Years 7-8

The Earth

Disk filename = “10.Earth”

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Topics Available

Year 7-8 General Science

<table>
<thead>
<tr>
<th>Disk Filename</th>
<th>Topic Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.Energy</td>
<td>Energy</td>
</tr>
<tr>
<td>02.Forces</td>
<td>Forces</td>
</tr>
<tr>
<td>03.Matter</td>
<td>Solids, Liquids &amp; Gases</td>
</tr>
<tr>
<td>04.Mixtures</td>
<td>Separating Mixtures</td>
</tr>
<tr>
<td>05.Elements</td>
<td>Elements &amp; Compounds</td>
</tr>
<tr>
<td>06.Cells</td>
<td>Living Cells</td>
</tr>
<tr>
<td>07.Life</td>
<td>Living Things</td>
</tr>
<tr>
<td>08.LifeSystems</td>
<td>Plant &amp; Animal Systems</td>
</tr>
<tr>
<td>09.Astronomy</td>
<td>Astronomy</td>
</tr>
<tr>
<td>10.Earth</td>
<td>The Earth</td>
</tr>
<tr>
<td>11.Ecosystems</td>
<td>Ecosystems</td>
</tr>
</tbody>
</table>

Year 9-10 General Science

<table>
<thead>
<tr>
<th>Disk Filename</th>
<th>Topic Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.Waves</td>
<td>Wave Energy (inc. Light)</td>
</tr>
<tr>
<td>13.Motion</td>
<td>Forces &amp; Motion</td>
</tr>
<tr>
<td>14.Electricity</td>
<td>Electricity</td>
</tr>
<tr>
<td>15 Atoms</td>
<td>Atoms &amp; Elements</td>
</tr>
<tr>
<td>16.Reactions</td>
<td>Compounds &amp; Reactions</td>
</tr>
<tr>
<td>17.DNA</td>
<td>Cell Division &amp; DNA</td>
</tr>
<tr>
<td>18.Evolution</td>
<td>Evolution of Life</td>
</tr>
<tr>
<td>19.Health</td>
<td>Health &amp; Reproduction</td>
</tr>
<tr>
<td>20.Universe</td>
<td>The Universe</td>
</tr>
<tr>
<td>21.EarthScience</td>
<td>Earth Science</td>
</tr>
<tr>
<td>22.Resources</td>
<td>Resources &amp; Technology</td>
</tr>
</tbody>
</table>

Year 11-12 Science Courses

Biology
- Preliminary Core
- Local Ecosystem
- Patterns in Nature
- Life on Earth
- Evolution Aust. Biota
- HSC Core
- Maintain. a Balance
- Blueprint of Life
- Search for Better Health
- Options
- Communication
- Genetics: Code Broken?

Chemistry
- Preliminary Core
- Chemical Earth
- Metals
- Water
- Energy
- HSC Core
- Production of Materials
- Acidic Environment
- Chem. Monit. & Mngmt
- Options
- Shipwrecks, Corrosion...
- Industrial Chemistry

Earth & Envir. Science
- Preliminary Core
- Planet Earth...
- Local Environment
- Water Issues
- Dynamic Earth
- HSC Core
- Tectonic Impacts
- Environ thru Time
- Caring for the Country
- Option
- Introduced Species

Physics
- Preliminary Core
- World Communicates
- Electrical Energy...
- Moving About
- Cosmic Engine
- HSC Core
- Space
- Motors & Generators
- Ideas to Implementation
- Options
- Quanta to Quarks
- Astrophysics

All Topics Available as PHOTOCOPY MASTERS and/or KCiC
- Photocopy Masters (PDF files)
- Black & White, A4 portrait-orientation
- for clear, economical photocopying.

KCiC = Key Concepts in Colour
- Full colour, formatted for on-screen study and data projection. PDF + Powerpoint®
- Powerpoint is a trademark of Microsoft Corp.
“Mind-Map” Outline of Topic
This topic is an introduction to Earth Science.
Earth Science includes studies of rocks and minerals, earthquakes and volcanoes, the weather and the oceans. Earth Science looks at the structure of the Earth itself, and how landforms, and even oceans and continents, come and go over time.

Internal Structure

Structure of the Earth

The 4 “spheres” of the Earth

Global Warming & Ozone

Gases of the Atmosphere

Air Pressure

Atmosphere, Hydrosphere & Weather

The Hydrosphere

The Lithosphere

Soils & Landscapes

Weathering & Erosion

Igneous, Sedimentary, Metamorphic Rocks

Minerals

The Water Cycle

THE EARTH

The Atmosphere

The Lithosphere

The Atmosphere

The Hydrosphere

Minerals

The Water Cycle

Soils & Landscapes

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The Water Cycle
Make your own “Mind-Map” TITLE PAGE. Cut out the boxes. Sort them into an appropriate lay-out on a page of your workbook, then glue them down. Add connecting arrows and colour in.

THE EARTH

The Lithosphere

The Hydrosphere

The Atmosphere

Structure of the Earth

Internal Structure

The 4 “spheres” of the Earth

Gases of the Atmosphere

Global Warming & Ozone

Air Pressure

Atmosphere, Hydrosphere & Weather

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Air Pressure

Atmosphere, Hydrosphere & Weather

Soils & Landscapes

Igneous, Sedimentary, Metamorphic Rocks

Minerals

The Water Cycle

Weathering & Erosion
The Structure of the Earth

You already know that the Earth is a planet which orbits our star, the Sun. The Earth is a ball of rock, largely covered by water, and surrounded by a layer of air. Now it is time to learn some more detail.

Inside the Solid Earth

Ignoring the oceans and the air for a while, we begin with the solid Earth.

Scientists have always been interested in earthquakes. By learning about earthquakes it was hoped that we might learn to predict them, and so avoid some of the deaths and destruction that they cause.

About 100 years ago, the study of earthquakes (called “Seismology”) became advanced enough that scientists began studying the way that earthquake shockwaves travel through the Earth.

