Curriculum Visions

Weather around the world

Teacher's Guide

You may also wish to visit our web sites:

www.CurriculumVisions.com
www.AtlanticEurope.com

for material on a wide variety of topics
and our on-line catalogue.

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Atlantic Europe Publishing

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Contents

Section 1: Weather around the world pack

The resources available

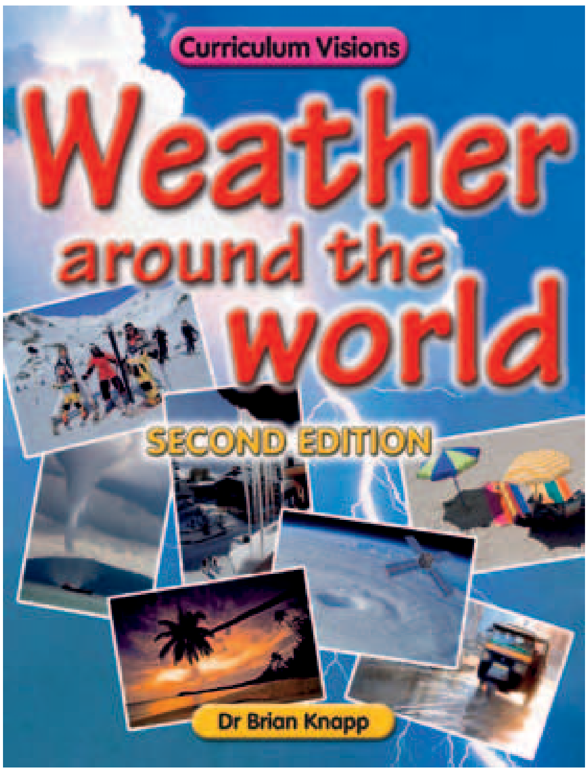
Welcome to the world of Curriculum Visions. We have a wide range of resources to help you study this popular and important topic:

1. ***Weather around the world.*** A 48-page, full-colour student paperback book that introduces students to weather around the world, covers the main processes at work in the atmosphere, the types of weather they produce and some of the hazards, such as tornadoes and hurricanes. There is also an important section on project work.

2. ***Weather around the world Teacher's Guide.*** What you're reading right now! This teacher's resource book contains practical guidance and photocopiable worksheets and activities with questions and answers. Our objective has been to make it easier for you to teach this subject.

3. ***The Weather PosterCard Portfolio.*** (*also called the Picture Card Poster Pack*) Four posters and a total of 28 A4-sized key diagrams/photographs on two folded, double-sided, and laminated sheets. Lamination provides extra protection and durability.

   The posters can be hung on the wall or cut up to make tough cards. The cards can be placed out on desks for group work or placed on the wall for background reinforcement or as key elements of a wall display. The posters are supplied in a plastic wallet that can also be used for storing the cards if you choose to cut the posters up. Lesson suggestions and notes on the pictures are available online (see below).



Please note that the detail shown on these screens may change as new materials are added regularly.

❹ ***Three Weather Adventure Stories.*** Three readers specially written to support this subject. Join Lucy and Philip on their adventures in the books *Blizzard*, *Tornado* and *Hurricane*.

❺ ***The Weather Picture Gallery CD.*** Contains a wealth of pictures suited for using with an electronic whiteboard and has a feature that allows you to print any of the pictures as a postcard.

❻ ***Web site***

at www.CurriculumVisions.com – this dedicated web site contains support for each of our Curriculum Visions titles, including Weather around the world. The information at www.curriculumvisions.com is part of a subscription site and is in addition to the other items. It is useful for projects at school or at home.

Matching the curriculum

Most teachers will agree that weather is among the most interesting, and difficult, subjects to teach. This is because explanations can rapidly run ahead of the ability of the students to understand them. You will have to decide on the level of challenge that your students need by picking and choosing from the worksheets. There is plenty here to allow you to combine weather with maths and science if you so wish. There are many charting and graphing worksheets that will test both skills and interpretations. If you think these are too demanding for your students, skip them or just photocopy the parts you think are suitable.

Learning objectives

The main concerns of the curriculum are to make sure that students know:

- How to recognise, define and measure the elements of the weather.
- How weather varies from time to time and place to place.
- About seasonality.
- How site conditions can influence the weather.
- How wind speed varies in sheltered and exposed sites.
- How weather conditions vary in different parts of the world.
- The nature of extremes of weather in other parts of the world.
- About how weather links to the water cycle.

Remember, you have these worksheets, together with material in *Weather around the world*, more data in the back of this book, the Weather Adventure Stories, the Picture Gallery CD and our extra web site information, to provide you with the back-up resources that you need.

If you are following the QCA unit 7, rather than the wider National Curriculum, then the topics you will be covering are:

Unit 7: Weather around the world

This is a 'medium' unit. It helps children to develop ideas about weather conditions around the world. The focus is the relationship between weather and tourism, but it could be extended to include other forms of human activity, for example occupations, settlement, transport, or amended to make another human activity the main focus.

Sections in this unit

1. Why do people go on holiday? Where have we been on holiday?
2. Where are hot and cold places located on a world map?
3. Where can we go on holiday? How will we get there?
4. What is the place like? How is it similar to, and different from, our locality?
5. How do we decide what we need to take with us?
6. What will the weather be like? How will it affect what we do?

This is a slightly different emphasis from the National Curriculum, relating to how the weather affects people when on holiday. The keys to this are at the front of the student book, where the first four pages introduce weather and tourism.

From this starting point, you can proceed to describe and explain the different kinds of weather around the world using the remainder of the book. World weather examples are also situated in this book on pages 122 to 137.

An interdisciplinary resource

There are many opportunities to link this material with other subjects. For example, weather is an important part of studying mountain environments. It is also clearly linked with science through data gathering (rainfall, temperature, etc) and manipulation and there are many worksheets in this *Teacher's Guide* that support this. This also ties this subject in with maths. Weather is an excellent topic for literacy-based exercises using postcards, while weather hazards provide opportunities for reportage-style writing.

Teaching with the pack

The material has been written and presented to cover a range of curricular requirements. The components of the pack provide you with the flexibility to teach the curriculum in whatever way you wish.

1. Using the student book

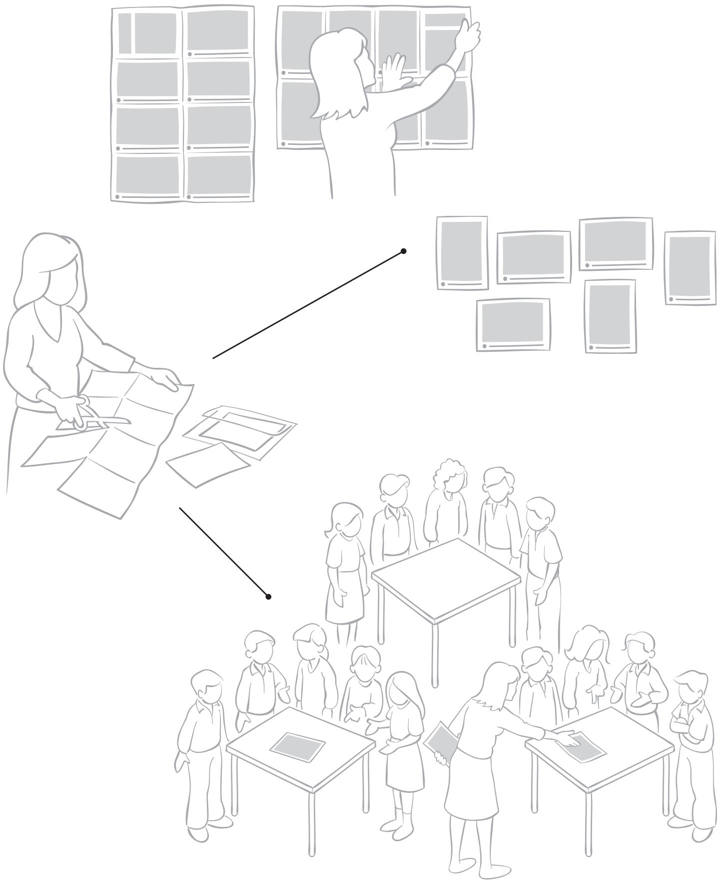
Weather around the world is a 48-page full colour paperback student book arranged to cover basic principles.

By working through the book, and using the worksheets and activities in this teacher's resource book, you will be able to meet a number of your curriculum requirements.

Weather around the world provides a foundation for understanding the way that weather processes work. Explanations of the teaching points that can be made on each unit are shown on pages 13 to 35 of this teacher's resource book.

Every two-page spread in *Weather around the world* forms the basis for one teaching unit. The book is designed to be used sequentially, although each unit is self-contained and can be used in isolation if you wish. This makes the material exceptionally flexible for your needs.

The introduction unit at the front of *Weather around the world* (pages 4–7) can be used simply as an introduction, helping students to quickly understand the scope of the task ahead, but also as a summary for review purposes.



3. Using the Teacher's Guide

This teacher's resource book brings together all of the elements of the *Weather around the world* pack, giving an overview of the pack components. It also contains a very extensive selection of photocopiable worksheets and activities.

Please note that occasionally there is more than one worksheet or activity matching a unit in *Weather around the world*. This will allow some students to develop the subject more extensively, while others can simply complete the essential worksheet or activity.

3. Using the PosterCard Portfolio

Giving students variety in their study is a key part of helping them to enjoy what they are learning. This is exactly what the PosterCard Portfolio does.

As posters. This uniquely flexible resource consists of four posters on two double-sided, gloss laminated, and folded sheets. Each poster has seven large (A4-sized) pictures making a total of 28 pictures.

Whether you choose to use the posters as they are or to cut one or both up, you will have a resource of large key diagrams, together with the exciting photographs you need to reinforce and broaden the work.

From posters to a portfolio of cards. Each poster can be cut up to give seven A4-sized cards. As each card is double-sided, there are 28 different images for use in class. Although they are laminated you can also encapsulate the cards for even greater durability and you could even use them as mouse mats.

Using the portfolio. Each picture is numbered and has a simple caption but there are no printed instructions, leaving you plenty of freedom in how to use the pictures.

The pictures can be used in a multitude of ways. Some suggested approaches are:

- ▶ Inspiring students at the start of the course by showing them the richness of the material they will be studying.
- ▶ To start a wall display on a theme such as 'Holiday weather in Miami' or 'Hurricane weather', where you use one or more pictures from the resource to start off the display.

- To get students to work in groups, by placing appropriate cards on tables, then giving out your own question sheets. Students can complete a task and then move from desk to desk as they explore each picture.
- To encourage cross-curricular work by using the picture as a starter for students to write their own story, poem, or drama.
- To have a picture large enough to use for whole class teaching.
- To make the pictures part of the work each week, by placing one of the pictures on the classroom wall and asking students to write about this, ‘Picture of the week’.

We are sure you will be inspired to think of a multitude of other uses either as posters or as cards.

Online support for using the portfolio. If you do want extra support such as notes on the pictures, their context, and suggested ways to use them in lessons then this can be found on the Curriculum Visions web site.

4. The Weather Adventure Stories

These full colour short stories are an excellent way of combining literacy and geography and also some history. They describe a major weather hazard, such as a tornado, a hurricane or a blizzard, and show how a family deals with it.

5. Using the Weather Picture Gallery CD

We also provide a CD which contains a gallery of 100 pictures for copying and pasting into projects, or for making your own worksheets (copyright restrictions apply).

The gallery includes many of the pictures in the student book, making it easier to engage in whole class teaching if you have an interactive whiteboard. All photos can be enlarged and all have further information. All the pictures can also be printed as postcards to use for literacy work.

6. Using the web site in school or at home

Every topic in *Weather around the world* is matched by a section on the Curriculum Visions web site. The purpose of the page-by-page support on the web site is:

- To provide extra information on each topic. This may be particularly helpful for the more able students.
- To provide extra case studies.
- To promote computer-based skills.
- To show students that information about the subject can be presented in a variety of media.
- To allow students to find an informative web site on curriculum-related material when they are surfing the Internet at home. **This is a subscription web site.**

7. Links

The *Weather around the world* pack can be linked to other books in the Curriculum Visions series, particularly *The Mountain Book*, which explains how the weather affects plants, animals and people.

We are always adding titles to the Curriculum Visions range, improving, and updating current ones, so what’s shown here may change. Please visit the Curriculum Visions web site to find out about the latest developments and subscribe to the newsletter with its free photocopiable worksheets and activities.

Section 2: Planning your study of the weather

The *Weather around the world* pack is based around the full-colour paperback student book (*Weather around the world*). The items that make up the pack are shown on pages 4 and 5. By using this material flexibly, you can create tasks for a wide ability range.

The student book is mainly planned in double-page spreads. In this teacher's resource book you will find:

- Photocopiable masters to accompany most of the spreads in the student book;
- Answers and background information for each master sheet.

The student book is designed to be used primarily in class and to be bought as class sets. You will find that sets are priced accordingly. There is also a hardback edition for library use.

Weather is a popular subject for all kinds of reasons. It is immediate, local, and everyone can achieve something from learning about it.

One of its strengths is that it can also be multidisciplinary, or cross-curricular if you prefer. The main subjects that can be brought into this topic are science, mathematics and geography. Maths (through the use of charts, converting temperature data, and science (through the principles of solar radiation and the water cycle) are highlighted in the early parts of the study, while geography is found throughout.

The Weather Adventure Stories also allow you to introduce the topic into the literacy hour.

The Weather Adventure Stories are in full colour and can be purchased separately.

Planning to use the materials

Make sure that students know that their book is web-linked and that they can get additional material by visiting our web site at:

www.CurriculumVisions.com

The web site address is also in the student book. Each unit in the book has an associated web page.

This site is filled with information they can use for their lessons, especially the climatic information for cities around the world and month-by-month weather reviews that simply cannot fit into the space available in the book.

The book is designed to be used sequentially so as to cover all of your syllabus needs, although each unit is self-contained and can be used in isolation if you wish.

When starting on the weather topic, it can be helpful to ask students to list weather-associated words that they think they know, and words from the index on page 48 that they do not know. By the end of their studies, all of the words that were unknown at the beginning should be understood. This will be easy to check through a short test.

Use the Weather Adventure Stories available separately as short colour books. This is an alternative starting point for the subject and can be especially good for reluctant readers. The stories show how important it is to recognise weather signs and be aware of the rapid changes that can take place in the weather.

At the end

Within each topic it will be important to check that certain things have been done:

1. That everyone understands the vocabulary from the unit; and
2. That the main ideas covered have been understood.

One way to achieve this is through a concluding question and answer session, either written or verbal. The worksheets will help with this task.

Making the best use of the illustrations

All units include diagrams and/or photographs. Photographs are descriptive of a specific location, whereas diagrams show the main characteristics of an idealised feature. Both have important advantages.

First, make sure every student knows why each illustration has been included on the page. Make sure that each illustration is referred to and discussed. Students may need guiding around the illustrations.

The pictures are as large as possible to help you to discuss them in a meaningful way. More pictures can be downloaded from our web site and many of those in the book are available on the Weather Picture Gallery CD and can be used on a whiteboard for whole class discussion.

It is also helpful to ensure that the questions you might ask about the illustrations are designed to check the students' comprehension and their ability to connect the illustration with the text.

Diagrams in the student book are produced in colour. The *Teacher's Guide* worksheets contain line illustrations similar to these diagrams, so that students can relate book to worksheet easily. Asking students to write on the worksheet, and colour in the diagrams, helps to reinforce appreciation of every part of a diagram, especially for the younger and less able.

Links

At the end of a unit it is important to conclude and also lead onto the next unit. Units should be seen as having natural links, and the teacher is best placed to point these out. An introduction to a lesson can also be used to make links back to work already done, as a reminder of the context of the work just tackled.

Weather around the world

The book highlights a spread on world weather types in order to give some basic information about holiday destinations and act as a vehicle for thinking about differences between weather conditions around the world. Material for world weather, especially for those who are more able, is amplified in this teacher's resource book. A much more comprehensive treatment of world weather can be found in the series of books called WeatherWatch (ISBN Vol 1: 1 8621 4032 4). This can be used as a reference set for the more able and it compares the weather around the world on a continent by continent basis for each month of the year.

Some starting ideas

Think for a moment how you might introduce the topic of weather. Here are two suggestions: from a local point of view and from a holiday point of view.

1. Local

You can always see weather by looking out of the classroom window. If you do this, you get a microcosm, a snapshot in time.

Here are some occasions when you might want to mention the weather as seen from the classroom window. It is important to discuss the weather not just when the sky has exciting cumulus clouds in it but also when students might regard it as uninteresting, such as when it is a dull day.

First the bad weather to look for

(i) A dark, dull day when it has rained for an hour or more and shows no signs of leaving off.

Most people try to ignore this kind of weather, but actually it is one of the most interesting. What you are experiencing is a front, most commonly a warm front. When it rains, the warm front will not have passed through yet, so it is a good time to measure some things, knowing that a change is on the way.

Have a sneak preview at the TV forecast to get a better idea of exactly when the front is likely and then time a weather spotters' session to be just before and just after the front passes. First, the sky is dark because the cloud is thick. It is important to point out that people flying in aircraft will be flying in sunshine with the cloud below them. That is, the cloud layer is usually no more than a few kilometres deep.

Try finding out the wind direction using a wind vane. Then measure the temperature. When the front has gone through (the rain clears up), take the same measurements again. With luck the temperature will have risen (you are in the warm sector) and the wind will be coming from a different direction (more southerly). It doesn't matter why it is coming from a different direction, but at least you can show that the wind can swing around quickly.

(ii) A day or several days when the sky is dull, and the air is still, damp and thoroughly miserable, but no rain is falling or it drizzles at most.

This happens most often in winter. Here, the stillness is the key. You are stuck in anticyclonic gloom. Children love to say this – anticyclonic glooooooom. Moist air has settled and cooled and so droplets are forming in the air. Enough droplets have formed to make a kind of mist, and even some light cloud. The air seems thick and heavy (literally, because it is a high pressure with air sinking) and damp, because the air is not moving enough to carry moisture away while, at the same time the cooling is making the air more and more moist.

Now for some good weather

(iii) A clear, still, hazy morning in summer

This is a warm anticyclone, settled weather and no cloud. The haze is caused by the dust in the air. Air is only clean when it has recently been washed of its dust. It takes days to become hazy, so this is a sign of settled conditions.

(iv) A fresh, crystal clear early morning with sunshine and a coolish breeze

This is a typical day for the development of cumulus clouds, so you may want to use a few minutes of your lessons at intervals throughout the morning to look at the changes, perhaps every half an hour for a few minutes. Better still, sketch the same piece of sky several times (or take pictures with a camera, or even a few frames of a video camera set on a tripod). Look through the pictures, or replay the video to see the changes.

Meteorologists call this 'unstable air'. Soon clouds will bubble up and, by midday, they will have partly obscured the sky, so that it will be cloudier. What happens exactly cannot be predicted from your window, however. It might rain (showers of rain or hail), thunderstorms might develop or it might just stay cloudy.

Remember, at this stage, the explanations don't matter as much as the fact that the students are observing change.

2. Global holidays

Students like talking about holidays and using postcards (perhaps made using the Weather Gallery CD) gives a way of introducing ideas of global location as well as weather.

Weather around the world begins this way, by using photographs of places near and far and reading the reports written on them. By using the reports, and accounts of students' own holidays, they can see that the weather changes globally. However, they must be clear that the weather they see on holidays may not be representative of the weather at that location through the year.

Students should come to the conclusion that what can be confidently said about using holiday information is:

The location is attractive for visitors for at least a part of the year.

What cannot be confidently said is:

The weather is always the same as someone experienced it on their holidays.

These are the problems:

Holiday visits may be due to guaranteed hot and sunny weather, but they may also be due to other factors, such as wishing to visit places of cultural interest, or it may be because people are really ignorant of the weather when they book their holidays. Thus, for example, people often book holidays to areas in the southern hemisphere using their normal northern hemisphere behaviour and are surprised to find themselves in the cooler or wetter time of the year when they reach their destinations. Many people go to tropical areas believing them to be hot and sunny, when in fact they are hot with considerable rain and cloud. Many people find themselves on holiday in the monsoon season!

Postcards can be combined with travel bag lists, showing what would be needed to be put in a travel bag for a holiday in the chosen destination.

3. Investigations and projects

Students are always interested in measuring the weather. A section in the student book does this and work in this guide suggests a number of projects.

Instruments

You can look at a barometer with the whole class. Some children can find this a difficult instrument to understand, but it is a good way into science – forces, pressure, and gases, liquids and solids.

The barometer actually gives us our first hint that the invisible air is actually made of something, because there can only be pressure if the atmosphere is filled with something pressing down on the barometer. The force is, of course, gravity.

This will lead you in to other measuring instruments such as thermometers and raingauges, all described in the student book and in the worksheets.

4. Regional weather forecasts

This is really for the older and more able.

Get students to contrast the weather forecasts that show isobars with those that only show cloud and sun symbols. Obviously, you can deduce much more from proper information, so try to steer clear of those forecasts that don't show decent maps.

Video a few days' weather forecasts and then run them one after the other so that you can review the week. Get children to make notes on what the weather forecaster said (a good exercise in précis work) and then to write up an account of the week. Make sure they write under structured headings.

You can also get weather forecasts and even satellite 'movies' of weather systems from around the world on the Internet. Try **www.Yahoo.com/weather/images**

This activity is really for the more able, but handy if you are comparing the weather in your home locality with that in other parts of the continent, or elsewhere in the world.

5. Folklore

Thus far we have seen something out of the window. Now we can find other sources. One of them is folklore. For example: "Red sky at night, shepherd's delight; red sky in the morning, shepherd's warning." Does it work? Ask the class to find out.

Here are some more examples:

"Flowers close up before a storm."

"When the rooster goes crowing to bed, he will rise with a watery head."

"Evening red and morning grey, are sure signs of a fine day.
Evening grey and morning red, put on your hat or you'll wet your head."

"A veering wind will clear the sky, a backing wind says storms are nigh."

"Birds flying low, expect rain and a blow."

"Fish jump high when rain is nigh."

"The daisy shuts its eye before rain."

"When dew is on the grass, rain will never come to pass."

"Clear moon, frost soon."

"When ropes are tight, it's going to rain;
When weather's fair, they're slack again."

"Mackerel skies and mares' tails
Make tall ships carry low sails."

Weather around the world book support

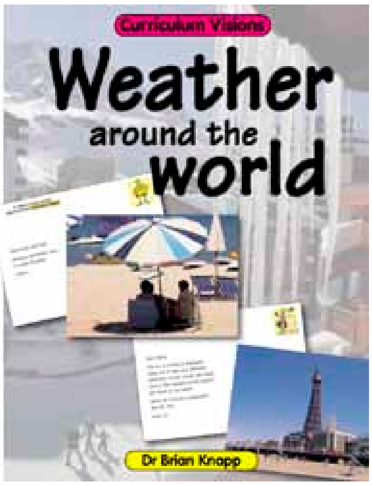
The student book and this teacher's resource book are rich in pictures and diagrams. They therefore form the core around which you and your students can build. However, the information can be greatly extended through the Weather Picture Gallery CD and the web site at:

www.CurriculumVisions.com

It is important to understand that the student book is quite self-contained and does not need the web. So, if using the web site information does not fit into your plans and teaching methods, just forget it. However, if you want to find additional pictures, videos, case studies and much more, or if you want your students to get involved in using IT, you will find our web pages have much to offer.

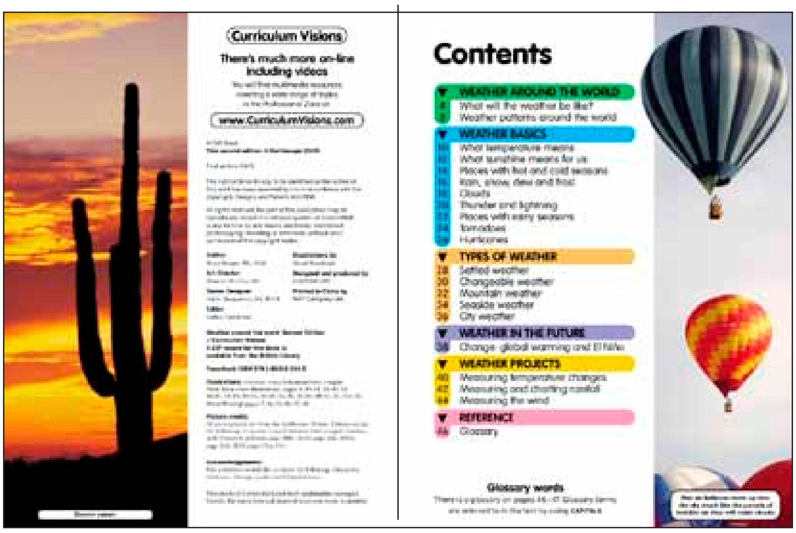
Remember that the web is a more informal learning place than a book, and the material can be changed frequently. Indeed, we shall aim to add to the contents of the Weather web site regularly so that students will always feel there may be something new to seek. This will make the subject even more dynamic and interesting. If you also have time to look at the web, you will find that there are many pictures and case studies that can be downloaded for your teaching needs. The web site is accessed by subscription.

Section 3: Weather around the world explained



Although the student book – *Weather around the world* – is clear and simple, a great deal of care and thought has been given to the structure and the content of each double-page spread. The worksheets in section 5 of this teacher's resource book also link directly to the pages in the student book.

Contents


Curriculum Visions

There's much more on-line including videos

www.CurriculumVisions.com

Contents

Glossary words

The book is organised into chapters and subdivided into double-page spreads. Chapters are shown on the contents page and are colour-coded. Matching coloured headers run across each spread. The concept is paralleled by the pages on the web site.

Each spread has a heading, below which is a sentence that sets the scene and draws out the most important theme of the spread. The main text of the page then follows in straightforward, easy-to-follow, double column format.

Words highlighted in **BOLD CAPITALS** in the student book are defined in the glossary on page 47. The majority are technical words important to the subject, but some are simply difficult words.

The glossary definitions help to reinforce the meaning of a word that may be slightly ambiguous if taken out of context. Many technical words used by geographers and scientists are also used in everyday situations where they may have a different meaning.

The glossary words are highlighted on the first page where they are encountered. They may be highlighted again on subsequent pages if they are regarded as particularly important to that page or spread.

Please note that case studies have been especially chosen from various parts of the world. Thus, one spread may have examples from the UK, the next may be from Europe and the next from the United States. In this way, students will automatically be exposed to a number of contrasting environments, both at home and abroad. However, it will be especially helpful to remind students to look carefully at the way the pictures and their captions are related to, and often extend, the theme of the spread.

Most captions to photographs give the location of the scene.

Chapter 1: Weather around the world

Spread 1 (pages 4-5 of Weather around the world)

1

Reproducible worksheets and supporting teacher's notes for this unit are on **pages 50–59** of this book.

What will the weather be like?

This is an introductory spread, and makes a four page unit together with the spread on pages 6 and 7.

The concept here is that students can be introduced to the variety of the weather not just by locally changing conditions, but also by locations overseas if these are put into a meaningful context.

The context used here is to think about travel planning. There are a number of postcards each showing both the obverse and the reverse. The reverse contains a description which reflects the nature of the weather at the time that the writer was visiting. It does not, of course, tell of climate, but simply of weather conditions.

The difference between weather and climate will need to be introduced at every level, and you may wish to introduce it here. Weather is a concept of the day to day phenomenon of the atmosphere. Climate is the average values of these phenomena. So, it is quite possible that the visitor will have arrived at a time which we would, if we lived there, describe as 'unseasonal', meaning different from the weather we would, on average, expect to experience at that time of year.

In some cases the weather described is not the same as the weather shown on the picture of the postcard. This provides an opportunity to probe into when people take photographs in order to portray a location at its most attractive.

The travel bags are an important part of these spreads and adults may have very different ideas as to what to pack for their children to the children themselves. There is a worksheet that develops this idea more fully.

Spread 2 (pages 6-7 of Weather around the world)

2

Reproducible worksheets and supporting teacher's notes for this unit are on **pages 50–59** of this book.

What will the weather be like? (continued)

You might find it particularly helpful to use the Weather Picture Gallery CD at this point because students can choose pictures of places they like from the CD and then make postcards of these for themselves, just by pressing the 'print postcard' button.

All of the Picture Gallery CDs have the postcard feature, so if you have Mountain, Coast, River, Where we live or any other of these CDs, you can use this to generate postcards. The postcards fit on to A4 paper.

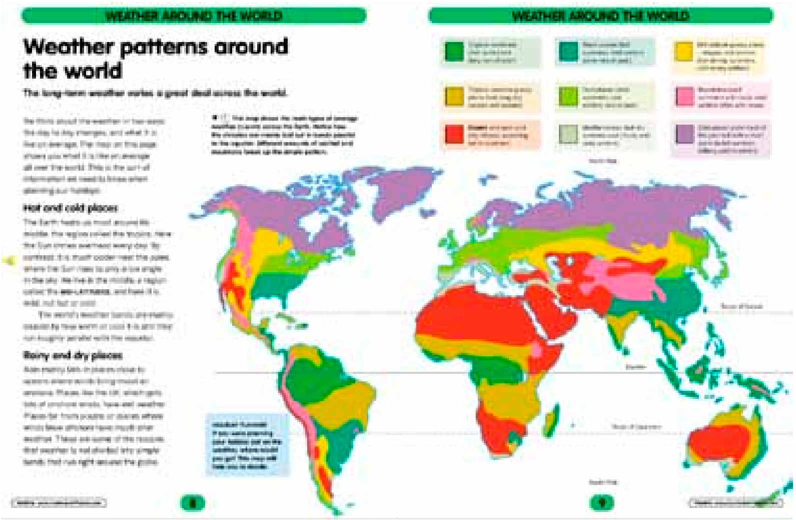
As a result of printing postcards, students can also write on to them what they think the weather would have been like. They will be able to see whether or not it is sunny, but you may wish to ask them how they can tell whether it is hot or cold, and whether there are any clues to the time of year.

In this context, you can introduce at this early stage the fact that not all places in the world have the same pattern of weather, and especially they do not have temperature-based seasons. So if it is hot all year in the tropics, does this mean it is fine for a holiday all year long? You can then explain that the tropics mainly have rain based seasons, so it would not be good news to go on holiday to an area during its rainy, or worse, monsoon season.

Places next to the equator tend to have much the same rain and temperature all year. Few of these are holiday destinations. Students might like to find out why not, as a long term project while they are doing their weather studies.

Places just on the poleward edge of the tropics are where the great deserts lie. These places are also of interest because it is sunny all year and rainfall is slight. But the holiday season is not 'summer' because then it is so hot as to be unpleasant for many tourists. These places have their high tourist seasons in 'winter'.

Spread 3 (pages 8–9 of Weather around the world)



3

Reproducible worksheets and supporting teacher's notes for this unit are on **pages 50–59** of this book.

Weather patterns around the world

This spread focuses on both weather and mapping skills.

The map shows the world divided on climatic boundaries. The key has been expanded so that students can see what the main characteristics of the weather are like. They do not need to know the technical names such as savanna, but the more able might like to learn them.

Clearly there is lots to talk over from the previous unit and hopefully students will have discovered that there are many questions to ask and just as many unresolved facts. This will hopefully encourage them to want to find out about the weather in more detail and to do this, of course, they need to know something about temperature and rainfall, and this spread begins to look into this aspect of weather.

You may want to have a globe and a torch handy so that you can show students how and why the Earth heats up more at the equator than at high latitudes. You can then shine the torch on the globe near the equator and show how the light rays of the torch cover the same area as they did when they left the torch. This represents hot conditions. The same torch moved so that it is shining near the poles but is still held horizontally will show that the same beam has to cover a bigger (elliptical) area and so the rays are less concentrated. In the case of the Sun they cannot therefore heat the ground as intensively and so the Earth is cooler in these latitudes.

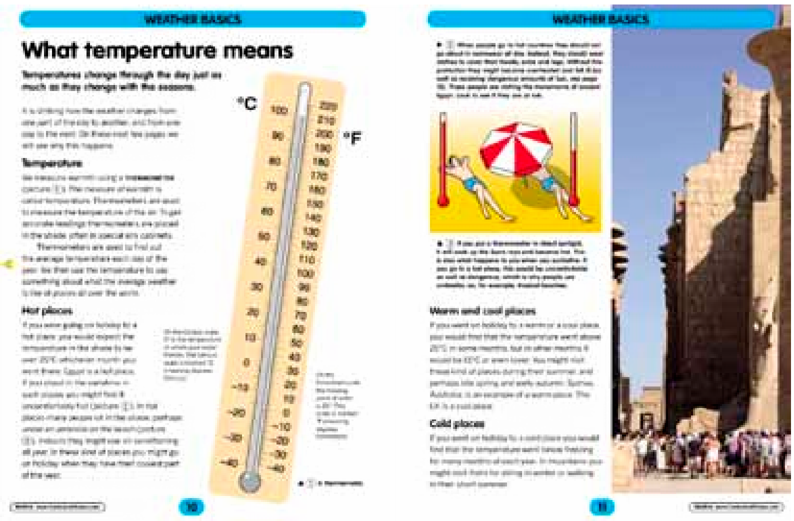
Of course it is not just the heating power of the Sun that affects the air temperature of a locality because the movements of hot and cold winds transfer energy from one part of the world to another. But the principle has been established of hot equator and cold pole.

The winds have an important effect in controlling climate at all latitudes because there are onshore winds and offshore winds at all latitudes. Students can be told that winds over oceans pick up moisture and when they come on land they release some of this moisture as rain. Places where this happens (UK included) have frequent rain. Where winds blow offshore they are coming from a landmass and so have little moisture. As a result they give little rain. Wherever winds blow offshore you get deserts. The deserts of South America show this effect particularly well as they are enhanced by the rainshadow effect of the Andes.

The main thing is to explain that the rain-bearing winds make the pattern of climate more complex than simply being based on latitude and this is why climate maps are complex. But it also means there is more to explore. You could, for example, give students the names of some capital cities, show them where they are in terms of latitude and then ask them to find out using the map on this spread whether they are dry or rainy places.

Chapter 2: Weather basics

Spread 4 (pages 10–11 of Weather around the world)



4

Reproducible worksheets and supporting teacher's notes for this unit are on **pages 60–63** of this book.

What temperature means

This is the first of two linked spreads. The first is on temperature, the second on solar radiation. This is why they are linked but separated.

Students will have been using words like temperature, but in order to understand what they are saying, it is important that they are introduced to temperature measuring systems and scales. There is also an important link to maths and science through this topic. If students make daily accurate measurements of the temperature around their school, they will be well on the way to knowing about accuracy in observation, one of the fundamentals of scientific study. By charting the results day by day, and making averages, they will learn important maths skills.

The ideas of hot and cold places are introduced here. It is all very well saying hot and cold, but students need to think what is meant by these words. On this spread we introduce some numbers as a guide. Books that talk more seriously about weather patterns, such as the WeatherWatch series, will define the temperatures more closely.

We also take the opportunity at this stage to explain that thermometers can record temperature in two ways: by directly absorbing the heat if placed in the Sun, and by recording the air temperature if placed in the shade.

Here you can talk about two things: the fact that it feels cooler in the shade, such as under an umbrella, and why this might be (skin heated by contact with the air) and why it feels so hot in the Sun (skin absorbs sunshine directly, and as the skin is a good insulator/ poor conductor of heat, the heat builds up in the upper skin layers).

Finally, we turn to the sort of clothes that might be taken to a hot place. The picture shows part of the Karnak temples of ancient Egypt at Luxor. Students may not have realised from the previous pages that long sleeved clothes and hats are a good idea. Here you can demonstrate people wearing them. On this page the purpose is to stop the skin from overheating (and causing heatstroke). On the next page the idea of sunburn is introduced separately.

Spread 5 (pages 12–13 of Weather around the world)

5

A reproducible worksheet and supporting teacher's notes for this unit are on **pages 64–65** of this book.

What sunshine means for us

This spread focuses on one of the most important aspects of direct solar insolation (sunshine). It is important from a weather aspect and also for health reasons. Many parents have difficulty getting their children to cover up and protect themselves adequately and this spread is designed to provide a vehicle for discussing this important weather-related health issue.

First, how many students put suncream and sun hats into their travel pages from unit 1? There are sure to be at least some who didn't, even for the sunniest places.

You may care to begin by discussing the diagram. This shows how the sunshine comes evenly from the Sun, but that near the poles the same amount of Sun spreads out over a larger area than near the poles. As described before, this can be shown by means of a torch and a globe in a darkened room.

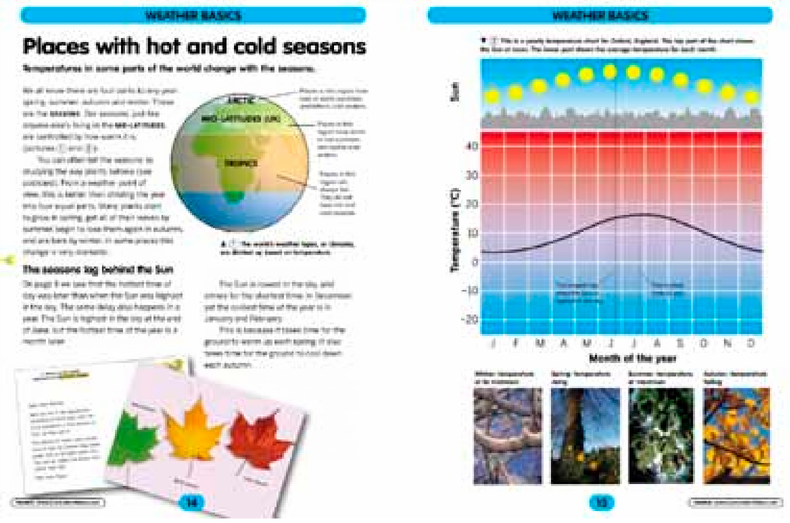
The important outcome of this is that students see that, the closer they go to the equator for their holidays, the more concentrated will be the Sun's rays. You can continue this discussion by showing how, in the same way, the higher the Sun is in the sky, the stronger the rays, meaning that a summer's day will have stronger sunshine than a winter's day and midday will have stronger Sun than early morning and late afternoon.

You will then need to introduce the topic of health, solar radiation, invisible UV rays and skin cancer. Following this, you can describe how there are various ways of reducing the health risk, but perhaps emphasise that there is one sure way to know when you are at risk: and that is if you go bright salmon pink and then get sunburn with, in extreme cases, blisters. The blisters are actually caused by excessive heat build up on the skin and so are part of the previous spread, but it serves to show how sunshine can have dramatic effects in the short term. Melanomers are a long term effect, and students must see that they can be equally real.

Covering up with light clothing and wearing a wide-brimmed sun hat are good ideas. Looking at sporting heroes, such as cricketers and seeing how they sensibly wear thick layers of skin cream might be another.

Students might also be introduced to the need to know they are using effective Sun blockers. The numbers on the student book (15+) are recommendations from Cancer UK. Finally they can imagine the beach scene and see for how long people expose themselves to the Sun while not realising it because they are enjoying themselves in various ways. The picture is Bournemouth, England, showing the need for protection here as well as overseas.

Spread 6 (pages 14–15 of Weather around the world)



6

Reproducible worksheets and supporting teacher's notes for this unit are on **pages 66–69** of this book.

Places with hot and cold seasons

This unit builds on the previous units which introduced global variation and the nature of temperature to show variation over a year in mid-latitudes, and to show seasonal variation with seasons.

This unit is obviously central to any discussion of seasons for countries such as the UK. It also allows students to think about the way we divide up our year and how it is weather related, but that artificial divisions of the year can sometimes run against natural divisions, made, for example, by plants, which respond to the actual pattern of temperature year by year.

The diagram on the left of the spread can be related back to the sunshine diagram on page 12. It shows that, on average, the more concentrated solar radiation near the equator results in higher air temperatures and that the fundamentals of weather vary with latitude. You may wish to combine this study with a section from 'Earth and beyond' in science (QCA 5E) which explains how the tilt of the Earth is responsible for the seasons by changing the angle of the overhead Sun. Our *Science@School Book 5E* does this.

The chart on the right shows annual temperature variation and compares it to the position of the midday overhead Sun. Do not let students think that this is a daily chart, although the similarities are very striking.

The way this chart is laid out is similar to the way that climate charts display temperature and so it serves as a model for understanding charts from other places around the world (and so, for example, getting to understand holiday weather from weather charts). You will find many weather charts of a similar kind for places around the world in atlases, but they are also given later in this book (in section 6, pages 122 to 137).

Spread 7 (pages 16–17 of Weather around the world)

7

A reproducible worksheet and supporting teacher's notes for this unit are on **pages 70–71** of this book.

Rain, snow, dew and frost

This spread follows on from the theme of temperature by providing basic information about moisture in the air. This material will overlap a study of the Water Cycle that you may be doing as part of 'Rivers'.

Where does rain come from? Why does it sometimes snow and not rain? What causes dew? These are all weather-related questions that commonly occur.

You may like to begin this unit by spraying some water onto a part of each desk top. Firstly, students can observe that the water is in the form of droplets. Spray some water into the air and watch it sink to the ground. These droplets are heavier than air and so they fall, just like rain. After a while, ask students to look to see what has happened to the droplets and they will observe that they have got smaller, and by the end of the lesson will probably have disappeared. This is evaporation and students can witness it very easily this way.

Now you might like to say that you are going to do a conjuring trick and get the moisture back out of the air again. You simply pour some iced water into a glass and get the students to watch as water droplets form on the outside. This is, of course, condensation.

In this way you can introduce students to the rather difficult idea of water being both liquid and gas. It is less difficult to explain snow as frozen water and most students will probably take your word for this.

So, using the book and the spray of water, you have shown how part of the Water Cycle works and how the water recycles itself without being destroyed – the water simply changes state. You can then ask where the biggest source of water is, and look for the answer "the oceans". Now you can tie in the idea introduced on an earlier spread that rain is more common on the side of continents facing the prevailing wind. Students can see that water evaporates from the ocean and is carried as invisible moisture over the land where it cools high in the air to form droplets that make clouds and that the droplets grow to make rain.

Spread 8 (pages 18–19 of Weather around the world)

8

Reproducible worksheets and supporting teacher's notes for this unit are on **pages 72–77** of this book.

Clouds

Clouds are an obvious part of the weather and they come in many shapes, sizes and patterns. In this unit we concentrate on cumulus clouds, leaving the layer clouds to the section on weather forecasting, page 27 of this teacher's resource book.

If you find you are able to choose a fresh day, and go out to look at the sky every hour or so, you will probably be able to show students how cloud is changing according to the diagram.

What you can also do is to tell them that these clouds are like invisible hot air balloons containing moist air. The ground is heated by the sunshine and the air in contact with the ground rises, although we can't see this. (The air is not directly heated by the sunshine.) The invisible air then rises and as it does so it goes into higher parts of the air that are cold. The 'balloon' of air is cooled and, just as we looked to see how condensation occurred on a glass of cold water in the previous spread, so the air in the 'balloon' is cooled until the moisture eventually turns from moisture into droplets.

We see the droplets immediately because they make the cloud.

Get students to notice the bottom of these clouds are flat. The flat line is the level at which condensation occurs. Once the clouds form you can see the way that they rise by looking at their cauliflower tops.

If rain falls from these clouds it can often be seen as trails out of the bottom of the cloud.

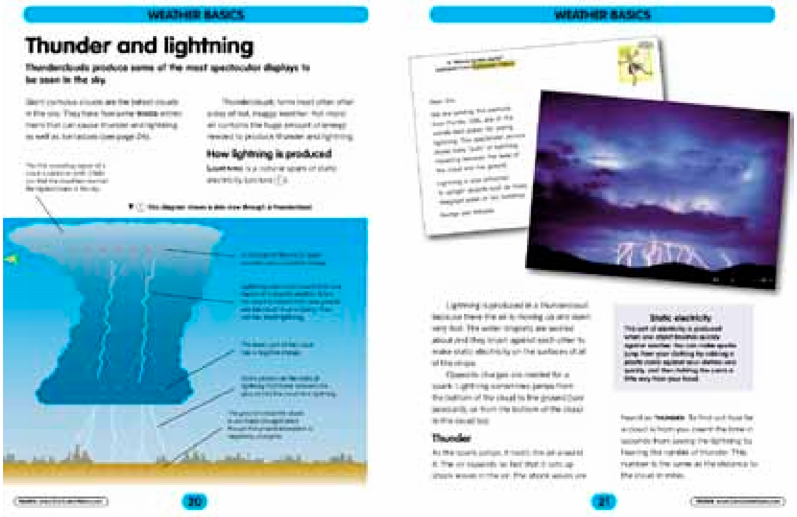
There is a cloud atlas on the web site and many cloud pictures on the Picture Gallery CD.

The two postcards on this spread are from places where cumulus clouds are very common, both in the south of North America. If students are sending postcards they can scour the CD and see if they can find other places with the same types of cloud and see where these are.

In general cumulus clouds occur on hot sunny days in places where moist air is available. They occur daily in many tropical locations and are common in mid-latitudes in summer.

Students should notice that they fade away when the ground stops being heated, that is at sunset.

Spread 9 (pages 20–21 of Weather around the world)



9

A reproducible worksheet and supporting teacher's notes for this unit are on **pages 78–79** of this book.

Thunder and lightning

This spread follows on naturally from spread 8, about cumulus clouds, because all thunderclouds are cumulus clouds.

This topic can be done at the same time as a science project on static electricity.

The key idea here is that if one material is rubbed vigorously against another, a surface electrical charge builds up which can be as high as tens or even hundreds of thousands of volts.

To do a practical for this, rub an inflated balloon against a jumper. After a short while the balloon will begin to stick to the jumper and you can let go and the balloon will stay where it is. This is an example of static electricity.

You can also hold the balloon close to hair and see the hair attracted to the balloon.

