic and igneous rocks should be included.

Safety notes
There are few hazards associated with this activity.
Water spillage on the floor could cause pupils to slip.
Pupils should be told to place rocks into beakers carefully. Dropping a rock may crack the beaker.

Answers
1. Sedimentary rocks: sandstone, limestone, mudstone, have separate grains with spaces between them.
2. Metamorphic rocks (gneiss, marble), and igneous rocks (granite, basalt), have interlocking crystals without spaces between them.
3. The grains in sedimentary rocks are rounded in shape.
4. The sedimentary rock (sandstone, chalk) absorbed the most water.
5. Water moves into the spaces between grains in the sedimentary rocks. It cannot move between the interlocking crystals in metamorphic and igneous rocks because there are no spaces.
6. Sedimentary rock (allow name).
7. Metamorphic or igneous rock (allow name).
Rocks and porosity

For each group:
- rock samples
- hand lens
- 400 cm³ beaker
- top-pan balance
- stopwatch
- paper towels

Each group will need a small sample of a sedimentary rock (eg sandstone, chalk), a metamorphic rock (eg gneiss), and an igneous rock (eg basalt, granite).

Several balances should be placed around the laboratory.

For your information

Running the activity
Pupils use hand lenses to look at the surface texture of samples of different types of rock and record a description and draw a diagram of the appearance of the grains or crystals on the surface of each type of rock in a table.

They use a balance to find the mass of a sample of rock both before and after soaking in water. Results are recorded in a table.

A demonstration of a sponge being dipped into water may be used to introduce the porosity part of the activity.

Expected outcomes
Pupils should be able to make a distinction between the more open-textured, porous sedimentary rocks that have grains with space between them; the less porous metamorphic rocks that have a less open, crystalline structure and the non-porous igneous rocks that have a very closely packed crystalline structure.

Pitfalls
Show pupils the correct way to use a hand lens before the practical commences. The hand lens should be held just in front of the eye, and the head lowered until the surface of the rock is in focus. Most pupils will need some guidance on what to look for, and how to draw the arrangement of grains found in a small part of the surface.

For the porosity part of the activity, warn pupils of the danger of spilt water on the floor and of the possibility of cracking the beaker if the rock is dropped into it. Instructions about the use of paper towels to blot dry the rock may avoid spilt water. The surface of the rock should be as dry as possible before re-weighing.

The number and range of rocks tested will depend on the time available, but at least one each of sedimentary, metamorphic and igneous rocks should be included.

Safety notes
There are few hazards associated with this activity.

Water spillage on the floor could cause pupils to slip.

Pupils should be told to place rocks into beakers carefully. Dropping a rock may crack the beaker.
You are going examine some rock samples to see what they look like and how well they soak up water.

**Equipment**
- rock samples
- hand lens
- paper towels
- 400cm³ beaker
- top-pan balance
- stopwatch

**Obtaining evidence**
1. Collect a sample of one type of rock.
2. Use a hand lens to examine the surface of the rock.
3. Write down what you can see.
   - Is the rock made from many grains of material with spaces between them?
   - Is the rock made from many interlocking crystals with no spaces between them?
4. Record your observations and a drawing of the grains or crystals in a copy of the table below.
5. Weigh this rock sample on a balance, and record its mass.
6. Collect a beaker and half fill it with water.
7. Place the rock sample in the beaker containing water.
8. Leave the rock sample in the water for five minutes.
9. Take the rock sample out of the water and blot it dry using a paper towel.
10. Use a balance to re-weigh the rock sample.
11. Repeat steps 1 to 10 with a sample of another type of rock.
### Considering the evidence

**Appearance**

<table>
<thead>
<tr>
<th>Type of rock</th>
<th>Appearance of texture</th>
<th>Diagram of grains or crystals</th>
</tr>
</thead>
<tbody>
<tr>
<td>UG</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TC</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Porosity**

<table>
<thead>
<tr>
<th>Type of rock</th>
<th>Mass of rock in g</th>
<th>Mass of water absorbed in g</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before soaking</td>
<td>After soaking</td>
</tr>
</tbody>
</table>

1. Which rock types had separate grains with spaces between them?
2. Which rock types had interlocking crystals with no spaces between them?
3. Which rock types had rounded grains?
4. Which type of rock absorbed the most water?
5. Explain your answer using ideas about grains, crystals and the spaces between them.
6. Which type of rock would hold a quantity of oil below the surface of the ground?
7. Which type of rock would trap oil and prevent it rising to the surface?
G1b

**Physical weathering**

### Running the activity

**Ice breaker:** About 24 hours prior to the lesson fill a glass bottle with water, replace the lid, place inside a clear plastic bag and seal with a rubber band. Put it into a freezer until the lesson. Show the bottle and ask pupils questions about what they observe. A second, unfrozen bottle could also be used to demonstrate what the bottle looked like before freezing.

**Hot and cold:** Heat a glass rod and then rapidly cool it in cold water to demonstrate freeze–thaw cracking.
As an additional demonstration, a small piece of granite held in tongs can be heated in a Bunsen burner and plunged into cold water to demonstrate the exfoliation of rocks.
It is also possible to use bar-breaking apparatus to demonstrate the expansion of solids when they are heated.

**Core:** Questions are provided.

**Help:** A writing frame is provided with gaps for pupils to fill in.

### Expected outcomes

Pupils understand that water expands when it freezes, and that materials can crack when exposed to hot and cold conditions.

### Pitfalls

It is difficult for all pupils in a large class to make detailed observations of the broken bottle. More than one bottle may be set up to allow pupils to make observations in groups.
Pupils should not be allowed to handle the broken glass.

### Safety notes

A label should be attached to the freezer warning that there is broken glass inside. Handle broken glass with care. It is better to leave the broken bottle in the plastic bag so that pupils do not handle the broken glass.
All present should wear eye protection, or the teacher should wear eye protection and the pupils be behind a screen, in case the glass rod shatters whilst being heated.
Great care should be taken when clearing away the broken bottle and the shattered pieces of glass rod.

### Answers

**Core:**
1. It expanded.
2. It broke.
3. The glass could not expand as much as the ice, there was too much force and so the bottle broke.
4. A carton is made from flexible material so it can expand and will not burst.
5. It will make the crack bigger.
6. They are moving faster/apart.
7. It cracked/shattered.
8. The outside contracted faster than the inside.
9. As rocks get hot during day they expand. On cold nights they contract. Each time the outside of the rock expands and contracts quicker than the inside. If they keep doing this, the rocks will crack.

**Help:**
1. Cracked/broken, the ice expanded, expand, less, it contracts, shatter/crack.
2. Shattered, contracted, shatter/break.
Physical weathering

**Equipment**

For the teacher:
- 2 glass bottles with screw lids
- 2 rubber bands
- Bunsen burner
- Beaker of ice cubes in water
- 2 clear plastic bags
- Glass rod
- Forceps

**For your information**

**Running the activity**

These are teacher demonstrations to show the effects of two types of physical weathering.

**Ice breaker:** About 24 hours prior to the lesson, fill a glass bottle with water, replace the lid, place it inside a clear plastic bag and seal with a rubber band. Put it into a freezer until the lesson. Show the bottle and ask pupils questions about what they observe. A second, unfrozen bottle could also be used to demonstrate what the bottle looked like before freezing.

**Hot and cold:** Heat a glass rod and then rapidly cool it in cold water to demonstrate freeze-thaw cracking.

As an additional demonstration, a small piece of granite held in tongs can be heated in a Bunsen burner and plunged into cold water to demonstrate the exfoliation of rocks.

It is also possible to use bar-breaking apparatus to demonstrate the expansion of solids when they are heated.

**Core:** Questions are provided.

**Help:** A writing frame is provided with gaps for pupils to fill in.

**Expected outcomes**

Pupils understand that water expands when it freezes, and that materials can crack when exposed to hot and cold conditions.

**Pitfalls**

It is difficult for all pupils in a large class to make detailed observations of the broken bottle. More than one bottle may be set up to allow pupils to make observations in groups.

Pupils should not be allowed to handle the broken glass.

**Safety notes**

A label should be attached to the freezer warning that there is broken glass inside. Handle broken glass with care. It is better to leave the broken bottle in the plastic bag so that pupils do not handle the broken glass.

All present should wear eye protection, or the teacher should wear eye protection and the pupils be behind a safety screen, in case the glass rod shatters whilst being heated.

Great care should be taken when clearing away the broken bottle and the shattered pieces of glass rod.
Large rocks can be broken down into smaller pieces by weathering. You are going to watch two demonstrations of how physical weathering can occur.

**Obtaining evidence**

1. Your teacher will show you a bottle of water that has been put into the freezer.
2. Look carefully at the bottle and note down what has happened to it.

**Considering the evidence**

1. What happened to the water in the bottle as it froze?
2. What happened to the bottle?
3. Why did this happen?
4. If you freeze milk in a glass bottle, the bottle will break. If you freeze milk in a cardboard carton, the carton will not split or break. Explain this difference.
5. If water inside a crack in a rock freezes, what effect will it have on the crack?
6. What is happening to the particles in the glass rod as it gets hotter?
7. What happened to the hot glass rod when it was plunged into cold water?
8. Why do you think this happened? Explain what is happening in different parts of the rod.
9. Explain how rocks in the desert may be weathered by this process.
**Physical weathering**

Large rocks can be broken down into smaller pieces by weathering. You are going to watch two demonstrations of how physical weathering can occur.

**Obtaining evidence**

**Icebreaker**

1. Your teacher will show you a bottle of water that has been put into the freezer.
2. Look carefully at the bottle and note down what has happened to it.

**Hot and cold**

3. Watch closely as your teacher heats up a glass rod, and then plunges it into cold water.

**Considering the evidence**

**Icebreaker**

1. Use the writing frame below to help you write about your observations and conclusions.

   The bottle with frozen water in it had ………………………………… because …………………………………………. ……. .

   If water in a crack in rock got very cold it would freeze and ………………….. . When ice melts the space it takes up is ………………….. because …………………………………………. ….. .

   This would cause the rock to ………………….. .

2. Use the writing frame below to help you write about your observations and conclusions.

   When the hot glass rod was put in cold water, the glass rod ………………….. .

   This happened because when the hot glass rod suddenly touched the cold water it ………………….. .

   In the desert, when rock is continuously getting very cold and then very hot the rock will ………………….. .

Wear eye protection and/or use safety screens.
## Chemical weathering

### Running the activity

Pupils work in pairs to test the effects of dilute sulphuric acid on limestone, sandstone, chalk and granite chips.

**Core:** Pupils follow the instructions on the sheet, making a table to record their observations, then answer the questions. They have to predict what will happen when marble is tested with acid.

**Help:** Pupils use this sheet to record their observations and answer the questions. They can either follow the instructions for the experiment on the Core sheet, or the teacher may show them what to do.

### Expected outcomes

Pupils should discover that the limestone and chalk are affected, but the sandstone and granite are not.

### Pitfalls

It may take a few minutes for the results to be obvious. Pupils tend to be impatient and think that little has happened.

### Safety notes

Eye protection should be worn.
Pupils should be warned to take care with acid and to wash their hands afterwards.

### Answers

**Core:**

1. No. Limestone should have started hard and ended up crumbly, fizzing should have been observed during the reaction. Chalk should have reacted in the same way. Sandstone and granite should not have reacted and should remain the same.

   Groups: affected by acid - limestone and chalk; not affected by acid - sandstone and granite.

2. Limestone, because it reacted the most with the acid.

3. Limestone - harder and stronger, but prone to chemical weathering. Sandstone - softer and crumblier, but less prone to chemical weathering.

4. Yes. Marble should react with acid because it is made of the same minerals as limestone and chalk, and these react with acid.

**Help:**

1. Limestone, it reacted the most with the acid.

2. Group 1 affected by acid
   - limestone
   - chalk

   Group 2 not affected by acid
   - sandstone
   - granite

3. **Rock** | **Advantages** | **Disadvantages**
   --- | --- | ---
   limestone | hard and strong | chemically weathered
   sandstone | not chemically weathered | soft and crumbly

4. Yes. Marble should react with acid because it is made of the same minerals as limestone and chalk, and these react with acid.
**Chemical weathering**

**Equipment**

For each group:
- watchglasses
- dilute sulphuric acid
- dropper
- samples of limestone, sandstone, granite and chalk

**For your information**

**Running the activity**

Pupils work in pairs to test the effects of dilute sulphuric acid on limestone, sandstone, chalk and granite chips.

Core: Pupils follow the instructions on the sheet, making a table to record their observations, then answer the questions. They have to predict what will happen when marble is tested with acid.

Help: Pupils use this sheet to record their observations and answer the questions. They can either follow the instructions for the experiment on the Core sheet, or the teacher may show them what to do.

**Expected outcomes**

Pupils should discover that the limestone and chalk are affected, but the sandstone and granite are not.

**Pitfalls**

It may take a few minutes for the results to be obvious. Pupils tend to be impatient and think that little has happened.

**Safety notes**

Eye protection should be worn.

Pupils should be warned to take care with acid and to wash their hands afterwards.

---

<table>
<thead>
<tr>
<th>Type</th>
<th>Purpose</th>
<th>Differentiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical</td>
<td>Pupils investigate the effect of acid on different rocks.</td>
<td>Core, Help</td>
</tr>
</tbody>
</table>

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Catalyst 2

This worksheet may have been altered from the original on the CD-ROM.
Acids in our environment can cause weathering of some rocks. This is called chemical weathering. In this experiment you are going to investigate chemical weathering.

**Equipment**
- watchglasses
- spatula
- dilute sulphuric acid
- dropper
- samples of limestone, sandstone, granite and chalk

**Obtaining evidence**
1. Draw up a table to record your observations.
2. Put a few limestone chips onto a watchglass.
3. Write down what the limestone chips look like before the test. Tap them with a spatula to see if they are hard or crumbly.
4. Add a few drops of sulphuric acid onto the limestone chips. Write down any changes that you see taking place during the test.
5. Write down what the chips look like after the test and if they are hard or crumbly.
6. Repeat steps 2 to 5 for each of the other types of rock.

**Considering the evidence**
1. Did all the types of rock react in the same way? Is it possible to divide the rocks into groups which reacted in different ways? If so, what groups would you use?
2. Which rock do you think will be the most affected by chemical weathering? Explain why.
3. Compare limestone with sandstone. What are the advantages and disadvantages of using these two materials for building houses?
4. Marble is made of the same minerals as limestone and chalk. Would you expect a marble statue to be affected by acidic rainwater? Explain your answer.
Chemical weathering

Use this sheet to record your observations and answer the questions.

It is possible to divide the rocks into two groups based on how they react. Use the table below for your answer.

Decide on the headings for the two groups and then write down which rocks go in which group.

