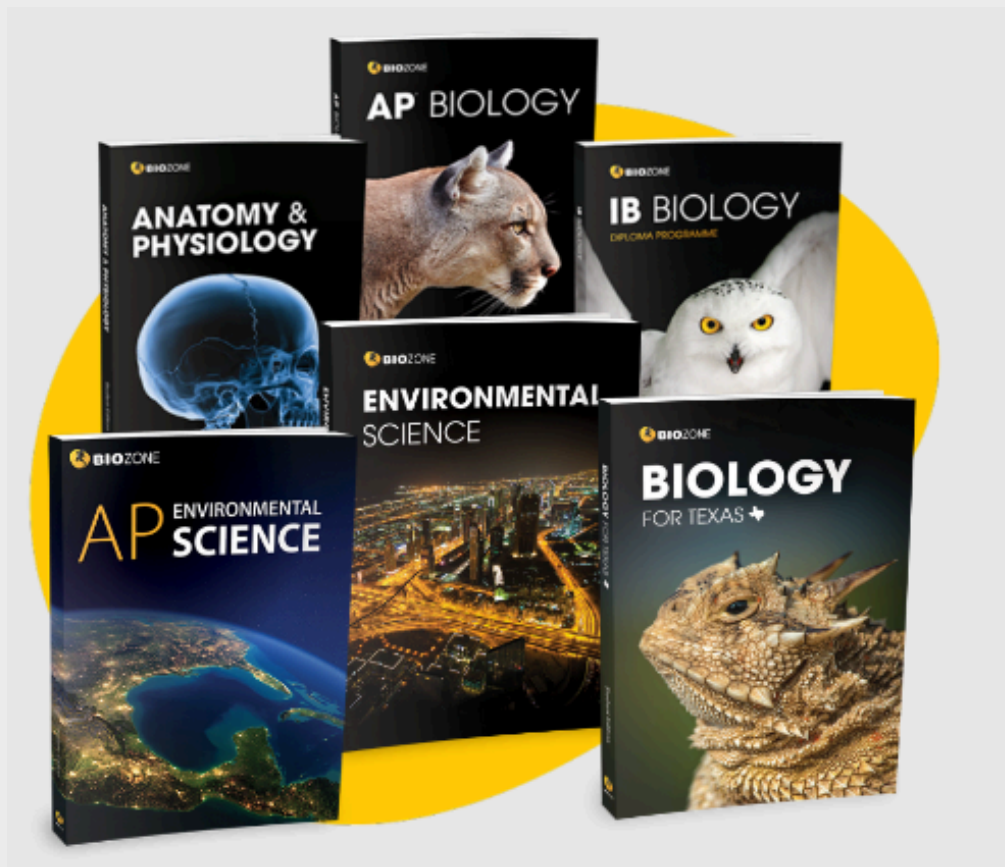


# BIOZONE

## TEXAS PROGRAMS





**BIOZONE**

Advanced  
Placement Titles



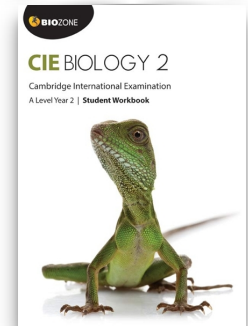
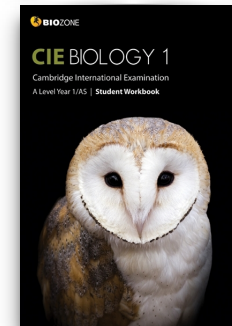
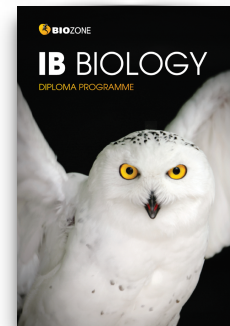
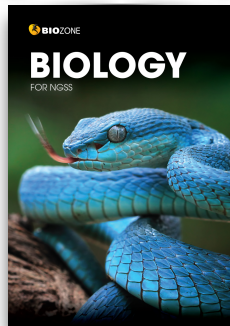
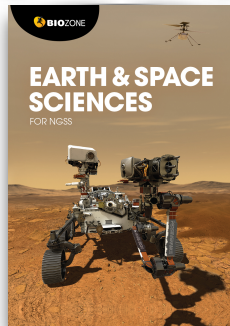
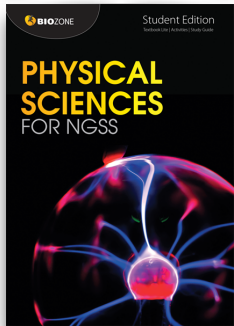
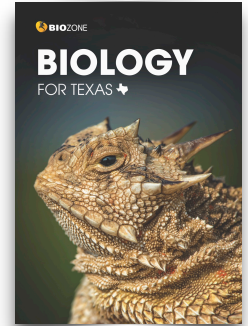
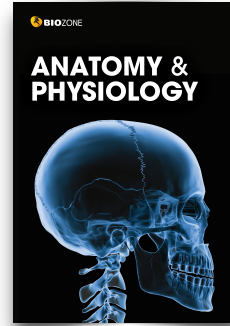
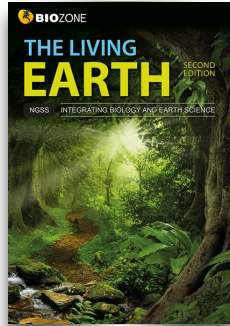
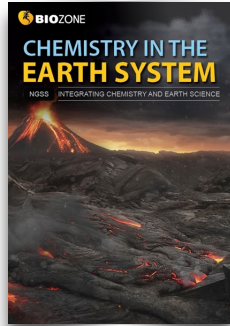
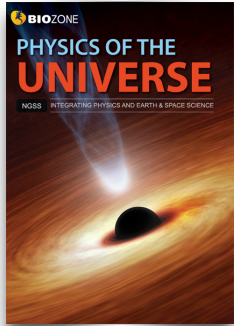
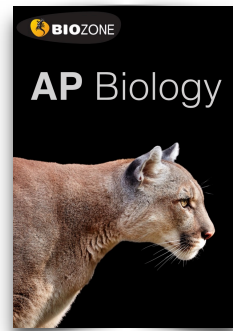
# Overview:

- BIOZONE's points of difference
- Environmental Science
- Earth and Space Science
- Digital platform: BIOZONE WORLD
- Wrap up and questions

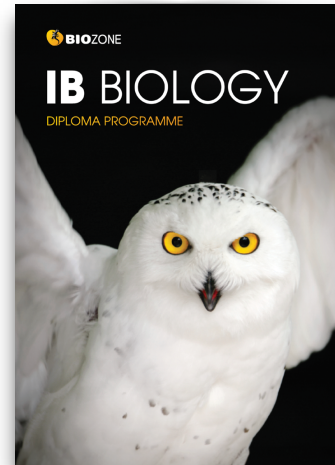
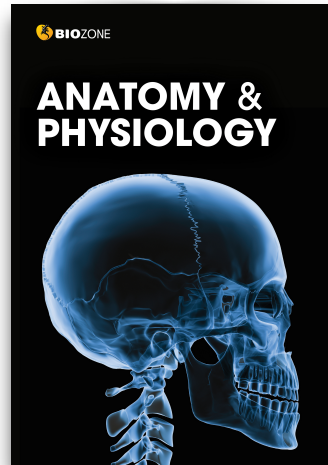
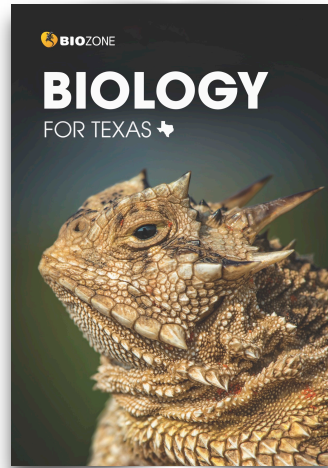


# BIOZONE

## SCIENCE US PROGRAMS



# Recent Editions



# BIOZONE's delivery

# Print | Digital | Blended

**BIOZONE ALPHA** CLASSROOM

Anatomy & Physiology (Sample) > Chapter 9: The Respiratory System > 150 Control Of Breathing > Activity

## 150 Control of Breathing

**Key Idea:** The basic rhythm of breathing is controlled by the respiratory center, a cluster of neurons located in the medulla oblongata, situated in the brain stem. This rhythm is adjusted in response to the physical and chemical changes that occur when we carry out different activities. Although the control of breathing is involuntary, we can exert some degree of conscious control over it. The diagram below illustrates these controls.

### The respiratory center and the control of breathing

Chemoreceptors in the aorta and carotid arteries monitor the blood's pH. Low pH (caused by high CO<sub>2</sub>) stimulates the respiratory center to increase the rate and depth of breathing.

The respiratory center has connections with the cerebral cortex, allowing voluntary control over breathing e.g. when talking, singing, sneezing, and coughing.

Phrenic nerve sends impulses to the diaphragm to stimulate contraction.