In a cloud, water droplets are moving very rapidly up and down, carried by violent currents of air. The droplets move so fast that they build up static electricity and become charged. When the charge is high enough a spark will jump from one part of a cloud to another or between the ground and the cloud. This is lightning.

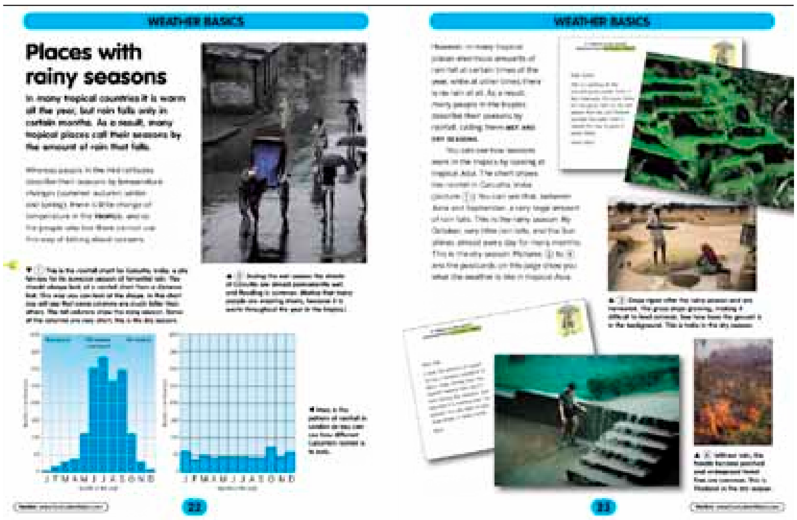
Students should know that there is only one kind of lightning – fork lightning. Sheet lightning is simply fork lightning that is hidden from direct sight so that all we see is the illumination of the clouds.

Thunder occurs because the lightning bolt heats up the air as it flashes. The hot air expands, and the waves of pressure this creates is heard as a sound wave – thunder.

Thunder and lightning are very common in the tropics, near tropics and in continental regions in summer. In the UK we get relatively little by way of thunder compared with some places.

Students might like to know that lightning in the tropics can cause great fires, such as savanna fires, and that many plants depend on these fires to germinate. So, for example, the bush fires of Australia are bad for houses, but good for the seeds of the natural forests.

Spread ⑩ (pages 22-23 of Weather around the world)



10

Reproducible worksheets and supporting teacher's notes for this unit are on **pages 80–83** of this book.

Places with rainy seasons

We are now in a position to bring some of the information about rain together and look at some places where rain makes the seasons. All of these places are in the tropics or near tropics.

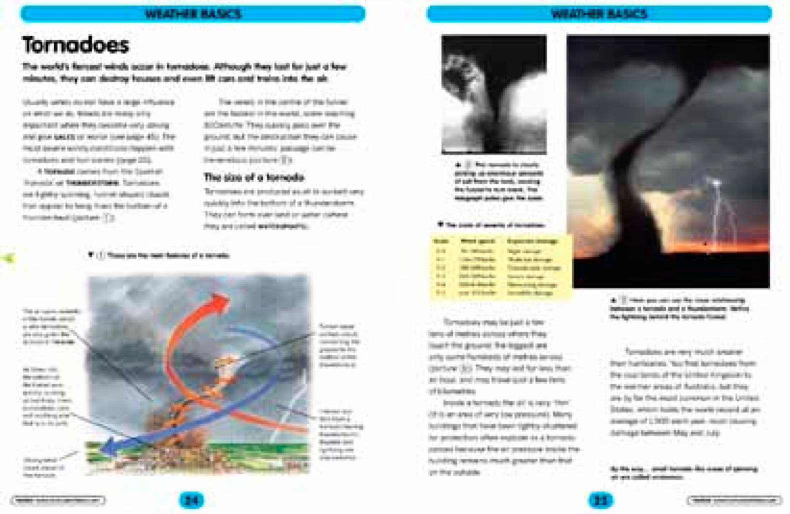
This important spread allows you to look at tropical and near tropical climates. The main focus on the left hand page is a rainfall chart for a location in India. All students should be able to see that the rainfall increases very considerably at one time of the year and this is the rainy season. It is known as the monsoon. A chart for the UK is shown alongside for comparison. Clearly we do not have a rainy season, nor do we receive such enormous amounts of rainfall.

You may wish to ask students to think about what happens when there is such heavy rainfall. There are clue pictures on the spread. A rainy season has both disadvantages (such as flooding, loss of life) and advantages (provides water for crops to grow). The other side of a wet season coin is a dry season. This is a sunny time of year, good for ripening crops, attracting tourists, but fraught with problems concerning drought and lack of grazing land for animals.

High rainfall can produce some amazing landscapes such as that of Bali shown on the spread. Students might like to find more emerald green paddy field pictures and ask themselves what this implies about rainfall. Of course, the fields are irrigated by diverting rivers, but the water has to get to the rivers in the first place and so this means a rainy climate for at least a part of the year.

With all this in mind, students might like to investigate the weather of a popular resort like Malaga, Spain, and think when would be the time of year when the hotel rooms would be cheapest (based on weather data for the town).

Spread ⑪ (pages 24–25 of Weather around the world)



⑪

A reproducible worksheet and supporting teacher's notes for this unit are on **pages 84–85** of this book.

Tornadoes

This spread focuses on one of the most dramatic weather events in the world – the arrival of a tornado.

You might like to begin this topic by asking students to read another *Curriculum Visions* book called *Tornado*, this is a reader in full colour, describing the way that two children experience a tornado.

Tornadoes do occur in the UK. Surprisingly for many people the UK has more tornadoes than most, although they are not usually large or very harmful. But in the news from time to time are reports of houses having their roofs sucked off.

The world's most powerful tornadoes occur elsewhere, in places which get hotter, more moist air than us. One place is called tornado alley and it stretches right across the southern states of the United States, and is at its most violent in May to June. This also implies that thunder clouds are at their most violent at this time, too, so this may not be the best time of year for a holiday to such regions.

Tornadoes are always associated with large thunderclouds. They are simply groundward extensions of the swirling winds inside a cloud. We see them because when they reach the ground they suck up soil and other debris and so look dark.

Tornadoes, as with hurricanes and other severe weather phenomena, are important features to teach because they represent a hazard that we should all know about. The more students are aware of natural hazards, the better they will be prepared to fend for themselves if they find themselves in a hazard situation.

Spread ⓬ (pages 26–27 of Weather around the world)

12

Reproducible worksheets and supporting teacher's notes for this unit are on **pages 86–89** of this book.

Hurricanes

A hurricane is another hazardous weather phenomenon. The winds are nowhere near as powerful as in a tornado, but hurricanes cover an enormous area, last for days and can cause coastal flooding as well as wind damage. In fact, more people get drowned from coastal flooding than killed directly from the winds of a hurricane. This is particularly the case with developing world countries such as Bangladesh, that occupy low lying land at the end of a funnel-shaped ocean. The hurricanes simply draw the water into the funnel and it floods half of the entire country.

In developed world areas, hurricanes cause a lot of damage, but this is mainly to low quality housing. Pictures of regular disasters in, for example, Florida, show flimsy wooden bungalows smashed, but concrete and brick buildings rarely suffer. The picture on the spread shows typical disaster damage to a substantial building. The facings to the hotel have been stripped away, but the building is intact.

Large scale weather hazards like this can easily be tracked and preparations made. Students might like to work out what these are, and will include evacuation, securing buildings, and what to do when you return to a building that is soaked through. One useful link is www.FEMA.gov

Hurricanes swirl round and round, with very powerful winds, but move quite slowly. You can make the comparison to a spinning top. You can also examine when Florida has its hurricane season and decide whether this is a good time, for example, to go to visit Disneyland.

Chapter 3: Types of weather

Spread ⑬ (pages 28-29 of Weather around the world)

⑬

A reproducible worksheet and supporting teacher's notes for this unit are on **pages 90–91** of this book.

Settled weather

The previous spreads have given some foundation about the weather and talked about world weather, holidays and hazards.

Most of us experience the weather as a local day to day event and we check on the weather through weather forecasts. So the next few pages describe simple weather forecasting and how local conditions can affect the weather, too.

This spread is concerned with the simplest weather type, that in which there is clear blue sky, and wall to wall sunshine.

It is always associated with a barometer reading of high pressure, so it might be useful to get students used to reading a barometer on a daily basis.

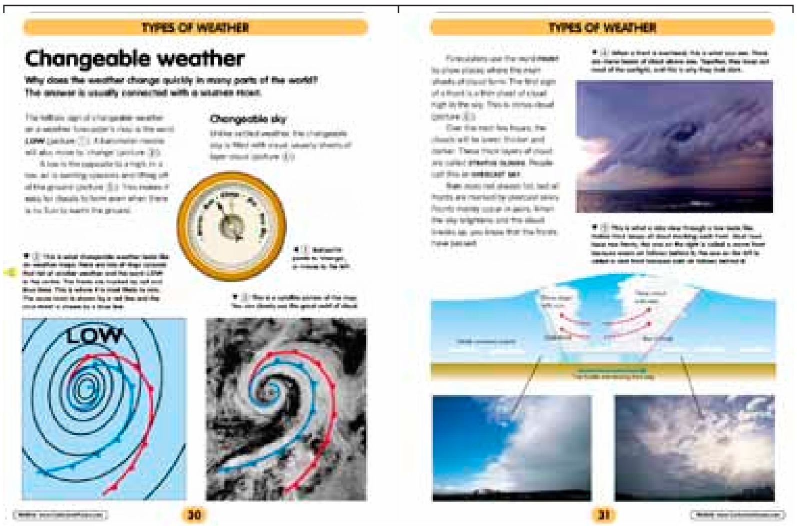
A barometer measures the pressure of the air. All over the world the air is under pressure because it is being drawn to the ground by gravity. If we look all over the world we can get an average of this pressure, so places where the pressure is higher than average are Highs and places where the pressure is lower are Lows.

A High and a Low are made by the way air moves. If the air currents are downwards, then the winds add to the pressure caused by gravity and the extra pressure gives a High. The reverse is true for a Low.

On previous pages we have seen that clouds and rain are produced when air rises. So when air currents are moving down, air cannot rise and so clouds cannot form. So a High means sinking air, settled conditions and no cloud – hot and sunny in summer, freezing in winter.

Get students to look out for Highs on the TV weather forecasts.

Spread 14 (pages 30–31 of Weather around the world)



14

A reproducible worksheet and supporting teacher's notes for this unit are on **pages 92–93** of this book.

Changeable weather

Settled weather is connected to Highs, changeable weather is connected to Lows.

As explained opposite, Lows are places where the air is rising, tending to offset the pull of gravity on the air.

Places where the air is rising allow the formation of clouds, and so Lows always mean cloudy conditions.

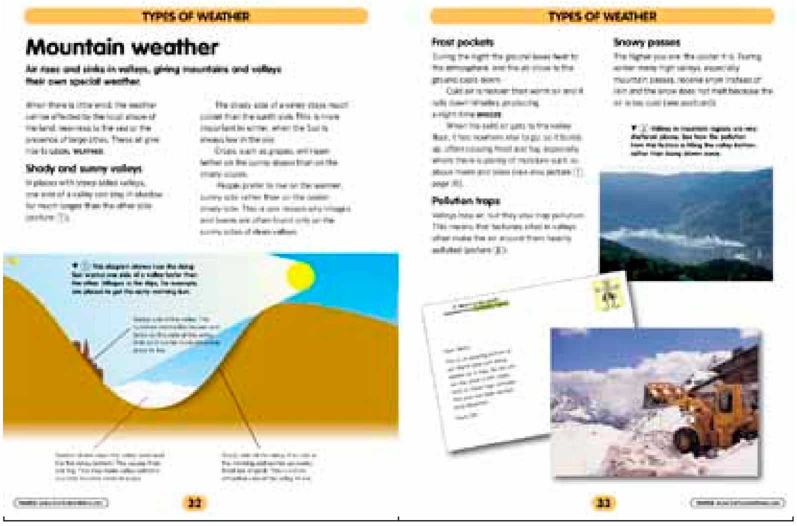
In the tropics, a great low pressure encircles the globe, meaning that it is cloudy and wet most days for most parts of the year. Locations such as Singapore can expect early afternoon rain most days each year.

In the mid-latitudes, places like the UK get a more complicated picture. Our Lows suck in cold air from the arctic and warm air from the tropics. At is gets sucked into a Low and swirls together, the moist warm air is pushed over the cold air, it rises and great sheets of cloud form. The clouds are called stratus if they are thick and low; cirrus if they are high and wispy.

In a Low the warm and cold air normally meet at two places called fronts. Most weather forecasters on TV talk about these every day. Students simply need to know that each Low normally has two fronts and that each form is a band of cloud and rain (or cloud and snow in winter).

If you look outside and there is a sheet of cloud overhead, you are in a low pressure. Students could check this by using a barometer.

Spread ⑮ (pages 32–33 of Weather around the world)



⑮

A reproducible worksheet and supporting teacher's notes for this unit are on **pages 94–95** of this book.

Mountain weather

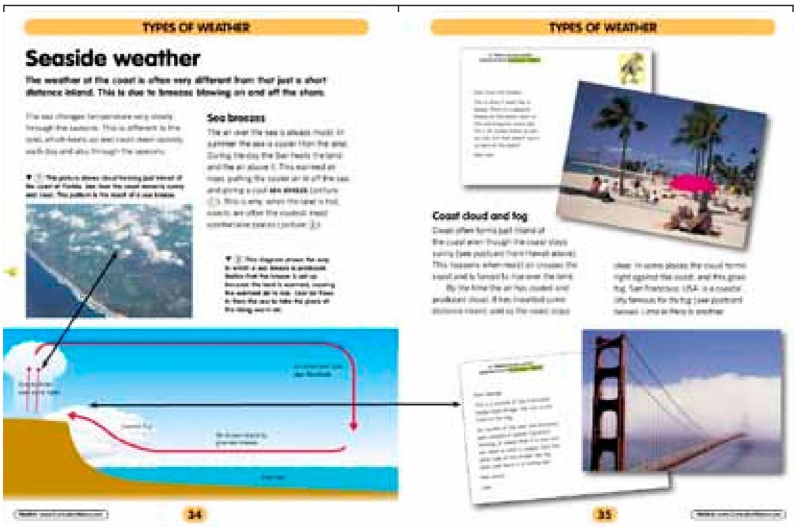
This spread can be done in combination with a topic on mountain environments.

The diagram on the left is the classic diagram that shows how the Sun shines on one side of a mountain valley much earlier than on the other side. This explains why settlements in valley locations in hills and mountains are mainly on the side which receives the early morning Sun. The French terms ubac, meaning shady or poleward side, and adret, meaning sunny or equatorward side are used at higher levels and in many books.

You can make a model to show how this works by taking a sheet of cardboard and bending it into a valley with mountain ridges to each side (sort of like the ups and downs in corrugated paper, but on a larger size). Then bring a torch up to represent the Sun and get students to suggest which side they would want to be on. Notice the feature is much more significant on east-west valleys than on north-south ones and is a winter phenomenon because in winter the Sun rises less in the sky and so the shady side (poleward facing) may not get any Sun at all.

The other features that are easy for students to appreciate are frost pockets and the altitude of the snowline.

Spread 16 (pages 34–35 of Weather around the world)



16

A reproducible worksheet and supporting teacher's notes for this unit are on **pages 96–97** of this book.

Seaside weather

This spread can be combined with several earlier on to consider why it is that people go to the seaside. Of course it is for space, the sea and activities, but it is also for a number of weather reasons.

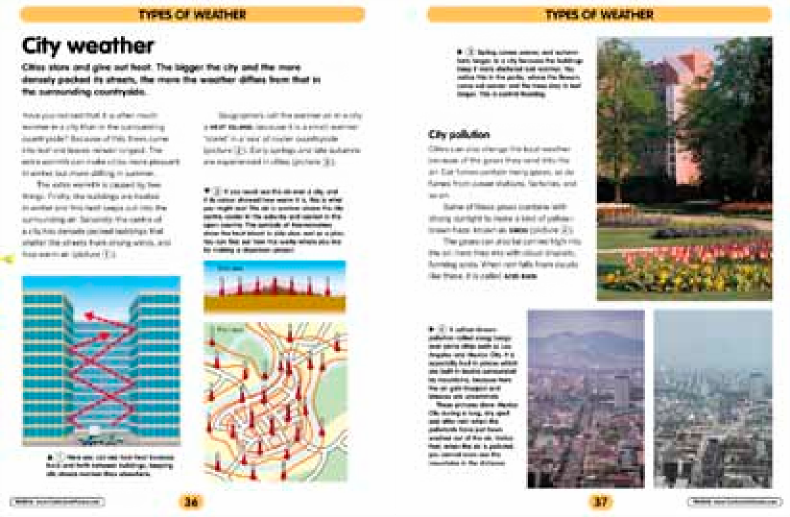
Students can be shown that the weather at the coast is often different from the weather just a few kilometres inland because of coastal effects.

This will not be true all of the time, but applies to settled conditions when local effects can become important. When the wind speed picks up to over 15 km per hour all local effects are lost.

The diagram shows the basic seaside effect: the sea in summer is cooler than the land and so, as the Sun rises higher in the sky it warms the ground which in turn warms the air. Warm air is lighter than cold air and so the warm air rises. This pulls in cold air off the sea and sets up a circulation. The effect can be to make the morning sea breeze feel cool, but as temperatures climb, the sea breeze then becomes a bonus because it stops the beach feeling as hot as inland. The sea breeze effect also causes clouds to form inland. Coastal regions (literally the coastal strip) may be sunny all day while just inland cumulus clouds form.

There are also some occasions when the cold air can make fog at the coast. From about April to June this is common along the east coast of England, and it is notorious in other parts of the world, for example San Francisco, as shown in the picture. Again the effect is very local. The San Francisco example is useful because the city is famous for its sunny weather, but during part of the summer the coast is plagued by fog and this would not be a good time to go on holiday to this destination (although a short way inland the fog disappears and there can be a temperature contrast of 15°C as a result).

Spread ⑰ (pages 36–37 of Weather around the world)



⑰

A reproducible worksheet and supporting teacher's notes for this unit are on **pages 98–99** of this book.

City weather

It is surprising how much local weather can be studied in a city. Not only can you look at the day to day weather and chart it, but you can also look at the way that temperature changes across a city. It also changes as you move just a few metres away from a building.

Ask students why they huddle in a doorway in windy and cold weather. The answer of course is that the micro climate is better in this sheltered location.

This spread shows how temperature changes across a city. Students coming in from the suburbs can notice this if they are being brought in on a school run in a car that has a thermometer for measuring external temperatures. They can see what the thermometer says each minute of their journey, Then they can see whether they can identify why this might be. Again, local effects like this work best in settled weather and would be disappointing on a windy day, so planning would be needed.

The spread also gives the opportunity to explain why flowers burst into bloom in a city earlier than in the countryside and why leaves stay on trees longer.

You can then move on to the topic of air pollution, because cities create pollution which often will not disperse easily because the sheltering effect of the buildings keeps the wind speeds in cities lower than in the countryside. It takes a wind of over 15 km/hr to disperse pollution from a city. In some places, such as continental Europe, where winter highs last for many weeks, pollution levels can build up to dangerous levels and cities have to start banning driving for health reasons.

Chapter 4: Weather in the future

Spread 18 (pages 38–39 of Weather around the world)

18

A reproducible worksheet and supporting teacher's notes for this unit are on **pages 100–101** of this book.

Change: global warming and El Niño

The purpose of this unit is to allow you to discuss the vitally important topics concerned with environmental change.

It is useful to introduce weather and holidays, but even young students should be made aware of the problems caused by Greenhouse Effects and others. It is, after all, their world that will suffer and the sooner they recognise they have a problem to address, the better.

There are a number of related issues. We know, for example, that the amount of carbon dioxide we put into the air is causing the atmosphere to warm up globally. This is because carbon dioxide is very effective at absorbing heat. As a result, the more the carbon dioxide in the air, the warmer the global atmosphere.

Effects of this change to the global climate include the melting of ice sheets and the rise of sea levels, the flooding of many low-lying countries and coastal cities, the extinction of arctic species and those which cannot adapt, the changing pattern of climatic regions (the UK may have severe weather more often, with higher summer temperatures and more winter rain), while many areas will experience greater drought and this, in turn, will affect the food supply.

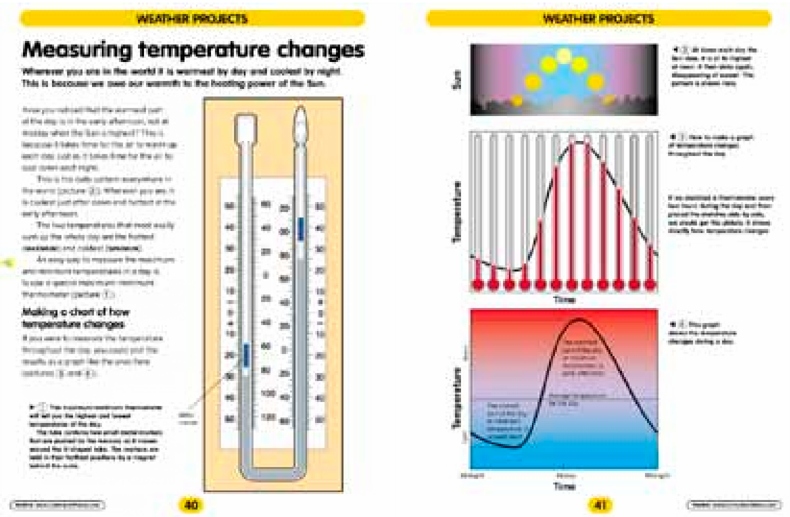
It is a very good subject for brainstorming with students. You can begin with: What if the ice sheets melt? Then see how far they can take the story.

The reduction in ozone (and increased exposure to UV rays) is another important topic.

We have introduced the topic of El Niño here, too. It does not really affect us, but it has huge effects on other people and students need to be aware of, and sensitive to, the way we can cause problems elsewhere.

Chapter 5: Weather projects

Spread 19 (pages 40–41 of Weather around the world)



19

A reproducible worksheet and supporting teacher's notes for this unit are on **pages 102–103** of this book.

Measuring temperature changes

This spread begins the chapter on project work. You will have noticed that many other spreads can be used as the basis of project work and these have been described in previous pages of this guide. These end pages focus on measurements and are very cross-curricular by nature.

Please also see section 4 of this teacher's resource book for more detail on measurements.

Temperature is a fundamental measurement of the weather and of science, so there are likely to be some thermometers in all schools. A maximum and minimum thermometer is cheap and can be bought from garden centres. It makes for easier day after day reading than ordinary thermometers. It can also give readings for times of day when students are not present, especially early morning where the lowest temperature occurs.

You do not have to explain how a maximum and minimum thermometer works, but it is useful to show how to read it against the dumbel and how to shake the dumbels back to the surface of the mercury again after readings have been made.

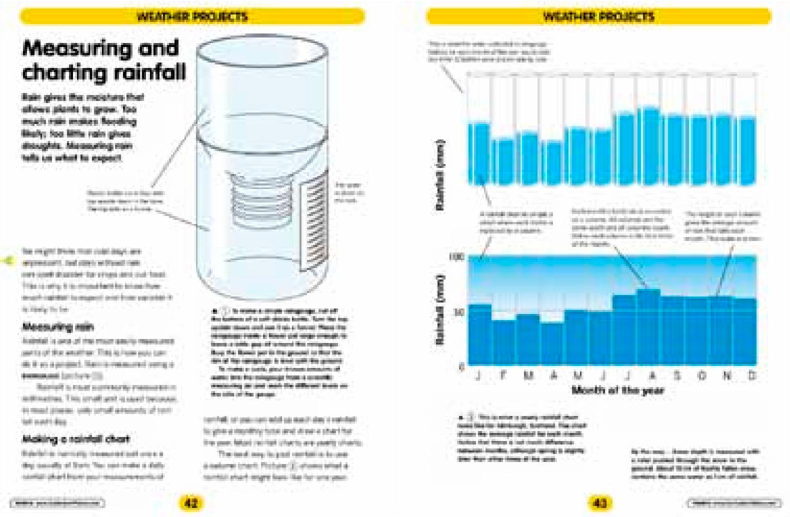
The chart on the right shows how to graph temperature through a day. It could, of course, be adapted to show how to plot minimum temperatures over a week or a month.

The stages of making a chart can be demonstrated by starting at the top. In this case the chart is from a day, and so to remind students, the height of the Sun over the horizon is shown. Then there are snapshots of thermometer readings put side by side. Students could make these by using a digital camera to record the thermometer each hour and then cropping the digital photograph using Photoshop or some other photo manipulation tool. Thus weather and ICT can be used effectively.

For those who find charts difficult, this is an important intermediary step. The bottom picture shows the thermometers replaced simply with numbers and a line joining them. To help, a coloured background suggests higher values are warmer (redder).

The chart can then be analysed to show how maximum daily temperature lags behind height of Sun (which it would not do if the Sun heated the air directly and so this demonstrates that the air is warmed with contact with the ground after the ground has been heated by the sunshine.)

Spread 20 (pages 42–43 of Weather around the world)



20

A reproducible worksheet and supporting teacher's notes for this unit are on **pages 104–105** of this book.

Measuring and charting rainfall

The second of these chart-making spreads also shows how to make a simple raingauge from a soft drink bottle cut in two with the top inverted and placed into the lower. This gives a funnel and a gauge. As the funnel is the same catching area as the gauge, the height of the water collected is the same as that amount that fell.

Students may say that this is hard to read, so you could then discuss how to magnify the result by using a container with a smaller diameter to collect the water. The smaller container would have to be calibrated, by pouring a centimetre of water in it and finding out how far up the side the water level came, then making a scale of millimetres by diving the height found into ten equal parts.

Charts can be difficult for younger students, so again we have first put the raingauges side by side to show the differences in levels and then, in the chart below, taken the gauges away.

Here we use bars not a continuous line because we have collected the water in discrete intervals of time (a day), whereas the temperature was collected as points on a continuously varying line.

The chart is actually for a UK location, but you might ask students how they would make a raingauge for a monsoon location (the chart is on page 22). When they think of this, they might also like to notice that they will still have to measure small amounts in other months. The brightest may come up with an inverted funnel to measure small and large amounts (the funnel is simply blocked up).

Spread 21 (pages 44–45 of Weather around the world)

21

Reproducible worksheets and supporting teacher's notes for this unit are on **pages 106–109** of this book.

Measuring the wind

Wind is actually quite hard to measure and is the least easy for students to do without proper equipment.

The easiest part of measurement is wind direction for anything like a piece of fabric tied to a stick will do as a model wind vane.

Measurements of wind direction are useful. If students measure the wind direction at the start of the day, and use a compass to get an accurate bearing, they can then look at their results at the end of the month and from this work out which is the most common wind direction. This is called the prevailing wind. If the prevailing wind is from the Atlantic, then it explains why we get lots of moist air and rain.

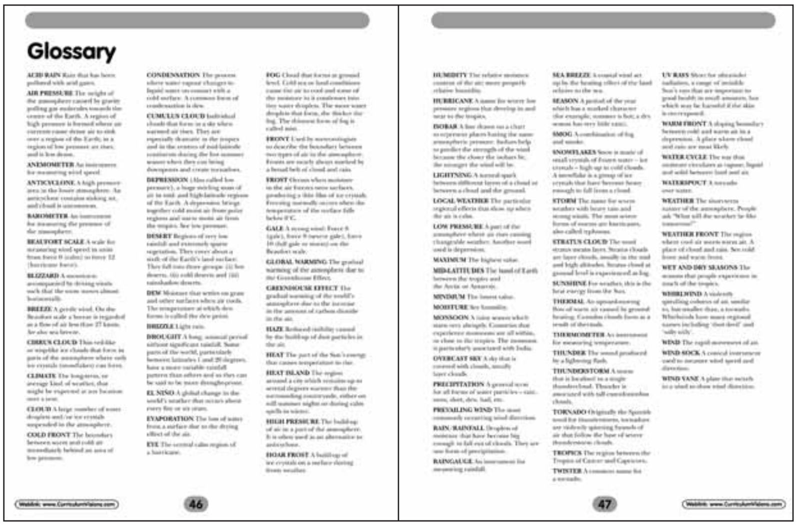
Wind speeds can be deduced by what they do to the environment, and this is what the Beaufort Scale is designed to do. It is an interesting scale to draw out, and students might like to make alternative drawings to those shown in the book.

Measuring actual wind speed can only be done with an anemometer and this is not a cheap piece of equipment. Some anemometers can be connected directly to computers so that the real wind speed can be seen on the computer.

Reference

The last three pages of the book contain the glossary and the index.

Glossary (pages 46–47 of Weather around the world)


Glossary

46

47

The entries in the glossary are listed in alphabetical order. The short definitions are given in simple language for the context in which they are used. They are, therefore, not necessarily the same as definitions given in an encyclopedia or dictionary.

Where necessary, more breadth is given to a definition (to make it encompass other meanings, or make the definition more general).

Index (page 48 of Weather around the world)


Index

48

A comprehensive index allows specific subjects to be found.

The index can be used to encourage research skills.

Section 4: Practical work

Practical work can form a major part of any weather study. Its value is in involving students in a wide range of decision-making activities. This is why it is given a section at the back of the student book.

(a) Classwork

Most, but not all, practical study can be done in class or in the school grounds. In general, practical and project suggestions are included in the worksheets beginning on page 50.

(b) Project work

Many students like to do projects, and few subjects lend themselves better to this than a study of local weather. The same project will suit students from a wide age and ability range because it is the interpretation of the data, rather than its collection, that changes with year group.

The equipment for effective weather work can be simple and cheap. Raingauges, as described below, cost nothing. Buying popular alternatives to scientific and purpose-built equipment saves a small fortune and yet makes the same educational points.

Safety first!

Before any kind of class or fieldwork, please make sure you have thought through the appropriate safety precautions.

Instruments

(i) Rainfall

The point about measuring rain is that everyone can do it. You can buy raingauges, in which case you have to allocate a budget. This may restrict you to one raingauge per school, which everyone must share. Or, you can make your own raingauges from cans, bottles and flower pots, in which case everyone can participate, they can be made at home, they involve parents, **and they are free**.

Although a purchased raingauge looks more 'professional', other than having a scale on the side, it does no better job than does an ice cream tub. In fact, by using the results from ice cream tubs for a whole class, you can develop the idea of variability over an area and quickly get students to think about fair tests, averages and range, all of which are in the science and maths syllabuses.

When getting students to do experiments (see worksheet 20), get them to take readings at home and to explain to the people at home why the ice cream tubs, or whatever, are as good as proper raingauges. Many adults appreciate being involved when it does not take much time.

Many kitchen and garden items are useful for measuring volume, but measuring a millimetre of rainfall can be difficult. Here is a tip. The bigger the surface area for collection, the more water is collected per millimetre of rain falling, and the easier it is to measure it without significant error. So, go for tubs. Also, children like to measure a lot of something, not a measly amount.

Here is a good chance for some simple, meaningful, scientific maths. For example, if you were to use a square kitchen bowl measuring 50 cm by 50 cm at its open mouth, it would have a large collecting area – 2,500 cm^2. If, after being left outside for one night, the contents were poured into a kitchen measuring jug and found to be 250 ml (1 ml = 1 cm^3), the rainfall could be calculated as:

$$\text{depth of rainfall (d)} = \frac{\text{volume collected (v)}}{\text{area of raingauge (a)}}$$

In this case:

$$\text{(d)} = \frac{250\,\text{cm}^3}{2{,}500\,\text{cm}^2} = 0.1\,\text{cm or } 1\,\text{mm}$$

So just 1 mm of rainfall produces a lot of water.

For a raingauge, choose an ice cream tub, a large baked bean tin, or a large plastic bowl.

Students can calibrate their own gauges. They need to know what 1 mm of rain gives in ml. It is easy to work out, as above. From this they can make a straight-line calibration graph, and as line graphs are in the science and maths syllabuses, maths, geography and science can all be tackled at the same time.

(ii) Temperature

Temperature measurements require a thermometer. A garden thermometer will be fine. Many students will have a thermometer at home, so they can do a project easily in their free time as well.

All of these thermometers will read to 0.5°C, which is quite accurate enough for many projects.

Again, the key is to produce a fair test. Make sure students understand that they must all have measured the temperature in the same way, for example, in the shade 1.5 m above the ground (eye height). Notice also that this is a good moment to discuss the nature and purpose of Stevenson screens (see worksheet 19) and to discuss why they are stood out in the open and at a prescribed height. Ask if Stevenson screens fixed to a wall would give accurate or comparable records? (Yes, they will be accurate for the shelter of a wall, but no they won't be comparable with properly sited Stevenson screens because the exposure will be different.)

Diurnal changes

The simplest graph can be made from records of the temperature on a simple thermometer placed outside in the shade (hang it from a tree if necessary) every hour throughout the school day. Because temperature is a continuous variable, the readings do not have to be taken on the hour, but can be done between lessons and at other convenient times. This gives an opportunity to discuss the fact that thermometers need to be placed out of direct sunlight, away from buildings, and so on, so that air temperature is recorded.

The diurnal effect should show up well. Draw the results onto a line graph and compare it with the full day graph shown on page 41 of the student book.

Seasonal effects

It is hard for students to measure the weather on a seasonal basis. It will be best to use long-term, published station data for this (see the web site).

Maximum and minimum

You can look into how maximum and minimum air temperature changes occur. This might be an extension of the heat island effect (see page 36 of the student book), but few students will have maximum and minimum thermometers at home. It is probably best therefore to make this a demonstration rather than a project.

Many pupils are unaware of how low the temperature becomes overnight. The coolest time of the day is just after dawn (test how many students think it is midnight), and most pupils do not go out until the temperature has begun to rise.

Compare the maximum and minimum figures with a reading taken at 9am to see how much colder the air was overnight.

The maximum temperature will be in the early afternoon. Discuss with students why it is not hottest at 12 noon when the Sun is at its highest, using page 40 of the student book as a guide. Then ask why the minimum temperature might be after dawn.

Clouds and temperature

Text book diagrams commonly show the Sun heating the ground, which in turn heats the air. But students may ask why the temperature still rises, even though it is cloudy all day.

A maximum and minimum thermometer might be handy to show that the maximum is lower on a cloudy day than on a sunny day. This shows that the radiation received by the Sun (insolation) is less. Some radiation does get through clouds, even though they reflect back about 80% of it.

(**NOTE:** to be more complete, you may also need to know this: the temperature of the air does not depend on whether or not the Sun is shining. The answer is complicated (as with so much of meteorology). Here is an abbreviated answer so you have the background.

Air moves from the tropics to the poles and back. This air is warmed or cooled regionally, not locally. Tropical and polar air mix in the depressions of the mid-latitudes. It takes a long time for air to cool or to warm, so air flowing from the Sahara Desert over the Atlantic Ocean to Britain, for example, is still warmer when it arrives than air flowing down from the Arctic Ocean. This is why a sunny day with air flowing from the tropics gives a 'scorcher', while a cloudy day with air flowing from the tropics is still hot.)

(iii) Clouds

When students look out of the window, they see clouds. These are the most obvious, real objects connected to weather studies. Clouds are also shifting and changing form all the time, so they are of perennial interest.

Many students are fascinated by the words for clouds. Try to spot the many kinds of different clouds.

Encourage students to try to identify each type of cloud and become a weather forecaster as a result.

Use the interest in cloud spotting to develop the principles of cloud formation. For example, cumulus clouds are associated with rising bubbles of air, stratus clouds with the lifting of a layer of air at a front or at mountains. These effects are all described in the student book.

Project: making a cloud

The most difficult part of weather study is to understand how clouds form and dissipate. This is because so many things are going on at the same time. The air has to be humid, the temperature has to be falling, and there have to be small particles of dust, soot, etc, in the air on which the water vapour can condense.

One way in which you can show how a cloud forms and how it can also go away, is to take a large clear glass jar (about 4–5 litre capacity) which has a neck big enough for you to get your fist into easily. This will be a model atmosphere.

Place a small amount of water in the jar, enough just to cover the bottom. This will provide the moisture in the atmosphere. Allow it to stand for a while so that the air in the jar becomes saturated with water.

Now place a transparent freezer bag over the neck of the jar and fix it with rubber bands. The bag has to be large enough to be punched right into the jar and pulled out again.

Now grab the end of the bag and push it into the jar quickly, then quickly pull it out again. This increases the air pressure in the jar (when you push the bag in) and decreases it rapidly when you pull the bag out. As a result of a sharp lowering of the pressure, the temperature drops quickly, just as it would when bubbles of air rise in the atmosphere.

The trouble is that nothing happens!

Don't worry. You have simply demonstrated that changing the temperature of moist air is not enough on its own to produce cloud.

Take the bag off the jar, light a match and wait for it to flare up and start releasing smoke. Hold it in the jar, then let it drop. It will produce smoke.

Quickly fit the freezer bag back again and repeat the push–pull sequence. This time, the cloud will appear because there are now smoky particles in the air for the vapour to condense on to.

If you push the bag back into the jar, the cloud should disappear because the air pressure will be increased, and with it the temperature. This shows that warm air can hold more moisture than cold air.

NOTE: you may have to experiment a bit to make this work, so don't make your first attempt a demonstration with all the students watching. Try it at home!

Describing clouds

Clouds are described using four words. The first two words – **cirrus** and **stratus** – refer to layer clouds. The next one is a bubbling cloud type called **cumulus.** Finally, **nimbus** or rain-bearing clouds – as in cumulonimbus, or nimbostratus.

> Photographs of the cloud types listed here, and many more, can be seen at our web site: www.CurriculumVisions.com

Stratus and cirrus

Clouds occur at all different heights. To tell people about the height, these terms are used:
cirro – the highest level clouds, made entirely of ice crystals; and
alto – medium-level clouds.

Mid-level clouds form between 2,000 and 6,000 m (7,000 to 20,000 ft). They are warmer than high-level clouds and are made up mainly of water droplets. They may also contain ice crystals (alto stratus, alto cumulus). These clouds are thick enough to have darker undersides.

Low-level clouds have undersides below 2,000 m/6,500 ft. They may also contain ice crystals (stratus, stratocumulus, nimbostratus).

Cumulus

Cumulus clouds are not layer clouds and so are not confined to any particular height band. These tower clouds may be produced by unstable hot air rising (like a hot air balloon), although they may also form at fronts, especially cold fronts. The depth of a cumulonimbus cloud can be 12,000 m/40,000 ft (cumulus, cumulonimbus).

Sometimes very ragged-looking cumulus clouds can be seen scudding across the sky. They normally form beneath nimbostratus clouds, at the edge of a warm front.

Here is a brief description of the main kinds of cloud, and what they mean in terms of weather.

Settled weather: cirrus streaks

High-level clouds means those entirely above 6,000 m/20,000 ft. There is little moisture at these levels. It is entirely in the form of ice, so the clouds are thin, have little mass and are typically ‘fuzzy’, forming streaks and ‘mares’ tails’. They are too high and too thin to have darker undersides.

Settled weather: fair weather cumulus

Fair weather cumulus clouds are often called cotton wool clouds. Each cloud may not last much more than half an hour. They are caused by rising bubbles of warm air (thermals) from ground heated by the sunshine, but they do not grow because air is sinking above them (high pressure), acting like a lid. This is why they tell of fine weather. They are thick enough to have darker undersides.

Settled weather: pink and purple on the horizon at sunset or brilliant coloured sunset (red sky at night)

The adage “Red sky at night, shepherd’s delight” is a truism that many children learn. The pink and purple colours, and the brilliant sunsets are caused by light being scattered by the dust in the air. The dust is only there because the weather is settled; it would get washed from the sky if the weather were changeable and rain was about.

First sign of change on the way: cirrostratus veils the Sun

Cirrostratus is different from stratus. Instead of ‘mares’ tails’ associated with fine weather cirrus, cirrostratus is a sheet of high level ice crystals that begin to make a thin veil. These clouds mark the leading edge of a depression.

Changeable weather getting close: altostratus, watery sky

Thin, medium-level layer cloud appears to have no form. It creates no halo, almost obscures the Sun, but without any shading, and gives a watery sky. When it occurs after high level cirrostratus, it means the front is getting closer.

Altostratus clouds are lower than cirrus clouds and are made entirely of water droplets. The clouds are too thin to produce rain.

Thunderstorm weather possible: altocumulus; mackerel sky

Altocumulus (Ac) at the start of a warm day means that bubbles of air are rising over a large area. It may well result in thunderstorm activity by afternoon. Altocumulus clouds never produce rain.

Thunderstorm with lightning and strong winds: cumulonimbus

Cumulonimbus clouds (Cb) can form individual towers or make a line of towers, called a squall line. The lower levels of these clouds contain water droplets; the upper levels have ice crystals as well. Large cumulonimbus clouds are connected with powerful thunderstorms that are called super-cells. These are the clouds that produce lightning, large hail, damaging winds, and tornadoes during the afternoon and early evening when the effects of heating by the Sun are strongest.

Sometimes pouch-like forms can be seen hanging from the base of tower clouds. Cumulonimbus clouds may lead to tornado development.

Cloudy weather with possible drizzle on the way: stratocumulus

Stratocumulus clouds are low, lumpy layers and rolls of clouds, often associated with drizzle. Stratocumulus are grey with darker undersides, but they are not really thick clouds.

Use a 'rule of thumb' to tell altocumulus from stratocumulus by holding your arm straight out in front of you. Altostratus clouds are thumb-sized, stratocumulus clouds are fist-sized.

If this kind of cloud is forced onto mountains, it may thicken and produce prolonged high intensity, drenching rain, known as Scotch Mist.

Low cloud and light rain or fog: stratus

This is the lowest of the clouds, with a base often just a few hundred metres above the land. This is why, if stratus cloud rolls on land from the sea, it simply gives fog.

Stratus cloud is not thick and never gives rain more intense than drizzle.

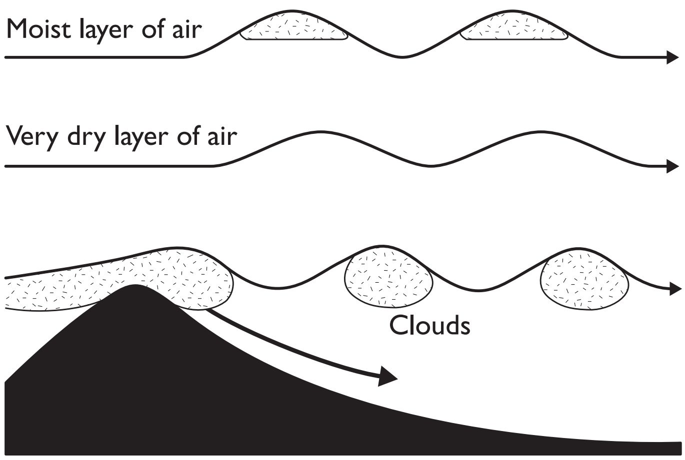
Period of continuous rain setting in: nimbostratus

Nimbostratus is simply rain-bearing stratus. It really refers to multilayered cloud that builds to great thicknesses and can produce heavy and prolonged rain. This is the kind of cloud often found at warm fronts.

Multilayered clouds are the result of the whole lower atmosphere being lifted off the ground at a front. Air cools and clouds form at all levels. Ice crystals form in the cold, upper regions of the cloud. As these fall, they grow and produce large raindrops.

Their bases lie below 2,000 m/6,500 ft, but their tops may rise to 10,000 m/33,000 ft.

Nimbostratus clouds are too thick to allow sunshine to penetrate them. They have no particular shape, but their undersides are generally dark and ragged.



Mountain cloud

Mountains may force layer clouds to rise over them, thickening the layers, or they may produce clouds when all the surroundings are clear. Both of these are relief effects.

On the lee of a mountain the air sinks, often bouncing up and down as it moves away from the mountain. The top of each bounce gives lens-shaped or lenticular clouds.

(iv) Wind

Air flow is easier to measure than its cause is to explain. It is perhaps best to concentrate on the effects of wind. That is, a wind from the north (or east in winter) brings cold air; a wind from the south brings warmer air; a wind from the north west (the most common) brings showery weather; a wind from the south west often brings mild, cloudy weather.

The idea that wind comes from somewhere can be used to produce a wind rose diagram, which is a bar chart based on a circle (see worksheet 21A). Bars are drawn from the circle in the direction of the wind, like spokes on a wheel. The longer the bar, the more times the wind has been measured from that direction. You can get the idea of prevailing wind from this.

The logical extension of this study for older students is to introduce them to air masses, but that will not be covered here.

Wind direction

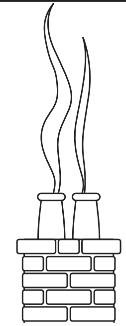
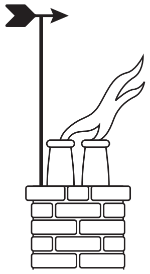
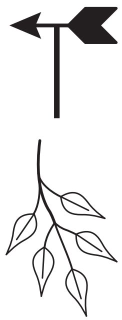
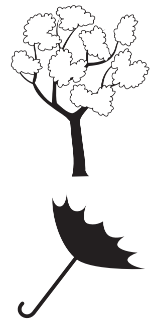
The direction of the wind gives important clues to the weather. More advanced students will also be able to deduce changes in pressure from the wind direction. This is because, if you stand with your face to the wind, the low pressure is on your right-hand side.

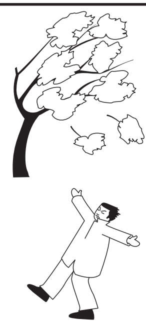
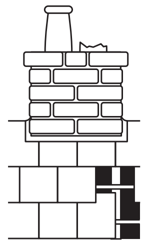
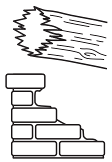
Wind direction can be measured accurately with a wind vane. Wind vanes can be purchased or made. If this is too much trouble, here is another way that uses the minimum of equipment and also gets children used to taking measurements.