<table>
<thead>
<tr>
<th>Type of rock tested with acid</th>
<th>Before</th>
<th>During</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>limestone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sandstone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>granite</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>chalk</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Compare how limestone and chalk react. Which rock will be most affected by chemical weathering?
2. Compare limestone and sandstone. What are the advantages and disadvantages of using these two rocks for building materials for houses?
3. Marble is made of the same minerals as limestone and chalk. Would you expect a marble statue to be affected by acid rain? Yes, because

© Harcourt Education Ltd 2004 Catalyst 2
This worksheet may have been altered from the original on the CD-ROM.
Where weathering happens

Running the activity
Give pupils world maps that show maximum and minimum temperatures and rainfall. They prepare lists of places that have extremes of temperature and high rainfall. Pupils use this information to predict places that will have high levels of physical and chemical rock weathering.

Pitfalls
Some difficulty may be encountered in recognising and naming places on the maps.

Answers
1. Physical weathering where exfoliation will occur.
2. Chemical weathering where acidic rain may fall.
3. Wind, glaciers.
Where weathering happens

Physical weathering of rocks takes place where rocks are heated and cooled and chemical weathering where rain falls onto the rocks. You are going to use weather information to predict where weathering occurs.

Equipment
- world map(s) showing maximum and minimum temperatures
- world map(s) showing rainfall

Obtaining evidence
1. Look at the map(s).
2. Make a list of places where there are extremes of temperature (very hot and very cold).
3. Make a list of places where there is a high rainfall.
4. Decide which places are likely to have a lot of weathering of rocks. Make a list of these places.

Considering the evidence
1. What type of weathering is likely to occur in places that have extremes of temperature (very hot and very cold)?
2. What type of weathering is likely to occur in places that have a high rainfall?
3. What else might have an effect on the amount of weathering of rocks in one particular place?
How do sediments move?

<table>
<thead>
<tr>
<th>Type</th>
<th>Purpose</th>
<th>Differentiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical</td>
<td>Pupils investigate the transport and deposition of sand.</td>
<td>Core, Help</td>
</tr>
</tbody>
</table>

### Running the activity

Core: Pupils follow the instructions on the sheet then answer the questions.

Help: Pupils fill in blanks to record their observations and conclusions. They can either do the experiments themselves, following the instructions on the Core sheet, or watch a teacher demonstration.

### Expected outcomes

Pupils see that sand is eroded most at the top of the tray where the water is flowing fastest, and is deposited at the bottom of the tray where the water is slowest. They observe the winding course taken by the water and the semicircular shaped 'delta' formed at the bottom.

### Pitfalls

These experiments could be quite messy – be prepared for spilt water and sand on the floor.

### Safety notes

Spilt water makes floors slippery.

### ICT opportunities

Pupils could search the Internet for the activities based on various stages in the rock cycle which can be found at:

**BBC Education: The Essential Guide to Rocks**

### Answers

Core:
1. Nearest the tap/hose.
2. Fast flowing.
3. At the edges, near the bottom.
4. Slowly
5. Became wider, deeper, delta-shaped deposit of sand at the bottom, other valid observations.

Help:
1. a. Top of the tray, the water is fast.
   b. Bottom of the tray, the water is slow.
How do sediments move?

Equipment

For each group:
- shallow tray
- clamps
- tube from cold water tap
- large plastic trough
- sand
- brick

For your information

Running the activity
Core: Pupils follow the instructions on the sheet then answer the questions.
Help: Pupils fill in blanks to record their observations and conclusions. They can either do the experiments themselves, following the instructions on the Core sheet, or watch a teacher demonstration.

Expected outcomes

Pupils see that sand is eroded most at the top of the tray where the water is flowing fastest, and is deposited at the bottom of the tray where the water is slowest. They observe the winding course taken by the water and the semicircular shape 'delta' formed at the bottom.

Pitfalls

These experiments could be quite messy – be prepared for spilt water and sand on the floor.

Safety notes

Spilt water makes floors slippery.
How do sediments move?

When a rock has been broken into pieces by weathering the rock fragments are carried by water. In this activity you will see how this takes place.

Equipment
- shallow tray
- clamps
- tube from cold water tap
- large plastic trough
- sand
- brick

Obtaining evidence
1. Fill a shallow tray with sand so that the bottom is covered. Fill a shallow water trough half full of water.
2. Angle the sand tray using a brick. Make sure the end of it is standing in the water trough.
3. Connect a rubber tube to the water tap. Hold the tube at the higher end of the tray and turn the water on gently.
4. Observe what happens to the sand for a few minutes.

Considering the evidence
1. Where is the sand washed away?
2. How quickly is the water flowing there?
3. Where is the sand deposited?
4. Is the water moving slowly or quickly there?
5. How did the ‘river’ of water flowing down the tray of sand change while you were watching it? Write a couple of sentences to summarise your observations.
How do sediments move?

When a rock has been broken into pieces by weathering the rock fragments are carried by water. In this activity you will see how this takes place.

Equipment

- shallow tray
- clamps
- tube from cold water tap
- large plastic trough
- sand
- brick

What to do

1. Fill a shallow tray with sand so that the bottom is covered. Fill a shallow water trough half full of water.
2. Angle the sand tray using a brick. Make sure the end of it is standing in the water trough.
3. Connect a rubber tube to the water tap. Hold the tube at the higher end of the tray and turn the water on gently.
4. Observe what happens to the sand for a few minutes.

Questions

1. Use your observations to complete these sentences.
   a. The sand is washed away from the ...........................................................
      because .................................................................
   b. The sand is deposited at the .................................................................
      because .................................................................

Try not to spill water onto the floor as this makes it very slippery. Take care not to slip if water is spilled onto the floor.
Running the activity

Pupils work in pairs. They repeatedly shake a plastic bottle of clay cubes and sieve off the dust after every 10 shakes, noting the mass of the cubes after each shaking. They plot a graph of their results and answer questions that relate the clay cubes to pebbles on a beach.

Core: Pupils make their own results table and graph.
Help: Pupils follow the instructions on the Core sheet, then use the Help sheet to record their results, draw their graph and answer more structured questions.

Other relevant material

Pebbles from a beach can be shown to illustrate how rounded they can get.

Expected outcomes

Pupils should note that the mass of the cubes gets less as they are eroded.

Pitfalls

Pupils should shake their sieves over newspaper to collect and dispose of the dust.

Safety notes

Ensure hands are washed after handling clay.

ICT opportunities

It would be possible to set up a spreadsheet to produce a graph of the results.

Answers

Core:
1. The cubes should get lighter.
2. Parts of the cubes have been eroded into small pieces of clay that pass through the sieve.
3. On a beach, pebbles crash into each other in the same way as the clay cubes when shaken.

Help:
1. Smaller/less/reduced, cubes, chipped off/eroded, smaller.
2. Bashed together, chipped off/eroded, cubes.
G3b  Erosion

Other relevant material
Pebbles from a beach can be shown to illustrate how rounded they can get.

Equipment
For each group:
- clay cubes (1 x 1 x 2 cm cubes fired in a kiln)
- sieve
- access to a digital balance
- newspaper
- plastic bottle or jar

For your information

Running the activity
Pupils work in pairs. They repeatedly shake a plastic bottle of clay cubes and sieve the dust after every 10 shakes, noting the mass of the cubes after each shaking. They plot a graph of their results and answer questions which relate the clay cubes to pebbles on a beach.

Core: Pupils make their own results table and graph.
Help: Pupils follow the instructions on the Core sheet, then use the Help sheet to record their results, draw their graph and answer more structured questions.

Expected outcomes
Pupils should note that the mass of the cubes gets less as they are eroded.

Pitfalls
Pupils should shake their sieves over newspaper to collect and dispose of the dust.

Safety notes
Ensure hands are washed after handling clay.
Erosion

As rock fragments are carried along in a river they are bumped against each other. This knocks bits off until the fragments become round pebbles.

Equipment

- clay cubes
- sieve
- digital balance
- newspaper
- plastic bottle or jar

Obtaining evidence

1. Draw up a table to record your results.
2. Count out 10 clay cubes and weigh them on the digital balance. Record the weight in your table.
3. Put the cubes into the bottle and close the lid.
4. Shake the bottle vigorously 10 times.
5. Hold the sieve over the newspaper and pour the contents of the bottle into the sieve.
6. Weigh the cubes again on the digital balance and record their weight in your table.
7. Repeat steps 3 to 6 five more times using the same clay cubes.
8. Plot a graph of ‘mass of cubes’ against ‘number of shakes’.

Considering the evidence

1. What do your results show?
2. Explain why this happened.
3. How does this experiment model the erosion of pebbles on a beach?
Use this sheet to record your results and answer the questions.

You will need to choose a suitable scale for the upright axis of your graph.

- Look at the measurements of mass in your table.
- Make sure you can get the six results on the graph without having them all bunched together at the bottom.

<table>
<thead>
<tr>
<th>Number of shakes</th>
<th>Mass of cubes in g</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (start)</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
</tr>
</tbody>
</table>

Considering the evidence

1. Complete these sentences.

   After each shake, the mass of the cubes is
   .......................... This change takes place because as
   the .......................... are shaken together bits are
   .......................... and the
   cubes become .......................... .

2. The same thing happens over a very long time to pebbles on a beach. They start out as pointed pieces of rock and end up as round pebbles.

   Complete this sentence.

   On a beach pebbles are .......................... by
   the sea and bits are .......................... in the same way
   as the .......................... in this experiment.
## Looking at rivers

### Running the activity

This is an Extension activity only. Pupils may work individually or in pairs to complete this task.

### Answers

<table>
<thead>
<tr>
<th>Location</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location 1:</td>
<td>The stream is flowing fast high up in the steep mountains, carrying pieces of rock of all sizes with rough/pointed edges.</td>
</tr>
<tr>
<td>Location 2:</td>
<td>The water is flowing fast down the lower slopes of the mountain, cutting/eroding the sides of the river to form cliffs. Large and small pieces of rock are carried, with pointed edges.</td>
</tr>
<tr>
<td>Location 3:</td>
<td>The river is flowing more slowly along flatter land. Pieces of rock have rubbed together to become more rounded, large pieces being deposited on the inside of curves/meanders and small pieces carried on in the water.</td>
</tr>
<tr>
<td>Location 4:</td>
<td>The river is now wide and slow moving, with pieces of rock being deposited on the gently sloping riverbed and only the smallest pieces of rock/silt being carried on.</td>
</tr>
<tr>
<td>Location 5:</td>
<td>As the river enters the sea it is very slow, very shallow and the silt is deposited in the river mouth forming islands.</td>
</tr>
</tbody>
</table>
Looking at rivers

You are going to look at a diagram of a river basin. This is the area of land drained by all the streams and rivers that eventually join together as one large river and flow into the sea. You are going to explain what happens at various places along the way.

For each of the locations numbered 1 to 5 in the river basin, write several sentences to describe what is happening there. Include the following points to explain the processes that are taking place:

- the speed of the water
- the slope of the stream or riverbed
- the size of the pieces of rock being carried or deposited
- the shape of the pieces of rock – pointed or rounded.
Investigate: Does particle size affect deposition?

Running the activity
Core: Pupils work in pairs to plan the activity. They are shown the apparatus they will use. When the plan is ready it is shown to the teacher for approval before continuing onto the practical. They carry out the activity using their plan. Measurements are recorded. Repeat measurements are made. They use results from their investigation to arrive at conclusions regarding the question. They carry out an evaluation of their investigation, and relate it to ‘real life’ situations of deposition.

Help: You could give most pupils the Core sheet to start planning from and then give the Help sheet to those who struggle. It provides full instructions of the practical part of the activity, together with a table in which pupils may record their results. They can then answer the questions on the Core sheet.

Extension: More able pupils are asked to consider several different ways of carrying out this investigation. They are asked to choose the best way and give reasons for their choice.

Other relevant material
- Skill sheet 8: Variables
- Skill sheet 11: Risk assessment
- Skill sheet 20: Writing frame: Planning an investigation
- Skill sheet 21: Writing frame: Reporting an investigation
- Skill sheet 24: Safety precautions

Expected outcomes
Core: Pupils should devise a viable method for carrying out this investigation, obtain results using this method and conclude that the larger the particle the quicker it settles. Pupils will then evaluate and suggest improvements to the method, and relate the results of the investigation to deposition in a river.

Help: Pupils should use the given method for carrying out this investigation, obtain results using this method and conclude that the larger the particle the quicker it settles.

Extension: Pupils should appraise different methods of carrying out this investigation and decide which is the best, with reasons. They then use this method for carrying out this investigation, obtain results using this method and conclude that the larger the particle the quicker it settles. Pupils will then evaluate and suggest improvements to the method, and relate the results of the investigation to deposition in a river.

This investigation looks at the rate of sedimentation of different size rock fragments in still water. In reality, the water in a river is moving. The deposition of rock fragments onto a riverbed is dependent on two major factors: the size of the fragments and the speed of the water. Pupils may need some guidance to arrive at the idea that the slower a particular size of rock fragment settles in still water, the further these particles would be carried if the water were moving. Hence small particles are carried further down the course of a river before they are deposited.
**Pitfalls**

Some pupils will present unrealistic methods, and will need to be 'steered' to a viable method.

Sizes of sand grains must be such that deposition occurs in a sensible time (eg 30 to 300 seconds). It is wise to carry out tests before the activity is begun.

Warn pupils not to spill water down the measuring cylinders as they mix the sand and water, as this may wash off the cross.

**Safety notes**

Water spillage may make floors slippery.

**ICT opportunities**

It would be possible to set up a spreadsheet for the results and subsequent calculations.

**Answers**

Core:

1. The largest.
2. The smallest.
3. The larger the grains the faster they are deposited (or reverse argument).
4. (Depends on results.)
5. (Depends on results - the closer repeats are the more reliable results and so the better they support the conclusions.)
6. (Depends on results.)
7. (Depends on results.)
8. In a river, larger grains are deposited earlier in the course, sand later and clay near the mouth.
9. Pupils may suggest use of flowing water, materials other than sand etc.
Investigate: Does particle size affect deposition?

Type | Purpose | Differentiation
--- | --- | ---
Practical | Pupils design and carry out an investigation into the effect of particle size on deposition. They present results, make conclusions and write an evaluation. | Core, Help, Extension

Other relevant material
Skill sheet 8: Variables
Skill sheet 11: Risk assessment
Skill sheet 20: Writing frame: Planning an investigation
Skill sheet 21: Writing frame: Reporting an investigation
Skill sheet 24: Safety precautions

Equipment
For the teacher:
- 1000 cm³ measuring cylinder
- several marbles of each of four or five diameters
- stopwatch

For each group:
- 100 cm³ measuring cylinder
- non-permanent felt-tip pen
- stopwatch
- access to a balance
- sand of several grain sizes

For your information
Running the activity
Core: Pupils work in pairs to plan the activity. They are shown the apparatus they will use. When the plan is ready it is shown to the teacher for approval before continuing onto the practical. They carry out the activity using their plan. Measurements are recorded. Repeat measurements are made. They use results from their investigation to arrive at conclusions regarding the question. They carry out an evaluation of their investigation, and relate it to ‘real life’ situations of deposition.

Help: You could give most pupils the Core sheet to start planning from and then give the Help sheet to those who struggle. It provides full instructions of the practical part of the activity, together with a table in which pupils may record their results. They can then answer the questions on the Core sheet.