From this, it became clear that the solid Earth is not totally solid, and has a layer structure, as shown.

The Lithosphere

But wait, the story gets more complicated!

Attached to the bottom of the crust is a layer of mantle rock which has “welded” itself to the crust rocks above.

This 2-part layer is called the lithosphere.

The thickness of the lithosphere varies. Under the oceans, it can be about 5 km thick and is mostly crust rocks with very little mantle rock attached. Under the continents the lithosphere is over 100km thick.

Compared to the 6,400 km diameter of the Earth the lithosphere layer is an extremely thin shell on the outside.
The Four “Spheres” of Planet Earth
The surface layers of rocks, water and air are home to ourselves and all the other living things we share this planet with. We can think of our “home” as having 4 “spheres”, or parts.

The Atmosphere
(“atmos” = vapour)
The atmosphere is the layer of air which surrounds the Earth.
It is the atmosphere in which all our weather occurs.
We need to breathe the oxygen gas of the air.
Other gases are vital to protect us from dangerous radiation from the Sun.

The Hydrosphere
(“hydro” = water)
The hydrosphere refers to the water layers on the surface of the Earth.
As well as the oceans, the hydrosphere includes the polar ice-caps, all the lakes and rivers, and even the underground water.

The Lithosphere
(“lithos” = rock)
The lithosphere was described previously. It is the thin, outer “skin” of the solid Earth.
The lithosphere is made up of the crust layer (low-density rocks) with a layer of the upper mantle attached.
This 2-part “skin” is separated from the main body of mantle rock by a “slippery layer” on which the lithosphere floats.
On the top of the lithosphere is a thin layer of soil which we depend on for growing our food.

The Biosphere
(“Bios” = life)
The biosphere refers to those parts of the Earth where living things are found. The biosphere overlaps the other “spheres” because living things fly and drift in the atmosphere, swim in the hydrosphere and burrow into the top of the lithosphere.
**Worksheet 1**  
**Earth’s Structure**

Label the diagram and answer the questions

a) ........................................

b) ........................................

c) ........................................

d) ........................................

e) What study led scientists to an understanding of the internal layers of the Earth?

f) Which layer is liquid?

g) What is the part in the middle made from?

h) What is “lithosphere”? Which parts of the Earth are combined to make it?

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**Worksheet 2**  
**The “Spheres” of the Earth**

Fill in the blank spaces.

The layer of gases around the Earth is called the a)............................... All our b)............................ occurs here.

We rely on the air for c)........................... to breathe, and to shield us from dangerous d).............................. from the Sun.

The watery parts of the Earth are called the e)............................... This includes the oceans, and also all the f)............................... and ................................ and underground water. It also includes the ice in glaciers and the polar g)............................... The Lithosphere is a 2-part layer comprising the h)............................... and the upper part of the i)............................... The lithosphere “floats” on the rock underneath. It is broken up into a number of pieces called “j)............................... plates” which can move around.

The parts of the Earth where living things are found is called the k)............................... This overlaps the other 3 “spheres”, because living things are found in all three.
The Atmosphere (“atmos” = vapour)
The atmosphere is mainly a mixture of gases.
The clouds are made up of microscopic droplets of liquid water,
and there may be some solid particles of dust in the air,
but nearly all of the atmosphere is gas.

Gases of the Atmosphere

About 99% of dry air is made of just 2 gases:

**Nitrogen (N\textsubscript{2})**
Nitrogen makes up almost \(\frac{4}{5}\) of the air.
We breathe it in all the time, but it does
us neither good nor harm.

**Oxygen (O\textsubscript{2})**
Oxygen makes up about \(\frac{1}{5}\) of the air.
It is very important for living things.

The other 1% contains a variety of gases, including:

**Argon (Ar)**
Argon is the most common of the “inert gases”.
There is also Neon (Ne), Krypton (Kr) & others.

**Carbon Dioxide (CO\textsubscript{2})**
CO\textsubscript{2} makes up only about 0.04% of air,
but it is vitally important to living things
and to the Earth’s climate.

---

Oxygen & Carbon Dioxide

These gases are so important that you need to know more about them.

**Oxygen**
Oxygen makes up about \(\frac{1}{5}\) of the air.
We breathe so that we can take in
oxygen. Without it, a human will die
within a few minutes.

Oxygen is a chemical element. Its
chemical symbol is “O”, but it normally
exists as 2 atoms joined together, so we
write its chemical formula as O\textsubscript{2}.

Oxygen is needed for things to burn.

**Try this experiment:**
Place glass jar or beaker
over a lit candle.

Soon, the candle goes out.
Why?
Because all the oxygen in the air inside
the beaker has been used up. Without
oxygen, the burning cannot continue.

Cellular respiration is (chemically) the
same as burning the glucose. It must
have oxygen to continue.

---

**Carbon Dioxide**

Carbon dioxide makes up only a tiny
fraction of the air, about 0.04%. Its
chemical formula is CO\textsubscript{2}, which means it
is made of molecules containing 1
carbon atom and 2 oxygen atoms.

CO\textsubscript{2} can be identified by its reaction
with limewater.

**Try this:**
Use a drinking straw to
gently blow bubbles through
a test tube of limewater.

Soon, the limewater
becomes cloudy as it
reacts with the CO\textsubscript{2} in
your breath.

CO\textsubscript{2} is the only gas which reacts with
limewater this way, so this test can be
used to identify this important gas.

<table>
<thead>
<tr>
<th>Air We Breathe In</th>
<th>Air We Breathe Out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>20 %</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>0.04 %</td>
</tr>
<tr>
<td></td>
<td>16 %</td>
</tr>
<tr>
<td></td>
<td>4 %</td>
</tr>
</tbody>
</table>
The Carbon Dioxide - Oxygen Cycle
You are reminded of the processes of Photosynthesis and Cellular Respiration in living things. Together, they connect a great cycle of nature.

What is really happening is that the energy of the Sun is powering all living things.

The O\(_2\) and CO\(_2\) simply get re-cycled.