All you need is a Silva-type compass from an Outdoor Shop. Set the compass so that the north needle is over the north position on the housing, and then mark out the eight main directions of the compass on a large chalk circle on the playground.

To find the direction of the wind, children can stand in the centre of the circle and deduce when the wind falls onto their faces.

H The Beaufort Scale (see page 45 of the student book)

Strength	0	1	2	3	4	5	6
Diagram of strength							
Description	Calm Calm; smoke rises vertically.	**Light air** Direction of wind shown by smoke drift, but not by wind vanes.	Light breeze Wind felt on face; leaves rustle; ordinary vane moved by wind.	Gentle breeze Leaves and small twigs in constant motion; wind extends light flag.	Moderate breeze Raises dust and loose paper; small branches are moved.	Fresh breeze Small trees in leaf begin to sway; crested wavelets form on inland waters.	**Strong breeze** Large branches in motion; whistling heard in telegraph wires; umbrellas used with difficulty.
Windspeed	0 km/hr 0 mph	3 km/hr 3 mph	6 km/hr 4 mph	16 km/hr 10 mph	26 km/hr 16 mph	38 km/hr 24 mph	50 km/hr 31 mph

Strength	7	8	9	10	11	12
Diagram of strength						
Description	Near gale Whole trees in motion; inconvenience felt when walking against the wind.	Gale Breaks twigs off trees; generally impedes progress.	Strong gale Slight structural damage occurs (chimney pots and slates removed).	Storm Seldom experienced inland; trees uprooted; considerable structural damage occurs.	Violent storm Very rarely experienced; accompanied by widespread damage.	Hurricane Severe damage.
Windspeed	59 km/hr 38 mph	74 km/hr 46 mph	86 km/hr 54 mph	100 km/hr 63 mph	115 km/hr 72 mph	Over 116 km/hr 73 mph

It's quite accurate enough to the nearest point of the compass. Alternatively, children can stand holding the compass (set as described above) and find where the wind catches them full in the face. They can read off the direction or, if you are doing maths, for example, take the bearing (the angle clockwise with respect to north).

Chart the results over, say, a week, or a month, or a week in each season. A wind rose can be made as described above.

Wind speed

Another useful measurement is that of wind speed. You could buy an anemometer. This will give accurate local results and, if you buy the portable version, you can use it to show how buildings and other features provide shelter. But, if you don't have the resources, it is difficult to gauge the wind accurately. One of the most interesting ways is to get a class to discuss the Beaufort Scale, which is a practical scale which was designed to help sailors judge wind speeds. A copy of it is reproduced on the page opposite.

A model anemometer has a limited use for telling wind speed, and equally meaningful results can often be obtained with a wind sock, a tube of lightweight fabric such as nylon. It is funnel shaped, with the wide end held open by a ring of wire, just like a fishing net. You can make one by using a cane from a gardening shop and a length of green garden wire; then make the wind sock of any very light material, the lighter the weight the better.

A long cane allows you to put the wind sock well above the ground. In this way you can start to show that the wind speed is greater above the ground. You can also walk around a building, showing the same shelter effects as if you used an anemometer. The results with a wind sock are best seen on a breezy day, because it takes a little wind to get the sock to lift. Ask your students to look at the angle of the wind sock. With calm conditions, the wind sock hangs limp; as the wind speed increases, the sock begins to lift until, in a strong wind, it is horizontal. Of course, the actual speeds at which these changes take place depend on the construction of the wind sock, so all of your demonstrations should stress comparative value – for example, "the wind sock is more nearly level in this area because the wind is greater than where we just held it…" and so on.

(v) Air pressure

The most sensitive instrument for measuring air pressure is a barometer. A small, aneroid barometer will give good results. This is a good way to introduce children to line graphs. Do not use bar charts for air pressure change because it changes continuously with time. A simple measurement each day for a week at the start of lessons will provide five readings that can be joined by a smooth curve.

To make this a more interesting task for children, and to get them to use their mathematics skills, have a look at the weather forecast before you start the period of air pressure measurements. Try to avoid a period of high pressure when nothing much is happening. The best times for rapidly changing weather are often October and April, whereas a period of high pressure in January or June can make the children dispirited.

This is what you should look for on your graph.

When the curve is sloping down to the right, the atmosphere is changing from high pressure to low pressure. When the slope is tilting up to the right, the change is from low pressure to high pressure.

Many children will like to do the measurement for its own sake. They can then say that humps in the chart are high pressure and dips are low pressure. Slopes are change. The absolute pressure is often not important.

How to talk about air pressure

When someone asks you to explain what pressure means, you have a challenge on your hands that goes to the heart of meteorology. Here is an ideal opportunity to talk about pressure as a force and to combine weather with science. Try something like this.

The air is a gas, made up of molecules of oxygen, nitrogen, carbon dioxide, water vapour, and so on. These molecules are all invisible, that is, they are transparent, but they do have mass.

Gravity pulls the molecules towards the centre of the Earth. The molecules near the outside of the Earth's atmosphere press down on those below, so that, at the ground, the number of molecules pressing down is greatest whilst, near the edge of the atmosphere, very few molecules are pressing down on others, and so air pressure is low.

You can represent this using polystyrene beads – the kind you get in packaging. Obtain a tall, transparent jar and a small sandwich bag. Blow a small amount of air into the bag and tie the end in a knot. Put it in the jar. You want it to be inflated but not taut. The idea is that the bag will squash down a little as the polystyrene beads are poured in on top. The polystyrene represents air molecules. The more there are, the greater their weight, the more pressure they put on the bag and the more it squashes.

An alternative method is to put the jar onto kitchen scales and add beads. The more you add (the more molecules of gas are in the column), the more they press down on the scale pan, and the more the scale reads.

The idea of using the polystyrene beads is that they are light, but still have some weight and yet can be thought of as molecules. Even if you piled the beads on top of a student, the student would not be crushed. And, of course, neither are we crushed by the pressure of air on our heads.

Highs and lows

The air pressure is always highest near the ground because the weight (mass x gravitational force) of the air above is pressing down. But, the air pressure is not the same everywhere near the ground. In some places it is higher – hence the term high pressure, whereas in other places it will be lower – low pressure.

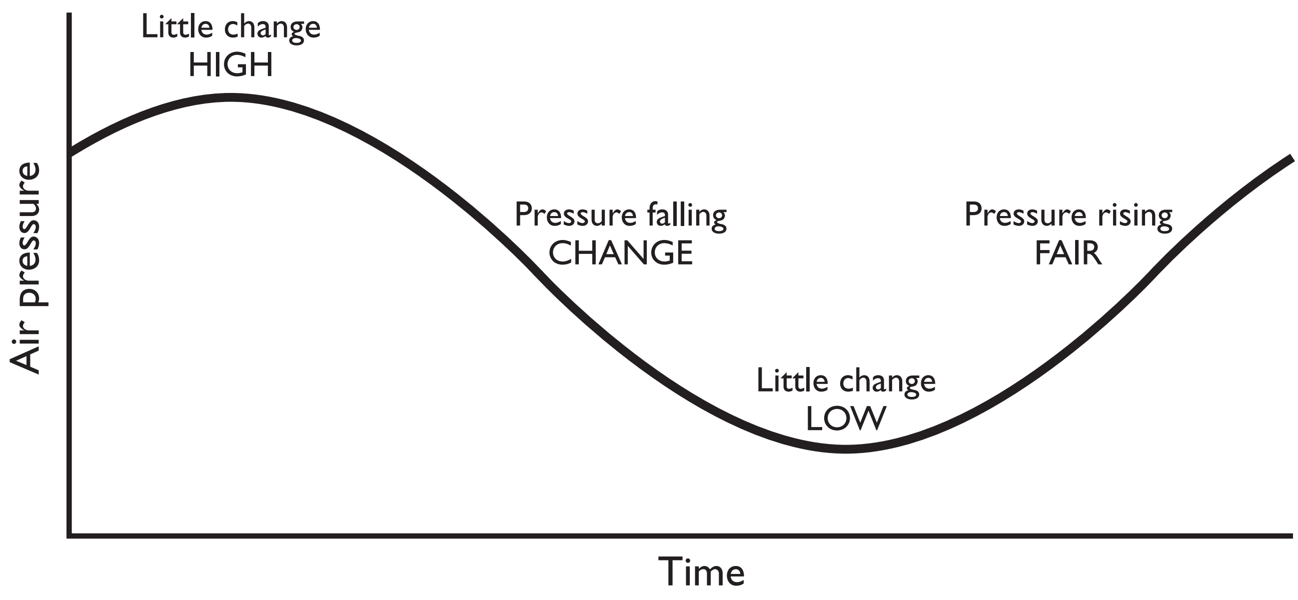
The difference in pressure can be due to two causes. On a very cold day when the air is still, the pressure is high because cold air is dense and the gas molecules pack together more tightly.

Highs and lows in the atmosphere are primarily caused by air flowing from one part of the atmosphere to another. This is part of the global circulation of the atmosphere. The topic is well beyond the syllabus, but the curious might be encouraged to think of mid-latitude highs and lows as follows.

First, get students used to the fact that moving air is a force. Blow down on a bowl of water and notice that the air flowing into the water surface pushes the water down before it has a chance to escape sideways. This is just like a high – the air flow is downwards and it builds up as a high faster than it can flow away. Thus you can easily see that pressure is caused by a flow of air.

The same is true in reverse. When air is sucked in, it causes a reduction in pressure and water rises. This can be shown by placing the nozzle of a vacuum cleaner over the water, but be careful if you don't have a wet and dry vacuum cleaner or you will get water into the bag!

Next, the idea that highs and lows are connected and are all part of a large flow. Imagine a fast-flowing river. What you see are eddies in the water. These funnel-shaped features are fast-spinning regions of water and quite random. Students can see eddies, so they can understand and see that some eddies go down, while others go up.



The jump is to imagine the atmosphere like this. As air flows along in mid-latitudes, it also creates eddies that carry air up whilst spinning, and these are balanced by those eddies that carry air down whilst spinning. All this is invisible because the air is transparent, but you can detect it using a barometer, so it is real enough.

Where the air spins, or corkscrews down, the air piles up on the ground and the extra pressure creates a high pressure region. Where the air corkscrews up, air is pulled off the ground and the rising air partly balances out the weight of the atmosphere. This gives a low pressure.

Where the air spins down, it also spins outwards. This allows air to come from high up in the atmosphere, where there is little moisture. So, high pressure tends to mean dry weather. Where the air corkscrews up, it pulls air in from the surroundings, and if this includes air that has been over an ocean it will be very moist. Rising moist air produces cloud and rain, and upward spiralling air gives a low pressure and also unsettled conditions. The low pressure is also known as a depression.

Incidentally, the air in a low is pulled inwards and upwards, so it often drags air from two different regions together. If this happens, the junction of the two different kinds of air will be called a front. Fronts are favoured places for cloud and rain.

So, here we have started with measuring air pressure, discovered highs and lows as spiralling corkscrews of invisible air, and seen that downward spiralling – an anticyclone – leads to high pressure with little rain, whilst upward spiralling – a depression – leads to cloud and rain.

Although the purists would find this description a liberty with reality, teachers do have to find some way of explaining the idea of highs and lows to students. The previous description is my way. For younger students it gives opportunities for activities. Line them up and ask them to alternate, one be an upward spiral, the next a downward spiral. So here, at least, atmosphere is on the move and it is rising and sinking and spinning all at the same time. You can at least conclude that “no wonder the weather is so variable!” as the children all lie exhausted on the floor after spiralling up and down for a while. You will find that this idea, with the class exercise, sticks in the mind for ever!

(vi) Evaporation, transpiration and condensation

Evaporation is the change from liquid water to water vapour. A source of energy is needed for this. Water evaporates when it is boiled, but you don’t need boiling conditions for evaporation, simply a source of dry air.

A saucer of water will turn to water vapour and disappear as if by magic.

Look for evaporation in the kitchen. Steam is water vapour that has evaporated and then condensed into droplets in the cool, room air.

Trapping transpiration

To trap the water transpired (evaporated) from plants, put a clear plastic bag around some leaves on a tree branch.

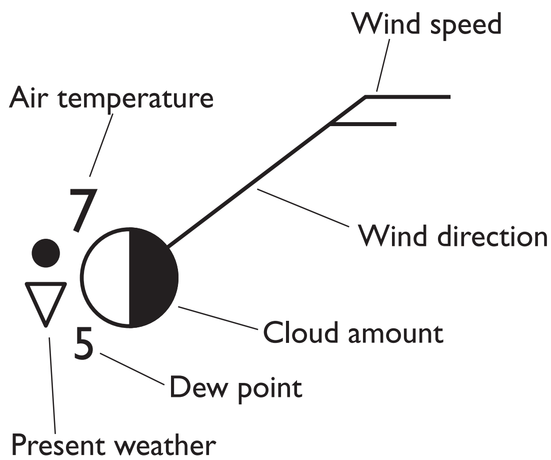
Choose a sunny day and then watch the water appear. Within a few minutes the inside of the plastic will be steaming up. If you hadn’t trapped it, all that water would have become moisture in the air.

Collecting condensation

You can collect dew using a polythene sheet, held down with stones, over a small hole with a cup in it. Place a stone in the centre of the sheet to make a cone shape. Set it up in the heat of the day and leave it overnight on a cold night to collect dew in the cup.

Weather chart symbols

▼ Diagram of the station data for a weather chart.



▼ Table of the symbols used to show the amount of cloud.

Symbol	Cloud amount (oktas)
	0
	1 or less
	2
	3
	4
	5
	6
	7
	8
	Sky obscured
	Missing or doubtful data

▼ Table of the symbols used to show the weather.

Symbol	Weather
	Mist
	Fog
	Drizzle
	Rain and drizzle
	Rain
	Rain and snow
	Snow
	Rain shower
	Rain and snow shower
	Snow shower
	Hail shower
	Thunderstorm

▼ Table of the symbols used to show the windspeed.

Symbol	Wind speed (knots)
	Calm
	1–2
	3–7
	8–12
	13–17
For each additional half-feather add 5 knots	
	48–52

What do I teach about weather systems?

This is a difficult topic. But the fact that weather systems are seen every day on the weather forecaster's chart makes it also irresistible. Students also often ask questions about the weather charts.

So there are two sections to the answer. You can describe what the symbols mean and leave it at that, or you can try to go further. Below, you will find a description of how weather systems form and what they contain. Much of this area of work is too advanced for the student book and is, therefore, only briefly referred to in it under the heading of 'Changeable weather', page 30.

Weather systems: what they are

Weather systems consist of alternating strings of high pressure regions (anticyclones or highs) and low pressure regions (mid-latitude cyclones, depressions or lows). Highs bring settled weather because air is sinking in them, whereas lows bring rain because air is rising, often at a frontal zone.

Lows of this kind occur anywhere between 30 and 60 degrees latitude. This includes all of Europe, much of north Asia, North America and in southern Australia and New Zealand.

Mid-latitude cyclones

The mid-latitudes contain numerous swirling eddies of air. Those eddies with a sinking motion are called high pressure regions or anticyclones. Those eddies with rising air are called low pressure regions, cyclones or depressions. The winds blow anticlockwise and inwards in the northern hemisphere and clockwise and inwards in the southern hemisphere.

Eddies with rising air suck in air from the surroundings. Typically, cool air with relatively little moisture can be sucked from the poleward side of the cyclone, and warm air with much more moisture is sucked in from the tropical side of the cyclone. The zone where these different kinds of air meet is one of the most active places for cloud development in the world. It is called a frontal zone, or simply a front.

A warm front has cold air ahead and warm air behind. A cold front has warm air ahead and cold air behind. Both warm and cold fronts are found in many cyclones; the cold front is often the more active feature.

Because the warm air is less dense than the cold air, as the two kinds of air are sucked into the cyclone, the warmer, less dense, air rises. The moist air in it cools and a great thickness of clouds form, from which rain commonly falls. The clouds are mainly nimbostratus on the warm front and cumulonimbus on the cold front.

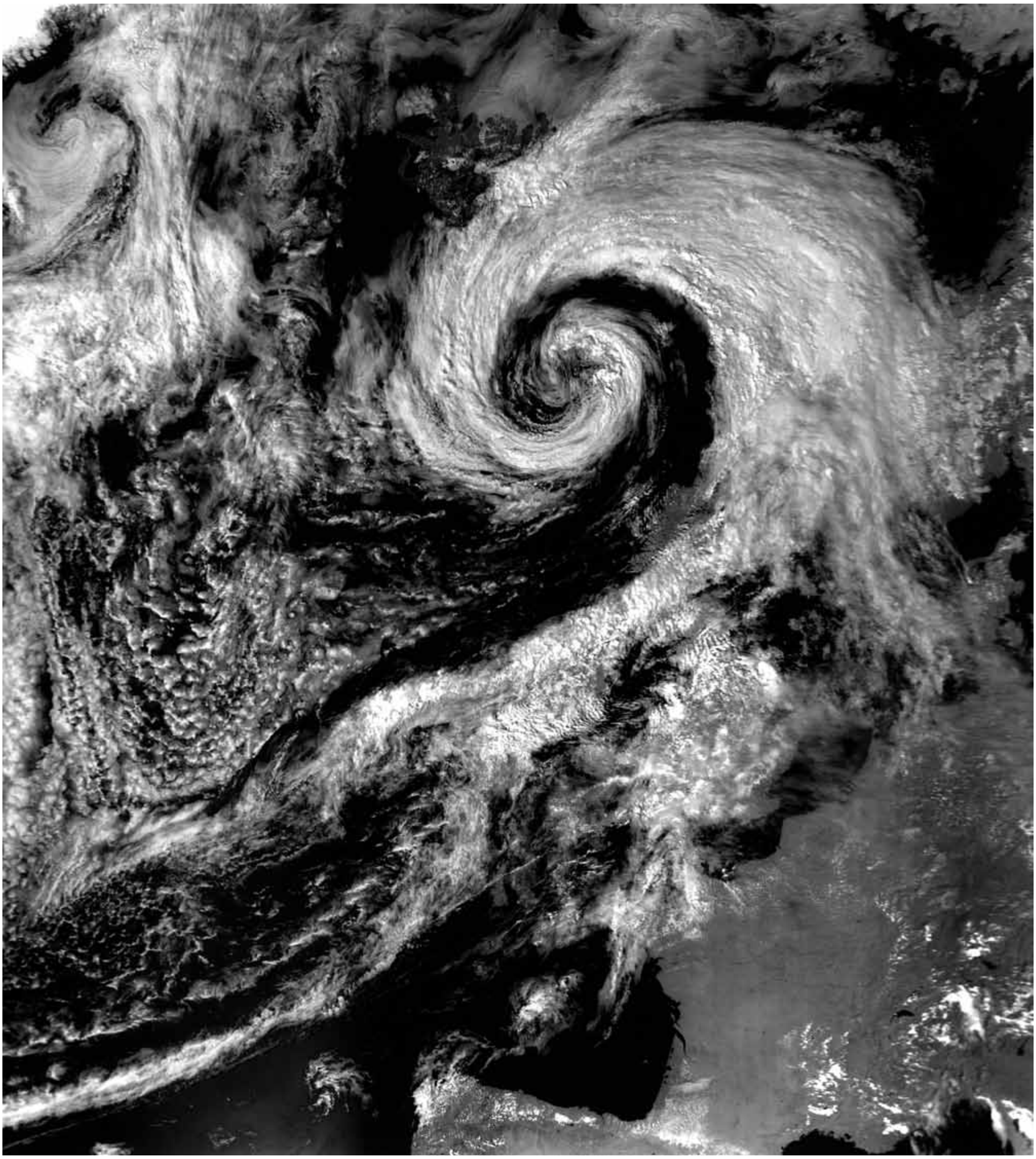
On satellite images, cyclones are identifiable by a comma-shaped pattern of cloud bands, as you can see on the next page.

This is the kind of weather map shown on TV and in the newspapers.

Students can be told that the lines are contours of pressure and that an H can be thought of as a hill (for high pressure) and an L as a basin (low pressure). Air flows from high to low just as the land slopes from hills to basins. The steeper the pressure gradient, the closer the lines, just as close lines mean a steep slope on a contour map. So, lots of lines mean windy conditions.

But it is very difficult to go on producing easily understood parallels because lows are 'eddies' that suck air up into the sky, whilst highs spiral air down to the ground.

Weather maps often show the teeth and bumps of fronts. The teeth and bumps point in the direction the front is moving. If you want to know more, in-depth information can be found on the web site.



▲ An enlarged version of the picture on page 30 of ***Weather around the world***.
(Photo reproduced courtesy of the University of Dundee)

Section 5: Photocopiable worksheets

Introduction

It is intended that you photocopy the front of the worksheets for students to complete.

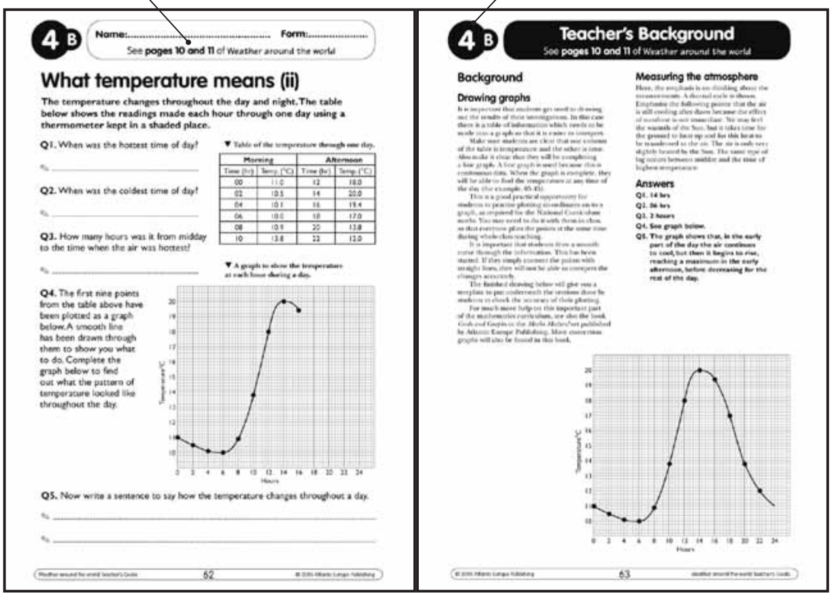
Each worksheet number is shown in a circle at the top of the page.

At the head of each worksheet are the relevant pages of the student book. So, '**See pages 10 and 11** *of Weather around the world*, means that the answers can be found by using pages 10 and 11 of the student book.

Page 49 provides instructions for the student. In some cases students will need to colour in the diagrams on the worksheet.

Opposite each worksheet are the answers, accompanied by background information. This additional information is intended to help you provide an overview to the relevant pages in the student book, set the context to the questions, and present some additional important points. Where appropriate, the background information to the worksheet may be several pages long.

Refers to the page numbers in the student book to which the worksheets relate.



The left-hand page is to photocopy and hand out to pupils.

The right-hand page provides the answers and teacher's notes.

Student instructions

Make sure you write your name and class at the top of each sheet.

✎ This symbol indicates where you should write your answers.

Graph paper

1

Name:.. **Form:**..................

Based on **pages 4 to 9** of *Weather around the world*

What will the weather be like? (i)

1. Choose one of the pictures from the Weather Picture Gallery CD that gives its place name. It does not have to be a picture of good weather. Then follow the on-screen instructions to make it into a postcard.

2. Write a short message to a friend on the back of the card, telling them what the weather was like in your chosen place. Then write their address on it and give it to them.

3. Write here what information you found out that helped you to put yourself in the shoes of someone at your chosen place. For example, did you look at the "Tell me more..." section of the CD? Did you type "the place name" and "weather" into a search engine on the Internet and look to see what came up? Or did you type "the place name" and "holiday" into the search engine? If you did both, did you get the same answers?

✎ ....

✎ ....

✎ ....

✎ ....

✎ ....

✎ ....

✎ ....

✎ ....

✎ ....

✎ ....

✎ ....

✎ ....

Background

This worksheet gets students under way with the idea of world weather by getting them to choose a place remote from where they live and then trying to find out what the weather was like there and writing about it.

In the long run, they could gather much of their information on weather study as a collection of postcards if you wish. They can, of course, also make their own postcards.

At this stage they will clearly know very little about the place they have chosen. But the choosing of a place does encourage research skills and so combine ICT with geography.

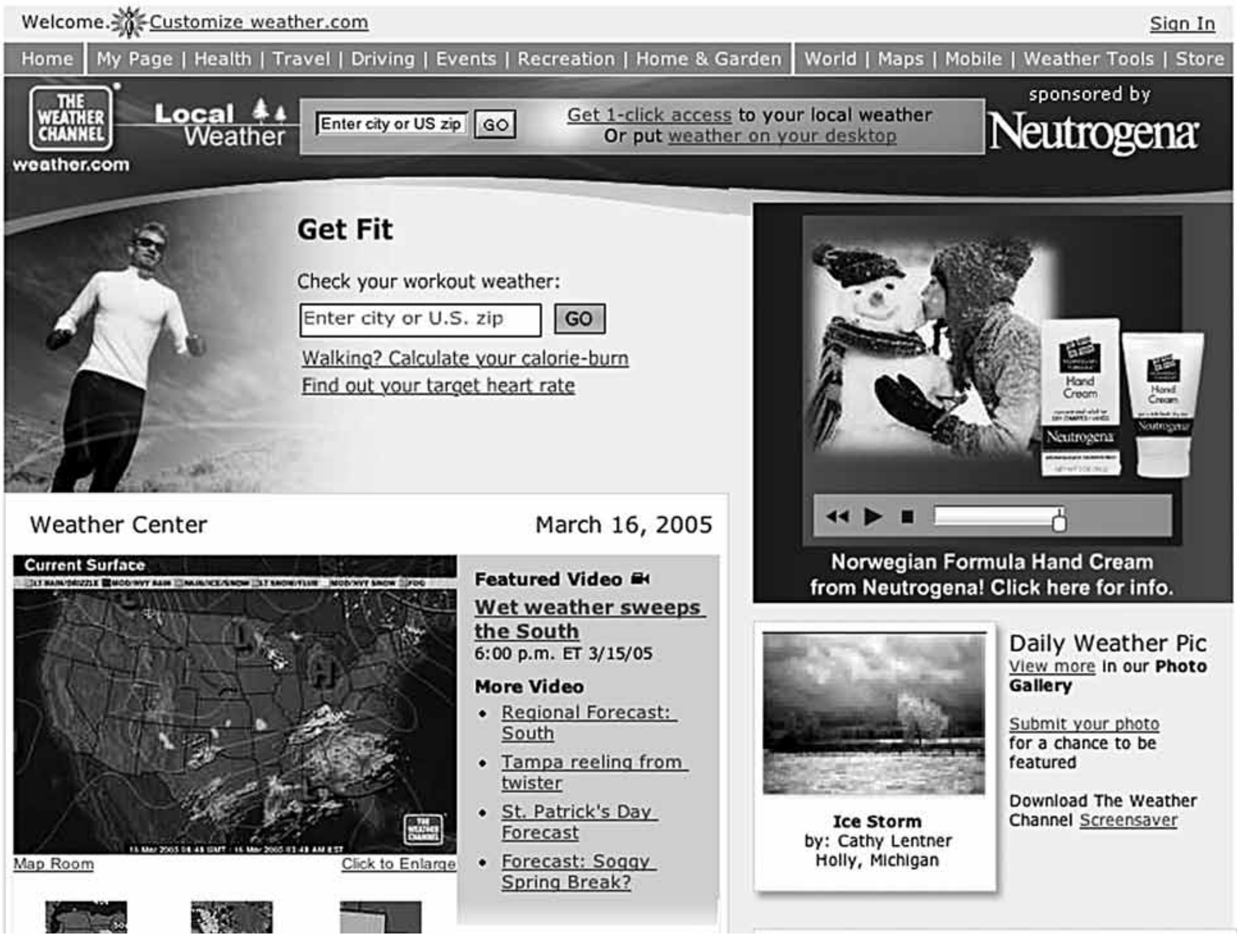
It is vital that if students search the Internet for information, that they are guided as to how to make some kind of assessment of that information. For example, they should use a variety of sources, not just one, and ask themselves if the source is biased. For example, have they found a holiday site, in which case the best of the weather will always be shown.

They can find the weather today from many web sites. One of the best is

www.weather.com

Just type in a name and you can get the weather for that place as instant conditions. It is an American site, so use the search space (near the top of the screen when this book was written) to get where you want.

Students may give their postcard to a friend to read and then take it back and save it. Or you may want to save it, because it will be instructive to see what they have written at this early stage of study and compare it with what they might think at the end of their studies.



▲ The www.weather.com home screen. Web sites change and browsers vary so the screen you access may not exactly match the one shown here.

2

Name:.. **Form:**....................

Based on **pages 4 to 9** of *Weather around the world*

What will the weather be like? (ii)

You have to plan for a holiday in four different kinds of places. They are listed below. For EACH place, write down what you would take in your bag. What you take must match what you think the weather will be like.

Q1. What would you take for a winter skiing holiday in the Alps?

✎ ....

✎ ....

✎ ....

Q2. What would you take for a Spanish beach holiday?

✎ ....

✎ ....

✎ ....

Q3. What would you take for a tropical rainforest holiday?

✎ ....

✎ ....

✎ ....

Q4. What would you take for a beach holiday in Britain?

✎ ....

✎ ....

✎ ....

When you have finished you will be given some suggestions made by another student. Compare what they have put with what you have written.

2 Teacher's Background

Based on **pages 4 to 9** of *Weather around the world*

Background

This worksheet covers the first three spreads because they are all interlinked.

As background to this worksheet, we asked six students of varying ages what they would take. To do this they had to think about where the place was and what they were going to do. All of the holidays except the skiing were assumed to be 'summer' holidays.

The results have been reproduced here in two ways: as typed lists and as versions of the actual answers.

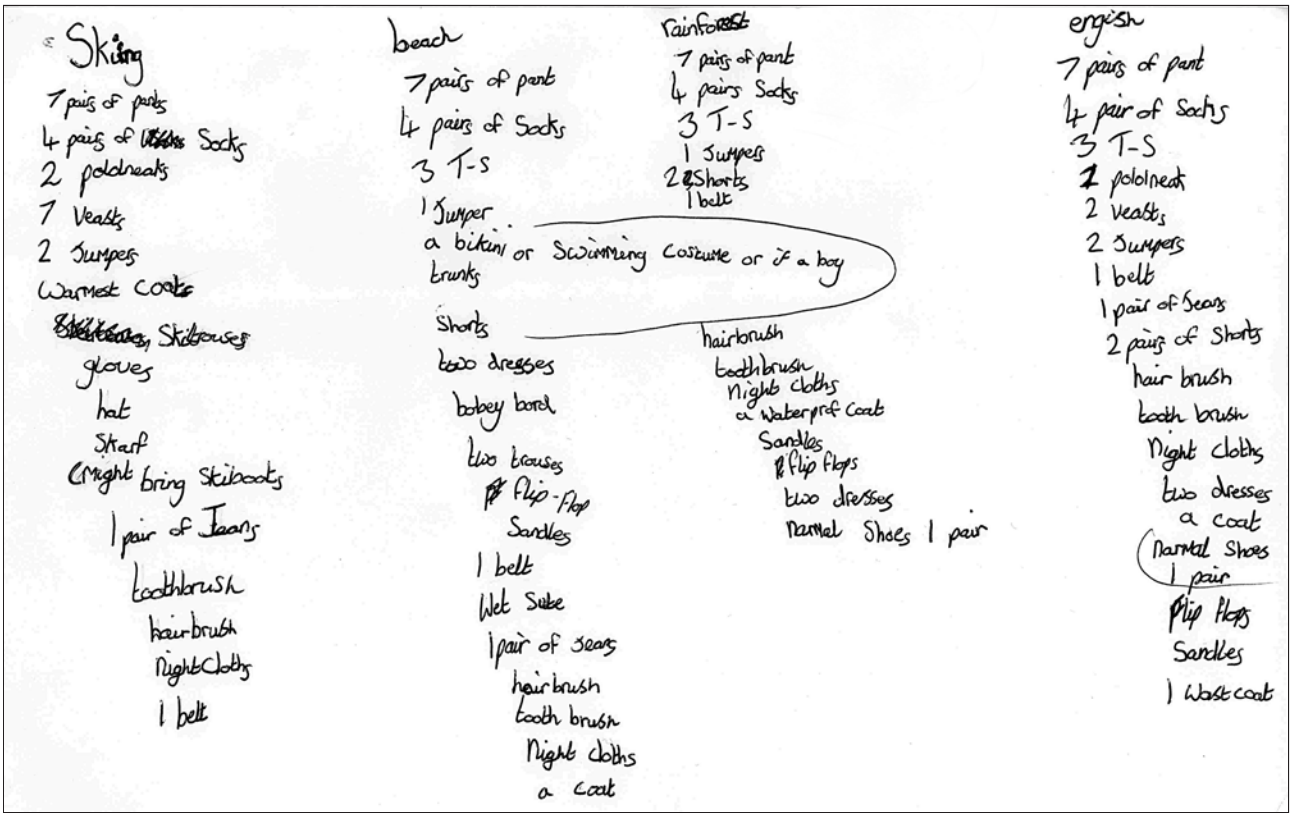
When students have completed their answers you may care to give out whichever sheets match the age and ability of your students. They can then compare what they have written with what the survey of students revealed.

Datasheets

The following pages contain example answers by students of various ages. You can use them for your own reference or hand out photocopied versions so that your students can compare what they thought with what people from other schools thought.

Name:.. **Form:**...................

Based on **pages 4 to 9** of *Weather around the world*


Skiing
7 pairs of pants
4 pairs of Socks
2 poloneaks
7 Veasts
2 Jumpers
Warmest Coats
Skitrouses
gloves
hat
Skarf
(might bring Skiboots
1 pair of Jeans
toothbrush
hairbrush
NightCloths
1 belt

beach
7 pairs of pant
4 pairs of Socks
3 T-S
1 Jumper
a bikini or Swimming Costume or if a boy trunks
Shorts
two dresses
bobey bord
two trouses
flip-flop
Sandles
1 belt
Wet Sute
1 pair of Jeans
hair brush
tooth brush
Night cloths
a Coat

rainforest
7 pairs of pant
4 pairs Socks
3 T-S
1 Jumpers
2 Shorts
1 belt
hairbrush
toothbrush
night cloths
a waterprof Coat
Sandles
flip flops
two dresses
narmal Shoes 1 pair

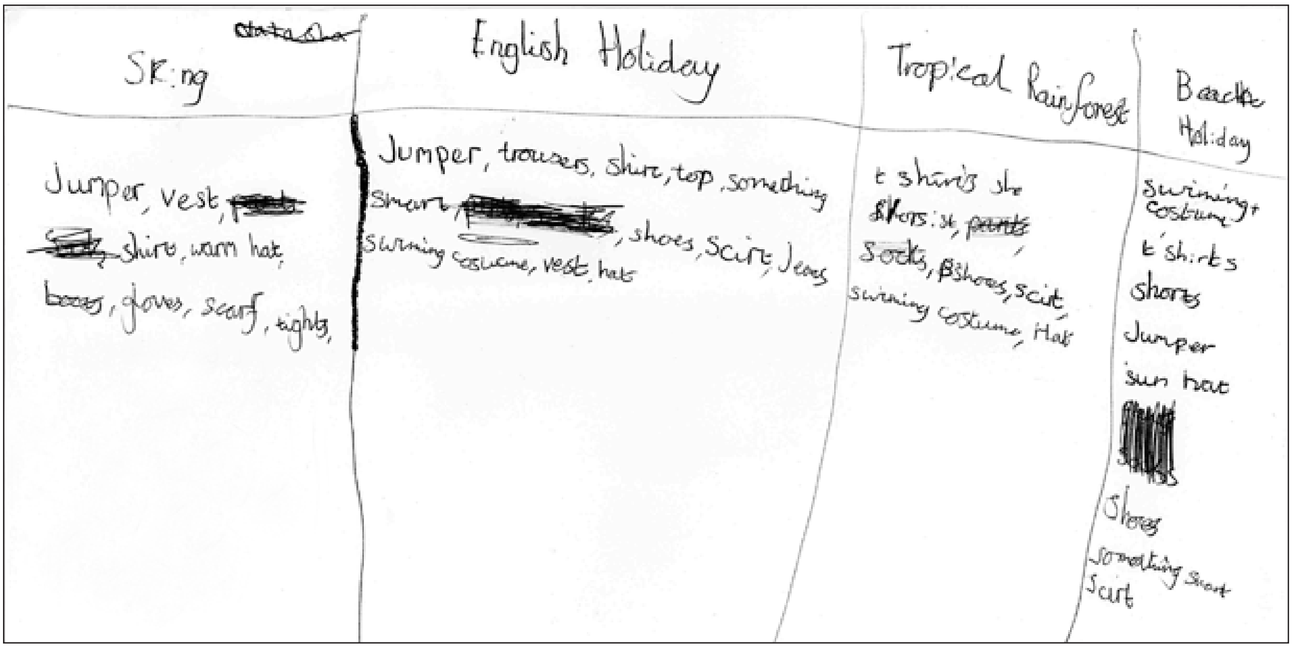
english
7 pairs of pant
4 pair of Socks
3 T-S
2 poloneak
2 veasts
2 Jumpers
1 belt
1 pair of Jeans
2 pairs of Shorts
hair brush
tooth brush
Night cloths
two dresses
a coat
narmal Shoes 1 pair
flip flops
Sandles
1 Wastcoat

LAURA (8)

Skiing	Spanish beach	Rainforest	English beach
7 pairs pants	7 pairs pants	7 pairs pants	7 pairs pants
4 pairs socks	4 pairs socks	4 pairs socks	4 pairs socks
2 polonecks	3 T-shirts	3 T-shirts	3 T-shirts
7 vests	1 jumper	1 jumper	2 polonecks
2 jumpers	a bikini/swimming costume/trunks	2 pairs shorts	2 vests
warmest coat	shorts	1 belt	2 jumpers
ski trousers	2 dresses	hairbrush	1 belt
gloves	bodyboard	toothbrush	1 pair jeans
hat	2 pairs trousers	waterproof coat	2 pairs shorts
scarf	flip flops	sandals	hairbrush
ski boots	sandals	flip flops	toothbrush
1 pair jeans	1 belt	2 dresses	night clothes
toothbrush	wet suit	1 pair normal shoes	2 dresses
hairbrush	1 pair jeans		a coat
night clothes	hairbrush		1 pair normal shoes
1 belt	toothbrush		flip flops
	night clothes		sandals
	a coat		1 waistcoat

Name:.. **Form:**...................

Based on **pages 4 to 9** of *Weather around the world*



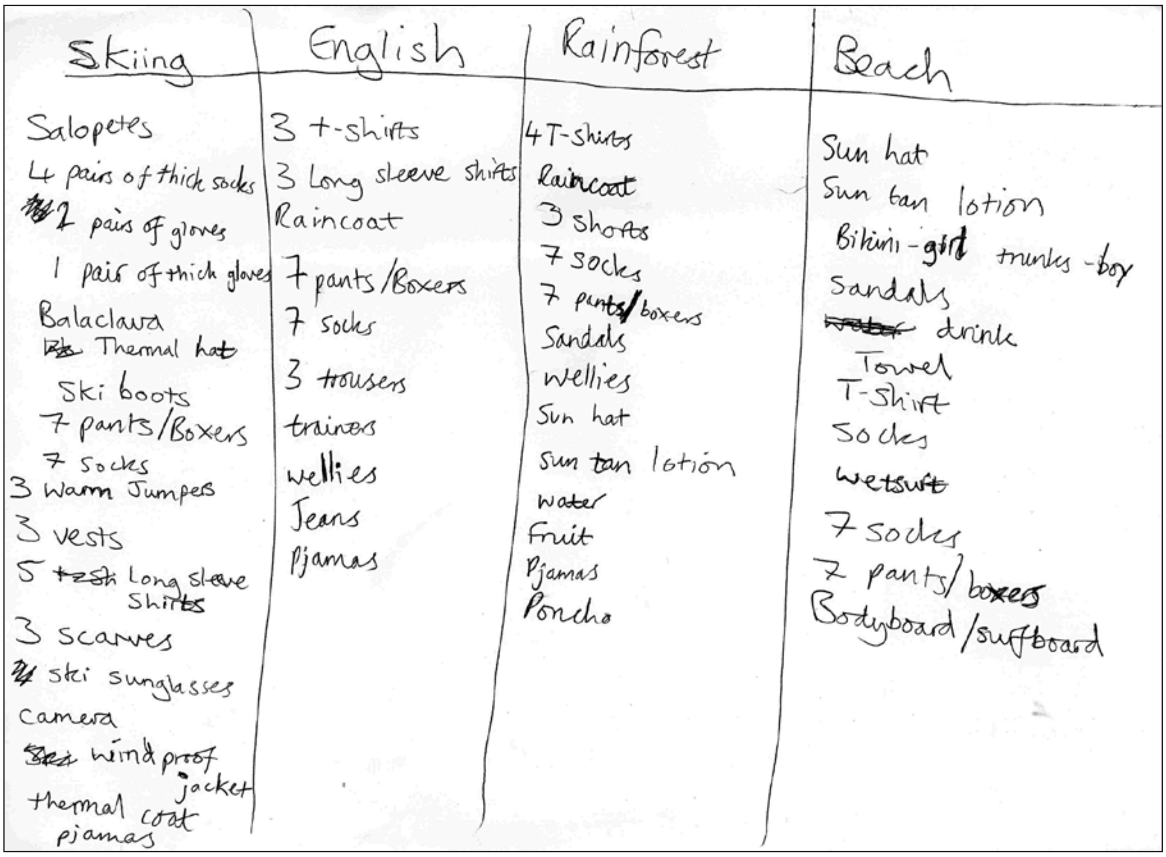
CHARLOTTE (6)

Skiing	Spanish beach	Rainforest	English beach
jumper	swimming costume	T-shirts	jumper
vest	T-shirts	shorts	trousers
shirt	shorts	socks	skirt
warm hat	jumper	shoes	top
boots	sun hat	skirt	something smart
gloves	shoes	swimming costume	shoes
scarf	something smart	hat	skirt
tights	skirt		jeans
			swimming costume
			vest
			hat

3

Name:.. **Form:**....................

Based on **pages 4 to 9** of *Weather around the world*



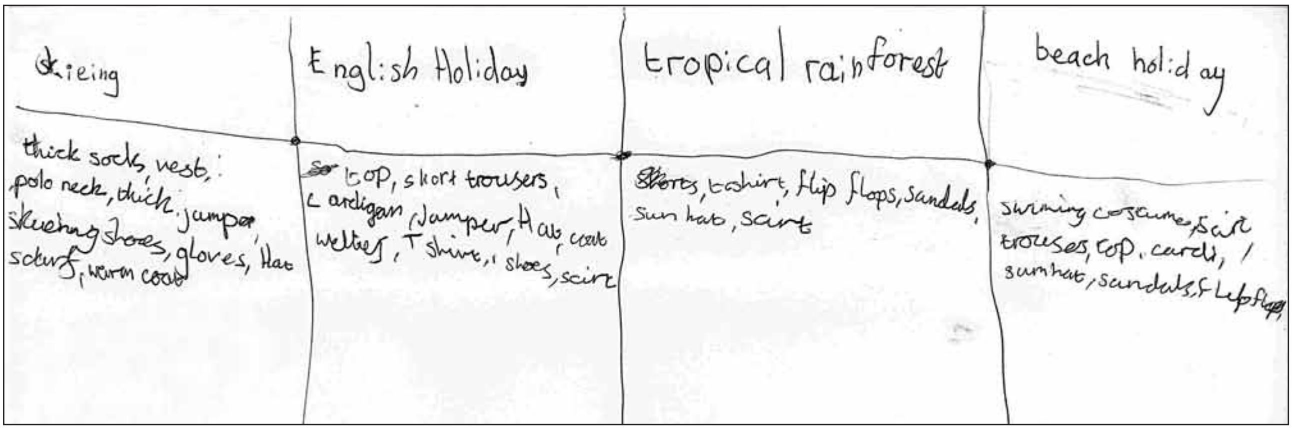
Skiing	English	Rainforest	Beach
Salopetes	3 t-shirts	4 T-shirts	Sun hat
4 pairs of thick socks	3 Long sleeve shirts	Raincoat	Sun tan lotion
2 pairs of gloves	Raincoat	3 Shorts	Bikini - girl trunks - boy
1 pair of thick gloves	7 pants/Boxers	7 socks	Sandals
Balaclava	7 socks	7 pants/boxers	~~water~~ drink
Thermal hat	3 trousers	Sandals	Towel
Ski boots	trainers	wellies	T-Shirt
7 pants/Boxers	wellies	Sun hat	Socks
7 Socks	Jeans	sun tan lotion	wetsuit
3 Warm Jumpers	Pjamas	water	7 socks
3 vests		Fruit	7 pants/boxers
5 Long sleeve Shirts		Pjamas	Bodyboard/surfboard
3 scarves		Poncho	
ski sunglasses			
camera			
wind proof jacket			
thermal coat			
pjamas			

THOMAS (11)

Skiing	Spanish beach	Rainforest	English beach
salopettes	sun hat	4 T-shirts	3 T-shirts
4 pairs thick socks	suntan lotion	raincoat	3 long-sleeved shirts
2 pairs gloves	bikini/swimming trunks	3 pairs shorts	raincoat
1 pair thick gloves	sandals	7 pairs socks	7 pairs pants/boxers
balaclava	drink	7 pairs pants/boxers	7 pairs socks
thermal hat	towel	sandals	3 pairs trousers
ski boots	T-shirt	wellies	trainers
7 pairs pants/boxers	socks	sun hat	wellies
7 pairs socks	wetsuit	suntan lotion	jeans
3 warm jumpers	7 pairs socks	water	pyjamas
3 vests	7 pairs pants/boxers	fruit	
5 long-sleeved shirts	bodyboard/surfboard	pyjamas	
3 scarves		poncho	
ski sunglasses			
camera			
windproof jacket			
thermal coat			
pyjamas			

Name:... **Form:**..................