Extension: More able pupils are asked to consider several different ways of carrying out this investigation. They are asked to choose the best way and give reasons for their choice.

Expected outcomes
Core: Pupils should devise a viable method for carrying out this investigation, obtain results using this method and conclude that the larger the particle the quicker it settles. Pupils will then evaluate and suggest improvements to the method, and relate the results of the investigation to deposition in a river.

Help: Pupils should use the given method for carrying out this investigation, obtain results using this method and conclude that the larger the particle the quicker it settles.
Investigate: Does particle size affect deposition? (continued)

Extension: Pupils should appraise different methods of carrying out this investigation and decide which is the best, with reasons. They then use this method for carrying out this investigation, obtain results using this method and conclude that the larger the particle the quicker it settles. Pupils will then evaluate and suggest improvements to the method, and relate the results of the investigation to deposition in a river.

This investigation looks at the rate of sedimentation of different size rock fragments in still water. In reality the water in a river is moving. The deposition of rock fragments onto a riverbed is dependent on two major factors: the size of the fragments and the speed of the water. Pupils may need some guidance to arrive at the idea that the slower a particular size of rock fragment settles in still water, the further these particles would be carried if the water were moving. Hence small particles are carried further down the course of a river before they are deposited.

Pitfalls
Some pupils will present unrealistic methods, and will need to be ‘steered’ to a viable method.
Sizes of sand grains must be such that deposition occurs in a sensible time (eg 30 to 300 seconds). It is wise to carry out tests before the activity is begun.
Warn pupils not to spill water down the measuring cylinders as they mix the sand and water, as this may wash off the cross.

Safety notes
Water spillage may make floors slippery.
Investigate: Does particle size affect deposition?

Rock fragments carried by the water are deposited at different places along the riverbed. You are going to investigate how the size of the particles affects the speed at which they settle.

**Equipment**
- 100 cm³ measuring cylinder
- non-permanent felt-tip pen
- access to a balance
- stopwatch
- sand of several grain sizes

**Planning and predicting**

1. Decide how you can measure the speed at which different sizes of particle settle. Look at the apparatus available for this activity.
2. Think of the other variables in this investigation, and how you can keep them the same.
3. Decide how many times you are going to repeat your experiments to get reliable results.
4. Write a plan giving details of what you are going to do. Include a diagram of the equipment you are going to use.
5. Decide what safety measures you should take.
6. Predict what you think your results will show, and write a scientific explanation for what you think will happen.
7. Show this plan to your teacher for approval before you begin to use the equipment. You may have to make some changes before you start.

**Obtaining evidence and presenting results**

8. Carry out your plan and record all of your measurements.
9. Present your results in a table. Use repeat results to work out averages.

**Considering the evidence**

1. Which size grains settled fastest?
2. Which sized grains settled slowest?
3. Describe how the size of grains affects the speed of settling.
Investigate: Does particle size affect deposition? (continued)

Evaluating

4. Were any of your repeat results very different from the other results for this size of sand?

5. What does your answer to 4 show about how much your results support your answer to 3?

6. Which parts of your plan did not work as well as you expected?

7. How could you improve your plan?

8. The deposition of rock fragments onto a riverbed is affected by both the size of the rock fragments and how fast the water is flowing. How do your results suggest which sizes of rock fragments will be deposited in different places along the course of the river?

9. What other experiments could you carry out to find out more about the deposition of rock fragments?
Investigate: Does particle size affect deposition?

Rock fragments carried by the water are deposited at different places along the riverbed. You are going to investigate how the size of the particles affects the speed at which they settle.

Obtaining evidence

1. Use a non-permanent felt-tip pen to write a cross about half-way up on the side of a 100 cm³ measuring cylinder. Make sure that you can see the cross when you look through the other side of the measuring cylinder.
2. Pour water into this 100 cm³ measuring cylinder up to the 100 cm³ mark.
3. Weigh out 20 g of one of the sizes of sand.
4. Add the sand to the water in the measuring cylinder.
5. Place your hand firmly over the top of the measuring cylinder and shake to mix the sand and water.
6. Place the measuring cylinder on the bench and start a stopwatch.
7. Look through the side of the measuring cylinder opposite the felt-tip pen cross. You will not be able to see the cross because of the sand in the water.
8. When you can see the cross again stop the stopwatch and record the time for this type of sand.
9. Using the same size of sand repeat steps 5 to 8 twice.
10. Repeat steps 1 to 9 using a different size of sand.
11. Record your results in this table.

<table>
<thead>
<tr>
<th>Size of sand</th>
<th>Time for cross to re-appear in seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Expt 1</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Considering the evidence

12. Answer the questions on the Core sheet.
Investigate: Does particle size affect deposition?

Rock fragments carried by the water are deposited at different places along the riverbed. You are going to investigate how the size of the particles affects the speed at which these fragments settle.

Planning and predicting

1. Decide how you can measure the speed at which different sizes of particle settle. Look at the equipment available for this activity.
2. Think of another way that you could measure the speed at which different sizes of particle settle. If possible think of a third way.
3. Decide which of these is the best way to carry out the investigation.
4. Give reasons for your decision in step 3.
5. Think of the other variables that are involved in this investigation, and how you can keep them the same.
6. Decide how many times you are going to repeat your experiments to get reliable results.
7. Write a plan giving details of what you are going to do. Include a diagram of the apparatus you are going to use.
8. Decide what safety measures you should take.
9. Predict what you think your results will show, and write a scientific explanation for what you think will happen.
10. Show this plan to your teacher for approval before you begin to use the equipment. You may have to make some changes before you start.

Obtaining evidence

11. Carry out your plan and record all of your measurements.
12. Present your results in a table. Use repeat results to work out averages.

Considering the evidence and evaluating

13. Describe your results and what conclusions you can draw.
14. Consider which parts of the plan did not work well and how you would improve them.
15. The deposition of rock fragments onto a riverbed is affected by both the size of the rock fragments and how fast the water is flowing. Describe how your results suggest which sizes of rock fragments will be deposited in different places along the course of the river.
Swirling sediments

Running the activity
Core: Pupils place a mixture of sand, gravel and stones into a 1000 cm³ beaker half filled with water. The water and rock fragments are swirled round with a circular motion. Pupils observe and record the movement of the rock fragments and the order in which they settle onto the bottom of the beaker.

Help: Provides a results table and a writing frame for conclusions.

Expected outcomes
Pupils see that smaller fragments move more quickly and settle more slowly than larger fragments.

Pitfalls
The mixture should contain fine grains of sand, a fairly fine gravel and small stones. Pre-washed sand and gravel, available from most large DIY stores, should be used to avoid cloudy water that will not settle quickly.

Although large plastic beakers would be safer to use, they do not allow clear vision of the rock fragments.

At the end of the activity the water can be poured away and the mixture of rock fragments collected in a bucket for re-use.

Safety notes
Pupils need careful instruction in a safe way to swirl the contents of the large beaker.

They should be warned of the danger of slippery floors if some of the water is spilled.

Answers
Core:
1. sand
2. stones
3. The smaller the fragments are, the more quickly they are carried, because they are lighter.
4. Stones at the bottom, then gravel, then sand at the top.
5. The heavier fragment settled first because the water was not moving fast enough to keep the fragments in motion.

Help:
Sand, stones, stones, sand, smaller, longer.
Swirling sediments

For each group:
- 1000 cm³ beaker
- 100 cm³ beaker
- mixture of sand, gravel and stones

For your information

Running the activity
Core: Pupils place a mixture of sand, gravel and stones into a 1000 cm³ beaker half filled with water. The water and rock fragments are swirled round with a circular motion.
Pupils observe and record the movement of the rock fragments and the order in which they settle onto the bottom of the beaker.
Help: Provides a results table and a writing frame for conclusions.

Expected outcomes
Pupils see that smaller fragments move more quickly and settle more slowly than larger fragments.

Pitfalls
The mixture should contain fine grains of sand, a fairly fine gravel and small stones. Pre-washed sand and gravel, available from most large DIY stores, should be used to avoid cloudy water that will not settle quickly.
Although large plastic beakers would be safer to use they do not allow clear vision of the rock fragments.
At the end of the activity the water can be poured away and the mixture of rock fragments collected in a bucket for re-use.

Safety notes
Pupils need careful instruction in a safe way to swirl the contents of the large beaker.
They should be warned of the danger of slippery floors if some of the water is spilled.

<table>
<thead>
<tr>
<th>Type</th>
<th>Purpose</th>
<th>Differentiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical</td>
<td>Pupils use a mixture of sand, gravel and stones to observe which deposits more quickly from moving water.</td>
<td>Core, Help</td>
</tr>
</tbody>
</table>
Swirling sediments

Different sizes of rock fragments are carried at different speeds by the moving water in a river. They are deposited at different places. You are going to model this.

Equipment
- 1000 cm³ beaker
- 100 cm³ beaker
- mixture of sand, gravel and stones

Obtaining evidence
1. Fill a 100 cm³ beaker with some of the mixture of sand, gravel and stones.
2. Half fill a 1000 cm³ beaker with water.
3. Pour this mixture into the 1000 cm³ beaker.
4. Hold the 1000 cm³ beaker tightly and swirl the water around. Move the beaker in a circular motion.
5. When the water in the beaker is moving around, place the beaker onto the bench.
6. Observe the movement of the sand, gravel and stones.
7. Record your results in a table.

Considering the evidence
1. Which rock fragments moved the quickest?
2. Which rock fragments moved the slowest?
3. Why did the three types of rock fragments move at different speeds?
4. In what order did the rock fragments settle onto the bottom of the beaker?
5. Explain your answer to 4.

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Swirling sediments

Different sizes of rock fragments are carried at different speeds by the moving water in a river. They are deposited at different places. You are going to model this.

**Equipment**
- 1000 cm³ beaker
- 100 cm³ beaker
- mixture of sand, gravel and stones

**Obtaining evidence**
1. Fill a 100 cm³ beaker with some of the mixture of sand, gravel and stones.
2. Half fill a 1000 cm³ beaker with water.
3. Pour this mixture into the 1000 cm³ beaker.
4. Hold the 1000 cm³ beaker tightly and swirl the water around. Move the beaker in a circular motion.
5. When the water in the beaker is moving around, place the beaker onto the bench.
6. Observe the movement of the sand, gravel and stones.
7. Record your results in the table shown below.

<table>
<thead>
<tr>
<th>Rock fragments</th>
<th>Description of movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>sand</td>
<td></td>
</tr>
<tr>
<td>gravel</td>
<td></td>
</tr>
<tr>
<td>stones</td>
<td></td>
</tr>
</tbody>
</table>

**Considering the evidence**
1. Complete these sentences about the sand, gravel and stones.

   .................. moved the quickest.
   .................. moved the slowest.
   .................. settled to the bottom first.
   .................. settled to the bottom last.

   The .................. the rock fragments the .................. they take to settle.
# Evaporating sea water

## Running the activity

Pupils measure out 25 cm³ of sea water using a measuring cylinder and place this in an evaporating dish. They set up apparatus consisting of Bunsen burner, tripod, gauze and ceramic mat, and evaporate the sea water to dryness. More able pupils could be asked to weigh the evaporating basin before the experiment and again when it contains the residue. They can work out the mass of salt from 25 cm³ of sea water. They could also be asked to work out how much sea water has to be evaporated to get a 500 g packet of salt as sold in a supermarket.

## Other relevant material

A photograph or slide of the Utah Salt Flats may be shown to pupils.

## Expected outcomes

Pupils should observe a layer of salt remaining when all of the water has evaporated.

## Pitfalls

To avoid heating too strongly pupils should be instructed on how to get a medium heat, non-luminous flame by adjusting the air hole of the Bunsen burner, and how to change the size of the flame by adjusting the gas tap control. It is important that the Bunsen burner is switched off before the last of the water is evaporated, to avoid cracking the evaporating basin. Pupils must be told not to taste the sea water residue.

## Safety notes

Eye protection must be worn. Pupils must be made aware of the hazard to eyes of water spitting from this experiment. During the experiment the Bunsen burner flame may need to be turned down to avoid spitting.

## ICT opportunities

Pupils could search the Internet for places where salt is obtained from evaporated deposits.

## Answers

1. water
2. salt (or a mixture of salts).
3. The materials in the residue have a boiling point higher than the temperature reached during the experiment.
4. Seas became trapped by land movement. Over many years the water evaporated to leave salt deposits.
Evaporating sea water

Other relevant material
A photograph or slide of the Utah Salt Flats may be shown to pupils.

Equipment
For each group:
- sea water
- 50 cm³ measuring cylinder
- evaporating basin
- Bunsen burner
- tripod
- gauze
- ceramic mat

‘Sea water’ can be made by dissolving 35 g of sodium chloride per dm³.

For your information

Running the activity
Pupils measure out 25 cm³ of sea water using a measuring cylinder and place this in an evaporating dish. They set up apparatus consisting of Bunsen burner, tripod, gauze and ceramic mat, and evaporate the sea water to dryness.

More able pupils could be asked to weigh the evaporating basin before the experiment and again when it contains the residue. They can work out the mass of salt from 25 cm³ of sea water. They could also be asked to work out how much sea water has to be evaporated to get a 500 g packet of salt as sold in a supermarket.

Expected outcomes
Pupils should observe a layer of salt remaining when all of the water has evaporated.

Pitfalls
To avoid heating too strongly pupils should be instructed on how to get a medium heat non-luminous flame by adjusting the air hole of the Bunsen burner, and how to change the size of the flame by adjusting the gas tap control.

It is important that the Bunsen burner is switched off before the last of the water is evaporated, to avoid cracking the evaporating basin.

Pupils must be told not to taste the sea water residue.

Safety notes
Eye protection must be worn.

During the experiment the Bunsen burner flame may need to be turned down to avoid spitting.
Evaporating sea water

Sea water contains many dissolved substances, such as sodium chloride (common salt). When the water evaporates these are left behind as solids.

Equipment
- sea water
- 50 cm³ measuring cylinder
- evaporating basin
- Bunsen burner
- tripod
- gauze
- ceramic mat

Obtaining evidence
1. Measure 25 cm³ sea water using a measuring cylinder and pour it into an evaporating basin.
2. Set up the apparatus for evaporating the sea water as shown in the diagram.
3. Heat the sea water using a medium non-luminous flame on the Bunsen burner.
4. As the volume of liquid decreases the sea water may ‘spit’. Turn down the size of the Bunsen burner flame to reduce this.
5. Just before the last of the water evaporates, switch off the Bunsen burner flame.
6. Leave the evaporating basin to cool for a few minutes.
7. Observe the residue left in the bottom of the evaporating basin.

Considering the evidence
1. What was lost from the sea water during this experiment?
2. What was left in the evaporating basin?
3. Why did the residue not disappear during the experiment?
4. Use ideas from this experiment to explain how salt lakes like the Salt Flats in Utah, USA were formed.
**Books and lessons**

### Running the activity

Put a pile of textbooks at the front of the class. The books should match the order, subject and classes of the lessons to be taught by a teacher the next day (or any other more suitable day in the timetable). One unrelated book should be placed somewhere in the pile. This could be a textbook for another subject the teacher does not teach, a travel book, a DIY book, etc.