Food (containing glucose) is made, destroyed and re-made over and over.

Photosynthesis makes all the food and oxygen on Earth.

The reason that CO\(_2\) levels are low compared to oxygen, is that the plants are very efficient at absorbing CO\(_2\) for photosynthesis.

Carbon Dioxide & Global Warming
Burning fossil fuels (coal, petroleum) produces huge amounts of CO\(_2\).

Measurements show that the level of CO\(_2\) in the air has increased significantly over the past 100 years or so.

Check your family’s latest electricity bill: it will tell you how many tonnes of CO\(_2\) have been released to make your electricity.

As well as CO\(_2\), another “greenhouse gas” called methane (CH\(_4\)) is also increasing in the air.

Methane is released when forests are cleared and wetlands are drained for grazing. Although only tiny amounts of methane are in the air, its effect is very powerful.

The Earth absorbs the heat from the Sun, and the surface warms up. As the surface warms, some of the heat radiates back into space, so the Earth’s cools again.

CO\(_2\) and methane “trap” some of the heat which would normally escape into space. This “Greenhouse Effect” is now believed to be causing the whole world to warm up.

This “Global Warming” is causing climate change so that weather patterns may be disrupted and many natural environments may be destroyed in the next century.

The sea ice around the north pole is beginning to melt. If the ice caps melted completely, the sea level could rise by more than 100m.
Ozone

Ozone is a different form of oxygen, with chemical formula $O_3$.

**Importance of Ozone**

Ozone is much more chemically reactive than oxygen, and is very dangerous if breathed in. At ground level, ozone is a nasty, dangerous air pollutant.

However, in the upper atmosphere it serves a vital function for land-living plants and animals... it absorbs dangerous ultra-violet (UV) radiation from the Sun.

UV radiation damages living cells and can cause deadly skin cancers. Plants cannot grow properly if exposed to excessive UV.

Without the “ozone layer”, UV radiation would make life on land virtually impossible.

**So What’s the Problem?**

In the second half of the 20th century, our industries produced a number of chemical gases called “CFC’s”. These are very useful substances used in refrigerators, some fire extinguishers, aerosol cans, plastics manufacture, and much more.

By the 1970’s scientists began to measure higher levels of UV radiation reaching the Earth’s surface because the ozone levels were getting less.

Research revealed that the ozone was being destroyed by CFC’s released into the air. CFC chemicals cause ozone to be destroyed faster than it is made.

CFC’s are very long-lasting and can continue destroying ozone for 30-50 years.

**Problem Solved?**

Scientists quickly searched for alternative chemicals to replace CFC’s which would not harm the ozone layer.

By 1995 most countries in the world had stopped using CFC’s.

The CFC released 30 years ago is still causing a loss of ozone, but the rate of loss is slowing down.

Scientists believe that ozone levels will start to increase again and eventually get back to normal.

Meanwhile, SLIP, SLOP, SLAP!!
Impacts of Science

The Science and Technology of electricity has been one of the most important things to have happened to human society in the past 100 years or so. The impacts of this on society have been almost entirely beneficial, while the impacts on the environment have been entirely detrimental.

Benefits to Society
Large scale use of electricity has given humans many benefits and has become essential to our economy, jobs, communications, leisure and lifestyle.

Our factories rely on electricity to make all our machines, clothing, appliances, medicines, etc.

Our business & finance systems run on computers and communications powered by electricity.

We enjoy a comfortable, safe and entertaining lifestyle with electrical lights, TV, air-con, appliances, phones and all the convenient gadgets.

Damage to the Environment
Large amounts of our electricity is generated from the burning of fossil fuels, such as coal. In the early days, this created a lot of pollution and problems such as “acid-rain”.

Many problems have been cleaned-up, but one HUGE problem remains... burning coal releases CO₂ gas into the atmosphere.

The levels of CO₂ have risen significantly and there is no longer any doubt about the effect: Global Warming due to a “Greenhouse Effect”.

Science and Economics

Starting in the 1970’s, some scientists began to warn us about some serious problems that were emerging.

Two of the most important problems concerned changes to the atmosphere.

Ozone Problem Solved?
This problem was described previously.

After alerting the world to the problem, scientists were able to suggest solutions, in the form of alternative chemicals to replace the destructive CFC’s.

The suggested replacement chemicals were also economically suitable, because they caused little change to costs, jobs and production methods.

Since there was no conflict between the scientific advice and the economy, governments quickly followed the advice and passed appropriate laws. Industry rapidly complied.

Greenhouse Problem Continues?
Scientists have also warned us about rising CO₂ levels and the dangers of Global Warming. They have also suggested many solutions, such as switching to alternative energy supplies like solar and wind power.

Unfortunately, the solutions do not fit easily into our global economy. To immediately follow the scientific advice would cause massive changes to industries, jobs, finances and everybody’s lifestyle.

That’s why governments hesitate to take decisive action. The scientific advice is in conflict with the economy.

People Make Decisions
It is NOT up to scientists to make the decisions needed. It is up to every citizen to vote for leaders who will act to solve problems. Good citizens need to know about both the Science and the economic necessities. In a democracy, people get the government they deserve.
Air Pressure

Remember that in a gas the particles are constantly flying everywhere at high speed.

They frequently collide with each other, and with the walls of their container. Each collision pushes on the inside of the container, or on each other. This means there is a constant push, or force, acting within the gas.

**Pressure** is measured as the amount of force pushing per unit of area.

The unit of pressure used most often in science is the kilopascal (kPa).

The "pascal" unit is named in honour of the great French scientist and mathematician Blaise Pascal (1623–62).

1 kPa = 1,000 N force per square metre.

Some examples of pressure values
- Normal air pressure (sea level) ≈ 100 kPa
- Inflated car tyre ≈ 200 kPa
- Inside a scuba airtank ≈ 800kPa

Air Pressure and Your Body

Normal air pressure at sea level is about 100 kPa. Over the area of your whole body this is like having a 100kg mass pressing on you.