Based on **pages 4 to 9** of *Weather around the world*



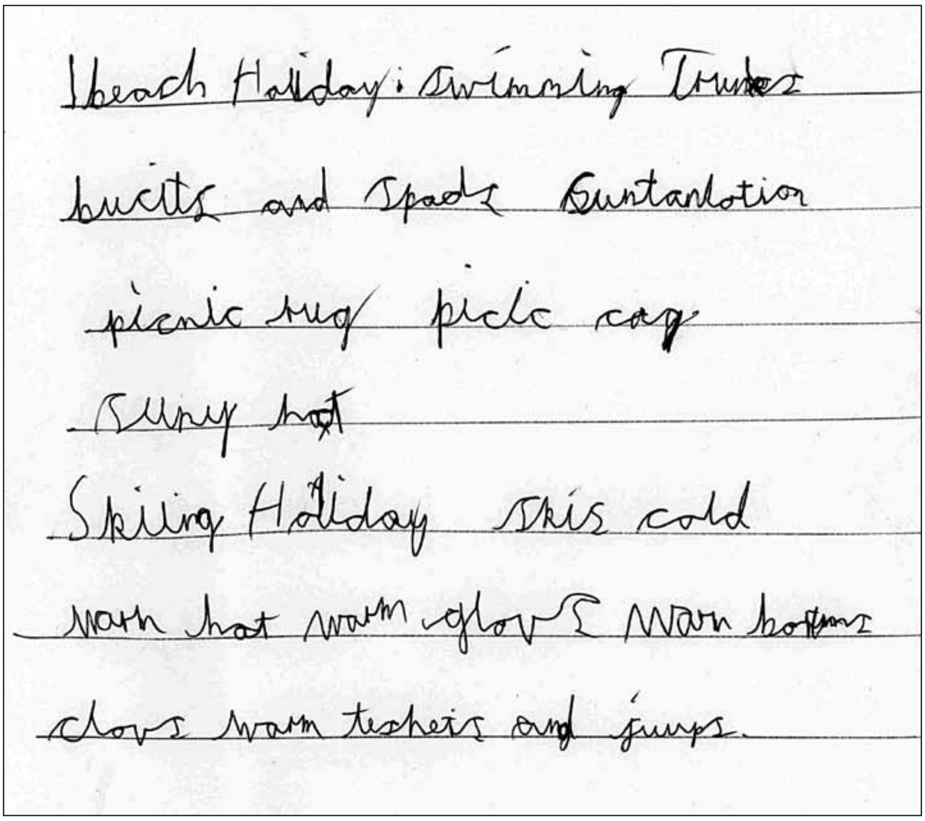
Skieing	English Holiday	tropical rainforest	beach holiday
thick socks, vest, polo neck, thick jumper, skieing shoes, gloves, Hat, sckurf, warm coat	top, short trousers, cardigan, Jumper, Hat, coat, wellies, T shirt, shoes, scirt	shorts, t-shirt, flip flops, sandals, sun hat, scirt	swiming costume, scirt, trouses, top, cardi, sunhat, sandals, flipflops

NATASHA (6)

Skiing	Spanish beach	Rainforest	English beach
thick socks	swimming costume	shorts	top
vests	skirt	T-shirt	short trousers
polo neck	trousers	flip flops	cardigan
thick jumper	top	sandals	jumper
skiing shoes	cardigan	sun hat	hat
gloves	sun hat	skirt	coat
hat	sandals		wellies
scarf	flip flops		T-shirts
warm coat			shoes
			skirt

Name:.. **Form:**...................

Based on **pages 4 to 9** of *Weather around the world*



beach Holiday: swimming Trunks
bucits and Spadz Suntanlotion
picnic rug pick cag
Suny hat
Skiing Holiday Skis cold
warn hat warm glovs warn bottoms
clovs warm troshers and jumps.

MARK (6)

Skiing	Spanish beach
skiis	swimming trunks
warm hat	bucket and spade
warm gloves	suntan lotion
warm bottoms	picnic rug
warm trousers	picnic bag
warm jumpers	sun hat

3

Name:.. **Form:**...................

Based on **pages 4 to 9** of *Weather around the world*

Skiing	Spanish beach	rainforest	English beach
2 jumpers	9 T-shirts	jumpers	5 pairs of shorts
2 pairs of shoes	9 shorts	7 trousers	4 pairs of Trousers
8 long-sleved tops	1 jumper	2 pairs of trainers	7 pairs of socks
8 trousers	sun Hat	ruck-sack	7 knickers
Toothpaste	costume	7 pairs of socks	rain coat
Flanell	goggls	7 knickers	coat
Sciors	flanell	P.J.	Sun Hat
coat	Tooth paste	coat	Swimming costume
Hat	7 pairs of socks	umbrella	rubber boat
9 pairs of socks	7 pairs of knickers	Tooth paste	P.J.
Snow boots	P.J	flanell	flanell
8 pairs of knickers			Tooth paste
P.J.			1 jumper

KEZIA (9)

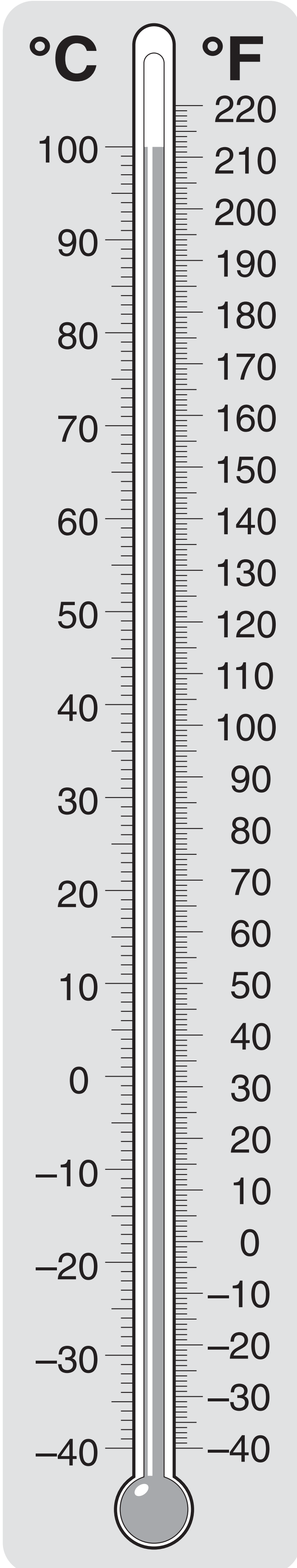
Skiing	Spanish beach	Rainforest	English beach
2 jumpers	9 T-shirts	rain coat	5 pairs shorts
2 pairs shoes	9 pairs shorts	2 jumpers	4 pairs trousers
8 long-sleeved tops	1 jumper	7 pairs trousers	7 pairs socks
8 pairs trousers	sun hat	2 pairs trainers	7 pairs knickers
toothpaste	costume	ruck sack	rain coat
flannel	goggles	7 pairs socks	coat
skiis	flannel	7 pairs knickers	sun hat
coat	toothpaste	PJs	swimming costume
hat	7 pairs socks	coat	rubber boat
9 pairs socks	7 pairs knickers	umbrella	PJs
snow boots	PJs	toothpaste	flannel
8 pairs knickers		flannel	toothpaste
PJs			1 jumper

4 A **Name:**.. **Form:**...................

See **pages 10 and 11** of *Weather around the world*

What temperature means (i)

Temperature is measured accurately with a thermometer placed in the shade. But we often talk about hot and cold without thinking about a thermometer. So what do we mean when we talk of hot places and cold places?



Q1. What temperature (°C) do you think of as hot? Mark it on the thermometer.

Q2. What temperature (°C) do you think is warm? Mark it on the thermometer.

Q3. What temperature (°C) do you think is mild? Mark it on the thermometer.

Q4. What temperature (°C) do you think is cold? Mark it on the thermometer.

Q5. Write down why you chose your temperatures.

✎ ....

✎ ....

✎ ....

✎ ....

✎ ....

✎ ....

✎ ....

4 A Teacher's Background

See **pages 10 and 11** of *Weather around the world*

Background

Thinking about temperature

Temperature is perhaps the most important measurement of the weather that we can use.

You may like to get the class used to thinking about temperatures by asking what the temperature for freezing is, and marking that on the thermometer.

You could tell the class that we know that the temperature is freezing (0°C) because water changes to ice, frost forms and so on. Here we have a very accurate way of telling what the real temperature is.

But people often talk of hot, warm, mild and cold. You hear this on the television and radio reports daily.

By asking students to mark what they think of as hot, warm, mild and cold, we are challenging them to think about the context of the remarks.

We actually use these words relative to our experience of what conditions are like on average for the time of year and for the location we are in. So, without realising it, we use our experience to tell us about a climatic value – the average temperature for that time of year. So warm in summer would not be the same as warm in winter. A warm winter's day might be 10°C, but a warm summer's day might be 20°C.

Let students compare what they have each done and then argue the case for what they have put. You may care to ask them what hot weather would be if they were in a tropical place where the average was 27°C.

Thinking about heat and health

The last section of the spread also begins to explore the relationship between heat and health. For example, hot, muggy conditions can lead to heat exhaustion and heat stroke. Heat stroke can occur if the temperature of the blood rises above 39°C/102°F and can cause confusion, incoherent speech, convulsions, organ damage and possible death. Cold conditions can lead to hypothermia.

The World Health Organisation recommends a maximum air temperature of 24°C/75°F for workers to work comfortably. A minimum of 16°C/61°F is recommended for office workers with sitting jobs.

You could extend discussion of the worksheet by asking students to say which temperatures on their thermometers were dangerous for health. You may wish to introduce the idea of windchill now or come back to temperature when you are studying wind later in the book.

4 B

Name:.. Form:....................

See **pages 10 and 11** of *Weather around the world*

What temperature means (ii)

The temperature changes throughout the day and night. The table below shows the readings made each hour through one day using a thermometer kept in a shaded place.

Q1. When was the hottest time of day?

✎ ....

Q2. When was the coldest time of day?

✎ ....

Q3. How many hours was it from midday to the time when the air was hottest?

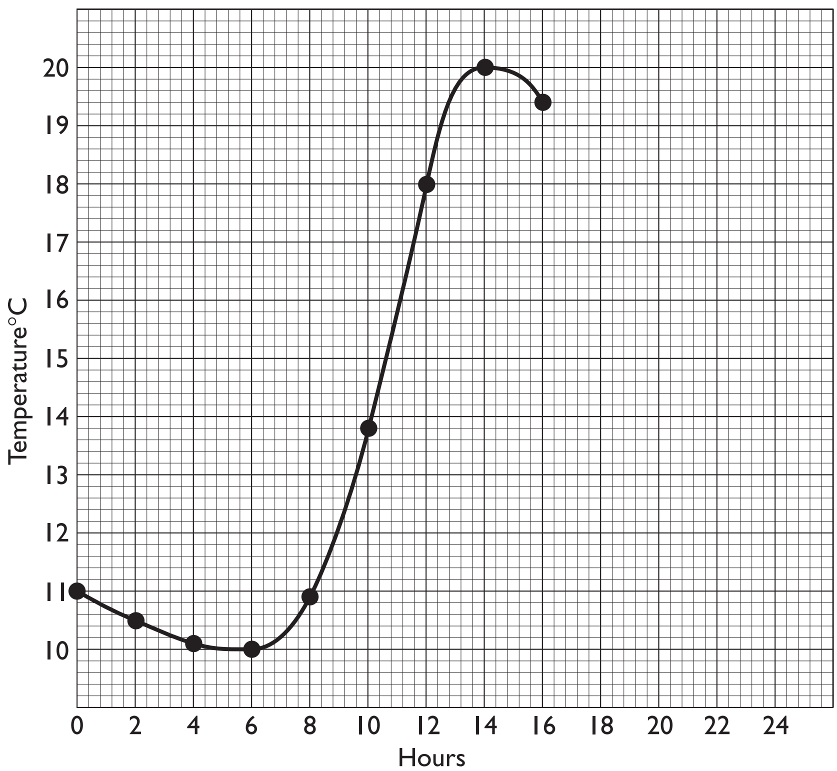
✎ ....

▼ Table of the temperature through one day.

Morning		Afternoon	
Time (hr)	Temp. (°C)	Time (hr)	Temp. (°C)
00	11.0	12	18.0
02	10.5	14	20.0
04	10.1	16	19.4
06	10.0	18	17.0
08	10.9	20	13.8
10	13.8	22	12.0

Q4. The first nine points from the table above have been plotted as a graph below. A smooth line has been drawn through them to show you what to do. Complete the graph below to find out what the pattern of temperature looked like throughout the day.

▼ A graph to show the temperature at each hour during a day.



Q5. Now write a sentence to say how the temperature changes throughout a day.

✎ ....

✎ ....

Teacher's Background

See **pages 10 and 11** of *Weather around the world*

Background

Drawing graphs

It is important that students get used to drawing out the results of their investigations. In this case there is a table of information which needs to be made into a graph so that it is easier to interpret.

Make sure students are clear that one column of the table is temperature and the other is time. Also make it clear that they will be completing a line graph. A line graph is used because this is continuous data. When the graph is complete, they will be able to find the temperature at any time of the day (for example, 05.45).

This is a good practical opportunity for students to practise plotting co-ordinates on to a graph, as required for the National Curriculum maths. You may need to do it with them in class, so that everyone plots the points at the same time during whole-class teaching.

It is important that students draw a smooth curve through the information. This has been started. If they simply connect the points with straight lines, they will not be able to interpret the changes accurately.

The finished drawing below will give you a template to put underneath the versions done by students to check the accuracy of their plotting.

For much more help on this important part of the mathematics curriculum, see also the book *Grids and Graphs* in the *Maths Matters!* set published by Atlantic Europe Publishing. More conversion graphs will also be found in this book.

Measuring the atmosphere

Here, the emphasis is on thinking about the measurements. A diurnal cycle is shown. Emphasise the following points: that the air is still cooling after dawn because the effect of sunshine is not immediate. We may feel the warmth of the Sun, but it takes time for the ground to heat up and for this heat to be transferred to the air. The air is only very slightly heated by the Sun. The same type of lag occurs between midday and the time of highest temperature.

Answers

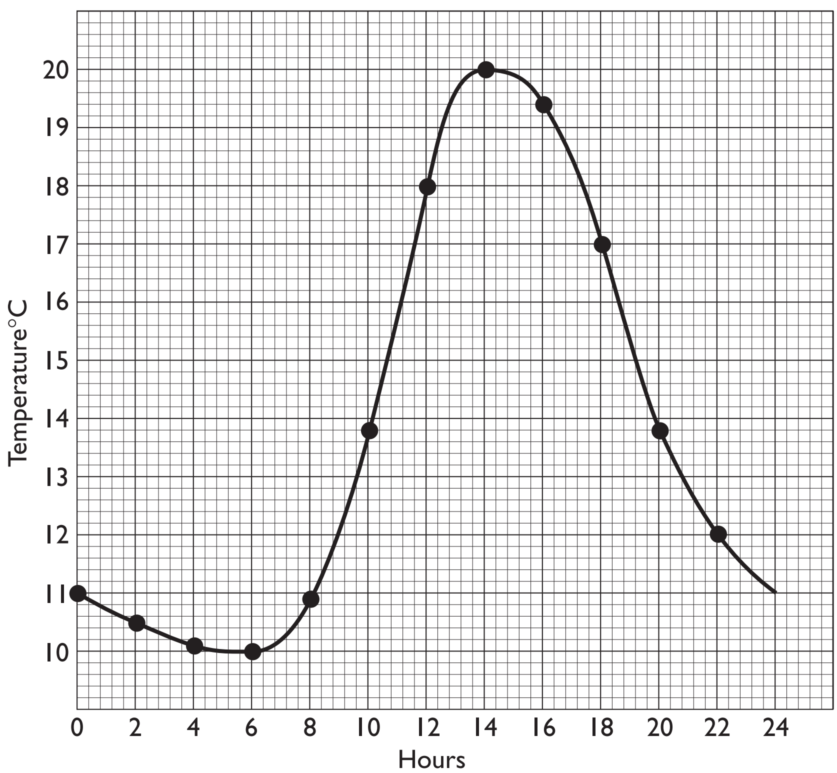
Q1. 14 hrs

Q2. 06 hrs

Q3. 2 hours

Q4. See graph below.

Q5. The graph shows that, in the early part of the day the air continues to cool, but then it begins to rise, reaching a maximum in the early afternoon, before decreasing for the rest of the day.



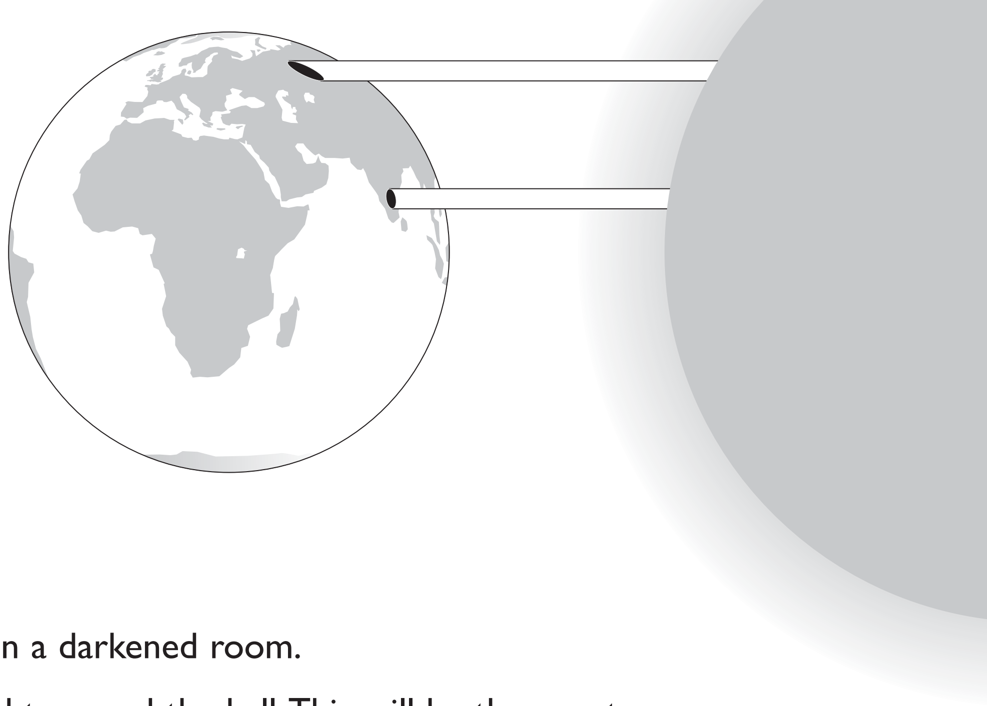
5

Name:... **Form:**....................

See **pages 12 and 13** of *Weather around the world*

What sunshine means for us

Sunlight is vital for most living things. But people think that too much sunshine can be a health risk. Here we make a model to show how the amount of sunshine reaching us depends on the place we are in the world.



You need to work in pairs or larger groups for this.

You need a large ball, such as a football, and a torch, preferably one that gives a long, straight beam.

You need to work in a darkened room.

First, draw a line right around the ball. This will be the equator.

Now hold the ball so that the equator is level. Hold a torch about 60 cm from the ball and keep it level.

Get a person in your group to use chalk or water-based pen (one whose ink can be washed off) to mark the area lit by the torch beam.

Keep the torch level and lift it up so that is shines on a place nearer to the pole. Mark the area again.

Place a piece of tracing paper over each marked shape and then look at them in the light. Try to work out how much bigger the area is nearer the pole than the area near the equator.

Q1. Use this result to explain why the Sun's rays have less strength near the poles than at the equator.

✎ ....

✎ ....

✎ ....

Background

It can be difficult for students to understand why the strength of the Sun's rays varies. This demonstration is designed to make this easier.

The students need to be told that the torch represents a part of the Sun's rays. Because it is the same torch, held in the same way at the same distance each time, it represents a fair test of how any bundle of Sun's rays will behave when it strikes the Earth's surface.

Because the same bundle of rays are used, they have the same heating power (and same UV power). If the same rays spread out over a bigger area, they are less concentrated and so have less power per square centimetre of skin surface, for example.

You can go on to develop this model to show how the rising Sun has the same effect. In this case you move the torch in an arc over a flat sheet of paper and mark out the area the torch beam covers each time.

From this students can see that concentration of UV rays depends in part on time of day and latitude. If, as most authorities currently believe, sunlight duration and intensity is linked to skin cancer, then students can see the time of day and latitude where people are most at risk.

Note that we have stated that the UV rays are part of the Sun's radiation and we are using the visible rays to mark their position. We are not saying that the visible rays do any damage.

6 A **Name:**.. **Form:**....................

See **pages 14 and 15** of *Weather around the world*

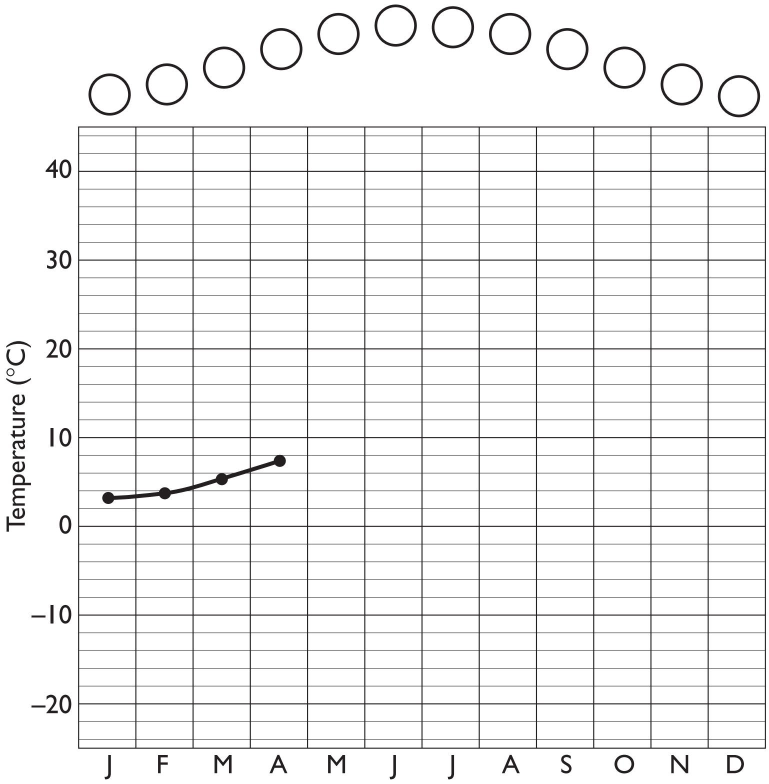
Places with hot and cold seasons (i)

This diagram shows the height of the Sun and also the average temperature for each month in Edinburgh.

▼ Table of average monthly temperature in Edinburgh, Scotland.

Month	Average Temp. (°C)
Jan	3
Feb	3
Mar	5
Apr	7
May	10
Jun	13
Jul	15
Aug	14
Sep	12
Oct	10
Nov	6
Dec	4

▼ Temperature graph and the height of the Sun for Edinburgh, Scotland.



Q1. Complete the graph on the right using the information in the table above.

Q2. Which month was hottest? ✎ ....

Q3. Which month was coldest? ✎ ....

Q4. How many months were there between the time when the Sun was highest in the sky and the hottest time of the year?

✎ ....

Q5. Explain why the hottest month is not the same as the month when the Sun is highest overhead.

✎ ....

✎ ....

6 A Teacher's Background

See **pages 14 and 15** of *Weather around the world*

Background

Worksheet 6B also provides questions on pages 14 and 15 of the student book.

Seasonality in climate can be introduced in two ways. It can be introduced to show how the rise in the height of the midday Sun is matched with the seasons, and it can be used to compare the nature of seasons in various parts of the world. The data given in the worksheet are to the nearest one degree for ease of plotting. Data to one decimal point are given in the table at the bottom of this page in case you need them.

In terms of the single station information, students will find that Edinburgh has its highest temperature in July (14.5°C/58.1°F) while the Sun is highest in the sky in late June (the summer solstice).

Students can think of a year in much the same way as a day, recognising that the lag between the Sun being highest in the sky and the warmest month has a comparable reasoning to the diurnal cycle.

It is useful for students to see that it is possible to identify similar patterns in a number of time scales in this way.

You can also examine the steepness of the line. Where the line is steepest, the temperature is changing most rapidly, so the change in the seasons will be more noticeable where the slope is steep – spring and autumn.

Suggestion: Use material from section 6 of this teacher's resource book (Teaching weather around the world) to compare Edinburgh with some extreme examples. Manaus in Brazil, for example, has a tropical rainforest climate and so shows an almost flat line, indicating that it has no temperature seasons. Chicago has a very steeply sloping curve, as can be seen in worksheet 6B. People who live in this part of the world notice the change between one week and another. Britain is somewhere in-between, so we notice a change, but only from one month to another.

Now you can go on to look at other places and ask how quickly the temperature seasons change.

You could also examine season words, such as the American use of the word fall, for autumn. This is connected with the rapid change in leaf colour, and the rapid drop in temperature in autumn (see picture on page 14 of the student book). The word 'fall' is particularly associated with the north-east of the USA, where the colour changes are very dramatic, and this is, in part, the result of the change in temperature being far greater than we are used to. The time of prettiest fall, literally sweeps southwards across the country sometimes in a matter of 2 to 3 weeks.

Be aware that on page 22 of the student book we shall be looking at rainfall seasons. You might therefore, care to take the opportunity to point out that, when we say season we really mean temperature season. But it would be rather presumptuous of us to think that this is the only kind of season. More people live in places that have seasons dominated more by changes in rainfall than by temperature, as we shall see in later worksheets.

Answers

Q1. See finished graph below.

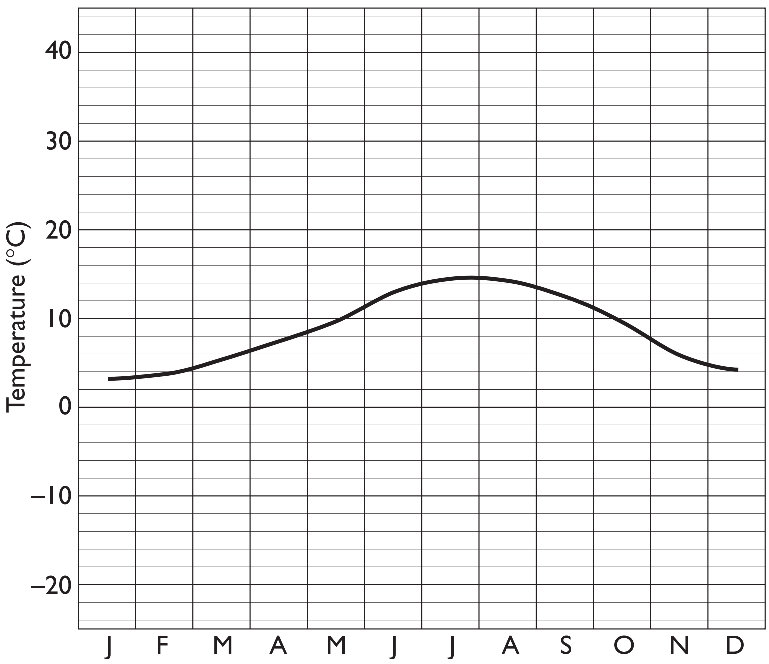
Q2. July

Q3. January

Q4. One month

Q5. The ground takes time to warm up on a seasonal, as well as on a daily, basis. (This is most obvious with oceans, which have a huge heat storage capacity.)

Month	Average Temp. (°C)
Jan	3.1
Feb	3.3
Mar	5.2
Apr	7.1
May	9.9
Jun	12.8
Jul	14.5
Aug	14.3
Sep	12.3
Oct	9.6
Nov	5.8
Dec	4.1



6 B

Name:.. Form:...................

See **pages 14 and 15** of *Weather around the world*

Places with hot and cold seasons (ii)

The temperature is important to us in many ways, so here we will make a new type of chart: one that shows what we might wear.

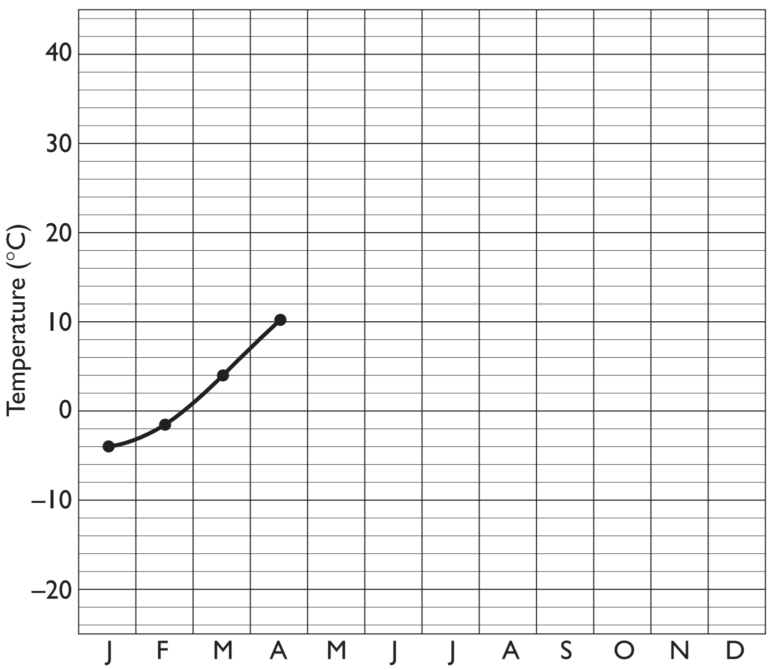
Q1. Using the data in the table below, complete this chart for Chicago, USA.

Q2. Below you will find a variety of different types of clothing. Add these to the chart to show what type of clothing should be worn through the year. Make up a key that shows which type of clothing belongs to which temperature range.

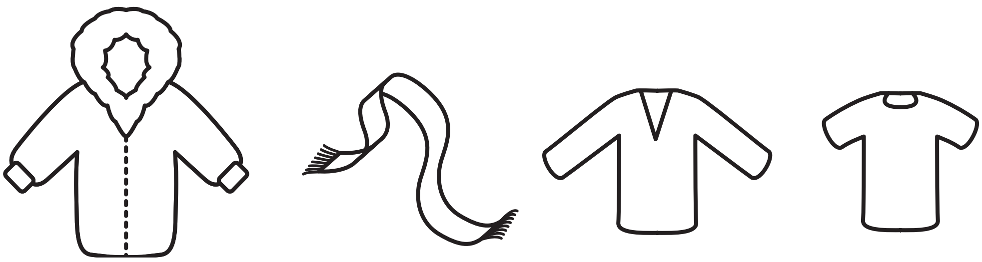
▼ Table of average monthly temperature in Chicago, USA.

Month	Average Temp. (°C)
Jan	–4
Feb	–2
Mar	4
Apr	10
May	16
Jun	21
Jul	24
Aug	23
Sep	20
Oct	14
Nov	6
Dec	–1

▼ Temperature graph for Chicago, USA.



Key



Teacher's Background

See **pages 14 and 15** of *Weather around the world*

Background

Worksheet 6A also provides questions on pages 14 and 15 of the student book.

This is a fun page that allows children to use their imaginations and develop different charts.

We begin with climate information, in this case a temperature chart for Chicago. Data are given to the nearest 1°C. More accurate data are given in the table on the right if you require them. You could, of course, make up a chart for other places using the climate information from section 6 in this teacher's resource book ('Teaching weather around the world').

The reason for choosing Chicago is that it has temperature extremes. Students can therefore choose a wide variety of types of clothing to represent the temperatures. Later, you might choose a place like Manaus in Brazil, which has no temperature variation, and discuss why people in different parts of the world might have different wardrobes!

One version of the chart is shown below.

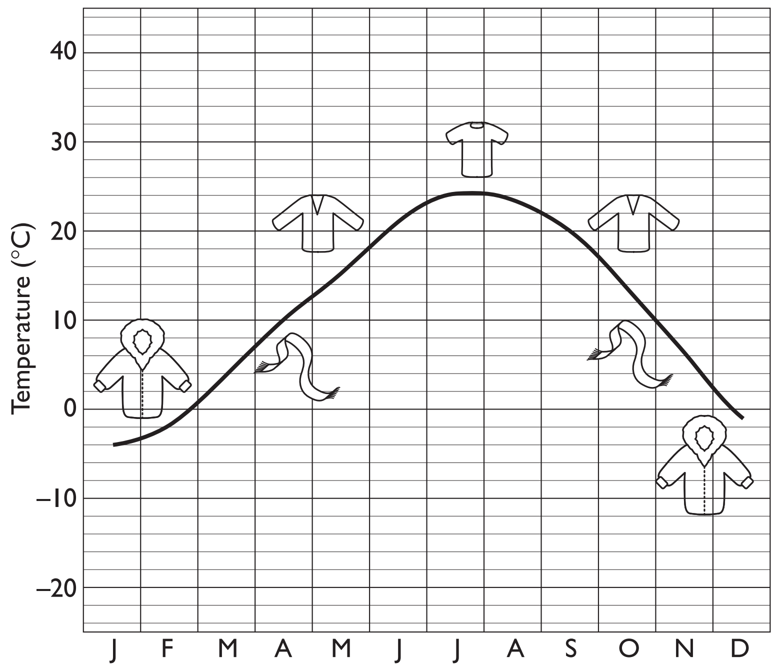
Please note, it is important to make students construct a meaningful key. They have to justify their choice of symbol and the temperature range over which it is appropriate.

Month	Average Temp. (°C)
Jan	–4.0
Feb	–1.6
Mar	4.0
Apr	10.2
May	15.8
Jun	21.4
Jul	24.1
Aug	23.5
Sep	19.8
Oct	13.5
Nov	6.3
Dec	–1.0

▲ Monthly average temperatures for Chicago, USA, given to one decimal place for reference purposes.

Answers

Q1 and Q2. Below is one example of what the chart might look like!



7

Name:.. Form:...................

See **pages 16 and 17** of *Weather around the world*

Rain, snow, dew and frost

Read pages 16 and 17 in your book and answer the following questions.

Q1. What are the two words for water as an invisible gas in the air?

✎ M............................ and V............................

Q2. What is the general word that includes all of these: rain, snow, dew and frost?

✎ P...

Q3. What is snow made from? ✎ ....

Q4. What is in the air that allows condensation to occur?

✎ ....

Q5. How can we tell the difference between fog and mist?

✎ ....

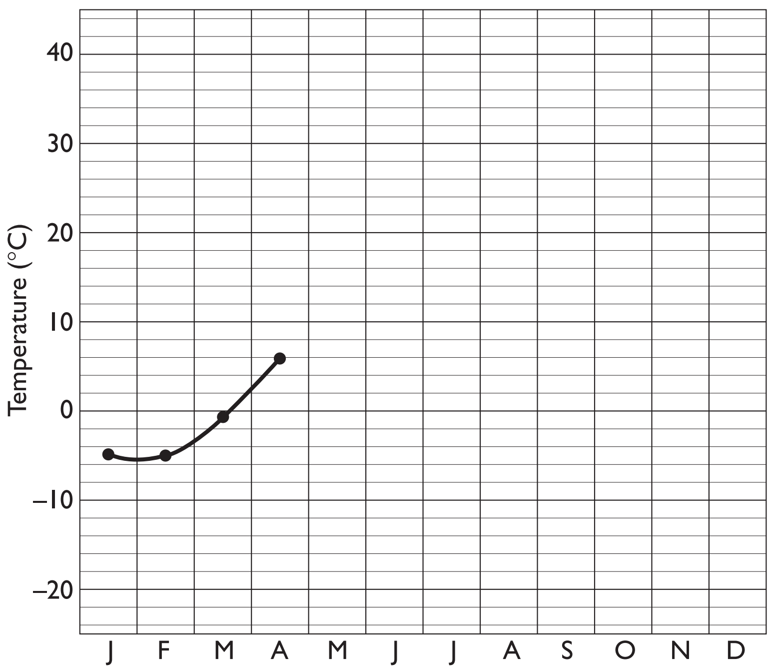
Q6. Complete the graph for Toronto, Canada. Ring those months when it would be most common for snow to lie on the ground. Explain your reasons.

✎ ....

▼ Table of average monthly temperature in Toronto, Canada.

Month	Average Temp. (°C)
Jan	–5
Feb	–5
Mar	–1
Apr	6
May	12
Jun	18
Jul	21
Aug	20
Sep	16
Oct	9
Nov	3
Dec	–3

▼ Temperature graph for Toronto, Canada.



7 Teacher's Background

See **pages 16 and 17** of *Weather around the world*

Background

Get the whole class to draw a line showing freezing (0°C). Months below this are snow months. (Snow will also lie, from time to time, in months just outside this core period.)

Encourage students to look at their local area climate chart and see why they might, or might not, get snow lying for long periods each year.

Compare Aberdeen and Toronto. In Aberdeen, only January is cold enough, on average, for lying snow, but February is almost as cold. Toronto is below freezing for four months of the year.

Using an atlas, look at the latitudes of Toronto and Aberdeen. They can come back to this data later and see the huge differences between maritime and continental climates.

Answers

Q1. Moisture and Vapour

Q2. Precipitation

Q3. Ice crystals

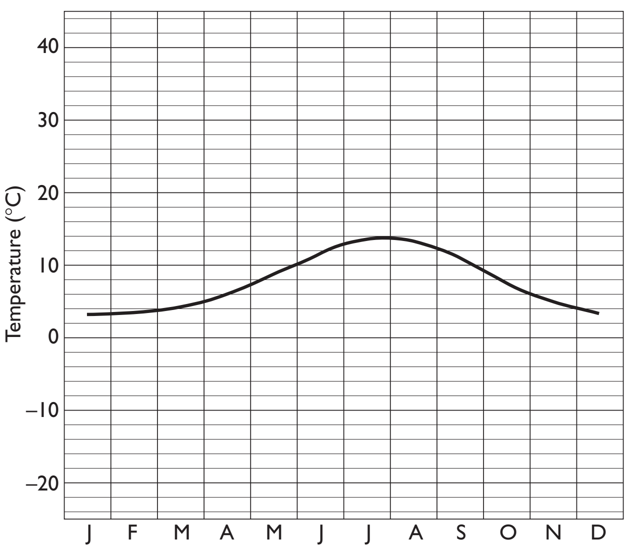
Q4. Dust (the term dust is used in a very general way here).

Q5. Fog has a visibility of less than 1 km.

Q6. See finished graph below. Students should have selected the winter months – November to March in particular – to show when snow is most likely to lie on the ground. You would expect snow to lie on the ground when the air temperature was close to, or below, freezing.

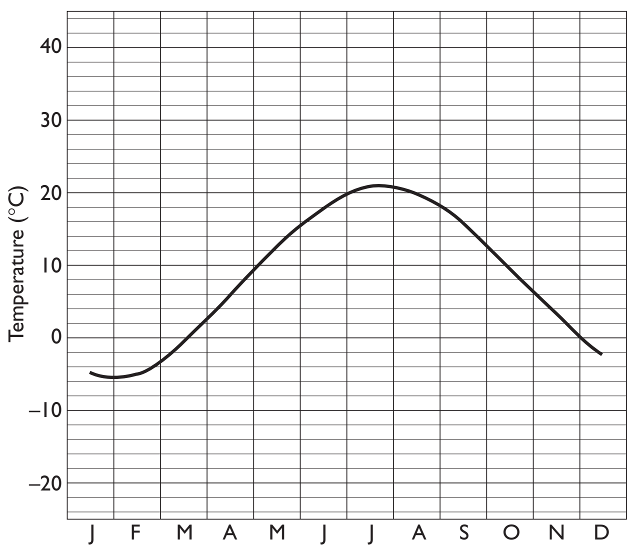
▼ Table and graph for monthly average temperature in Aberdeen, United Kingdom.

Month	Average Temp. (°C)
Jan	3.2
Feb	3.4
Mar	4.5
Apr	6.3
May	8.8
Jun	11.8
Jul	13.6
Aug	13.4
Sep	11.5
Oct	8.7
Nov	5.6
Dec	3.9



▼ Table and graph for monthly average temperature in Toronto, Canada.

Month	Average Temp. (°C)
Jan	–4.9
Feb	–5.0
Mar	–0.7
Apr	5.9
May	12.2
Jun	17.8
Jul	20.8
Aug	19.9
Sep	15.8
Oct	9.3
Nov	3.2
Dec	–2.5



8 A

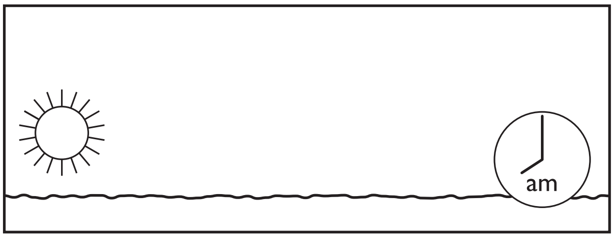
Name:... **Form:**...................

See **pages 18 and 19** of *Weather around the world*

Clouds

When conditions are right, cumulus clouds grow to great heights and become towering giants. These are the clouds that produce showers of heavy rain. Most towering clouds follow a daily pattern.

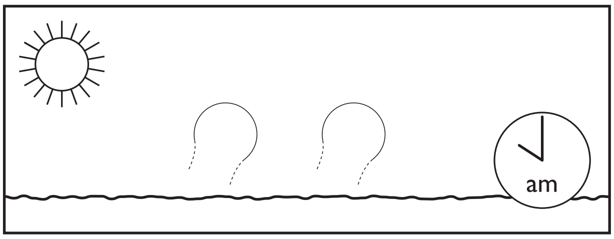
For each of these diagrams, write a sentence to explain what is happening.



Q1. ✎ ....

....

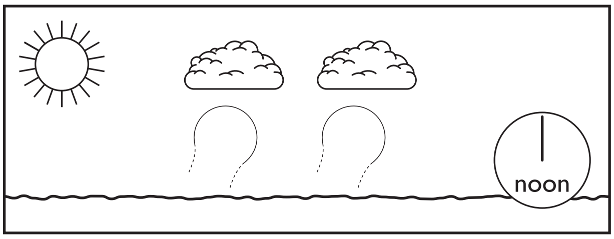
....



Q2. ✎ ....

....

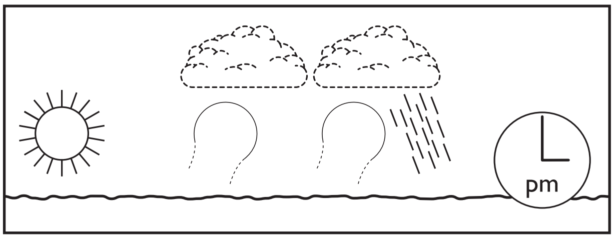
....



Q3. ✎ ....

....

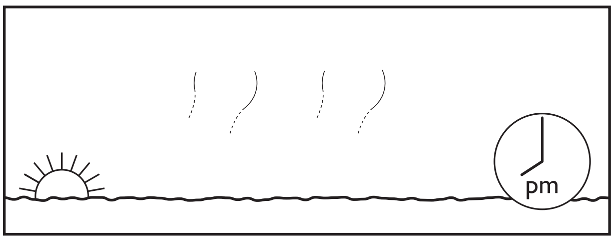
....



Q4. ✎ ....

....

....



Q5. ✎ ....

....

....

Teacher's Background

See **pages 18 and 19** of *Weather around the world*

Background

Cumulus clouds

Cumulus clouds are individual clouds that form when warm air rises. (For more information see pages 38 to 40 of this teacher's resource book.) They may form patterns of small clouds (often called pillow clouds) or even high-level patterns consisting of thousands of tiny clouds (forming a 'mackerel sky'). Under suitable conditions, and particularly in the tropics or interiors of continents in summer, they may also form giant towering thunderclouds, known as cumulonimbus clouds.

The pattern of cumulus clouds tells how air is behaving in the sky. There is always a balance between rising and sinking air. Clouds occur where warm moist air is rising; clear patches show where air is sinking. With giant thunderstorms, the cool sinking air provides very strong winds at ground level, while the rising air can generate tornadoes.

The development of rain-bearing cumulus clouds

Rain-bearing cumulus clouds are called cumulonimbus clouds. They typically begin to billow up on a hot morning, their towers gradually building until they dominate the sky. The great height to which they grow shows that they contain very strong updraughts, or thermals.

Cumulus clouds, rain and hail

The different amounts of water and ice in a cloud are critical to the way that rain forms. In tropical cumulus clouds, thermals can be very strong and water droplets may have to be very large before they can fall. But strong air currents actually sweep the droplets together until they become large enough to fall from the cloud. This explains why tropical rain is made of large droplets.

Sometimes droplets are carried rapidly up and down inside a cloud by the fierce thermals. As they reach the cloud top they begin to freeze, and get a coating of ice (called rime); then they are forced rapidly downwards, gathering a coating of more small water droplets before being carried aloft once more where the surface water again freezes. After several cycles, large hailstones may form in this way, sometimes reaching the size of golf balls or even oranges.

Answers

There are bound to be a great variety of answers to this worksheet. Here are the ideas that each diagram contains.

Q1. The early morning sky is clear and bright. The Sun is already beginning to heat the ground, and some parts of the air are becoming hotter than others.

Q2. By mid-morning there are bubbles of hot air breaking away from the heated layer of air near the ground. They cannot yet be seen because the water is still vapour. No condensation has yet occurred.

