

A Geography Course
for Secondary Schools

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**WORLD
WATCH**
Geography

2
TEACHING GUIDE

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Introduction

World Watch is a geography course for the 21st century. It is designed for secondary schools that want to stimulate curiosity, thinking skills, and a love of learning. The course comprises four components: Student's Books, Skills Books, My E-Mate companion website, and Teaching Guides.

Core features

- It draws its content and skills from international secondary school syllabuses while focusing on Pakistan for examples.
- At all levels, learning is built on students' knowledge; the teacher eliciting what they already know and building on this, not simply loading them with facts.
- The language, content, and tasks are progressively graded according to class levels.
- Each level is split into separate units, each focusing on a different topic.
- High priority is given to independent and critical thinking skills.
- Ideas for discussion are provided to help students to express their own ideas in open-ended tasks.
- Mapping skills are taught in a progressive way that builds on the students' previous learning.
- Diagrams and charts/tables are used to vary the presentation of content.
- Students are encouraged to make connections between the geographical environment and the way people live.

Student's Books

- The Student's Books form the core of the course. The illustrations, photographs, and maps bring alive the familiar environment and distant places, and both natural and man-made geographical features.
- The 'Contents' page details the learning outcomes for each unit.
- Each unit of the Student's Book consists mainly of reading texts and making observations, followed by assessment questions.
- The 'Overview' at the end of each unit virtually represents the various topics in the unit and how they are interlinked to each other.
- Fact boxes contain interesting information about the relevant topics and key fact boxes at the end of each unit summarize the unit.

Skills Books

- At each level, there is an accompanying Skills Book.
- The tasks are varied and enjoyable, and include maps, diagrams, charts or tables, crosswords, fill-in-the-blanks, and situational questions.
- Skills Book pages should be introduced in class and can be completed either in class or for homework.
- Students are usually expected to write in the Skills Book.
- There is a brief learning outcome at the top of every page.

Teaching Guides

Teaching Guides are an invaluable resource for the teacher. It provides a framework for formative assessment of students for each lesson. It has the following features:

- background knowledge
- student learning outcomes
- step-by-step lesson plans
- ideas for further activities and student research

Contents

Page Nos/ Units	Teaching objectives Student's Book and Skills Book	Learning outcomes Students should be able to:	Key words and phrases
Page Unit 1 Rocks, minerals, and soil	2 <ul style="list-style-type: none"> to explain the different types of rocks, minerals, and soil to explain how soil is formed naturally to explore different types of soil 	<ul style="list-style-type: none"> describe the characteristics of different types of rock and soil. explain how rocks and soil are formed. identify different rocks and soil from samples and pictures. 	sedimentary, metamorphic, igneous, intrusive, extrusive, mechanically formed, chemically formed, organically formed, mineral, ore
Page Unit 2 Inside the Earth	10 <ul style="list-style-type: none"> to explain the internal structure of the Earth to explain the role of plate tectonics in the formation of landforms 	<ul style="list-style-type: none"> describe the internal structure of the Earth. give a simple explanation of plate tectonics and faults. explain how tectonic faults and movements affect landforms. 	tectonic plate, fault, earthquake, tsunami, volcano, magma, lava
Page Unit 3 The atmosphere and weather	17 <ul style="list-style-type: none"> to explain the layers of the atmosphere and how changes in the atmosphere affect weather to investigate the use of weather measuring instruments 	<ul style="list-style-type: none"> identify and explain the causes of different types of weather. explain how different factors affect weather. make simple measurements and recordings of weather. 	atmosphere, lithosphere, hydrosphere, biosphere, pressure, cyclone, isobar, barometer, temperature, thermometer, isotherm, maximum, minimum, inversion
Page Unit 4 Our water supply	22 <ul style="list-style-type: none"> to explain the water cycle to explore ways to combat water problems to identify methods of recycling water 	<ul style="list-style-type: none"> explain where the water supply comes from. explain the importance of protecting our water supply. describe different arrangements for drainage and sewage treatment. 	humidity, precipitation, reservoir, sewage
Page Unit 5 Climatic regions of the world	28 <ul style="list-style-type: none"> to explain the factors affecting climate to explain through examples the climatic regions of the world to identify the climatic zones of Pakistan 	<ul style="list-style-type: none"> describe the Earth's main climatic regions. explain the factors that affect climate, including wind patterns and ocean currents. identify and describe the climatic regions of Pakistan. 	tropical, temperate, polar, rainforest, monsoon, Mediterranean, continental, steppe, tundra, desert, continental, monsoon

<p>Page Unit 6</p> <p>Climate change</p>	<p>39</p>	<ul style="list-style-type: none"> • to explore the reasons for climate change • to explain greenhouse gases, their effects, and methods to reduce the effects • identify the effects of climate change on plants and animals 	<ul style="list-style-type: none"> • explain climate change, global warming, and the greenhouse effect. • discuss the importance of the ozone layer and how human activity affects it. • discuss what can be done to combat global warming. 	<p>ozone layer, climate change, greenhouse effect, depletion</p>
<p>Page Unit 7</p> <p>A changing Earth</p>	<p>48</p>	<ul style="list-style-type: none"> • to explain how weathering and erosion can change land features • to differentiate between the different types of erosion • to explore ways to prevent desertification 	<ul style="list-style-type: none"> • explain how weathering affects the physical and human features of places. • describe and explain water and wind erosion. • describe and explain coastal erosion. 	<p>erosion, weathering, desertification, urbanization, overgrazing</p>
<p>Page Unit 8</p> <p>Human settlements</p>	<p>51</p>	<ul style="list-style-type: none"> • to differentiate between settlements on the basis of size • to explore some settlements in Pakistan and other parts of the world • to explain the patterns and functions of settlements 	<ul style="list-style-type: none"> • compare settlements of different sizes and explain how and why they developed. • compare and explain the layouts and shapes of settlements. • investigate their own settlement and describe its layout, development, and purpose. 	<p>settlement, natural resource, human resource, settlement, hamlet, village, town, city, mega city</p>
<p>Page Unit 9</p> <p>Agriculture</p>	<p>71</p>	<ul style="list-style-type: none"> • to define agriculture and differentiate between its different types • to explore livestock farming in Pakistan • to explain the economic importance of agriculture and the forestry and fishing industries to Pakistan 	<ul style="list-style-type: none"> • describe different types of farming and agriculture. • explain the importance of different crops and livestock in Pakistan. • explain the importance of agriculture, forestry, and fishing to Pakistan's economy. 	<p>subsistence, intensive, extensive, commercial, plantation, mixed farming, cereal crop, irrigation, fish farming</p>
<p>Page Unit 10</p> <p>Minerals and power</p>	<p>80</p>	<ul style="list-style-type: none"> • to describe the characteristics of minerals and gemstones, and identify where they are found in the world • to compare mineral and gemstone mining and power industries in Pakistan and elsewhere in the world • to explain how fossil fuels are formed 	<ul style="list-style-type: none"> • identify metallic and non-metallic minerals and gemstones found in the world. • compare the mining industry in Pakistan with that in Germany. • identify the mineral and power resources of Pakistan. 	<p>metal ore, metallic mineral, non-metallic mineral, gemstone, coal mining, natural gas, oil, mining industry</p>

Rocks, minerals, and soil

Background knowledge for the unit

Rock is a natural material made up of solid crystals of different minerals that have fused together. Rocks can be grouped into three basic types: igneous, sedimentary, and metamorphic.

Igneous rocks are volcanic—formed from molten material. Extrusive rocks (e.g. pumice, basalt, obsidian, tephrite, etc.) are formed from lava that has solidified on the surface of the Earth. Intrusive rocks (e.g. granite, gabbro, quartz) are formed by magma that has solidified underground. When igneous rocks cool quickly, they have small crystals; when they cool slowly, they have large crystals. The most common igneous rock is granite, which makes up large parts of every continent. Under the sea, the main rock is basalt, the most common volcanic rock. Basalt can sometimes be intrusive (formed underground).

The oldest rocks on Earth are types of granite: geologists think that some granite in Australia is more than four billion years old.

Sedimentary rocks are formed when other rocks are eroded. They are made up of fragments of other rocks, and many (mainly limestone) contain the remains of plants or animals, and fossils. Other sedimentary rocks include: chalk, flint, sandstone, mudstone, shale, dolomite, and tufa.

A fossil is the preserved remains of a plant or animal that lived at least 10,000 years ago, or it is the trace of these remains. Some of the oldest fossils are the remains of algae that lived in oceans more than 3 billion years ago. Preserved remains include bones, shells, and teeth. Trace fossils are not fossilized remains, but the fossilized traces of organisms, such as the imprint of a leaf, skeleton, or footprint.

When animal or plant material is fossilized, it has been covered with sediment (such as sand), or lava, soon after it died, so that it did not

decompose. Minerals from the sediment seep into the plant or animal remains. Amber is a type of fossil formed from the sticky resin of trees.

Metamorphic rocks are formed when sedimentary or igneous rocks are changed by pressure, heat, or both. Examples are: quartzite (made from sandstone), marble (from limestone), gneiss (from granite), and slate (from shale).

Soil is formed from eroded material, but there are several factors that affect soil:

- **Composition:** Rock is made of different minerals.
- **Time:** 1 cm depth of soil takes about 1000 years to form.
- **The shape of the land:** The soil that forms is affected by the slope of the land and its aspect (whether it faces north, south, east, or west) because different aspects have different temperatures, wind, and rainfall.
- **Drainage:** Soil is changed by how well water carrying dissolved materials passes through it.
- **Climate:** Rainfall and temperature affect the plants and other living things in the soil, and how well water evaporates depends on the surface of the soil.
- **Vegetation** affects the amount of humus (organic material) in the soil.
- **Human activity,** such as construction, can change the angle of a slope or the vegetation on the ground. It can alter drainage patterns.

Before we proceed

To prepare for this unit, collect as many samples of identified rocks as possible, also samples of soil of different types: clay, silt, sand, chalk, loam, and peat. This is easier if you, or anyone you know, are visiting different places. If you do not know what the samples are, you and the students can use information from this unit to try to identify them. If

possible, also have some identified, labelled, samples, which can be bought from school suppliers. Failing this, close-up photos can be used, but the real thing is much better.

If it is not possible to take the students to look at rock in their surroundings, ask them to notice anything in or around their homes that is made from rock; let them look around the school for examples of uses of different types of rock, and have plenty of photos of different rock used in buildings, pavements, ornamental features such as statues, floors, kitchen worktops, and so on; also those in everyday use (the abrasive material used in 'glasspaper' or 'sandpaper' is made from sand; other useful abrasives are corundum, flint, and pumice). It is surprising how many different types of rock are in everyday use.

Expected learning outcomes

Students should be able to:

- describe the characteristics of different types of rock and soil
- explain how rocks and soil are formed
- identify different types of rock and soil from samples and pictures
- ask questions and draw conclusions about their observations of the types of rock and soil they see around them
- explain how different soils vary in colour, permeability, and nutrient content

PAGES 2-3

'What is rock?'; 'What are rocks made of?'; 'Different types of rock'; and 'Igneous rocks'

Resources

- samples (or photos) of different types of rock
- magnifying glass

Introduction

Ask the students about any types of rock they have noticed in use in and around their homes and school. Ask what the rocks are used for and whether they know what type of rock is used for each purpose: for example, hard rock is good for floors, outdoor paving, and kitchen worktops; softer rocks are easier to carve for ornamental purposes; if chalk is used at school, ask what makes it good to use for writing. (It is soft and wears away easily.)

Activity

Provide some unlabelled samples of rock for the students to look at and handle. Ask them to sort them into sets of rocks that have similarities, then ask how they are similar. They might have sorted them by colour, but a closer look shows that their textures differ, and marks, holes, or grooves in the rock can give clues about how it was formed. The crystals it is made up of might be too small to see, but a magnifying glass can reveal their colours, shapes, and patterns, showing how they fit together.

Ask the students how rock is different from other materials. (It is a solid, natural material and very strong. Most rocks are hard, but some are softer than others. Most rocks are heavy for their size but not all rocks are very dense: for example, pumice will float in water.)

Using the Student's Book

Ask the students to read pages 2–3 of the Student's Book 'What is rock?' and 'What are rocks made of?', to learn about the definition of rock, its structure, and how it is formed. They will also find out about the properties of some rocks that make them useful for certain purposes. Ask them to compare the magnified photos of porous and non-porous rock to explain what these terms mean, and introduce other words that are also used for this property of rocks (permeable and impermeable) and to say how their structures differ.

The students can then read page 3 'Different types of rock' and 'Igneous rocks', and 'It's a fact' and look at the photos and read the captions. They should then be able to name some examples of igneous rocks.

Ask what makes granite good for kitchen worktops. (It is hard, has attractive patterns and can be polished.) Also ask them to look at the photograph of Zuma Rock, Nigeria. It is an example of a natural feature made of gabbro. Ask them to look at the photograph of the world's tallest cliffs, which are formed from granite (the Trango Towers in the Karakoram Mountains). They could compare the photos of the Trango Towers and the cliffs at Beachy Head, England, and comment on why the Beachy Head cliffs have worn away and collapsed, whereas the Trango Towers have stayed tall. (Beachy Head cliffs have the force of the sea, carrying sediment and pebbles, eroding them and they are made of chalk—a soft rock; Trango Towers are not attacked by the sea and are made of granite, a hard rock that is not easily weathered or eroded.)

Ask what they can tell from the photo and caption about what was happening on the coast of Antrim in Northern Ireland when the rocks there were formed.

The students could write these questions and their answers in their notebooks.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned that there are three main types of rock: igneous, sedimentary, and metamorphic.
- I learned about the characteristics of igneous rocks and how they are formed.
- I learned what makes rocks suitable for different purposes.

PAGES 4-5

'Sedimentary rocks'; 'Limestone'; 'Limestone landscapes'; and 'How do stalactites and stalagmites form?'

Using the Student's Book

Ask the students to name some sedimentary rocks they have read about (sandstone, limestone, and chalk). They can then read page 5 'Sedimentary rocks', and study the diagram showing how these rocks are formed. Ask about the differences between sedimentary and igneous rocks. They should be able to use the terms permeable/non-permeable, and soluble/insoluble correctly.

They can then read about an example of a sedimentary rock (limestone), and some of its features. Ask what makes caverns so common in limestone areas, and how stalactites and stalagmites are formed.

The students should then answer Questions A and B.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how sedimentary rocks are formed.
- I learned about some examples of sedimentary rocks.
- I learned about some of the features of limestone.

PAGE 6

'Metamorphic rocks'**Resources**

- Skills Book page 2 'Rock types',
- Skills Book page 3 'Rock sorting',
- Skills Book page 4 'Rock quiz',
- Skills Book page 5 'Guess which rock it is'

Introduction

As a reminder, ask the students to name three main types of rock and explain how they are formed. Tell them they are now going to find out more about metamorphic rocks, which are formed deep in the Earth when rock is compressed and changed by heat. They can then read about the changes that converted other rocks they know to metamorphic rocks.

Using the Student's Book

Ask the students to read page 6 'Metamorphic rocks', and to look at the photos and read the captions. They can then answer Questions C and D.

Using the Skills Book

Now that the students have learnt about the three main types of rock, they can complete Skills Book page 4 'Rock quiz' and play the game 'Guess which rock it is' on page 5 in pairs.

They can complete page 2 'Rock types' and 'Rock sorting' on page 3 for homework.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned that metamorphic rocks are formed when other rocks are changed by heat and pressure.
- I learned that although coal and diamonds are made from carbon from organic remains, they are formed by pressure, in a similar way to metamorphic rocks.

PAGES 6-9

'The rock cycle'; 'What is soil?'; and 'How does soil form?'**Resources**

- a box of classroom chalk
- the same quantity of soil
- a grater, such as a nutmeg or cheese grater or something to crush the chalk with
- a jar of water
- a small, shallow tray, about 15–20 cm long and 10–15 cm wide
- Skills Book page 6 'A soil profile'
- Skills Book page 7 'The factors that form soil'

Introduction

Explain that, just as the Earth's tectonic plates continue to move, and to change the landscape, the formation of rocks is a continuous process, with rock being formed, weathered, eroded, and transformed into soil and new rocks. So, just as we have the water cycle, in which water is changed from one form to another and moves from place to place, this process is called the 'rock cycle'.

Activity

Demonstrate how the rock cycle works by grating or crushing at least ten sticks of chalk and collecting the powdered chalk in the small tray. Mix it with water in a jar to make a thin, runny paste. Mix this with about the same amount of soil, then spread it in the tray and leave it in a sunny place to dry.

Show the students how to record this as a cycle: Rock (chalk) was worn away (weathered). → This was washed away in water as sediment. → It flowed to another place. → The water evaporated. → A new form of rock was deposited.

Using the Student's Book

Ask the students to read page 6 of the Student's Book 'The rock cycle', and explain that there are

many different processes that change rock and form new rocks. Some of these are similar to the demonstration; others use heat and pressure.

Ask what else is formed when rocks are weathered (soil) and read pages 7–9 ‘What is soil?’ with them. Check that they study the diagram that shows the five factors that are required for soil formation, by asking them to name these five factors and to say how they help to form soil. Soil profiles can be seen where deep holes are dug in the ground, for example, for road works or construction. They can also be seen where riverbanks have been eroded by floods.

Ask them to look at the soil profile diagram, and explain that a soil profile shows the different layers of soil that have formed over many thousands of years. Read out the letter that labels each layer and ask the students what that layer consists of. They should also read ‘It’s a fact’.

Then they should read page 13 ‘How does soil form?’ Ask what they have learnt about how different actions by different things, animals, or people, change the soil.

They can then complete Question E.

Using the Skills Book

Students could complete pages 6–7 for homework.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned that soil begins as particles of weathered and eroded rock.
- I learned that new rocks are formed from old ones in the rock cycle.
- I learned about the factors that affect soil formation.
- I learned how a soil profile shows the layers of soil that have formed over the years.

PAGES 9–11

‘Types of soil’ and ‘What is a mineral’?

Resources

- some samples of different types of soil; if possible, clay, silt, sand, chalk, and loam
- magnifying glasses
- small jars containing water
- Skills Book page 8 ‘Clay, sand, silt, or loam’

Introduction

Explain that there are many different types of soil, depending on the rock it came from and the amount of animal or plant material it contains.

Activity

Give the students the opportunity to look closely at some samples of different types of soil, using a magnifying glass, if available. Mix a little of each sample with some water—just enough to make a paste. They should rub a little of each sample between their fingers and notice whether it feels smooth and silky or rough and gritty. They should also try to roll the soil into a small ball or a snake shape and see if it sticks together. They could put the soils in order from smoothest/silkiest to grittiest. The smoothest soils are usually clay; silt is fairly smooth and silky; chalk is less so; sand is usually the grittiest, and loam can feel quite gritty, as it usually contains sand particles. Peat can be quite gritty, depending on the organic matter it contains, but it is quite easy to distinguish because of its dark colour; also it crumbles easily when dry.

To find out if soil contains a lot of humus (animal and plant material), mix it with a lot of water in a jar and leave it to settle. Material that floats is humus. Loam contains a lot of humus and peat is almost all humus.

Using the Student’s Book

Ask the students to read pages 9–10 of the Student’s Book ‘Types of soil’, and to use the table

and pictures to help them to check their ideas about the soil samples they examined.

Ask if the information on the table suggests any other test they could use to help them to distinguish between types of soil. (They could suggest a way to put the soils in order according to the amount of water they soak up, or how well water runs through them.)

Then they should read page 11 'How does soil form?' including 'It's a fact' and the diagram of soil formation. Ask them what they have learnt about how different actions by different things, animals, or people, change the soil.

Explain that soil contains minerals from the rock it was formed from, as well as others that have been deposited in sediment. The students can then read about minerals on pages 14–15, and notice the different shapes of the crystals that make up minerals, and the different arrangements of crystals: shapes that interlock in blocks or sheets.

Tell them that there is a scale for measuring the hardness of minerals, which they can read about in 'It's a fact' on page 11. They can then complete Question F.

Using the Skills Book

The activity on page 8 'Clay, sand, silt, or loam' could be completed for homework, with the students using information from their practical activities using rocks, and on information from this unit.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned that soil begins as particles of weathered and eroded rock.
- I learned about the factors that affect soil formation.
- I learned how a soil profile shows the layers of soil that have formed over the years.

Answers to assessments

- A
1. It is made up of sediment (particles eroded from rocks).
 2. They both build up from deposits of minerals that are carried in water that seeps through limestone, but the difference is that a stalactite grows downwards from the roof of a cavern, while a stalagmite grows upwards from the floor of a cavern.
- B
1. They are formed when rainwater or ground water seeps through the soil and reaches the rocks below. It runs into small spaces in the limestone and erodes holes and cracks, called swallow holes or sinkholes. Some of these holes grow large enough to become caverns.
 2. Water drains through the ground into sinkholes.
 3. Answers will vary. The students could describe a feature such as a limestone pavement or cliff.
- C
- 1 a) The students' own descriptions should include the colours they see and the distinctive patterning of marble.
 - b) The students' own responses should include: marble is a metamorphic rock that is formed when limestone is changed by heat and pressure; it is quarried in Balochistan and Agadir, Morocco. It is used for building and other purposes that require a fairly hard rock.
 - 2 a) The students' own responses should include the building shown in this unit— the Hassan II Mosque in Casablanca, Morocco.
 - b) The students' own responses should include the fact that the Hassan II Mosque is made of white marble; some buildings are made from pink, yellow, green, blue/grey, or blue/black marble.

D 1 a–b) the students' own responses; examples are given here:

Rock	Something made from it	Why the rock is good for this use
limestone	cement	It is easily crushed.
sandstone	buildings	It is quite soft and easy to cut into blocks for building.
chalk	sticks of chalk used for writing	It wears away easily and leaves marks on a dark, matt surface.
granite	kitchen worktops	It is hard and can be polished.
gabbro	paving stones	It is hard and does not weather easily.
obsidian	sharp knives	It is very hard and, when cut and shaped, it has smooth surfaces.
pumice	as an abrasive for removing hard skin	It is abrasive and quite rough, but light and soft—easy to cut and shape.
basalt	for making a base for roads	It is hardwearing but can be cut into blocks.
marble	for buildings	It has very attractive patterns and its light colour (often white) gleams in the sunshine.
slate	roof tiles	It is impermeable and easy to cut into thin sheets.

E 1 a) eroded rock, along with animal and plant remains and minerals

b) the different layers of soil that have formed over thousands or millions of years

c) O

d)

O organic material (material from plants and animals)

A minerals that dissolve in water that seeps through the soil

B deposited minerals

C weathered rock

R solid rock that has not been weathered

2 a–b) the climate (wind and rain erode soil and rock); living things such as burrowing animals, the human processes of digging or adding materials to soil; the actions of plants, such as roots that make holes in the soil and leaves (that later become humus); time (soil changes over time); topography (the shape of the land—soil washes away easily on slopes, collects in pools in hollows where water runs in and deposits sediment (and the water becomes salty if none runs out))

F 1 a)

i) crystals ii) quartz iii) calcite

iv) mica v) pyrite vi) feldspar

vii) Mohs viii) talc ix) diamond

x) corundum

b) diamond or corundum

c) They are very hard.

Answers to the Skills Book

Page 2 'Rock types'

- A. (top-left caption) Rocks formed when magma moves up to the surface of the Earth and cools just below it
(top-right caption) Rocks formed deep inside the Earth under immense pressure and heat
(bottom caption) Rocks formed when layers of eroded sediment are pressed under lakes, seas, rivers, and oceans
- B. (top-right heading) igneous rocks
(top-left heading) metamorphic rocks
(bottom heading) sedimentary rocks

Page 3 'Rock sorting'

- A 1–2. The following should be written on the rucksack of the geologist collecting igneous rocks: basalt, gabbro, granite, obsidian, and pumice.

The following should be written on the rucksack of the geologist collecting sedimentary rocks: chalk, clay, limestone, sandstone, and shale.

The following should be written on the rucksack of the geologist collecting metamorphic rocks: coal, marble, and slate.

Page 4 'Rock quiz'

- A 1. sedimentary 2. porous 3. impereable
4. stalactite 5. stalagmite 6. calcite
7. igneous 8. granite 9. gabbro
10. obsidian 11. pumice 12. extrusive
13. slate 14. marble

Page 5 'Guess which rock it is'

- A 1–2. Rocks formed deep inside the Earth under immense pressure and heat

The students should play the game as instructed, using the information about rocks in this unit to answer their partner's questions with correct answers (yes or no), until their partner has deduced which rock was chosen.

They take turns to be the questioner and continue until all the rocks have been identified.

Page 6 'A soil profile'

- A 1–2. Students should complete this activity from information given in the Student's Book.
B 1–3. Students' own answers

Page 7 'The factors the form soil'

- A. Students should draw and label using the information from their Student's Book.
B 1. loam
2. It is rich in nutrients from the humus it contains; it holds some water, but it drains well enough not to become waterlogged.

Page 8 'Clay, sand, silt, or loam'

- A 1. sand 2. clay 3. silt 4. peat
B 1–2. Students' own answers

Background knowledge for the unit

The Earth's structure consists of three main layers: core, mantle, and crust. Scientists believe that the innermost layer is made up of solid iron and nickel. The inner part of the core is very hot (up to around 5500°C), solid, and very dense. The outer part of the core is liquid iron and nickel. The thickest layer of the Earth's structure is the mantle. This is hot enough to become molten but is kept solid by enormous pressure. Although it is solid, its consistency is plastic, so it can be squashed and can flow very slowly.

The outer layer—the crust (made of rock)—is the thinnest layer, but its thickness varies. The oceanic crust is between 5 and 10 km thick, but the continental crust is much thicker—mainly between 25 and 35 km. The continental crust is less dense than the oceanic crust; this stops it sinking into the softer mantle. The denser oceanic crust can be pushed down into the mantle, and so it is continually being destroyed in some places and renewed in others. For this reason, the oceanic crust has much newer parts than the much older continental crust.