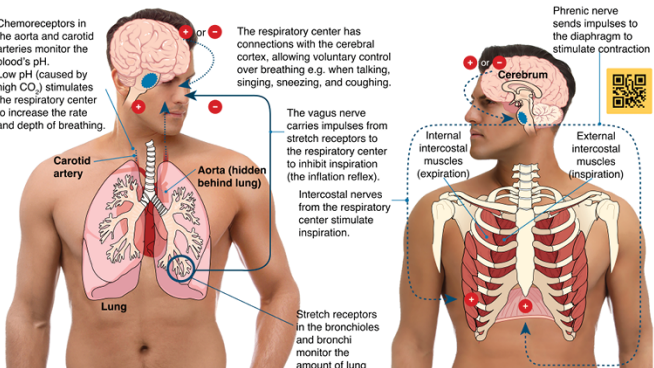
The vagus nerve carries impulses from stretch receptors to the respiratory center to inhibit inspiration (the inflation reflex).

Internal intercostal muscles (expiration)

External intercostal muscles (inspiration)

Intercostal nerves from the respiratory center stimulate inspiration.


Stretch receptors in the bronchioles and bronchi monitor the amount of lung



**BIOZONE ALPHA** LIBRARY

Anatomy & Physiology > Chapter 3: The Skeletal System > 31 The Human Skeletal System

- SLIDES: The Human Skeleton
- VIDEO: Anatomy of the skeleton (advanced)
- WEB LINK: Human axial skeleton
- WEB LINK: Skeletal system
- WEB LINK: Skeletal system
- 3D MODEL: Skeleton: Modern Human labelled
- 3D MODEL: Skull: Female Human
- VIDEO: The Skeletal system
- WEB LINK: What are the five main functions of ...
- ACTIVITY 32: The Bones Of The Spine
- ACTIVITY 33: The Limb Girdles
- ACTIVITY 34: Bone
- ACTIVITY 35: The Ultrastructure Of Bone



# STUDENT OWNED RESOURCE

A 3-in-1 hybrid resource:

Part textbook

Part study guide

Part activity workbook

An all-in-one comprehensive resource, eliminating the need for a separate textbook.


330 **202 Tipping Point: Warm Water Coral Reefs**

**Key Idea:** Warmer oceans are causing thermal stress to coral ecosystems, leading to wide-scale mortality.

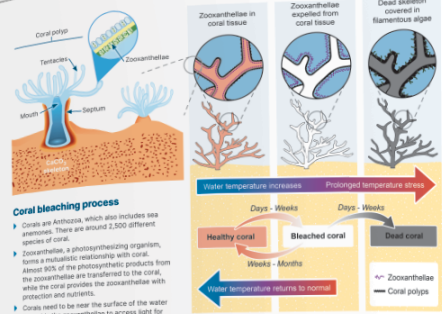
An increase in sea temperatures could mean the death of coral reefs. Healthy coral reefs depend on the symbiotic relationship between a coral polyp that builds the reef and photosynthetic organisms called zooxanthellae. Zooxanthellae live within the polyp tissues and provide coral with most of its energy. A 1-2°C temperature increase maintained for weeks is enough to disrupt its photosynthetic enzymes. The zooxanthellae either die or are expelled from the coral. The result is **coral bleaching**. Some coral bleaching is reversible if water temperature cools once more original bleaching events. If the temperature remains outside its tolerance levels, the coral dies. Coral bleaching events can impact more than just the organisms themselves. The coral is essential for transfer of energy through the food chain as it provides habitats for other species in the food chain. Although the **tipping point** of each coral reef system is regional and dependent on the temperature of the surrounding ocean, the extent of coral bleaching worldwide has made it a global phenomenon.

**Coral bleaching in the Great Barrier Reef**

- Great Barrier Reef, off the coast of eastern Australia, is the largest warm water coral system in the world. It is formed from a patchwork of over 2,900 individual reefs.
- The Great Barrier Reef has experienced five mass bleaching events since 2016, the latest in 2024.
- In some regions of the reef, only a few small areas of coral in deeper water were unaffected by bleaching.
- Record, warm ocean temperatures around the reef, linked to **anthropogenic climate change** by scientists, have coincided with past bleaching events.



**Coral bleaching process**



**Coral bleaching as a tipping point**

- Climate scientists project that around 70-90% of warm water corals will be lost once the global temperature threshold reaches 1.5°C for a sustained period. Around 90% of corals will disappear at just half a degree more.
- Some corals are resilient and the zooxanthellae can return once ocean waters cool. However, once enough coral has died because of prolonged temperature stress, a tipping point will be reached where the coral ecosystem will fall to recover. Corals will not reproduce and spawn, therefore there will be no larvae to regenerate new coral colonies. The system will typically tip into a different algae dominated ecosystem.