Q3. The bubbles of air get higher and cooler. Now they form droplets and their upper regions can be seen as clouds. This is when clouds 'suddenly' appear in the sky. New bubbles of air are rising in the wake of those that are already forming cloud.

Q4. The clouds are getting taller and deeper. The droplets of water are being whisked about inside the cloud, bumping into each other and forming bigger droplets. These big, heavy droplets fall out of the cloud as rain. We experience them as showers because the individual clouds soon pass over us, but the rain is continuous from each cloud.

Q5. As the heat from the Sun wanes, no new air bubbles rise. Those that are in the sky complete their life cycles, and rain continues for a while into the evening. Then the sky begins to clear and a fine night occurs.

Name:.. Form:....................

See **pages 18 and 19** of *Weather around the world*

How 'bubbling' clouds are made

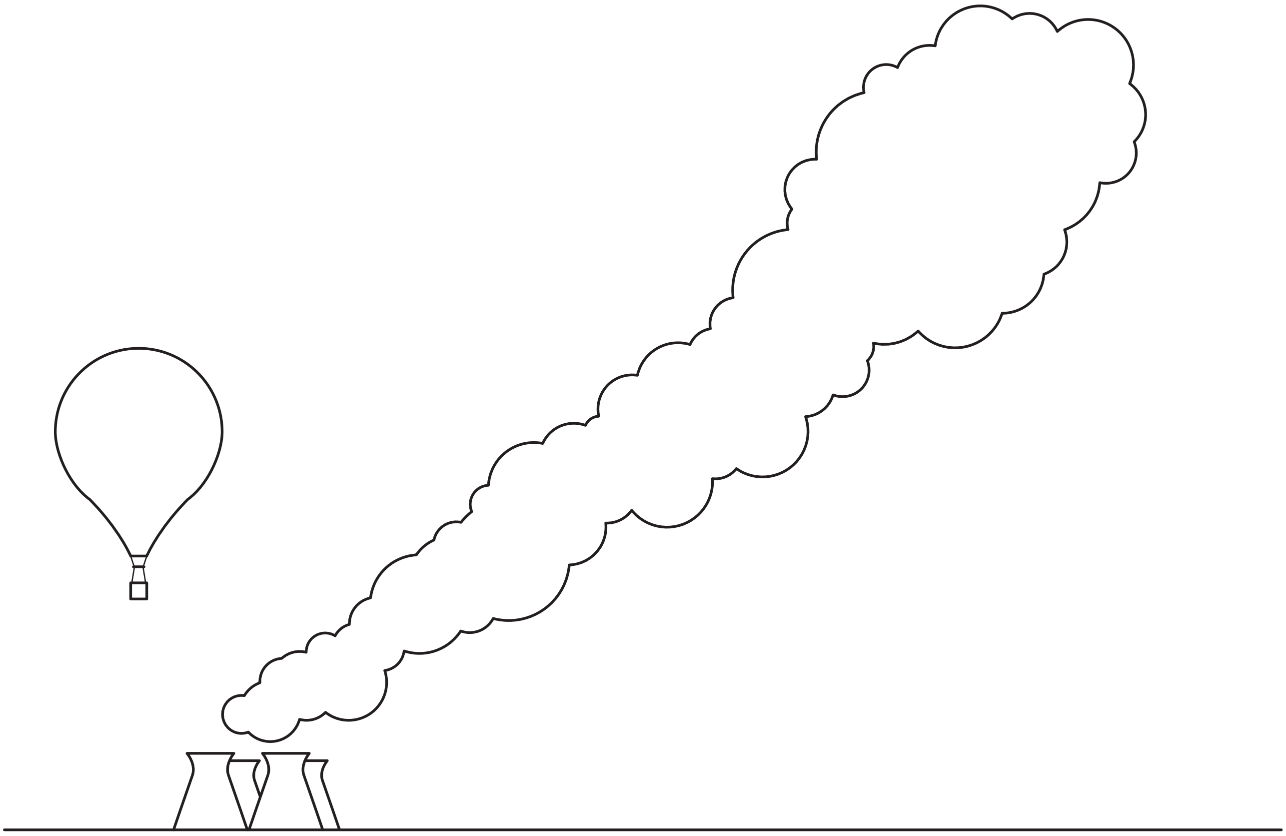
Clouds are made up of masses of tiny droplets of water so small that they stay suspended in the air as a kind of spray. They 'float' even in gentle currents of rising air.

Q1. Write a sentence to explain why hot air rises.

✎ ....

✎ ....

Q2. This diagram below shows a hot-air balloon. Nearby is a power station with a plume of cloud rising from it. Draw an arrow to show which way the balloon will travel.



Q3. To form towering clouds, you need hot air. What are the other vital ingredients?

✎ ....

Teacher's Background

See **pages 18 and 19** of *Weather around the world*

Background

Thermals

The Sun does not directly heat the lower part of the air. In fact, the lower atmosphere is almost completely transparent to incoming sunshine. This is why we feel the direct warmth of the Sun on a cloudless day.

The air is warmed indirectly. First, the Sun heats up the continents and the oceans: then the air gets its heat by contact (conduction) with the land and water. The air also absorbs heat radiated from the land and water. As a result, the air is heated from below, not from above. This is of great importance because it means that the air is heated at the base, just like the bottom of a saucepan of liquid when it is heated on a stove.

When any fluid (either a gas such as air or a liquid such as the oceans) is heated, the hot fluid swells and becomes less dense. So, like a bubble rising from the bottom of a heated saucepan, as soon as air is warmed it rises through the colder air above.

Sometimes you can see the hot air as a kind of shimmering over land and roads on a hot day. This is the shimmering that also causes mirages.

You can also see the effect of heating indirectly because it is responsible for the formation of cumulus clouds. Each of these 'bubble-like' clouds surrounds a rising column of air, called a thermal, and these are strong enough for birds and glider aircraft to use them to gain height.

Answers

The purpose of the worksheet is to make sure that students remember the two main 'ingredients' of a cloud: warmth and moisture.

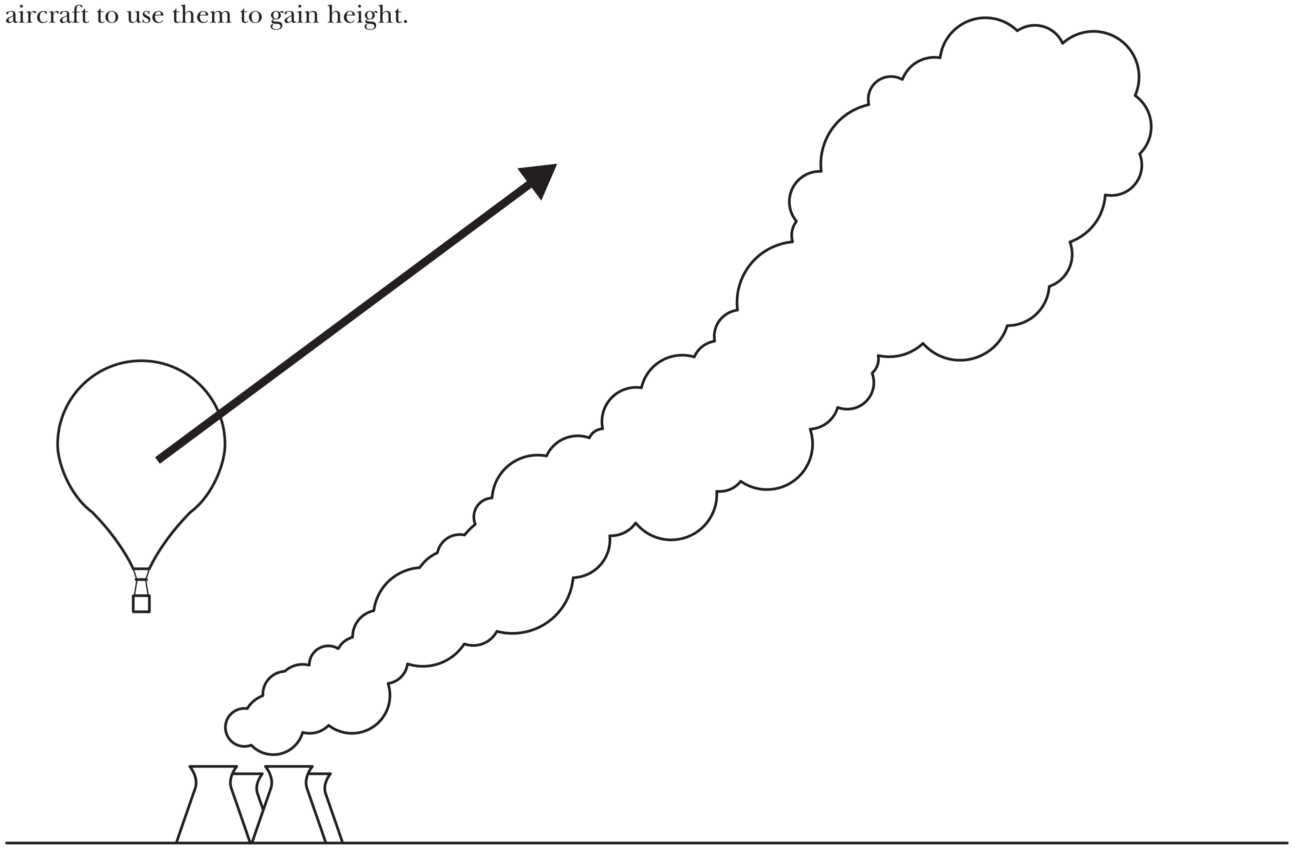
In this worksheet we concentrate on cumulus clouds because they are the clouds that can be explained in the most graphic and interesting way.

Make sure students also know that clouds are carried along by the air (wind) so that, as hot air rises, it is also carried sideways.

Q1. Hot air rises because it is lighter, or less dense, than its surroundings. (Accept rises like a float, but NOT is a float).

Q2. See diagram below. The balloon rises upwards because it contains air that is less dense than its surroundings. But, there is also a prevailing wind which will blow it sideways. This is shown by the nearby plume of cloud from the power station. The question thus relies on students making inferences from other similar environmental features.

Q3. Moisture and dust



Name:.. Form:...................

See **pages 18 and 19** of *Weather around the world*

Clouds in layers

Layer clouds spread out evenly across the sky. Most layer clouds indicate changeable weather, and some are connected with long periods of rain.

Q1. What is the name for the lowest kind of layer cloud?

✎ S..............................

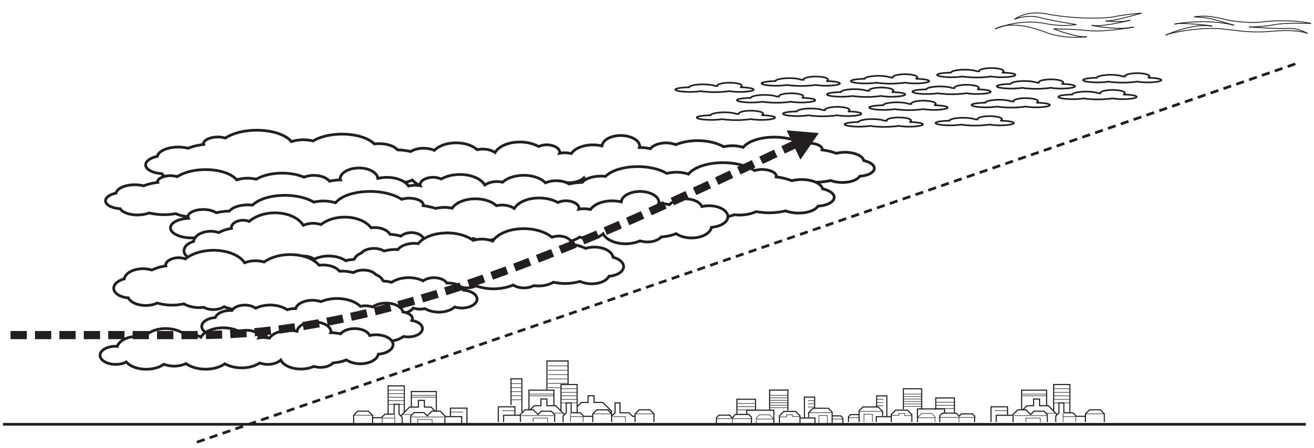
Q2. Which layer clouds are made of ice crystals?

✎ C..............................

Q3. Which two types of layer cloud never produce rain?

✎ C.............................. and A..

Q4. Match the words cirrus, altostratus and stratus, to their correct places on the diagram below.



8 C Teacher's Background

See **pages 18 and 19** of *Weather around the world*

Background

Layer clouds

Layer clouds are of two types: the thin wispy veils of ice crystals, called cirrus clouds, and the thicker cloud sheets of water droplets (and perhaps ice crystals), called altostratus (if they are thin and of medium height) or stratus (low) clouds. See the full descriptions on pages 38 to 40 of this teacher's resource book.

Layer clouds are rarely found in the hot tropics where towering cumulus dominate, but are mostly typical of mid- and high-latitudes. They provide the bulk of the clouds that form around depressions, and they are also commonly found where flows of air are forced up over hills, mountains or coastal cliffs.

Stratus clouds and rain

It is useful if students are introduced to the idea that cloud thickness determines the likelihood of rain. In part, this can be shown by colour. The thicker the cloud, the darker the base because less light can get through. Thin, white clouds can therefore, never produce rain.

Some thick clouds do not appear to produce rain either. In fact, they most likely do, but the air between the cloud base and the ground is probably so dry that the raindrops evaporate before they reach the ground. Sometimes you can actually see this as grey wisps of rain falling from the cloud base.

How raindrops form in layer clouds

In the mid-latitudes, only summer thunderstorms have the fierce thermals that drag droplets together to make large raindrops. In most layer clouds, the currents of rising air are much weaker, and a different rain-making process is at work.

By making some of the world's first high-level aircraft flights in the 1920s, the Norwegian scientist Bergeron discovered how rain, sleet and snow all form from a single process.

During his flights he found that water droplets get lifted up into the upper regions of a cloud where ice crystals occur. In this zone, the water droplets help provide the moisture needed to make ice crystals grow big enough to form large snowflakes, which then fall from the cloud. If the air below the cloud is warm, the snowflakes melt and the cloud produces droplets of rain. If the air is cold, the crystals do not melt and the clouds produce snow, or partly melted snow, called sleet.

The thickest of the layer clouds are the rain-bearing nimbostratus (*nimbo* simply means rain-bearing.) There are few swift thermals in these clouds, and thunder and lightning rarely occur.

Nimbostratus clouds occur when a great thickness of moist air is lifted bodily upwards. This can occur at a mountain front and also at a warm front of a depression.

In many cases you can see multi-level clouds. All this means is that the air was not moist throughout its depth when it was lifted. Those regions that were moist have produced cloud, whereas those regions where the air was less moist have remained clear.

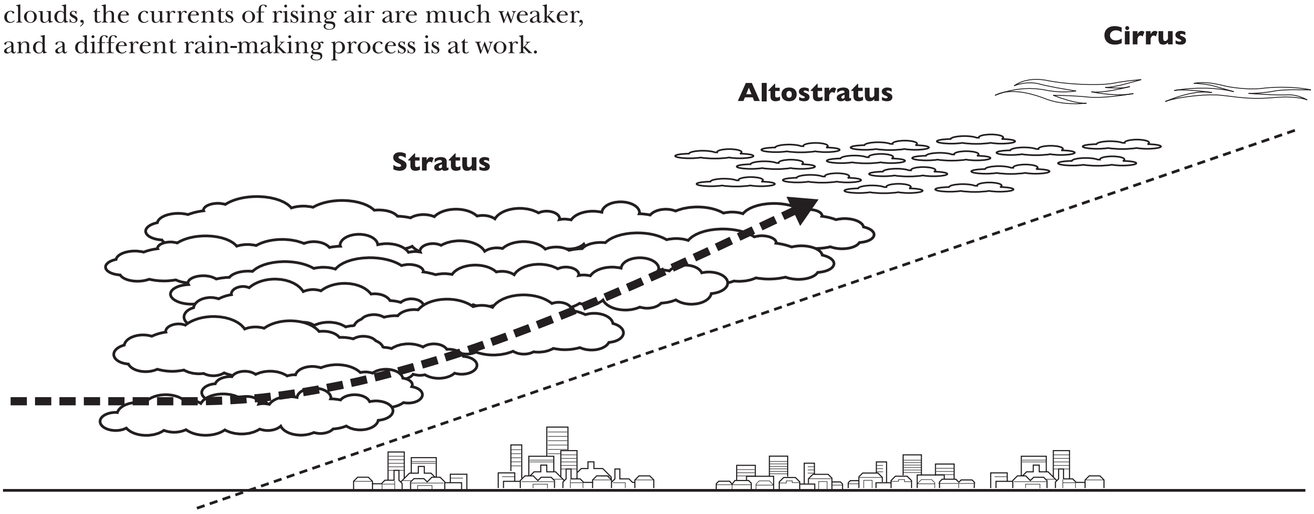
Answers

Q1. **Stratus**

Q2. **Cirrus**

Q3. **Cirrus and altostratus**

Q4. **The clouds in descending order are:**



9

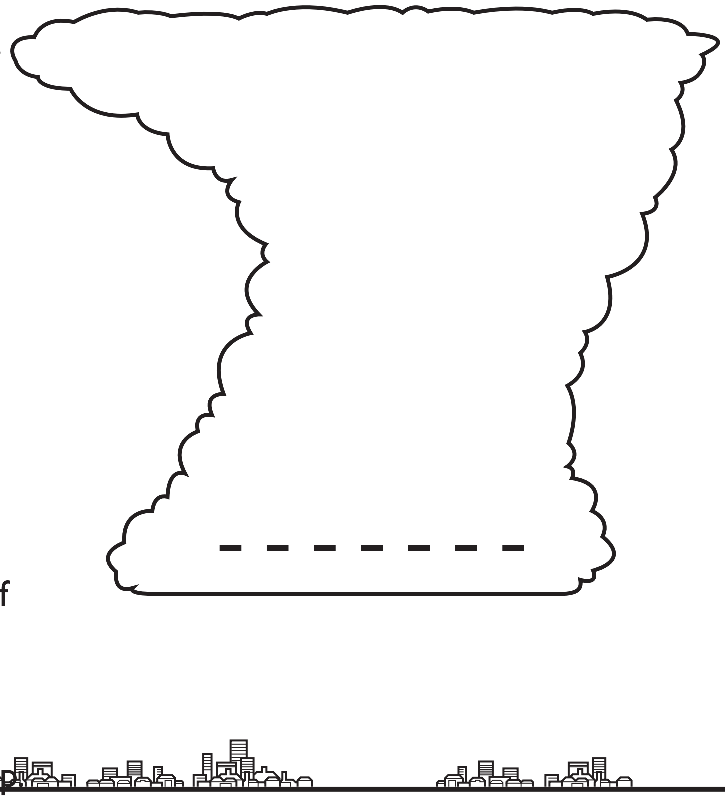
Name:.. Form:....................

See **pages 20 and 21** of *Weather around the world*

Thunder and lightning

Thunder and lightning occur in tall tower clouds. Lightning may be created in daytime storms, but it is most spectacular at night.

Q1. What is lightning an example of?



✎ S .... E ....
.....

Q2. Static electricity jumps between places that have opposite charges. Only some of the charges have been drawn on to the diagram on the right. Mark the places where you think there are other charges. Make sure you draw in the sign, '+' or '–', of the charge, too.

Q3. Now draw on the diagram where the lightning sparks might jump.

Q4. What is sheet lightning?

✎ ....

✎ ....
....

Q5. What causes the sound we know as thunder?

✎ ....

✎ ....

Q6. The picture on the right shows an 18th-century design for a lightning proof umbrella. What would the risks have been of using this in a thunderstorm?

✎ ....

9 Teacher's Background

See **pages 20 and 21** of *Weather around the world*

Background

This is a good opportunity to combine geography and science in the study of static electricity.

This is the same kind of static electricity as the sparks produced by rubbing a comb against a jumper. The only difference is in the size of the voltage and the size of the spark.

Lightning (and the sound of the expanding hot air caused by the lightning flash, ie thunder) is produced by strong thermals that cause water droplets to brush against each other. This brushing effect gradually builds up an electric charge. Lightning cannot develop in thinner clouds, because the updraughts are not great enough to cause water droplets to brush against each other.

Static electricity in a cloud is produced by multitudes of tiny raindrops being whisked past larger drops. The result is to set up one kind of charge in the upper cloud (where the fine drops are) and an opposite charge on the larger drops near the bottom of the cloud.

The charge in the cloud causes an opposite charge to occur on the ground below it. (Notice that this is a positive charge, whereas we normally think of the ground as being negatively charged, as indeed it is everywhere except under the cloud.)

Pulling a comb through hair is enough to produce static electricity and to cause hair to be attracted to the comb. It works best on a dry day because the insulation effect of the air will then be at its best.

Answers

Q1. Static electricity

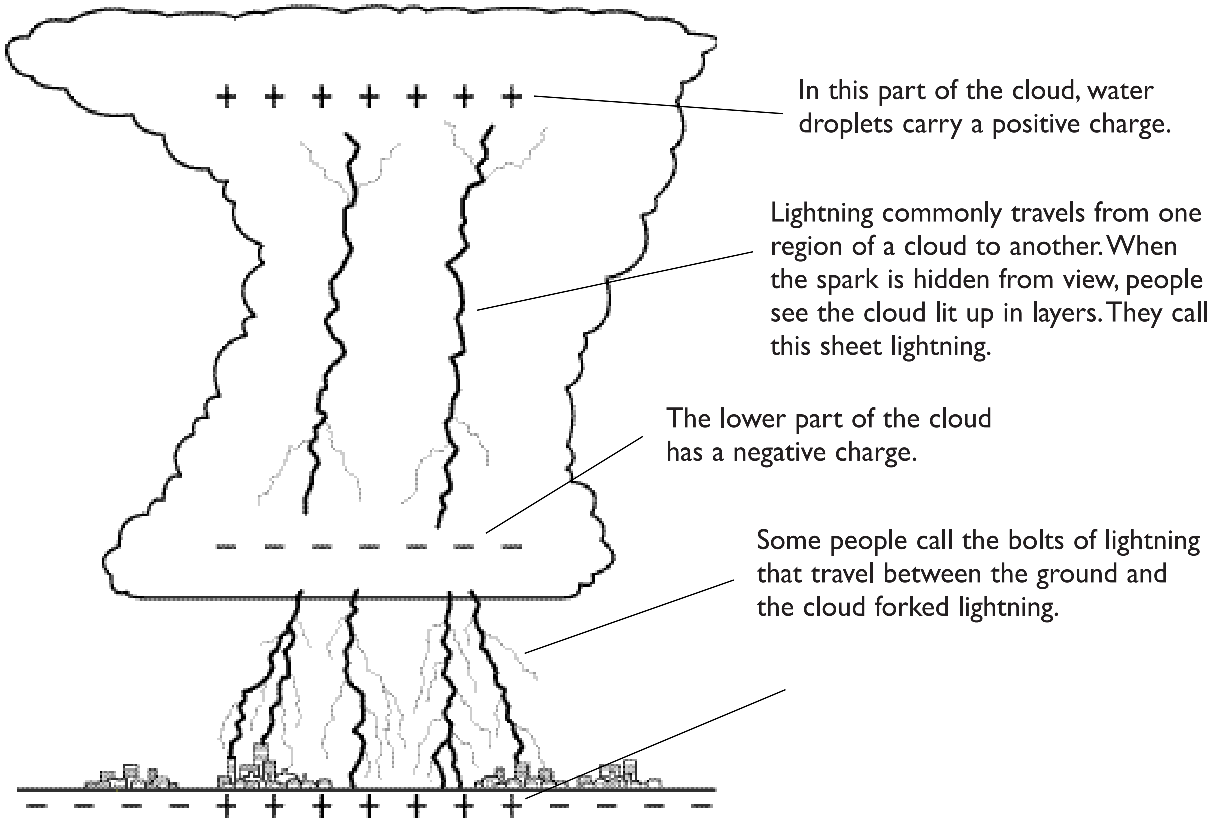
Q2. See diagram below.

Q3. See diagram below.

Q4. Ordinary fork lightning that happens between layers of cloud so that we see only the reflected flash of light. In fact, sheet lightning is the same as fork lightning.

Q5. Thunder is the shock wave produced when the air expands as it is heated by the spark (lightning) jumping through the air. (We hear it because the frequency of the shock wave is within our audible range. It rumbles because the shock wave is bounced off layers of cloud and the ground and so it reaches us from many directions. The main 'crack of thunder' is the direct single shock wave.)

Q6. It would not be a good idea to try to attract electricity to yourself! The current flowing through a lightning flash is large. The lightning could easily jump from the spike of the umbrella through the person rather than simply running down the thin cable to the ground. Best to stay indoors!



10A

Name:... **Form:**...................

See **pages 22 and 23** of *Weather around the world*

Places with rainy seasons

Read pages 22 and 23 of your book and answer these questions.

Q1. What is a rainy or wet season?

✎ ....

✎ ....

Q2. What is a dry season?

✎ ....

✎ ....

Q3. What is the rainy season called in India? ✎ ....

Q4. Shown below is a rainfall chart for Darwin, Australia. It has been partly completed using the table. Complete the chart and colour part of it yellow to show the dry season and the other part blue to show the rainy season.

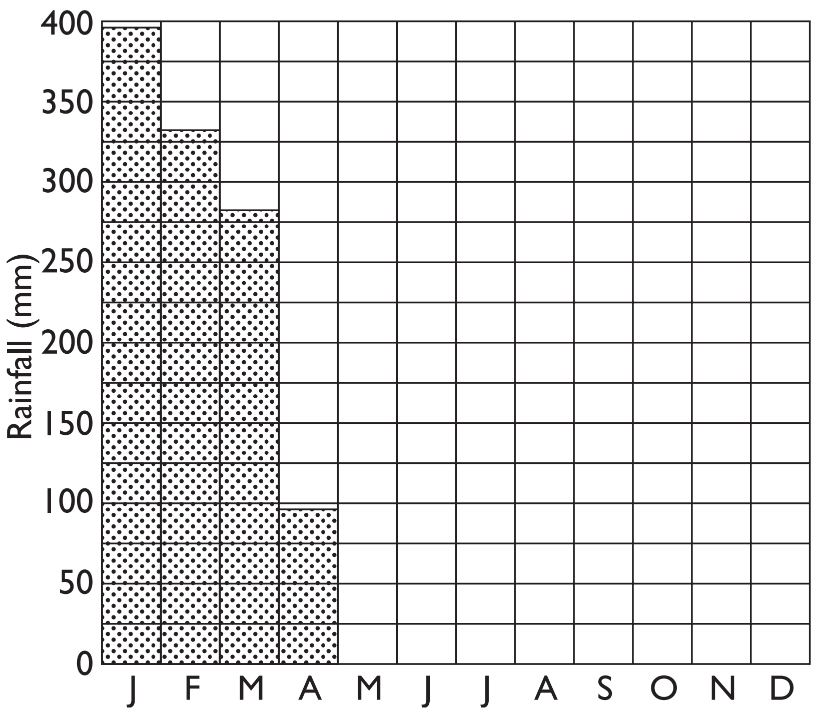
Q5. What time of year is the rainy season?

✎ ....

▼ Table of monthly rainfall in Darwin, Australia.

Month	Amount of rainfall (mm)
Jan	400
Feb	330
Mar	280
Apr	100
May	20
Jun	0
Jul	0
Aug	0
Sep	20
Oct	60
Nov	130
Dec	240

▼ Rainfall chart for Darwin, Australia.



Teacher's Background

See **pages 22 and 23** of *Weather around the world*

Background

The purpose of this worksheet is to look at patterns of rainfall through the year. Students have to identify the rainy season and the dry season by observing the differences in the heights of the columns. They then have to estimate the length of the rainy season.

This will provide a basis for discussion of the nature of seasons in terms of rainfall rather than of temperature.

Explain to students that, in most tropical places, rainy and dry seasons are more important than temperature seasons. The term 'rainy' means that it rains from time to time, not that it rains all the time. You can also use the term 'wet season', to convey the impression of 'rains often'. Even during a monsoon it does not rain all the time, although it might rain without stopping for several days before there is a dry spell. Point out that a monthly figure for rainfall is usually made up of rainy days and dry days, wherever you are in the world.

Darwin has been chosen because it is a southern hemisphere location and so can be used in comparison with northern hemisphere locations.

Monsoon effects

July is the height of the dry season for northern Australia, when the Indian monsoon (the counterpart of the Australian monsoon) is at its height. Air flows out from the high pressure regions of the southern hemisphere to the low pressure regions north of the equator in Asia. Virtually no rain falls. The Trade Winds blow constantly for many weeks, giving clear, sunny skies. The daily range of temperature is high because of the clear air.

As the Sun moves into the southern hemisphere, the land heats up, the continental high becomes weaker and a low develops over northern Australia. Rain-bearing winds begin to blow into the low and the wet season begins, arriving in Darwin in September. The rains do not burst, as in India, but develop gradually, as in Africa and South America.

The height of the monsoon is January. The rain is connected with slow-moving lows, which travel in a south easterly direction. Occasionally, they have tornadoes and hurricanes associated with them. The high temperatures and high humidity make the weather oppressively muggy.

TIP: Reading a rainfall chart

Stand back from the chart and look at its shape. Remember, the taller the column, the more it rains. Each column stands for a month.

Try to decide if the columns all appear to be the same height (it rains about the same each month) or whether the columns are very different in height (there is a rainy season). Also, look to see if there are columns with nothing, or very little (there is a dry season).

Answers

NOTE: On the worksheet rainfall has been given to the nearest 10 mm, for ease of plotting. The rainfall to the nearest mm is given below for your reference.

Q1. The rainy season is the period of the year when the rainfall is much greater than at any other part of the year.

Q2. The dry season is the period of the year when the rainfall is much less than at other times of the year. It is sometimes, but not always, nil.

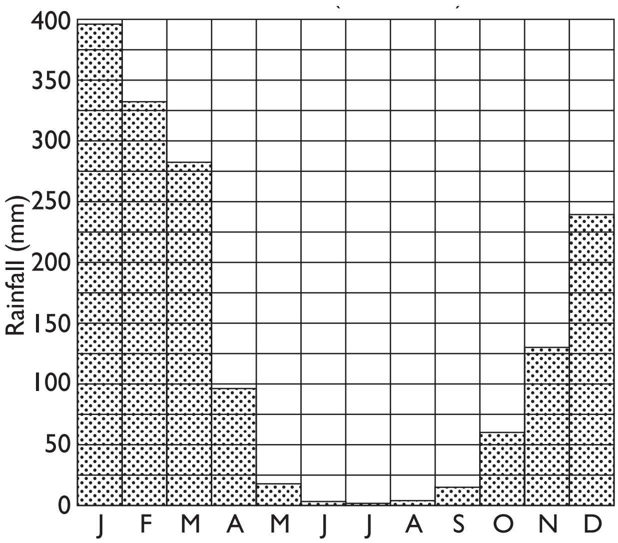
Q3. The monsoon

Q4. See chart below. The dry season should be coloured from March to September and the 'wet' should be from October to April.

Q5. October to April

Month	Amount of rainfall (mm)
Jan	396
Feb	331
Mar	282
Apr	97
May	18
Jun	3
Jul	1
Aug	4
Sep	15
Oct	60
Nov	130
Dec	239

▼ Completed rainfall chart for Darwin, Australia.



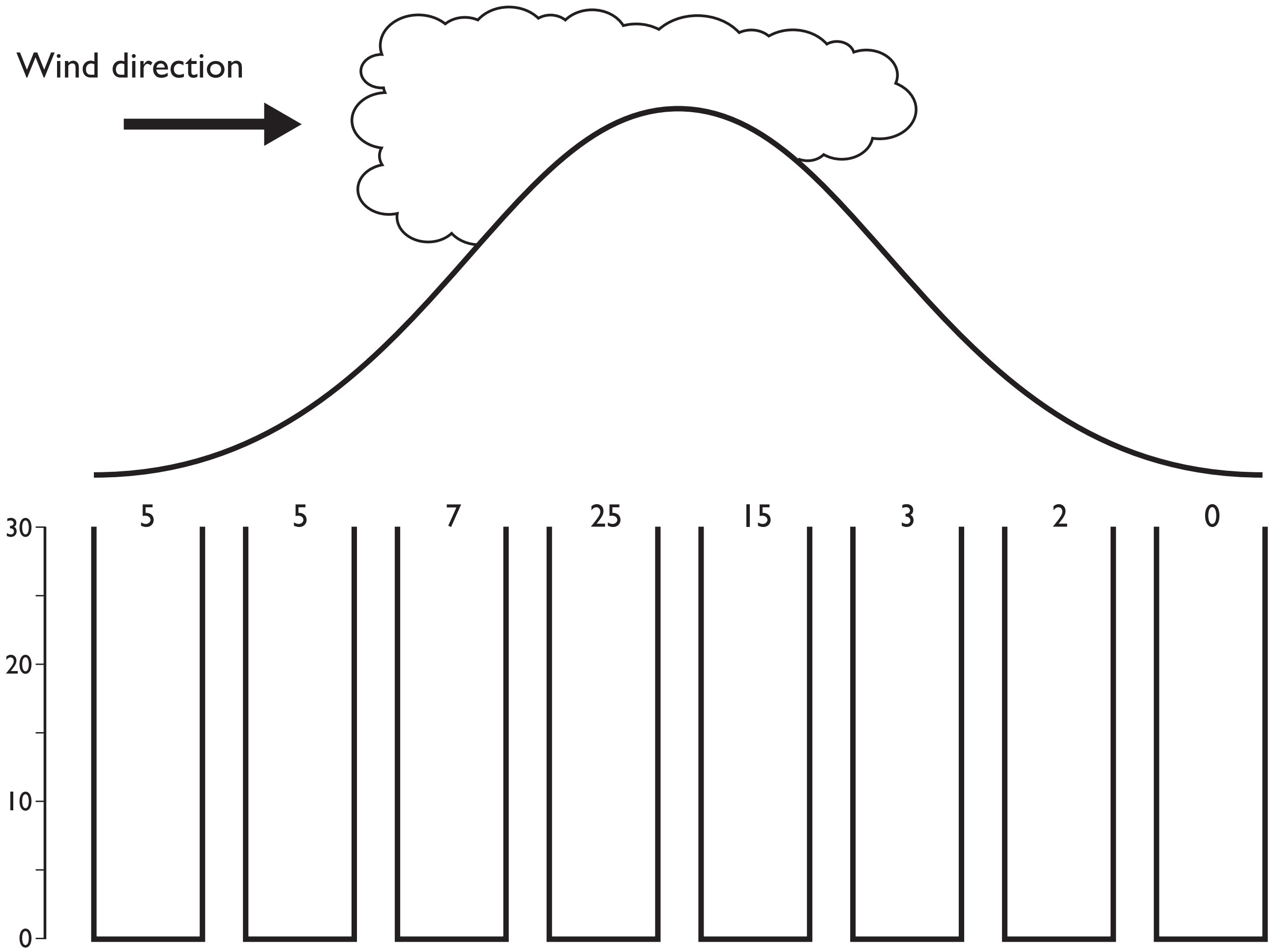
Name:.. Form:....................

Based on **pages 22 and 23** of *Weather around the world*

Rainshadow

This is a side view of a hill. Below it are some raingauges showing the amount of rain collected in each during a day.

Q1. Complete the column chart of the rainfall at each site. Use the scale on the left and the numbers at the top of each gauge to work out how tall each column should be. Shade the columns in blue.



Q2. Does the rainfall vary with height across the hill?

✎ ....

Q3. Is there any difference between the amount of rain that fell on each side of the hill?

✎ ....

✎ ....

Teacher's Background

Based on **pages 22 and 23** of *Weather around the world*

Background

Weather of hills and mountains

Hills and mountains produce their own kind of weather – wetter on the exposed (windward) and drier on the sheltered (leeward) side.

As air flows towards mountains, it is forced to rise and cool. On the windward side of mountains, cooling air eventually has to shed some of its moisture. As a result the windward side of mountains is often masked in cloud even when the surrounding land has clear skies. This mountain rain, called *relief rain*, is extra rain – that is, in addition to the rain that might occur elsewhere in the area.

On the leeward side of the mountains, the air sinks and warms. As a result it can hold all of the remaining moisture, and the clouds formed on the windward side of the mountains evaporate. The leeward side is often called the *rainshadow region*, because it will rain much less here.

In some areas, especially those close to very high mountains, the mountains may force so much water from the air that almost none is left for the lowland beyond. In these cases a desert forms. The 'rainshadow deserts' in the southwestern United States, and in Argentina and Chile, are examples of this kind of extreme effect.

Students should be encouraged to think about patterns of rainfall, not just the rain that falls at a single location. This worksheet is designed to help them practise their graphical skills as well as their understanding of how rainfall varies with altitude.

The use of raingauges at the base of each column should help those who are not used to drawing charts to see where to place each column. In this kind of chart, the rainfall columns do not touch each other.

The pattern shown below has been designed to help you to show rainshadow effects. You may wish to discuss rainshadow effects at this point, or you may prefer to leave this for a later part of the course.

At its simplest level, rainfall is seen to increase with altitude.

More observant students will notice that the peak of rainfall is ahead of the highest peak of the hill. This can be made clearer by asking students to draw a smooth curve through the tops of each column.

The moist air was moving from left to right, so the right side of the diagram is a rainshadow effect. Notice that no rain fell on the plain in the rainshadow zone, even though 5 mm of rain fell on the plain ahead of it.

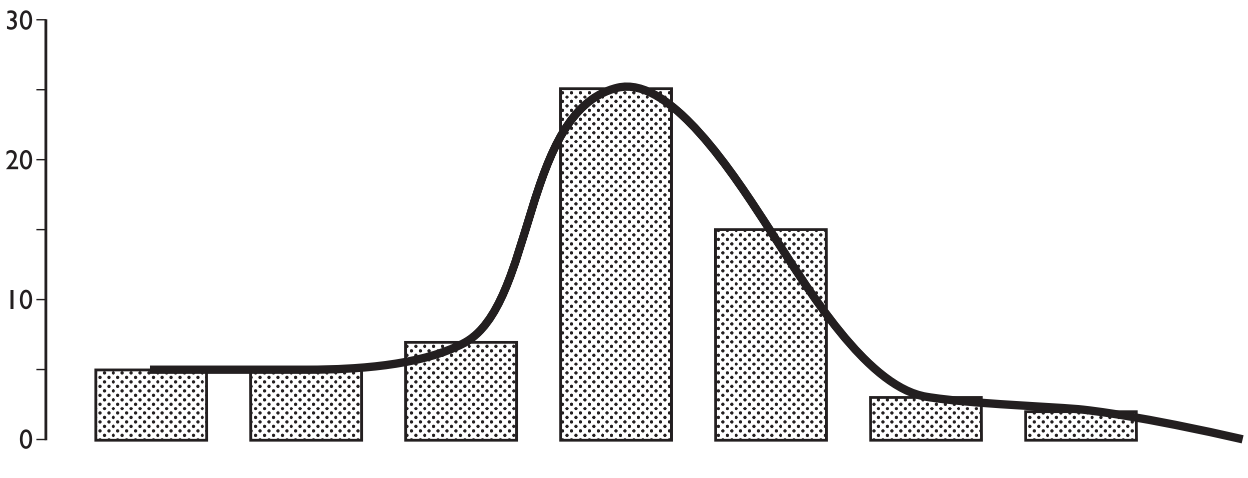
The peak of rainfall often comes before the top of the hill if most of the moisture has already been converted into raindrops on the windward side of the hill. If most of the moisture has already gone, increasing height will not 'wring' much more moisture from it. Hill tops are not therefore, necessarily the wettest places. An extreme example of this can be found in the Himalayas where the foothills are saturated with rainfall but the mountain peaks have (as snow) quite small amounts of precipitation.

Answers

Q1. See chart below.

Q2. In general, the rain falls on higher elevations.

Q3. The rainfall increases with the height of the windward side of the hill, but falls off more rapidly with height on the leeward side. This is the rainshadow effect.



Name:... Form:...................

See **pages 24 and 25** of *Weather around the world*

Tornadoes

Tornadoes produce the most violent winds on Earth and can cause great damage in small areas.

Here is the scale used to measure a tornado.

F-0: 70–109 km/hr, chimney damage, tree branches broken.

F-1: 110–179 km/hr, mobile homes pushed off foundations or overturned.

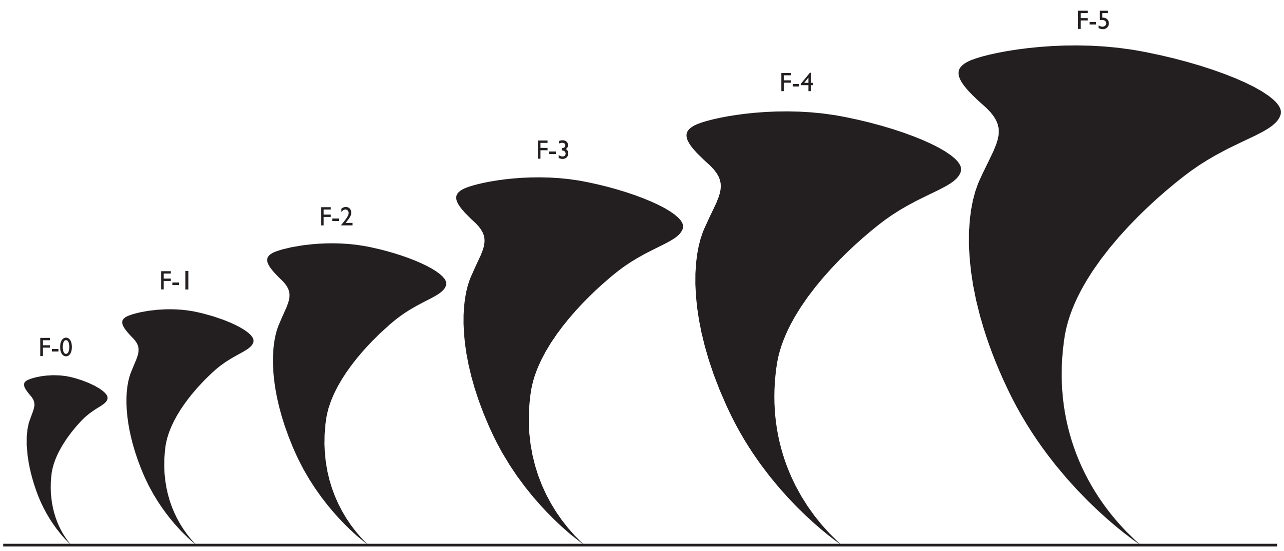
F-2: 180–249 km/hr, considerable damage, mobile homes demolished, trees uprooted.

F-3: 250–329 km/hr, roofs and walls torn down, trains overturned, cars thrown.

F-4: 330–414 km/hr, well-constructed walls levelled.

F-5: over 415 km/hr, homes lifted off foundations and carried considerable distances, vehicles thrown as far as 100 metres.

Q1. Use the diagram below as the start of a poster that would help people to understand the speed, size and danger of tornadoes. You can be as inventive as you like, but you must be informative.



Teacher's Background

See **pages 24 and 25** of *Weather around the world*

Background

Many people experience cold, blustery winds as a thunderstorm passes by. A tornado is probably an extreme version of this wind, which develops into a tight, swirling motion.

To understand this, it is helpful to ask a student to sit in a swivel office chair, with their legs outstretched. Another student can give the chair a push so that the chair begins to turn. The student sitting in the chair then pulls in their legs and the speed of turning increases. This effect is best experienced by the student in the chair, so each student should be given the opportunity to swivel. The effect is the same as when a ballet dancer pirouettes.

Tornadoes tend to occur in the afternoons and evenings: over 80% of all tornadoes strike between noon and midnight.

Coping with tornadoes

The information below is based on that supplied by the Federal Emergency Management Agency (FEMA) of the US government. You can use it to help students understand what it is like to be caught by a tornado.

How to deal with tornadoes

When a tornado is coming, you have only a short amount of time to make life-or-death decisions. Advance planning and quick response are the keys to surviving a tornado.

When a tornado strikes

If at home:

- Go at once to the basement, storm cellar, or the lowest level of the building.
- If there is no basement, go to an inner hallway or a smaller inner room without windows, such as a bathroom or toilet.
- Stay away from the windows.
- Go to the centre of the room. Stay away from corners because they tend to attract debris.
- Get under a piece of sturdy furniture such as a workbench or heavy table or desk and hold on to it.
- Use your arms to protect your head and neck.
- If in a mobile home: get out and find shelter elsewhere.

If at work or school:

- Go to the basement or to an inside hallway at the lowest level. Avoid places with wide-span roofs such as auditoriums, cafeterias, large hallways, or shopping malls.
- Get under a piece of sturdy furniture such as a workbench or heavy table or desk and hold on to it.
- Use your arms to protect your head and neck.

If outdoors:

- If possible, get inside a building.
- If shelter is not available or if there is no time to get indoors, lie in a ditch or low-lying area or crouch near a strong building. Be aware of the potential for flooding.
- Use your arms to protect your head and neck.

If in a car:

- Never try to outdrive a tornado in a car or truck. Tornadoes can change direction quickly and can lift up a car or truck and toss it through the air.
- Get out of the car immediately and take shelter in a nearby building.
- If there is no time to get indoors, get out of the car and lie in a ditch or low-lying area away from the vehicle. Be aware of the potential for flooding.

Note: One of the Curriculum Visions Weather Adventure Stories, *Tornado*, describes the way a tornado hits a small town. This story can also be read out in class, or even acted out.

Answer

No answer is provided here because each student will produce their own unique solution.

12 A

Name:.. **Form:**...................