These four main layers of the Earth can be subdivided into sections such as the lithosphere, which is made up of the crust and the upper, more solid, part of the mantle. The tectonic plates form the lithosphere. These were part of an enormous land mass that geologists have named Pangea (from Greek, meaning 'all Earth'), which formed when two huge land masses they have named Laurasia and Gondwana (or Gondwanaland) joined up. Most of the land in today's southern hemisphere was part of Gondwana: Antarctica, South America, Africa, Madagascar, and Oceania. The Arabian Peninsula and the Indian subcontinent were also part of Gondwana, but these moved northwards and changed their orientation. Eurasia and North America were in Laurasia. Tectonic plates move a few centimetres each year.

In addition to changing the sizes and shapes of the continents, the movements of tectonic plates formed mountains, valleys, plateaus, and plains. These movements continue to change the shape of the land and cause earthquakes. Weak spots such as fissures in the Earth's crust form, allowing magma to escape in the form of volcanoes.

Before we proceed

This unit helps the students to understand the structure of the Earth, what it is made of, how it was formed, and how it has changed (and continues to change).

Expected learning outcomes

Students should be able to:

- use diagrams to describe the internal structure of the Earth
- give a simple explanation of plate tectonics, earthquakes, volcanoes, and tsunamis
- suggest how people can be helped to stay safe in areas of high tectonic activity

PAGES 14-15

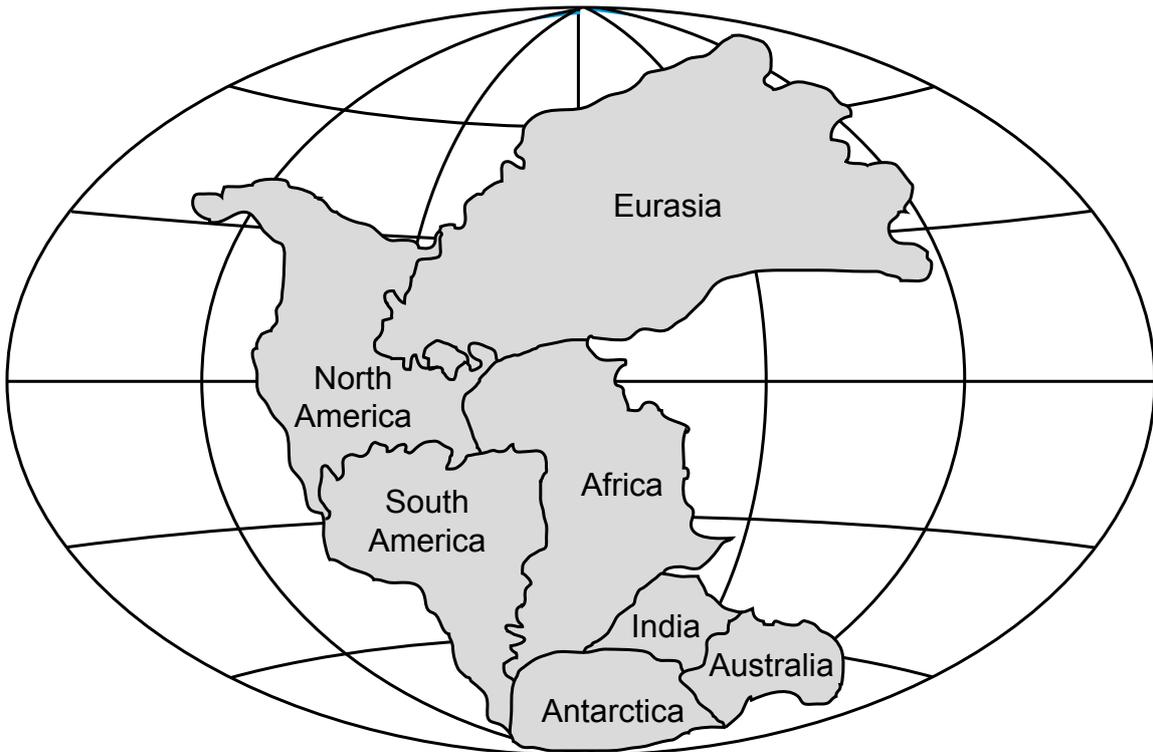
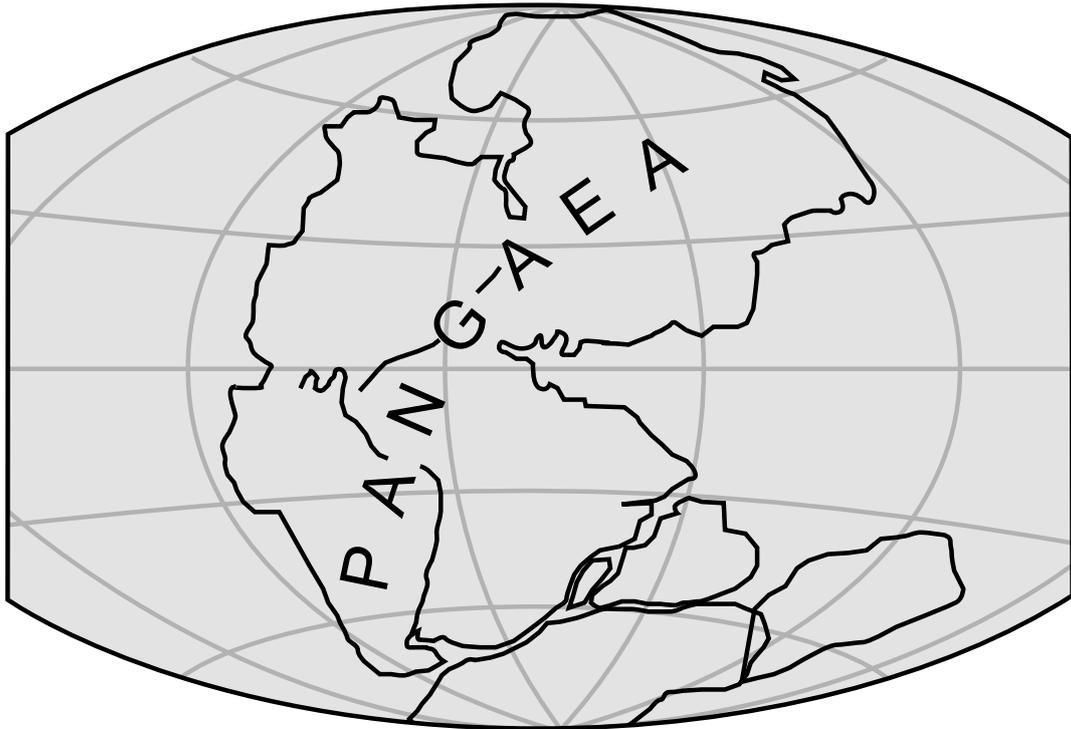
'How do we know what is inside the Earth'

Resources

- Skills Book page 9 'What is the Earth made of?'

Introduction

Ask the students what they know about the materials the Earth is made of and what we would find if we could dig or excavate down to the centre of the Earth.



Activity

Ask the students to draw diagrams to show what we might find if we could bore a hole down to the centre of the Earth. They should keep their diagrams, so that they can compare them with what geologists have discovered using scientific equipment.

Using the Student's Book

Ask the students to read page 14 of the Student's Book, and help them to read the labels on the diagram of the Earth's internal structure. They should compare this with their own diagrams so that they can see what they have learnt.

They should then read the table on page 15 that describes the materials that make up each layer of the Earth. Explain that the depths for each layer given in the table are the greatest depths of each layer, from the surface—not the thickness of each layer. (Apart from the crust whose thickness is the same as its depth from the surface, as it is the top layer.)

Explain that the parts of the Earth's crust that are under the oceans are called the oceanic crust and those where there is land are the continental crust. Explain that the oceanic crust is between 5–10 km thick, whereas the continental crust is about 25–35 km thick.

They could work out the thickness of each layer of the Earth using the information in the table. This could be recorded in their notebooks on a copy of the table, with an extra column added, headed 'Thickness'. Ask them to list the layers of the Earth in order from thinnest to thickest.

Remind the students to read 'It's a fact'. They should then answer the Question A.

Using the Skills Book

The students could complete page 9 for homework, using what they have learned from the Student's Book. Remind them of the Earth's three main layers and ask them to look at the diagram on page 14 of the Student's Book and read the table on page 15 before they complete this exercise.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned that the Earth is made up of layers of different types of material.

- I learned that the continents are part of the Earth's crust and that this is the thin outer layer of the Earth.

PAGES 15-16

'Tectonic plate boundaries'

Resources

- Skills Book page 10 'Tectonic plate boundaries'

Introduction

Explain that billions of years ago the continental plates were one huge land mass that geologists named Pangea and that parts of this were the supercontinents Gondwana and Laurasia, which had been separate, but joined up.

Explain that this land mass gradually pulled apart; some parts broke off, and the land masses slowly moved around the Earth.

It is useful to show the students a map showing what geologists believe the Earth looked like before the continents had their present form and were still joined as the huge land mass Pangea—made up of land masses called Laurasia and Gondwana. The maps on page 11 of this book will help.

Using the Student's Book

Explain that the continents are part of large masses of rock that move around on top of the softer material of the upper part of the Earth's mantle, and that when they pull apart, push against one another, or grind past one another, they change the shape of the land.

Look at the map on page 15 with them and point out the places where the tectonic plates meet (boundaries) and ask the students to look at the arrows to find out in which direction each plate is moving.

Explain that the directions of the movements where the tectonic plates meet give rise to different types of boundary between the plates:

- Where the plates slide past one another, the boundary is called a conservative boundary.
- Where they are pulling apart, it is a divergent boundary.
- Where they are pushing against one another, it is a convergent boundary.

Ask if they remember what they learned about the formation of mountains, valleys, plateaus, and plains and how the movement of tectonic plates created these.

The students can now read more about the tectonic plates on pages 15–16, including the information on the photos, maps, and diagrams. Invite them to tell the story of the Indian subcontinent. They can then complete Questions B and C.

Using the Skills Book

Ask students to complete page 10 ‘Tectonic plate boundaries’ remind the students that the boundaries of tectonic plates are where the plates meet and where the forces from their movements can change the shape of the land. They should re-read the explanations of this on pages 15–16 of the Student’s Book.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned that the Earth’s crust and the top part of the mantle is split into huge plates of rocky material called tectonic plates.
- I learned that the Indian subcontinent was part of a supercontinent called Gondwana.
- I learned that tectonic plates have moved around and are still moving.
- I learned that the forces of the moving tectonic plates create landforms such as mountains, valleys, plateaus, and plains.

PAGES 17-18

‘Violent events of the Earth’; ‘Volcanoes’; ‘Composite volcano’; and ‘Shield volcano’

Resources

- a globe
- map of the world
- *Oxford School Atlas for Pakistan*
- Skills Book page 11 ‘Volcanoes’

Introduction

Remind the students/ elicit that there is molten rock beneath the Earth’s crust and ask them to give a definition of molten rock. (Rock that is so hot that is liquid.) Remind them/ elicit that this molten rock is called magma, but when it escapes onto the surface of the Earth, it is called lava. Ask them to give examples of events and places where this has happened. They should be able to name and locate some of the Earth’s well-known volcanoes. Help them to find these on a globe or map of the world.

Using the Student’s Book

Ask the students to read the sections of page 17 headed ‘Violent events of the Earth’ and ‘Volcanoes’ to find out how volcanoes are caused, and the types of volcano found in Pakistan. Then ask them to describe these without looking at the Student’s Book.

Explain that some volcanoes no longer erupt and others have not erupted for hundreds of years, and ask them to find, on this page, the words for volcanoes that behave in different ways (active, dormant, and extinct). Also ask them to find the words for cracks in the Earth’s crust (fissure), for openings through which magma escapes (vent), and for a reservoir of magma below a volcano (magma chamber).

After they have read about composite volcanoes, invite different students to give explanations of different parts of the process of the formation of a composite volcano, using the diagram on page 17 to help. They could copy this diagram into their notebooks, and then use it to help them to complete their homework.

Then, after they have read about shield volcanoes, invite different students to give explanations of different parts of the process of the formation of a shield volcano, using the diagram on page 18 to help. They could copy this diagram into their notebooks, and then use it to help them to complete their homework.

Ask them to write a short summary of the main differences between composite and shield volcanoes. They should then complete Question D.

Using the Skills Book

The students should complete page 11 'Volcanoes'

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how different types of volcano are formed.
- I learned about fissures, vents, and composite and shield volcanoes.

PAGES 18-19

***'Earthquakes'; 'Tsunamis';
and 'Living in places
that have earthquakes
volcanoes, or tsunamis'***

Resources

- Skills Book page 12 'A seismometer and seismograph'
- Skills Book page 13 'Shaking Earth'

Introduction

To prepare for this lesson, ask the students to choose an earthquake they have heard of, and to find out as much as they can about it. They should make notes about the location of the earthquake, the size of the area affected, how powerful it was, and its effects.

In the lesson, invite some students to report what they have found out to the class, who could ask questions afterwards. Their questions should help them to find out more about the earthquake.

Ask the students to find the location of the earthquake on a map in their *Oxford School Atlas for Pakistan*, and to compare the map with the map of the Earth's tectonic plates on page 15 of this book. Ask which tectonic plate the earthquake was on, and ask if they can figure out what might have caused the earthquake. Explain that sudden movements of tectonic plates cause earthquakes, when they bump into one another, pull apart, slide past one another, or partially slide beneath or on top of one another.

Using the Student's Book

Ask the students to read the paragraph on page 18 of the Student's Book headed 'Earthquakes' and 'It's a fact'. They should also look at the diagram of how an earthquake happens. Explain that some earthquakes are more powerful than others and that scientists have found ways to measure their magnitude, which is the amount of energy earthquakes release. Explain that to do this, they use a seismometer, which is an instrument that records the magnitude on a seismograph, and that the Richter scale is a scale used to measure the magnitude of earthquakes. ('Seismic' means concerning vibrations of the Earth.) Then ask them to read the table that explains the Richter scale, and the rest of the information about earthquakes.

While waiting to try the Skills Book activity below, they could continue to read the Student's Book (the sections of page 19 headed 'Tsunamis' and 'Living in places that have earthquakes, volcanoes, or tsunamis').

Using the Skills Book Activity

Different groups of students could work on Skills Book page 12 'A seismometer and a seismograph' in groups at different times during the lesson so that they all have the opportunity to try it.

Ask them to read the instructions from the Skills Book and carry out this activity. Explain that this is a very simple form of seismograph, recording their approximate measurements of the strength of the table's shaking.

After they have completed the Skills Book activity, read the remaining pages of this unit and ask them to explain how an earthquake starts, how we know how powerful it is, and the meanings of seismometer, seismograph, magnitude, aftershock, epicentre, and Richter scale.

Ask students another question: On the Richter scale, what would be the magnitude of the following earthquakes:

1. severe damage to bridges, buildings, railways, and other structures (9.0–9.9)
2. not noticed by people, but can be recorded using a seismometer (less than 2)
3. felt only by a few people (2.0–2.9)

Ask how tsunamis are connected to earthquakes. Also ask what they have learnt about living in places that are likely to experience earthquakes, volcanoes, or tsunamis.

The students can now (or for homework) complete Question E of the Student's Book.

Skills Book page 13 'Shaking Earth' could also be completed for homework.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how volcanoes happen and about different types of volcano.
- I learned how the movement of tectonic plates causes earthquakes and tsunamis.
- I learned some of the ways in which people manage to live in areas that have volcanoes, earthquakes, or tsunamis.

Answers to assessments

- A 1 a) crust, lithosphere, asthenosphere, lower mantle, outer core, inner core
 b) the crust
 c) The thinnest parts are under the oceans.
- B 1. A divergent boundary is one between tectonic plates where they are pulling apart. As the tectonic plates pull apart, magma flows into the gap and forms a ridge.
- 2 a) up to 10 centimetres, but usually just 1 or 2 cm
 b) It turned around.
 c) The Indian Plate and the Eurasian Plate are pushing against one another and pushing up the land where they meet. The Himalayas are on this land. As the two plates continue to push against one another, the mountains continue to rise slowly.
- C 1. Sana is correct.
 2. Zara cannot be correct because large masses of rock cannot float on water. Meer cannot be correct because the asthenosphere is made up of rock that is solid, not molten but not as rigid as the tectonic plates.
- D 1 a) Shield volcanoes are formed where tectonic plates are pulling away. They also form at hot spots which is a plume of magma rising from deep within the Earth.
 b) Fissure volcanoes are those which have many small vents but no main vent.
 c) Composite volcanoes form where tectonic plates push one another. They have one main vent.
- 2 a) Mauna Loa (shield volcano)
 b) Tor zawar (fissure volcano)
 c) Hekla, Iceland (composite volcano)

- E 1. It lies on boundaries between tectonic plates: the Eurasian Plate, the Arabian Plate, and the Indian Plate (part of Indo-Australian Plate).
- 2 a) Use sensing equipment to check for any changes in the volcanoes, then warn people who live nearby.
- b) Receive messages from the global tsunami warning system that was set up after the December 2004 tsunami. The warning will give people more time to escape.
- c) Use sensing equipment to check for any tremors, then warn people who live nearby. Also construct homes and other buildings that do not collapse easily, to make them safer in earthquakes.
- 3 a–c) The student’s own responses should take into consideration: families that have lived there for many generations; it is their home, so they do not want to leave: farmers who want to keep their land, fishermen who need to be near the coast and do not want to change their way of life; they cannot easily afford to migrate somewhere else or it would be too much of an upheaval.
- 4 a) a seismometer
- b) Heavy furniture may overturn; poorly built buildings can be seriously damaged.
5. an underwater earthquake or volcano

Answers to Skills Book

Page 9 ‘What is the Earth made of?’

- A 1–3. The diagram should be labelled to match the one on page 14 of the Student’s Book and the labelling boxes should include as much of the following information as possible:

Page 10 ‘Tectonic plates boundaries’

- A 1–2. Ask them to look at each diagram and compare it with the diagrams on page 16 of the Student’s Book to find out what kind of boundary it is and how it can change the shape of the land. They can then write a heading for each diagram and an explanation of what is happening.

Page 11 ‘Volcanoes’

- A 1 a–b) Ask the students to use the explanations they wrote of the different types of volcano to help them to complete page 11 of the Skills Book for homework.

Page 12 ‘A seismometer and seismograph’

- A–B 1. Students’ own answers

Page 13 ‘Shaking Earth’

- A 1 The students should look carefully at the locations of the earthquakes from 1990 to 2005 (Map 1), and then mark them on the tectonic plates (Map 2). They should find that the earthquake zones are along the boundaries of tectonic plates.
- 2 a) They are at the boundaries of tectonic plates.
- b) They are far from the boundaries of tectonic plates.

The atmosphere and weather

Background knowledge for the unit

Around the Earth is the layer of gases (usually called 'air') that are kept there by the Earth's gravity. There is no precise boundary between the atmosphere and outer space, but a point at 100 km from the edge of the Earth's radius is considered as the boundary. This is known as the Kármán line. The atmosphere becomes increasingly thinner with increasing distance from the Earth, but in outer space there is no air.

Scientists have identified several layers in the atmosphere, based on characteristics such as temperature and gas composition. They are: troposphere (the layer closest to the Earth), stratosphere, mesosphere, thermosphere, and exosphere. The different layers have different atmospheric pressures and different combinations of gases. The troposphere is the only layer where the air is suitable for photosynthesis in plants, and for respiration in humans and other animals.

The troposphere is where our weather takes place. The main gas in the atmosphere is nitrogen (about 78%); about 21% of the air in the atmosphere is made up of oxygen, with about 0.9% argon, 0.037% carbon dioxide, and small amounts of other gases (including ozone); also about 0.4% water vapour.

Without the atmosphere there could be no life as we know it on Earth, as the atmosphere absorbs ultraviolet radiation from the Sun; it keeps the surface warm, and reduces the extremes of temperature between day and night that occur on celestial bodies where there is no atmosphere.

Before we proceed

This unit provides information, illustrations, and diagrams about the different layers of the Earth's atmosphere and explains the factors that affect the weather, particularly air pressure. It explains how different aspects of the weather are measured and recorded: air pressure, temperature, humidity, precipitation, wind speed, wind direction, cloud cover, and hours of sunshine.

There are descriptions and illustrations of different types of wind, characterized by their typical speeds, direction, where they occur, where they originate, and their effects, combined with other factors, such as oceans and temperature.

It introduces the structure of the Earth's atmosphere, and how the movement of air affects air pressure and weather. Students learn how meteorologists observe, measure, and record the weather, including the units and vocabulary they use. It encourages them to observe and measure the weather for themselves using simple methods.

Expected learning outcomes

Students should be able to:

- describe the main characteristics of the Earth's atmosphere
- describe and explain the causes of different types of weather
- make simple measurements and recordings of weather
- explain how weather can be predicted
- explain why particular types of wind are common in some parts of the world

PAGES 22-23

'How is the Earth's atmosphere divided,' and 'The gases in the atmosphere'

Introduction

Ask the students what they know about the Earth's atmosphere. The expected answer is that it contains air. Ask them to give a definition of air. (It is a mixture of gases and the main gas in the atmosphere is nitrogen.)

Ask if the density and pressure of air are the same everywhere—high up on mountains, and higher still. They already know that mountaineers often need breathing equipment if they climb high mountains, such as Everest. Ask why. (Because the air is thinner; the gases are spread out more thinly. This means that each breath takes in less oxygen than at lower altitudes.)

The students might enjoy the challenge of answering the question of why the air around the Earth does not escape into space, where there is no air. Ask if air has a colour. (No.) Then ask: If the air does not have a colour, what do you think might make the sky blue?

Tell the students that they are going to find out the answers to these questions, and more about the Earth's atmosphere, from their Student's Book.

Using the Student's Book

Ask the students to read pages 22–23 'The Earth's atmosphere' and 'The gases in the atmosphere', including the charts and quotations. They can then answer the questions they were asked at the start of the lesson. Then invite them to give examples of what they might find if they could get to each layer of the atmosphere. They can look at the photos and read the captions to find out more about noctilucent clouds and the Aurora Borealis, and to help them explain the differences between these.

They should then complete Question A.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about the different layers of the Earth's atmosphere
- I learned that air becomes thinner the higher you go from the Earth's surface
- I learned that air is essential for life on Earth.

PAGES 24-27

'Weather'; 'Weather forecasts'; 'Temperature'; 'Humidity'; 'Air pressure'; 'Measuring air pressure'; 'Wind'; 'Wind direction'; and 'Wind speed'

Resources

- clippings of weather forecasts from newspapers and the Internet for at least a week

Introduction

Tell the students that they are going to learn about the factors that cause weather and about weather forecasts. Remind them that all our weather takes place in one layer of the atmosphere, and ask which layer this is. (the troposphere—the nearest layer to the Earth's surface)

Activity

Give out some copies of weather forecasts and ask the students to read them in groups. Invite them to explain the symbols used and to suggest how meteorologists can forecast the weather.

Using the Student's Book

Tell the students that the next pages will explain more about how the weather is measured and recorded. They should read page 24 'Weather' and 'Weather forecasts', including the information panel, and look at the illustration and photo.

Ask what aspects of weather can be measured, and about the units they are measured in. They should have found out that: temperature is measured in degrees (the Celsius Scale is now usually used instead of the Fahrenheit Scale); precipitation is measured in millimetres; wind speed is measured in kilometres per hour, miles per hour, or knots; wind direction is the compass point the wind is coming from. The ones that might be new to them are humidity, cloud cover, air pressure, and how sunshine is measured. Tell them that these will be explained.

The students can then read 'Temperature' and 'Humidity' on pages 24–25. Ask why the thermometers are placed in a Stevenson screen, and point out if necessary, that a thermometer measures air temperature and that if it were in direct sunshine, it would give a higher reading than the actual air temperature. They should be able to explain how the Stevenson screen protects the equipment and allows a correct air temperature reading.

Ask them to explain why there is more than one thermometer in the Stevenson screen. Referring to the illustration on page 25, they should be able to explain how the two different types of thermometer are used for measuring humidity. Also point out that there is usually a maximum and a minimum thermometer, for recording the highest and lowest temperatures in 24 hours.

Ask the students to read 'It's a fact' on page 26 to find out how humidity is calculated.

Explain that an important factor in weather is air pressure and ask if the students know what this means. (The downward force with which the air presses on the Earth's surface.) Explain that air pressure is not always the same and that different places can have different air pressure at any one time.

The students can now read the sections headed 'Air pressure' and 'Measuring air pressure' on pages 25–26. Ask what they found out about air pressure, including the units used for measuring it, and the area of ground used for this measure; what makes air pressure lower on higher ground, and the equipment used for measuring air pressure. Use the diagram on page 25 to explain that air pressure is higher on lower ground because there is more air above lower ground. This means that the weight of the air above the ground is more than that over high ground. Check that they know that air pressure can be measured using a barometer.

Explain that air pressure changes when the air moves (wind) and the cause is the Earth's rotation. This warms parts of the Earth that face the Sun and cools those that move into darkness away from the Sun. Warm air rises above cold air; cold air rushes in to take its place. This creates a wind. When air moves quickly we have a strong wind.

Ask the students to read the section on wind on pages 26–27 and to choose one that describes

today's weather (which might be no wind at all), a wind that blows trees over, a wind that just makes the leaves flutter, a wind that can blow the roof off a house, and a wind that moves in spirals.

The students can now complete Question B.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how meteorologists measure and record air pressure, temperature, and humidity.
- I learned how changes in air pressure affect the weather.
- I learned why weather forecasts are important.

PAGES 27–29

***'Cyclone'; 'Anticyclone';
'Tornado'; 'Monsoon'; 'Rain;
cloud cover'; and 'Sunshine'***

Preparation

To avoid having to collect many sets of equipment, this lesson can be organized so that different groups of students begin a different Skills Book activity at the same time. They can rotate activities during another lesson. While some groups are working on the Skills Book activities, others can work from the Student's Book. Those working from the Skills Book will need to go out into the school yard. The equipment should be ready before the start of the lesson.

Resources

- Skills Book page 14 'Measuring wind speed'
- Skills Book page 15 'Wind direction',
- Skills Book page 16 'Measuring cloud cover'
- materials as specified in the Skills Book

Introduction

Explain how the lesson will be organized and allocate each group their tasks: a Skills Book activity, which they should be able to carry out by reading the instructions on the respective page.