How come you don’t feel squashed?

Simply because your body has the same amount of pressure inside, pushing outwards.

Air pressure decreases with altitude. If you go up in an aircraft, or drive up a high mountain, the outside air pressure gets less. You will feel the pressure difference in your ears, until it equalizes again.

Astronauts in space or on the Moon, where there is no air, need pressure suits to breathe, and also to protect them from the zero pressure around them. Their own “body pressure” pushing outwards would cause fatal damage without the suit.

Atmosphere v. Space

The pressure of the atmosphere is due to the weight of all the air above pressing down.

As you go higher up, there is less and less air above you, so the air gets “thinner” and the pressure gets less.

So how high up can you go before there is no air, and you are in outer space? There is no simple answer to that!

The air gets thinner and thinner, but there are a few atoms and molecules of gas even as far up as 500km. Technically, there are still a few gas molecules, but the pressure is effectively zero. You are in the vacuum of space.

However, even just 3-4km up you may have some difficulty breathing.

By 20km up you’d need a pressure suit (like an astronaut’s space suit) to breathe and survive the low pressure.

By 50km up there is virtually no air pressure, and by 100km you can say that you are in space.
Worksheet 3
Atmospheric Gases

Match each description to a list item (A,B,C,etc)

| Description                                               | List Item
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Most abundant gas of the atmosphere.</td>
<td>A. Nitrogen</td>
</tr>
<tr>
<td>2. Gas which absorbs UV radiation.</td>
<td>B. Methane</td>
</tr>
<tr>
<td>3. Process which plants use to make their food.</td>
<td>C. Oxygen</td>
</tr>
<tr>
<td>4. Gas which turns limewater cloudy.</td>
<td>D. Argon</td>
</tr>
<tr>
<td>5. Main “greenhouse gas”.</td>
<td>E. Carbon Dioxide</td>
</tr>
<tr>
<td>6. Gas needed by plants to make food.</td>
<td>F. Ozone</td>
</tr>
<tr>
<td>7. Gas released by photosynthesis.</td>
<td>G. Photosynthesis</td>
</tr>
<tr>
<td>8. Gas needed for cellular respiration.</td>
<td>H. CFC</td>
</tr>
<tr>
<td>9. Chemical which destroys the ozone layer.</td>
<td>I. Cellular Respiration</td>
</tr>
<tr>
<td>10. Another “greenhouse gas”, apart from CO₂.</td>
<td></td>
</tr>
</tbody>
</table>

List Items (Not all will be used. Some may be used more than once.)

A. Nitrogen
B. Methane
C. Oxygen
D. Argon
E. Carbon Dioxide
F. Ozone
G. Photosynthesis
H. CFC
I. Cellular Respiration

Worksheet 4
The Atmosphere

Fill in the blank spaces.

Almost \( \frac{4}{5} \) of the air is made up of the gas a)...................................... Most of the remainder is b)............................ gas, which we breathe in, to use for cellular c)...................................

The last 1% of the air is a mixture of many gases including d)............................ (the most abundant of the minor gases)

Although it makes up only 0.04% of air, the gas e)...................................... is very important to living things. It is absorbed by plants for f)............................ by which they make food. This process releases g)............................ gas, so these gases are recycled over and over.

Carbon dioxide is important for world climate. It traps some of the h)............................ which would normally radiate into space. This is called the “i)............................ Effect”.

Humans have increased the amount of CO₂ in the air, mainly by the burning of j)............................ fuels such as k)............................ and l)............................ As CO₂ levels rise, the world is warming up. This is called “m)............................ Warming”.

Ozone is a form of n)............................ gas. It forms in the high atmosphere, where it absorbs dangerous o)............................ rays from the Sun. For many years humans were using chemicals called p)............................ (abbreviation) which destroy ozone.

Gases push in all directions. This force (per unit of area) is called q)............................ Air pressure r)............................ as you go upwards in the atmosphere. Above about 3-4km you may have difficulty s)............................ By about 20km up, you’ll need a t)............................ suit, and by about 100km up you are in u)............................
Worksheet 5
Graphing Skills

The data table shows the air pressure at increasing heights above the Earth’s surface.

Graph the data on the grid as a series of points, then join them with an even curve.

<table>
<thead>
<tr>
<th>Height (km)</th>
<th>Air Pressure (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>57</td>
</tr>
<tr>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>25</td>
<td>4</td>
</tr>
<tr>
<td>30</td>
<td>2</td>
</tr>
<tr>
<td>40</td>
<td>1</td>
</tr>
<tr>
<td>50</td>
<td>0 (almost)</td>
</tr>
</tbody>
</table>

Questions
1. What does “kPa” stand for? .................................................................
2. Some people have breathing difficulties if air pressure drops below about 70 kPa. About what altitude will this happen? .................................................................
3. What is the air pressure on Mt Everest, almost 9km high? ........................

Worksheet 6
Carbon-Oxygen Cycle

This diagram represents one of the cycles of nature, with the tree representing all plants and the elephant representing all animals.

1. Fill in the names of the processes, and the substances, in the spaces around the diagram.
2. Which of the gases in the diagram is involved in “Global Warming”?
3. Another human-caused factor in “Global Warming” is that forests are being cleared in many places, to create more farming & grazing land.

Suggest how this might contribute to Global Warming.
(Your answer will link to the diagram)
The Hydrosphere ("hydro" = water)
The hydrosphere includes the oceans, lakes and rivers, underground water and the ice-caps and glaciers.
Almost 98% of the water on Earth is salty water in the oceans, and most of the remaining 2% is frozen solid.
We depend on only about 0.3% of the hydrosphere for our drinking water and for our crops and livestock, as well as for cleaning and industrial uses.
Luckily, there is a natural cycle which constantly replenishes our fresh water supplies.

The Water Cycle

Evaporation
liquid → gas
The Sun drives the whole water cycle by providing the heat to evaporate water, mainly from the oceans. The water evaporates, but the salt stays behind.