See **pages 26 and 27** of *Weather around the world*

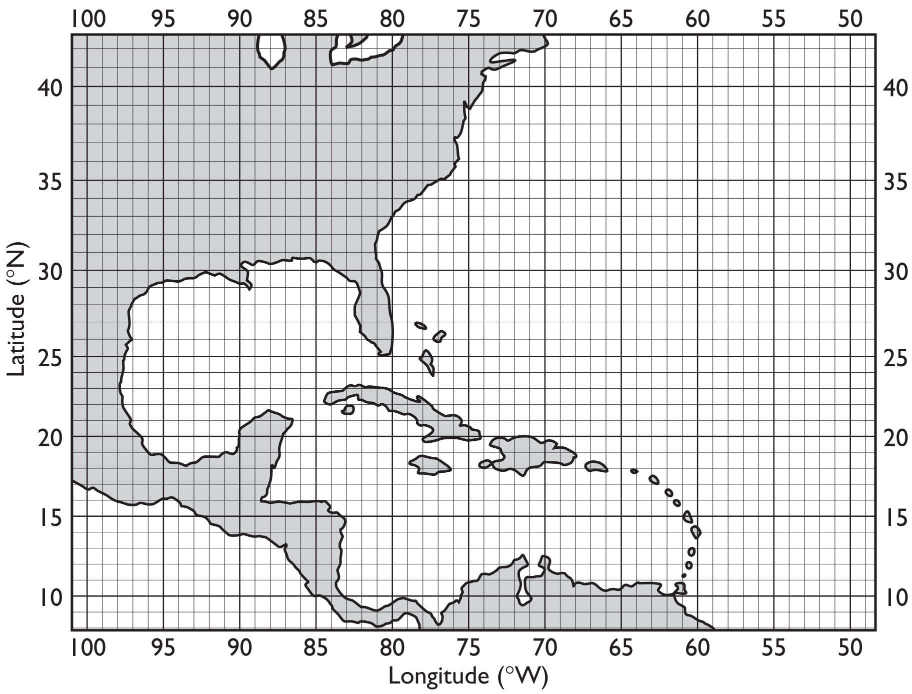
Hurricanes (i)

Track a typical hurricane using the table below and find out what happened. Each of these data points is for noon.

Date	Latitude (°W)	Longitude (°N)	Wind speed (kph)
21st	50	14	180
22nd	62	17	190
23rd	71	22	240
24th	80	21	240
25th	88	28	210
26th	92	31	190
27th	86	34	80
28th	78	37	60
29th	73	41	50

Q1. What do Asians call hurricanes? ✎ ....

Q2. Plot the points given in the table above on the map on the right, and then join all the points with a smooth line.



Q3. Where do you think greatest damage was done?

✎ ....

Q4. Where did the winds start to slacken? Can you think of a reason for this?

✎ ....

✎ ....

Teacher's Background

See **pages 26 and 27** of *Weather around the world*

Background

Worksheet 12B also provides questions on pages 26 and 27 of the student book.

Hurricanes are spiralling masses of air with the winds reaching over 120 km/hr (73 mph). They are called hurricanes in the Atlantic and eastern Pacific (from the West Indian word *hurrican*, meaning big wind) and typhoons (from the Chinese *taifun* which means great wind) in the western Pacific.

Hurricanes form only when moisture evaporates from oceans with temperatures above 27°C. The oceans transfer heat directly to the lowest levels of the air, causing the air to rise. At the same time, enormous amounts of water are taken up by the air as water vapour, or moisture.

As the air rises, it cools and cannot hold all of the moisture. The moisture thus starts to turn back into water droplets, at the same time releasing heat energy which causes the air to rise faster still. The spin of the Earth will cause the rising air to spin as well, creating a hurricane. Hurricanes only die away when they pass over cold ocean water or land, as the supply of hot, moist air is then cut off.

Once a hurricane has formed, it behaves like a spinning top, whirling around and around and at the same time following a wobbly path across the ocean, steered by the prevailing winds.

The power generated by a single hurricane is immense. Each day a hurricane may contain the same energy as a country uses in power for the whole year. Not surprisingly, such concentrated energy has mighty effects on buildings and other structures.

Where do hurricanes form?

Most hurricanes begin life thousands of kilometres from where they cause damage. Their spawning ground is over the oceans, in a band between 5 and 30 degrees from the equator. This is the latitude where the oceans are hot (and so can produce enormous amounts of moist, hot air, above 27°C), and where the natural spin of the Earth has enough effect to set a tropical thunderstorm spinning.

Don't confuse hurricane-force wind with an actual hurricane. The word hurricane means tropical storm in the West Indies. It was adopted by British sailors (and later others) to mean also a very fierce wind, whatever its cause. To avoid confusion, weather forecasters often use 'tropical cyclone' for the storm, and hurricane-force wind for a destructive wind.

What paths do hurricanes follow?

By far the most common places for hurricane-force winds are:

- the areas bordering the Caribbean Sea and the Gulf of Mexico
- the East Pacific in Central America;
- the West Pacific from Queensland in Australia to Japan;
- the Bay of Bengal.

Most hurricanes follow a broadly curving path that takes them first west, more or less parallel to the equator, and then on an increasingly curved path towards the poles. If they get as far as the mid-latitudes where there are prevailing westerly winds, the hurricanes are carried east.

Answers

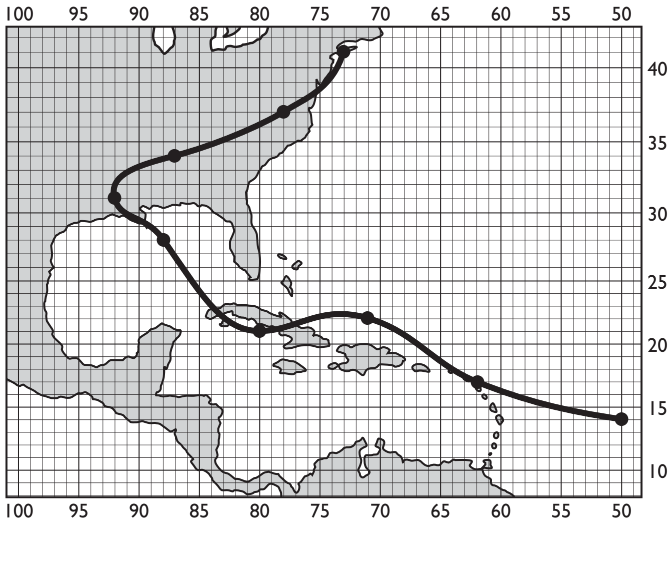
Q1. **Typhoons**

Q2. **See diagram below.**

Q3. **Over the islands of the Caribbean.**

Q4. **Over the mainland of the United States. Once the hurricane is over land, there is much less moisture available to be sucked into the hurricane to provide the energy it needs to keep going.**

(NOTE: The reduced hurricane – below 120 km/hr (73 mph) – is called a tropical storm until it gets into the mid-latitudes. Such storms eventually find their way across the Atlantic and give stormy weather to Britain. By this time, the hurricane will have travelled around three sides of the Atlantic.)



12 B

Name:.. **Form:**...................

See **pages 26 and 27** of *Weather around the world*

Hurricanes (ii)

Hurricanes comprise two fearful parts: strong winds and storm surges.

Q1. The diagrams below show how a hurricane works and some of its effects. Fill in the words missing from the description below, using the diagrams and information in the student book.

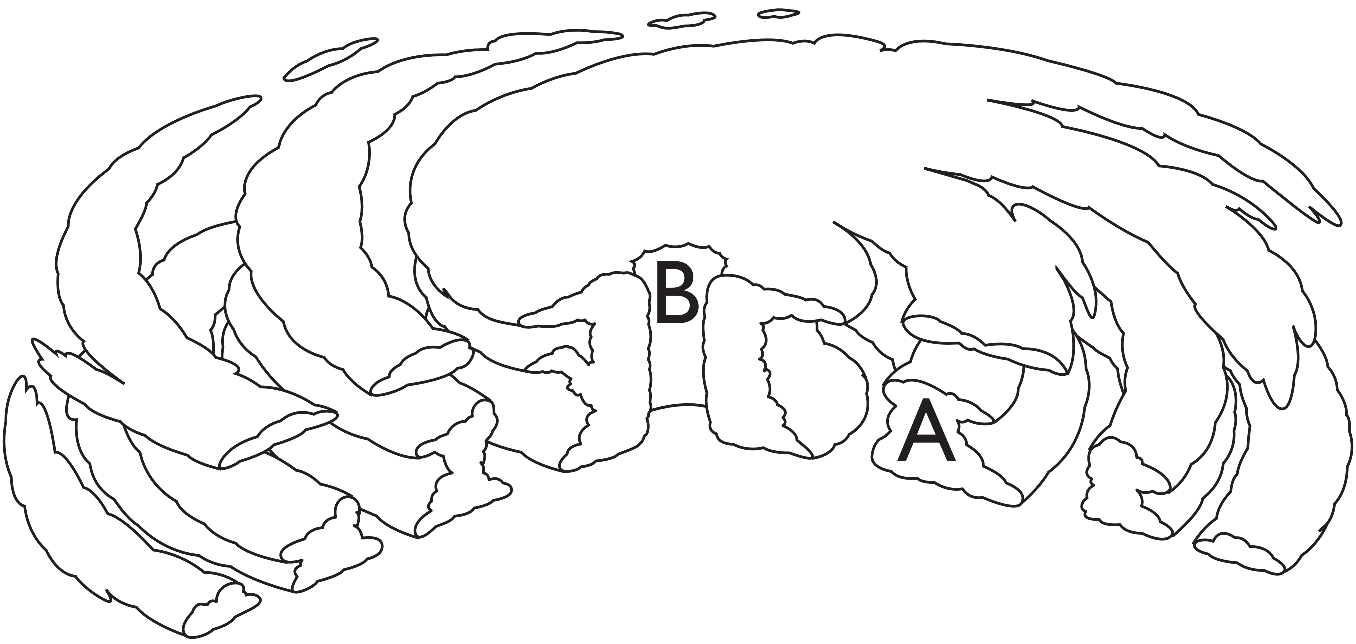
A hurricane contains many tall spirals of ....(A). These release

torrential .... In the centre of the hurricane is the ....(B).

Here the winds are .... and the sky is often ....

A hurricane may be ....km across and take .... hours to cross

an area. In general, they move at ....km/hr.



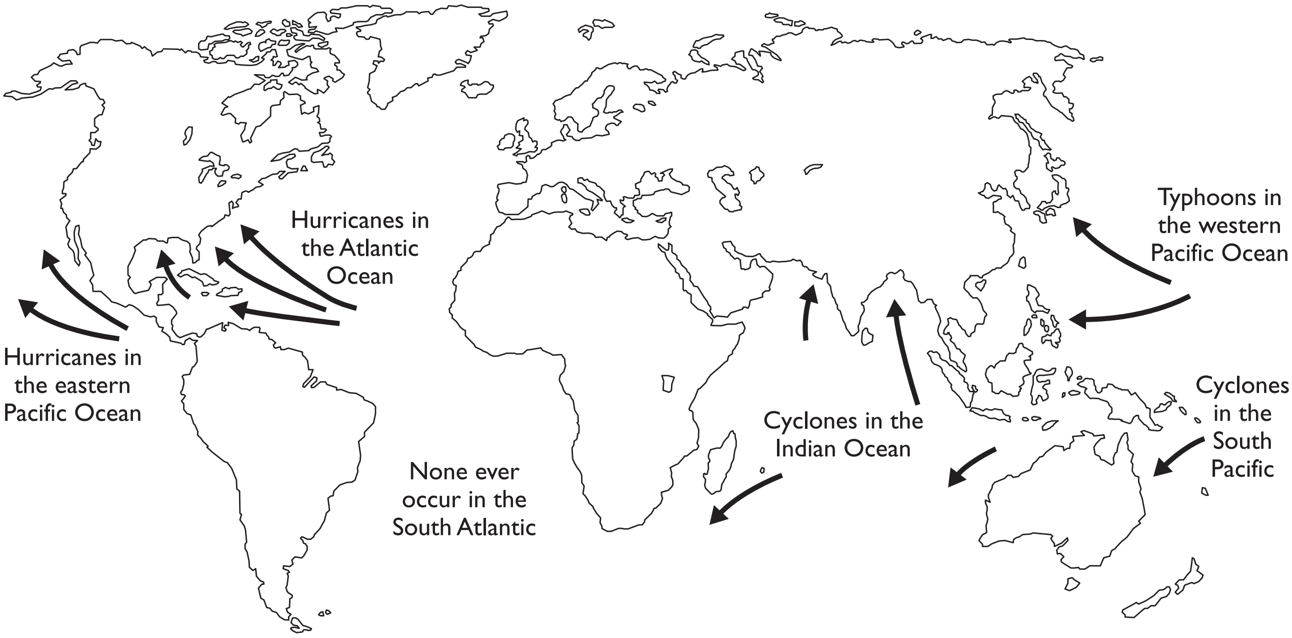
12 B Teacher's Background

See **pages 26 and 27** of *Weather around the world*

Background

Worksheet 12A also provides questions on pages 26 and 27 of the student book.

Hurricane areas are shown on this map.



Answers

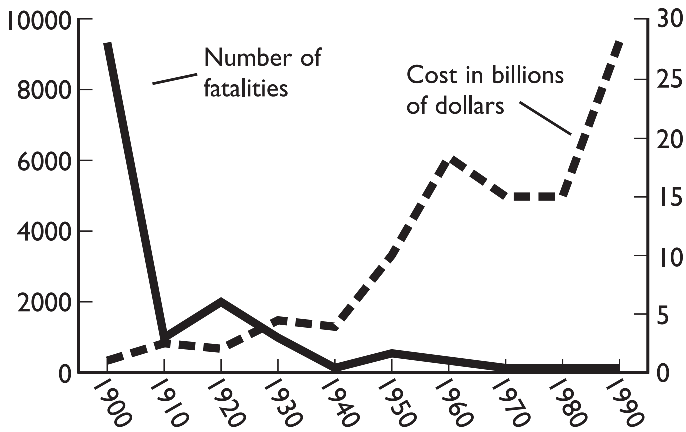
Q1. A hurricane contains many tall spirals of CLOUD (A). These release torrential RAIN. In the centre of the hurricane is the EYE (B).

Here the winds are CALM and the sky is often CLEAR AND SUNNY.

A hurricane may be 800 km across and take 12 hours to cross an area. In general they move at 20 km/hr.

Note: One of the Curriculum Visions Weather Stories, *Hurricane!*, describes why hurricanes are so destructive. This story can also be read out in class, or even acted out.

The loss of life and cost of damage from hurricanes is shown on this graph for the USA. You could sketch this up on a board and ask students to say whether they think this graph would also be true for Bangladesh, and if not why not – in Bangladesh the opposite would be true as the value of property is lower and people less protected.



13

Name:.. Form:.....................

See **pages 28 and 29** of *Weather around the world*

Settled weather

Most people look forward to settled weather, especially if they are going on holiday or are going to be outdoors. But how can you work out if the weather is settled?

Q1. Would you expect to see clouds when the weather is settled? If so, what kind would they be?

✎ ....

Q2. What kind of weather hazard might form during the night in winter?

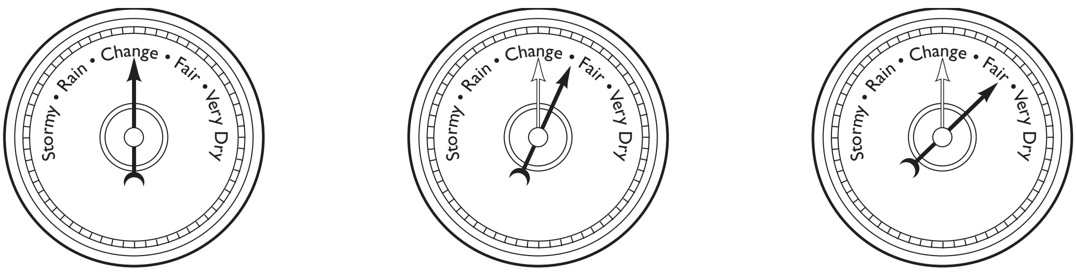
✎ ....

Q3. If you looked at the horizon just after the Sun had set, what colour might the sky be if the weather was settled?

✎ ....

Q4. Here are some pictures of a barometer at various times of the day. Is the weather becoming more settled or less settled? How can you tell?

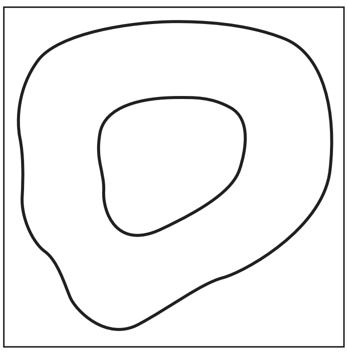
✎ ....



12 noon (12:00)

3 pm (15:00)

Q5. The diagram on the right shows the kind of pattern you see on a weather forecaster's map. The forecast is for fine sunny weather. Write a single word in the centre of the diagram to say what kind of pattern it is.



Teacher's Background

See **pages 28 and 29** of *Weather around the world*

Background

Anticyclones are also called high pressure regions or simply 'highs'. It is the pressure equivalent of a hill, with the greatest pressure in the centre and decreasing pressure outwards. In fact the high air pressure is caused because air is sinking (it is a downward eddy, matching the upward eddy of a depression), so air builds up and then pushes outwards.

Highs are larger, move more slowly, and last longer than lows. Winds are slight and conditions are often calm. Because air is sinking, no bubbles of hot air can rise from the ground and no cloud forms. During high pressures, the air is usually very dry (it has a low relative humidity).

Anticyclones are different in summer and winter. In summer, hot air trying to rise from the ground battles with air sinking through the atmosphere. In winter the ground is cold and so the air is cooled. This makes the air near the ground heavy and so it adds to the sinking produced by a high in any case. Highs tend to develop over oceans in summer when the ground is hot (for example, in the Mediterranean). In winter, anticyclones take over in the centres of continents such as we see in northern Europe, Asia and North America.

Over Britain, high pressure may develop after air sweeps across the country from the Arctic. A centre of high pressure is actually uncommon, and more often a smaller area, called a ridge, forms. A ridge moves quickly across Britain, giving a day or so of clearer weather between lows. At night, light winds and clear skies allow temperatures to plummet, all the more so if snow is lying on the ground. This is when local fog patches occur. You can observe the end of the ridge because there is an increase in high and medium cloud ahead of the next depression.

Britain normally experiences a true high when an anticyclone from the south, usually the Azores, buds off, or enlarges, northwards. Most of our spells of warm, dry weather in summer are connected with highs.

Sometimes a large anticyclone moves north, pushing frontal depressions north to Scandinavia or south to Spain. Because the depressions can no longer move from west to east, the anticyclone is called a 'blocking high'. Such highs are often long-lasting and may cause periods of drought.

Answers

Q1. There may be no cloud at all, or you might see fair-weather cirrus mares' tails, or you might see a few shallow fair-weather cumulus clouds. Any of these answers would be correct.

Q2. Fog

Q3. Purple, red or pink

Q4. More settled because the barometer needle is moving to the right (clockwise), showing that the air pressure is rising.

Q5. HIGH. This is a high pressure region, or a 'HIGH'. See below.

14

Name:.. **Form:**....................

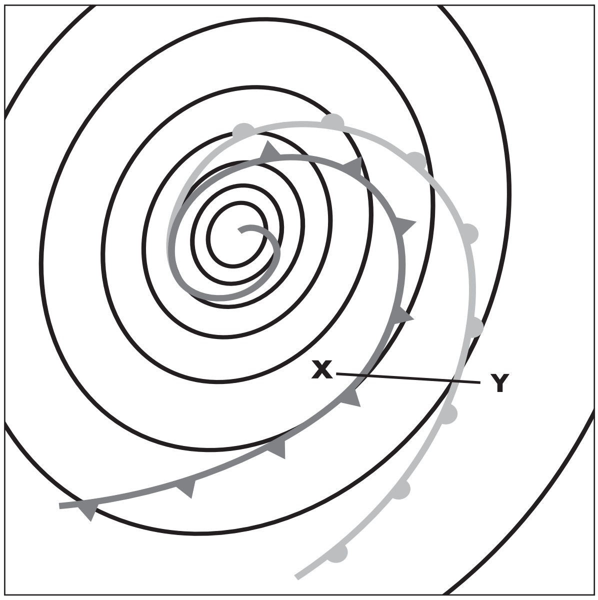
See **pages 30 and 31** of *Weather around the world*

Changeable weather

Most of the changeable weather for people living in the mid-latitudes comes from swirling masses of air called depressions. Weather maps show them very clearly.

Q1. Diagram A shows the kind of pattern you see on a weather forecaster's map. Write a single word in the centre of the diagram to say what kind of pattern it is.

Diagram A



Q2. What do the rings on the diagram tell us about the weather?

✎ ....

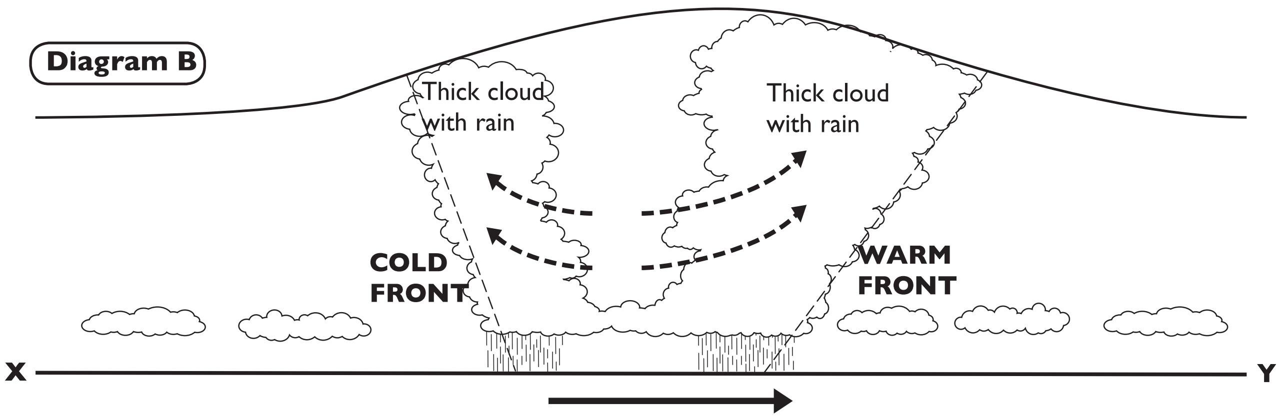
✎ ....

Q3. On Diagram A, what are the two curved lines with semicircles and triangles on them?

✎ ....

.....**Q4.** Diagram B is a side view of a depression and shows where the cloud is thickest. Use this information to shade Diagram A to show where the thick cloud occurs on the map.

Diagram B



The fronts are moving this way.

Q5. If you were standing in a place on the right of the side view and the fronts all moved to the right, how many times would it rain?

✎ ....

Teacher's Background

See **pages 30 and 31** of *Weather around the world*

Background

This worksheet is based on the familiar weather maps used by weather forecasters. If you study your local weather, you will inevitably use the weather forecasts and thus students will be exposed to the weather maps.

Mid-latitude depressions

Layer clouds are most commonly found in mid-latitude depressions, where warm air from tropical regions meets cold air from polar areas. The colder air is heavier than the warm air, and it hugs the ground, making the warm air ride over it, off the ground. The warm air begins to cool as it lifts off the ground, and eventually layer clouds form.

Explaining fronts and isobars

It is quite hard to grasp the idea of isobars and fronts. The concept of isobars is briefly introduced on page 28 of the student book (in the caption to picture ①).

We are trying to achieve the understanding that change is associated with the word 'LOW' and settled weather with the word 'HIGH'. In reality, weather is more complicated than this. This point is most easily made as part of a class discussion.

The worksheet tries to relate the closeness of the isobars to wind speed. The closer the isobars, the windier it will be. This relationship between isobars and contours has been made on pages 28 and 30.

The other important concept to get across is that fronts relate to cloud and rain. It is not so important to separate warm from cold front, or the fact that different clouds occur.

In case you get asked why the fronts are different slopes, the answer lies in the speed at which the warm air is pushed off the ground. The slope at the cold front is twice the slope at the warm front. So, whereas the air is lifted relatively gently at the warm front and gives thick layer cloud (nimbostratus), the air is lifted so quickly at the cold front that it often behaves in much the same way as the fast-flowing air rising on a warm day, giving widespread cumulus (cumulonimbus because it produces rain).

Video the weather forecast

One way to see lots of weather maps and hear the words LOW and HIGH often is to video the weather forecast from the TV. If children see the weather forecast in class, as opposed to at home, they can see it over and over again and compare the actual forecast to pages 28–31 in the student book. They can also be shown that depressions come in families. On the weather forecaster's chart they are often strung out, so you know that one period of changeable weather will be followed by another. Incidentally, families of depressions are directed by the high-level, fast-flowing air, called jet streams.

Answers

Q1. LOW. This is a low pressure region, or a 'low'.

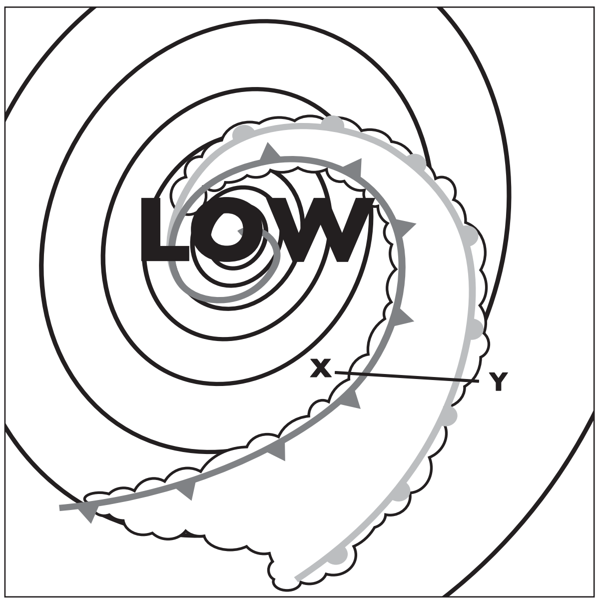
Q2. The isobars are close and so it will be windy.

Q3. Fronts (in fact, the line with semicircles is a warm front, the one with triangles is a cold front).

Q4. See the diagram. Essentially the cloud is thickest along the fronts.

Q5. Twice, because there is rain at each front.

Diagram A



15

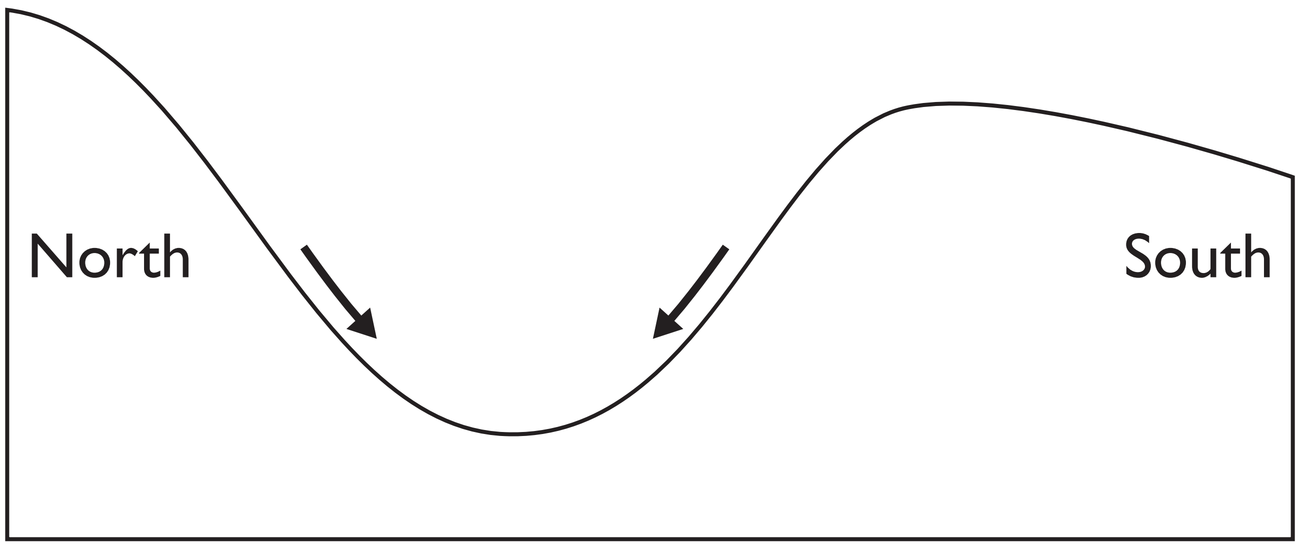
Name:.. Form:....................

See **pages 32 and 33** of *Weather around the world*

Mountain weather

The weather on hills and in valleys and over mountains is often quite different from that on flatter land. This is especially true when there is little wind and a clear sky.

Q1.Q2.✎Q3.Q4.



15 Teacher's Background

See **pages 32 and 33** of *Weather around the world*

Background

This section concerns local weather effects. They all depend on calm atmospheric conditions. A strong wind will destroy the special local weather conditions in valleys, at the coast, or in cities.

Mountain and valley winds

When the atmosphere is calm, mountains cause their own local winds to form. At night, for example, the upper slopes of the mountains lose heat quickly, and the air in contact with them gets cold, but in sheltered valleys the air remains quite warm. Cold air is heavier than warm air, so the cold mountain air rolls down into the valleys.

By morning, this process may have filled the valleys with cold air. This can make mountain valleys very frost-prone and fog may form. It also explains why many crops, such as fruit trees, are grown on the slopes, not on the valley floors, and why many villages are not on the shaded side of the valley.

Mountains can also produce winds that affect the surrounding plains when air piles up on one side of the mountains. In these cases, air can sometimes break out across the mountains and flow into the distant plains, at the same time perhaps sinking by a thousand metres or more. This sinking makes the air warm up and dry out. Warm winds, such as the Foehn (Föhn) of the Alps, and the Chinook of North America, last for many days.

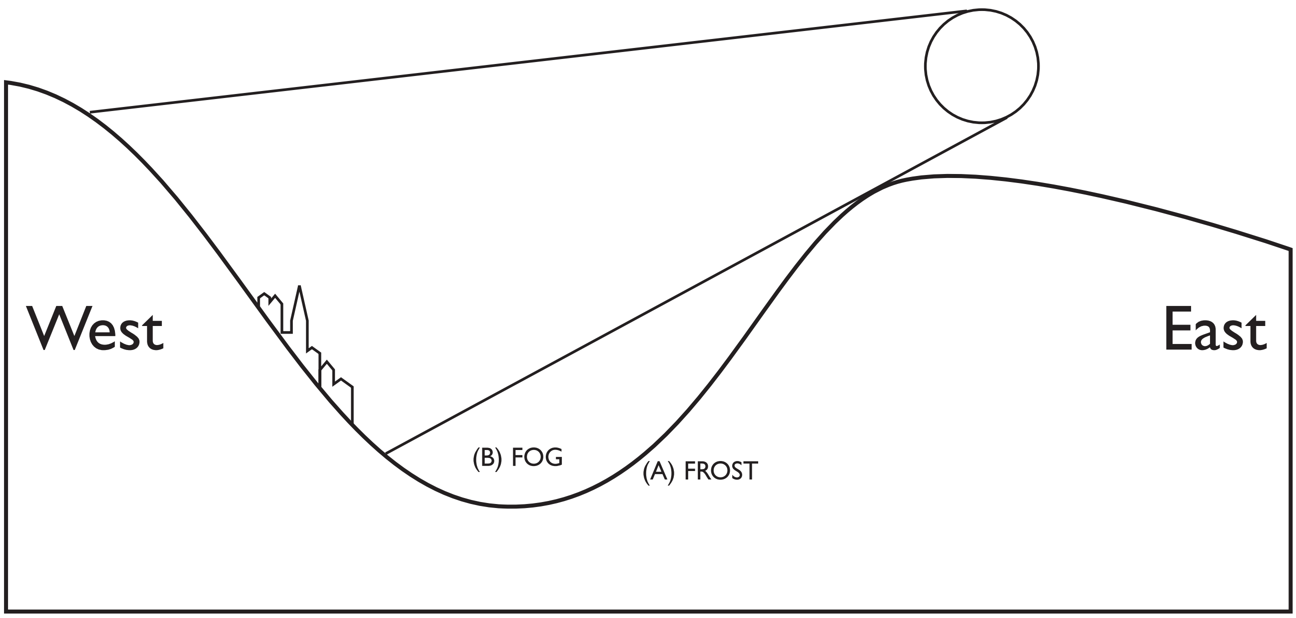
Answers

Q1. See diagram below. Frost will occur particularly in the valley bottom. Fog will occur above it.

Q2. Cold air drains down (see the diagram on page 32 of the student book).

Q3. See diagram below.

Q4. See diagram below. It is desirable to be above the frost and fog and to be on the side that warms up fastest in the morning.



16

Name:... **Form:**...................

See **pages 34 and 35** of *Weather around the world*

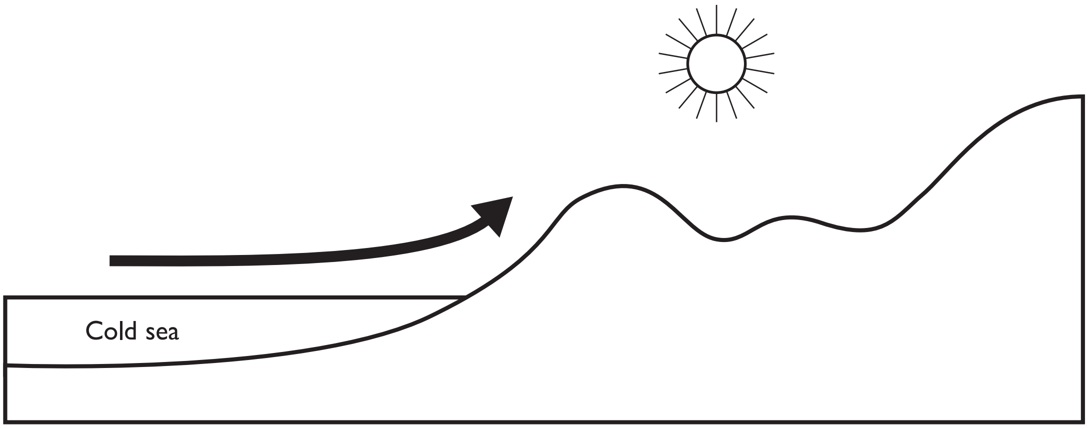
Seaside weather

The coast often has very special weather because of the closeness of the sea and land. A cold sea makes the air over it cool, but at the same time it picks up a lot of moisture. As this air moves, it can produce cloud or fog.

Q1. The diagram below shows a coastal region in early morning. Notice that the sea is cold.

(a) Is the land warmer or colder than the sea? ✎ ....

(b) The arrow shows the gentle flow of air. Write the name of this kind of flow of air onto the diagram.



Q2. The air over the sea has been cooled down and the water vapour has changed to droplets. This has caused f................ to form. Fill in the missing word. (Note: people who live on the eastern side of Britain often experience this phenomenon in late spring. Some people call it 'haar'.)

Q3. Why is the sky clear inland?

✎ ....

✎ ....

Q4. As the land warms up even more, what may form over the land?

✎ ....

✎ ....

16 Teacher's Background

See **pages 34 and 35** of *Weather around the world*

Background

The subject of coastal weather can bring in a wide range of topics. On a large scale you could consider talking about maritime and continental effects. Generally, it affects the region within 5–10 km of the coast. Remember that, as with other local effects, the coastal weather phenomena shows up most clearly on a day when regional calm has set in.

Think of the range of effects that best suits your location if you are at the coast, or emphasise holiday problems and benefits if your school is inland and students rarely visit the coast.

The most commonly experienced effect is the sea breeze, produced by diurnal heating. The daytime heating of the land sets up a convection current. This causes air to rise over the land, pulling cool, moist air off the coast. This gives a welcoming, cooling sea breeze on days that are scorching hot inland. By afternoon, the rising air over the land may give rise to cumulus cloud and showers, but the coast will remain clear and sunny.

When the sea is very cold, the air flowing over it can be cooled far enough for condensation to occur and then fog is swept onto the coast. This situation occurs most commonly in Britain on eastern coasts in late spring, when the North Sea is still very cold. The Shetland term 'haar' is now used to describe this phenomenon down the whole eastern seaboard.

In some places, coastal fog is even more dense and persistent. The most famous place for coastal fog is California. San Francisco bay is dull and foggy for much of the summer, while on the inland side of San Francisco bay there is scorching sunshine. There is more information on this and further examples on the web site.

At night, the land cools quickly but the sea temperature hardly changes, so that the land is colder than the sea. If this is the case, the breeze reverses and an offshore wind occurs. This may take warm air over a cold sea, causing cooling and the production of offshore fog banks. The diagrams below show this.

Answers

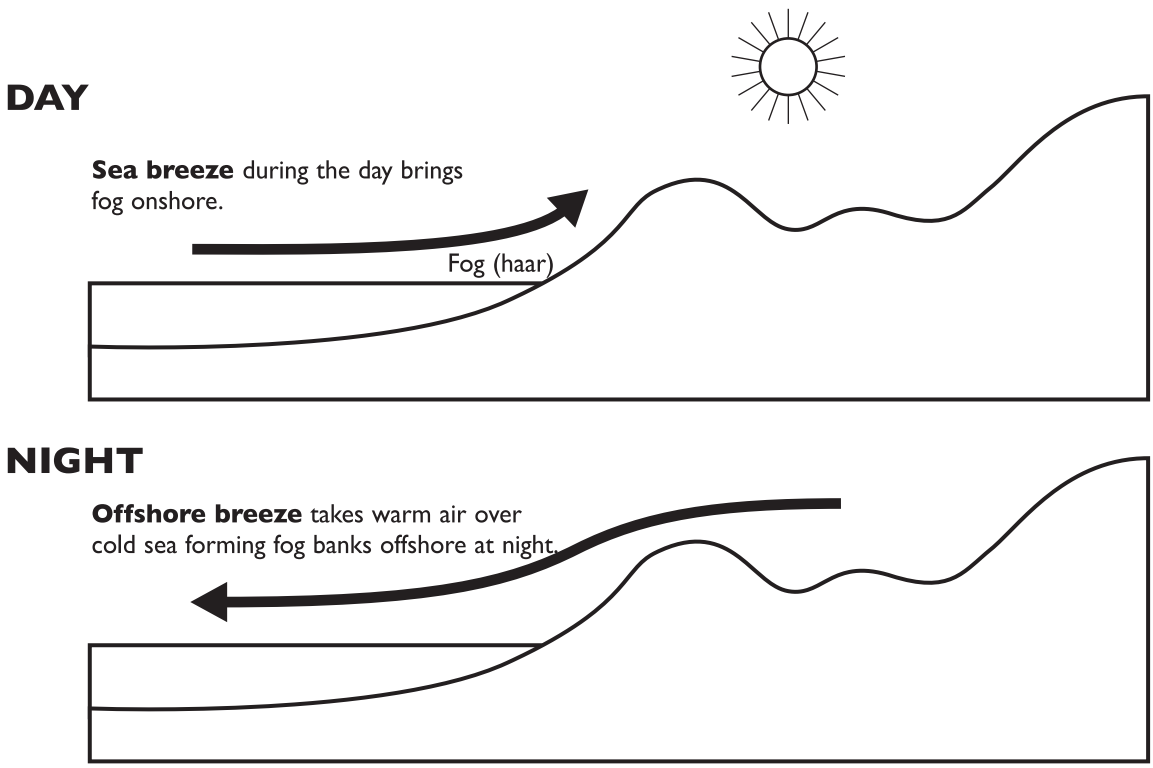
Q1. (a) Warmer

Q1. (b) Sea breeze

Q2. Fog

Q3. Because the Sun heats the land and warms the air. As a result, the fog droplets evaporate.

Q4. Cumulus clouds, because of the rising warm air.



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Name:.. Form:...................

See **pages 36 and 37** of *Weather around the world*

City weather

If you want to do a project on the weather in a city, a town or a village, you can choose to study either temperature or rainfall. Here are some suggestions on how to prepare for a project on temperature.

Remember that many projects need lots of measurements. It is easiest to get enough measurements by getting many members of your class involved.

How places trap the heat

This is a good project for an area within a city or a town. It also gives the opportunity to try to develop a fair test experiment.

The purpose is to see what effects built-up areas have on the temperature within a town or city.

The problem you have to overcome is how to get results from many parts of the town or city all at the same time. The answer is to get friends from a year/class group to use thermometers that they have at home.

If a group of you are doing the project together, you will need to bring your thermometers in to class so that, during a lesson, all the thermometers can be tested against some standard (preferably a scientific thermometer that the teacher has, or the teacher's own thermometer). In this way everyone knows how their thermometer reads compared with the teacher's standard.

Once you have recorded how your thermometer reads compared with the teacher's reference thermometer, the task of making the recordings can be done.

Make up a simple table showing day, time and temperature. On each day you and your friends hang their thermometers in the open away from buildings and out of direct sunlight for about 5 minutes. Choose a convenient time, say 7.45 in the morning, when everyone will be up, but at home. Everyone might do this for, say, a week.

At the same time you record the weather on that day, particularly the wind speed (from a weather forecast on TV). One thing you will be looking for is whether or not windier weather destroys the sheltering effect of the buildings.

Next, you need a street map of your local area. Place a sheet of tracing paper over it and mark on each student's home and beside it write the temperature for Monday (corrected against the teacher's thermometer if necessary).

Once the records are all on the map you can see which area was the coldest. Then you see if all of the coldest places were close together, or if they were all on the outskirts, or in some other place. After that you can try to find out why it was coldest in those places.

Then look for the warmest places and try to see why they might be the warmest.

On page 36 of *Weather around the world* you can see a map made up, with the places marked where the records were made, shown by thermometers. In this case it is colder near to parks, rivers and in places where there are more gardens. Is this true in the case of your project? It was also warmer for those living near city centres. Was this also true for your project?

Now plot your records over time (Monday, Tuesday, and so on), for as many days as you decide. Compare charts. Use the wind information to find out if windier days had fewer contrasts.

Write up your results as a report.

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Teacher's Background

See **pages 36 and 37** of *Weather around the world*

Background

This is a good experiment because it brings in aspects of group work and standardisation as well as spatial analysis of results using maps.

To get many results taken at the same time, all participating students have to have a thermometer at home. It is also a good opportunity to get parents involved in real experimentation. (It also gives a splendid opportunity for students to see what a range of instruments are available for measuring weather.)

For older students, with guidance, you can draw isotherms (lines of equal temperature) using the mapped records of temperature and see what patterns arise.

So, with a simple instrument, such as a thermometer, everyone, including the less able, can participate in obtaining a wealth of data. Everyone gets a map, and parents get involved. It's great fun, for who knows what the results might be?

Results

You should find that those locations that are more built up are warmer showing the heat island effect. The difference may be just a degree but, with a decent sample, that should be fine as evidence.

However, a wind can eliminate any heat island effect. So, for best results, try a period when the weather forecast shows an anticyclone at the start or end of the week. You will then get at least one day with calm conditions when the urban heat island effect should show up clearly.

You can also deal with pollution

As much of the topical discussion is on the health and safety aspects of atmospheric pollution, you may need to be careful to steer students so that they concentrate on the weather effects of pollution, while reading page 37 of the student book. The key features to note include the idea that an increase in the number of pollution particles increases the number of particles in the air that will allow condensation. Carbon materials, in particular, are hygroscopic and attract water. Thus there is more likelihood of rain over cities than in the surrounding countryside. The effect is not, however, very large. Do not attempt to measure it.

The more important effect is the way in which gases and particles are carried downwind from cities, where they act as condensation centres and turn the water acidic, thus causing acid rain to fall on the areas distant from the source of pollution. There is more about acid rain on our web site.

The other major local weather phenomenon is the increase in smog. This is particularly severe in valleys and basins because there the extra production of pollutants is combined with the cradling effect of the natural depression in the land surface to make it very difficult for the pollution to escape. Strong sunshine causes a photochemical reaction, which makes the natural haze turn yellow–brown.

The pictures in the student book are of Mexico City, Mexico, which is notorious for health-related problems associated with smog, but many cities in the USA, as well as in Germany and elsewhere, have severe smog problems caused by traffic.

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Name:.. Form:...................

See **pages 38 and 39** of *Weather around the world*

Change

What is going to happen to the weather in the future?
How can we find out?

This is a research project you can carry out using the Internet.

(1) You have two choices. If you want some simple facts then type this into your browser:

http://www.defra.gov.uk/environment/climatechange/schools/7-11/info/index.htm

This is the starting point for you to study climate change.

Follow the links.

OR...If you want something harder, then type this into your browser:

http://www.exploratorium.edu/climate/

or this:

http://www.sciencenewsforkids.org/articles/20041208/Feature1.asp

This is the starting point for you to study climate change.

Follow the links.

(2) Type the word 'climate' and the word 'change' into the search line of your search engine. See if you can find any more promising links.

(3) Write a paragraph here for each of the most important two things you have found out about the weather of the future.

✎ ....

✎ ....

✎ ....

✎ ....

✎ ....

Background

This is an Internet research project. As we are close to the end of the book, students will have a better grasp of the ideas of weather than they had at the beginning.

First, you may want to make sure that your students know the meaning of the word climate. Up to this point we have been using terms such as 'average weather' and 'long-term weather'. Climate change, however, is what you will find on the web sites and so the term will need to be clear.

Some links to web sites have been suggested which were active on the day of writing, but as you know, web sites have a habit of changing. So if the links do not change then the root link to the top of is www. defra.gov (UK gov) and next lower one is exporatorium.edu (a US site) and the bottom one is www.sciencenewsforkids.org

Many of the sites are too hard for the target audience and so you may want to skim around for yourself before suggesting students do, or give them a wider list than the one presented here.

It is the intention that students complete point 3 as a paragraph for each idea they think is important, not a single word.

19

Name:.. Form:...................