- D 1 a) The students' own responses could include: when they go outdoors, take part in sports, going on holiday, and so on.
- b) the students' own responses
- c)
- i) a dry, sunny day, with 10% humidity, temperature reaching 30°C, and a light north-westerly breeze
 - ii) a dry, sunny day, with the occasional cloud, 20% humidity, and gentle air from north-north-west
 - iii) a cloudy day, with the occasional light shower, 70% humidity, and a strong westerly breeze
 - iv) a dull and cloudy day with 80% humidity and violent storms from a west-north-westerly direction
2. fine and dry
3. The Earth is rotating and orbiting the Sun, so the air in some parts of the Earth cools down while it warms up in other parts. Cool air is denser than warm air, so cool air moves downwards. This downward push increases the pressure nearer to the ground. Areas of high pressure like this are linked with fine weather. Then, when the cool air warms and rises, it creates an area of low pressure and wet weather.

Answers to Skills Book

Page 14 '*Measuring wind speed*'

- A 1. The students should make their anemometer by following the instructions and using the materials listed on page 14.
2. The students' own answers will depend on the current wind direction on each date and time in your location.

Page 15 '*Wind direction*'

- A–B. Students should follow the instructions to find out wind direction on different days.

Page 16 '*Measuring cloud cover*'

- A 1. Students' own answers will depend on the current cloud cover on each date and time in their locations.

Background knowledge for the unit

Scientists have estimated that the total amount of water on the Earth and in its atmosphere is about 1,385,000,000 km³. Of this, about 97% is in the oceans, seas, and bays.

The remaining 3% portion is split as follows: just over three-quarters in glaciers, ice caps, and inland seas; just under a quarter is groundwater; leaving around one hundredth, a tiny fraction.

That tiny fraction (one hundredth of the total) is split as follows: lakes about $\frac{3}{5}$, atmosphere and soil moisture just under $\frac{2}{5}$, and rivers less than $\frac{1}{5}$.

There is always water in the atmosphere. We see this in clouds, fog, and mist, but even clear air contains water, in particles that are too small for us to see. But water in the atmosphere accounts for only about 0.001% of the Earth's total water volume. If all of the water in the atmosphere came down as rain, it would only cover the Earth to a depth of about 2.5 cm!

The atmosphere is the main route for water to be transported through the water cycle. In addition to downhill flows on land, water continuously cycles via the atmosphere through transpiration, evaporation, condensation, freezing, and precipitation.

About 90% of the water in the atmosphere comes from evaporation from water bodies such as oceans and lakes: the remaining 10% is from transpiration from plants.

Factors that affect evaporation are:

- The strength of the wind: A strong wind moves the water molecules near the surface of the ground up into the air.
- Temperature: Warmer air has greater capacity for water vapour. This capacity doubles with every increase of 11.1°C.

Humidity slows the rate of evaporation. This is why we feel hotter in humid air than in drier air. Our bodies cool down mainly by evaporation of perspiration. Humid air slows down the rate of evaporation, so we cannot cool down so quickly.

The dew point is the temperature to which the air must be cooled before water condenses from it. The air cools at night. If it cools to the dew point, we see dew on the grass and other plants early in the morning when the humidity is high. The dew point depends on a combination of humidity, temperature, the strength of the wind, and how clear the sky is.

Fog is the same as clouds—water droplets in the air—but we call it fog when it is nearer to the ground (or mist when visibility is better). We see fog near the ground when the surface of the Earth cools at night, cooling the air near it to dew point. The water vapour in this cooled air condenses into droplets. We cannot see water vapour, but we can see droplets of water.

The water we are using today has existed in one form or another for millions of years, and the amount of fresh water on Earth has stayed fairly constant over time, as it is recycled through the atmosphere and back through evaporation and condensation. However, the Earth's human population has increased enormously, and continues to do so. So there are more people who need a share of that water. The amount of water there is will not increase, so we have to look after it.

Fresh water is a very small proportion of the Earth's water—only about 2.5 per cent; the rest is salty. Only 1% of the available fresh water is easily accessible, because a large amount is trapped in glaciers, ice caps, and snow. Only about 0.007% of the water is accessible to people.

This water is not fairly shared: some places have plenty while others face droughts and pollution, especially in developing countries. Rich arid

countries, for example Kuwait, can cope with the shortage of fresh water because they can fund desalination plants and effective waste water treatment.

Many human activities use water very inefficiently, for example: crops such as cotton that need a lot of water, are grown in arid areas, where water is wasted through irrigation. Many industries use large amounts of water, for example: most of the water used in industry is used for cooling purposes in power plants. However, there are schemes in action which use 'grey water' for this purpose. Grey water is the relatively clean waste water from baths, sinks, washing machines, and other household appliances.

Also, many industries pollute the water system with nutrients, germs, chemicals, oil, sediment, and heat. Heat is a 'thermal pollutant' where water from an industry warms the water in a lake or river. The warmer the water, the less oxygen it can hold. This can harm or kill many aquatic plants and animals, but algae can thrive.

Before we proceed

This unit provides information, illustrations, and diagrams that help students to understand the water cycle and the different conditions that produce different types of precipitation and related weather, such as fog, mist, and dew.

The students also learn about domestic and industrial water supplies: the sources, treatment, and transportation of water, and treatment and disposal. They learn about the solutions being tried in Pakistan to cope with insufficient water, floods, and waste treatment. These include some innovative solutions that sometimes solve other problems at the same time.

Expected learning outcomes

Students should be able to:

- describe the water cycle
- describe that water can exist in three states: water vapour, liquid, and ice
- explain how different forms of precipitation occur
- conduct, record, and draw conclusions from an investigation about water purification
- investigate some of the ways in which water is supplied to industries and settlements in Pakistan
- investigate some of the ways in which waste water is treated in Pakistan
- describe how water wastage can be managed

PAGES 32-33

'Where is water stored on the Earth?' and 'Precipitation'

Resources

- Skills Book page 17 'The water cycle'

Introduction

Ask the students what they know about the water cycle. They could try drawing and labelling a diagram of the water cycle based on their existing knowledge. This revision will help to consolidate their understanding and prepare to develop it further.

Using the Student's Book

Ask the students to check their water cycle diagrams by comparing them with the one on page 32 of the Student's Book, and to mark anything they got wrong. They could discuss this with a partner and use their diagrams to present an explanation of the water cycle. They can then continue to read the section of this page headed 'Where is water stored on the Earth?', including 'It's a fact'.

In their notebooks, they could compile a glossary of words connected with water, for example: water cycle, groundwater, percolation, run-off, water table, reservoir, etc.

Before they read page 33 'Precipitation', ask them to cover the page with a notebook and then to reveal only the first paragraph, which asks them to name as many types of precipitation as they can. They can then continue to read the pages, including the charts.

Ask them to add the words for changes of state of water to their glossaries.

They should then complete Question A.

Using the Skills Book

The students can complete Skills Book page 17 'The water cycle' for homework.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how the water cycle moves water around between the ground, bodies of water, and the air.
- I learned about different types of precipitation.
- I learned that the Earth always has the same amount of water.

PAGES 33-34

'Frozen precipitation' and 'Fog and mist'

Resources

- Skills Book page 18 'Precipitation'

Using the Student's Book

Tell the students that they are going to learn about precipitation, beginning with different types of frozen precipitation. Ask them to look at the pictures on page 33 and discuss the differences between these types of precipitation.

Using the Skills Book

Students can complete page 18 'Precipitation' for homework.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how snow and hail form.
- I learned how fog and mist form, and that they are the same as clouds.
- I learned the difference between fog and humidity.

PAGES 34-36

'Water supply of Pakistan'; 'Indus floods'; 'How can Pakistan solve its water problems?'; and 'How is water supplied to towns, cities, and villages?'

Resources

- a map of the city where they live
- information from the school's water supplier about where the water comes from, how it is treated, and how it gets to the town; this could be displayed for the students to read.

Preparation

Before the lesson, ask the students to find out where their water supply at home comes from and how it gets to their homes.

Introduction

Ask the students what they found out about their water supply at home. Provide a city map and ask them to find the source on a map, and see if they can trace its route to their homes. Explain that in Pakistan, it is likely that the water has travelled via the River Indus from the mountains in the north. Discuss how the water is treated before it comes to their homes, and how good they think its quality is.

In some places, ground water may be supplied to homes. In some places like Quetta, water is supplied to homes from streams, springs, rivers, and *karez*. Water from underground is pumped up to the surface using water pumps or tube wells.

Also talk about tap water and discuss whether it is fit for drinking or not. Ask if they use bottled water at home for drinking purposes and why.

Using the Student's Book

Ask the students to read pages 34–36, and ask what they have learnt about Pakistan's water supplies and the problems they face. Ask if floods help, and why, when there is suddenly a lot of flood water, this does not help with water shortages. (Flood water is usually polluted, runs off, and is wasted.)

Discuss how Pakistan is trying to solve its water-supply problem. Also discuss the differences between the water supplies in a city, a town, or a rural village; why they differ; and how things could be improved.

Ask the students to write a short report in their notebooks about the water supply to cities, villages, and towns in Pakistan; what is good about it and the problems it faces, and what can be done to improve things.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about the water supply in our hometown.
- I learned about the problems with Pakistan's water supply, and how they are being tackled.

PAGES 36–37

***'What about waste water?'
and 'Energy from sewage'***

Introduction

Tell the students that this lesson will focus on what happens to all the waste water from our homes, schools, industry, and so on.

Using the Student's Book

Ask the students if they know where the waste water from their homes goes. Ask if they know where it ends up. Tell them that in some places waste water and sewage are treated before being released into the environment through rivers, but not all waste water is treated.

Ask them to find out by reading page 36 'What about waste water?' and discuss how waste water affects rivers and the sea if it is not treated. Ask what problems the poor drains were causing in Orangi, Karachi before the project helped the people there to fix the drains.

Ask what they have learnt about how sewage can be treated, then explain that it can be converted into energy.

They can then read about 'Energy from sewage'. Ask them what the advantages of this system are.

They can then complete Question B.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about how sewage water is treated.
- I learned how energy can be produced from sewage water.

PAGE 37

***'A village water supply—
from drains!'***

Resources

- Skills Book page 19 'Purification of water'

Introduction

Tell the students that in this lesson they are going to carry out an investigation into how water can be purified through filtering. Give them an example of how tea is strained with a strainer.

Using the Student's Book

Remind the students of what they learned about a useful way of treating sewage and waste water, and tell them that they are going to find out about another interesting way of treating it to produce clean water!

They can then read about 'A village water supply— from drains'. Then ask them how the system works. What happens to the solid material in the

sewage, and how the water that runs out of the system can be used. Ask why this system is very useful for rural villages in particular. (Many do not have proper drains and also have water shortages.) They also have plenty of land that can be used for these projects, which is not the case in most cities. Discuss what makes this system better than just filtering the sewage.

The students can then complete Question C.

Using the Skills Book

If you have enough equipment for the activity on page 19 'Purification of water', the students can work on this investigation in groups. If not, some groups could work from the Student's Book, while others carry out the investigation and then write a report about it.

The students should set up the investigation as shown in the Skills Book, pour the muddy water from one jar slowly through the filter, but keep the other jar of muddy water. They should then compare the water that comes through the filter with the muddy water and describe what they see, then answer the questions.

Ask them how the filter worked. (It has tiny holes that allow water through, but not solid material.) Explain that this principle is used in sewage treatment works to separate solids from liquid, but the water that comes out still contains germs and other liquid pollution.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how waste water and sewage are treated.
- I learned about the dangers of open sewers.
- I learned about projects in Pakistan for converting sewage into biogas and for converting sewage into water suitable for irrigation.

Answers to assessments

- A 1 a) troposphere
- b) The students' own responses, which should indicate that they know that:
- Water vapour in the air comes mainly from water that has evaporated from oceans, seas, lakes, and rivers, and from the surface of the ground.
 - Clouds are collections of drops of water that have condensed from water vapour in the air.
 - When drops of water in clouds become large and heavy, they fall from the clouds as rain.

2.

Words	Definitions
a) run-off	water flowing along the ground
b) percolation	water soaking through the ground
c) water table	the highest level of ground that is saturated with water
d) transpiration	water given off by plants
e) evaporation	water changing from liquid to vapour
f) condensation	water vapour changing to liquid
g) precipitation	water in any state that falls from the air
h) freezing	liquid water changing into solid
i) sewage	human waste from toilets and drains
j) sludge	solid waste from sewage
k) microbe	tiny living things such as bacterium
l) biogas	a natural gas made when microbes digest waste material

- B 1. They treat waste material; but they also make use of the waste to produce gas for stoves and boilers, and even for vehicle fuel.

- 2 a) to control water flow to reduce flooding
 b) to store water when there is plenty
 c) to protect water from pollution
3. If they get blocked, pools of sewage can form near residences and lead to the spread of germs that cause disease.
- 4 a i) It can be taken to tanks where solid material is separated from liquid. The liquid goes through filter materials such as pumice, gravel, or sand, and chemicals can be added to kill germs.
 ii) Sewage can be converted into biogas.
 iii) Sewage can be purified in wetlands.
 b) the students' own responses
- 5 a) biogas plant
 b) wetland filter
- C 1. The water supply in Pakistan comes mainly from the River Indus. There is plenty of water in the monsoon season, but very little in the dry season. Three solutions to this problem are: controlling water flow; storing water; and reducing waste of water.
- 2 a) true b) true c) true d) false

Answers to the Skills Book

Page 17 'The water cycle'

- A 1. The student's completed diagrams should match those on page 32 of the Student's Book.
2. The students' own responses should take into account all stages of the water cycle, and might also include the water being drunk by an animal or taken up through the roots of a plant, being boiled during cooking or to make a hot drink, being used to wash something/someone, and so on.

Page 18 'Precipitation'

A 1.

'Across'

1. snow
2. drizzle
3. hail
7. condense
8. evaporate
9. mist
10. sleet
11. fog

Down

1. sublimation
4. precipitation
5. freeze
6. melt

Page 19 'Purification of water'

- A 1. The students carry out the practical investigation as instructed.
- 2 a) The students' own responses should describe the change in the muddy water.
- b) The students' own responses should include uses such as watering plants, flushing toilets, or any use that does not require germ-free water.
- c) It would need more filtering, and a way of killing any microbes. This is very thorough treatment, but can be done; it is how water in the International Space Station is recycled.

Climatic regions of the world

Background knowledge for the unit

Climate is determined from average weather conditions over a long period—usually 30 years. From recorded weather statistics, meteorologists can determine the patterns of weather conditions such as temperature, humidity, atmospheric pressure, wind, and precipitation, as well as average conditions. Climate includes the amounts by which weather conditions vary, for example: differences in temperature, rainfall, wind speed, direction, and so on.

Weather describes the short-term conditions in a place.

There are different systems for describing climate. Most climatologists use the Köppen classification system, which uses letters to define the characteristics of a climate. This is rather complicated, but the descriptions used in this unit are based on it and described by name for simplicity.

Although the world can be split into climatic zones by latitude, with the colder places nearer the Poles and the hotter places nearer the Equator, there are factors other than proximity to the Poles or to the Equator that influence climate. Within these zones, places at the same latitude can have very different climates, depending on: land elevation (height above or below sea level); position in relation to plains or mountains; the size of the land mass; distance from the sea, and wind patterns.

Although Pakistan is within the Earth's temperate climate zone, its climate is mainly continental, as it is situated on a large land mass between latitudes 24° and 37°N, and much of it is semi-arid. The south is nearer the Equator than the north, and is therefore warmer. Altitude plays a part, too, with the mountainous areas of FATA, Khyber Pakhtunkhwa, and western Balochistan having colder climates. Distance from the sea, wind

patterns, and ocean currents also affect the climate, creating warm humid summers and the mild, dry winters near the coast of Sindh and Balochistan.

Before we proceed

This unit provides information, illustrations, photographs, and diagrams that help students to understand the influences on climate, and why places at the same latitudes can have very different climates. They can compare photographs and climate statistics of different places.

The students also learn about extreme climates: very hot, very cold, very dry, or very wet. They discover the causes of these different climates and how people adapt their lifestyles and buildings to live in different climates.

Expected learning outcomes

Students should be able to:

- identify and describe the main climatic regions of the Earth
- explain the factors that affect climate
- describe some extreme climates
- differentiate between weather and climate
- identify the different climatic regions of Pakistan, and some of the causes of the differences
- describe some ways in which people adapt to extreme climates

PAGES 40-42

'What is climate?' as far as 'Tropical monsoon climate'

Resources

- Oxford School Atlas for Pakistan
- Skills Book pages 20–21 'Comparison of different climatic regions of the world'

Introduction

Ask what climate means. Explain/ elicit the difference between weather and climate. They could record what they know about climate in a chart. Here is an example:

What I know about climate	Questions	Answers*
1. Places near the Equator are hotter than places near the Poles. 2. Mountainous places have cooler climates than places on lowland. 3. Some places have rainy seasons or monsoons.	1. Why can deserts, with hot climates, have very cold temperatures at night? 2. Why do some places have wetter climates than others? 3. What causes monsoon climates?	* They should write the answers after completing the unit. This helps them to assess what they have learnt.

Using the Student's Book

Ask the students to name the main climatic regions of the Earth. They should make a note of their answers. Ask why some places have warmer climates than others. (Places near the Equator like Kuwait generally have warmer climates than those nearer to the Poles like Greenland.) Explain that the Earth's main climatic zones are marked by latitude, and ask what else that might affect the climate of a place.

The students should be able to locate the Tropics on a map of the world. Ask them to name some

countries in these regions. They can then read pages 40–41, and look at the diagram on page 41 to find out about the climatic regions of the world.

Ask if they need to change their answers about the names of the Earth's main climatic regions, they should copy those listed on page 41. Then ask them between which latitudes tropical climates are found. (between the Tropics of Cancer and Capricorn, i.e. between latitudes 23.5°N and 23.5°S) They should then complete Question A1.

Explain that there are different types of tropical climate, which they are going to read about. They should read the sections headed 'Tropical climate', 'Tropical rainforest climate', and 'Tropical monsoon climate' on pages 41–42. Ask why the monsoon climate regions of Pakistan are not tropical monsoon climates. (Tropical climates are hotter, having mean temperatures of at least 18°C.) Ask them to describe what they see in the photo of a tropical rainforest climate in Sumatra. They should also locate Sumatra in Indonesia, and Chittagong in Bangladesh on a world map on page 41. Ask what they notice in the photo of the tropical monsoon climate on page 42.

They could then write notes about the different tropical climates in their notebooks. For homework, they could find out more and add this information to their notes.

Using the Skills Book

The students can begin page 20 of the Skills Book 'Comparison of different climatic regions of the world', but should complete only the section on the climates they have learnt about during this lesson. The others should be completed after the appropriate lessons. Ask them to read the descriptions of climates and to find the ones that describe tropical monsoon and tropical rainforest climates, and to complete these with examples.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about the main climatic regions of the world.
- I learned about the different factors that affect climate.

- I learned about the differences between tropical monsoon and tropical rainforest climates.

PAGES 42-43

'Tropical savannah climate'

Resources

- *Oxford School Atlas for Pakistan*
- Skills Book pages 20–21 'Comparison of different climatic regions of the world'

Introduction

Explain that they are going to learn about another type of tropical climate: the tropical savannah climate. Ask what savannah means. (grassland plains—mainly found in Africa, Asia, and northern parts of South America)

They should locate Nigeria on a map of the world in their *Oxford School Atlas for Pakistan*. Ask them to describe its location. They should notice its latitude within the Tropics, the size of the land mass it is on, distance from the sea, the land elevations of different parts of the country, and the wind patterns. (See the map on page 42.)

Ask about the factors that might affect Nigeria's climatic zones. They should notice that the south has a coast on the South Atlantic Ocean, where the climate is tropical monsoon, influenced by monsoon winds that affect West African regions between latitudes 9° and 20°N, blowing south-westerly during warmer months and north-easterly during the cooler months. Central Nigeria and most of Western Nigeria have a tropical savannah climate, with a rainy season and a dry season.

As in other tropical countries, altitude affects some parts within the main climate areas of Nigeria, with high mountains having an alpine climate.

Using the Student's Book

The students should read pages 42–43 'Tropical savannah climate'. Ask/elicite what they found out, and what causes the wet and dry savannah climates of Nigeria. Ask which other continents

have regions with savannah climates. They could locate these on maps of the world and on more detailed maps of the continents.

They can then complete Question B.

Using the Skills Book

The students should continue the exercise on pages 20–21 of the Skills Book, 'Comparison of different climatic regions of the world', but should complete only the section on the climate they have learnt about during this lesson. The others should be completed after the appropriate lessons. Ask them to read the descriptions of climates and to find the one that describes the tropical savannah climate, and to complete it with examples.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about the conditions of tropical savannah climates.
- I learned why Nigeria has different climatic zones.
- I learned how winds affect the climates of different parts of Nigeria.

PAGE 43

'Continental climate' (all sections)

Resources

- *Oxford School Atlas for Pakistan*
- Skills Book pages 20–21 'Comparison of different climatic regions of the world'

Introduction

Explain that this type of climate is generally found in parts of the world just outside the Tropics and on large land masses. Explain that this type of climate is more common in the northern hemisphere than in the southern hemisphere, because large land masses are found in the northern hemisphere.

Using the Student's Book

Ask the students to read page 43 'Continental climate', 'Hot summer continental climate', and 'Warm summer continental climate'. Ask them to look at a map of the world and to use the descriptions of the locations of regions with continental climates on this page to help them to find places that could have a continental climate. (These are likely to be in the northern hemisphere, on the east coasts, and in the interiors of large land masses, around latitude 40°N, or farther north.) They should be able to give an example (South Korea), based on what they have read.

Ask what kind of weather makes a continental climate different from a tropical climate. (Mean monthly temperatures are lower than 18°C and sometimes it snows in winter)

The students should be able to describe the main characteristics of each type of continental climate and say what causes these differences. Ask them to discuss with a partner, and compare the climates of Warsaw, Poland, and Seoul, South Korea, and to explain the differences to one another.

Using the Skills Book

The students should continue pages 20–21 of the Skills Book 'Comparison of different climatic regions of the world', but should complete only the section on the climate they have learnt about during this lesson. The others should be completed after the appropriate lessons. Ask them to read the descriptions of climates and to find the one that describes the continental climate, and to complete it with examples.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about the conditions of continental climates with warm or hot summers.
- I learned why continental climates have different rainfall patterns and different summer temperatures.
- I learned how the size of the land mass and the distance from the sea affect the climate of a region.

PAGE 44

'Temperate climate' (all sections)

Resources

- *Oxford School Atlas for Pakistan*
- Skills Book pages 20–21 'Comparison of different climatic regions of the world'

Introduction

Explain that this lesson will focus on temperate climates, which are usually found in regions between the Tropics and the Antarctic or the Arctic Circle, and are neither very hot nor very cold. Ask them to look at a map of the world and try to identify places that might have a temperate climate. Remind them that places on large land masses (particularly near east coasts), especially in the northern hemisphere, are more likely to have a continental than a temperate climate, even though they are around the same latitudes.

The students should make a note of their ideas about places with temperate climates.

Using the Student's Book

Ask the students to read page 44 'Temperate climate', 'Warm temperate climates', and 'Maritime temperate climates', and consider this information when checking their answers from the Introduction. Explain that 'maritime' means near the sea.

Ask them to distinguish between the two types of temperate climate (warm and maritime). Ask why regions between latitudes 26° and 45° tend to have warm temperate climates, and what gives maritime temperate climates warmer winters and cooler summers than many other places at the same latitudes. (Ocean currents because the sea/ocean takes much longer to warm up or cool down than does the land.)

They can then complete Question C.

Using the Skills Book

The students should continue pages 20–21 of the Skills Book ‘Comparison of different climatic regions of the world’, but should complete only the section on the climates they have learnt about during this lesson. The others should be completed after the appropriate lessons. Ask them to read the descriptions of climates and to find the one that describe the warm temperate and maritime temperate climates, and to complete them with examples.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about the different types of temperate climate.
- I learned how ocean currents and winds affect climates.

PAGES 44–45

‘Arid climate’ (all sections)

Resources

- *Oxford School Atlas for Pakistan*
- Skills Book pages 20–21 ‘Comparison of different climatic regions of the world’

Introduction

Explain that in this lesson they are going to learn about arid and cold climates. Ask/elicite what arid means (dry), and invite them to name some regions with arid climates, and to locate them on a map of the world. They should be able to locate deserts in Pakistan and other countries, such as Egypt and Kuwait, which they learned about in Grade 6. Ask about the latitudes of the world’s deserts (around 30° North or South). Ask what they know about the temperatures of these regions, and what makes them so hot. (They are near the Equator, so are always closer to the Sun than other regions of the Earth.)

Using the Student’s Book

Explain that, as well as hot arid regions (deserts) there are cold arid regions, which they will find out more about in this unit.

They can then read ‘Arid climate’ and ‘Hot arid (desert) climate’ on pages 44–45. Ask what they have learnt about temperature changes in arid regions. (There are large differences between day and night temperatures.) Also ask how Makkah, which is in a region with an arid climate, can have flash floods. (Although Makkah has a very low rainfall, most of this falls at around the same time. Makkah is at a fairly low elevation, and rain that falls on the nearby mountains rushes downhill on to the lowland.)

Next, ask the students to read the section on page 45 about cold places with arid climates: hot dry summers (but not as hot as desert summers) and cold dry winters.

Ask how these places, which are located in temperate climatic zones of the Earth, can have this type of climate. (They tend to be at high elevations or next to high mountains.) Invite the students to explain the factors that can cause this type of climate at high elevations close to high mountains, and to give examples.

The students could copy the rain shadow explanation and diagram and use this to help them to write an explanation of how the rain shadow affects climate.

Using the Skills Book

The students should continue pages 20–21 of the Skills Book ‘Comparison of different climatic regions of the world’, but should complete only the section on the climates they have learnt about during this lesson. The others should be completed after the appropriate lessons. Ask them to read the descriptions of climates and to find those that describe the hot and cold arid climates, and to complete them with examples.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about the conditions of hot and cold arid climates.
- I learned how the rain shadow affects climate.