Ask pupils to look at the pile of books and to use this information to predict the order, subject and classes of the lessons to be taught by the teacher the next day. The unrelated book will cause conflict that the pupils must try to resolve. The exercise is related to the ages of rock layers, eg in a cliff face, and the idea of sequential sedimentation.

### Other relevant material

A photograph and/or diagram of layers of rock in a cliff face may be useful.

Sheet detailing the teacher's timetable for the next day.

### Pitfalls

It may be difficult for all pupils to see the book titles at the same time. The lesson will run more smoothly if a list of the titles, in order from the top to the bottom of the pile, is presented on an OHT, whiteboard or photocopied sheets.

Some pupils may need help to get started. They may need some guidance to arrive at the idea that the teacher prepares lessons in the same order that they are taught and has used each book and then put it aside on top of the pile.

### Answers

1. From book pile.
2. From book pile.
3. From bottom of pile for first lesson to top for last lesson.
4. Yes, the unrelated book.
5. Possible explanations depend on the book included: someone else left it there; the teacher is interested in this subject; the teacher is going on holiday; the teacher is going to do some DIY, etc.
6. Depends on pupil answer.
7. The book at the bottom of the pile was used first and therefore was used to prepare the first lesson of the day. The order of books then follows the order of lessons during the day. This is similar to layers of rock in a cliff face. The lowest layer is the oldest and the top layer is the youngest.

For more able pupils the unrelated book could be compared to the result of an intrusion of igneous rock between two of the sedimentary rock layers.
Books and lessons

When your teacher prepares lessons he/she uses books to get relevant information. Your teacher has left a pile of books on the desk from the preparation of tomorrow’s lessons. You are going to see what information you can gain from this pile of books.

Obtaining evidence

1. Look at the pile of books your teacher has left after preparing lessons for tomorrow.
2. Write down the titles in the order that they have been left in the pile.
3. Answer the questions below.

Considering the evidence

1. Which subjects do you think your teacher is going to teach tomorrow?
2. Which classes will he/she be teaching in tomorrow’s lessons?
3. What is the order of these lessons during the day?
4. Is there a book in the pile that does not fit into this timetable?
5. Can you explain why this book is there?
6. Ask your teacher for a sheet giving his/her timetable for tomorrow. Did the order of the books fit in with this timetable? Check if your conclusions are correct.
7. What is the connection between the pile of books and the order of rock layers seen in a cliff face?
## Suggested alternative plenary activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Review learning</th>
<th>Sharing responses</th>
<th>Group feedback</th>
<th>Word game</th>
<th>Looking ahead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupils work in groups of three to match key words to their definitions.</td>
<td>Brainstorm in groups to come up with questions based on what they have seen in Activity G1a.</td>
<td>Pupils work in groups of four and use what they saw during Activity G1b to suggest why rocks break in cold weather.</td>
<td>Word ‘splat’ using key words from the lesson.</td>
<td>Show an animation of plants growing in cracks in rocks and causing them to break up. Catalyst Interactive Presentations 2</td>
</tr>
</tbody>
</table>

### Review learning
- Pupils work in groups of three to match key words to their definitions.
- In turn, groups report back one matching pair each to the whole class.

### Sharing responses
- Pupils work in groups of four to brainstorm the questions opposite.
- Pupils use information gained in Activity G1a to help them suggest answers to the questions opposite.
- Each group selects its best answer to each question.
- In turn, groups report their best answers to the whole class.

### Group feedback
- Pupils work in groups of four to write an answer to the question opposite. Each group writes their answer on enough small pieces of paper for each of the other groups to have a copy.
- Each group discusses the answers of all groups, and chooses which they want to present to the class.
- In turn, groups present their chosen answer for class discussion.

### Word game
- Initiate a ‘word splat’ by asking pupils to devise questions that can be answered by pointing to the key words for the lesson. The key words should be written on the board/OHT.
- Divide the class into two groups and a pupil from each group should be invited to stand close to the board/OHT.
- Choose a pupil to ask a question. The pupils by the board/OHT must each say the word and try to point to it first. The loser chooses another member of his or her group to stand at the board/OHT.

### Looking ahead
- Pupils watch an animation of plants growing in cracks in rocks and causing them to break up.
- Pupils work pairs to discuss what else, other than physical weathering, could break up rocks.
- Pairs report their answers to the whole class.

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## Rock breaking

### Review learning

Match each word to its definition.

<table>
<thead>
<tr>
<th>Word</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crystal</td>
<td>A scientist who studies rocks</td>
</tr>
<tr>
<td>Geologist</td>
<td>Process of alternate freezing and melting of water which widens cracks and splits rocks</td>
</tr>
<tr>
<td>Grains</td>
<td>Allows water to pass through or into it</td>
</tr>
<tr>
<td>Freeze-thaw</td>
<td>Small pieces joined together to form rock</td>
</tr>
<tr>
<td>Interlocking</td>
<td>Pieces joined to leave spaces between them</td>
</tr>
<tr>
<td>Mineral</td>
<td>The way grains or crystals fit together</td>
</tr>
<tr>
<td>Non-interlocking</td>
<td>Compound contained in a rock</td>
</tr>
<tr>
<td>Porous</td>
<td>Pieces joined to leave no space between</td>
</tr>
<tr>
<td>Texture</td>
<td>Regularly shaped interlocking pieces of a solid compound</td>
</tr>
</tbody>
</table>
G2 Disappearing rocks

**Suggested alternative plenary activities (5–10 minutes)**

<table>
<thead>
<tr>
<th>Review learning</th>
<th>Sharing responses</th>
<th>Group feedback</th>
<th>Word game</th>
<th>Looking ahead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Show pupils photos of mountain scenes with scree slopes below steep cliff faces.</td>
<td>Pupils use the evidence from Activity G2a to write a letter suggesting which type of rock should be used to build a new cathedral.</td>
<td>Pupils use the evidence from Activity G2b to decide which sorts of UK are likely to have the most weathering of rocks.</td>
<td>Check progress by pupils writing a poem about weathering of rocks.</td>
<td>Pupils suggest what happens to the rock fragments formed by weathering.</td>
</tr>
<tr>
<td><strong>Sharing responses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tell pupils there are plans to build a new cathedral in their town. They have been given the job of choosing which stone is to be used to build the cathedral.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pupils work in groups of four to suggest which stone should be used and why.</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Each group reports back their suggestion, with reasons, to the whole class.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Group feedback</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Give pupils maps showing annual rainfall and maximum/minimum temperatures for the UK. (These maps may be available from a Geography Department or can be found in an atlas.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pupils work in groups to predict which areas of the UK are likely to have the most weathering of rocks.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Groups report back their ideas with reasons for their choices.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Word game</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pupils work, in groups or individually, to write a poem about the weathering or rocks. A series of photographs showing mountain scenes and weathered buildings, statues etc, may be used as stimulus material.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Pupils read out their poems to the class.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Looking ahead</strong></td>
<td>Question</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set the question for individuals to consider and suggest answers to. Then ask them to share their responses with other pupils. Make it clear they may not know the answer and need to suggest their ideas and predictions.</td>
<td>What happens to the rock fragments formed by weathering?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pupils can summarise the suggestions and record them in their books, to reconsider after further lessons.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**G3 Transporting rock**

### Suggested alternative plenary activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Review learning</th>
<th>Sharing responses</th>
<th>Group feedback</th>
<th>Word game</th>
<th>Looking ahead</th>
</tr>
</thead>
<tbody>
<tr>
<td>Show photos of layers of rock exposed on cliff faces.</td>
<td>Pupils use evidence from Activity G3a to write questions to given answers about the way that rock fragments are carried in rivers.</td>
<td>Pupils use evidence from Activity G3b to write five sentences that describe how the smooth round pebbles on a streambed got there.</td>
<td>True/false quiz about the way that rock fragments are carried in rivers.</td>
<td>Show video-clips of sandstorms and rocks shaped by wind erosion; glacier and large rocks carried down by glacial action.</td>
</tr>
<tr>
<td>Catalyst Interactive Presentations 2</td>
<td></td>
<td></td>
<td></td>
<td>Catalyst Interactive Presentations 2</td>
</tr>
</tbody>
</table>

### Review learning
- Show pupils photos of layers of rocks exposed on cliff faces. Ask pupils to think about how the layers have been made.

### Sharing responses
- Give pupils a number of question answers on a worksheet or OHT. Pupils work in groups to write a question that would elicit each of the answers.
- Each group in turn reads out one question and answer for class discussion.

### Group feedback
- Pupils work in groups of four to write five sentences that describe how the smooth round pebbles on a streambed got there.
- Each group in turn reads out their five sentences for class discussion.

**Sample answer**

Weathering breaks large rocks up into smaller fragments.
Rain washes the fragments into a mountain stream.
The fragments are carried along by the fast-flowing water in the stream.
As the rock fragments are carried along they bump onto each other knocking off the rough edges.
When the water flow is a little slower the smooth pebbles are deposited.

### Word game
- Make a set of cards for each pupil: True, False and Unsure. (You could use a different colour card for each word.)
- Read out the statements on the teacher sheet. Pupils hold up the card for their answer simultaneously. Explain the answers. If many pupils get an answer wrong, repeat the statement later.

### Looking ahead
- Show video-clips of sandstorms and the strangely shaped rocks formed by wind erosion.
- Pupils work in groups to explain what has happened to create the strangely shaped rocks.
- Each group in turn reports back their ideas for discussion by the whole class.
- Show video-clips of a glacier and very large rocks that have been carried down and deposited by a glacier.
- Pupils work in groups to explain how the large rocks have been moved. Each group in turn reports back their ideas for discussion by the whole class.
The answers to 10 questions about erosion and deposition are shown below. Write a question to go with each answer.

### Answers

1. Fine sand or clay.
2. The water moves more quickly when a river is in flood.
3. Only fast-flowing water can move pebbles.
4. The rock fragments bump into each other, knocking off the sharp edges.
5. Weathering and transport.
6. Nearer the mouth where the river is slow.
7. The wind blows sand against the rocks.
8. Deposition.
9. Wind and glaciers.
10. They consist of rocks of all sizes, even large boulders, and are not smooth and round.
G3 Transporting rock

Sharing responses

Teacher sheet

Questions
1. What sort of rock fragments are found near the mouth of a river?
2. Why do rivers in flood carry more rock fragments than rivers not in flood?
3. Why are pebbles found on the bed of mountain streams but not rivers?
4. Why are the pebbles found in a stream round and smooth?
5. What are the two processes involved in erosion?
6. Which part of a river has the least erosion?
7. How do wind cause rocks to be eroded into strange shapes?
8. What is the name given to the formation of sediment on a riverbed?
9. What else, other than water, can transport rock fragments?
10. How are rock fragments transported by glaciers different from those transported by rivers?
Word game

Statement

1. The smaller the rock fragment the further it is carried down a river. [true]
2. Sharp rock fragments are turned into smooth pebbles by acid rain. [false]
3. Erosion is another word for carrying rock fragments away after weathering. [false]
4. Fast-flowing water can carry pebbles, gravel, sand and clay. [true]
5. Transformed rock fragments are deposited when the water is no longer travelling fast enough to keep them in suspension. [true]
6. Fast-flowing water causes less erosion of the river bank than slow-flowing water. [false]
7. Rock fragments can be carried by glaciers. [true]
8. Rock fragments cannot be carried by wind. [false]
9. Many of the rock fragments carried by glaciers are larger than those transported in stream or rivers. [true]
10. The action of waves on the coastline of the sea causes erosion. [true]
**G3 Investigate: Does particle size affect deposition?**

### Suggested alternative plenary activities (3–10 minutes)

<table>
<thead>
<tr>
<th>Review learning</th>
<th>Group feedback</th>
<th>Analysing</th>
<th>Evaluating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Review of what is deposited on a riverbed in different places along its course.</td>
<td>Groups report their results to the class.</td>
<td>Teacher-led review of how a sample set of results can be used to answer the question posed by the investigation.</td>
<td>Group discussions followed by feedback and class evaluation of the investigation.</td>
</tr>
</tbody>
</table>

**Review learning**

- Pupils work in groups to describe the material found on a riverbed at different positions along its course.
- In turn, groups report back their suggestions to the class.
- Write up refined ideas in a table on the board or OHT.

**Group feedback**

- Groups of pupils report back the results of their investigation.
- A set of results is recorded on the board or OHT (or a sample set of results can be used).

**Analysing**

- Ask pupils to discuss in groups how this set of results can be used to answer the question: “How does particle size affect deposition?”
- Each group in turn report their ideas for class discussion. Make it clear that the fast-settling sediments will be deposited closer to the source of the river and the slow-settling ones closer to the mouth of the river.

**Evaluating**

- Pupils work in groups to discuss the questions opposite.
- Each group reports back their ideas for class discussion.

**Questions**

- What worked well?
- What did not work so well?
- How reliable are the results?
- How could the investigation be improved?

**Answers**

At source: smooth round pebbles of 1 to 3 cm diameter.
Leaving mountains: coarse sand, with quite large particles.
In valley: fine sand, with small particles.
At mouth: clay or mud, with very small particles.
Investigate: Does particle size affect deposition?

Review learning

What sort of material is deposited in different places along the course of a river?

Discuss this question in your group.

Use your ideas and the table below to note down a description of the material at each place along the river.

<table>
<thead>
<tr>
<th>Position of riverbed</th>
<th>Size of particles</th>
<th>Description of material</th>
</tr>
</thead>
<tbody>
<tr>
<td>In the mountains near its source.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Just after leaving the mountains.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In a wide valley half-way along its course.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Close to the river mouth.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Layers of sediment

Suggested alternative plenary activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Review learning</th>
<th>Sharing responses</th>
<th>Group feedback</th>
<th>Brainstorming</th>
<th>Looking back</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupils match words to definitions.</td>
<td>Show a photo of a cliff face with several layers visible.</td>
<td>Pupils consider what a layer of rock can tell you about the way it was formed using information gained from Activity G4a.</td>
<td>Sequencing activity using statements about fossil formation.</td>
<td>Pupils revise and consolidate knowledge from the unit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Review learning
- Pupils work individually to match words to definitions.
- They form groups of four to discuss their answers.
- Each group in turn reports back to the whole class on one word and its definition.

Share responses
- Pupils study a photo of a cliff face with several layers of rock.
- They suggest which layers contain the oldest and youngest rocks.
- They suggest how we might be able to tell the age of each rock.

Group feedback
- Pupils review their findings from Activity G4a.
- They work in groups of four to answer the question “What can a layer of rock tell you about the way it was formed?”
- Each group in turn reports their ideas back to the whole class for discussion.
- Lead the discussion to consider grain size, presence of fossils (eg shells), thickness of layers, speed of deposition, sharpness of boundaries, etc.

Brainstorming
- Give pupils the pupil sheet with a number of statements about the formation of fossils and ask them to put them in the correct chronological order.
- Individuals or groups report back their answers for class discussion.