Condensation is the change gas → liquid which occurs as the moist air rises and cools. Clouds are made up of tiny droplets of liquid water. The droplets are so small that they remain suspended in the air. If they grow larger, they may then fall as rain.

Transpiration
Plants absorb water from the soil into their roots. Water is then drawn upwards through the xylem tubes to the leaves, and evaporates from the stomates. (microscopic pores in the leaf)

This process is called Transpiration. It keeps plants cool, and ensures a good flow of water and soil minerals to the leaves for photosynthesis.

The process also moves huge quantities of water into the atmosphere from vegetated areas.
Atmosphere, Hydrosphere & Weather

The day-to-day weather, and the long-term climate, are controlled by both atmosphere and hydrosphere.

Air Pressure and Weather

Most of our winds, storms and weather patterns are due to air pressure effects in the atmosphere.

In some places, a huge “bubble” of the air (maybe 1,000 km across) can warm up. This “bubble” expands so that the air particles become further apart and the air pressure becomes lower than the surrounding air. This is a “low pressure cell”.

Meanwhile, in another place the air is cooling and contracting. The air particles are forced closer together, so the pressure rises... a “high pressure cell”.

Both pressure systems begin to rotate because of the spin of the Earth, so circular winds blow around each “cell”.

Low pressure cells often bring storms and rain (and cyclones) while “highs” tend to bring fine, dry weather. Both create the winds that blow around them, and from one to the other.

Reading the Weather Map

The curved lines are “isobars”. They connect places with the same air pressure, and surround High and Low pressure areas with circular patterns. Winds blow clockwise around lows, and anti-clockwise around highs.

When isobars are tightly together, winds are stronger.

When far apart, conditions are calm.

Oceans and Climate

Ocean currents can have a huge impact on climate.

On opposite sides of the North Atlantic Ocean the climates are very different. In north-east Canada the climate is so cold that agriculture is very limited. At the same latitude in Europe it is cold in winter, but summer is mild and many crops are grown.

The difference is the warm ocean current which warms the climate of Europe. Frigid cold currents chill coastal Canada.

In the Pacific Ocean, warm currents near South America cause wind patterns which bring prolonged droughts to Australia. This is called “El Nino”. In most years there are cold currents instead, and these bring rain and cyclones to the Australian coast.
Worksheet 7
Water Cycle

The “water cycle” can be represented by this diagram.

1. Name the processes P, Q & R.
   - P = .............................................
   - Q = .............................................
   - R = .............................................

2. Where does the energy come from to drive this cycle?

3. Draw another arrow on the diagram to show where the process of “transpiration” would fit into the cycle.

---

Worksheet 8
Air, Water & Weather

Fill in the blank spaces.

Most of the water in the “Hydrosphere” is in the a)................................ Some of it is frozen in the ice caps and in b)................................. The remainder is in lakes and rivers or it is c)....................... .................................. The “water cycle” is powered by the heat of the d)....................... This causes water e)................................, or turn from f)............................. to ..........................

Water also enters the atmosphere by g)..................................., which is evaporation from plants. This moves a lot of water from soil to the air.

As the water vapour rises, it cools and h)............................. back to liquid. The tiny droplets remain suspended in the air, forming i)..........................

If the droplets grow large enough they will fall down as j).............................., or (if frozen) they will fall as k).............................. or ................. All these things are collectively called “l).............................”

The cycle is completed when the water drains back to the m).......................... by flowing down n).......................... or seeping underground.

Weather and climate are controlled by both o).............................. and ....................................................

A lot of day-to-day weather is caused by high and low p)............................. cells in the air. These cells rotate so that q).............................. blows around them, bringing moist air, clouds, storms, etc.

The oceans have a big influence on r)............................. For example, periods of drought in Australia are caused by warm currents in the s)........................ ocean. This is called an t)"..............................” event. (Spanish name)
The Lithosphere (“lithos” = rock)
The solid, rocky outside layer of the Earth is a very thin “skin” compared to the size of the Earth itself.
To study the lithosphere, the first step is to learn what it is made from.

Rocks are Made from Minerals
What is a rock?
Most rocks are mixtures of a variety of crystalline chemicals called “minerals”.
Each mineral forms crystals of a particular shape, colour and “hardness”.

Quartz (or Silica)
The most common mineral on Earth is a glass-like substance called quartz.

(It's not surprising that it's “glass-like”... quartz is the main ingredient for making glass!)
Many small fragments of quartz is what we call sand.
If you hold a rock in sunlight and it “sparkles”, that's probably because it has small crystals of quartz in it.

Calcite
Another common mineral is calcite.
Rocks containing calcite can be easily identified by placing a drop or two of acid on them. (A drop of vinegar will do)
If calcite is present, the acid will “fizz” with little bubbles.
Acid reacts chemically with calcite to make CO₂ gas. That's what makes the bubbles.

Silicate Minerals
The “silicates” are a large family of minerals which are all related to quartz. (Quartz is also known as “silica”) 95% of rocks contain silicates.
Each particular silicate mineral is quartz with various chemical elements embedded in its crystal structure. This changes its colour, hardness and crystal shape.
The elements embedded in silicates are (most commonly) aluminium, calcium, magnesium, iron and potassium.

Some Silicate Minerals

Most silicates occur mixed together in common rocks. When they occur in pure crystals they are “gems”, and “semi-precious stones”
The Rocks of the Lithosphere
Rocks can be mixtures of many different minerals combined in any proportions. This means that thousands of different kinds of rock are possible. However, all rocks can be classified into just 3 groups, according to how the rock was formed.

Igneous Rocks
Igneous rocks are formed from molten minerals that have cooled and solidified. These rocks are associated with volcanic activity.

Magma & Lava
In many parts of the world, heat and movements in the lithosphere cause the rocks to melt deep below the surface.

This molten material is called “magma”. Sometimes it can force its way to the surface and a volcanic eruption occurs. The molten rock that erupts at the surface is called “lava”.

As the magma or lava cools down, the molten minerals solidify and form solid crystals. This forms igneous rocks.