PAGES 46-47

'Polar climate'; 'Tundra climate'; 'Ice cap climate'; and 'Alpine climate'

Resources

- *Oxford School Atlas for Pakistan*
- Skills Book pages 20–21 'Comparison of different climatic regions of the world'
- Skills Book page 24–25 'Same latitude, different climate'

Introduction

Explain that in this lesson they are going to learn about regions that have different types of polar (cold) climate. Ask if they know the meanings of the following words: tundra (regions that have low and slow-growing vegetation, mainly small shrubs, sedges and grasses, mosses, and lichens, with perhaps a few scattered trees), ice cap (places that are permanently covered with ice), and alpine (mountain).

Using the Student's Book

Explain that polar climates are the coldest of all, but that there are different types of polar climate, which they will find out more about in this unit. Ask them about the very cold places they learned about in Grade 6 (most of Alaska, USA, and Yakutsk, Russia). What kind of weather do these places have? (cold, icy, sometimes foggy but with hardly any precipitation—even snow)

They can then read about 'Tundra climate' and 'Ice cap climate' on page 46. Ask them what they have learnt about temperatures in these regions. (In tundra regions, average winter temperatures are around -28°C —with temperatures sometimes as low as -50°C , and the warmest summer months can have average temperatures as low as 10°C , sometimes dropping to below zero at night, and hardly ever above 12°C during the day. In ice cap regions, the temperature hardly ever rises above 0°C . Also ask how these climates affect the vegetation of these regions. (It grows slowly; there

are very few trees; bushes are small; the main vegetation is algae, mosses and lichens, with some grasses.)

Ask what they have learnt about climate and altitude. (The higher a region, the lower its average temperatures, with air temperatures falling by about 6.4°C for every thousand metres of altitude.)

They should next read about 'Alpine climate' on page 47. Ask what types of places can have alpine climate. (This climate occurs on mountains, above the treeline—the height at which trees will grow.)

Ask about the altitude of the treeline. (It varies, according to latitude: near the Tropics the treeline is higher than in places farther from the Equator.) Invite volunteers to explain why the air temperature is lower on high than low ground. There are several reasons: (i) The Earth's surface stays warm for a longer time than the air; the Earth's surface warms the air, so air that is farther away (higher up) is warmed less, especially if it is dry. (ii) At higher elevations the air is less dense; this means that the particles of gases in the air are spread out, so there is less air to hold the warmth. (iii) At higher elevations there is less air pressing down; the lower the air pressure, the lower the air temperature.

The students can now complete Question D.

Using the Skills Book

The students should continue pages 20–21 of the Skills Book 'Comparison of different climatic regions of the world', but should complete only the section on the climates they have learnt about during this lesson. This will complete the page. Ask them to read the descriptions of climates and to find those that describe the polar climates (tundra, alpine, and ice cap), and to complete them with examples. These should be the only remaining climates in the chart to be completed.

They should also be able to complete Skills Book pages 24–25 'Same latitude, different climate'. Ask them to work with a partner to list the main factors that affect climate, and then to read the descriptions of the climates of Samsø, Denmark and Nain, Canada, noticing the latitude and land elevation of each place and its location in relation to oceans/seas and land mass, and any wind or ocean currents, as well as the information about the climates of the two places.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about the conditions of the different polar climates.
- I learned how latitude, altitude, wind patterns, distance from the sea, the size of the land mass, and ocean currents affect climate.

PAGES 48-49

'Climatic zones of Pakistan'

Resources

- *Oxford School Atlas for Pakistan*
- Skills Book pages 22–23 'Factors affecting climate'
- Skills Book pages 26–27 'Monsoons'

Introduction

Explain that in this lesson they are going to learn about the different climatic zones of Pakistan.

Using the Student's Book

Ask the students to describe the climate of their part of Pakistan. They might not be able to name the climate, but could describe the normal weather conditions throughout the year.

They should then look at a map of the world in *Oxford School Atlas for Pakistan*. Ask which climatic zone Pakistan is in (temperate), and remind them that these zones are marked by latitude, and that there are other factors that affect climate too. Then ask them to read about temperate climates. Ask if any region of Pakistan really does have a temperate climate. This is not one of the main climate types of Pakistan. Explain that they are going to find out about the factors that affect the climate in different regions of Pakistan, and why they do not have a temperate climate, despite being in a temperate climate latitude zone.

They should then look at the map of Pakistan on page 49 of the Student's Book, and read the

section headed 'Climatic zones of Pakistan'. Ask what they know about the conditions that affect climate (latitude, altitude, wind patterns, distance from the sea, the size of the land mass, and ocean currents) and ask which of these factors affect different parts of Pakistan. Pakistan is quite long from north to south, so the south is closer to the Equator than the north, which makes the south warmer. Altitude affects the climates of some regions: parts of Khyber Pakhtunkhwa, FATA, and Balochistan have high mountains, so they are the coldest regions. Ocean currents affect the south, near the coast, where summers are warm and humid. The climate of Pakistan is affected by wind patterns; in the winter, cold winds blow mainly from the north-east over the Himalayas. These winds are dry because they do not cross any seas. The winds change in the summer, coming from the south and south-west, across the Indian Ocean. These winds are warm, coming from warmer regions, and wet, because they cross the ocean. They bring humid weather and the monsoon.

Ask the students to look at the diagram of how monsoons are formed on page 42, and to read the section headed 'Rainfall'. They can use this to help them to write an explanation of the monsoon.

Using the Skills Book

The students should be able to complete pages 22–23 of the Skills Book 'Factors affecting climate', using information from this and previous units, and Skills Book pages 20–21 'Comparison of different climatic regions of the world', which they should have already completed. Remind them to consider all the factors that affect climate: latitude, altitude, distance from the sea, size of land mass, ocean currents, and wind patterns.

They should also be able to complete Skills Book pages 26–27 'Monsoons', using information from this unit, including the diagram and explanation of monsoons on page 46.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about the conditions of the different polar climates.
- I learned how latitude, altitude, wind patterns, distance from the sea, the size of the land mass, and ocean currents affect climate.

Answers to assessments

- A 1 a) Climate means the average weather of a place over a long period of time.
- b) latitude, altitude, wind patterns, distance from the sea, the size of the land mass, ocean currents
- c) any two from: being at a higher altitude, affected by cold winds, being on a large land mass or far from the sea, or affected by cold ocean currents
- B 1 a) 23.5°N and 23.5°S
- b) It has a mean monthly temperature of at least 18°C.
- 2 a) tropical monsoon
- b) tropical rainforest
- c) tropical savannah
- 3 a) The students should have copied the monsoon winds diagram, labelled the land and sea, and added the direction arrows and labels for the winter winds, as on page 42 of the Student's Book.
- b) The students should have copied the monsoon winds diagram, labelled the land and sea, and added the direction arrows and labels for the summer winds, as on page 42 of the Student's Book.
- The students' notes should explain that the land heats up more quickly than the sea, so the air over the land is heated quickly in the summer. This hot air rises, and cooler air from over the sea rushes in to take its place. The air from over the sea carries water vapour. As it blows over the hot land, the air heats up and rises. As the air rises, it cools, so the water vapour in the air condenses and falls as rain.
- In the winter, the land cools more quickly than the sea, so there is a change in wind direction, as the air above the sea is warmed, so it rises, leaving a space for cooler air from above the land to rush into.
- C 1 a) Warsaw, Poland has a warm summer continental climate. London, UK has a maritime temperate climate.

- b) Warsaw and London are at similar latitude: London is at 51°N, and Warsaw is at 52°N. Warsaw has cold, snowy, cloudy winters and warm, sunny but stormy summers. London has much milder winters, but cooler summers than Warsaw.
- c) The different climates of the two cities at similar latitudes are caused because Warsaw is on a large land mass, but London is on a small land mass, and near the sea. Ocean currents keep London cooler in the summer, but warmer in the winter.
- 2 a) Chittagong, Bangladesh has a tropical monsoon climate. Hong Kong has a warm temperate climate.
- b) Chittagong has a hot climate. (Mean monthly temperatures are higher than 18°C, with wet and dry seasons. It receives less than 60 mm of rain in the month of December.) Hong Kong is on the eastern side of Asia at latitude 22°N. Summer is the wettest season; it is rainy but warm.
- c) In Chittagong, the changing directions of the winds there cause the change of seasons. The driest month is around the winter solstice (the shortest day). In Hong Kong, the winds come mainly from the Tropics, bringing warm, moist air.
- 3 a) is not an arid climate
- b) is not an arid climate
- c) is an arid climate
- d) is an arid climate
4. Arid climates have less than 250 mm of precipitation per year. Climates 'a' and 'b' have more precipitation than this.
- D 1. Various answers are possible, including the following:
- a) hot arid: Kuwait, Saudi Arabia
- b) tundra: Gobi Desert tundra: parts of Alaska, USA, parts of Iceland, parts of Greenland and Russia

- b) Both have low annual precipitation and large differences between day and night temperatures. The hottest summer temperatures in cold arid climates can be very high (even higher than 40°C), but in tundra climates temperatures hardly ever rise higher than 12°C, while winter temperatures can drop much lower than in other places at the same latitudes.
 - c) The tundra has permafrost, but cold arid climates do not.
- 2
- a) The nearer a place is to the Equator, the warmer its climate. But places at high elevations have cooler climates than those at lower elevations at the same latitude. Places near the sea usually have milder climates than those farther from the sea at the same latitudes.
 - b) The size of the land mass: places on large land masses have greater differences between their summer and winter temperatures. Ocean currents: warm or cool currents of water affect temperature. Wind patterns: winds from different directions can bring cooler or warmer temperatures, dry weather, or precipitation.
- E 1
- a) the mountains of Khyber Pakhtunkhwa, FATA, and western Balochistan
 - b) Answers will vary, but should be based on information in this unit.
 - c) Answers will vary, but should be based on information in this unit.
- 2
- a) Winds from the Indian Ocean reach Hyderabad, Islamabad, Karachi, and Lahore, but mountains shelter Peshawar and Quetta from these southerly and south-westerly winds.
 - b) No. The north-east has the highest rainfall but no monsoon.
 - c) The areas with high mountains have the highest annual rainfall but the mountains shelter them from the monsoon winds from the south and south-west.

Answers to the Skills Book

Pages 20–21 'Comparison of different climatic regions of the world'

A 1 a–b) The students should have completed only the sections of the chart that describe tropical rainforest and tropical monsoon climates.

Description	Climate type	Example
The monthly mean temperature is at least 18°C; there is no summer or winter; it remains hot all year round and there is at least 60 mm of rain each month.	tropical rainforest	Sumatra, Indonesia
The monthly mean temperature is at least 18°C; seasons change with shifting wind patterns; dry and very wet seasons.	tropical monsoon	Chittagong, Bangladesh

The students should have completed the section of the chart that describes the tropical savannah climate.

Description	Climate type	Example
The monthly mean temperature of this climatic region is at least 18°C; seasons change with shifting wind patterns; summers are dry or slightly wet.	tropical savannah	North and Central Nigeria

The students should have completed only the section of the chart that describes the continental climate.

Description	Climate type	Example
This climate occurs mainly on east coasts and interiors of large land masses around latitude 40°N; average temperature in summer is higher than 10°C and lower than -0°C in the coldest month.	continental	Seoul, South Korea; Warsaw, Poland

The students should have completed only the sections of the chart that describe the warm and maritime temperate climates:

Description	Climate type	Example
This climate is neither very hot nor very cold and occurs mainly between latitudes 26° and 45°N or S; winds mainly blow from the Tropics; summer is the wettest season.	warm temperate	Hong Kong
This climate is neither very hot nor very cold; it occurs mainly between latitudes 26° and 45°N or S; the ocean currents keep its climate warmer than other climates at the same latitudes.	maritime temperate	London, UK

The students should have completed only the sections of the chart that describe the hot and cold arid climates.

Description	Climate type	Example
This climate occurs mainly around latitudes 30°N or S; it is the hottest, sunniest, and driest climate of all; less than 250 mm of rain per year; nights can be cold but hardly ever below 0°C.	hot arid	Saudi Arabia, Kuwait
This climate occurs in the rain shadow of mountains; it is very dry and there is never more than 250 mm of rain per year; summers are hot and dry but winters can be very cold—as low as -40°C; it sometimes snows in winter.	cold arid	Gobi Desert, China and Mongolia

The students should now have completed the chart by identifying the three main Polar climates and completing the examples.

Description	Climate type	Example
The average monthly temperature is lower than 10°C and average annual temperature is between 0 and 10°C; there is permafrost; the temperature in winter can drop as low as -50°C; there is very little precipitation.	tundra	Yakutsk, Russia and Alaska, USA

Regions above the treeline have this kind of climate; the average monthly temperatures are no higher than 10°C; there is very little precipitation (around 230–300 mm per year).	alpine	Ben Lawers, Scotland, UK, and Mount Yushan, Taiwan
It is the coldest of all climatic regions of the world; it is hardly ever warmer than 0°C; there is permanent ice.	ice cap	Parts of Greenland, Antarctica

Pages 22–23 'Factors affecting climate'

- A 1 a–c) The globe should be shaded and labelled to match the key and should show the three main climate zones: tropical, between the Tropics of Cancer and Capricorn, temperate (between the Tropics and each Pole), and polar within the Arctic and the Antarctic circles.
- B 1 a) polar (more accurately maritime polar)
 b) polar tundra
 c) Ocean currents bring rain to Reykjavik, but stop the winters being as cold as those of Fairbanks, which has a polar tundra climate. Fairbanks is on a larger land mass, so it has colder winters and warmer summers than Reykjavik. Fairbanks has a slightly higher elevation, which keeps it slightly colder at night in the summer, but with slightly higher daytime temperatures.
 d) tropical savannah
 e) hot summer continental
 f) It is at a high altitude.
 g) warm summer continental
 h) It is on a smaller land mass and near the sea, where ocean currents bring rain but keep it warmer than places far from the sea.

Pages 24–25 'Some latitude, different climate'

- A 1 a) i) latitude ii) altitude iii) wind patterns iv) distance from the sea v) the size of the land mass vi) ocean currents
- 2 a) Both Samsø and Nain are at around latitude 56.6°N and they are at similar altitudes, with Nain at 11 metres and most of Samsø at less than 64 metres. The factors that make their climates different are wind patterns, ocean currents, and the size of the land mass.
 b) Nain has a tundra climate, which is much colder than Samsø (maritime temperate), with heavy snow in winter. Samsø has a higher annual rainfall but less snow. The differences are because Nain is on the eastern side of a large land mass where the cold Labrador current flows along its coast, but Samsø is an island. Cold north winds blow across Labrador, while warmer, wetter winds from the Atlantic Ocean blow across Denmark, which is sheltered from the colder, northerly winds by Finland, Sweden, and Norway.

Pages 26–27 'Monsoons'

- A 1 a) In winter, in the months of December and January, the winds blow across Pakistan from north-east to south-west, from the Himalayas towards the Indian Ocean. This is because warm air rises from the sea, which is warmer than the land. Cold air from the land rushes in to take its place. The effect of this in Pakistan is cold weather in the north but milder weather in the south.
 b) In summer, in the months of June and July, the winds change direction and blow inland from the Indian Ocean. This is because the land is warmer than the sea, so warm air above the land rises, and cooler, wetter air from the sea rushes in to take its place. The effect of this in Pakistan is the monsoon.

Background knowledge for the unit

The Earth's climate has been changing since time began, but there have been great increases in temperature during the past 150 years, and the hottest 10 years ever recorded have been during the past 20 years.

Changes in climates have occurred naturally since the Earth first formed around 4.54 billion years ago. Geologists have named the different stages of the Earth's development according to the events and conditions on Earth. Events such as the formation of land masses, continents, mountains, and volcanoes affected the climate during Earth's evolution. After the Cretaceous period, around 100 million years ago, the Earth began to cool down, leading to the Ice Age, when ice sheets up to 3 km thick covered North America and Europe. (This was when mammals began to diversify and humans evolved near the Tropics.) Some of this ice remains, for example, near the Poles.

When humans evolved, they had little effect on the Earth's climate, but since the Industrial Revolution of the eighteenth century, they have had a considerable effect. Most scientists believe that human activity is now having a greater effect on climate change than natural factors, and that the most significant human action is the burning of fossil fuels for energy to support industry and transport, and for domestic heating, lighting, and cooling. Deforestation has also had a significant effect, since forests provide a 'carbon sink' (an area that absorbs carbon and so reduces the amount of carbon dioxide released into the atmosphere).

Computer modelling can be used to predict climate changes; this is based on the possible effects of population growth, changes in industry, carbon dioxide emissions, changes in the carbon sinks of the oceans and forests, the shrinking of glaciers and polar ice, and on the effects of the United

Nations Environmental Programme.

There has been an average increase of 0.8°C in the global temperature since 1880 and an increase of 3.4 mm in sea levels per year. If possible, check out the website: <https://climatekids.nasa.gov> in class and discuss. You can also ask the students to browse this website at home.

Scientists have predicted that, due to climate change, temperature increases will lead to an increase in droughts and cause deserts to spread. Rises in sea level would affect low-lying regions, such as the Netherlands, the Maldives, and other island groups, and places situated in the lower courses of river valleys, such as Amsterdam, Manhattan, and London. Melting glaciers could cause floods in regions downstream: for example, in parts of Pakistan and Bangladesh. Melting permafrost releases carbon dioxide and methane from frozen peat bogs into the atmosphere.

Storms and cyclones will become more frequent and more severe. These would affect South-east Asia, and the south-east of the USA in particular.

Most scientists agree that reducing greenhouse gas emissions and protecting and increasing carbon sinks are vital actions in counteracting global warming.

Before we proceed

This unit explains the ozone layer, climate change, the greenhouse effect, and global warming, and their effects on the Earth and its inhabitants. It explains how humans are contributing to these, and the actions they must take to mitigate them.

Expected learning outcomes

Students should be able to:

- explain climate change, global warming, and the greenhouse effect
- discuss the importance of the ozone layer, and explain how human activity affects it

- discuss what can be done to combat global warming
- identify the main greenhouse gases, their sources, and some of their effects on the Earth
- identify the natural features that act as carbon sinks

PAGE 52

‘What is climate change?’; ‘How do we know that the Earth is getting warmer?’; and ‘What changes the Earth’s temperature?’

Introduction

Ask the students what they know about the meaning of climate. They should know the difference between weather and climate. Explain that they are going to learn about how the climate is changing—not only changes in the climates of specific regions, but changes in the climate around the world. Elicit what they know about climate change. They will probably have heard about it on television or read about it in newspapers and heard people talking about it. They could be asked to discuss with their parents at home how the climate has changed over the past 20 years.

Ask about the evidence of climate change that people are already noticing—both in their own regions and in other parts of the world. They should know about effects such as rises in air temperatures, desertification, flooding, perhaps rising sea levels, and the melting of some glaciers.

Using the Student’s Book

Ask the students to read page 52 and to make a note of any facts they find on this page. Ask them to share these with the class. Ask why scientists are particularly worried about the changes that are happening now, rather than thinking that they are just part of the Earth’s natural changes. (The current changes are happening very quickly compared with those in the past, and the gases in the Earth’s atmosphere are changing.)

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned that the Earth’s climate is changing.
- I learned about the meaning and effects of global warming.
- I learned that the Earth’s climate changes naturally.

PAGES 53–54

‘What does the greenhouse effect mean?’; ‘Where are the extra greenhouse gases coming from?’; and ‘What changes could the greenhouse effect cause?’

Resources

- *Oxford School Atlas for Pakistan*
- Skills Book page 28 ‘Climate change vocabulary’
- Skills Book pages 29–30 ‘How the greenhouse works’

Introduction

Ask what they know about the changes to gases in the Earth’s atmosphere. (Greenhouse gases are being produced, causing the greenhouse effect.) Ask what they know about ‘greenhouse gases’, and check that they know what a greenhouse is. Explain that the term ‘greenhouse effect’ suggests that greenhouse gases have the same effect as a greenhouse. Tell the students that they are going to find out what these terms mean and why greenhouse gases are a problem.

Using the Student’s Book

Ask the students to read about the greenhouse effect on page 53. After they have read this page they should be able to name some greenhouse gases and to explain how they can be helpful and why they can cause problems.

Explain that the greenhouse effect is beginning to melt the permafrost, and ask what they know about the permafrost. (They learned about this in their work from Unit 5 on climatic zones of the Earth, and should know that it is a layer of the ground that is permanently frozen, found in polar climates.) They should be able to name places that have permafrost (Alaska, USA, parts of Russia and Greenland, and some areas in the Arctic Circle). They could look at a world map and maps of the Arctic and Antarctic to locate the places with this type of climate.

The students can then read pages 54–55, including the diagram and the ‘It’s a fact’ to find out where the extra greenhouse gases are coming from, and the effects they are having on the Earth’s climate.

Ask how greenhouse gases are affecting the seas and oceans, and the permafrost, and about the problems that these changes could cause.

They can then complete Question A.

Using the Skills Book

The students can now begin page 28 of the Skills Book ‘Climate change vocabulary’. Explain that there will be some answers that they will not know, and that they can complete these after the lessons that follow. For homework, they can complete pages 29–30.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned where the Earth’s extra greenhouse gases are coming from.
- I learned about the possible changes that could be caused by the greenhouse effect.
- I learned how the greenhouse effect is changing the seas, the oceans, and the permafrost.

PAGES 54–56

‘Disappearing ice’; ‘What happens to the ice from a retreating glacier?’; and ‘Land ice’

Resources

- *Oxford School Atlas for Pakistan*

Introduction

Ask the students to look at a map of the world in their *Oxford School Atlas for Pakistan* to find the places that have glaciers and ice caps or sea ice. Discuss how global warming could affect these places.

Using the Student’s Book

Ask the students to read pages 54–55 ‘Disappearing ice’ and ‘What happens to the ice from a retreating glacier?’ Ask if they read anything that surprises them. (They might be surprised to find that not all glaciers are retreating due to global warming; although most glaciers are retreating, a few in the highest regions of the Karakoram Mountains are advancing.) Ensure that they understand the terms ‘advancing’ (spreading, due to an increase in the area covered) and ‘retreating’ (reduction in the area they cover). Explain that glaciers are constantly moving downhill. The ice tends to melt when it reaches lower elevations. A few glaciers have periods during which they advance very quickly. Their movement is normal until they accelerate suddenly, then they continue to move normally. There are different causes for these periods of sudden movement, including changes in the bedrock below, or meltwater pooling at the base of the glacier.

Ask them to read page 56. Ask what they have learnt about the effects of melting sea ice and land ice, and why these differ. They should be able to locate Greenland and Antarctica on a map of the world and to explain why the ice in Greenland is more likely to melt than that in Antarctica.

Ask them to read the 'It's a fact' and to say what trends are being recorded in sea levels. They should now be able to complete Question B.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how global warming is affecting the Earth's sea ice and land ice.
- I learned about the effects of melting glaciers.
- I learned about the effects of melting sea ice and ice caps.

PAGES 56-58

'How does climate change affect animals and plants?' (all sections) and 'How does climate change affect people?'

Resources

- Skills Book page 31 'Impact of climate change'

Introduction

Explain that this lesson will focus on the effects of climate change on living things: plants, humans, and other animals. Ask if they have heard or read about people, other animals, or plants being affected by climate change.

Using the Student's Book

Ask the students to read pages 56–57 'How does climate change affect animals and plants?'. They should then be able to give a summary of these without looking at the Student's Book. For homework, different groups could then use the Internet to find out more about the effects on one of the animals mentioned, and to write a report about it.

Discuss how plants are being affected and how climate change might affect the plants in the region where they live.

They should then read pages 57–58 to find out how climate change is affecting people around the world, beginning with places near where they live. They could begin to collect information about any of these effects that they can find in the newspaper, television, or the Internet in Pakistan.

The students can then complete Question C.

Using the Skills Book

Ask the students to read the sentences on page 31 'Impact of climate change', and to use what they have learnt in this unit to help them to choose the correct words or phrases to fill the gaps. This could be completed for homework, to review what they have learnt and to consolidate the vocabulary related to climate change.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how climate change is affecting animals and plants, and what they might do in order to survive.
- I learned how climate change is affecting people.
- I learned about the effects of climate change in Pakistan.

PAGES 58-59

'What is the ozone layer?' (all sections) and 'What can we do to reduce greenhouse gases?' (all sections)

Resources

- *Oxford School Atlas for Pakistan*
- Skills Book page 32 'Reducing greenhouse gases'

Introduction

Explain that in this lesson they are going to learn the meaning of the ozone layer, why it is important

to the Earth's climate, and how greenhouse gases are affecting it. Ask what ozone is. (It is a gas that is present in the troposphere—the lower part of the Earth's atmosphere—in small amounts, but there is a layer of ozone higher in the atmosphere, near the outer part of the stratosphere.) They should now be familiar with the different levels of the Earth's atmosphere.

Using the Student's Book

Ask the students to look at the diagram of the Earth's atmosphere on page 22 of the Student's Book, to check that they know the order of the different layers of the atmosphere and the names that scientists have given to them. They should then read page 58 to find out about the ozone layer. They could write a summary of this without looking at the Student's Book before continuing to read about the importance of the ozone layer in protecting living things from too much radiation from the Sun.

Explain that too much ozone low in the atmosphere can be harmful. Ask the students to read on to find out why, and to find out about the effect of greenhouse gases on the ozone layer.

Students might have heard about international agreements to take action to reduce greenhouse gases, and should read to find out about them. They will be aware of many examples of activities that produce greenhouse gases near where they live, and might know about some of the ways in which people are trying to reduce these. Ask them to read on to the end of the unit to find out about some of the main ways of doing this.

They can then complete Question D.

Using the Skills Book

The students should continue to read page 32 of the Skills Book 'Reducing greenhouse gases'. They should be able to complete any answers they omitted on Skills Book page 28 'Climate change vocabulary'.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how people can help to reduce greenhouse gases.
- I learned how I can help to reduce greenhouse gases.