See **pages 40 and 41** of *Weather around the world*

Measuring temperature changes

This diagram shows some weather instruments in a specially designed case called a Stevenson screen. The instruments are a standard thermometer and a maximum and minimum thermometer.

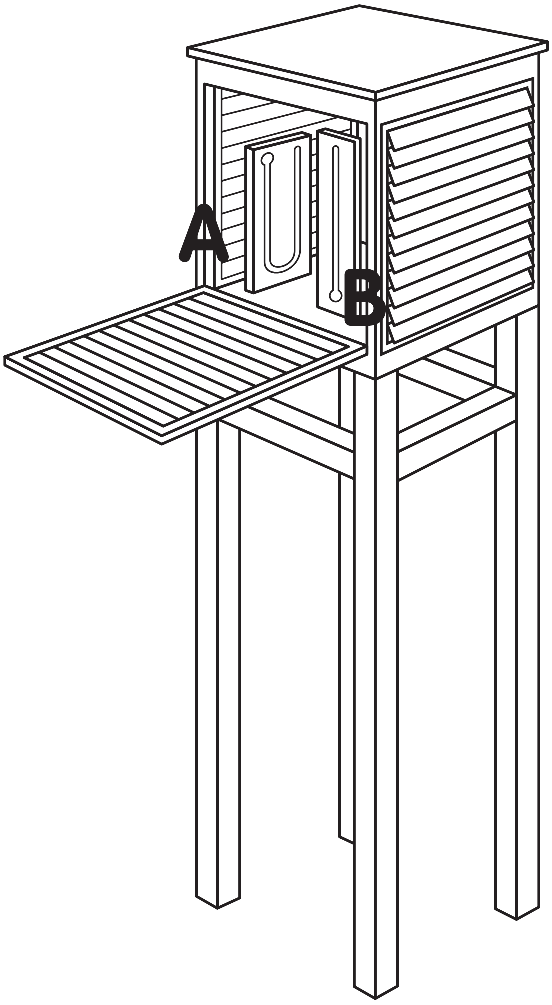
Q1. Which is the standard thermometer, A or B? ✎ ....

Q2. Which is the maximum and minimum thermometer, A or B? ✎ ....

Q3. The slatted sides allow air to flow through the box, but they stop direct ✎ S.......................... from reaching the thermometers. Fill in the missing word.

Q4. All cases for weather thermometers are kept off the ground by tall legs. There is a standard height for the legs. Why is this necessary?

✎ ....



Teacher's Background

See **pages 40 and 41** of *Weather around the world*

Background

This worksheet is intended to give students an introduction to thermometers and temperature.

(1) Expansion/materials

A simple thermometer can be examined to show that it contains a very narrow bore tube with a bulbous reservoir at the bottom. A tube of this size is called a capillary tube. Students can be told that there is a vacuum above the liquid in the capillary tube. If there were not, the air trapped above the liquid would push against it and prevent an even expansion. Thus the scale would be unreliable.

Notice too that the scale on a thermometer is linear, that is, it has even divisions. This means that the expansion of the liquid is also linear.

The material used for the liquid is also important. The least expensive thermometers have alcohol stained red as their liquid; the more expensive have mercury and these can measure temperatures well below freezing.

Get students to examine both types if you can. The reading is always against the flat part of the meniscus, which is at the bottom in alcohol and the top in mercury.

Also ask how is it that the liquid rises but the glass thermometer casing doesn't expand, and cancel out the effect? One reason is that glass has a very low coefficient of expansion compared to the chosen liquids and, of course, the liquid is confined in the capillary tube to emphasise the expansion of the liquid.

(2) Standardisation/fair test

The worksheet contains a diagram of a standard meteorological station. The questions give the opportunity to check that students know the difference between the two types of thermometer and also that they understand the principle of placing instruments in standard locations, so they are comparable.

The slatted sides allow the free passage of air but keep out direct sunshine. All measurements are therefore shade temperatures, which is the international standard. Having instruments a standard height above the ground is also important for the purposes of a fair test.

Students should be told that all the weather data they will be given, or that is in the student book or in an atlas, has been derived from equipment using a standard set-up like the one shown here. Thus they can have confidence that the comparisons between places around the world are fair.

(3) Conversions

Use a thermometer with Fahrenheit and Celsius to introduce the idea of scales. The conversion graph is given below in case you need it.

Answers

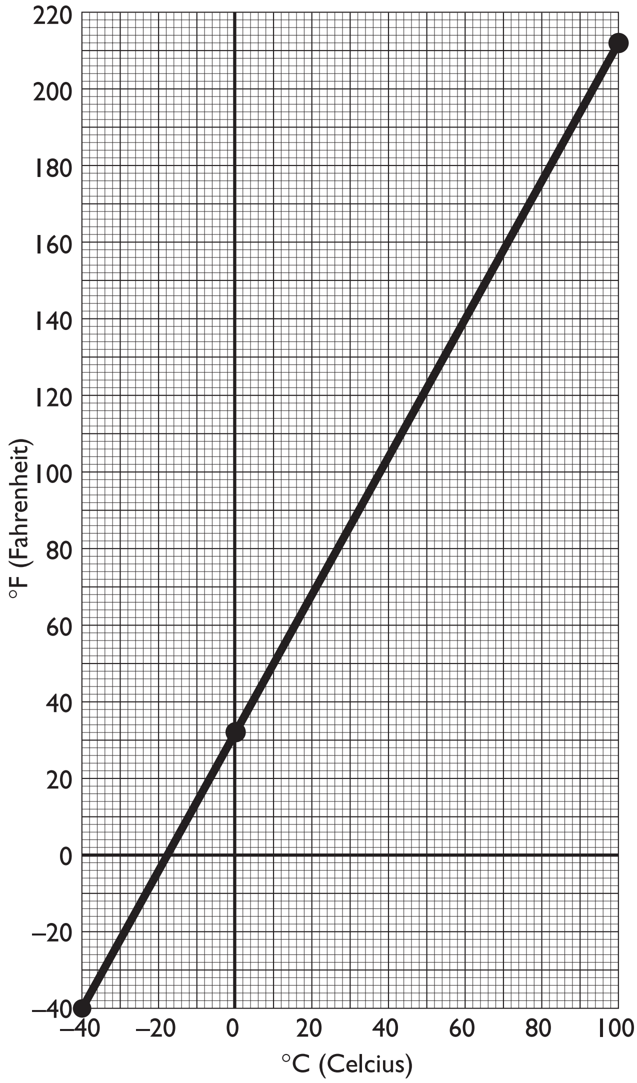
Q1. B: The upright single thermometer measures temperature at any instant.

Q2. A: The U-shaped thermometer measures maximum and minimum temperatures.

Q3. Sunshine.

Q4. So that one location can be compared with another. It provides the basis for fair test.

▼ A graph to convert between Celsius and Fahrenheit.



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Name:.. Form:...................

See **pages 42 and 43** of *Weather around the world*

Measuring and charting rainfall

This is a project to allow you to explore the way that rain falls in a small area. For this you need about 14 identical raingauges. This is a project to compare the amounts of rain collected, so you don't have to worry about how big the gauges are. Use 10 plastic ice cream tubs, or some cans (but make sure they don't have sharp edges). It is important that the containers are identical and that they are exposed in the same way (placed flat on the ground). You will also need a way of measuring the rainfall collected. A scientific measuring cylinder is best, if you can get one. Otherwise, a small kitchen measuring cup may do. The quantities of water collected may be very small.

Three experiments are suggested here.

(1) Find out how much a building shelters the ground from the rain.

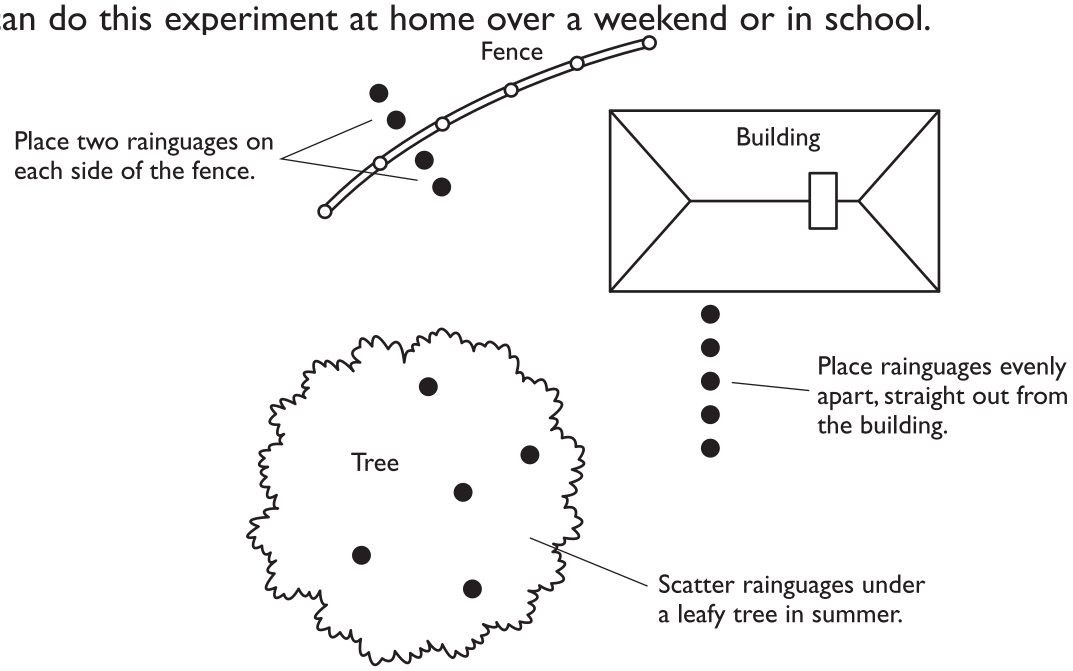
(2) Find out how rainfall varies under a leafy tree.

(3) Find out what rainfall is like on either side of a tall wooden fence or hedge.

For each experiment choose a rainy period, so that you can collect as much rain as possible.

Discuss your requirements, and the way in which you will record and present your results, with your teacher, before you begin.

You can do this experiment at home over a weekend or in school.



20 Teacher's Background

See **pages 42 and 43** of *Weather around the world*

Background

Investigating rainfall patterns over a local area forms the basis of a very rewarding set of projects. Essentially the objective is to investigate the shelter provided by buildings, trees and other structures.

The practical exercise on the reverse of this sheet has been left in outline form only so that you have the opportunity of discussing the project with the students, rather than letting them just follow a prescribed sheet.

The exact form the project takes will also depend on the layout of your premises, and so on. Encourage the students to get involved in thinking the project through.

(1) Start with the collecting tubs. Ask why it matters that they are all the same size and shape and exposed in the same way? This allows you to discuss how comparative readings can be made if the instruments are all the same, even if you do not use standardised equipment.

Far too many people think that worthwhile experiments can only be undertaken with specially bought equipment. This is not true. Many comparative projects cost nothing in terms of equipment and yield excellent results.

The key to all of the measurement procedure is to make sure that the results give a fair comparison.

(2) The period of time for the project is important. It is best to do it during unsettled weather when the rainfall will definitely exceed the evaporation, by a large margin, between rainy spells. Spring and autumn are often best: a day or two may be sufficient for collecting purposes. It does not matter at what time the project starts and stops, provided the start and stop times are the same for all tubs.

(3) To draw up the results for strings of raingauges, it is best to produce a side-view column chart. Get the students to measure the distances of the raingauges from the wall of the building, then plot rainfall collected against distance. In this way they will find out how far shelter might extend.
Draw the results from under the tree differently, as a plan. They can simply write the value of the record in colour. Choose different colours for different amounts. In this case the objective is to show how rainfall is intercepted by trees and how it falls randomly from the leaves. Make sure you have a raingauge beyond the tree for comparison. If this experiment is repeated seasonally, the effect of leaves can also be seen.

(4) The instructions on the practical exercise say nothing about wind direction: this has been left for you to mention. Wind blowing rain towards a building will produce no effects of shelter, whilst wind blowing rain away from a building will give considerable shelter effects. You can therefore, plan with students to measure the lee as opposed to windward rainfall patterns.

(5) You may consider that it is best for students to try this project at home in their own gardens or in a friend's or relative's garden. In such locations the tubs are more likely to go untampered. Students could place a raingauge tub in their garden at home and measure the rain that fell, say, over a weekend (6 pm, Friday to 6 pm Sunday, for example). Then all the results can be plotted on a street map. It is possible to show the more able students how to draw isohyets (lines of equal rainfall) from this point information. More about this appears on our web site.

NOTE: Expect less rain in sheltered places, such as close to walls and in the lee of fences. Rain falls irregularly under a tree, depending on how it falls through the leaves. In summer the leaves may trap it all and no rainfall will be collected.

21A

Name:.. Form:...................

See **pages 44 and 45** of *Weather around the world*

Measuring the wind

The simplest thing you can measure is the wind direction. But even though it is simple, you can get much useful information about the weather.

You will need a wind vane of some kind. This may be a proper wind vane, or it might be a flag and a compass.

You will make measurements every day at the same time for a month. You will always stand in open ground well away from buildings and trees. If possible, stand in the same place each day (but this may not be possible at weekends). Spread the measuring load among the class.

On each day find the direction of the wind. The direction is OPPOSITE the direction the flag is fluttering in. That is you are measuring the direction the wind is coming from, not the direction it is going to. You record the wind as a direction, choosing one of these: north, northwest, west, southwest, south, southeast, east, and northeast. You can also choose calm.

At the end of the month put your measurements into a table like this, totalling each category. So you might have seven days when the wind came from the north west. Put 7 under northwest.

You are now going to put those measurements onto a special chart called a wind rose. If there were 7 days from the northwest, draw a column 7 units long and colour it in. Do the same for the other directions.

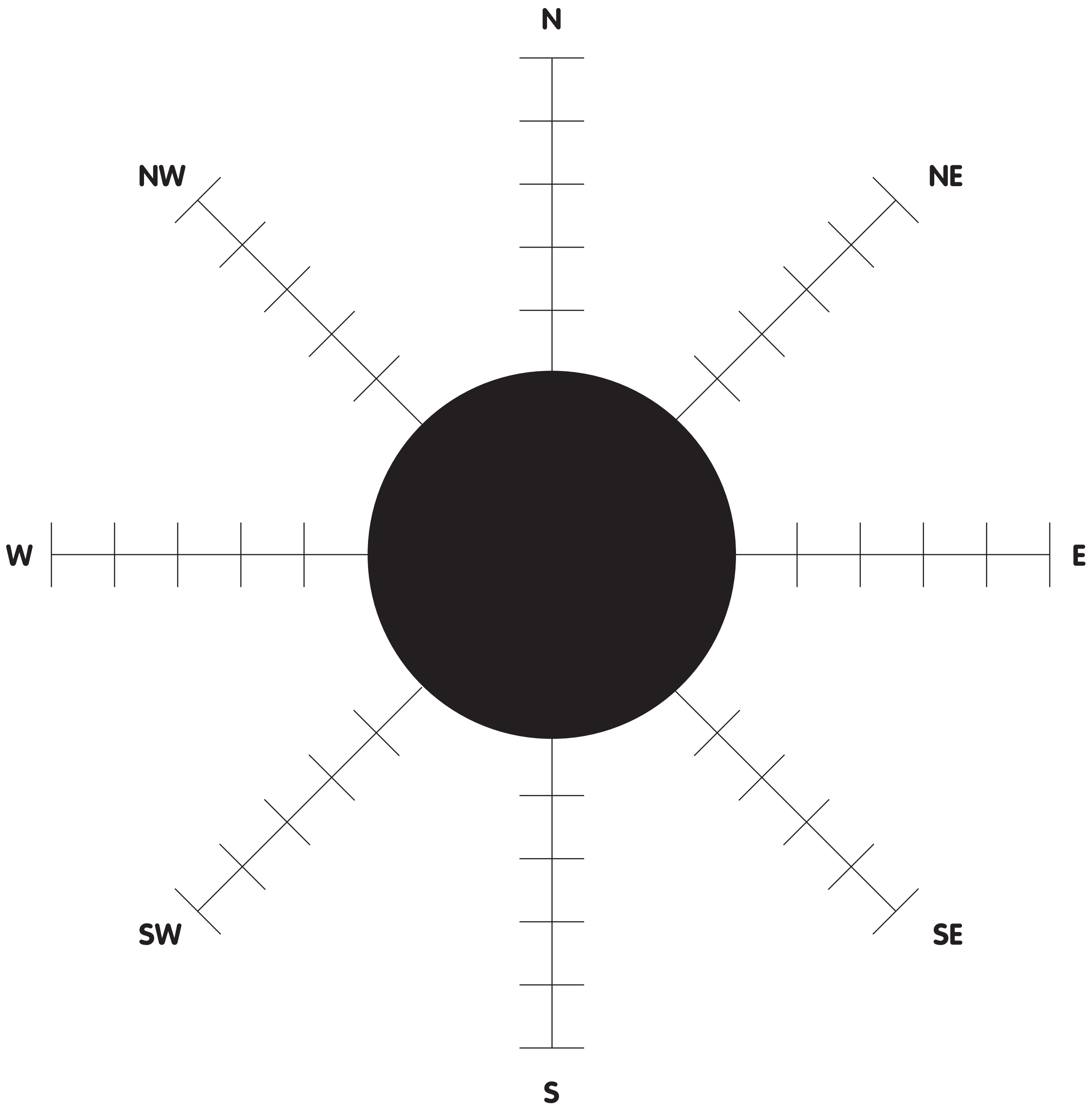
The bar pointing furthest shows the most common, or prevailing wind. This is often the northwest. Is that what you have found?

21A

Name:.. **Form:**...................

See **pages 44 and 45** of *Weather around the world*

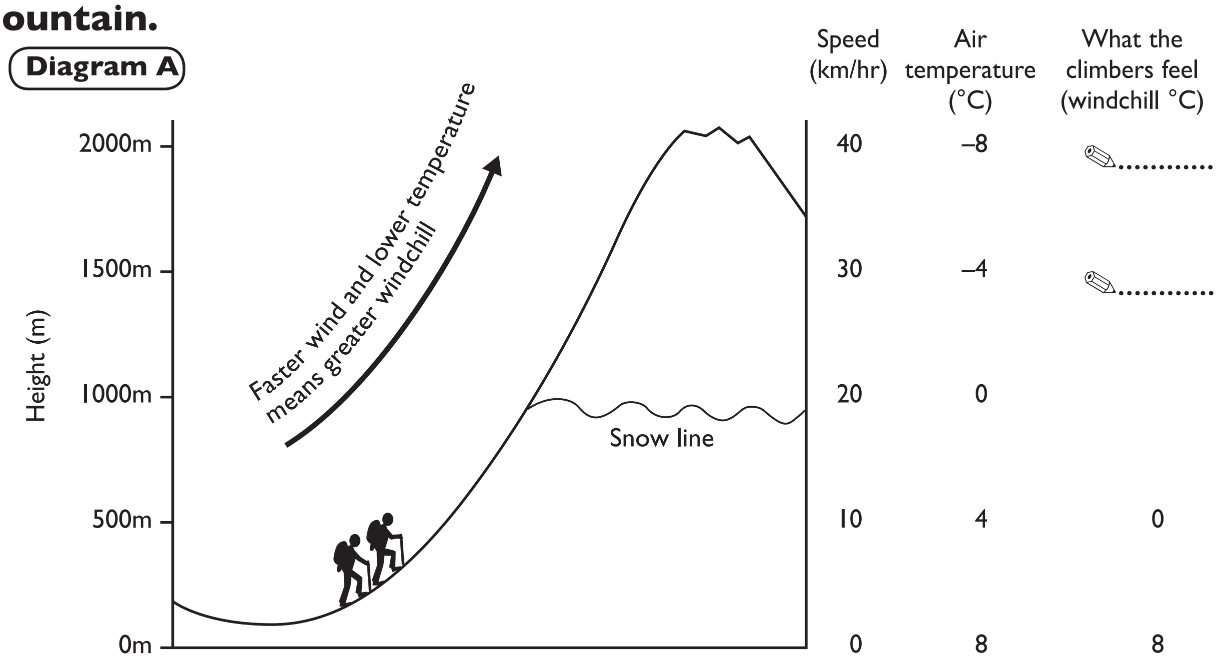
north	northwest	west	southwest	south	southeast	east	northeast



Wind and windchill

One of the more interesting local studies about wind is windchill. You know that it feels chillier when the wind is blowing than when it is calm. But the effect can be surprisingly large. Follow these climbers and see what happens as they find themselves on a windy mountain.

Diagram A



The table below shows temperature against wind speed. It also gives you the windchill temperature – the temperature that the body feels in the wind, as opposed to the actual air temperature.

Wind speed (km/hr)	Air temperature (°C): 8	4	0	–4	–8
40	–5	–11	–17	–23	–29
30	–3	–8	–14	–20	–25
20	0	–5	–10	–15	–20
10	5	0	–4	–8	–13
0	8	4	0	–4	–8

Windchill temperatures freezing or below are separated by a thicker line.

Q1. Use the information in the table to complete the three windchill temperatures on the right-hand column of Diagram A. The lowest two have been completed for you.

Q2. The climbers imagined that the air would feel freezing when they reached the snow line, but at what height did it actually feel freezing?

✎ ....

Teacher's Background

Based on **pages 44 and 45** of *Weather around the world*

Background

Windchill is a term that refers to the combination of air temperature and wind speed. The wind causes the body to lose heat faster and, therefore, feel colder. Suppose the temperature is 8°C and the wind speed is 30 km/hr. To a person out in these conditions it would feel the same as if the temperature was –3°C in still air.

In still air, we lose some heat by radiation to the air around. This tends to warm up the nearby air. We don't lose much heat by conduction, though, because air is a good insulator. After a while, the air close to our bodies warms up and stays there, so we feel comfortable in it. But, when the wind blows, new air is brushed past our skin all the time and it never gets a chance to heat up, so we lose much more heat trying to warm up the air all the time. This is called windchill, meaning the chilling effect of the wind.

Windchill can't be measured. What you actually measure is the temperature and the wind speed, but we can work out what the windchill temperature is. If the wind speed is below about 7 km/hr, the wind chill effect is minimal. Also, if the wind is above about 70 km/hr, it has hardly any more effect because the skin is already losing heat at its greatest possible rate.

Effects of windchill

There are many dangerous effects that windchill can produce. Hypothermia and frostbite are both examples of severe windchill effects. There is some danger of frostbite when the air temperature is –10°C and the wind is blowing at 40 km/hr. Meteorologists now report windchill temperatures when conditions are severe: "This may seem quite nice, but when you add in the effect of the wind, it is actually bitterly cold…". Most commonly you see windchill reported when the windchill temperature is a couple of degrees above freezing, or colder. Notice that, on the diagram, the air temperature decreases by 8°C for every 1,000 m of ascent. You could therefore make up your own valley to mountain diagram using this figure.

NOTE: One of the Weather Adventure Stories, *Blizzard!*, describes the way in which windchill is important in survival. This story can also be read out in class, or even acted out.

Answers

Q1. See table below.

Q2. At 500 m. At 500 m the windchill is already 0°C. In still air the snow line shows the freezing level as 1,000 m.

Height (m)	Wind speed (km/hr)	Air temperature (°C)	Windchill temperature (°C)
2,000	40	–8	–29
1,500	30	–4	–20
1,000	20	0	–10
500	10	4	0
0	0	8	8

Section 6: Teaching weather around the world through the Gallery CD and charts

In this section you will find basic information on how to teach weather patterns around the world, and then case studies which students can use on their own or when making comparative studies between the UK and other countries. You can also use it when you need background information about a country you might be studying.

One fundamental to this study is to compare the pattern of weather of your home location with that of a foreign place. We did this at the beginning of the book with postcards. Remember that you can make postcards from all of the pictures on the Picture Gallery CD, some of which include weather charts for places like London and Miami, Florida.

Unfortunately many students, may have little direct knowledge of the comparison place they are studying. So, the risk is that the students will get taught unfortunate stereotypes about the nature of a distant location.

Of course, this shouldn't happen when thinking about comparative places within the UK. But, in these cases it will still be helpful to see local areas in pictures. Some places are featured on the web site. Also do consider using the WeatherWatch set to get a month by month assessment of the weather in places around the world.

e-mail

One of the most vivid ways of bringing the nature of a foreign place alive is to read an e-mail that a school in a distant location writes for a school in Britain. So what is it that is useful and what makes the e-mail vivid?

For one thing it is because it is real. It is one group of people at a specific place talking to another group. But, more than that, it is because the people in each location are able to talk about the everyday detail that spells out their world.

In an e-mail people talk about their lifestyle rather than their climate. Climate is incidental. But, very important pointers of the climate can be picked up from the lifestyle. For example, if people talk about it being dark for months on end, it is a clear pointer to seasonal differences, and so on.

A day in the life

Another way to approach an understanding of climate might be to learn about lifestyles rather than hard facts about the climate. This may lead on to providing a reason for learning climatic figures which can then be sought out.

You might consider getting students to write a letter about their daily lives and see how much climate they put into it. Do they describe what clothes they wear, for example, what they think are the features of the weather and the season? What do they do for their holidays, and, if they go to a distant location, is their journey weather-related? What kind of heating do they have at home? And what kind of cooling?

Many books try to give a feeling for lifestyle. A 'day in the life' approach is often quite illuminating. They are written to talk about lifestyle and may feature climate. You may care to use the one here (Delhi teaboy); others will be added to the weather web site.

Weather facts related to 'a day in the life'

The climate of India is tropical monsoon. As with other tropical places, the idea of seasons is not marked in terms of temperature, so much as in terms of rainfall. India has a single, dry season and a single, rainy season.

The special nature of the continent means that the moisture-bearing rains arrive very quickly and at about the same time each year. The monsoon thus ‘breaks’. During the monsoon, there are rainy days and dry days: the sort of changeable weather that might be experienced on mid-latitudes – except that it is much warmer. It does not rain all the time, but it can rain for days on end.

The end of the monsoon is not abrupt. The rainy days simply taper off, as the dry season takes hold.

It is driest and coolest in January, but as the year progresses, the Sun heats the land more and more. Without clouds to provide shade, the temperature builds up and up until it is much like the temperature of the hot deserts. Shade temperatures of over 40°C are common. At the same time, the humidity builds as moist air is pulled from the oceans. Many people suffer from nervous exhaustion and heat stroke at this time of year. In fact, June and July are cooler than May because the cloud and cooling effect of the evaporating rain are important. All of these facts can be introduced from ‘a day in the life’ story, such as the one on the next page.

A weather day for Chandera

Chandera lives with his mother and five brothers and sisters in the end of a large pipe. The pipe is the kind that is laid underground to carry mains water. But, the pipe has been by the side of the road for a long time, and as no one seemed to want to bury it in the ground, and Chandera’s mother was new to the city and with no money, it seemed as good a place to live as anywhere.

During the day Chandera’s mother stays close to the end of the pipe with the youngest of his sisters. All the other brothers and sisters go out to find work. That is why Chandera, aged 8, is a tea boy.

It is stifling hot in the pipe during the day, but also very hot outside the pipe as soon as the Sun rises high in the sky. It is May, the hottest time of the year, and the sky is clear and blue, as it has been for many weeks. The nicest time of the day is early morning, but by 9 am the Sun is blazing down, scorching the Earth, and the city. Everywhere is as dry as dust.

Chandera returns some glasses to the tea stall where he works. The owner clips him over the head for no real reason except that it is intolerably hot, and like most people in the city, he is irritable and liable to argue for the slightest reason, or even no reason.

The tea stall owner has a cover over the stall to keep the heat off. Chandera thinks that the tea might boil without any help from the gas burner today, it is so hot.

By midday, Chandera is trying to keep out of the heat by resting under the stall. Most people are also sitting about. It is so hot that almost anything you do is exhausting. Chandera has thin, cotton clothes, a pair of baggy trousers and a shirt. Cotton is very good in the hot weather, and baggy clothes let some air get to the body, while at the same time keeping the heat of the Sun at bay.

By early evening, the Sun is less intense. The city is beginning to bustle once more as people come out to do their shopping, or to eat in the many restaurants.

Chandera continues to carry tea from the stall to the customers in the nearby offices and shops. It is a bit easier now, but the heat from the Sun has soaked into the walls and the road so they are still warm to the touch. The city will not cool down tonight, he thinks. It will be hot and still.

Just up the road, two people begin fighting – more trouble caused by the heat.

Chandera knows that tomorrow will be as hot, if not hotter, than today. And, it is still over a month before the start of the rains. If only they would come sooner, but of course they won’t. It will simply get hotter and hotter, day by day, until early June when the monsoon rain will come. On that day, the sky will be jet black with thick, rain-laden clouds. Then, when the first rains come, everyone will go out into the street and stand around getting drenched in the rain, and feeling cool for the first time in months. It doesn’t matter if the streets turn all muddy and you are wet through for weeks and weeks afterwards, at least you are cool!

WORLD WEATHER DATA

The world weather (climate) data provided in this section is based around station climate charts and graphs like the one below. There are also climate charts and graphs for students to construct in the photocopiable worksheets. They provide an excellent way of teaching mathematics and geography together, both at Key Stage 2 and Key Stage 3.

What is shown on climate charts and graphs

Climate station data is usually given in two pieces. One refers to rainfall, the other to temperature. Notice that the rainfall chart is a bar chart because rainfall is collected in monthly units. The temperature data is plotted as a line graph, with the data points being connected with a smooth line. This is because temperature varies continuously. This means that, for example, you can find the temperature at any time of a month.

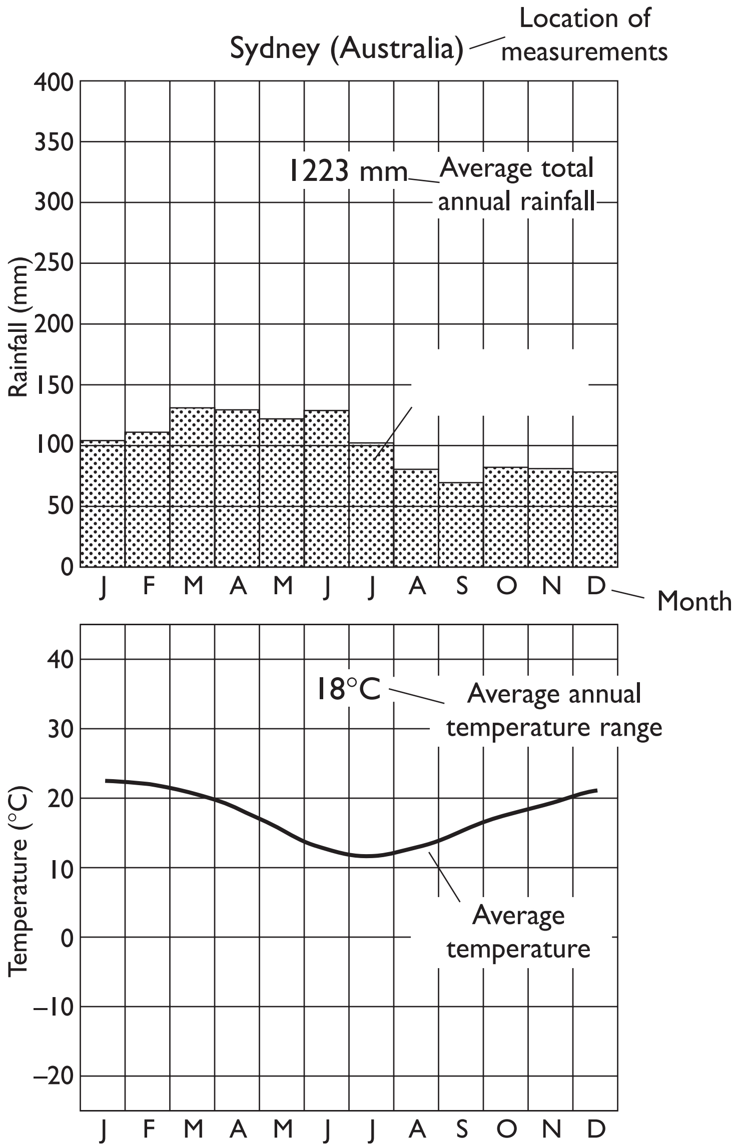
Rainfall charts have rainfall on the upright axis, most often in mm. Temperature graphs have temperature on the upright axis, most often in °C.

The rainfall total is often given in a box situated on the graph. The average annual temperature range is usually given on the temperature graph. Note that this is a RANGE (highest minus lowest for the year) and not the average, annual temperature. This can be confusing to students and needs to be pointed out.

The best way to look at rainfall data is to stand well back and capture an impression of the pattern. Are there peaks and troughs? These would correspond to wetter periods (often rainy seasons) and drier periods (often dry seasons). Are all of the bars long (a wet climate) or short (a dry one)?

The best way to look at temperature is first to find out if the curve shows consistently high temperatures (an equatorial climate) or low ones (a high latitude climate) and whether the curve is even (a maritime climate) or has a large hump or trough (a continental climate).

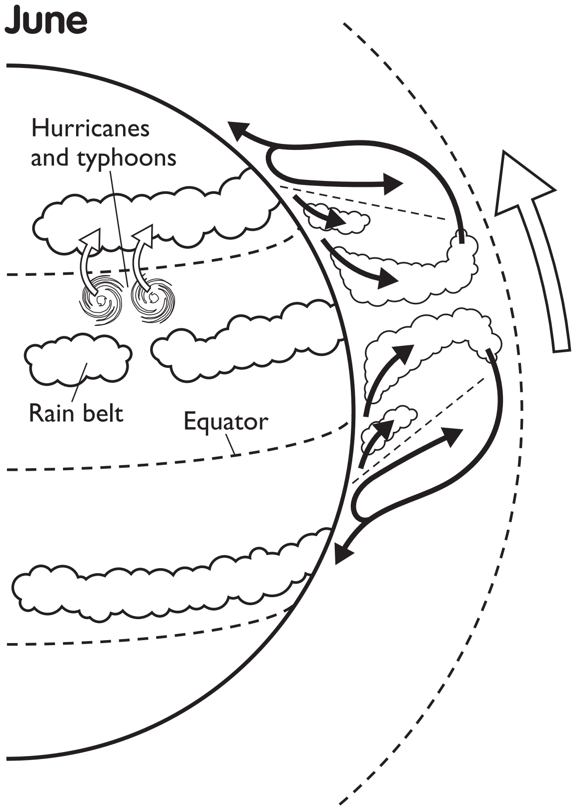
If students can identify these patterns, they are well on the way to making the most of the data, and they will be surprised how much they can find out from the charts and graphs. In the following sections, the charts and graphs have all been interpreted for the major climatic regions.



Explaining the seasons of the tropics

The tropics experience seasons because of the movement of the overhead Sun. Because the Sun is always high in the sky, all places are hot; seasons are created by rain. Get students to see how the rain belt, marked by clouds, moves during the year. Remember it moves away from the equator and then back again, so places closer to the equator have two rainy seasons while those near the edge of the range (like India) have only one.

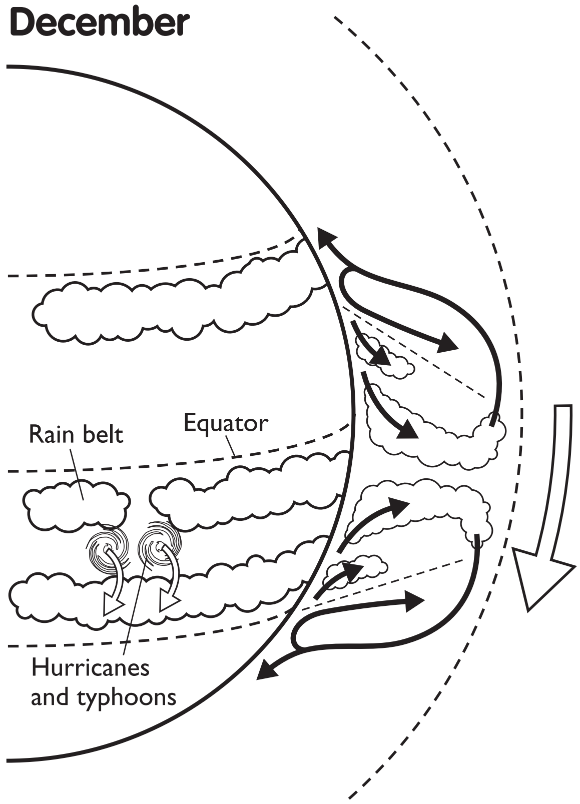
June



◀ In June, the Sun is overhead at its most northerly point. It heats the Earth most strongly to the north of the equator.

The heated air rises, sucking moisture from the oceans and generating huge cumulus clouds that produce thunderstorms. This is the rainy season, the time when hurricanes and typhoons are at their most active in the northern hemisphere.

December



◀ In December, the Sun is overhead at its most southerly point. It heats the Earth most strongly to the south of the equator.

The heated air rises, sucking moisture from the oceans and generating huge cumulus clouds that produce thunderstorms. This brings the rainy season in the southern hemisphere, when hurricanes and typhoons are at their most active in the southern hemisphere.

THE HUMID TROPICS

The humid tropics occupy the zone to either side of the equator. All the humid tropics receive large amounts of rain, but some areas receive rain throughout the year, while others have it only in one time period.

Because the temperature remains high throughout the year, there is no summer or winter, but rather a dry season and a wet season. In some areas that have rainfall throughout the year, there are simply no seasons at all. In fact, in most of these areas the changes that occur between the heat of day and the cool of night are far greater than the difference between the hottest and coolest times of the year.

In a zone that lies within five degrees of the equator, many coastal areas receive rain more or less every day throughout the year. In these areas there is a daily cycle of weather, with sunny mornings followed by rain in the early afternoon.

The world's biggest forests (the Amazon and the Congo) also release enough moisture from their leaves to act just like oceans, providing the moisture for rainfall every day, even in areas thousands of kilometres from the oceans.

In this part of the world, the climate greatly depends on the forests. Without them, these areas would be far drier. This is one reason why many people believe that the tropical rainforests should not be cut down.

Away from the equator, rain tends to fall for just part of the year – the wet season. The wet season coincides with the time of year when the Sun is most overhead, so the rainy season in the northern hemisphere tends to be from May to October, and in the southern hemisphere between November and April.

Tropical rainforest climate

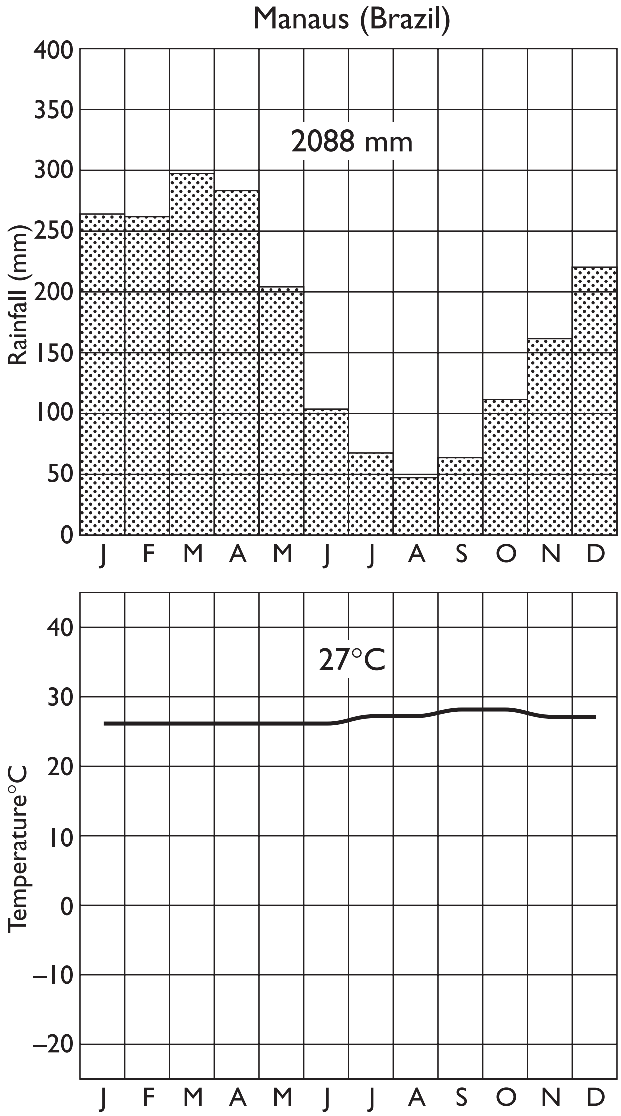
Examples: Borneo, Cameroon, Rondonia state of Brazil, South Malaysia, Singapore, Papua New Guinea, tropical Pacific islands.

All months have average temperatures above 18°C, and a range through the year of less than 6°C. The main variations are from the daily cycle of the weather.

Many of the regions that lie astride the equator have weather that is very similar all year round. Areas within five degrees of the equator vary, on average, by no more than a few degrees Celsius from the hottest to the coldest months. Many, although not all, equatorial areas also have rainfall throughout the year and so do not experience wet or dry seasons.

These warm, humid conditions have allowed the most extraordinary forests to grow in a girdle about the Earth. They are called tropical rainforests.

Tropical islands are surrounded by ocean, so it is easy to see the source of the moisture that forms the clouds that give the torrential rainstorms on most days. But, parts of the world's biggest rainforests, such as that in the Amazon Basin, are thousands of kilometres from the ocean, and there are no constant winds to drive the moisture ashore. Instead, the moisture is provided by the trees themselves. Their roots pump rainfall from the soil up through the trunks and out through the leaves. By this process, called transpiration, plants gather the nourishment they need for life, but they also give vast amounts of moisture back to the air, allowing the clouds to form and more rain to fall.



▲ Manaus (Location: 3°S, 60°W) is a Brazilian city near the heart of the Amazon rainforest. It has no dry season, although there is less rain from June to September. The lowest month receives about the same as an average month in southern England, the highest month about the same as in the Lake District or Western Highlands.

During the period of less rain, much of the rain is recycled from transpiration from the rainforest trees. Notice that the temperature hardly changes throughout the year.

Monsoon

Monsoon comes from an Arabic word meaning 'season'. It is a term used to describe climates that affect hot areas with a season of torrential rainfall, which often begins abruptly. Monsoons are a climatic variation on the more normal pattern of wet and dry seasons that occur throughout much of the tropics.

Sudden changes between seasons are not common, and where they occur they reflect special local conditions. For this reason it is not possible to explain all monsoon areas in the same way. In West Africa, for example, the monsoon occurs when dry, scorching Trade Winds from the Sahara Desert are suddenly replaced with moist winds from the Atlantic Ocean.

The end of the wet season is always less abrupt than the start. It occurs gradually, about three months after the start of the monsoon, as the Sun shines less fiercely and the continent cools down and stops drawing air from the oceans.

The Indian monsoon

The Indian subcontinent experiences a special kind of tropical climate triggered by the shape of the land. This huge triangular subcontinent is bordered by the Indian Ocean to the east, the Bay of Bengal to the west, and the world's highest mountains – the Himalayas – to the north.

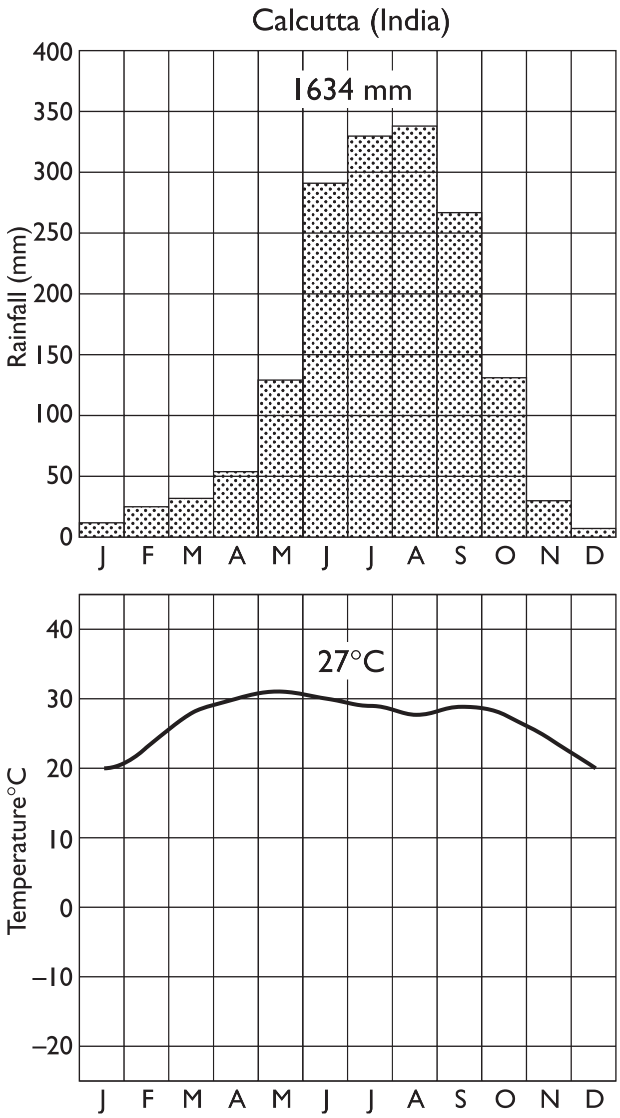
India is coolest in December, but the Indian Ocean and the Bay of Bengal are still warm. Air sinks over the cool land and flows out to the oceans. No moisture flows onto the land, and this produces the dry season.

By April, the Sun is back in the northern hemisphere. Skies over India are still clear, allowing the full strength of the Sun to heat the land. During May, the air gets hotter and hotter. This is the hottest time of the year; it is regularly over 40°C, and in the heat tempers can fray. Everyone looks forward to a break in the weather and a flow of colder, moist air from the ocean. But, only in June does it become hot enough to reverse the flow of air from land to sea.

The change is particularly dramatic over India. Air rushes in from the oceans, changing the climate from clear skies to rain in a matter of a few days.