Magma cools slowly, deep underground. This allows the mineral crystals to grow larger and be clearly visible in the rock. Lava cools quickly at the surface, and the crystals are too small to see.

The colours vary, too. Igneous rocks with large amounts of quartz are pale in colour. If there is less quartz and more silicate minerals, the colour is usually darker.

Some Common Igneous Rocks

Granite
Granite forms from slow-cooling magma. You can see the separate mineral crystals, including a lot of quartz.

Basalt
This is basalt from a recent lava flow. You can still see the flow patterns from when it was liquid. Basalt is dark-coloured with microscopic crystals.

Pumice
This is a rock that floats! Pumice is like the “froth” on lava from volcanic gases forming bubbles.
The Rocks of the Lithosphere
Rocks can be mixtures of many different minerals combined in any proportions. This means that thousands of different kinds of rock are possible. However, all rocks can be classified into just 3 groups, according to how the rock was formed.

Sedimentary Rocks
Sediments
Rocks are worn down and carried away by water, wind and ice. Erosion of rocks produces gravel and sand and silt, or mud.

Eventually, these eroded fragments settle to the bottom of a lake or ocean. These are called sediments.

As more and more sediments accumulate on top, the layers are compressed by huge forces. Any water is squeezed out. The grains become cemented together and the whole mass becomes a hard rock. (Although it's usually not as hard as igneous rock)

Fossils
Some sedimentary rocks contain the remains and traces of ancient living things that were buried in the sediments.

This fish lived 150 million years ago. Its body was trapped in silt which later became shale rock.

Common Sedimentary Rocks
Shale
This rock forms from layers of silt or mud. Colours vary, but it is fine-grained. You can see the sedimentary layers in this sample.

Sandstone
Forms from sand particles compressed and cemented together. This piece has been cut to make a decorative wall.

Conglomerate
You can see that this rock is made from gravel cemented with a dark mud.

A Mountain of Limestone
Limestone is mostly calcite mineral

This entire mountain range is made of sedimentary rocks which have been uplifted from the ancient seafloor by earth movements. You can clearly see the sedimentary layers.

During erosion, the pebbles, mud, sand, etc. are often sorted out and separated from each other. Sediments are often made of particles all the same size.
Metamorphic Rocks

These are rocks that are formed when a previous igneous or sedimentary rock is changed by extreme heat and/or pressure within the lithosphere.

Heat & Pressure Causes Changes

The extreme heat near a chamber of molten magma can cause changes to surrounding sedimentary rocks.

For example, the sand particles in sedimentary sandstone can partly melt so they all fuse together to form a mass of glassy quartzite rock.

Perhaps the best known metamorphic rock is marble. It is formed from limestone, a sedimentary rock containing a lot of calcite mineral.

Under great heat and pressure, the calcite is re-crystallised and the rock becomes much harder. Beautiful colours and patterns may develop due to small amounts of other minerals in it.

People have been using marble for statues and decorative structures for thousands of years.

Just like the limestone from which it came, marble will “fizz” if a few drops of acid are placed on it.
Fill in the blank spaces.

Minerals
Most rocks are mixtures of various a)................................, each with its own b)........................ shape, colour and hardness.

The most common mineral on Earth is c)........................ which is hard and d)...................-like.

Another common mineral is calcite, which is easily identified by placing a drop of e)...................... on a rock sample. If calcite is present, it will f)..................

95% of rocks contain one or more of the many types of g)........................ minerals. These are based on quartz, but have various metals embedded in the h)........................ structure. This changes the colour, crystal shape and i).......................... 

Igneous Rocks
Igneous rocks form from j)........................ minerals and are associated with k)........................ activity.

Molten rock deep in the Earth is called l)......................... If it cools deep underground, it will cool m)........................ and mineral crystals have time to grow. A common rock of this type is n)........................ in which you can easily see different o).......................... 

If the molten rock erupts at the surface it is called p)............................. This cools q)..........................., so the crystals are very r)............................. A common rock of this type is s)..........................

Sedimentary Rocks
Rocks and soil are worn down and carried away by water, wind, etc. This is called t)............................. Eventually the sand, clay or silt is deposited on a lake or sea floor as u).............................. More and more layers accumulate, v).............................. the layers below, until the sediments become rock. Often, some mineral in the sediments acts like w)............................. and helps hold the rock together.

Sometimes the body or traces of living things are trapped in the sediments and are preserved as x)..........................

Two common sedimentary rocks are shale, made from y).............................. sediments, and z).............................. from sand.

Metamorphic Rocks
These are made when an existing rock is changed by aa).............................. and/or b)...............................

The heat from nearby ab).............................. activity can change sandstone into ac).............................. 

The huge ad).............................. that occur when mountain ranges are being formed can squeeze shale into a new structure called ae)..............................

Rocks containing a lot of calcite, such as af).............................. can be re-crystallised by heat and pressure to become ag).............................. This beautiful rock has been used for statues for thousands of years.
Weathering of Rocks

Most rocks are pretty hard, but they're not indestructable. Rocks are gradually “broken down” into smaller pieces, and chemically changed into new substances. This breaking-down of rock is called weathering.

There are 2 quite different weathering processes that occur.

Physical Weathering
This means the physical breaking of rock into smaller particles, without changing it chemically.

The classic example is when quartz crystals are broken into small fragments to form sand grains. It's still quartz, but the grains are smaller.

What causes physical weathering?

One of the main causes is temperature change. On a hot day the outside of a rock becomes hot and expands slightly. At night it gets cold and contracts.

This cycle of expanding and contracting cracks the surface and small fragments fall off. On a cold night in the mountains, you can often hear the clatter of small rock fragments tumbling down the cliffs and gorges.

If it gets cold enough to freeze water this process speeds up. Water seeps into cracks in the rock. When it freezes, it expands and cracks the rock further until pieces break off.

Another major process of physical weathering is the tumbling of stones in a fast-flowing river, or by the waves near the coast. Sand and rocks are tossed and tumbled together so they are first rounded, and then worn down into smaller and smaller pieces.