Answers to assessments

- A 1 a) Climate change means a change in the Earth's normal weather patterns.
- b) The Earth's average climate is getting warmer. We call this global warming.
- c) Greenhouse gases radiate heat in all directions. They keep the atmosphere warm.
- d) Carbon dioxide, nitrous oxide, and methane are examples of greenhouse gases.
- e) Most of the methane in the atmosphere comes from agriculture, decaying landfill, and decaying peat bogs.
- f) Most of the carbon dioxide in the atmosphere comes from burning fossil fuels for power.
- 2 a) manufacturing/industry, agriculture and forestry, energy production, transport, buildings (including air conditioning), other energy uses, including homes and shops
- b) energy (25%), agriculture, forestry, and other land use (24%), industry (21%), transport (14%), buildings (6%), other energy (10%)
- c) any four from the following:
- Do not leave television sets or other electrical equipment on standby.
 - Do not leave land bare: plants, especially trees, are good at absorbing carbon dioxide from the atmosphere.
 - Change from vehicles running on petrol or diesel (fossil fuels) to electric or solar-powered vehicles which do not produce greenhouse gases.
 - Do not leave the engine running while the vehicle is parked.
 - Make the shape of a vehicle more streamlined: put a deflector at the front of trucks and do not leave a roof box on a car if it is not needed; and

- do not drive with the windows open.
- Drive more slowly.
 - Make sure vehicle tyres are inflated enough.
- d) hotter summers and more heatwaves; droughts in some places but very heavy rainfall in others
- 3 a) healthy peat bogs c) forests
e) permafrost
3. a gradual change towards something, for example: higher or lower rainfall, higher or lower temperatures, more or fewer storms, or higher or lower sea levels
- B 1. partly because global warming is melting the ice around the Poles
2. The permafrost stores carbon but, if it melts, it releases carbon dioxide into the atmosphere. If it continues to melt, it will also release methane from peat bogs that are normally frozen.
- 3 a) False; most of the world's glaciers are retreating and some are forming glacial lakes. A few glaciers in the Karakoram Range are advancing. A few are not changing.
b) true
c) true
- 4 a) Greenland is not as cold as Antarctica.
b) Sea levels around the world would rise by more than 75 metres.
- 5 a) The students' own responses, for example:
- Melting sea ice means that polar bears' habitats are shrinking. They have to swim longer distances to find food. Many become exhausted and die from starvation.
 - Baleen whales feed on plankton (tiny living organisms). Warmer water contains less plankton, so baleen whales are dying from starvation. They travel farther in search of food and they are being found washed up on beaches in areas where whales have never been seen before.

- Rising sea levels could endanger sea turtles' eggs or very young hatchlings, which are laid and hatch on beaches in Brazil. Higher temperatures are more suitable for female hatchlings but cooler temperatures are better for males, so the population of male sea turtles is reducing. This could threaten turtle populations.
 - Some birds that migrate to cooler climates for the summer are beginning to migrate earlier. They could starve if the insects they usually feed on have not yet hatched.
 - The world's oceans are absorbing more and more carbon dioxide. This makes the water more acidic. In more acidic water, coral, and shellfish cannot absorb the calcium carbonate they need for healthy skeletons or shells. When the sea stays warm for longer than normal, coral becomes white and does not regain its pink colour. This makes it less able to fight off disease.
 - In some places, floods in the spring wash away salmon eggs laid in stream beds. This could wipe out whole salmon populations.
- b) students' own responses, for example:
- Alpine plants grow on high ground, where temperatures do not get very high. If their habitat becomes too warm, there is nowhere higher for them to grow.
 - Some plants are producing flower buds earlier because of warmer temperatures. But there can still be overnight frosts that kill the buds.
- 6 a–b) students' own responses, for example:
- Climate change is affecting water supplies, for example: Pakistan is one of many countries that already have very little water. Higher temperatures and other changing

weather patterns are changing the amount of water in lakes, rivers, and streams. Some regions are facing droughts. This change means that many people could face water shortages at home and for farms or other businesses.

- In some places, temperatures could become too high for the crops normally grown there. Changing weather patterns are also affecting the amount of water that can be used for irrigation. Stronger storms and floods can damage crops, so there could be food shortages.
- As well as producing greenhouse gases, the burning of coal, oil, and natural gas produces air pollutants such as ozone, sulphur dioxide, and nitrogen oxides. These can cause health problems. Sunlight and low-level ozone can increase the effects of pollutants. For example, Tokyo, Islamabad, New York, and London already have high levels of pollution that harm health, especially for very young or very old people or those who have breathing problems.
- Heatwaves are becoming more common. These are especially dangerous to infants, older people, and people with poor health. For example: in 2003, a heatwave in Europe caused about 50,000 deaths. In June 2015, the heatwave in southern Pakistan had temperatures as high as 49°C. It caused the deaths of about 2000 people, mainly from dehydration and heatstroke.
- As winters become warmer, ticks and mosquitoes that carry diseases can survive longer throughout the year. Bites from these insects could cause disease or even death.
- Settlements along some coasts and small islands, especially on lowland, will be threatened by floods if sea levels rise. Hundreds of millions of

people around the world could lose their homes or businesses and face danger.

- As temperatures rise, more and more people need to use air conditioning, which uses a lot of electricity. However, many will use less energy for heating in the winter.
 - Droughts, floods, and damage to dams could cause problems for hydroelectricity plants, so there could be power shortages.
- C 1 a) Sea levels are rising and the seas are becoming less salty in places.
- b) i) Due to global warming, polar bears' habitats are shrinking. They have to swim longer distances to find food. Many become exhausted and die from starvation.
- ii) Baleen whales feed on plankton (tiny living organisms). Warmer water contains less plankton, so baleen whales are dying from starvation. They travel farther in search of food and they are being found washed up on beaches in areas where whales have never been seen before.
- iii) Alpine plants grow on high ground, where temperatures do not get very high. If their habitat becomes too warm, there is nowhere higher for them to grow.
- iv) Rising sea levels could endanger sea turtles' eggs or very young hatchlings, which are laid and hatch on beaches in Brazil. Higher temperatures are more suitable for female hatchlings but cooler temperatures are better for males, so the population of male sea turtles is reducing. This could threaten turtle populations.
- 4 a) Do not leave television sets or other electrical equipment on standby.
- b) Do not leave land bare: plants, especially trees, are good at

absorbing carbon dioxide from the atmosphere.

- c) Do not leave the engine running while a car is parked.

D 1 a) stratosphere

b) The Sun's radiation keeps the Earth warm enough for plants and other living things to live, but some of its ultraviolet radiation is harmful. The ozone layer keeps out most of the harmful ultraviolet radiation.

c) chlorofluorocarbons (CFCs), carbon dioxide

2 a) Answers will vary. They could include problems caused by:

- droughts, higher temperatures that reduce rainfall, affecting water supplies for homes and irrigation
- temperatures that become too high for the crops normally grown, leading to food shortages
- stronger storms and floods can damage crops, leading to food shortages
- pollutants such as ozone, sulphur dioxide, and nitrogen oxide from the burning of fossil fuels that can cause many health problems, particularly in cities
- heat waves that can be especially dangerous to infants, older people, and people with poor health, causing dehydration and heat stroke
- flooding in coastal settlements (for example in the Indus Delta) if sea levels rise
- damage to dams from droughts and floods that could cause problems for hydroelectricity plants, leading to power shortages

b) In some places, melting ice from glaciers has caused floods: for example, in Chitral, in 2015, when melting ice and heavy rainfall caused a glacial lake to overflow the Khanpur

Dam on the Haro River in Khyber Pakhtunkhwa.

In 2010, there was a landslide near Attabad that created a dam across the Hunza River. A lake formed behind the dam and flooded towns, fields, and roads, including part of the Karakoram Highway.

- 3 a) Answers will vary. They could include reports of floods, droughts, heatwaves, pollution, and so on.
- b) Answers will vary.

Answers to the Skills Book

Page 28 'Climate change vocabulary'

A 1. The students should have completed the crossword with the following answers:

Across

- | | |
|-----------------|----------------|
| 3. greenhouse | 4. carbon |
| 5. fossil | 8. methane |
| 9. stratosphere | 10. atmosphere |

Down

- | | |
|-----------|----------------|
| 1. global | 2. troposphere |
| 6. ozone | 7. change |

Pages 29–30 'How the greenhouse works'

A–B. Students should follow the instructions and record the temperature in the table. They should then give their own answers on based on their observation and calculate of the differences between the temperatures. The should draw a diagram of a greenhouse in the given space.

Page 31 'Impact of climate change'

A 1 a) The students' own responses should mention islands and regions with lowland elevation; coastal places at low elevations; regions that are prone to drought; regions that can be affected by downstream melting from glaciers; regions that have monsoons, cyclones,

- and storms, and regions near the Equator.
- b) The students' own responses should include the effects of rising sea levels, higher temperatures, melting ice caps, and glaciers; also the effects of melting permafrost, the loss of forests/other changes in land use, and increase in greenhouse gases.
 - c) These should include: reducing the burning of fossil fuels and other activities that increase greenhouse gases, and reducing deforestation.
- 2
- a) As the sea ice melts, polar bears, which live on the sea ice around the North Pole and feed mainly on seals, have to swim farther to find large enough, stable pieces of ice. This makes them very tired, especially females who have cubs to look after. Because of this, many adults and cubs are dying from starvation.
 - b) Rising sea levels could endanger sea turtles' eggs or very young hatchlings, which are laid and hatch on beaches in Brazil. Higher temperatures are more suitable for female hatchlings but cooler temperatures are better for males, so the population of male sea turtles is reducing. This could threaten turtle populations.
 - c) Students' answers should include that flash floods, droughts, storms etc. and rising temperature affect the production of food and livestock.
- c) Use less energy in manufacturing, and find ways of using alternative energy from non-fossil sources for heat and light in factories. Use recycled materials where possible: for example, in steel and aluminium manufacturing. Reduce waste and leakage of chemicals.
 - d) Develop biofuels (fuels made from living things or their products, such as plant sugar and plant oils) to replace fossil fuels such as petrol and diesel, and because the plants grown for producing biofuels absorb carbon dioxide from the atmosphere.
 - e) Insulate buildings to reduce energy consumption by introducing and enforcing regulations for new buildings to improve their insulation and so reduce the use of heating and air-conditioning. Encourage people in workplaces, at home, and at school, to switch off electrical equipment and lights when they are not being used.

Page 32 *'Reducing greenhouse gases'*

- A 1
- a) Develop the production of power from wind, solar radiation, and water (hydro and tidal). Find ways to use less energy: for example, making energy-efficient electrical goods such as fridges that use less power.
 - b) Improve the management of drainage, fertilizers, manure, and other waste products, by using waste products to produce energy; prevent deforestation.

Background knowledge for the unit

Weathering and erosion are closely-linked natural phenomena but are not exactly the same. Weathering refers only to the effect on the natural feature, material, or structure that is worn away: for example, rock can be broken by water that seeps into cracks and then freezes. Erosion is when rocks and sediment are picked up and moved to another place by the movement of ice, water, wind, or the force of gravity.

There are three types of weathering: physical (or mechanical), chemical, and biological (or organic).

Physical or mechanical weathering is very common where there is little soil and few plants, for example, in hot deserts and in mountain ranges. Expansion and contraction of the surface layer of rocks breaks them up. This is the result of the repeated melting and freezing of water in climates where there are wide variations in temperature. It can happen in colder climates such as tundra, alpine, or in hot desert climates.

Flowing water can also cause mechanical weathering, especially when the water carries particles of grit and sediment.

A common type of mechanical weathering is 'freeze-thaw' weathering, which takes place where water runs into cracks, freezes, and expands. This expansion is powerful enough to break the rock into pieces.

Exfoliation is a more complex type of mechanical weathering. It takes place mainly on high land where certain types of igneous rock are exposed and there is pressure from other layers of rock. The pressure cracks the rock, and the cracks follow the land surface. Where the land is flat, the cracks are wide and flat, rather than deep into the ground. On mountain sides or hillsides, the cracks are quite steep. Water runs into the cracks and dissolves some of the minerals in the rock, forming

new minerals (chemical weathering). The cracks enlarge, and large flat slabs of rock break off.

Chemical weathering happens mainly when materials react with minerals in the rock to form new materials.

Biological weathering: occurs when living things, including animals, plants, or even microscopic organisms, break down rock. Tree roots grow through cracks in the rock as they try to reach water. As they grow, they push the rock apart. Animals scrape away rock in order to create a cavity for shelter, or the organic acid produced by plant roots or microorganisms dissolves the rock.

Erosion often begins with weathering, during which flowing water or wind removes soil, rock, or dissolved material from one place and transports it to another place.

The force of the water takes material from the riverbanks or river bed and transports it downstream, and then deposits it on other parts of the riverbanks or river bed.

Animations of these processes can also be seen on My E-Mate companion website.

Coastal erosion happens where wave action, tidal currents, wave currents, drainage, or strong winds remove material from coastal land and transport it out to sea or to other parts of the coast. The processes are the same as for rivers.

As for coastal erosion, the actions of water and wind erode and shape high and lowland. Fast-moving water or air erodes the rock and transports particles (even quite large ones). The Grand Canyon in Arizona, USA, was cut through the mountains by erosion. Uluru, in Central Australia, was created by erosion, where the softer rocks of the surrounding high land were eroded, leaving the mountain that came to be known as Ayers Rock.

When the water or wind slows down or stops, it deposits material in a different place. This can create fertile land (as in floodplains, such as those of the Indus and Nile).

Ice is important in land erosion: glaciers are constantly moving downhill, wearing away the rock beneath them and depositing it in mounds, called terminal moraines, where they stop. Glaciers formed the fjords of Norway and Iceland.

Bare soil is eroded more easily than land covered by vegetation, often leading to landslides.

Erosion by wind and water can be minimized by constructing physical structures such as gabions, riprap, and windbreaks.

Plants can help to minimize erosion: for example, grass and other vegetation on sand dunes, or woodland, and even forests can be planted as windbreaks.

Wetland coastal areas can be protected by creating living shorelines, with native plants on a base protected by stone and sand. Animals such as oysters can also help to anchor the soil. Once the land is secure, living shorelines become a natural habitat, protecting the coast from erosion and storms.

People can help to minimize land and river erosion by ensuring that land is not left bare, avoiding deforestation, and, where possible, leaving natural floodplains to flood—and avoiding building on them.

Before we proceed

This unit explains different types of weathering and erosion and their effects, including coastal erosion and landforms; and there are explanations of how the effects of erosion can be minimized or avoided. Examples from around the world are included to illustrate how deserts form and expand, and the role of humans in causing erosion and desertification. The importance of vegetation, especially trees, in combatting erosion, is highlighted, with examples of successful uses of vegetation.

Expected learning outcomes

Students should be able to:

- explain the terms ‘weathering’ and ‘erosion’
- explain how weathering and erosion can affect the physical and human features of places
- describe some causes and effects of desertification, and give examples from Pakistan and the rest of the world

- identify some of the projects that are taking place in Pakistan to prevent the erosion of farmland and habitats, and to prevent desertification
- explain how human actions can cause or worsen erosion

PAGE 62

***‘Weathering and erosion’;
‘How does weathering occur?’ (all sections)***

Resources

- Skills Book page 33 ‘The effects of weathering’

Introduction

Elicit what the students know about weathering and erosion. Different students could contribute to the explanation. Point out that these processes are linked, but not exactly the same, and that they are going to find out more about them.

Using the Student’s Book

Ask the students to read page 62 to find out how weathering and erosion are different, then invite them to explain this without looking at the Student’s Book.

Ask them to close their Student’s Books, then ask them to name the different types of weathering. Invite volunteers to explain each of these and give examples. Ask how rainwater can change the appearance of a building. Make sure they understand the main features of each type of weathering.

Also ask what stalactites and stalagmites are; they will have learnt about these in Grade 6. The students can then complete Questions A and B.

Using the Skills Book

Ask the students to look at the Venn diagram on page 33 and explain how to use it. Venn diagrams are used to present information visually. The overlapping sections are for weathering that involves more than one type of process, for

example mechanical and organic, which are the processes involved where people wear away a stone step (the action involves living things and mechanical abrasion).

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned that weathering and erosion are involved in wearing away and breaking up rock.
- I learned that erosion also moves material that has been worn away and deposits it somewhere else.
- I learned about the different types of weathering: mechanical, chemical, and organic.

PAGES 62-64

'Water erosion'; 'Stream erosion'; 'River erosion'; and 'Run-off erosion'

Resources

- Skills Book page 34 'Preventing water erosion'

Introduction

Ask the students what they have learnt about weathering. They should know the main types of weathering and the difference between weathering and erosion.

Ask them to consider what they know about the causes of erosion, and to list these in their notebooks. After completing this topic they should write a new list and compare it with this one, in order to highlight what they have learnt.

Using the Student's Book

Ask how rivers, streams, and rain cause erosion, and what happens to the soil and rock they erode.

They should then read pages 62–64 about the different types of water erosion. They can then complete Question C.

Using the Skills Book

The students should be able to complete Skills Book page 34 'Preventing water erosion' for homework. Ask them to look at each picture and make a note of how water is causing erosion of the land, thinking about the direction from which it is coming, the direction of its flow, and what it is doing to the land. They should then consider how to prevent this erosion: whether the water-flow could be diverted, or its force reduced, or whether vulnerable parts of the land could be strengthened and protected.

They can then consider the methods of erosion prevention they have read about in the Student's Book, choose the best solution, and explain how it will help.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how streams and rivers erode land.
- I learned how run-off from rainfall can erode land.
- I learned how erosion by streams, rivers, and run-off can be prevented.

PAGES 64-65

'Coastal erosion'; 'Hydraulic action'; 'Attrition'; 'Abrasion'; 'Solution'; and 'Coastal landforms'

Introduction

Elicit what they know about the ways in which the sea changes coastal landforms. They should remember what they learned in Grade 6 about the coast of Karachi, where the action of the sea has created landforms such as caves, arches, stacks, and stumps. Tell them they are going to find out more about how the sea shapes coastlines.

Using the Student's Book

Ask the students to read pages 64–65, 'Coastal erosion', including the diagrams. Then ask how the sea causes cliffs to collapse. They should be able to explain this, using the terms hydraulic action, attrition, abrasion, and solution.

They should also be able to explain how the cave, arch, and stack form, what changes the sea is likely to make, and what type of coastal landforms would remain.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how waves can create sea caves in cliffs.
- I learned how erosion eventually enlarges a cave in a headland until creates an arch.
- I learned how erosion can eventually break an arch, leaving a stack, and then erode the base of a stack, until it collapses, leaving a stump.

PAGES 65–66

'Wind erosion'; 'Effects of wind erosion'; and 'Preventing wind erosion'

Resources

- a tray of dry, dusty soil
- a tray of wet soil
- a tray of soil with grass or other plants growing in it; this could be fairly dry
- a hairdryer

Introduction

Use the hairdryer on cold setting to show the students how wind erosion affects soil. Ask them to watch what happens.

1. Begin with the tray of dry soil and the hairdryer set on low speed (cool setting, if possible, but warm will be fine). The hairdryer should be

directed so that it does not blow soil onto anyone. Switch on the hairdryer and hold it slightly above the soil and almost parallel with it, so that the air from the hairdryer blows on the soil. Increase the speed of the hairdryer if possible.

2. Repeat the above procedure on the tray of wet soil.
3. Repeat the above procedure on the tray of soil with plants growing in it.

Ask the students to use what they have seen to explain what happens when wind blows across dry, dusty land, wet land, and land with vegetation growing on it.

Using the Student's Book

Ask the students to read pages 65–66 'Wind erosion' and 'Effects of wind erosion'. Then ask them to explain how wind can change the shape of a solid rock. Also ask what happens to the materials eroded by wind. Ask how this material can affect farmland, crops, buildings, people, animals, machinery, and traffic. Also ask how this material can change the landscapes of other places; they should be able to give an example in Pakistan.

Ask them to explain how dust from the Sahara Desert gets to places as far away as the north of England.

Ask them to think about the trays of soil they looked at earlier in the lesson and to suggest how wind erosion could be prevented or minimized. (Keep the land moist and plant trees or other vegetation that will help to hold the soil in place and keep it moist.) They should then read about prevention of wind erosion.

The students can then complete Question D.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how wind erodes land.
- I learned how wind erosion can cut away solid rock.
- I learned how wind erosion can be prevented.

PAGES 66-67

'Erosion caused by humans'; 'Deforestation'; 'Why are forests so important?'; 'Overgrazing'; 'Agriculture'; and 'Urbanization'

Resources

- *Oxford School Atlas for Pakistan*

Introduction

Ask the students to talk to a partner about human actions that can increase wind and water erosion, and to make notes. Give them a few minutes for this and then ask for feedback. They should know about the effects of deforestation from their earlier work on forests and climate change. They should make a note of this during their discussions.

Ask them what urbanization means. They should know that urban areas are cities and towns and should be able to figure out that urbanization means covering large areas of land with cities or towns. Ask if they thought of this during their discussions.

Also ask how agriculture can help to cause erosion. They should know that land that is left bare is easily eroded by wind and water. Tell them that overgrazing by livestock can also leave the land bare and easily eroded.

Using the Student's Book

Ask the students to read the following sections on pages 66–67: 'Erosion caused by humans', 'Deforestation', 'Why are forests so important?', 'Overgrazing', and 'Agriculture', also 'It's a fact' They should look at the diagram on page 60 to find out how trees help to protect land from wind erosion.

Ask them to look at the photo of overgrazed land and to explain how this land could easily be eroded. (There is very little vegetation left, leaving the land dry and dusty, and easily eroded by wind.) Point out that animals' hooves can also compact the land,

making it hard, so that it does not drain easily, leading to run-off.

The students should now read the section on 'Urbanization'.

They can then write a short report in their notebooks, explaining how human actions can lead to erosion and how this can be prevented. They can complete Question E.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned that human actions lead to soil erosion.
- I learned about the effects of deforestation and poor farming methods.
- I learned how urbanization can lead to soil erosion.

PAGES 67-69

'Desertification'; 'Effects of desertification'; 'Desertification around the world'; 'Desertification in Africa'; 'Desertification in Pakistan'; 'The Indus Basin'; and 'Sandy deserts'

Resources

- *Oxford School Atlas for Pakistan*

Introduction

Ask what desertification means. They should be able to figure out that it refers to land that changes into desert. Ask them how this happens. Their previous learning about climate change and erosion should help.

Using the Student's Book

Ask the students to read the sections of pages 67–68 headed 'Desertification', 'The effects of

desertification', and 'Desertification around the world', and ask which parts of the world they think are likely to suffer from desertification (places with arid and semi-arid climates).

They should now look at the world map that shows desertification vulnerability. If necessary, explain how to interpret the map using the key. They should use a political map of the world in the *Oxford School Atlas for Pakistan* in conjunction with this map to help them to find out which countries are vulnerable to desertification.

Ask them to read on to find out why much of the Africa is particularly vulnerable to desertification. Ask if Africa's desertification problem could have been avoided, and how (through better land management, including the avoidance of overgrazing and deforestation). It is useful to discuss why people do things that damage the land they need for agriculture. Point out that people living in poverty or struggling to survive do not usually have a choice about what fuels to use; they need to graze their livestock in order to produce food, they cut down trees to make charcoal because they need it for fuel, and they might overgraze their land because they have no other way of feeding their livestock.

Ask the students to explain why land continues to deteriorate once desertification has begun.

They can then find out about desertification in Pakistan, how it is affecting the Indus Basin and about the sandy deserts of Pakistan by reading pages 68–69. Ask them what salinity means, and how this is affecting the soil in many parts of Pakistan.

They can then complete Question F.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how human actions lead to desertification.
- I learned why some parts of the world are especially vulnerable to desertification.
- I learned about the actions we can take to prevent desertification.

PAGE 69

**'Preventing desertification';
'Planting olive trees';
'Planting eucalyptus trees';
and 'Planting lemons'**

Resources

- *Oxford School Atlas for Pakistan*

Introduction

Ask what they have learned about desertification, and how it can be prevented. Tell them that they are going to find out about some ways in which farmers and landowners in Pakistan are helping to protect their land from desertification, with help from the Pakistan Agricultural Research Council.

Using the Student's Book

Ask the students to read the sections of page 73 headed 'Preventing desertification', 'Planting olive trees', 'Planting eucalyptus trees', and 'Planting lemons', and 'It's a fact'. Then ask them to close their Student's Books and answer the following questions:

- Which tree that is native to countries in the Mediterranean region of Europe is being planted in Punjab to help to prevent desertification? (olive)
- Parts of which other regions of Pakistan might also be suitable for planting olives? (Balochistan, Khyber Pakhtunkhwa, and Potohar).
- In what type of soil and climate do olives grow? (an arid climate and poor soil.)
- How will olive trees help to prevent desertification? (They will prevent wind and water erosion and help to stop the Thar Desert expanding.)
- What useful products come from these trees? (olives and olive oil).
- Which tree is being planted in Khushab to protect land from erosion and to stabilize the sand dunes? (eucalyptus.)

- What product will come from this tree? (wood)
- Which tree is being planted by farmers in Tharparkar, Sindh, to help stop the expansion of the Thar Desert? (lemon). How will these trees be useful? (for their fruit and to provide shade to reduce evaporation from the land)

They can then write a short report about the ways in which farmers are helping to prevent desertification, including finding out more from the Internet or other sources about a specific project in Pakistan.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how trees can help to prevent desertification.
- I learned about three projects that are helping to prevent desertification in Pakistan.