Looking back
- Pupils revise and consolidate knowledge from the unit. They can use the Unit map, Pupil checklist, or the Test yourself questions.

Deposit – Solid material settling out from suspension to form a layer on a riverbed or seabed;
Fossil – Bones or shells turned into rock over millions of years;
Layers – A deposit that has been laid down during one season;
Limestone – A sedimentary rock formed from the deposition of marine shells and bones;
Sediment – A layer of solid material deposited on a riverbed or seabed.
### Layers of sediment

**Review learning**

Match each of the following words about deposition of sediment with one of the definitions.

<table>
<thead>
<tr>
<th>Word</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposit</td>
<td>Bones or shells turned into rock over millions of years</td>
</tr>
<tr>
<td>Fossil</td>
<td>A sedimentary rock formed from the deposition of marine shells and bones</td>
</tr>
<tr>
<td>Layer</td>
<td>A deposit that has been laid down during one season</td>
</tr>
<tr>
<td>Limestone</td>
<td>A layer of solid material deposited on a riverbed or seabed</td>
</tr>
<tr>
<td>Sediment</td>
<td>Solid material settling out from suspension to form a layer on a riverbed or seabed</td>
</tr>
</tbody>
</table>

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Brainstorming

The following statements are about the way that fossils are formed. They have been written in the wrong order. Place them in the correct order in which they happened.

1. Fine sand and clay deposits on the seabed.
2. Shells and bones turn into rock, trapped in the sedimentary rock layers.
3. The water from a river mouth carries suspended fine sand and clay into the sea.
4. Shells and bones from dead marine animals fall to the seabed.
5. Pressure from the weight of layers above turns lower layers of sediment into rock.
6. Sediment builds up into layers many metres thick.
7. Shells and bones are buried in sand and clay sediments.
Earth detectives - Think about

Suggested alternative plenary activities (5–10 minutes)

<table>
<thead>
<tr>
<th>Group feedback</th>
<th>Bridging to other topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pupils use a series of written statements and put the statements in the correct order to describe the thinking that led them to the conclusion that Earth movements explained the fossil problem.</td>
<td>Introduce the idea of evolution for class discussion and how a fossil record is evidence for evolution.</td>
</tr>
</tbody>
</table>

Group feedback

- Pupils use a worksheet of written statements that lead to the conclusion that Earth movements can explain the presence of this fossil. The statements on the worksheet are in the wrong order. Pupils work in groups to place them in the correct order.
- Each group in turn reports their order and reasoning to the whole class.

Bridging to other topics

- Pupils look at information on the pupil sheet about how fossil evidence helps to show the evolution of the horse.
- Pupils work in groups to write sentences to describe this.
- Each group in turn reads out their sentences for class discussion.

Pupil sheet

Answers
3; 5; 1; 7; 4; 2; 6

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sheet 1 of 1
The fossil of a 190-year-old fish was found in a rock layer at the top of a cliff, where we would expect the youngest rocks to be located.

The statements below offer an explanation of how this fossil came to be in this location, but they are in the wrong order.

Re-arrange the statements in the correct order.

1. Pressure caused by the weight of material above caused the layer containing the fish remains to turn into rock.
2. The layer of rock containing the fish fossil was moved up until it was just below the surface of the Earth.
3. The fish died and was buried in a layer of sediment 190 million years ago.
4. Earth movements, eg earthquakes, moved the rock layers.
5. During many millions of years layers of sediment were deposited above the layer containing the fish remains.
6. Erosion exposed the fish fossil to view at the top of the cliff.
7. The fish remains slowly turned into rock.
Look at the table below, showing how evidence from fossils has enabled scientists to suggest how the horse evolved.

Work with other pupils in your group to write a few sentences describing how the evidence in the table helps to show how the evolution of the horse took place.

<table>
<thead>
<tr>
<th></th>
<th>Size</th>
<th>Front Foot</th>
<th>Teeth</th>
<th>Habitats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present day</td>
<td>1.6 m</td>
<td>knee</td>
<td>large</td>
<td>Plains of Europe</td>
</tr>
<tr>
<td>3 million years ago</td>
<td>1.6 m</td>
<td>adapted from the 'wrist' in the early horse's front limb; allowing the horse to run very fast</td>
<td>adapted for eating grass</td>
<td>Plains of North America</td>
</tr>
<tr>
<td>26 million years ago</td>
<td>1.0 m</td>
<td>one large central toe formed a hoof to enable it to run on firm ground</td>
<td>large, adapted for eating grass</td>
<td>Plains of North America</td>
</tr>
<tr>
<td>55 million years ago</td>
<td>0.4 m</td>
<td>padded feet with toes that spread out helped it walk on the damp forest floor</td>
<td>small, adapted for eating soft vegetation</td>
<td>Forests</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Present</th>
<th>3 million</th>
<th>55 million</th>
</tr>
</thead>
<tbody>
<tr>
<td>dawn horse (Eohippus)</td>
<td>early horse (Merychippus)</td>
<td>modern horse (Equus)</td>
</tr>
<tr>
<td>0.4 m</td>
<td>1.0 m</td>
<td>1.6 m</td>
</tr>
</tbody>
</table>

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This worksheet may have been altered from the original on the CD-ROM.
1. Draw lines to match the words to their descriptions.

<table>
<thead>
<tr>
<th>Word</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>porous</td>
<td>Made up of grains or crystals of different minerals or mixtures of minerals.</td>
</tr>
<tr>
<td>rock</td>
<td>Round pieces that make up a rock.</td>
</tr>
<tr>
<td>interlocking</td>
<td>These have flat sides and sharp edges and usually have a definite shape.</td>
</tr>
<tr>
<td>crystals</td>
<td>The different elements and compounds that make up rocks.</td>
</tr>
<tr>
<td>grains</td>
<td>Crystals that fit together with no gaps.</td>
</tr>
<tr>
<td>minerals</td>
<td>The way grains and crystals fit together.</td>
</tr>
<tr>
<td>physical weathering</td>
<td>Grains that fit together with gaps between them. Water can get into these gaps and soak through the rock.</td>
</tr>
<tr>
<td>texture</td>
<td>Breaking rocks into small pieces. The rock is not changed into different substances.</td>
</tr>
</tbody>
</table>
Rock breaking (continued)

2 The drawings show how freezing and thawing can break up rocks.

a These sentences describe how freeze-thaw can break rocks. The sentences are all mixed up! Write the number of the picture next to the sentence it goes with.

At night the water freezes and it expands (gets bigger). The ice pushes against the cracks and holes and makes them bigger. ☐

Water gets into cracks and holes in the rocks. ☐

Eventually the cracks and holes get so big that bits of the rock break off. ☐

b Look at these pictures of granite and sandstone. Granite / sandstone is more likely to be weathered than granite / sandstone because there are / aren’t gaps in the rock.

3 Write true or false for each sentence.

a Plant roots can break rocks into smaller pieces. ☐

b Heating and cooling cannot break rocks into sand. ☐

c Ice can break rocks into smaller pieces. ☐

d Granite is made from interlocking crystals and is easily damaged by ice. ☐

Underline the right words. Cross out the wrong words.
Disappearing rocks

1. Underline the right words. Cross out the wrong words.
   
   a. Rainwater has a pH of 5.5. If rainwater is more acidic, its pH might be 6.5/9.5/4.5.
   
   b. The gas from the air that dissolves in rain to make it slightly acidic is called carbon dioxide/oxygen/nitrogen.
   
   c. Rainwater reacts with some rocks and dissolves them. These rocks are made from calcium carbonate. A rock made from calcium carbonate is granite/limestone/slate.
   
   d. The gas made when rainwater reacts with calcium carbonate is called oxygen/carbon dioxide/nitrogen.
   
   e. The test for this gas is that it relights a glowing splint/turns limewater milky/pops with a burning splint.

2. Draw lines to match the words to the descriptions.

- limestone: Made when limestone underground is dissolved by rainwater. This takes millions of years to happen.
- soil: Made from tiny pieces of weathered rock.
- humus: Decayed plant and animal matter found in soil.
- cave: A rock made of calcium carbonate. It is used for buildings and statues.
G2 **Disappearing rocks** (continued)

3 Even the hardest rocks gradually get worn away. They can be worn away by physical processes. They can also be worn away by chemical processes.

- **Water expands as it freezes in cracks in the rock.** This can break up the rock.

- **Plant roots grow into cracks and push them apart to break up the rock.**

- **Rainwater can react with and dissolve rock.**

- **Rocks heat up in the day and expand. At night they cool and contract. This makes the rocks shatter.**

**a** Find all the physical changes. Colour them red.

**b** Find all the chemical changes. Colour them blue.
1. Use some of these words to fill in the gaps.

When weathered pieces of rock bump against each other the pieces become __________________ and __________________ .
This is called __________________ .

2. Look at the table. It contains ways rocks can be weathered. It also contains ways rocks can be eroded.

<table>
<thead>
<tr>
<th>Water freezing in cracks in the rock</th>
<th>Glaciers (rivers of ice)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainwater</td>
<td>Rivers</td>
</tr>
<tr>
<td>The sea</td>
<td>Wind</td>
</tr>
<tr>
<td>Plant roots</td>
<td>Repeated heating and cooling</td>
</tr>
</tbody>
</table>

a. Find the methods of weathering. Colour them in green.

b. Find the methods of erosion. Colour them in yellow.
3 Write true or false for each sentence.

a Fast winds can move big grains of sand. ......................

b Slow rivers can move big pieces of rock. ......................

c As pieces of rock are moved by a river they bump against each other, bits get knocked off and the pieces get more jagged in shape. ......................

d As the wind blows sand against rocks, the sand wears away the rock ......................

e Glaciers are rivers of ice that move very quickly. ......................

......................

f As glaciers move they scrape the rock underneath them and break pieces of the rock off. ......................

4 Use some of these words to fill in the gaps.

When a ...................... slows down, the pieces of rock it carries settle out in layers. This is called ...................... .

The layers are called ...................... .
G4  Layers of sediment

1. Draw lines to match the words to their descriptions.

- Sedimentary layers
- Fossil reptiles that lived 65 to 200 million years ago.
- People who study fossils.
- Parts of living things preserved in sedimentary layers.
- Made the first maps showing the ages of rocks.
- People who study rocks.
- Pieces of eroded rock that settle out from water or wind.
- William Smith

2. A rock layer is 250 million years old. Do you think it could have fossil dinosaurs in it? Yes / No

3. Look at this drawing of layers of rocks.

- Which layer is the youngest?
  - 40 million years old
- Which layer is the oldest?
  - 450 million years old
- Which layers are younger than 200 million years?
  - 60 million years old, 200 million years old
- Which layers are older than 200 million years?
  - 300 million years old
- Which layer is likely to have dinosaur fossils in it?
Earth detectives

1 Mary Anning was a fossil hunter. She was born in 1799 and lived in Lyme Regis in Dorset. Her father died when she was 11 years old.

To make money for her family, Mary collected and sold fossils. Fossil collecting was dangerous. She had to walk under crumbling cliffs.

Mary made some important discoveries. She found the first Ichthyosaur in 1821. In 1823 she found the first nearly complete skeleton of a Plesiosaur. She also found many other kinds of fossil sea reptiles.

a When was Mary Anning born? ...........................................

b Where did Mary live? .........................................................

c What did Mary do to earn money for the family?

.................................................................

d Mary Anning is famous for finding Ichthyosaurs and Plesiosaurs. But what were these creatures?

- flying reptiles
- sea reptiles
- land-living dinosaurs

2 Mary Anning also discovered the first complete skeleton of a Pterodactyl found in Britain. Here is a picture of one.

a What do you think Pterodactyls were?

- flying reptiles
- sea-living reptiles
- land-living dinosaurs

b Why did you pick this answer?

Because the Pterodactyl is ..........................................................

.................................................................
Rocks and weathering

G1 Rock breaking

1. porous - Grains that fit together with gaps between them. Water can get into these gaps and soak through the rock.
   rock - Made up of grains or crystals of different minerals or mixtures of minerals.
   interlocking - Crystals that fit together with no gaps.
   crystals - These have flat sides and sharp edges and usually have a definite shape.
   grains - Round pieces that make up a rock.
   minerals - The different elements and compounds that make up rocks.
   physical weathering - Breaking rocks into small pieces. The rock is not changed into different substances.
   texture - The way grains and crystals fit together.

2. a. 2, 1, 3
   b. Sandstone is more likely to be weathered than granite because there are gaps in the rock.

3. a. true
   b. false
   c. true
   d. false

G2 disappearing rocks

1. a. 4.5
   b. Carbon dioxide.
   c. limestone
   d. Carbon dioxide.
   e. Turns limewater milky.

2. limestone - A rock made of calcium carbonate. It is used for buildings and statues.
   humus - Decayed plant and animal matter found in soil.
   soil - Made from tiny pieces of weathered rock.
   cave - Made when limestone underground is dissolved by rainwater. This takes millions of years to happen.

3. a. Coloured red - Water freezing in cracks in the rock. Plant roots. Rocks heating up in the day
   b. Coloured blue - Rainwater can react with and dissolve rock.

G3 Transporting rock

1. rounded, smaller, erosion

2. a. Coloured green - water freezing in cracks in the rock, rainwater, plant roots, repeated heated and cooling
   b. Coloured yellow - glaciers, rivers, the sea, wind

3. a. true
   b. false
   c. false
   d. true
   e. false
   f. true

4. river, deposition, sediments

G4 Layers of sediment

1. sedimentary layers - Layers of sediments.
   fossils - Parts of living things preserved in sedimentary layers.
   dinosaurs - Fossil reptiles that lived 65 to 200 million years ago.
   geologists - People who study rocks.
   palaeontologists - People who study fossils.
   sediments - Pieces of eroded rock that settle out from water or wind.
   William Smith - Made the first maps showing the ages of rocks.

2. a. Flying reptiles.
   b. Able to fly with its wings.

3. a. A
   b. E
   c. A, B
   d. C, D, E
   e. B

G5 Earth detectives

1. a. 1799
   b. Lyme Regis in Dorset.
   c. Collected and sold fossils.
   d. Sea reptiles.

2. a. Flying reptiles.
   b. Able to fly with its wings.
HELP

1. The rocks shown below were formed in different ways. Use some of the words shown below in your answers.

![Rock illustrations](image)

- Slate
- Gabbro
- Gritstone

**a** Copy and complete the following sentences:
   - i. Gabbro is not porous because ...
   - ii. Gritstone is porous because ...

**b** i. Which rock is made from crystals?
   - ii. Which rock does not contain crystals or grains?

**c** Which rock could have been made from tiny pieces of sand that have been squashed together?

CORE

2. Look at the diagram of gritstone rock in question 1. The ground below gritstone cliffs is often very sandy. This is due to weathering.

- a. Explain how sand could be formed from gritstone.
- b. Describe how water could cause cracks to form in gritstone cliffs.
- c. Explain how weathering might be different in desert rocks.

3. Here is a diagram of a piece of rock from Mount Snowdon, in Wales.

Explain why a geologist would describe the rock as 'a mixture of minerals'.