Chemical Weathering
This is when the minerals in a rock are chemically changed by reaction with oxygen and natural acid chemicals in the environment.

The crystal structure of the mineral changes to a new, softer substance, and the rock softens and falls apart.

Quartz does not change chemically, (it only breaks physically into sand grains) but many of the silicate minerals change into what we might call “clay”.

Rocks containing the mineral calcite are especially easy to weather. As you know, calcite reacts chemically with acids. If water with some dissolved acid seeps through calcite rocks, the rock slowly dissolves away. This is how limestone caves develop.

So, where do the acids come from?

Carbon dioxide (CO₂) gas from the air dissolves in water to form a (very weak) acid solution. Living things in the soil produce natural acids, and the rotting of dead vegetation releases natural acids.

In many cases, both physical and chemical weathering occur together. Rock becomes fragmented and softened, so that it disintegrates.
Erosion

Once rocks have been weathered, another process becomes possible. Erosion is the movement of rock and soil from one place to another. The main things which cause erosion are flowing water or ice, and the wind.

Wind Erosion
In deserts and along beaches, the wind often moves loose dust and sand. Sand is often piled up to form “sand dunes”.

These can slowly “migrate” as sand is blown up and over the top, and cascades down the other side.

Erosion by Water
Moving water is a major cause of erosion.

As rivers flow, they carry tonnes of fine sand and “silt” down to the sea. Eventually these solid particles will settle to form sediments. They may form sand-bars, or beaches, or simply be buried to become new sedimentary rocks millions of years later.

Erosion by Ice
There are no glaciers in Australia, but in many colder climate areas, they are one of the most important agents of erosion.

A glacier is nature’s bulldozer. The slow, relentless movement of billions of tonnes of ice gouges out the rock, weathering and eroding in one step.

In steep mountain creeks, the fast flowing water can transport pebbles and boulders. The tumbling stones help cut through the bed-rock and gouge out canyons and valleys.

The action of waves at the coast is a powerful agent of erosion.

These sea cliffs are at “The Gap”, Watsons Bay, Sydney.
Soil Formation

We rely heavily on soil for growing food crops and grass for grazing animals. Good soil can take thousands of years to develop, and is often less than a metre thick. Soil formation depends on weathering and erosion.

A Soil Profile

The diagram shows a cross section through a soil which has formed from the bedrock underneath.

Working from the bottom upwards, the profile reveals the stages in soil formation.

Fine-grained sand and clay “subsoil”

Rock broken into smaller pieces. Quartz forms sand grains. Chemical weathering turns silicates into clay.

Solid bedrock, not yet weathered

“Topsoil” is usually darker than subsoil because it contains “humus”. This is rotted plant material which changes the texture of the soil, helps hold moisture and fertilizes plant roots.

The topsoil is the essential, fertile layer.

The plants and rotting humus produce acids which seep down through the subsoil. This causes the chemical weathering.

Cracked and broken rock... weathering beginning. Tree roots often grow into cracks and break the rock.

Deposition Soils

Many soils are formed by erosion and deposition, rather than weathering of the bedrock. The soil in this photo has been deposited as alluvial sediments during floods.

Floodplains are flat and ideal for farming and each flood deposits another silt layer, so the soil stays fertile.
Landscapes Formed by Erosion & Deposition

Many landscapes, both ordinary and spectacular, are the result of the weathering and erosion of rock, or the deposition of sediments.

Wind Erosion
This rock formation in Western Australia is called “Wave Rock”. It has been eroded into this shape by wind-blown sand.

Erosion by Rain
The soft volcanic ash of this part of Turkey washes away in rain, except where it is “capped” by harder, darker rock. Erosion has produced these strange “fairy chimneys”. Local people hollow them out to use as homes.

River Erosion & Deposition
Once they’re down out of the mountains, rivers meander sideways and erode a wider and wider valley. Seasonal flooding deposits sediments to form a flat floodplain.

Flood waters cut new channels creating islands, and river meanders get cut-off to form billabongs, or “ox-bow lakes”.

Ice Erosion
A glacier once filled this valley and gouged out all the rock. The U-shape is typical of erosion by ice.
(Mountain valleys eroded by water are V-shaped)

Coastal Deposition
This sand spit and beaches have formed from sand deposited by tides rushing in and out of this coastal bay.
Worksheet 10
Weathering & Erosion

Answer these Questions

1. Explain the difference between physical weathering and chemical weathering by completing these sentences.

Physical weathering breaks rock into a)............................................, but does not change it into b)...................................

Chemical weathering changes rocks and minerals into c)..........................................................

2. a) Describe 2 things which cause physical weathering of rock.

b) Name a substance which can react to cause chemical weathering.

3. Explain the difference between weathering and erosion by completing these sentences.

Weathering a)........................... rock into smaller pieces, or changes it into b).........................................................

Erosion c).......................... the weathered rock to a d)..........................................................

4. List 3 things which cause erosion.

5. Complete the sentences to describe the ways that soil can form.

Soil can form from the underlying bedrock by a)............................. of the rock. The rock is b)............................. broken into smaller particles, and also c)............................. changed into substances such as clay.

Good d)“.............................” always contains a lot of e)“.............................” which is rotted plant material

Some soils are formed by f)............................. of eroded silt. On a river g)............................plain, every flood deposits h).............................

6. Give one example of a landscape created by:

a) wave erosion at a coastline .........................................
b) deposition of sediments on a coastline..................................
c) river erosion and seasonal flooding ..................................

7. What do you think has created the landscapes in these photos?

a)..........................................................
b)..........................................................

Student Name..............................................................
Topic Test
The Earth

Answer all questions in the spaces provided.