Answers to assessments

- A 1 a) Weathering is when rock is broken into smaller pieces by conditions such as rain or wind. Erosion is when sediment and fragments of rock are moved from one place to another by wind, water, or gravity.
- b) mechanical, chemical, and organic
- c) Students' own drawings and explanations of any type of weathering they have seen
- d) Students' drawings and explanations above should identify the type of weathering: mechanical, chemical, or organic. They should explain the process.
- B 1 a) Chemical weathering occurs when rock dissolves in water or weak acids and forms new materials. Mechanical weathering happens when rock is broken into smaller pieces, for example, when water gets into holes in the rock and freezes. Then it expands, cracking the rock.
- b) Organic weathering is caused by living things, for example, when plants break up rocks when their roots push through the small holes in the rock and enlarge them, or when animals scratch rocks.
- c) It breaks up the rock and soil.
- 2 a) erosion of the bed of a river or stream: scour
- b) piles of rocks or concrete rubble arranged on a riverbank to prevent bank erosion: riprap
- c) metal cages filled with rocks or concrete and fixed to a riverbank to prevent erosion: gabions
- d) cutting down forests: deforestation
- e) when a large area of rock and soil moves down a hillside: landslide
- f) rainwater running down the surface of land: run-off

- C 1 a) Streams and rivers carry sediment that wears away the rock that the water flows across. Flowing water wears away the banks and bed of the stream or river.
- b) students' own examples of erosion
- c) Students' own suggestions should include either run-off barriers or terraces.
- D 1 a) Wind carrying rock and soil particles can wear away rock by abrasion. Sand contains quartz, a very hard mineral, so wind that carries sand can erode rock faster.
- b) The soil is dry, and lighter than wet soil, so the wind can blow it away more easily.
- c) There are no natural barriers to slow the wind, so the winds there are stronger and can pick up more material than can gentle winds.
- d) Leave stubble from harvested crops to hold the soil in place. Plant trees or other vegetation, whose roots can hold the soil in place. Spread mulch to keep the soil moist.
- E 1 a) The students' own responses should include:
- Deforestation can have irreversible consequences. A community of people used to live on Easter Island, but as the population grew, they cleared the forests for agriculture and, because of this, the soil was easily eroded by water and wind, until there was so little soil on the island that people could no longer produce food and most of them starved to death. From this we can learn that we should not leave land bare, especially in warm climates.
- b) Farmers and developers are in business to make money, but in the past they did not always realize what consequences would follow their actions. Subsistence farmers have very little land, and the little land they have could become

overgrazed. Their crops might be affected by drought and it could be then difficult for them to produce crops in the future. Sometimes, people are so desperate for food now that they cannot think about the future (and might not even survive into the future).

- c) They can build terraces, plant trees, or use barriers.
- d) They can place thick tubes of netting filled with straw and fix them to the ground by long stakes. These barriers change the direction of the water to stop it flowing straight down the slope, and they slow it down.
- e) They can plant trees or other vegetation, or cover the ground with mulch.
- F 1 a–b) deforestation, overgrazing of livestock, poor methods of growing crops, and urbanization

Deforestation

Trees help to prevent water and wind erosion by acting as windbreaks, and by holding the soil together with their roots. Leaves that fall from the trees form a layer of leaf litter. This, along with other plant and animal material, decays and forms humus. As more leaves fall, they cover the humus.

Leaf litter and humus are porous, so rainwater can percolate through them into the soil below, rather than flowing over the surface as run-off.

Another useful function of trees is that their canopies shelter the forest floor from erosion by heavy rainfall.

Overgrazing

Where too many animals graze on the land for too long, they trample the ground, squeezing out the air, so that it becomes compacted and absorbs less water. If the land is overgrazed, the vegetation is reduced, making the land vulnerable to wind and water erosion.

Poor methods of growing crops

Modern farm machinery ploughs the fields more deeply, breaking the soil into small particles that can easily be blown or washed away. Modern pesticides and chemical fertilizers kill the organisms that help to bind the soil together.

Urbanization

Urbanization (the building of cities, towns, and roads) speeds up erosion. Heavy machinery used in construction work compacts the soil. Buildings and roads cover land that used to be covered with vegetation. The ground in towns has mainly asphalt or concrete surfaces, which are impermeable. This changes the drainage patterns and creates run-off in places where water cannot percolate through the soil. Towns also alter wind patterns—usually increasing low-level wind speeds. This adds to wind erosion.

Run-off from urban areas carries sediment that is contaminated with oil and other chemicals. So, not only is there increased run-off to erode nearby land and flood the waterways, but polluted sediment is also deposited by this run-off.

2. The students' own reports about a wasteland area that they know, should explain what has happened to it and how they would try to put it right if they were a local governor. This should focus on how the land became degraded or eroded and the methods that could be used to improve it and prevent further damage. They should use what they have learnt from this unit.

Answers to the Skills Book**Page 33 'The effects of weathering'**

- A 1. Chemical weathering: a
 Mechanical weathering: b and d
 Organic weathering: e
 Organic and mechanical weathering: c

Page 34 'Preventing water erosion'

- A 1. The students' own ideas should include the fact that run-off water flows down the gentle slope, taking soil with it, eroding the land. The water flow could be slowed down by using run-off barriers (such as large bales of straw wedged into trenches, or thick tubes of netting filled with straw, staked to the ground to hold them in place) that stop the water flowing straight down the slope. Good drainage would also help so that water could soak into the ground.
- B 2 a) The riverbank could be strengthened and protected by riprap or gabions (which should be drawn and described as in the Student's Book, page 63).
- b) The hillside could be terraced for agriculture, or held in place by planting trees. It would be too steep for run-off barriers.
- c) The barren hillside should have run-off barriers to slow down the flow of water.

Background knowledge for the unit

The earliest settlements developed because people lived together in groups, which probably began as family groups and became extended family groups and tribes. These groups stayed together for protection from invaders, and to share work and services. They chose a location that provided for their needs:

- A good water supply: many settlements developed around water supplies in regions that are otherwise quite dry; for example, oases in deserts, and villages near water supplies in arid regions, such as the Indus Valley and the Nile Valley, where settlers found ways to adapt their lives to annual flooding because the floods provided rich farmland.
- Safety from flooding: for example villages on hills surrounded by plains, unless the floods were useful (see above).
- Protection from attacks: defensive sites are often on ground that is higher than its surroundings so that invaders could be seen approaching from a distance. Defending downhill is easier than defending uphill.
- Climate: higher land provides a cooler climate in hot regions.
- Aspect: settlements are often on the sunny side of a deep valley, especially in cooler climates. This helps in growing crops.
- Shelter: provided by hills or forests from cold prevailing winds and rain; some towns developed in a gap between areas of higher ground, for example, Quetta, which has a high altitude, but has developed along valleys high in the mountains.
- Resources: these include raw materials (such as wood, metal ores, or coal) that are important for industry, especially where the materials are heavy, bulky, or difficult to transport.

Modern settlements depend less on these factors now that water supplies can be piped for long distances and essential items can be transported more easily.

Settlements also develop around activities:

- Trading centres have grown up at the junctions of natural land routes or where routes meet rivers. Examples include towns and villages along the ancient Silk Route. This often led to the development of roads, railways, and canals. An example is Quetta, which developed on the Bolan Pass, which used to be the only way through the mountains from Central Asia to South Asia.
- Trading centres have also grown up along coasts, especially at natural harbours or the mouths of rivers where ports developed: examples include Gwadar, in Pakistan, and Liverpool, in the UK.

The purposes of settlements have changed: for example, many ports, such as Karachi, have become industrial and commercial centres; resorts in attractive locations not far from cities have promoted the development of the tourism industry.

Settlements can also be classified according to:

- size and services: but there are variations in the ways in which geographers classify settlements by size and services.
- shape depending on the location: for example, along a road or river a settlement has a natural linear or ribbon shape; a settlement that has developed around crossroads or bridging point over a river has a clustered or nucleated shape; a rural settlement, consisting mainly of farms, is dispersed, or may even be classed as isolated—where single dwellings are far from others.

Before we proceed

This unit helps the students to develop an understanding of the factors that determine the locations of settlements, the extent to which they develop, their purposes, shapes, and the natural and human influences that change them.

Expected learning outcomes

Students should be able to:

- compare settlements of different sizes and explain how and why they developed
- give a simple explanation of the factors that affect the layouts and shapes of settlements
- investigate their own settlement and describe its layout, development, and purpose
- explain the causes of expansion of some settlements into large cities
- explain the interactions between settlements

PAGES 72-74

***'What is a settlement?';
'Services'; 'The influence of
a settlement'; 'Megalopolis
(or mega city)';
'Conurbation' and
'Metropolis'***

Resources

- Skills Book pages 35–36 'The settlements hierarchy'
- *Oxford School Atlas for Pakistan* for population maps of different countries, or online access to population maps
- a map of the United Kingdom that shows the main towns
- a physical map of the United Kingdom
- a map of Pakistan that shows the main towns
- a physical map of Pakistan

Introduction

Ask the students to name some different types of settlement. If necessary, explain 'settlement' as 'a collection of people and their homes, and the services they need'. You could start them off with 'town'. At this point they may not know all the terms that will be introduced in this unit such as conurbation, megalopolis, or megacity, but should have heard the terms village, hamlet, town, city, and perhaps, metropolis.

Activity

Ask the students to work in pairs to arrange the completed list in order of size. They could then share this as a whole class, and give descriptions of the different settlements they named. Invite them to suggest distinctions between village/town, town/city, and so on.

Using the Student's Book

The students should now read page 72–74 of the Student's Book 'What is a settlement?' including the settlements hierarchy diagram and 'It's a fact'. Ask them where they would place their own settlement on the settlement hierarchy, and to explain how they decided. They could carry out the same exercise for other settlements they know, or know about. Discuss any they found difficult to place (perhaps because they needed extra information, such as population figures).

They could copy the settlement hierarchy into their notebooks, ready to add examples as they work through this unit.

The students should now read the sections on page 73 headed 'Services' and 'The influence of a settlement', and describe the two settlements shown in the photos. Ask them to locate London and Hexham on a map of the United Kingdom. They could also look at a physical map, which might help them to suggest why the two settlements developed in these locations. (London began as a port and trading centre. It is close to mainland Europe and so had good access to Europe and beyond. There is a greater population density in south-eastern parts of the UK than in the north. Hexham developed near a river crossing and became a market town. The population of the surrounding area has a low density, so its influence is not great, as people who live farther away than

about 50 kilometres are nearer to cities such as Carlisle, Newcastle, or Durham.)

The students should then read the sections on page 74 headed 'Megalopolis' and 'Conurbation'. Ask them to locate the megacities Manila, in the Philippines, and Gauteng City Region, in South Africa, on a map of the world and to consider how far the influences of these megacities extend, and for what. This might require further research for homework or during another lesson.

They could also locate Karachi, Rawalpindi, Islamabad, and Faisalabad on maps of Pakistan, and on a world map, and to comment on the influence of these settlements. Which regions come into the range of influence of these settlements? They should consider where visitors come from and for what, and how far the influence of these settlements might reach beyond Pakistan, how, and for what. (For example, via various forms of transport and via the Internet for trading.)

They should then answer Questions 1 and 3.

Using the Skills Book

The students should be able to complete the activity on pages 35–36 'The settlements hierarchy' using information from page 72 of the Student's Book to help. The questions in section B require them to explain their answers.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how settlements can be classified according to their size and services.
- I learned about some large settlements on different continents and in Pakistan.
- I learned about the influence of settlements and why large settlements influence a large area.

PAGES 74-75

'Settlements in Pakistan' and 'Quetta; A city'

Resources

- political and physical maps of Pakistan

Introduction

Point out that people often use the words 'town' or 'city' for any large settlement, and remind the students of the terms they learnt from the settlements hierarchy.

Using the Student's Book

Ask for examples of large settlements such as a megalopolis or megacity, a conurbation, and a metropolis in Pakistan. Tell them that they are going to learn about other types of settlement in Pakistan, beginning with a large city. Ask them to name any large cities in Pakistan. Examples include Quetta, Muzaffarabad, Hyderabad, Lahore, Rawalpindi, Karachi, Bahawalpur, Sargodha, Sialkot, Larkana, Sukkur, Gujrat, and Mardan.

They can refer to the settlements hierarchy on page 72 to find the population range of large cities as defined by many geographers. (300,000 to 1 million)

Explain that they are going to find out how Quetta developed and how its location affected this. Ask where Quetta is. They should know that it is the capital city of Balochistan. Ask them to find Quetta on a map of Pakistan, and to describe its location. They should now read about Quetta on pages 74–75, and look carefully at the map and photographs.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how a large city developed in Pakistan.
- I learned how the shape of Quetta was influenced by the landscape.

- I learned that Quetta developed because it was on an ancient trade route.

PAGE 75

'Kotri: a large town'

Resources

- political and physical maps of Pakistan

Introduction

Ask the students to name any large towns near to where they live. They should check the definition of a large town on page 73, but remind them that people often refer to large towns as cities, and sometimes call smaller cities towns. Explain that they are going to find out about the large town Kotri, and ask if they know where it is. They should locate Kotri on a map of Pakistan. Ask them to describe its location, including the province it is in, the land, and any geographical features they can find, for example, mountains, lakes, plains, rivers, roads, and railways.

Using the Student's Book

Ask the students to read page 75. Explain that Kotri has developed on flat land on the banks of the River Indus, near a port called Jhirk, and that it has developed at a meeting place for transport: ships, railways, and roads (now including the N5 and N55 motorways and the M9 Hyderabad bypass). Kotri is situated close to Hyderabad and this proximity to a large settlement should provide trading links.

Ask about the advantages and disadvantages of a settlement being located on low, flat land near a river. (Flat land on the rich soil of the Indus flood plain is good, fertile farmland, providing a food supply for the settlement; it is easy to build roads, railways, and buildings on flat land; however, flat land near a river can flood.) Ask what they have found out about Kotri Barrage on this page. (The Kotri Barrage is used for controlling the flow of the Indus.)

Ask about the main differences (other than size) between the settlements of Kotri and Quetta.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how a settlement near a port can develop into a large town with many services.
- I learned how flat, fertile land and good transport links can help a settlement to grow.

PAGES 75-76

'Rasool Pur—a village'

Resources

- *Oxford School Atlas for Pakistan*
- city maps of Pakistan
- If possible, access to the Internet to watch an informative video on 'Rasool Pur'

Introduction

Ask the students to name any villages near where they live. They should check the definition of a village on page 73. Ask how a village differs from a town. (It has a smaller population, fewer buildings, and fewer services.) Tell them that they are going to find out about a village in Punjab named Rasool Pur. Explain that, although its population has now reached 3000, and it has primary and high schools, and a range of shops and other services, it is still called a village.

Activity

If possible, allow time for the students to watch a video on the Internet about Rasool Pur, and invite their comments about life there. Otherwise, ask them to watch it at home under the supervision of an adult and have a discussion about it in class. They should note the absence of crime and the cleanliness of the streets. They could describe how life in Rasool Pur differs from life in a city such as Karachi, Quetta, or even a large town such as Kotri.

Using the Student's Book

Ask the students to read pages 75–76. Ask them to describe its location, including the province it is in, and the land. Ask about the advantages and disadvantages of living on low, flat land. (It is easy to build roads, railways, and buildings on flat land, but if it is near a river, it could be flooded.)

Ask about the main differences (other than size) between Rasool Pur, Kotri, and Quetta.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about life in a rural settlement in Pakistan.
- I learned about the work of some of the people of Rasool Pur, a village in Punjab.

PAGE 76

'Siddique Roonjho—a hamlet'

Resources

- *Oxford School Atlas for Pakistan*
- city maps of Pakistan

Introduction

Ask the students to name any hamlets near where they live. They should check the definition of a hamlet on page 73. Ask how a hamlet differs from a village. (It has a smaller population, fewer buildings, and fewer services.) Tell them that they are going to find out about a hamlet in Sindh named Siddique Roonjho. Explain that it has no services such as schools, shops, or businesses.

Using the Student's Book

Ask the students to read page 76, and to look at the photos of Siddique Roonjho. They should find out that the village developed in a place that had a water supply and that the people who settled there migrated from the Indus Delta because the water supply there became too salty.

Ask them to describe the differences between Siddique Roonjho and Rasool Pur, and to comment on the lives and work of the people of Siddique Roonjho, and the problems they face.

The students could discuss why the people of Siddique Roonjho stay there with such a difficult way of life: months with no water supply, no schools, and where one has to make a long and difficult journey to the nearest medical centre and shops. If necessary, point out that it can be hard for people to leave their homes, whatever difficulties they face; they try to overcome problems in order to stay.

They could also discuss the ways in which they think the problems faced by the people of Siddique Roonjho could be put right, and whether (and why) this should be done—and whether any organization should take responsibility. Draw attention to the fact that their water shortage is caused by the lack of fresh water from the Indus River—mainly due to the building of barrages.

Ask what factors influenced the building of many settlements. They can then read 'It's a fact', and identify any factors they think influenced the building of any of the settlements they have studied in this unit.

Activity

Ask the students to work in groups on a role-play where local government officials try to persuade the people of Siddique Roonjho to leave their settlement and go to Karachi, where they will have a better water supply, more services, and so on. Different students could take on the roles of government officials, men from the village, and women from the village.

They can then complete Questions A2 and E.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned some factors that makes places good locations for settlements.
- I learned some of the factors that cause settlements to change or become disused.

PAGES 76-77

'What makes a situation suitable for settlement?'**Resources**

- *Oxford School Atlas for Pakistan*
- map of the world
- Skills Book page 37 'The sites for settlements'

Introduction

Remind the students that they have learnt about some of the factors that make places good sites for settlements. See if they can remember these. Write each factor they suggest and compare them with those listed in 'It's a fact' on page 77. They could copy these into their notebooks for future reference.

Using the Skills Book

Rather than complete the Skills Book activity after reading the Student's Book, ask the students to work on this first, to encourage them to use discussion skills to develop their geographical knowledge and understanding. This also provides an opportunity for them to assess their own learning.

Ask the students to work in pairs. They should look at the map on page 37 of the Skills Book and decide on the best places for early (rather than modern) settlements, referring to their list of factors for good settlement sites, before writing their answers.

Using the Student's Book

Ask the students to read pages 76–77 'What makes a situation suitable for settlement?' They should then look at their answers to the Skills Book activity and decided whether these could be improved. This is a useful opportunity for self-assessment.

Ask them to suggest some natural factors that made Karachi a good site for settlement, and factors that helped it to develop into a city, and

then a large metropolitan area. They should list these, and will be able to find out more as they work through this unit.

They can then complete Question D. For section B, they will need the *Oxford School Atlas for Pakistan* or a map of the world on which they can locate the settlement they choose.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned more about the factors that make places good locations for settlements.
- I learned how Karachi developed as a settlement, from a fishing village to a metropolitan area.

PAGES 77-79

'The functions of settlements' up to and including 'The pattern of settlements'**Resources**

- *Oxford School Atlas for Pakistan*
- Skills Book page 38 'The patterns of settlements'
- Skills Book pages 39–40 'The functions of settlements'

Introduction

Explain that settlements often have a function or purpose, as well as being a collection of homes, but that this function sometimes changes over time: use Karachi as an example. Elicit what its first function was (fishing port), and what its function is now (still a port, but also an industrial and commercial centre).

This lesson could be spread over two teaching sessions where appropriate.

Using the Student's Book

Ask the students to read the sections on pages 77–78, 'The functions of settlements', 'Market town', 'Port', 'Industrial town' and 'Resort', to find out about the main functions of settlements. They should locate each settlement using the *Oxford School Atlas for Pakistan*. Ask them to close their Student's Books, then ask what the first functions of Amboise (France), Khewra (Punjab), and Malam Jabba (Khyber Pakhtunkhwa) were. They should also be able to explain how and why the functions of each of these settlements has changed.

The students could also be asked to name other settlements whose functions are: a) port b) industrial town c) market and d) resort.

On a board or flipchart, draw the diagram of settlements on page 79, but omit all features except for the buildings. Add the heading for each type of settlement: nucleated (cluster), linear (ribbon), dispersed, and isolated. Ask the students to look at the nucleated settlement diagram and see if they can explain what geographical features could have led to the development of a settlement with this shape. (a central point, such as a harbour, market, meeting place, or religious centre). Repeat this for the other types of settlement. Then ask the students to look at the diagram on page 78 and compare it with their answers.

They can then complete Question B.

Using the Skills Book

Skills Book page 38 'The patterns of settlements' should be completed first, and then the students' work could be checked, before they decide which settlements to choose for the activity on Skills Book pages 39–40 'The functions of settlements'.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned why settlements develop in specific types of shape and layout.
- I learned that settlements have a function and how this function can change.

PAGES 79–80

'Planned settlements'

Resources

- *Oxford School Atlas for Pakistan*
- If possible, access to the Internet

Introduction

Explain that the settlements they have learnt about so far developed naturally, but that some settlements are planned; instead of building homes and other buildings when they are needed, in places that are available, the layout of the settlement is planned. Ask if they can think of any planned settlements. They should know about Islamabad, the capital city of Pakistan. Ask if they know of any much older settlements in Pakistan. They should know, from their social studies lessons, about the Indus Valley settlements Harappa, Lothal, and Mohenjo-Daro.

Using the Student's Book

Ask the students to read the sections on pages 79–80, 'Planned settlements'. They should be able to locate each settlement on map the world in their *Oxford School Atlas for Pakistan*, even if they are not marked, as they can find the country or region of each settlement. Ask what they notice about the layout of each planned settlement. (The roads are laid out in a grid pattern to make the best use of the land for building.)

Point out that although the Ancient Greeks built Miletus, it is in Turkey, not Greece.

Ask about the purposes of some of the planned settlements they have learnt about: capital cities, homes for workers. Ask if they can think of other purposes for which a settlement might be planned, for example, for a specific industry or craft (or collection of industries or crafts), a defensive site such as a fort or castle, a sports complex, or an entertainment centre. The students can complete Question C.

Activity

The students could use the Internet to find out more about the settlements mentioned on these pages. Allocate a different planned settlement to each group of students, and ask them to draw a sketch map of it, and make notes about its layout, how it was organized, and its purpose. Ask them to find out names of planned cities of the world for the next lesson.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about the layouts of ancient and modern planned settlements.
- I learned that settlements have a function, and how this function can change.

PAGES 80-81

'Brasilia' and 'Islamabad'

Resources

- *Oxford School Atlas for Pakistan*

Introduction

Ask the students to name as many planned modern cities as they can. List their answers, which can be checked for accuracy later. Examples (and the dates they were founded) include: La Plata, Argentina; Abuja, Nigeria (1991); Aracaju, Sergipe, Brazil (1855); Ankara, Turkey (1923); Austin, Texas, USA (1839); Belmopan, Belize (1970); Bhubaneswar, India (1948); Dhaka, Bangladesh (1971); Brasilia, Brazil (1960); Canberra, Australia (1927); Chandigarh, India (1966); Gandhinagar, India (1960); Indianapolis, Indiana, USA (1825); Islamabad, Pakistan (1960); Jefferson City, Missouri, USA (1821); Jhongsing, Taiwan (1955); New Delhi, India (1911); Ottawa, Ontario, Canada (1857); Quezon City, Philippines (1948–76); Washington D.C., USA (1800); and Wellington, New Zealand (1865).

Using the Student's Book

Tell the students that this lesson will focus on two planned capital cities: Brasilia and Islamabad.

Beginning with Brasilia, ask the students to look at the map of Brazil in their *Oxford School Atlas for Pakistan*, and to compare the locations of the old capital, Rio de Janeiro, and the new capital, Brasilia.

Ask them to read about Brasilia and to look at the photos to find out why a new site was chosen for the capital city, and how the city was organized.

Then ask about the purpose of this new capital and what made this location good; also about any problems about the location, and how these were solved. Ask why unexpected migration happened there. (The city was planned to house government authorities and their staff, but many of the construction workers stayed there after their work was complete, and many other people migrated there to find work, so its population became much larger than expected.)

The students could focus on the way in which the city is organized and comment on whether they think having different sectors for different purposes is a good idea, or not, and why. Ask how the Monumental Axis affects the city.

Ask the students if they think Brasilia looks a pleasant place to live, and why.

They can then read about a similar process that took place in Pakistan—the building of a new capital city, far from the old one.

Ask them to read about Islamabad and to look at its photo, and a map of Pakistan in their *Oxford School Atlas for Pakistan*, to find out why a new site was chosen for the capital city and how the city was organized.

Then ask about the purpose of this new capital and what made this location good; also about any problems about the location, and how these were solved.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned some of the reasons why new capital cities are planned.
- I learned how sites are chosen for planned capital cities, and how they are organized.

PAGES 81-82

'Settlement for workers'**Introduction**

Explain that this lesson will focus on settlements that were planned to provide homes for workers for a particular business. They will learn about a settlement in the north of England, which was named Port Sunlight because the company that built it was a soap manufacturer that produced a soap called 'Sunlight'.

Using the Student's Book

Ask the students to read pages 81–82 about Port Sunlight and to look at the photo. Ask them about the good and bad points of the site. (The site was near the company's factory. It had good road, rail, and canal links to other parts of the UK, especially the nearby cities of Manchester and the port of Liverpool. Sea transport was useful in the late 19th century because this was before air travel.) The land is flat, which is good for building, but it was marshland. Ask the students why marshes were less of a problem in 1888 than they were in ancient times. (More modern technology, after the Industrial Revolution, made it easier to drain them.)

The students could comment on how the planners of Port Sunlight tried to provide a pleasant environment for the workers, and how they tried to influence how they spent their time. (The layout had plenty of open spaces and parkland, with a hospital and schools as well as a leisure centre, art gallery, and a church.)

Ask why the population of Port Sunlight has shrunk, rather than increasing, unlike most settlements.

Activity

Invite students to work in groups to discuss how an industry in their region might plan a settlement for its workers. They should consider the ways in which it might be like Port Sunlight, as well as the differences. They can then write an explanation of their ideas, and draw labelled sketches and maps.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about a small planned settlement in England, and considered how to plan a settlement for workers in Pakistan.
- I learned how settlements can be planned to give workers a healthy and pleasant life.

PAGES 82-83

'Mombasa: a large settlement in Kenya, Africa'**Resources**

- an outline map (or several small outline maps) of Africa with no countries or towns named

Introduction

Explain that this lesson will focus on a settlement in Africa, then display a large outline map of Africa (or give each group of students a smaller outline map to share), and ask them if they can locate Kenya on this map. They could mark where they think it is. Then let them check, to see how close they were in their *Oxford School Atlas for Pakistan*.