![Rock diagram](image)
**EXTENSION**

4 a In which of the situations shown above would these types of weathering most likely occur?
   i Freeze-thaw
   ii Biological weathering

b Explain how biological weathering happens.

c When rocks are broken down and carried away from the area, scientists say that erosion is happening, not weathering.

Explain why erosion is happening in diagram A, rather than weathering.
HELP

1. Here are two tombstones in the same graveyard. They were both put up in 1908.
   a. Which tombstone is most likely to be made from granite?
   b. What has happened to tombstone A to fade the lettering?
   c. Copy and complete the following sentence:
      Tombstone A has changed, since 1908, because ...

2. In Cornwall, many older houses are built from granite. In Derbyshire they are built from limestone.
   a. In which county will the older houses have changed the most?
   b. Is the rain in Derbyshire most likely to be acidic, alkaline or neutral?
   c. Granite cliffs have been around for much longer than granite houses. How will the surface of a granite cliff feel different from the surface of a granite house?

CORE

3. a. What is humus?
   b. Apart from water, why are plants not likely to grow well in a sandy desert, compared with in normal soil?

4. The table shows the results of Tom's pH testing of water from different places. Only four of the samples were rainwater.
   a. Which type of water is most likely to cause chemical weathering of limestone?
   b. Which type of water is closest to neutral?
   c. i. Which type of water is least likely to be rainwater?
      ii. Explain why you chose this one.
   d. Which type of acidic water is probably not 'normal' rainwater?
   e. Which naturally occurring substance probably caused the pH value of samples B, C and D?

<table>
<thead>
<tr>
<th>Place</th>
<th>pH of the water</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.6</td>
</tr>
<tr>
<td>B</td>
<td>5.5</td>
</tr>
<tr>
<td>C</td>
<td>6.0</td>
</tr>
<tr>
<td>D</td>
<td>5.9</td>
</tr>
<tr>
<td>E</td>
<td>8.6</td>
</tr>
</tbody>
</table>
Disappearing rocks (continued)

**EXTENSION**

5 This diagram shows a close-up from a 1 m square face of an Italian cliff. It is made from a rock called dolomite.

![Diagram of a dolomite cliff showing weathered pockets and main rock.]

This table contains data about the two main minerals in dolomite rock.

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Characteristics</th>
<th>Solubility of the product from weathering (in g/100 g of water)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnesium carbonate</td>
<td>Fairly hard. Slowly weathered by acidic rain</td>
<td>21.96</td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td>Fairly hard. Slowly weathered by acidic rain</td>
<td>0.63</td>
</tr>
</tbody>
</table>

a i Which mineral was most likely to have been originally in the 'weathered pockets' in dolomite rock?

ii Explain why you think this.

b Explain why, as well as having 'weathered pockets', dolomite cliffs also contain large vertical cracks.

c At the foot of the Italian cliffs are vast areas of broken rock called scree. Why might there be more scree below dolomite cliffs than below granite cliffs?

6 a On the Moon there is no evidence of chemical weathering. Suggest two reasons why there is no evidence.

b There is evidence of hot-cold weathering on Moon rocks. Explain why this happens.
   (Hint: think about why we see phases of the Moon.)

c Moon rocks also show evidence of being blasted to pieces by large impacts. What could cause these impacts on the Moon?
These pictures show a house gradually, over a long time, falling into the sea.

a. Write down the order in which the pictures were drawn.

b. What process has happened to the cliff since the first sketch was drawn?

c. Why has this happened?

d. Where is most of the cliff now?

Amil lives in a sandy desert. He wears a hood to protect his head when it is windy.

a. From what substance does Amil’s hood protect him?

b. Why does Amil need his hood more in a strong wind than in a light breeze?
Transporting rock (continued)

CORE

3 Craig is experimenting with some rocks he collected. He hits a piece of rock with a hammer to break it up into small pieces. Then he puts the pieces into a jar, adds some water and shakes it up. He leaves it to settle overnight. This diagram shows the jar the next morning.

a i Which lettered layer was deposited first?
   ii Explain how you knew this.

b Which lettered layer contains the smallest solid particles?

c Layer C contains small fragments of rock. Which layer is most likely to be sand?

d Which lettered layer could be called ‘soil’?

e Craig left the jar undisturbed for another week. What had probably happened to the cloudy water by the end of the week?

4 In the Alps (the highest mountain range in Western Europe), the rivers are very fast flowing. The water looks grey and is extremely cloudy. By the time the water reaches the sea it is slow moving and clear.

a Explain why the mountain rivers are a cloudy grey colour.

b What has caused the change in the water, at the sea?

EXTENSION

5 This diagram shows a bird’s-eye view of a river. It is flowing across a flat plain, after dropping down from a range of mountains.

a In which direction is the water flowing?

b i What will happen to the speed of the water as it reaches point P?
   ii Why will this happen?

c i What does the diagram suggest about the hardness of the rocks in area X, compared with those in area Y?
   ii Explain how you reached your answer.

d What will be happening to the river bank:
   i at point A?
   ii at point B?
   iii Explain why these changes will be happening.

e There are no large boulders on the river bed, in the area shown in the diagram. Explain why not.
1. Rocks on a mountain can be changed back into sedimentary rock. Four processes are needed for this to happen.

- transport
- sedimentation
- weathering
- burial

These processes must take place in the right order.

a. Write down the four processes in the correct order.

b. Copy and complete the following sentence:

The sedimentary rocks will form in layers because ...

2. This diagram shows layers of sedimentary rock in a cliff.

a. i. Which layer is the oldest?
   ii. Apart from the label, how do you know this?

b. Which layer is being eroded?

c. Which layer is most likely to contain humus?

d. Triceratops was a dinosaur. It lived about 190 million years ago. In which layer might you find fossils of a triceratops?

e. The woolly mammoth first appeared about 70 million years ago. In which layer might you find fossilized mammoth bones?

f. What must have happened to sea level since layer B was deposited?

g. Why are fossils helpful to geologists?
Layers of sediment (continued)

**CORE**

3. Look at these diagrams of five fossil animals and the data table.

<table>
<thead>
<tr>
<th>Fossil</th>
<th>Time when alive on Earth (millions of years ago)</th>
<th>Probable diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>140–190</td>
<td>Carnivore</td>
</tr>
<tr>
<td>B</td>
<td>140–190</td>
<td>Carnivore</td>
</tr>
<tr>
<td>C</td>
<td>280–570</td>
<td>Herbivore</td>
</tr>
<tr>
<td>D</td>
<td>0.1–2</td>
<td>Herbivore</td>
</tr>
<tr>
<td>E</td>
<td>Present day–7</td>
<td>Omnivore</td>
</tr>
</tbody>
</table>
Layers of sediment (continued)

a Which creature became extinct first?

b i Did animal E hunt animal A for food?
   ii Give a reason for your answer.

c i Which two types of animals could have actually seen each other?
   ii Just by looking at their fossils, suggest a reason why they did not actually meet.

d In a cliff containing layers of sedimentary rocks
   i which fossil is most likely to be found in the lowest layer?
   ii which fossils are most likely to be found in the same layer?
      (Hint: there are two pairs to look for.)

e i Which two animals are likely to be part of the same predator and prey food chain?
   ii Give reasons for your choice.

EXTENSION

4 The table is about rocks and fossils from a time called the Paleozoic age.

<table>
<thead>
<tr>
<th>Where found</th>
<th>Era</th>
<th>Rock types</th>
<th>When formed (million years ago)</th>
<th>Zone fossils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aberystwyth</td>
<td>Cambrian</td>
<td>Shale</td>
<td>500–570</td>
<td>Paradoxider</td>
</tr>
<tr>
<td>Moffat</td>
<td>Ordovician</td>
<td>Sandstone</td>
<td>435–500</td>
<td>Trinucleus and leptograptus</td>
</tr>
<tr>
<td>Wenlock</td>
<td>Silurian</td>
<td>Limestone and shale</td>
<td>395–435</td>
<td>Deiphon and monograptus</td>
</tr>
<tr>
<td>John O’Groats</td>
<td>Devonian</td>
<td>Sandstone</td>
<td>345–395</td>
<td>Lingula</td>
</tr>
<tr>
<td>Castleton</td>
<td>Carboniferous</td>
<td>Limestone</td>
<td>280–345</td>
<td>Goniatite and dibunophyllum</td>
</tr>
<tr>
<td>Tynemouth</td>
<td>Permian</td>
<td>Sandstone</td>
<td>225–280</td>
<td>No fossils</td>
</tr>
</tbody>
</table>
Homework

Layers of sediment (continued)

The map shows areas of the mainland UK where these rocks and fossils can be found.

a The fossil 'lingula' is found in area A.
   i In what era were the rocks formed?
   ii When were they formed?

b The rocks in area E were formed in the era after those in area A.
   i In what era were these rocks formed?
   ii Name two fossils found in these rocks.

c The town of Moffat is in southern Scotland.
   i What type of rocks are found near Moffat?
   ii What fossils would you find in these rocks?

d No fossils are found in the rocks of area C. How old are these rocks?

e i In what types of rock can you find the fossil 'monograptus'?
   ii In which areas on the map might you find monograptus?
   iii The rock in area D is not as old as the rock in area E. In which area would you find 'monograptus'? 
### HELP

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 a i</td>
<td>Gabbro is not porous because it is made from interlocking pieces with no spaces between them.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Underscores indicate pupil answers; accept equivalent answers.</td>
<td>1</td>
</tr>
<tr>
<td>1 ii</td>
<td>Gritstone is porous because it is made from grains which are non-interlocking so water can get into the spaces between the grains.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Underscores indicate pupil answers; accept equivalent answers.</td>
<td>1</td>
</tr>
<tr>
<td>1 b i</td>
<td>Gabbro</td>
<td>1</td>
</tr>
<tr>
<td>1 ii</td>
<td>Slate</td>
<td>1</td>
</tr>
<tr>
<td>1 c</td>
<td>Gritstone</td>
<td>1</td>
</tr>
</tbody>
</table>

Total for Help 8

### CORE

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 a</td>
<td>Gritstone is made from sand grains stuck together. weathering breaks grains away from each other. sand is formed from these separated grains. Accept equivalent answers.</td>
<td>1</td>
</tr>
<tr>
<td>2 b</td>
<td>Water seeps into small cracks. it freezes and expands in winter. the crack is forced apart. Accept equivalent answers.</td>
<td>1</td>
</tr>
<tr>
<td>2 c</td>
<td>Hot sun makes the rock expand. cold nights make the rock contract. cracks appear and pieces flake off. Accept equivalent answers.</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>It contains crystals of different compounds/minerals that are mixed together in the rock.</td>
<td>1</td>
</tr>
</tbody>
</table>

Total for Core 11

### EXTENSION

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 a i</td>
<td>B or D</td>
<td>1</td>
</tr>
<tr>
<td>4 ii</td>
<td>C</td>
<td>1</td>
</tr>
<tr>
<td>4 b</td>
<td>Roots force into cracks. roots grow, making cracks larger.</td>
<td>1</td>
</tr>
<tr>
<td>4 c</td>
<td>Waves batter/crash against the cliff, rock fragments are broken off. fragments are carried to another place.</td>
<td>1</td>
</tr>
</tbody>
</table>

Total for Extension 7
**G2 Disappearing rocks**

**HELP**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 a</td>
<td>B</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>It has weathered.</td>
<td>1</td>
</tr>
<tr>
<td>c</td>
<td>Tombstone A has changed, since 1908, because: rainwater has reacted with the limestone and made a new substance that has dissolved away. Accept equivalent answers.</td>
<td>1</td>
</tr>
<tr>
<td>2 a</td>
<td>Derbyshire</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>Acidic</td>
<td>1</td>
</tr>
<tr>
<td>c</td>
<td>It would feel powdery/crumbly.</td>
<td>1</td>
</tr>
</tbody>
</table>

**CORE**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 a</td>
<td>Decayed animal and plant material or material rich in minerals that plants need to grow.</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>There is not much humus so the soil is not very fertile.</td>
<td>1</td>
</tr>
<tr>
<td>4 a</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>C</td>
<td>1</td>
</tr>
<tr>
<td>c i</td>
<td>E</td>
<td>1</td>
</tr>
<tr>
<td>ii</td>
<td>It is alkaline and rainwater is usually acidic.</td>
<td>2</td>
</tr>
<tr>
<td>d</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>e</td>
<td>Carbon dioxide</td>
<td>1</td>
</tr>
</tbody>
</table>

**EXTENSION**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 a i</td>
<td>Magnesium carbonate</td>
<td>1</td>
</tr>
<tr>
<td>ii</td>
<td>The weathered product is more soluble than the one from calcium carbonate so will dissolve away faster leaving pockets/holes.</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>Cracks might have contained larger deposits of magnesium carbonate. Accept equivalent answers.</td>
<td>1</td>
</tr>
<tr>
<td>c</td>
<td>Faster weathering so the rocks are more broken up.</td>
<td>1</td>
</tr>
<tr>
<td>6 a</td>
<td>There is no atmosphere so no carbon dioxide to make acidic rain. Accept equivalent answers.</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>Moon rocks are either in the Sun, when they expand or in shadow when they cool and contract.</td>
<td>1</td>
</tr>
<tr>
<td>c</td>
<td>Meteorites hitting the Moon.</td>
<td>1</td>
</tr>
</tbody>
</table>
### Helen 

**Title:** Transporting rock

#### HELP 

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>C somewhere before A.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>A somewhere before B.</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>Erosion</td>
<td>1</td>
</tr>
<tr>
<td>c</td>
<td>Sea has battered the cliff.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Rock has broken off</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>and been transported away.</td>
<td>1</td>
</tr>
<tr>
<td>d</td>
<td>On the beach/under the sea.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Accept answers that indicate understanding of transport.</td>
<td></td>
</tr>
<tr>
<td>2a</td>
<td>From sand.</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>Strong wind can carry larger grains of sand/can blow the sand harder or with more force.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total for Help 9

#### CORE

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>3a i</td>
<td>C</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>It is the bottom layer.</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>c</td>
<td>B</td>
<td>1</td>
</tr>
<tr>
<td>d</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>e</td>
<td>It had sedimented and formed another layer.</td>
<td>1</td>
</tr>
<tr>
<td>4a</td>
<td>It contains a lot of solid particles/rock particles that have not sedimented because it is moving very fast.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>It has slowed down so the solids have sedimented/settled out.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total for Core 11

#### EXTENSION

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>4a</td>
<td>Towards the sea/to the left/left to right.</td>
<td>1</td>
</tr>
<tr>
<td>b i</td>
<td>Sows down.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>River is becoming wider/nearing the estuary. Accept equivalent responses.</td>
<td>1</td>
</tr>
<tr>
<td>c i</td>
<td>Bank eroded/worn away.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Silt/sediment deposited.</td>
<td>1</td>
</tr>
<tr>
<td>iii</td>
<td>Water flows faster round the outside of a curve so it erodes the bank or the opposite argument.</td>
<td>1</td>
</tr>
<tr>
<td>d</td>
<td>All has been deposited when the river reached the plain.</td>
<td>1</td>
</tr>
</tbody>
</table>