In the midst of the rainy season it is common for the streets to be flooded, due to the very heavy rainfall. The poor suffer most during the monsoon: because they have to build on easily flooded land, their settlements are often flooded for weeks on end.

The farming year is controlled by the monsoon season. Seeds are planted and crops grow in the rainy season, then ripen in the dry season that follows.



▲ The rainy season in Calcutta, India (Location: 23°N, 88°E), begins fitfully in May, but by June rain is falling each day. Clouds during the monsoon help to moderate the temperature, so that the middle of summer is not the hottest time of the year. Notice that the monthly rainfall at the height of the monsoon is about half of the yearly rain for much of lowland Britain. The total rain would be comparable with that in the British mountains.

Savanna climate

Examples: East Africa, much of Brazil, inland India, Indo-China, Northern Australia

All months have average temperatures above 18°C, and a range throughout the year of less than 18°C.

Between the rainforests and the deserts, all areas have a wet and a dry season. For several months there may be almost no rain at all, then for several months thunderstorms will occur on many days.

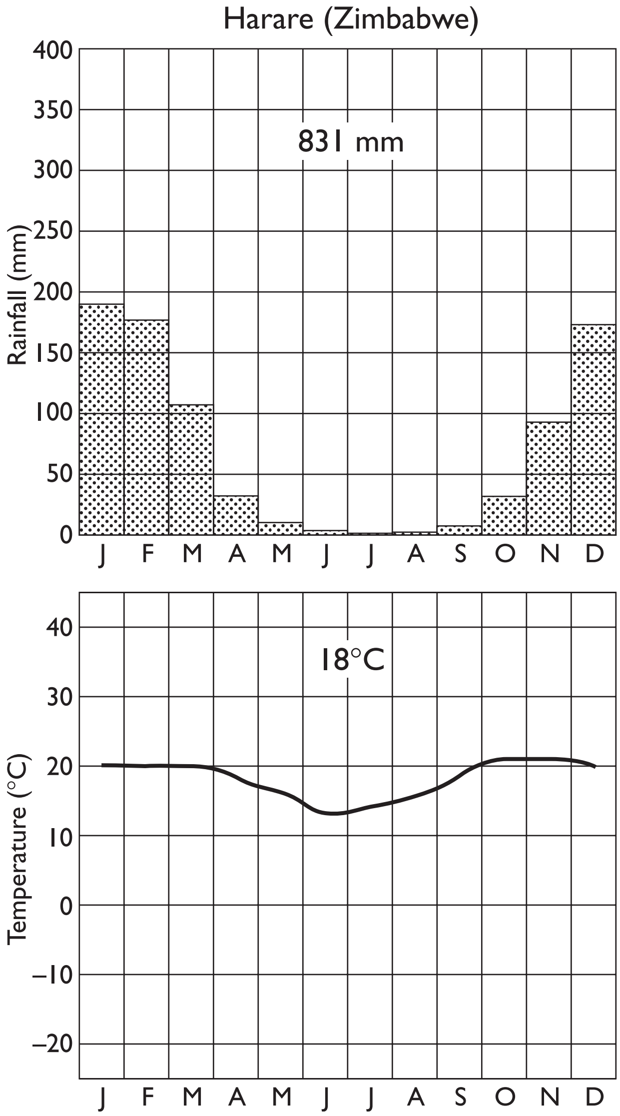
These lands change dramatically with the seasons. In the dry seasons they are parched and brown, trees lose their leaves and the grasses wither until they appear to be dead. The scrub becomes as dry as tinder.

Then, as the seasons change, storms begin to build, and lightning flashes may set the dry land on fire. Finally, the storms bring rain and the land begins to come alive as plants grow and leaves burst forth, turning the landscape green again.

This savanna climate, named after the open grassland/woodland vegetation that occurs there, can be a very productive region for farmers. But, towards the deserts the dry season gets longer and the rainy season less reliable, and the chances of crops failing becomes very high. In these places, people often live on the verge of disaster.

Natural grasslands of the African savanna also contain some deciduous trees, such as acacia (thorn trees). Many animals cope with the long, dry season and lack of grazing land by migrating. Their migrations, like that in East Africa of animals like the wildebeest, are the greatest on Earth.

People cope with the long, dry season in many ways. In rural areas of the developing world, people store food until the wet season allows replanting, and they try to conserve water in small reservoirs and in stone jars. The lack of water makes these people extremely efficient at using this vital resource.



▲ Harare, Zimbabwe (Location: 18°S, 31°E), is a part of the dry savanna. The temperatures are moderate because Harare is on a high plateau. The total rainfall is about the same as in lowland Britain, but with a long, dry season.

DRY CLIMATES

Large parts of the world experience a climate where the amount of rain that falls is small and very unreliable. The world's greatest deserts lie in a belt on both sides of the tropics of Capricorn and Cancer. The North African Sahara and the deserts of the Middle East and Australia are examples of this kind of desert.

Dry climates also occur in the centres of the continents, simply because they are so far from the moisture-bearing winds that they receive only small amounts of rainfall. The Gobi Desert of Asia has this kind of climate.

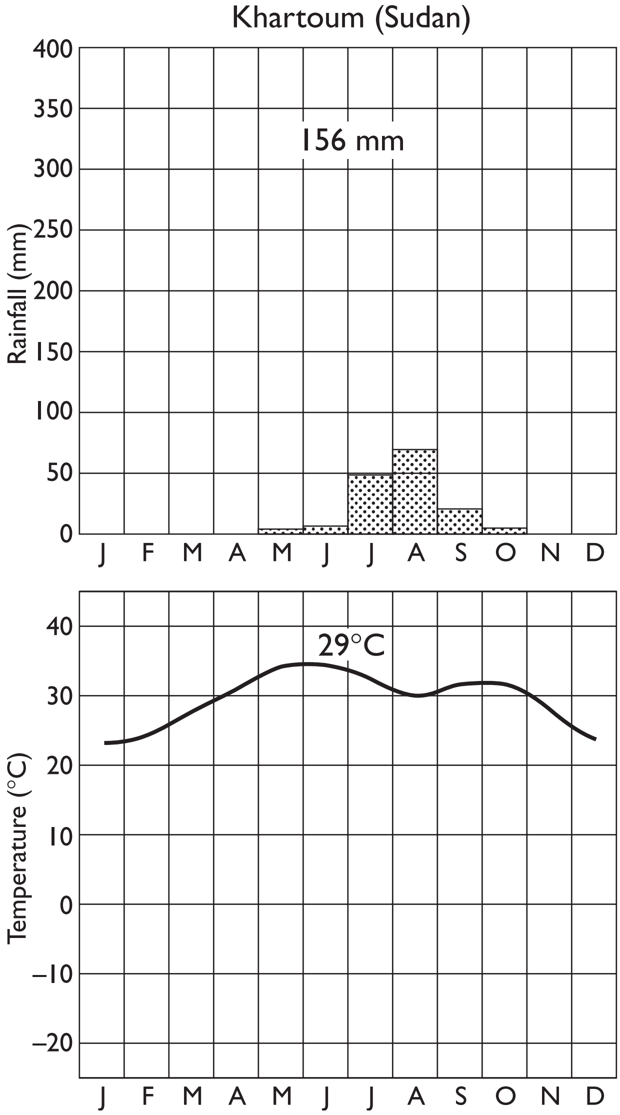
Some dry climates also occur in regions that shelter behind large mountain ranges such as the Andes and the Rockies. The deserts of Nevada, California and Arizona in the United States and the Patagonian Desert of Argentina, have this kind of climate.

Finally, dry climates may occur close to the coast where hot, dry winds always blow from the land, rarely from the sea. The Atacama Desert of Chile, Baja California in Mexico, and the Kalahari Desert of Namibia, are examples.

In some cases, there is more than one cause for dryness. Such places are the driest places on Earth.

Desert climates are called arid climates. Along their margins are regions which get a short, unreliable, wet season, whose climates are collectively called semi-arid, although they are also known by names such as steppe, bush and prairie. The dry savanna (semi-arid thorn scrubland) lies on the side closest to the equator of the main deserts. The largest area is known as the Sahel, and it stretches to the south of the Sahara Desert. It is one of the places where hundreds of millions of people try to grow subsistence crops against all the odds. The Sahel has experienced devastating droughts between 1912 and 1915, 1941 and 1942, and, worst of all between 1968 and 1974. Each successive time the disaster is greater because the population is growing fast.

Both arid and semi-arid climates are so dry that trees are found only near rivers or where spring water rises to the surface (an oasis). Plants that grow in these regions reflect the amount of rain that falls. The rule is, the drier the climate, the more woody the plants; the wetter it is, the more grass-type plants thrive.



▲ Khartoum, Sudan (Location: 16°N, 33°E) is one of the world's driest places. Deep in the Sahara Desert, it experiences rainfall only occasionally. Years without any rain may be followed by a torrential downpour and flooding. For this reason, the rainfall averages shown in this chart do not show a pattern that can be expected every single year. Notice that the temperature range is very high.

Deserts

Examples: Sahel of Africa, Iraq, Iran, Namibia, interior Australia.

The rainfall average is usually below 50 mm a year in arid regions, and below 300 mm in semi-arid regions. Rainfall is very unreliable.

In all arid and semi-arid regions, clear skies allow temperatures to soar in the day (when the Sun shines) and fall dramatically during the night (when the heat is lost to a cloudless sky). In the Sahara Desert, temperatures sometimes vary by over 50°C from day to night.

Rainfall is very low and very unreliable. In deserts there may be no rain for years and then a sudden downpour of hundreds of millimetres of rain that will cause flash flooding.

Lack of water means that little vegetation protects the surface from wind action. This allows the wind to form loose materials into features such as sand dunes.

Dry, scorching winds require special kinds of clothing. Arab people dress in loose clothes that can be rearranged to cover the face during duststorms. This is a traditional way of dealing with such a harsh climate.

Steppe and prairie climates

Examples: Steppes of Russia, Great Plains of North America.

The rainfall is too low for trees to grow except by watercourses. The temperature varies greatly between summer and winter, and from year to year.

The centres of the great continents are plainlands. In the Americas, Australia and Asia these areas are far from the sea and are sometimes also cut off from moisture-bearing winds by high mountains. The driest areas are deserts, but much of the land is covered with natural grasslands that are called steppes in Asia, prairies in North America, and pampas in South America.

These mid-latitude semi-arid zones have some things in common with the tropical savanna regions (of which the Australian bush is an example), but they also have many contrasts. For example, both regions have a wet season of low, unreliable rainfall, often in the form of torrential thunderstorms. Like the dry (thorn) savanna, the steppes may have several years with good rainfall followed by several years of drought.

This natural cycle of rainfall, in the prairies of the United States, caused the great disaster of the Dust Bowl. Native Americans, having long experience of this land, were mainly nomads because they knew they couldn't rely on it as cropland. The first Europeans labelled this land the Great American Desert. Yet new immigrant settlers from the east did not understand the problems that this climate brings and they began to plough the soil. All was well for a few years until the dry years began.

You can see how regular the cycle of good and bad rainfall years may be by noting the years when farming was a disaster: the 1890s, then the 1910s and then again the 1930s were the worst years of all.

In this last period, the winds that blew over the ploughed land carried away so much topsoil that it coloured the sky as far as the other side of the continent.

Disasters are only avoided today by using irrigation water and methods of farming that conserve soil moisture.

The real difference between the dry savannas and the steppes is not felt so much in summer – both regions have temperatures that reach a ground-baking 40°C – but also in the winters. In the mid-latitudes, cloud-free skies allow the ground to lose heat and the land gets colder and colder. Winter temperatures of –40°C are commonplace in the Asian steppes and the North American prairies, where flat, treeless lands offer no barrier to the winds.

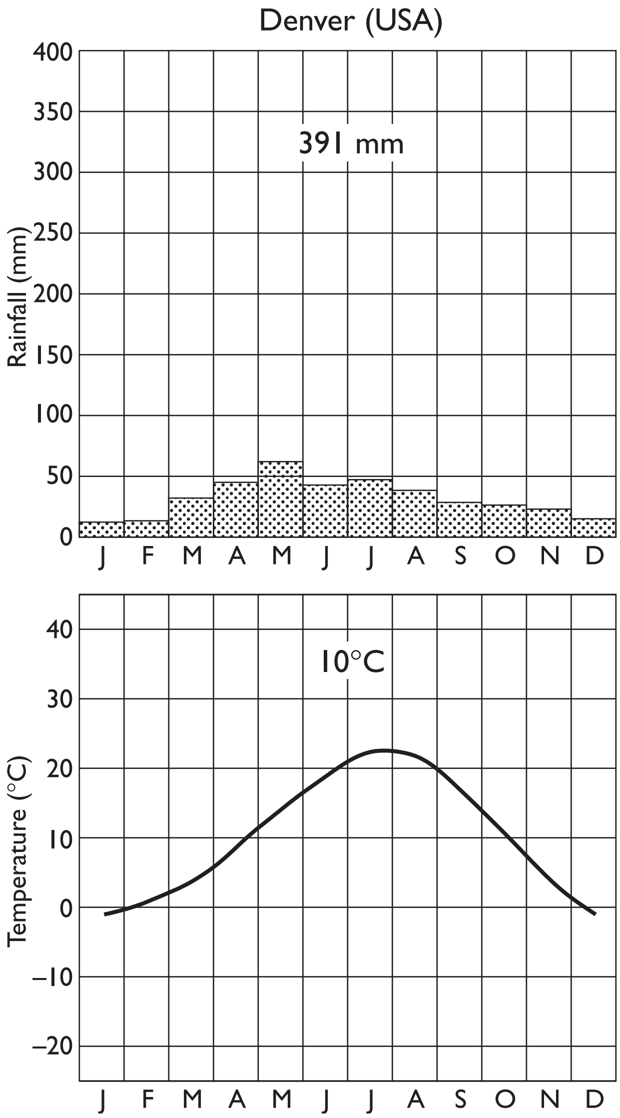
A combination of low temperatures and strong drying winds that blow for weeks on end make it especially difficult to survive these areas in winter. The harshness of the climate is one reason why, on average, fewer major cities are found in the centres of continents.

The prairies of North America are lands of great extremes. Summers are sunny and hot, with frequent afternoon thunderstorms and the chance of tornadoes. Winters are cold with no more than a sprinkling of snow.

The steppes and prairies have a climate that seems to go in cycles. There may be a decade of good rains followed by a decade of drought. This is what makes the steppes and the prairies so difficult for farmers, and a reason why there are so few big cities in these areas.

Traditionally, in order to cope with this difficult climate, native peoples were nomadic. Now some of the difficulty is eased by the use of groundwater supplies, or water diverted from rivers.

▼ Denver, Colorado, USA (Location: 40°N, 105°W) is the 'capital' of the Great Plains, the high plateau steppelands of North America.



HUMID MID-LATITUDE CLIMATES (includes UK)

The humid mid-latitudes are regions where hot air from the tropics and cold air from the poles mixes. Those nearest the tropics (places such as Florida, USA, and coastal New South Wales, Australia, which are called subtropics) have near tropical summers, but changeable winters; those closer to the poles (places like New England, USA, the United Kingdom and Western Europe and South Island, New Zealand) have changeable weather throughout the year.

The mid-latitudes are, however, especially influenced by depressions. This is quite different from the tropics and the dry regions, where rain usually falls in the form of severe thunderstorms.

The west coasts of the northern hemisphere and the east coasts of the southern hemisphere have the most moderate temperatures in the mid-latitudes. This is because they are greatly affected by warm ocean currents such as the Gulf Stream (also known as the North Atlantic Drift) in the North Atlantic Ocean, and the North Pacific Current. In the southern hemisphere, the Brazil Current and the Southern Equatorial Current have the same warming effect. Air blowing over this warm water is also warmed, thus keeping the winter temperatures mild.

The opposite sides of the continents do not have the advantage of the warm ocean current, so during their winters, temperatures can plummet below freezing. Summers are also hotter, and moist air coming from the nearby oceans feeds violent thunderstorms. This is easy to see looking at opposite sides of the Atlantic Ocean, where England has a mild west coast climate, but New England, USA, experiences an east coast type of climate, with hotter summers and colder winters.

Some areas are influenced by depressions throughout the year, bringing rain in every season. Western Europe, southeast Australia, and the area comprised of the northwest United States and southwest Canada are like this. Some areas experience depressions and rain only in the winter, allowing sunny skies and high temperatures in summer – the shores of the Mediterranean Sea and places like California have this kind of climate. Other areas have wet summers and dry winters – for example northern India and much of China.

Depressions

In the mid-latitudes, there is a continual battleground between cool air flowing from the poles (or, in winter, from the cold hearts of the continents) and warm, moist air flowing from the tropics. Where these quite different kinds of air meet they swirl together to produce circulating patterns of cloud and rain, called depressions.

Because depressions bring together several types of air, each one is unique. This is what makes predicting the weather so hard for weather forecasters.

Each type of air has its own pattern of temperature and moisture which has been created during its journey over land or sea. For example, warm air moving towards the poles gives clear skies and warmer conditions. On the other hand, the clear, dry, cold air that lies over the snow-covered heart of Canada during winter, often flows southeast over the warm ocean currents of the Gulf Stream. This heats the air and gives cloudy skies. Similarly, the cold south wind blowing from Antarctica towards New Zealand is changed as it flows over the warm waters of the South Pacific. This is the air that will eventually produce the cool, rainy days for which the South Island is so well known.

When cool and warm air meet, the warm air is forced up over the cool air and a depression is created. Depressions are briefly described in *Weather around the worl*d, but their exact working is outside the scope of the syllabus.

Mediterranean climate

Examples: Southern France, Greece, California, Perth (Australia).

Regions where the coldest month is below 18°C but above –3°C. The average temperature of the warmest month is over 10°C.

This is a warm, temperate climate with a dry, sunny and warm summer and a cooler, wetter winter. The Mediterranean climate only occurs on coasts and occupies a very small part of the world.

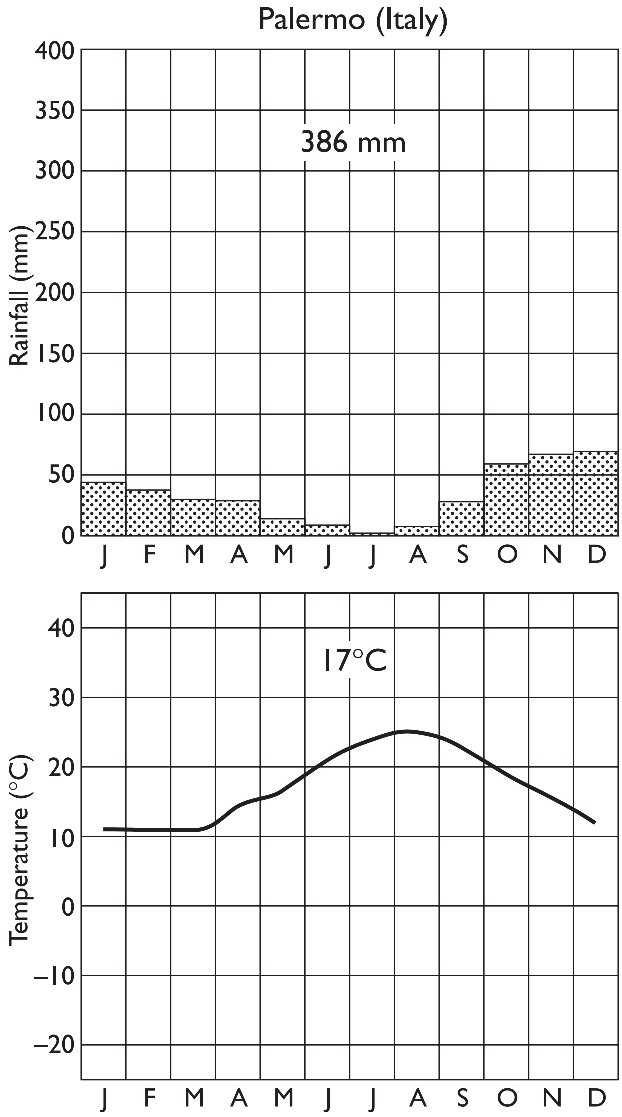
Mediterranean climates are world famous as summer holiday destinations. In Europe, they are also popular in winter because the climate is milder than further north.

Places with a Mediterranean climate rely on the influence of the cool sea during the summer. Air sinks over the sea and the nearby land, so clouds rarely form.

The opposite effect occurs in winter, when the sea is warm and moist air can flow into the region, bringing rain. In the regions bordering the Mediterranean Sea, depressions occur in winter, bringing bands of rain that are similar to the rest of Europe.

The Mediterranean Sea is unique; other places that have a Mediterranean climate, such as California and the area near Perth, Australia, owe their summer sunshine to cold, offshore currents, not an inland sea.

▼ Palermo, Italy (Location: 38°N, 13°E) lies on the northern tip of the island of Sicily. In the summer, the influence of the cool Mediterranean Sea means that the island experiences cloudless skies and almost no rainfall. However, as winter approaches the influence of the sea is less, and depressions track along the Mediterranean Sea, producing winter rain. Notice that winters can also be quite cool.



Subtropical (warm temperate) climate

Examples: Southern United States, New South Wales.

Rainfall evenly spread throughout the year, with periods of high humidity, when tropical air flows into the region and periods of cold 'bursters' when winds arrive from polar regions.

The subtropical regions share some of the features of the tropics and the mid-latitudes. They get their summer, tropical, influences (and the Trade Winds) from the east, and their winter influences (and the Westerlies), and its much more changeable weather, from the west.

This change in wind direction means that places on opposite sides of the continent have very different types of weather. Those on the western margins have a Mediterranean climate. Those on the east have rain in summer as well as winter. In summer and autumn the air often feels hot and 'sticky'.

Hurricanes and typhoons are most common in the eastern margins of the subtropics. They may occur throughout the summer, but especially in late summer and early autumn in the Gulf of Mexico and along the coasts of China, Japan and northeastern Australia.

▶ Sydney (Location: 34°S, 151°W) has a warm, temperate climate with a fairly even distribution of rainfall throughout the year.

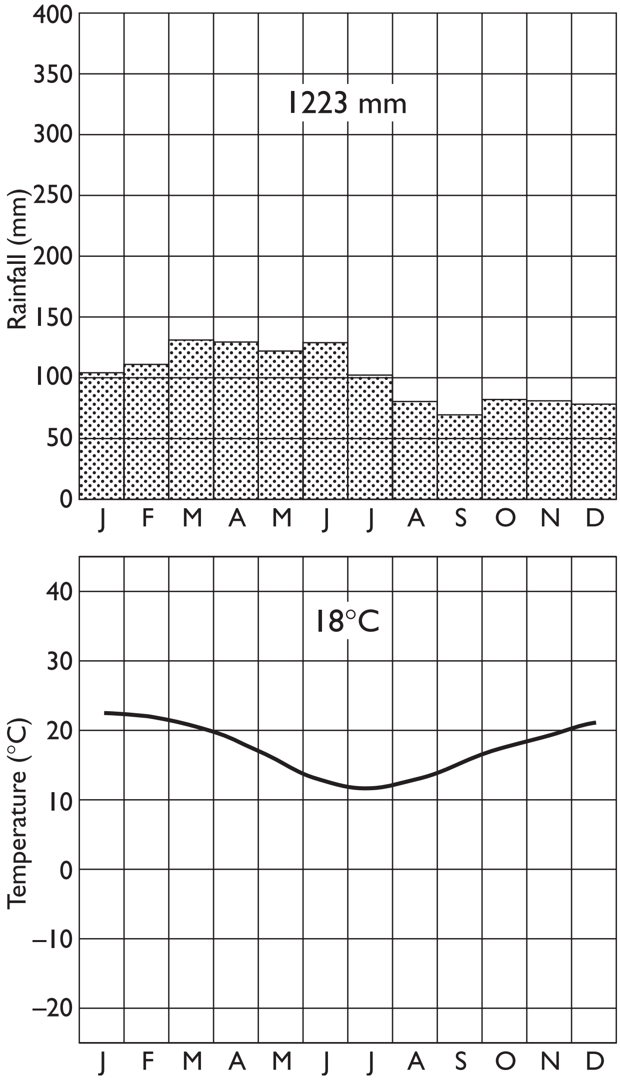
Unlike most parts of Australia, Sydney receives more rainfall than the amount of moisture that evaporates from the same area. Because Sydney is located on a narrow coastal plain between the Pacific Ocean and a range of mountains called the Great Divide, it also receives relief rainfall from winds blowing onshore.

Although Sydney receives over 1,223 mm average rainfall each year, it has relatively few wet days – on average Sydney has fewer than 60 wet days each year. When Sydney receives rainfall, it usually comes through the action of cold fronts or thunderstorms.

By world standards, temperatures in Sydney do not change greatly from season to season. This is because the city is located beside a warm ocean current. The ocean also moderates the temperature, providing welcome cooling in summer and raising temperatures in winter.

Sydney gets most of its rain in autumn, making the climate unpleasantly muggy at this time of the year. By contrast, spring is a much fresher season. Although in summer, especially November and December, it is normally hot, there is always a chance of a sudden cold blast of wind from the south, known as the 'Southerly Burster', and temperatures may fall by 10°C in a few minutes.

Sydney (Australia)

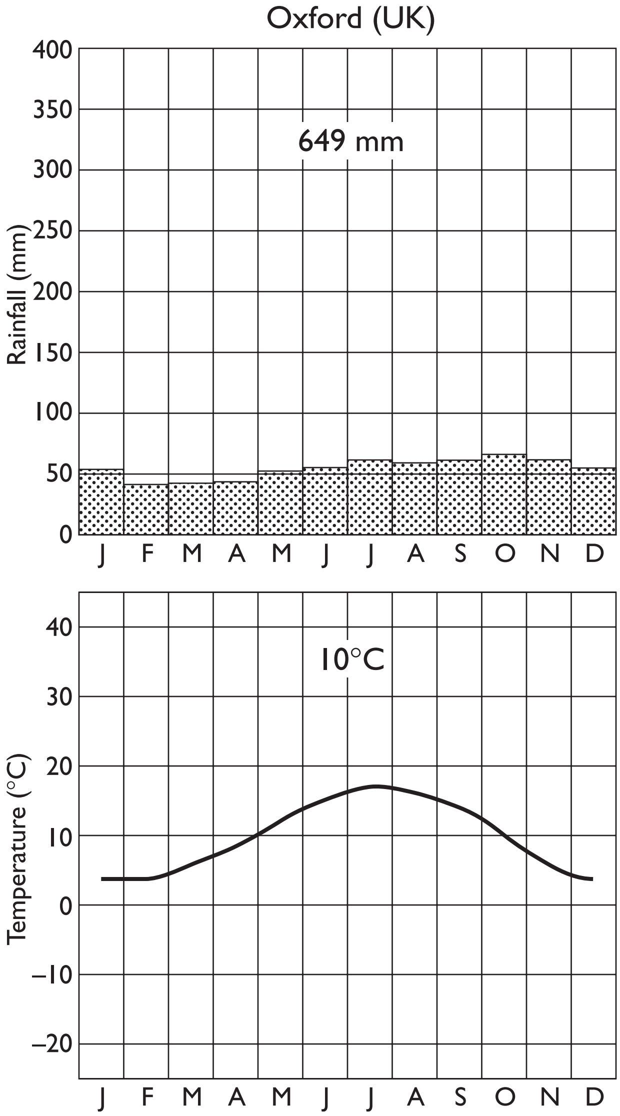


Cool temperate rainy climate

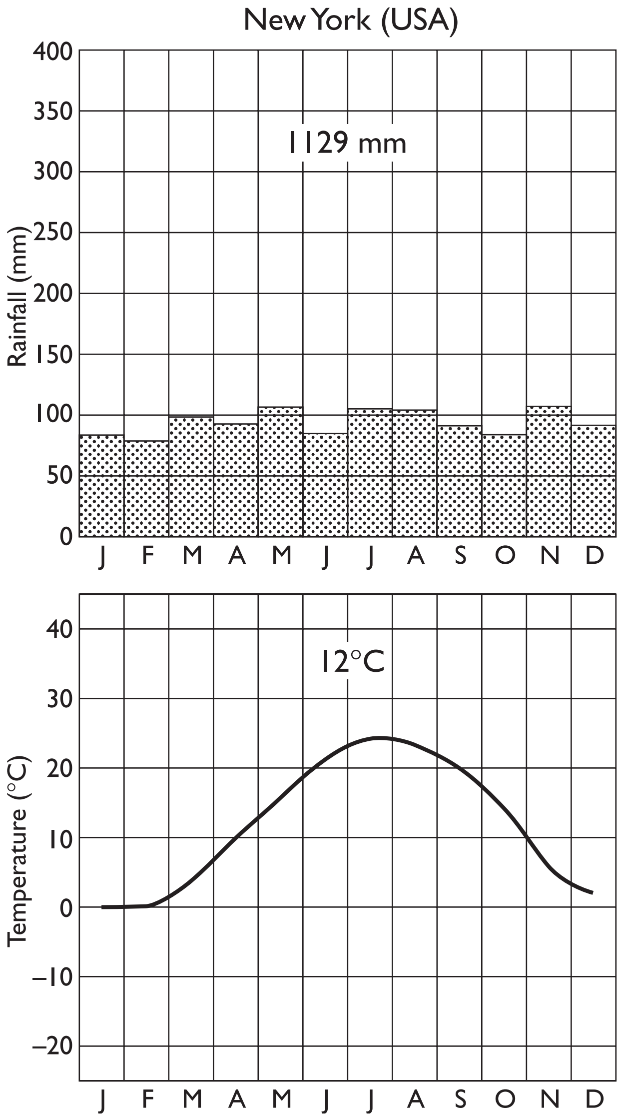
Examples: Northwestern Europe, South Island New Zealand, British Columbia, New England.

The mid-latitudes between 40 and 60 degrees are dominated by the passage of depressions and anticyclones, driven by jet streams in the westerly winds. Rain occurs evenly in all seasons.

There is an important contrast between the east and west margins of the continents, just as in the subtropics. In this case, the contrast is because of the warm ocean currents crossing the Atlantic and Pacific Oceans. Westerly winds bring moist, mild air across the regions, and there are only short spells without rain. In turn, this makes the areas very green, making them famous as the best pasturelands in the world.



▲ Oxford, UK (Location: 52°N, 1°W) has an even pattern of rainfall throughout the year, brought by a constant stream of depressions. The influence of the North Atlantic Drift means that winters are mild and summers remain quite cool. Compare this chart with New York opposite.



▲ New York, USA (Location: 41°N, 74°W) has an eastern margin climate, with a temperature range of 24°C. (compared with Oxford's 13°C, see opposite). The hot, humid summers contrast with cold, snowy winters, and while winter rain and snow falls from depressions, summer rain is much more likely to be due to thunderstorm systems.

By contrast, eastern margins of continents have much hotter summers and colder, snowier winters.

Thus, while Hudson's Bay in Canada, is snow-covered for most of the year and the ground below the surface remains frozen, Oxford, in the UK and at the same latitude, has only a few days of frost each year.

Humid cold climates

Examples: Northern North America and Siberia.

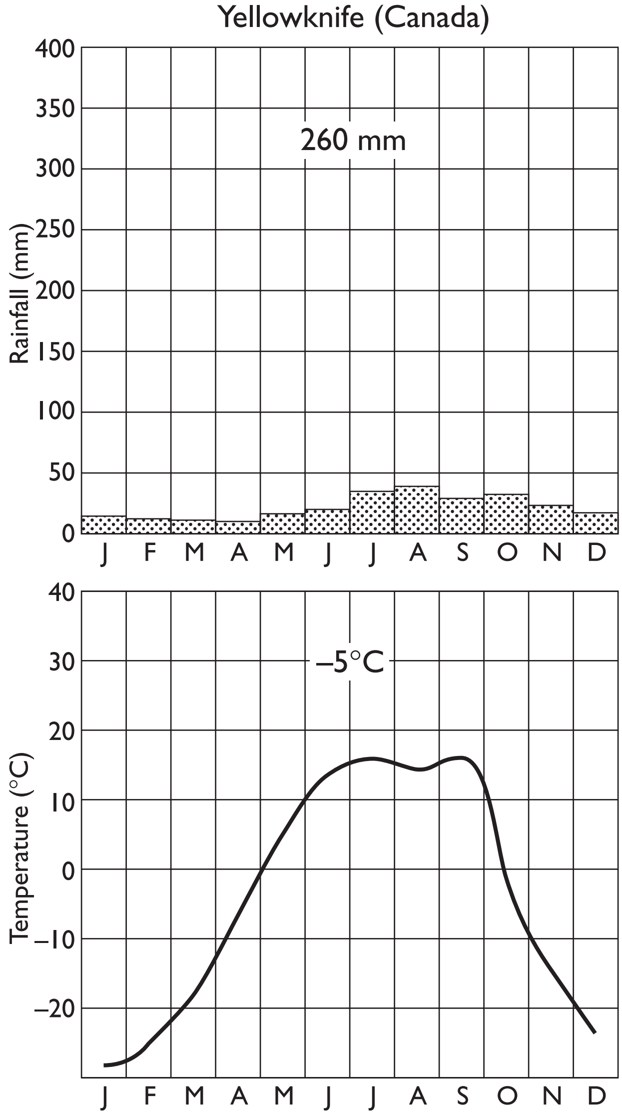
The average temperature of the coldest month is below –3°C but the warmest month is over 10°C.

These regions experience a climate that is dominated by a long, dark and bitterly cold winter. They are at their most severe in the centres of the big northerly continents, including much of Russian Siberia.

The natural vegetation of much of this region is coniferous trees. They are able to stand up to the long cold winters when the ground freezes solid. In the drier areas, there is not enough moisture for conifers; instead, tall grasses are found.

Parts of these regions have soil that is permanently frozen (permafrost) just a few metres below the surface. Since the end of the Ice Age thousands of years ago, these areas have simply never been warm enough to allow the soil to thaw. Notice that while winters are long and cold, summers are quite warm and on individual days temperatures can be in the 20s!

▼ Yellowknife, Canada (Location: 62°N, 114°W). Summer temperatures rise just above 15°C for only 4 months each summer, then plummet to below –25°C.



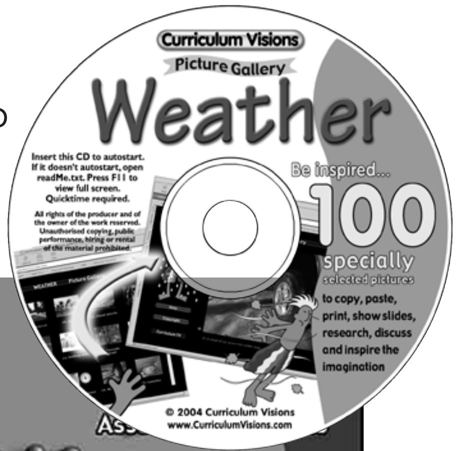
Section 7: The Weather Picture Gallery CD explained

The Weather Picture Gallery CD contains 100 photographs and diagrams. These pictures can be used for any curriculum area such as literacy but the images on this CD have been specially selected for the weather topic. Many of the pictures are in *Weather around the world* allowing you to integrate your teaching and reinforce key geography concepts.

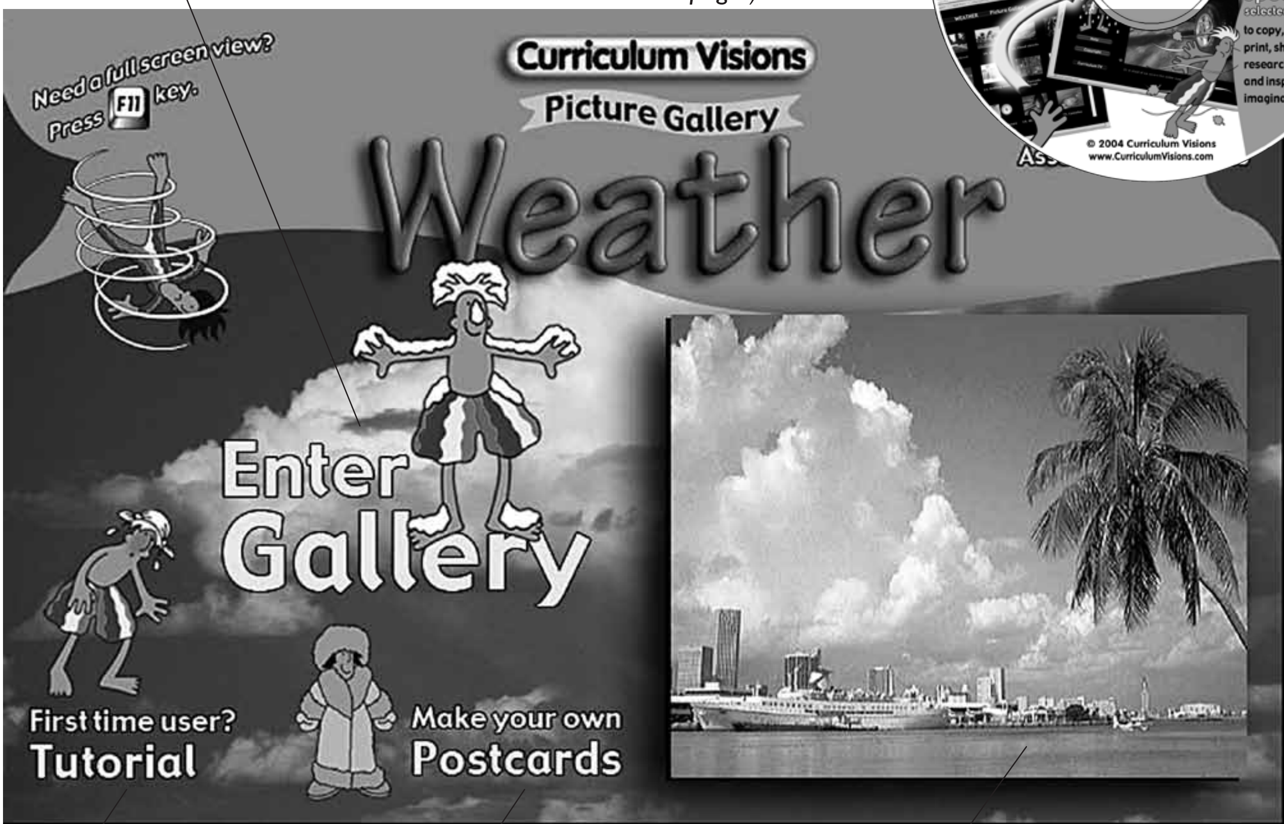
The information in *The Weather Picture Gallery CD* is browser-based, which means that it can be opened in any browser used to surf the Internet.

A browser application makes the CD content look and feel just the same as it would on the Internet. The advantage is that you can practise a wide range of computer-based skills at a speed far faster than if you had to download information through an Internet connection. You can network the CD (provided you have bought a licence) so that many students can access the data at the same time.

▼ **The Weather Picture Gallery CD and introductory screen** *(the appearance of the CD and its contents may vary from that shown on these pages)*.



Click here to go straight into the gallery with the thumbnail view of all 100 pictures.



The tutorial shows you how the CD can be used.

Clicking on 'Make your own Postcards' shows you how you can make a postcard from any one of the 100 pictures in the gallery!

A mini-movie showing a selection of the 100 pictures from inside the gallery.

Installing the CD

The CD can be used on both Macintosh and Windows-based machines.

Inserting the CD will usually cause it to start up automatically in Windows. However, this depends on the configuration of your machine and the place where the browser application is kept.

If the CD does not automatically start up your browser, then do this:

Windows

1. Eject the CD and try again. If it still doesn't start then:
2. Open Internet Explorer.
3. Type Control O and browse until you find your CD drive. In it look for the file 'index.html'. Select this and click OK.
4. Save the home screen as a Favorite for quick location in future.

Mac OS X
(Instructions for first time loading)

1. Place the CD into your CD drive.
2. Open Internet Explorer by double-clicking on its icon in the dock.
3. Type (Command) O and browse until you find the CD.
4. Inside the CD scroll down to 'index.html'. Double click on 'index.html' to launch the CD.
   (Important: do not double click directly on index.html – open it from within your browser.)

In all cases, once you have got the disk working, make the home screen of *The Weather Picture Gallery CD* one of your Favorites and then when you load the disk next time you can find *The Weather Picture Gallery CD* directly from this list.

Copying text and images

All of the elements are unlocked and can therefore be copied for use in other documents. Simply scroll across text or (right) click on images to copy them in the method that suits you.

The home screen

(*See overleaf, on page 128, for illustrations of the screens described below.*)

The *Weather Picture Gallery CD* home screen shows a gallery of all 100 pictures in thumbnail view.

If you click on any of the pictures in the gallery it will show as an enlarged 'pop-up' view. Clicking on this pop-up picture will take you back to the gallery with the thumbnail view.

Each picture has a simple caption underneath it. At the end of each caption you are given a number of options:

...tell me more brings up an extensive caption describing the picture and additional information including cross links to other topics. This description helps children with observation and interpretation skills. It is ideal for literacy tasks.

...show enlarged view places the picture in a larger frame.

...print a postcard arranges the selected image into a postcard format, complete with humorous 'stamp' and space for the children to write their own message. Just trim to the shape shown and fold the piece of paper over.

You can create a postcard with any one of the 100 pictures in the gallery. Once again an ideal literacy aid.

Index

This displays an alphabetical listing of key words on the left panel. If you click on any corresponding image numbers shown after the key word then the relevant picture will be displayed in the pop-up view on the right.

Help

The help section contains a 'Tutorial' and other assistance for students, teachers and parents.

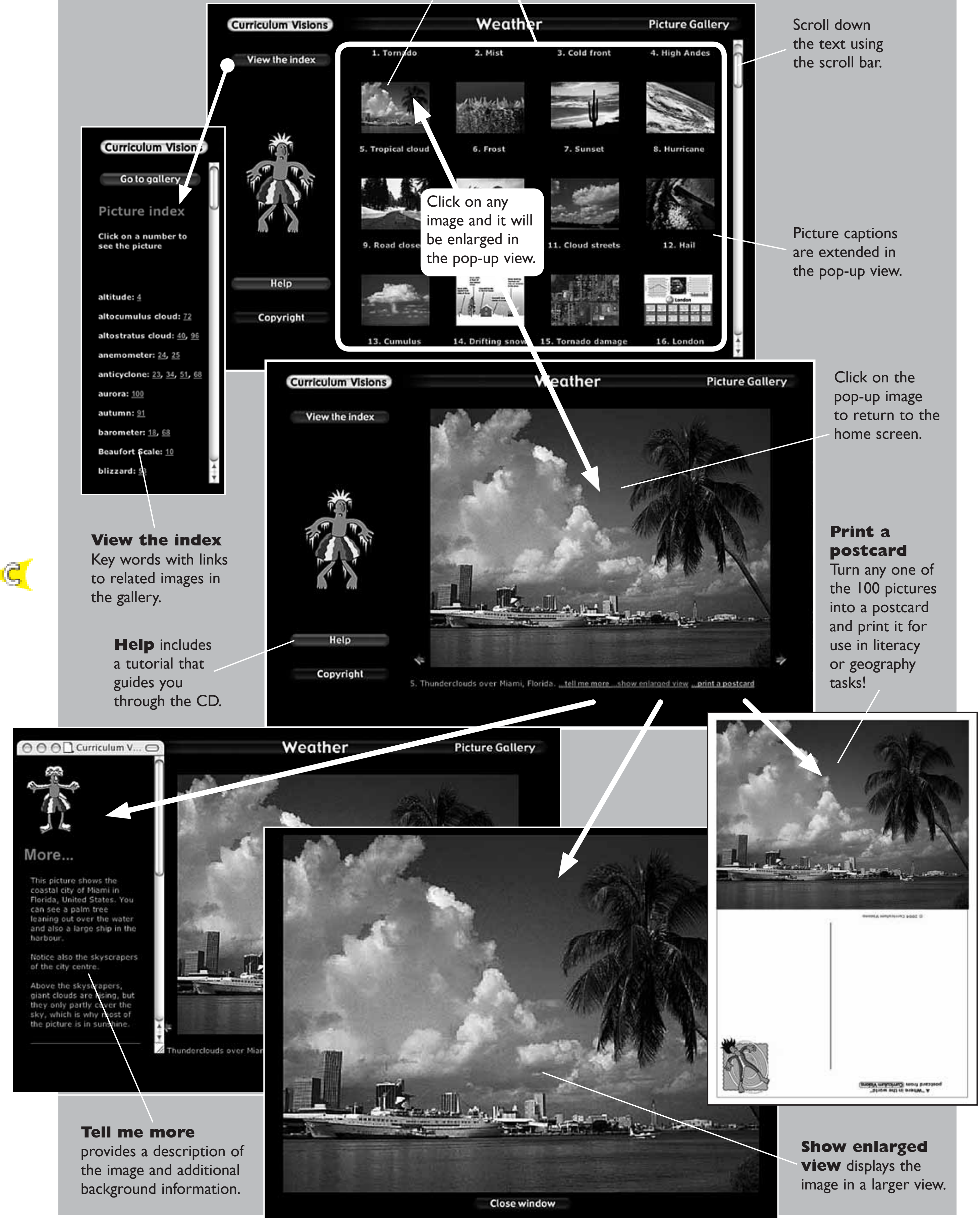
▼ The home screen and related links.

Home screen
Click any thumbnail picture in the gallery to see a pop-up view.

Scroll down the text using the scroll bar.

Click on any image and it will be enlarged in the pop-up view.

Picture captions are extended in the pop-up view.



Click on the pop-up image to return to the home screen.

View the index
Key words with links to related images in the gallery.

Print a postcard
Turn any one of the 100 pictures into a postcard and print it for use in literacy or geography tasks!

Help includes a tutorial that guides you through the CD.

Tell me more
provides a description of the image and additional background information.

Show enlarged view displays the image in a larger view.