Using the Student's Book

The students should read the section on pages 82–83 headed 'Mombasa: a large settlement in Kenya, Africa' to find the answers to the following questions:

- What size settlement is Mombasa? (They should refer to the settlements hierarchy on page 72.)
- What factors made this a good place for a settlement?

- What shape or layout of settlement might the early settlement of Mombasa have had? (They should explain their answers.)
- What was the purpose of this settlement?
- What new purposes did it develop, and what factors helped?
- Is it a natural or planned settlement?

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about Mombasa in Kenya: the size and type of this settlement, and its purpose.
- I learned about the factors that helped Mombasa to develop from a fishing village to a large industrial settlement.

PAGE 83

'Naro Moru: a small settlement in Kenya, Africa'

Introduction

Explain that they are now going to find out about a small settlement in Kenya, called Naro Moru. Ask them to consider, while reading about this settlement, why it developed as a small settlement, rather than a larger one like Mombasa.

Using the Student's Book

The students should read the section on pages 83 headed 'Naro Moru: a small settlement in Kenya' to find the answers to the following questions:

- What size settlement is Naro Moru? (They should refer to the settlements hierarchy on page 72.)
- What factors made this a good place for a settlement?
- What shape or layout of settlement might the

early settlement of Naro Moru have had? (They should explain their answers.)

- What was the purpose of this settlement?
- What new purposes did it develop, and what factors helped?
- Is it a natural or planned settlement?

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about the Naro Moru in Kenya: the size and type of this settlement, and its purpose.
- I learned about the factors that helped Naro Moru to develop.

Answers to assessments

- A 1 a) hamlet, village, town, city, metropolis, conurbation, megalopolis
- 2 a) Islamabad (metropolis, but combined with Rawalpindi—a conurbation)
- b) Siddique Roonjho (village)
- c) London (conurbation)
- d) Quetta (large city)
- e) Kotri (large town)
- f) Rasool Pur (small town)
- g) Faisalabad (metropolis, but becoming a conurbation)
- 3 a) water supply, safety from flooding, defence, aspect, shelter, trading, resources
- b) raw materials for industry, a nearby port, good land transport, an attractive setting
- B 1 a) nucleated/cluster b) linear/ribbon
- c) dispersed d) isolated
- C 1 a) Mohenjo-Daro, Sindh, Pakistan
- b) Miletus, Turkey
- c) Port Sunlight, England
- d) Islamabad, Pakistan, and Brasilia, Brazil
2. They are inland, rather than on the coast. There were no existing inhabitants. They had a water supply.
- 3 a) land suitable to build on, good transport links to nearby settlements, national cities, and international destinations.
- b) Answers will vary.
- D 1. Answers will vary, but should include: the natural harbour for fishing and trade; flat land for farming and building; river for a water supply, transport and fishing; gently sloping hills to higher ground for safety from flooding; a cooler climate than other nearby places; more fertile than nearby desert regions.

- 2 a–b) Being near the coast and a river, Karachi was ideally placed for transport for trading. This drew in more settlers, and opportunities for industries to develop, making use of materials that were traded there and serving the local population. It developed into an industrial centre. Roads and railways, and later an airport, were not difficult to build on the flat or gently sloping land. So Karachi’s influence grew to become national, and then international.
- 3 a–b) Answers will vary, but the students should refer to their previous learning about different settlements included on pages 77–78 of this unit: Frankfurt Rhine-Main (Germany), Greater Boston (USA), Faisalabad (Pakistan), Greater Manchester (UK), or Rabat-Salé (Morocco).

- E 1 a) the students’ own discussions
- b)

Life in Siddique Roonjho	
Advantages	Disadvantages
<ul style="list-style-type: none"> unpolluted air—which is not found in a city a better water supply than the villagers had in their old settlement flat land for farming; supplies of fish and wood 	<ul style="list-style-type: none"> an unreliable water supply having to travel to buy expensive bottled water hardly any services like schools or hospitals far from shops and other services

- 2 a) Answers will vary, but should take into account the villagers’ skills, and what work they might find, whether they would easily find somewhere to live (and be able to afford it), whether they would be happy in a city, and so on.
- b) They might gain an income and a more secure water supply and other services, such as medical help, schools, and shops. They might lose their sense of community, traditional skills, and way of life, and their freedom to organize their community.

3 a) Answers will vary, but should compare:

- education (Rasool Pur has schools, and everyone is literate; Siddique Roonjho has no school, and children do not travel to schools in other settlements because of transport difficulties; no one in Siddique Roonjho can read or write.)
- whether the child has to work (They go to school in Rasool Pur, but not in Siddique Roonjho, so they might work to help their families.)
- play (Children have opportunities and safe space to play in both settlements.)
- travel (Many families in Rasool Pur have some means of transport; people depend on the few fishing boats in Siddique Roonjho; Rasool Pur has good road links to nearby towns, but Siddique Roonjho does not.)
- Children have opportunities to learn how to read or write in a town like Rasool Pur. (In Siddique Roonjho, children learn traditional crafts, how to survive using anything they can find for building homes and making them comfortable, also some learn about fishing; in Rasool Pur they have opportunities to learn about caring for useful animals such as poultry, as well as local trades and crafts.)
- medical and dental care (There are medical facilities in Rasool Pur but not in Siddique Roonjho, where people have to make journeys that can take seven hours to Karachi.)
- the child's future work and life (Children in Rasool Pur have more opportunities because of their education; they also have a better chance of continuing to live in their settlement; those in Siddique Roonjho have fewer opportunities because of their lack of education, and difficulties about water supply, land, and

transport might cause problems for the survival of their settlement.)

b) Answers will vary, but should compare:

- education: Quetta is a city with many schools and higher education, but Siddique Roonjho has no school, and children do not go to school because of difficulties with transport.
- whether the child has to work: in Siddique Roonjho, children might have to work to help their families, however, many city children work, too.
- play: children have opportunities and safe spaces to play in Siddique Roonjho; Quetta has parks; but in some parts of Quetta, like other cities, outdoor play might not be so safe due to heavy traffic and other reasons; also, in cities like Quetta, many poor people live in slums, but a small rural settlement like Siddique Roonjho, there are no slums.
- travel: There are no roads or transport facilities in Siddique Roonjho; however, Quetta has a grid system of roads around the city, as well as road, rail, and air links to other cities and countries.
- what they might learn that town or city children would not learn: In Siddique Roonjho, children learn traditional crafts, how to survive using anything they can find for building homes and making them comfortable, also some learn about fishing; in Quetta they have opportunities to study and to visit museums, art galleries, and so on.
- medical and dental care: These are found in Quetta but not in Siddique Roonjho, where people have to make journeys that can take seven hours to Karachi.
- the child's future work and life: Children in Quetta have more opportunities because of their education; they also have a better

chance of continuing to live in their settlement, or to travel to other places for work; those in Siddique Roonjho have fewer opportunities because of their lack of education, and difficulties about water supply, land, and transport might cause problems for the survival of their settlement.

- 4 a) Answers will vary, but should take into account the unreliable water supply, and the land and resources that are available (e.g. fish, but if the water in the Indus Delta continues to become more saline, or pollution increases, this could affect the fish); transport; land for farming, and building.

- b) wet point: a supply of water in a dry region

resources: close to where natural resources could be found (fish)

- F 1 a–c) Answers will vary, depending on where the children live.

Answers to Skills Book

Pages 35–36 'The settlements hierarchy'

- A 1. The students should have completed the diagram as it appears on page 72 of the Student's Book.
2. Siddique Roonjho—hamlet
Islamabad/Rawalpindi—conurbation
Mega Manila—megacity or megalopolis
Faisalabad—metropolis
Rasool Pur—village
Quetta—large city
Kotri—large town
- B 1. The settlements were classified according to their populations and the services they have.
2. There are fewer people to use the services.
3. They provide a greater range of services, especially services that cannot be found in smaller settlements.

Page 37 'The sites for settlements'

- A 1. Students should mark four ideal sites for early settlements. Good choices for a) to d) can include:
- a) on the bay, on the coast, near the streams: sheltered harbour for fishing and trading; a track, so there is a useful route to other places; nearby woods for fuel and building materials; river or streams for a water supply and fish; flat land for farming and building
- b) in or near the woods by the river: water supply and fish for food; river—possible boat transport and fish; trees for shelter; wood for fuel and building materials; flat land for farming and building; a track providing a route to other places (The woods in the north-east might not be so good—there might not be a water supply, although they would provide shelter and there is a track leading to other places.)

- c) near the woods in the south-west; wood for fuel and building materials; food supply—fish from the sea or streams; water supply; shelter (woods and mountains); track—route to other places; sea for fishing
- d) where three routes meet near the river: water supply, nearby woods for fuel and building materials; food supply—fish; some flat land for farming and building on; a possible trading or marketplace
- e) on the plateau near the centre of the map: a high point—good for defence; water supply from stream; flat land for farming

Page 38 *'The patterns of settlements'*

- A 1. The students should have drawn two examples of each of the following types of settlement, to match those shown in the diagram in the Student's Book page 78:
- a) nucleated b) linear
 - c) dispersed d) isolated
2. Answers will vary. The students should have named each settlement they drew on the map to match the function it might have.
3. Answers will vary. The students should have listed the settlements they drew (by name) and explained why they developed in these patterns: for example, along a road, a river, or a valley; around a central point such as a harbour, market, meeting place, or religious centre); around a bridging point in a river; around a place where routes meet; scattered around in small farms on agricultural land; single families living far apart because of their work (such as forestry or on large farms).

Pages 39–40 *'The functions of settlements'*

- A 1. Answers will vary. The students should have drawn two examples of the settlements they drew on the previous page.

- 2 a) Answers will vary.
b) Answers will vary.
- B 1. Answers will vary.

Background knowledge for the unit

Agriculture means keeping animals and cultivating plants and fungi, for food, fibre, fuel, medicines, and other products. Agriculture began when people started to live in fixed settlements.

Foods include cereals (grains), vegetables, herbs, spices, fruit, oil, and meat, and other animal products such as eggs and milk. Fibres include cotton, wool, hemp, silk, and flax. Raw materials include wood, bamboo, rubber, oil, and resins. Materials from plants are also refined for use as dyes, drugs, perfumes, and biofuels; and plants are also grown for decorative use, as indoor pot plants, for gardens, and for cut flowers.

Agriculture provides employment for more than a third of the world's working population. In Pakistan, around 43% of the population were employed in agriculture in 2014–15.

The websites of the World Bank and FAO (Food and Agriculture Organization, a department of the United Nations) provide interesting statistics about agriculture: www.worldbank.org and www.fao.org. For example, the percentage of the world's land that is used for agriculture, including the percentages for different countries, and the changes over time.

In 2013, 37.7% of the world's land was used for agriculture. The highest percentage for any country was 82.1% in Uruguay. The second highest in 2013 was Saudi Arabia with 80.6% of land being used for agriculture—a sharp rise from 1961 (40.1%), mainly because of a government restructuring programme for agriculture during the 1970s and 1980s, which developed irrigation and desalination, promoted the use of chemical pesticides and fertilizers, and introduced subsidies for farmers.

In 2013 the area of Pakistan's agricultural land was 47.1%—an increase from 46.3% in 1961.

Before we proceed

In this unit students learn about different types, systems, and methods of agriculture, and develop an understanding of the ways in which the shape of the land, the underlying rock and soil, and the climate influence agriculture in different places. The students learn about the importance of agriculture to Pakistan's economy, including the different types of agriculture and how they are suited to different regions, building on their understanding of weather, climate, and landforms. They use maps, photographs, and tables to explore Pakistan's place in world agriculture. The students also learn about the uses of plant and animal products, and about the ways in which many of these are being developed in the interest of protecting the environment as well as supplying a growing population.

Expected learning outcomes

Students should be able to:

- give an outline explanation of the main methods and types of agriculture: subsistence, intensive, organic, arable, livestock, forestry, and fishing
- name the world's main agricultural products
- identify the factors that influence the type of agriculture that is suitable for any location
- identify the factors that influence the farming methods used in any location
- explain how agriculture affects the environment
- explain how safe farming methods can protect the environment

PAGES 86–89

'What does agriculture mean?'; 'Different methods of farming'; 'Organic farming'; 'Arable farming'; and 'Wheat'

Resources

- *Oxford School Atlas for Pakistan*
- Skills Book pages 41–42 'Different types of agriculture'
- Pictures of, or actual, everyday items some that are made from agricultural products and some that are not: for example, clothing made from cotton, linen, and synthetic fibres, shoes made from leather, plastic, and rubber; foods (including meat, fish, ice cream, nuts, pasta, rice, and spices); items made from wood, bamboo, and paper.

Introduction

Invite the students to share any knowledge they have of agriculture. This might be very limited if they live in a city and have not visited rural areas. The students could list any plants they know about that are agricultural crops. Also ask them to list livestock animals that they know about.

Activity

Ask the students to sort the pictures or everyday items into two sets: those made from agricultural products and those that are not. They could set aside any they are not sure about.

Then ask what each item is made from. Tell them any they do not know, and ask if that material comes from agriculture. Then point out any that are wrongly sorted and explain why. Tell them that forestry and fishing are usually included with agriculture, and that agricultural crops and animals are kept for other products as well as food.

Using the Student's Book

Ask the students to make their own mind maps to link some of the animals and plants to the items they sorted. They should keep their mind maps for later reference, to help them to assess what they have learnt from this unit.

Invite the students to give a definition of agriculture. They should make a note of this before beginning to read the Student's Book. Ask them to look at the diagram on page 86, and to compare this with their original ideas about agriculture. They can then read pages 86–89 'What does agriculture mean?' and 'Different methods of farming', 'Organic farming', 'Different types of agriculture', 'Arable farming' and 'Wheat', including the 'It's a fact'. They should also look at the photos and maps on these pages.

Ask about the differences between subsistence and commercial farms. Then ask how organic farming differs from other types of farming. In small groups, they could discuss the advantages and disadvantages of organic farming, and why organic farming is only practised by a minority of farmers.

Invite a volunteer to explain what is meant by a cereal crop and a staple food. (a grass grown for the food from its grain, and a food most people eat every day, respectively) They should be able to give some examples of foods made from wheat, such as bread, pasta, cakes, and biscuits.

Ask them to name the world's leading wheat producing countries (China and India). Also ask which parts of Pakistan are the main wheat growing areas, and what makes them suitable for wheat farming. (Punjab and Sindh, because they have the right conditions for wheat: there is plenty of flat or gently sloping land, rich soil from the Indus, plenty of sunshine and warm weather, and although they do not have enough rain, they have good irrigation systems.)

Ask the students to explain what is meant by kharif and rabi crops, and to give examples of each. Point out/ elicit that being able to plant these winter and summer harvest crops enables arable farms in Pakistan to have two good crops each year.

They should then answer Question A1.

Using the Skills Book

Ask the students to complete pages 41–42 ‘Different types of agriculture’. This activity provides a summary of some of the main vocabulary introduced in the first section of this unit. The students should be able to begin the crossword for homework. They may need to leave out some answers until they have completed later sections of this unit.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about different types and methods of farming.
- I learned why wheat is the world’s main food crop and about the main wheat growing countries.
- I learned why wheat can be grown in some regions but not in others.

PAGES 89–93

‘Rice’; ‘Cotton’; and ‘Sugar cane’

Resources

- *Oxford School Atlas for Pakistan*
- Skills Book page 43 ‘Arable farming’
- Skills Book page 44 ‘Products from crops’

Introduction

To recap the previous lesson, ask the students to explain why a great deal of wheat is grown in Punjab and Sindh. They should be able to explain that these provinces have plenty of flat or gently sloping land with rich soil, and a climate that is warm and sunny, as well as irrigation canals. Ask if they can name Pakistan’s second most important cereal crop (rice), and if they know where it is grown (north-eastern Pakistan).

Using the Student’s Book

Explain that they are going to begin by finding out about the rice growing regions of the world and why they are suitable for growing rice. They should then read pages 89–91 of the Student’s Book ‘Rice’ and look at the map and pictures to find out more. Point out that rice needs these conditions while it is growing, but the land needs to be dry for the harvest.

Ask whether rice is a staple food; they should know the meaning of this term from the previous pages. They should also be able to describe the conditions needed for growing rice and to explain why the countries marked on the map are the world’s main rice-growing countries, and what makes north-eastern Pakistan suitable for rice-growing.

They can then complete Questions A2–3 and B1–4.

Tell the students that the next crops they will learn about are cotton and sugar cane—another two important crops around the world, and important cash crops for Pakistan. Explain/ elicit that a cash crop is a crop grown for making a profit, not just for the farmer’s own use, so it is not a subsistence crop. Pakistan’s textiles industry grew because of the large supply of cotton grown in the country.

Also point out that sugar cane is grown as a food crop, but cotton is not, but they might be surprised to learn about the non-food products of sugar cane and the food products from cotton.

The students should now read pages 91–93 of the Student’s Book ‘Cotton’ and ‘Sugar cane’, including the information in the charts, diagrams, maps, and pictures.

Ask what makes southern Punjab and central Sindh good cotton-growing areas. (Their climates protect the plants from disease-carrying pests, the hot summers are perfect for cotton plants, and, although the rainfall is too low, irrigation is good.) Also, cotton can survive in quite saline (salty) soil, so the saline soil that is found in many parts of Pakistan is not a problem, unless it becomes too saline. Cotton crops can survive short droughts so the dry seasons are not a problem, and can be supported by irrigation if the droughts are prolonged. Ask what they notice on the map about the locations of cotton-producing countries. (They are mainly in warm climatic zones.)

The students should also be able to explain what makes Punjab and parts of Sindh, Khyber Pakhtunkhwa, and Balochistan suitable for growing sugar cane. (There is higher rainfall than in most of Pakistan, combined with good irrigation and rich alluvial soil.)

Invite them to talk about any surprising facts they have read about these crops.

Using the Skills Book

There are two pages in the Skills Books that will support the students' learning from this section of unit 9: pages 43–44 'Arable farming' and 'Products from crops'. They should be able to complete these for homework, and will need to refer to the Student's Book or notes they have made in class.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned the meaning of arable farming.
- I learned why different regions are suitable for growing different crops.
- I learned about the world's most important crops, and Pakistan's main crops.

PAGES 93–94

'Livestock farming' and 'Cattle'

Resources

- *Oxford School Atlas for Pakistan*

Introduction

Summarize the last lesson by reminding the students that they learned about the world's and Pakistan's main agricultural crops, what makes places suitable for growing them, and their products. Tell them that they are going to learn about agriculture where animals are reared. Ask if they know the word that means all animals kept for food or non-food products (livestock), and ask if they can list all the animals kept as livestock.

Using the Student's Book

Ask the students to look at the table on page 93, and to compare the list of the world's main livestock animals with their own lists. The list on this page does not include all livestock—just the main ones: for example, mules, asses, llamas, alpacas, and ostriches are not included, because their numbers are very small.

Ask them to read the section of pages 93–94 headed 'Cattle' including the diagram and table, to find out about the numbers of each animal on farms around the world, the conditions they need, and the main countries where each type of animal is farmed.

Ask them to look at the map to find the main cattle farming areas and to think about what they know about the climate and land in these regions, in order to understand why cattle are farmed there and why few are kept in some other regions of the world. They could share their ideas about this.

Ask how cattle can damage the land, and what they think could be done to minimize this damage.

They can then complete Questions C1–2.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about the different animals that are farmed around the world.
- I learned what makes cattle very useful animals to farm.
- I learned about the ways in which over-grazing can damage the land.

PAGES 94–95

'Sheep'; 'Goats'; and 'Poultry'

Resources

- *Oxford School Atlas for Pakistan*
- Skills Book page 45 'Products from livestock'

Introduction

Ask the students what animals are kept as livestock on farms in Pakistan. If any of them have visited a farm, they could tell the class about it. Tell them that they are going to find out about some of the animals farmed in Pakistan, beginning with sheep.

Using the Student's Book

Ask the students to name any products that come from sheep. They should know meat, wool, and skins—also milk and the cheese that is made from it. Point out that sheep can be good for the land, especially on mixed farms (those that also grow crops) and on farms that also have cattle, because they break up the soil, which helps seedlings to grow, fertilize the land with their waste, and eat many types of unwanted plants, including those that are poisonous to cattle, such as ragwort.

Ask them to read pages 94–95, to find out why sheep are often found on high land, with poor soil, that is not suitable for growing any crops. They will also find out about another common animal in Pakistan, the goat, and about other livestock that are common in Pakistan.

Ask which animal could easily be kept in: a) an arid region, b) a hilly area with short grass on poor soil, c) large plains.

They should also read the section about poultry, after which they could write an explanation of why and how the government of Pakistan encouraged poultry farming.

The students can then answer Question C3 and then Skills Book page 45 'Products from livestock'. They should try to do this without re-reading the Student's Book.

Using the Skills Book

To complete page 45 'Products from livestock', the students could work in groups, without looking at the Student's Book, to name as many products as they can that come from cattle, and the part of the animal or natural product they come from.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about the main types of livestock kept in Pakistan and the places that are suitable for keeping particular animals.
- I learned about the many products that come from animals.
- I learned about some of the positive and negative effects of livestock on the environment.

PAGES 95–97

'Forestry' and 'Fishing'

Resources

- *Oxford School Atlas for Pakistan*

Introduction

Ask the students what they remember from their previous work in Grade 6 about the products that come from forests, for example, timber, chipboard, firewood, charcoal, rubber, Brazil nuts and other nuts, berries, and materials for paper-making.

If they have visited any forests they could describe the type of trees they saw and anything they found out about the products and uses of the forest. Remind them that forests are useful in other important ways as well as for their products: for leisure and tourism; for shade in and around towns; for their contribution to the environment (preventing water and wind erosion; retaining moisture; providing shelter from wind and storms; and, very importantly, storing carbon, which helps to keep carbon dioxide out of the atmosphere and so reduce global warming).

Tell them that they are going to find out about the forestry industry around the world and in Pakistan.

Using the Student's Book

Ask the students to read pages 95–96, and to look at the map. Beginning with the map of the world's forests, ask them what they notice immediately about where the forests are and where the places with little woodland are. They should think about what they know about climates around the world. Large land masses in the northern hemisphere (especially northern USA, Canada, Russia, and

northern Europe) are noticeably forested, including very cold places, as are places around the Tropics (including Brazil, Peru, Bolivia, Chad, Equatorial Guinea, and the Central African Republic). Arid areas and deserts have no forests.

Ask which countries have the highest percentage of land that is forested. They should use political maps to find out which countries are shown: these include several countries in central Africa, Guinea Bissau, Congo, and Cameroun; a large area of South America, including Brazil, Bolivia, Paraguay, and Uruguay; Vietnam, Cambodia, Laos, Papua New Guinea, and Malaysia; Finland, Sweden, and Russia.

The students should now read the section on page 96–97 headed ‘Fishing’. Ask them to describe different methods of fishing. Ask what they have found out about the fishing industry in Pakistan, and what makes it important for the country. For homework they could find out more about some of the fish that are caught in Pakistan, and record what they find in the form of a scrapbook or notebook that includes drawings, photographs, and information about fish, ports, and the fishing methods used.

They can then complete Questions C4, D1–2, and E1.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about the locations of the world’s main forests and the main products of forests.
- I learned about Pakistan’s main forests.
- I learned about the fishing industry around the world and in Pakistan.

In addition to answering the assessment questions about this unit, the students could also return to the mind maps they made at the start of the unit, and make a new version, using what they have learnt. Comparing the two mind maps helps them to assess their own learning.

Answers to assessments

- A 1 a) farming to produce food for the farmer and family
 b) large-scale farming for earning an income
 c) using hand tools, and no machines or tractors
 d) using machinery and tractors
 e) using no chemical pesticides, herbicides, or fertilizers
 f) growing crops
- 2 a) It is a staple food, eaten all over the world.
 b) China

Punjab and Sindh are the main growers of wheat because of suitable climate and land. Their soil is fertile and they have a large irrigation network to supply water to their agricultural land.

- 3 a) China, because it is a very big country and has plenty of flat land and terraced valleys, with enough rain and high enough temperatures in the growing season, with warm sunshine and dry weather when the rice is ripening.
 b) North-eastern parts, because they have a higher rainfall than other parts of the country.
 c) It is an important export crop and 90% of the world’s rice is eaten in Asia.

- B 1 a) Pakistan imports more food than it exports.
 b) It means that the country produces more than enough food to feed its population.
2. It is a crop grown for making a profit, not just for the farmer’s own use.
- 3 a) any two from: Angola, Burkina Faso, Cameroun, Central African Republic, Chad, Congo (Democratic Republic), Côte d’Ivoire, Egypt, Ethiopia, Ghana, Guinea, Cuba, Kenya, Madagascar, Malawi, Mali, Morocco, Mozambique, Niger, Nigeria, Senegal, Somalia, South

- Africa, Sudan, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe
- b) any two from: Argentina, Brazil, Bolivia, Ecuador, Paraguay, Peru, Venezuela
 - c) It is a very large country, with plenty of flat land and a range of suitable climates, including places with average rainfall as well as arid and semi-arid areas, and a range of temperatures. Cotton can even be grown in the arid and semi-arid areas.
 - d) Southern Punjab and central Sindh are suitable, even though they do not have enough rain, because their arid climate protects the plants from attacks by microbes that cause disease, and pests that damage them. They have good irrigation that provides enough water to make up for the low rainfall; also, the hot summer weather is just right for the growing season.
 - e) any from: cotton textiles, cushion fillings, paper, plastics, foods such as margarine and salad oil, livestock feed, soap, floor coverings, humus for agricultural land, paper, chipboard, biomass fuel, and disposable cups and plates
 - f) Answers will vary. They could include: lint (fibre) for making cotton textiles; the short fluff on the seed for making cushion fillings, paper, plastics, and other products; cotton seed oil for making margarine and salad oil; meal from the seeds in livestock feed; other leftover materials for making soap and floor coverings; stalks and leaves for humus, bagasse for making paper, chipboard, biomass fuel, and disposable cups and plates.
- 4 a) Punjab and Sindh, with smaller amounts grown in Khyber Pakhtunkhwa and Balochistan, because they have rich alluvial soil and good irrigation.
 - b) Eco-friendly means that is not likely to cause pollution or other damage to the environment.