Total for Extension 7
# Layers of sediment

## HELP

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 a</td>
<td>Weathering → Transport → Sedimentation → Burial</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>The sedimentary rocks will form in layers because different sized pieces settle out at different times/at different speeds. Underscore represents pupil responses.</td>
<td>1</td>
</tr>
<tr>
<td>2 a i</td>
<td>E</td>
<td>1</td>
</tr>
<tr>
<td>ii</td>
<td>It is at the bottom/it is the deepest/furthest down.</td>
<td>1</td>
</tr>
<tr>
<td>b</td>
<td>E</td>
<td>1</td>
</tr>
<tr>
<td>c</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>d</td>
<td>C</td>
<td>1</td>
</tr>
<tr>
<td>e</td>
<td>B</td>
<td>1</td>
</tr>
<tr>
<td>f</td>
<td>Must have dropped.</td>
<td>1</td>
</tr>
<tr>
<td>g</td>
<td>Helps them to work out the age of a rock/rock layer.</td>
<td>1</td>
</tr>
</tbody>
</table>

Total for Help: **10**

## CORE

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 a</td>
<td>C/trilobite</td>
<td>1</td>
</tr>
<tr>
<td>b i</td>
<td>No</td>
<td>1</td>
</tr>
<tr>
<td>ii</td>
<td>Not around at the same time. Accept equivalent answers.</td>
<td>1</td>
</tr>
<tr>
<td>c i</td>
<td>A and B</td>
<td>1</td>
</tr>
<tr>
<td>ii</td>
<td>One lived in the sea and the other on land/is a bird.</td>
<td>1</td>
</tr>
<tr>
<td>d i</td>
<td>C</td>
<td>1</td>
</tr>
<tr>
<td>ii</td>
<td>A and B</td>
<td>1</td>
</tr>
<tr>
<td>iii</td>
<td>D and E</td>
<td>1</td>
</tr>
<tr>
<td>e i</td>
<td>D and E</td>
<td>1</td>
</tr>
<tr>
<td>ii</td>
<td>Both around at the same time. Then two from: one eats meat/is a carnivore/omnivore, both lived on the land.</td>
<td>2</td>
</tr>
</tbody>
</table>

Total for Core: **11**

## EXTENSION

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 a i</td>
<td>Devonian</td>
<td>1</td>
</tr>
<tr>
<td>ii</td>
<td>Between 345 and 395 million years ago</td>
<td>1</td>
</tr>
<tr>
<td>b i</td>
<td>Carboniferous</td>
<td>1</td>
</tr>
<tr>
<td>ii</td>
<td>Goniatite and dibunophyllum.</td>
<td>1</td>
</tr>
<tr>
<td>c i</td>
<td>Ordovician</td>
<td>1</td>
</tr>
<tr>
<td>ii</td>
<td>Trinucleus and leptograptus.</td>
<td>1</td>
</tr>
<tr>
<td>d</td>
<td>225–280 million years ago</td>
<td>1</td>
</tr>
<tr>
<td>e i</td>
<td>Limestone and shale.</td>
<td>1</td>
</tr>
<tr>
<td>ii</td>
<td>Area D and area E.</td>
<td>1</td>
</tr>
<tr>
<td>iii</td>
<td>Area E</td>
<td>1</td>
</tr>
</tbody>
</table>

Total for Extension: **10**

---

*This worksheet may have been altered from the original on the CD-ROM.*
Rocks and weathering

1. Complete the sentences using the words below. Use each word once only.

Rocks are made of different elements and ................................ called .................................. These are found in the rock in tiny bits which are called ................................ or .................................. Sometimes these can be seen with the naked eye, but in some rocks you need a ................................ to see them. In some rocks the grains are ................................ together, and in others the crystals fit together with no ................................ between them. Rocks that have spaces in them can absorb water and are called .................................

2. Write down two things that can cause physical weathering of rocks.

1 ................................................

2 ................................................

3. Complete the sentences by crossing out the wrong words.

When a rock is heated up by the Sun it expands/contracts and when it gets cold it expands/contracts. When this happens occasionally/repeatedly, it causes the rock to crack and crumble.

4. The sentences are about freeze-thaw weathering of rocks.

Put them in order by writing numbers in the boxes.

☐ Expanding ice pushes the cracks wider.

☐ Water freezes during cold weather.

☐ Water gets into small cracks in the rock.

☐ The cracks eventually are so wide that the rock crumbles into fragments.

☐ Water expands as it turns to ice.
5. Which of these gases dissolves in rainwater to make an acid that causes chemical weathering? Circle the correct letter.
   A. argon
   B. carbon dioxide
   C. carbon monoxide
   D. oxygen

6. What happens to rock fragments as they are carried downstream in a river? Underline the true statements.
   A. Rock fragments get larger.
   B. Rock fragments get rounder.
   C. Rock fragments get smoother.
   D. Rock fragments get darker.

7. Put the following rock fragments in order to show which part of a river they are deposited in. Write your answers in the left side of the table.

<table>
<thead>
<tr>
<th>Rock fragment</th>
<th>Part of river</th>
</tr>
</thead>
<tbody>
<tr>
<td>clay</td>
<td>source (in the mountains)</td>
</tr>
<tr>
<td>gravel</td>
<td></td>
</tr>
<tr>
<td>stones</td>
<td></td>
</tr>
<tr>
<td>sand</td>
<td></td>
</tr>
<tr>
<td></td>
<td>mouth (by the sea)</td>
</tr>
</tbody>
</table>

8. Complete the sentences by choosing from the words below.

When sediments are ........................., on the sea bed they form .......................... These can then be covered by more sediments of the same or a different kind. The oldest layer of rock is usually at the .......................... This type of rock often contains ......................... which are the remains of the skeletons of animals.
G  Rocks and weathering

1. Complete the sentences using the words below. Use each word once only.

Rocks are made of different elements and ......compounds...... called
......minerals....... These are found in the rock in tiny bits which are called
......grains...... or ......crystals....... Sometimes these
can be seen with the naked eye, but in some rocks you need a
......microscope...... to see them. In some rocks the grains are
......cemented...... together, and in others the crystals fit together
with no ......spaces...... between them. Rocks that have spaces in
them can absorb water and are called ......porous.......

2. Write down two things that can cause physical weathering of rocks.

1. rain - freezing and thawing
2. heat - expansion by heating in the Sun, cooling at
   night and contracting

3. Complete the sentences by crossing out the wrong words.

When a rock is heated up by the Sun it expands/contracts and when it
gets cold it expands/contracts. When this happens occasionally/ repeatedly,
it causes the rock to crack and crumble.

4. The sentences are about freeze-thaw weathering of rocks.
   Put them in order by writing numbers in the boxes.

4. Expanding ice pushes the cracks wider.
2. Water freezes during cold weather.
1. Water gets into small cracks in the rock.
5. The cracks eventually are so wide that the rock crumbles into
   fragments.
3. Water expands as it turns to ice.
5 Which of these gases dissolves in rainwater to make an acid that causes chemical weathering? Circle the correct letter.
A argon
B carbon dioxide
C carbon monoxide
D oxygen

6 What happens to rock fragments as they are carried downstream in a river? Underline the true statements.
A Rock fragments get larger.
B Rock fragments get rounder.
C Rock fragments get smoother.
D Rock fragments get darker.

7 Put the following rock fragments in order to show which part of a river they are deposited in. Write your answers in the left side of the table.

<table>
<thead>
<tr>
<th>Rock fragment</th>
<th>Part of river</th>
</tr>
</thead>
<tbody>
<tr>
<td>stones</td>
<td>source (in the mountains)</td>
</tr>
<tr>
<td>gravel</td>
<td></td>
</tr>
<tr>
<td>sand</td>
<td></td>
</tr>
<tr>
<td>clay</td>
<td>mouth (by the sea)</td>
</tr>
</tbody>
</table>

8 Complete the sentences by choosing from the words below.

When sediments are deposited on the sea bed they form ______ layers _______. These can then be covered by more sediments of the same or a different kind. The oldest layer of rock is usually at the ______ bottom _______. This type of rock often contains ______ fossils _______ which are the remains of the skeletons of animals.
Rocks and weathering

1a What does weathering do to rocks? 
1 mark

b Give two factors that can cause weathering of rocks. 
2 marks

2 The diagram shows the positions of layers of rock beneath the surface.

- a Granite is the oldest of these rock layers. How can you tell this from the diagram? 
  1 mark
- b Which of the layers chalk, sandstone or limestone would contain the oldest fossils? 
  1 mark
- c Explain your answer to question b.
  1 mark

3 The diagrams show the texture of the surface of two rock samples.

- a Describe the grains that make up sample A. 
  2 marks
- b Suggest how the grains in rock B became rounded in shape. 
  2 marks
- c Both rock samples were weighed before and after they had been soaked in water for 30 minutes. The results are shown in the table.

<table>
<thead>
<tr>
<th>Rock sample</th>
<th>Mass before soaking (g)</th>
<th>Mass after soaking (g)</th>
<th>Gain in mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>56.7</td>
<td>57.4</td>
<td>0.7</td>
</tr>
<tr>
<td>B</td>
<td>56.5</td>
<td>63.6</td>
<td>7.1</td>
</tr>
</tbody>
</table>

Explain why the two rock samples gave different results. 
2 marks
4 a Which gas dissolves to make rainwater acidic?  
1 mark

b Which two changes are caused by the acid in rainwater?  
Write down your two choices from the list below.  
2 marks

- The writing on a gravestone disappears.
- Iron railings go rusty.
- A wooden fence post becomes rotten.
- The face of a statue loses its features.

5 The diagram shows water flowing slowly through a plastic trough.  
A sample containing sand, gravel and stones is poured into the trough.  
After a few minutes the positions of the sand, gravel and stones are observed.

a Which row shows the correct positions? Write down your choice of three letters in order from the table.  
1 mark

<table>
<thead>
<tr>
<th></th>
<th>Sand</th>
<th>Gravel</th>
<th>Stones</th>
</tr>
</thead>
<tbody>
<tr>
<td>row 1</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>row 2</td>
<td>B</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>row 3</td>
<td>C</td>
<td>B</td>
<td>A</td>
</tr>
</tbody>
</table>

b Explain why the sand, gravel and stones travelled to different positions.  
2 marks
6 The diagram shows water running into a crack in the rock.

a What happens to water when it freezes to cause the rock to crack?  
1 mark

b What type of weathering process does this illustrate?  
1 mark

7 Granite is a very hard rock, but, over time, it will change as a result of weathering by rainwater. Rainwater is slightly acidic. Andrew wants to investigate the weathering of granite. He takes two similar pieces of granite. He puts one piece into a beaker containing strong acid solution and the other piece into a beaker containing water.

a Andrew wants to check how acidic his solution of acid is. Choose how he should do this from this list:  
1 mark

b What has Andrew used as a control for his investigation?  
1 mark

c After two weeks Andrew removes the granite from the acid solution and examines it carefully. Why is it important to wash the rock first?  
1 mark

d What should Andrew compare the rock with so he can be sure it is weathered?  
1 mark

e Andrew is still not sure that weathering has taken place. Which additional step in his method would have helped him most to be sure? Choose from the list below.  
1 mark

- Weigh the rock before starting the experiment.
- Wash the rock carefully before starting the experiment.
- Weigh the rock before and after the experiment.
- Dry the rock carefully after the experiment.
Rocks and weathering

1. The diagrams show the texture of the surface of two rock samples.

   ![Diagram A]
   ![Diagram B]

   a. Describe the grains that make up sample A.  
   2 marks

   b. Suggest how the grains in rock B became rounded in shape.  
   2 marks

   c. Both rock samples were weighed before and after they had been soaked in water for 30 minutes. The results are shown in the table.

<table>
<thead>
<tr>
<th>Rock sample</th>
<th>Mass before soaking (g)</th>
<th>Mass after soaking (g)</th>
<th>Gain in mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>56.7</td>
<td>57.4</td>
<td>0.7</td>
</tr>
<tr>
<td>B</td>
<td>56.5</td>
<td>63.6</td>
<td>7.1</td>
</tr>
</tbody>
</table>

   Explain why the two rock samples gave different results.  
   2 marks

2. The diagram shows water flowing slowly through a plastic trough.

   A sample containing sand, gravel and stones is poured into the trough.
   After a few minutes the positions of the sand, gravel and stones are observed.

   ![Diagram of water flowing through a trough]

   a. Which row shows the correct positions? Write down your choice of three letters in order from the table.  
   1 mark

<table>
<thead>
<tr>
<th></th>
<th>Sand</th>
<th>Gravel</th>
<th>Stones</th>
</tr>
</thead>
<tbody>
<tr>
<td>row 1</td>
<td>A</td>
<td>B</td>
<td>C</td>
</tr>
<tr>
<td>row 2</td>
<td>B</td>
<td>C</td>
<td>A</td>
</tr>
<tr>
<td>row 3</td>
<td>C</td>
<td>B</td>
<td>A</td>
</tr>
</tbody>
</table>

   b. Explain why the sand, gravel and stones travelled to different positions.  
   2 marks
Rocks and weathering (continued)

3 a Which gas dissolves to make rainwater acidic? 1 mark

b Which two changes are caused by the acid in rainwater? Write down your two choices from the list below.
- The writing on a gravestone disappears.
- Iron railings go rusty.
- A wooden fence post becomes rotten.
- The face of a statue loses its features.

2 marks

4 The diagram shows water running into a crack in the rock.

- a What happens to water when it freezes to cause the rock to crack? 1 mark
- b What type of weathering process does this illustrate? 1 mark

5 The diagram shows the positions of layers of rock beneath the surface of the Earth.

- a Why are there layers of rocks beneath the surface? 1 mark
- b The diagram shows bedding planes. What are bedding planes? 1 mark
- c Limestone was made from the shells and bones of sea creatures. Explain how the layer of limestone was formed from this material. 2 marks
6 Granite contains crystals of the minerals feldspar and quartz. A small piece of granite is left in a solution of hydrochloric acid for a long time. The granite crumbles. In the material that remains, crystals of quartz are observed. Explain what has happened to the granite.

2 marks

7 Granite is a very hard rock, but, over time, it will change as a result of weathering by rainwater. Rainwater is slightly acidic. Andrew wants to investigate the weathering of granite. He takes two pieces of granite and photographs them with a digital camera. Then he puts one piece of granite into a beaker containing strong acid and another piece into a beaker containing water.

a After two weeks Andrew removes the granite from the acid solution and examines it carefully. Why is it important to wash the rock first?

1 mark

b What should Andrew compare the rock with so he can be sure it is weathered?

1 mark

c Andrew is still not sure that weathering has taken place. Which additional step in his method would have helped him most to be sure? Choose from the list below.

• Weigh the rock before starting the experiment.
• Wash the rock carefully before starting the experiment.
• Weigh the rock before and after the experiment.
• Dry the rock carefully after the experiment.

1 mark

d Katie says that Andrew should use a third piece of granite in the experiment. Why would this be a useful control for this experiment?