1. (10 marks)
   True or False?
   a) The innermost layer of the Earth is liquid.       T or F
   b) Oxygen is required for things to burn.      .....  
   c) CO₂ is needed for cellular respiration.    .....  
   d) Ozone is a form of oxygen.                  .....  
   e) Clouds in the sky are made of gas. (water vapour) ..... 
   f) Silicate minerals are similar to calcite.    .....  
   g) Slow-cooling igneous rocks have the smallest crystals.  ..... 
   h) Fossils are found in igneous rocks.          .....  
   i) Temperature change can cause physical weathering. .....  
   j) Sand dunes are created by wind erosion.      .....  

2. (6 marks)
   Briefly explain the difference between:
   a) magma and lava.  
   b) evaporation and condensation.  
   c) weathering and erosion.

3. (10 marks)
   Match each description to an item from the list. To answer, write the letter (A,B,C, etc) of the list item beside the description.

   Description matches with List Item
   a) Combination of crust plus upper mantle rocks.                A. Transpiration
   b) Second most abundant gas in the atmosphere.                  B. lava
   c) Needed for photosynthesis.                                   C. Quartz
   d) Type of atoms in ozone.                                      D. Oxygen
   e) Its value decreases with altitude.                            E. acid
   f) Evaporation from plants.                                     F. magma
   g) Most common mineral.                                         G. Carbon dioxide
   h) Molten rock, deep down.                                      H. Calcite
   i) Metamorphic rock, from limestone.                            I. Lithosphere
   j) Causes a lot of chemical weathering.                         J. glacier
   k) air pressure
   l) marble

Score = /26

List Items: Not all will be used. Some may be used more than once.
Answer Section

Worksheet 1
a) Crust
b) Mantle
c) Outer Core
d) Inner Core
e) Seismology: study of earthquake waves
f) Outer core
g) iron & nickel metals
h) It is made up of the crust rocks with some mantle rock attached.

Worksheet 2
a) atmosphere
b) weather
c) oxygen
d) UV radiation
e) hydrosphere
f) lakes & rivers
g) ice caps
h) crust
i) mantle
j) tectonic
k) biosphere

Worksheet 3

Worksheet 4
a) nitrogen
b) oxygen
c) respiration
d) argon
e) carbon dioxide
f) photosynthesis
g) oxygen
h) heat
i) Greenhouse
j) fossil
k) coal & petroleum
l) Global
m) oxygen
n) ultra violet (UV)
o) CFC’s
p) pressure
q) decreases
r) breathing
s) pressure / space
t) space

Worksheet 5
1. kilopascals (pressure unit used a lot in Science)
2. 3-4 km approx (reading from graph)
3. (from graph) 27-28 kPa (approx)

Worksheet 6
1. Processes: (top) photosynthesis, (bottom) cellular respiration.
Substances: (left) oxygen + glucose, (right) carbon dioxide + water.
2. Carbon dioxide
3. Clearing forests reduces the amount of plants carrying out photosynthesis. Since plants absorb CO₂, less plants means that CO₂ levels rise. This promotes the greenhouse effect.

Worksheet 7
1. P = evaporation
Q = condensation
R = precipitation
2. Energy is from the Sun.
3. Arrow should go from the ground (actually from plants) to the cloud.

Worksheet 8
a) oceans
b) glaciers
c) underground
d) Sun
e) evaporate
f) liquid to gas
g) transpiration
h) condenses
i) clouds
j) rain
k) hail or snow
l) precipitation
m) oceans
n) rivers
o) atmosphere and hydrosphere
p) pressure
q) wind
r) climate
s) Pacific
t) El Nino

Air Pressure Changes with Altitude
### Worksheet 9

<table>
<thead>
<tr>
<th>a) minerals</th>
<th>b) crystal</th>
</tr>
</thead>
<tbody>
<tr>
<td>c) quartz</td>
<td>d) glass-</td>
</tr>
<tr>
<td>e) acid</td>
<td>f) fizz / bubble</td>
</tr>
<tr>
<td>g) silicate</td>
<td>h) crystal</td>
</tr>
<tr>
<td>i) hardness</td>
<td></td>
</tr>
<tr>
<td>j) molten</td>
<td></td>
</tr>
<tr>
<td>k) volcanic</td>
<td>l) magma</td>
</tr>
<tr>
<td>m) slowly</td>
<td>n) granite</td>
</tr>
<tr>
<td>o) mineral crystals</td>
<td></td>
</tr>
<tr>
<td>p) lava</td>
<td>q) quickly</td>
</tr>
<tr>
<td>r) small</td>
<td>s) basalt</td>
</tr>
<tr>
<td>t) erosion</td>
<td>u) sediments</td>
</tr>
<tr>
<td>v) compressing</td>
<td>w) cement</td>
</tr>
<tr>
<td>x) fossils</td>
<td>y) silt / clay / mud</td>
</tr>
<tr>
<td>z) sandstone</td>
<td></td>
</tr>
</tbody>
</table>

aa) heat and/or pressure
ab) volcanic
ad) pressures
af) limestone
ac) quartzite
ae) slate
ag) marble

### Worksheet 10

1. a) smaller pieces
   b) a new substance
   c) new chemical substances
2. a) temperature change,
    flowing water tumbling rocks
   b) acid or oxygen
3. a) breaks
   b) new substances
   c) moves or transports
   d) new location, different place
4. Moving water, wind, ice (glaciers)
5. a) weathering
   b) physically
   c) chemically
   d) topsoil
   e) humus
   f) deposition
   g) flood
   h) a new layer of silt
6. a) sea cliffs
   b) beach, sand bar
   c) floodplain
7. Wind erosion
   Wave erosion

### Topic Test

1. a) F  
   b) T  
   c) F  
   d) T  
   e) F  
   f) F  
   g) F  
   h) F  
   i) T  
   j) T

2. a) Magma is molten rock deep underground, while lava is molten rock at the surface.
   b) Evaporation is liquid → gas.
   Condensation is gas → liquid.
   c) Weathering breaks rock down, erosion moves it to a new location.

3. a) I  
   b) D  
   c) G  
   d) D  
   e) K  
   f) A  
   g) C  
   h) F  
   i) L  
   j) E