- c) white sugar and gur; alcohol for the pharmaceutical industry; press mud, used in organic fertilizers for crops and in animal feed; bagasse, used in making paper and chipboard; for biomass fuel, and disposable cups and plates
- C 1 a) buffalo, camels, cattle, goats, pigs, sheep, rabbits
 - b) In addition to meat, milk, and hides, various products come from many parts of cattle; for example, fertilizer; leather for gloves, clothing and shoes; skin for drums and violin strings; and materials used in making asphalt, cosmetics, soap, plastic, medicine, insulation, tyres, china, ice cream, piano keys, chewing gum, capsules for vitamins, wallpaper paste, and candles.
 - c) Overgrazing causes the grass to become very short for cattle to graze. When cattle tramples the soil, air, water, and nutrients are squeezed out and so the grass cannot grow. The hooves of the cattle leave holes in the soil which kill the grass. These holes get filled with water and once the water has evaporated, weeds grow in these holes.
- 2 a) Cattle are mostly farmed in the temperate climatic zones. Students should be able to recall from unit 5 that the climate of temperate zones is neither too cold nor too warm. Such climate is ideal for farming cattle.
 3. any four from the following: hens, ducks, geese, turkey, quail
 4. inland fishing (lakes and rivers); fish farming (aquaculture); commercial fishing (seas and oceans)
- D 1 a) Parts of Asia and Africa have little or no forests at all. The reason for this could be that these parts lie in the arid climate zone.
 - b) Students' own answers could include Finland, Sweden, and Gabon.
 - c) The correct option is i).

- 2 a) Answers will vary. They could include paper, rubber, wood, medicine, food, etc.
- b) protecting land from soil erosion; generating income from the products of the forests; slowing down global warming
- c) An alpine forest grows on very high elevations. The unusual factor about the alpine forests in Pakistan is that they grow at or above the heights of 4000 metres above sea level.

E 1. Answers will vary.

Answers to the Skills Book

Pages 41–42 'Different types of agriculture'

A 1.

Across: (2) poultry (5) livestock (7) organic
(8) arable (9) agriculture

Down: (1) subsistence (3) commercial
(4) pesticide (6) fertilizer

B. The sentences will vary and should use each word from the crossword in a way that shows that the students know its meaning.

Page 43 'Arable farming'

A 1.

Land	Crop	Climate
gently sloping land with well-drained clay/loam soil	cotton	plenty of water in the growing season; hot weather but short frosts do not harm it
soil that is rich in nutrients	sugar cane	high temperatures (summer average around 32°C) and moderate rainfall (250 mm per year)
flat land or terraced valley sides	wheat	temperate climate; plenty of water in the growing season; sunshine in the ripening season

- 2 a) Wheat is mainly grown in Punjab and Sindh, which have plains with rich soil brought by the Indus and other rivers. They do not have enough rain, but they have one of the world's largest linked-up irrigation systems. They have plenty of flat or gently sloping land and a warm climate.
- b) Rice is grown in the north-eastern regions of Pakistan because they have more rain than the rest of the country.

(But even here the plants need irrigation to provide enough slow-flowing water in the growing season.) When the plants mature, they need less water, and while they are ripening, the fields need to be almost dry to make harvesting easy, so the region's dry weather is just right at this time.

- c) Southern Punjab and central Sindh are Pakistan's main cotton-growing areas. There is not enough rainfall, but their arid climate protects the plants from attacks by microbes that cause disease, and pests that damage them. Irrigation provides enough water to make up for the low rainfall. The hot summer weather (32°C average in June) is just right for the growing season, as cotton needs plenty of sunshine. It grows best in alluvial soil, but it can grow in places that have some salt in the soil and can survive short droughts, so it can be grown in arid and semi-arid areas.
- d) Sugar cane is a tropical plant that needs plenty of water in the growing season, and soil that is rich in nutrients. It is grown all over Punjab and Sindh, a small area in Khyber Pakhtunkhwa that has rich alluvial soil and good irrigation, and a little is grown in Balochistan. It can be grown in regions where temperatures can become quite low, and can survive short periods of frost.

Page 44 'Products from crops'

- A 1. products of the cotton plant: fibre for making cotton textiles; cushion fillings, paper, plastics, cotton seed oil used in foods such as margarine and salad oil; leftover meal from the seeds is used in feed for livestock; other leftover materials are used in soap and floor coverings; the stalks and leaves are used as humus.
- B 1. products of sugar cane: white sugar and gur, alcohol for the pharmaceutical industry, press mud, used in organic

fertilizers for crops and in animal feed; bagasse, used in making paper and chipboard; for biomass fuel, and disposable cups and plates.

- C. 1 a–b) Answers will vary. The students should describe a product from each of the plant crops mentioned on this page, saying what part of the plant it comes from.

Page 45 'Products from livestock'

- A 1. Answers should include some of the following: meat (from flesh), milk (produced to feed their young), and hides (from skin); fertilizer (from dung); gloves, clothing, and shoes, and skin for drums and violin strings (from skin and intestines); materials used in making asphalt, cosmetics, soap, plastic, medicine, insulation, and tyres (from glands and organs): china, ice cream, piano keys, chewing gum, capsules for vitamins, wallpaper paste, and candles (from bones and horns).

Background knowledge for the unit

For more than a decade, surveys and reports on the mineral resources of Pakistan have shown that the country is rich in various minerals, but that these have never been exploited to anything approaching their full potential.

In 2016 the Geological Survey of Pakistan published a report on the mineral resources of Pakistan. It reported that Punjab has large deposits of energy minerals (such as coal and oil), metallic minerals, and industrial minerals. Khyber Pakhtunkhwa was reported as having 'vast' mineral resources with 'huge prospects of different metallic and non-metallic minerals' as well as 'various precious and semi-precious gemstones and other minerals.'

The report described the rich potential of Balochistan, which is an important producer of Pakistan's minerals: more than 50 metallic and non-metallic minerals (of which 29 are being exploited), including metallic minerals such as chromite, copper, iron, lead, zinc, manganese, antimony, and gold; and non-metallic minerals, including barite, fluorite, calcite, magnesite, granite, coal, marble, granite, gabbro, and basalt.

Most of Pakistan's gemstones come from Khyber Pakhtunkhwa, but there are also known deposits in Balochistan, Gilgit-Baltistan, and FATA. Mining is mainly carried out by individuals or small groups of miners, rather than by large, commercial organizations. The gems are sold mainly in their raw form, but projects are underway to provide training in cutting and polishing stones. This hugely increases their value.

Reports such as this have now influenced the development of mines, such as those in the coalfields of Sindh. Coal seams have also been found in Punjab.

While several countries whose coal mining industries developed much earlier have closed many of their coal mines for various reasons, including their contribution to greenhouse gases, Pakistan has only just begun to exploit its coal deposits. With this development, regulations about safety in the mining industries have been introduced.

The planned development of the coal mining industry has influenced plans for the building or improvement of roads, such as roads to the coal-powered electricity generating plant in Jhelum district.

The report has influenced the plans of the Minerals Development Department of Pakistan, which has planned to introduce safety and welfare provision for mine workers, especially to protect against health problems caused by their work. The department has planned for improved water supplies for the mining regions and improved education for the children of mine workers.

Fossil fuels provide useful sources of energy, including generating electricity, but the drawbacks of burning them for energy include air pollution that can cause asthma, chronic bronchitis, and reduced lung function, as well as the greenhouse gases they add to the atmosphere, increasing global warming.

The coalfields in the Ruhr Valley in Germany developed alongside other industries. The area developed as Germany's main industrial area because of the natural resources such as coal, iron ore, and limestone, which helped the iron and steel industry to develop. Also, textile and chemical industries developed there because there were good transport links (roads, railways, and canals, and the River Rhine) and plenty of workers from the nearby towns and villages, including the cities of Essen and Dortmund. During the 1940s, iron and steel and the industries of the area were important for producing weapons and equipment for Germany during the Second World War.

Before we proceed

In this unit, the students learn what is meant by the term 'mineral'; about the appearance of many metallic and non-metallic minerals and gemstones, their uses, and how they are extracted from the Earth. They learn about mineral resources and trade around the world and in Pakistan.

The students also learn about fossil fuels and power resources around the world and in Pakistan, including coal, natural gas, and oil. They learn how fossil fuels were formed from the remains of plants and animals that lived 300 to 400 million years ago, and how they are extracted from the Earth, including the different methods of mining.

Expected learning outcomes

Students should be able to:

- name and describe some metallic and non-metallic minerals and gemstones
- describe the mineral, gemstone, and power industries in Pakistan and the rest of the world
- explain how fossil fuels were formed
- describe some ways in which minerals and fossil fuels are extracted from the ground
- identify the risks faced by miners, and how their health and safety can be protected
- compare the advantages and disadvantages of developing the mineral and fossil fuel industries

PAGES 100-101

'What is a mineral?'; 'Metal ores'; and 'Metallic minerals'

Resources

- *Oxford School Atlas for Pakistan*
- for each group of four: a set of small pieces of paper, each with the name of one of the following metals written on it: aluminium, chrome, lead, mercury, zinc, tin, titanium, iron; also a set of pieces of paper, each with the name of one of the following metal ores written

on it: bauxite, chromite, galena, cinnabar, zincite, cassiterite, ilmenite, haematite

Introduction

Ask what a mineral is. Students should know this from their previous work on rocks, minerals, and soil (unit 1). They might need to be reminded of what they learned. Tell them that they are going to find out how scientists define minerals. Explain that most metals are found in the form of ores in the ground. An ore is the raw form of a metallic mineral. It is purified to produce a metal as we know it. A few metals (such as gold) occur naturally.

Using the Student's Book

Ask the students to read 'What is a mineral?' and 'Metal ores'. Check that they know what is meant by crystals. They should remember this from their work on unit 1 and they can see a picture of a haematite (iron ore) crystal on this page. They should then read the section headed 'Metallic minerals'. To help them to interpret the world map of mineral ore deposits, they should refer to a political map of the world that has all the countries named.

Activity

The students should now close their Student's Books. Give each group two sets of papers—one with names of metals and the other with names of metal ores written on them, and ask them to match each metal to the ore it comes from. They should match the easiest ones first (those where the ore has a similar name to the metal) and then see which others they can remember.

The answers are: bauxite/aluminium, chromite/chrome, galena/lead, cinnabar/mercury, zincite/zinc, cassiterite/tin, ilmenite/titanium, haematite/iron.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned what is meant by mineral and about the mineral ores that are mined for different metals.
- I learned where the world's main deposits of metallic minerals are found.

- I learned where there are metallic mineral resources in Pakistan and where they are mined.

PAGES 101-103

**'Non-metallic minerals';
'Cement'; 'Potash';
'Phosphates'; 'Salt' and
'Gypsum'**

Resources

- *Oxford School Atlas for Pakistan*
- leaflets or information downloaded from the Internet about Khewra Salt Mines

Introduction

Remind the students what is meant by 'mineral' and ask if they can think of any minerals that are not metals. They might know about the salt mines at Khewra, and will have heard of them during their work on human settlements (unit 8). Ask them to find Khewra on a map of Pakistan, and allow a few minutes for them to read some leaflets or web downloads about the mine. They could work in groups, sharing this reading so that different students find out different information. They should make notes to help them to write a few paragraphs to read to their group. This should not take more than about 15 to 20 minutes. It could be followed by some questions for each group to answer about Khewra and salt mining in Pakistan, for example:

- Where is Khewra? (Punjab)
- When was salt first mined there? (320 BCE)
- About how much salt is in the mines at Khewra? (220 million tonnes)
- How big are the Khewra mines? (about 110 sq km)
- What is the salt used for? (mainly in the chemical industries, but some is purified for food use)
- Which other mineral is mined at Khewra? (gypsum)

- Where are the other salt mines in Pakistan? (Warchi (near Islamabad), Kalabagh on the banks of the Indus River, and Jatta (near Koh)).

Using the Student's Book

Ask the students to read pages 101–103 of the Student's Book, 'Non-metallic minerals', including the tables, and look at the pictures to find out about some of the most useful minerals and how they are used.

They could then choose one of the minerals mentioned in these pages, other than salt, and use maps to find out where it is mined. They should make notes on what they know about the mineral and what they need to find out in order to write a report about it. This can be continued for homework.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned about the uses of the main non-metallic minerals mined around the world.
- I learned where non-metallic minerals are mined in Pakistan.

PAGE 104

'Gemstones'

Resources

- *Oxford School Atlas for Pakistan*
- Skills Book pages 46–47 'All in the mines'

Introduction

Recap the last lesson by reminding the students that they learned about the main metallic and non-metallic minerals of Pakistan and the rest of the world, and that gemstones are also minerals. Gemstones are pieces of mineral crystal that can be cut, shaped, and polished, and are valued for their rarity and beauty.

Ask the students to name some gemstones, and list their responses. For each gemstone they mention, ask what colour it is, and whether they know where it can be found. Tell them that northern Pakistan is known to have very large deposits of high quality gemstones, and that geologists are sure that there are more still to be identified.

Using the Student's Book

Ask the students read the sections of page 104 headed 'Gemstones' to find out more about the different gemstones and where most of them are mined.

Ask them to close their Student's Books before presenting a class quiz on gemstones—perhaps have the students in groups of four and ask each group a question. They could record how many they get right.

Q: What colour are emeralds?

A: Green

Q: What colour are sapphires?

A: Blue

Q: Which country is the world's main supplier of opals?

A: Australia

Q: Which country is the world's main supplier of diamonds?

A: Russia

Q: Which country is the world's main supplier of sapphires?

A: Madagascar

Q: Myanmar is the world's main supplier of which gemstone?

A: Ruby

Q: Colombia is the world's main supplier of which gemstone?

A: Emerald

Q: What colour are garnets?

A: Red/brown

Q: What colour is lapis lazuli?

A: Blue

Q: Which city is Pakistan's main trading centre for gemstones?

A: Peshawar

Q: Which province does most of Pakistan's corundum come from?

A: Khyber Pakhtunkhwa

Q: Which province of Pakistan has mines for all the following gemstones: emerald, sapphire, ruby, topaz, tourmaline, garnet, amethyst, quartz, agate, turquoise, and lapis lazuli?

A: Balochistan

Using the Skills Book

Pages 46–47 of the Skills Book 'All in the mines', provides an opportunity to recap this and the previous two lessons, and to prepare for those which are to follow. Students will not yet be able to answer the questions on coal, but should read these in preparation for future lessons, when they can be answered.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned what many of the world's main gemstones look like and the main places where they are mined.
- I learned where Pakistan's gemstones are mined.

PAGES 104-106

'Gemstone mining in Pakistan'

Resources

- *Oxford School Atlas for Pakistan*

Introduction

Remind the students that although Pakistan has great resources of gemstones, the gemstone mining industry has not been developed. Ask why. They should think and discuss with their partners where the gemstones are, consider any difficulties in mining them, and make a note of some questions that may arise out of this discussion. They can then continue reading about gemstone mining in Pakistan to find the answers.

Using the Student's Book

Ask the students to continue reading about gemstone mining in Pakistan on pages 104–106. Ask if they found the answers to their questions and, if so, what answers they found. Ask how the government is trying to encourage the gemstone industry.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how gemstones are mined in Pakistan.
- I learned about gemstone trading.
- I learned about some of the positive and negative effects of mining on an area.

109 106–109

***'What is a fossil fuel?';
'Coal'; 'How coal was
formed'; 'Coal mining in
Pakistan'; 'Deep mining';
'Longwall'; 'Room and
pillar'; 'Surface mining;
and 'Safety'***

Resources

- *Oxford School Atlas for Pakistan*
- Skills Book pages 46–47 'All in the mines' (to complete from a previous lesson)

- Skills Book page 48 'Coal producing countries of the world'

Introduction

Ask what they know about fossil fuels. Perhaps they can name some. Ask why these are called fossil fuels. If necessary, explain that this is because they are formed from organisms that were once living.

Using the Student's Book

Ask the students to read pages 106–107 about fossil fuels, coal, and how coal is formed, and to look at the pictures and read the captions. They could copy the flow chart that shows how coal is formed. When they have done so, invite students to use the flow chart to explain to the class how coal is formed. Another student could describe the different types of coal, without looking at the Student's Book.

Ask the students to look at the map on page 106, alongside a political map of the world, to identify the countries that have important coal deposits. Point out that in 2014 Pakistan had more coal than most of the top ten coal-producing countries, but produces much less coal. They can read on to find out more.

Ask them to read pages 108–109.

Ask why coal was not very important for producing electricity in Pakistan. (Pakistan has numerous hydroelectricity plants.) Also ask why Pakistan is beginning to use more coal for producing electricity. (More coal is being discovered; the population is growing quickly and using more and more electricity. Also, hydroelectricity can also cause environmental problems, such as increased salinity in rivers caused by dams and barrages that reduce the flow of river water.)

Ask what they have found out about different methods of coal-mining. They should be able to describe open-cast (surface) mining, and two methods of deep mining (longwall and room, and pillar), and to say which methods are used by most coal mines in Pakistan.

The students will notice that there were several serious accidents in mines in Pakistan in the first three months of 2016, and the number of mine accidents has been increasing. Ask why there have been so many accidents. (The coal industry has

recently begun to develop more quickly than in the past, so there are more mines and more workers. However, as in the mining of minerals, health and safety equipment and procedures have been much slower to develop.)

Using the Skills Book

The students can now complete any questions they have not answered on pages 46–47 ‘All in the mines’.

For homework, they could refer to the map of the main coal producing countries on page 48 of the Student’s Book ‘Coal producing countries of the world’, to help them complete the outline map on this page.

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how coal is formed as a fossil fuel and about different grades of coal.
- I learned about the world’s coal reserves and coal industry.
- I learned about Pakistan’s coal reserves and how its coal industry is developing.

PAGE 110

‘Coal mining in Germany’

Resources

- *Oxford School Atlas for Pakistan*
- Skills Book pages 49–50 ‘Coal industry of Pakistan’

Introduction

Explain that they are going to find out more about coal mining in another country (Germany), where the coal industry developed using modern methods a long time before Pakistan’s coal industry. They will find out how modern methods might change the coal mining industry in Pakistan.

Using the Student’s Book

The students should begin by finding Germany on a world map in their *Oxford School Atlas for Pakistan* and then looking at a map of Germany to find the Ruhr Valley. They should notice that there is a large area of flat land, which they will know from their work on settlements, is ideal for the development of settlements; also the River Rhine links the area to the North Sea.

Ask them to read page 110 ‘Coal mining in Germany’, to find the answers to the following questions:

- Q: What factors helped the coal industry to develop in the Ruhr Valley in Germany in the eighteenth and nineteenth centuries?
- A: The Ruhr Valley has iron deposits as well as coal. Iron and coal are needed in the steel industry, so the steel industry grew up around the coal mines. This meant that heavy materials did not need to be transported very far for manufacturing steel. The textiles industry also developed in this area, providing another market for coal for energy. The development of railways around the Ruhr Valley helped in transporting coal to the ports for export.
- Q: What helped German coal mines to have modern equipment?
- A: The equipment was made in Germany.
- Q: Why is Germany closing its coal mines?
- A: This will help to reduce greenhouse gases.
- Q: How is the closing of coal mines changing the environment of the Ruhr Valley?
- A: Mines are being converted into leisure parks and are being converted into museums. The air will be cleaner.
- Q: How will modern methods and regulations help miners in Pakistan?
- A: Regulations could help to check miners’ health and how long they can work in very high temperatures; dust levels would be controlled; they would have protective clothing and breathing equipment; there would be fewer accidents.

The students can then complete the exercise on page 112. They should work individually to complete sections A and B. They should carry out

the discussion in section C with a partner before sharing their conclusions. They should consider the equipment that miners in Pakistan use; the fact that the coal industry in Pakistan is only just developing; the locations of the coalfields; the opportunities that new investment and development in the Thar coalfield will bring, and how this might influence the development of existing coalmines, and safety regulations.

Using the Skills Book

This activity can be used in different ways:

- 1) The students should discuss the advantages and disadvantages of coal for Pakistan before they begin. They could discuss this with a partner at school, or at home with a friend or member of their family, and make notes of the possible advantages and disadvantages. Points to consider include how the coal industry could affect employment; the development of other industries; generating electricity; the landscapes near coal mines; air quality; water quality; global warming; possible requirements for coal in the future; other energy sources; and how likely Pakistan would be to export coal.

Ask them to list the advantages and disadvantages on the table provided, and then to use these ideas and information from the Student's Book and other sources to help them to write an essay about the effects on Pakistan of developing the coal industry.

- 2) Use this as an opportunity to structure a class discussion. Allow the students to write some notes in the table on this page about the advantages and disadvantages of coal mining for Pakistan. Then invite a student to present an opinion, giving a reason. The others should listen politely. Then invite a student volunteer to challenge the opinion respectfully, giving his/her reason. Following this, another student might wish to support one or other of the opinions. The emphasis should be on listening to other people's opinions and either supporting or challenging them respectfully, using evidence.

Discussion and review

Ask the students what they have learnt in this

lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how the coal industry developed in Germany.
- I learned how the landscape, other resources, and transport affected the development of Germany's coal industry.
- I learned how Germany's coal industry is changing, and why.

PAGES 110-111

'Natural gas and oil'

Resources

- *Oxford School Atlas for Pakistan*
- Skills Book page 51 'Vocabulary'

Introduction

Explain that they are going to find out more about other fossil fuels: natural gas and oil. Like coal, they are formed from materials from organisms that were once living. Tell them that in many cases natural gas is found close to coal deposits, and that they can find out more about this from the next pages they read.

Using the Student's Book

Ask the students to read pages 110–111 'Natural gas and oil' to find out how natural gas and oil are formed. Ask what similarities they can find between this and the way in which coal is formed. (Both are made when the remains of living things are compressed under layers of sediment and rock, but coal is formed from plants—mainly trees.)

Ask them to name a natural gas and to say how it used to be wasted. (Methane near coal deposits was not used until recently, but nowadays it is collected and sent through pipelines to places where it is needed.)

The students can then complete Question D.

Using the Skills Book

Students could complete the word search puzzle or page 51 for homework

Discussion and review

Ask the students what they have learnt in this lesson. They could make a note of this, summarizing the lesson, for example:

- I learned how natural gas and oil are formed.
- I learned about Pakistan's oil and natural gas resources, and how and where they are being developed.

Answers to assessments

- A
1. a) gold b) gypsum c) salt
d) potash e) sulphur f) turquoise
g) emerald h) coal i) natural gas
j) oil
 - 2 a) Canada, Pakistan, Russia, South Africa, the USA
b) Reko Diq in Chagai, Balochistan, as well as rivers in northern Pakistan
 - 3 a) Shown on the map are: Chile, Democratic Republic of Congo, Uganda, the USA. Others include Botswana, Namibia, and South Africa.
b) Nokundi and Saindak in Chagai, Balochistan
 4. lead and zinc
- B
- 1 a) Balochistan and Khyber Pakhtunkhwa
b) The students' own answers should refer to the fact that no complete survey of Pakistan's minerals was completed until very recently; also the minerals are mainly in places that are difficult to reach by road, and mining has been carried out mainly by very small businesses or individuals without access to modern methods.
 - 2 a–c) The students should have drawn a map of Pakistan with the provinces marked and labelled, and each province's capital city marked.
d–e) The students should have marked the gemstones mentioned in this unit in the correct provinces on their map. They should have included a key for their map.
- C
- 1 a) These are in mountainous areas.
b) It is in a mountainous area, and there has been political unrest in Khyber Pakhtunkhwa.
 - 2 a) The gemstones are mainly located in places that are difficult to reach: high in mountains, up steep cliffs, where it is difficult to transport equipment. Only

about five months of the year have suitable weather for mining, and the ground is frozen in the winter. Also, some modern equipment would not work properly at high altitudes because of low air-pressure.

- b) They have to climb up ropes on steep cliffs to reach some of the gemstones. They have to use donkeys or horses to carry their equipment, or carry it themselves.

They use explosives and simple equipment which can damage the stones.

The air in the mines quickly becomes polluted with gas and dust, so they have to leave until it clears naturally, as they do not usually have breathing equipment.

- 3 a) basic safety equipment such as face masks; machinery to remove pollution from the air in mines and regulate the temperature; regulations on health and safety

- b) training in cutting and polishing stones; a local centre for trading in gems

- 4 a) They damage many of the stones with the equipment they use. They sell their stones in their raw state, but could get higher prices for polished stones sold in a proper trading centre.

- b) In some areas, particularly FATA, many gemstones deposits are still to be identified. Some gemstone mines can only be reached by climbing ropes up the cliffs. The ground is usually frozen and there are only a few months of suitable weather each year. It is too difficult to get modern mining equipment up there. Some modern equipment would not work there because of the low air pressure.

- 5 a–b) The students’ own discussions and responses should take into account the effects on local employment and income, local roads and transport, and the effects on the environment, water, and agriculture. Examples:

Would a large mining company be good for local people?

Reasons for large mining company	Reasons against large mining company
jobs for many local people; training miners skills for local people; development of local trade such as shops; improved roads and transport Families could become better off and so better able to provide for their children’s education.	pollution of the air, water; and land polluted streams and rivers damage to agricultural land; damage to naturally beautiful landscapes; loss of habitats for wild animals

- D 1 a) a fuel formed naturally over millions of years from dead trees and other plants
- b) They are formed from similar types of materials in similar conditions.

c) Longwall

Hydraulically-powered supports hold up the roof while a machine cuts coal from the coal face. When all the coal in the area has been mined, the supports are taken out section by section, and the roof is allowed to collapse. The coal face can be 100–350 metres long. Few of Pakistan’s coal mines have this equipment, so miners cut the coal with pickaxes, and support the roof with wooden pit props.

Room and pillar

Miners cut ‘rooms’ into the coal seam and leave behind ‘pillars’ of coal to support the roof of the mine. The pillars of coal use up to 40% of the total coal in the seam, but sometimes they can be taken out later.

Surface mining (also called open pit or open cast)

The coal is near the surface of the ground, so more of the coal deposit can be mined than in an underground mine. Surface mines can cover an area of many square kilometres and use very large pieces of equipment, such as power shovels, large