1 mark

e Andrew photographed both rocks again after the experiment, using a digital camera. He put the images onto his computer. How could he use the images to help him decide if weathering had taken place?

1 mark
## Green (NC Tier 3–6)

### Rocks and weathering

**End of unit test mark scheme**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 a</td>
<td>Breaks the rock into smaller pieces.</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>b</td>
<td>Any two from: Rain, wind, waves, sunshine, frost, Heating and cooling or expansion and contraction or freeze-thaw or water in cracks expands as it freezes and cracks the rock apart.</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2 a</td>
<td>It is the lowest or bottom layer.</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>b</td>
<td>Limestone</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>c</td>
<td>This layer was deposited first or the sandstone and chalk were deposited on top later.</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>3 a</td>
<td>Interlocking crystals.</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>b</td>
<td>Sharp edges were knocked off as the fragments were transported in a river.</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>c</td>
<td>Any two from: Rock A has no gaps between the grains. Rock B has gaps between the grains. Rock A is not porous or water cannot collect in the gaps. Rock B is more porous or water collects in the gaps.</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>4 a</td>
<td>Carbon dioxide</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>b</td>
<td>The writing on a gravestone disappears. The face of a statue loses its features.</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>5 a</td>
<td>Row 3: CBA</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>b</td>
<td>The lighter or smaller the grains or pieces of rock the further they are carried.</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>6 a</td>
<td>Water expands.</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>b</td>
<td>Physical weathering</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>7 a</td>
<td>Measure the pH</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>b</td>
<td>Similar rock in water.</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>c</td>
<td>To remove the acid solution which is harmful.</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>d</td>
<td>Compare with his control rock sample.</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>e</td>
<td>Weigh the rock before and after the experiment.</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scores in the range of:</th>
<th>NC Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-7</td>
<td>3</td>
</tr>
<tr>
<td>8-13</td>
<td>4</td>
</tr>
<tr>
<td>14-17</td>
<td>5</td>
</tr>
<tr>
<td>18-25</td>
<td>6</td>
</tr>
</tbody>
</table>

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## Rocks and weathering

### Question Answer Mark Level

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Mark</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Interlocking crystals.</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Sharp edges were knocked off as the fragments were transported in a river.</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Any two from: Rock A has no gaps between the grains. Rock B has gaps between the grains. Rock A is not porous or water cannot collect in the gaps. Rock B is more porous or water collects in the gaps.</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>2a</td>
<td>Row 3: CBA</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>The lighter or smaller the grains or pieces of rock the further they are carried.</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>3a</td>
<td>Carbon dioxide</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>The writing on a gravestone disappears. The face of a statue loses its features.</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>4a</td>
<td>Water expands.</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Physical weathering</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>5a</td>
<td>Different layers of rocks are formed one after another.</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>The lines where beds of rock meet.</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>The shells and bones were compacted by the pressure of material above them. The shells and bones were cemented together.</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>Only feldspar is attacked by the acid, leaving the insoluble quartz crystals.</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>7a</td>
<td>To remove the acid solution which is harmful.</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Compare with his control rock sample (in the water).</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Weigh the rock before and after the experiment.</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Make sure it was not the water weathering the rock.</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Compare the images before and after the experiment.</td>
<td>1</td>
<td>6</td>
</tr>
</tbody>
</table>

### Scores in the range of: NC Level

<table>
<thead>
<tr>
<th>Range</th>
<th>NC Level</th>
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</thead>
<tbody>
<tr>
<td>4-9</td>
<td>4</td>
</tr>
<tr>
<td>10-14</td>
<td>5</td>
</tr>
<tr>
<td>15-18</td>
<td>6</td>
</tr>
<tr>
<td>19-25</td>
<td>7</td>
</tr>
</tbody>
</table>
### Rocks and weathering

<table>
<thead>
<tr>
<th>Learning outcomes</th>
<th>I can do this very well</th>
<th>I can do this quite well</th>
<th>I need to do more work on this</th>
</tr>
</thead>
<tbody>
<tr>
<td>I can describe textures of different rocks.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can use ideas about texture to explain why a rock is porous or non-porous.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can describe the physical processes that cause weathering of rocks.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can describe the chemical processes that cause weathering of rocks.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can describe how rock fragments are carried.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can describe the process involved in erosion.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can explain why different rock fragments are deposited in different places.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can explain why the appearance of rock fragments changes as they are transported.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can plan and carry out an investigation to find the effect of particle size on deposition.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can recognise different sedimentary layers by their appearance.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can explain how layers of sediment are produced.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can describe how fossils are formed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can use information about fossils to suggest the age of rock layers.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can think about things laterally to try to find new explanations for problems.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word</td>
<td>Definition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>biological weathering R</td>
<td>Tiny pieces of material, such as sand.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>chemical weathering</td>
<td>Groups of particles with a symmetrical structure.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>crystals</td>
<td>All rocks are made up of compounds called minerals.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>delta</td>
<td>Different rocks are made up of different minerals or different mixtures of minerals.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>deposition</td>
<td>The feel or appearance of a material.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>erosion</td>
<td>A type of igneous rock with big crystals.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>estuary R</td>
<td>Crystals in rocks which fit together with no gaps between them are interlocking.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fossils</td>
<td>A type of sedimentary rock made up of grains of sand cemented together.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>freeze-thaw weathering R</td>
<td>Round grains in rocks which do not fit together, as there are gaps between them, are non-interlocking.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>geologists</td>
<td>A substance such as a rock with lots of tiny holes in it is porous.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>glacier R</td>
<td>Breaking rock down by chemical or physical processes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>grains</td>
<td>Breaking down rocks into smaller pieces, without changing them into new substances. Physical weathering can be caused by water, wind and changes in temperature.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>granite</td>
<td>Water inside a crack freezes and expands, exerting a force on the rock. The ice then thaws. This process is repeated many times until the rock eventually breaks apart. R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>humus</td>
<td>Breaking down rock by the action of plants or animals. R</td>
<td></td>
<td></td>
</tr>
<tr>
<td>interlocking</td>
<td>A type of sedimentary rock formed from the shells and bones of sea creatures, which contains calcium carbonate.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lateral thinking</td>
<td>The breaking up of rocks by chemicals in the environment.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>limestone</td>
<td>The substances in the rocks are changed into new substances.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>minerals</td>
<td>The top layer of soil, made of tiny grains of rock and humus.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>non-interlocking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>physical weathering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>porous</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sandstone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sediment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sedimentary layers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word</td>
<td>Definition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>texture</td>
<td>Dead animal and plant material found in soil. It provides plants with nutrients.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>topsoil</td>
<td>Loose pieces of rock are broken down while being transported.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>weathering</td>
<td>A slow-moving river of ice that can erode rocks by scraping across the top of them. R</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Small pieces of rock settling at the bottom of a river or the sea.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Small pieces of rock and dead living things which build up in layers at the bottoms of lakes or seas over millions of years.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Where a river flows into the sea. R</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>New land formed by deposition at the mouth of a river.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Layers of sediment that have built up over millions of years and become cemented together into rock.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The remains of animals or plants that have been buried deep underground for millions of years and preserved.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scientists who study the Earth and rocks.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Thinking in a different direction.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Key words

Rocks and weathering

- biological weathering
- chemical weathering
- crystals
- delta
- deposition
- erosion
- estuary
- fossils
- freeze-thaw weathering

- geologists
- glacier
- grains
- granite
- humus
- interlocking
- lateral thinking
- limestone
- minerals

- non-interlocking
- physical weathering
- porous
- sandstone
- sediment
- sedimentary layers
- texture
- topsoil
- weathering

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G1 Rock breaking

**Green**

a. A mineral is a rock made up of grains or crystals which are compounds.

b. The water will stay on the surface of the granite.

c. It expands.

d. They expand.

e. They contract.

1. a. A

2. b. When rock is broken into smaller pieces, but not changed into different substances, we call this physical weathering. It can be caused by frost and changes in temperature.

G2 Disappearing rocks

**Green**

a. Acidic

b. The pH meter provides an accurate number and not just a colour change.

c. Chemical weathering is when chemical changes take place in a rock.

d. Limestone is made of the mineral calcium carbonate, which completely reacts with acid. Some minerals in granite do not react with acids, so it weathers much more slowly.

e. Humus is soil which is rich in minerals that plants need for growth.

1. Chemical weathering can be caused by acid in rainwater. Chemical changes take place in the rocks and new substances are made.

2. The older gravestone has had longer for chemical weathering to occur. Some of the older stone has been changed into different substances so that the letters are not as clear as when they were made. The newer stone has not had as much chemical weathering because it is not so old.

3. Granite is a rock which does not weather chemically or physically very much.

**Red**

a. The water will stay on the surface of the granite.

b. Water seeps into the cracks in a rock. When the temperature falls and the water turns to ice, the ice expands and causes the rock to break into pieces.

c. Granite is not as porous as sandstone is. So granite is unlikely to have water inside it.

d. The bricks will be made of material which does not expand very much when heated.

1. Falling of rocks can cause them to break into pieces. Rocks exposed to alternating hot and cold temperatures will crack because of their expansion and contraction. Rocks which allow water to penetrate inside will then be broken if the water is frozen, melted and refrozen many times.

2. In a desert, it is very hot during the day, but it can get very cold at night. During the day, the hot rocks expand. During the cold nights, they contract. Rocks are a mixture of different minerals, and some of them expand and contract more than others. This causes huge forces of strain in the rock. This expansion and contraction happens every day and night, causing cracks to appear in the rock. Eventually, the rock breaks apart. The same thing happens to the smaller pieces. This happens until all the rocks are broken down to small grains of sand.

3. Plant roots can force their way through cracks in rocks. When they grow they make the cracks bigger. Eventually the rocks get broken apart.

4. a. Fast physical weathering occurs where extremes of temperature occur daily or very often, as in a desert. Fast physical weathering would also occur where there is a wet climate where it freezes often. Fast physical weathering also occurs where the weather is very windy and stormy, causing rocks to be blown about.
Rocks and weathering (continued)

G

iv Individual answers that show a suitable container to collect gas by water displacement.
v Bubble the gas through a solution of limewater. When the limewater turns cloudy it will show that the gas was carbon dioxide.

1 Chemical weathering occurs when rocks react with other substances, like acids, to form new substances. In physical weathering, no new substances are formed; only the shape or size of the rock is changed.
2 Chemical weathering has changed the rock into new substances. Over the long period of time from 1780, much chemical weathering has occurred and the sharp edges of the letters have been worn away making them difficult to read. The more recent letters made in 1945 have not had long enough to wear away very much, so they appear much as they were when they made.
3 In cold conditions as in the Arctic and in dry places like a desert.
4 When rock is chemically and physically weathered, it turns into soil.

G3 Transporting rock

Green

a The earth and rocks in front of the house have collapsed over the years and fallen into the sea.
b Rivers move very fast near to their source in the mountain. Here the water can carry quite large pieces of rock. Rivers move more slowly when they get to the sea and can only carry small grains of rock.
c Strong winds have great power and can move large rocks. A gentle breeze has very little force and can move only grains of sand or tiny rocks.
d Where a river flows into the sea the water is slow-moving and can carry only tiny bits of rock or sand. Near the river’s source the water is fast-moving and can carry larger rocks as the water has more force.

1 Erosion happens when weathered rock is carried away. Rock can be eroded by wind or water. Fast-moving wind and water can carry bigger pieces than slow-moving wind or water. When the wind or water is no longer moving fast enough to carry the rock pieces, they are deposited.
2 The water that runs off fields into rivers after heavy rain carries tiny pieces of rock and earth. This makes the water look muddy or dirty.
3 Individual answers.

Red

a Erosion would be quicker near the source of a river. Here the water moves quickly and has a great force that can carry away large rocks.
b The faster the air movement, the greater force it has. Having greater force enables fast-moving air to carry larger grains.
c At the mouth of a river the water is moving very slowly. Slow-moving water has little force and can only carry very small grains of sand which make up sediment.
1 Flash floods make water run off the surface at great speed and cause rapid erosion.
2 The water on the inside of the bend is flowing slowly, causing deposition of sediment. The water on the outside of the bend is moving much more quickly and carries the sand particles along with it.
3 Sediment is deposited at the mouth of the river because this is where the river meets the sea. At this point the water flows very slowly and all the sand and sediment in the water fall to the bottom and do not get washed along with the water.
4 Pebbles of granite can get washed along with the water of a fast-moving river and be deposited at the mouth of the river, where the water slows up and the particles drop to the bottom of the water.
5 Weathering can be caused by water freezing in rocks and breaking them apart when the ice forms and expands; it can be caused by chemical reactions with the minerals in the rocks or by plant roots growing into the cracks of rocks and splitting them when the plant grows larger. Erosion happens when rock is carried away from where it was weathered. It makes the rock fragments rounded and small. Rocks can be eroded by wind, water or glaciers.

G4 Layers of sediment

Green

a The top layer.
b The bottom layer.
c A fossil is a part of a creature that has been preserved in a sedimentary layer.
d Younger.
e 85 million years old.

1 Sedimentary layers are made from sediment. They build up in layers over millions of years at the bottom of lakes or seas. Parts of creatures that are preserved in sedimentary layers are called fossils.
2 a Layer 5.
b Layer 1.
c Layers 4 and 5.
3 Individual answers.
G5 Earth detectives

Green

a Some people like Mary Anning look for fossils to sell them and make money. But most people look for fossils because they are interested in learning about what kind of animals lived a long time ago. Also they are interested in the way that the Earth was formed and how the layers of rock formed.
b He found a fossil fish in the side of a cliff.
c Earth movements have raised up the rocks, together with any fossils in them.
d 'A being of imagination – she has so many ideas and such power of communicating them.'

1 six
2 Lateral thinking.
3 Individual answers.

Red

a Some people like Mary Anning look for fossils to sell them and make money. But most people look for fossils because they are interested in learning about what kind of animals lived a long time ago. Also they are interested in the way that the Earth was formed and how the layers of rock formed.
b He found a fossil fish in the side of a cliff.
c Earth movements have raised up the rocks, together with any fossils in them.
d 'A being of imagination – she has so many ideas and such power of communicating them.'

1 six
2 Lateral thinking.
3 Individual answers.

G Rocks and weathering (continued)

Red

a There are times when the rivers carry hardly any sediment and times when they carry a lot.
b younger
c The order has been changed because of the folding of the crust back on itself.
d 85 million years old.

1 a Layer 5.
   b Layer 1.
   c Layer 3.
   d Layers 4 and 5.

2 A very large meteorite or comet crashed into the Earth. Scientists haven’t gathered enough information yet to be certain that this was the reason.

3 Dinosaurs didn’t live before 200 million years ago.

4 Individual answers.

5 The evidence was that the fossils in a section of sedimentary rock were always in the same order from the top to the bottom – even those in a different part of the country.

Green

a Some people like Mary Anning look for fossils to sell them and make money. But most people look for fossils because they are interested in learning about what kind of animals lived a long time ago. Also they are interested in the way that the Earth was formed and how the layers of rock formed.

2 Lateral thinking.

3 Individual answers.