1. Summarize the link between ocean warming and coral bleaching:

\_\_\_\_\_

\_\_\_\_\_

2. Coral ecosystems provide a habitat to around 25% of all marine organisms, including photosynthetic plankton and bacteria, while only occupying 1% of the ocean. They act as a nursery for many open ocean species of fish. What would be some likely consequences of the coral reefs reaching their climate tipping point?

\_\_\_\_\_

\_\_\_\_\_

3. Ocean heatwaves are occurring more frequently. How does that impact a coral reefs ability to recover?

\_\_\_\_\_

\_\_\_\_\_

4. Why does the death of the coral in an area often lead to a tipping point, while this is not necessarily the case with bleached coral?

\_\_\_\_\_

\_\_\_\_\_

5. Why are warm water corals particularly vulnerable to ocean temperature increases?

\_\_\_\_\_

\_\_\_\_\_

6. Observe the images of coral reefs on the previous pages. What are some observable differences between bleached and healthy coral? Discuss in pairs and note your ideas below.

\_\_\_\_\_

\_\_\_\_\_

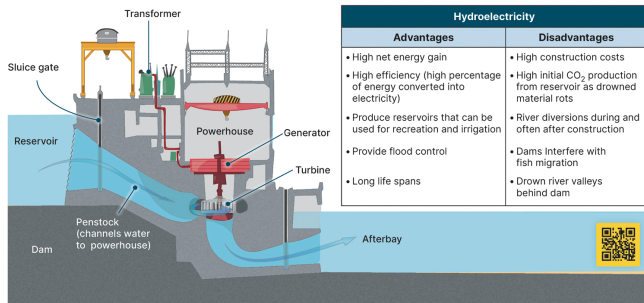
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## 127 Hydroelectricity

**Key Idea:** Hydroelectricity dams have the dual usage of both producing electricity and storing water for domestic and agricultural use.

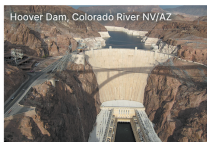
Hydroelectricity accounts for around 20% of global electricity production. Electricity is produced by utilizing the gravitational potential energy of water stored in reservoirs behind dams. As water falls, directed along pipes into the powerhouse, the potential energy is converted into kinetic energy, which turns turbines to generate electricity. The larger the volume of water and the further it has to fall,

the greater the amount of energy it contains. Large dams can therefore produce large amounts of electricity. The generation of electricity itself produces no CO<sub>2</sub> emissions or other air pollution, but the construction of the dam requires massive amounts of energy and labor and often requires river diversions. Construction of large hydroelectric dams is highly controversial because creating a reservoir behind the dam often requires the submergence of towns and land. Dams constructed inefficiently can also fill up with silt and gradually decline in their generation capacity.

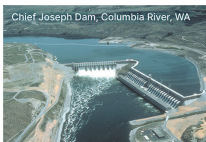


Hydroelectricity	
Advantages	Disadvantages
<ul style="list-style-type: none"> <li>• High net energy gain</li> <li>• High efficiency (high percentage of energy converted into electricity)</li> <li>• Produce reservoirs that can be used for recreation and irrigation</li> <li>• Provide flood control</li> <li>• Long life spans</li> </ul>	<ul style="list-style-type: none"> <li>• High construction costs</li> <li>• High initial CO<sub>2</sub> production from reservoir as drowned material rots</li> <li>• River diversions during and often after construction</li> <li>• Dams interfere with fish migration</li> <li>• Drown river valleys behind dam</li> </ul>

### Using hydroelectric power



The mass of water and the distance it falls are important in determining the amount of electricity that can be produced. The power (the energy produced per second) produced by a hydroelectric power plant can be approximated from the mass of water flowing past the turbine and the height of its fall.



Water doesn't have to be stored in a dam for a hydroelectric power plant to work. Water can be directed to flow past the turbine and simply use the force of the flowing water (called **run-of-the-river**). The dam is usually there to divert water towards the intake or powerhouse or to store water in case of lower river levels.



**Pumped storage** is a useful way of storing excess energy in hydroelectric plants. During off-peak times, water flowing through the plant is used to pump water to a higher storage pond. During high demand, this water can be run through a separate powerhouse to provide extra electricity to the local grid.

1. (a) Explain how hydroelectric dams are used to generate electricity:

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- (b) Describe the relationship between water volume, height of the dam, and electricity production:

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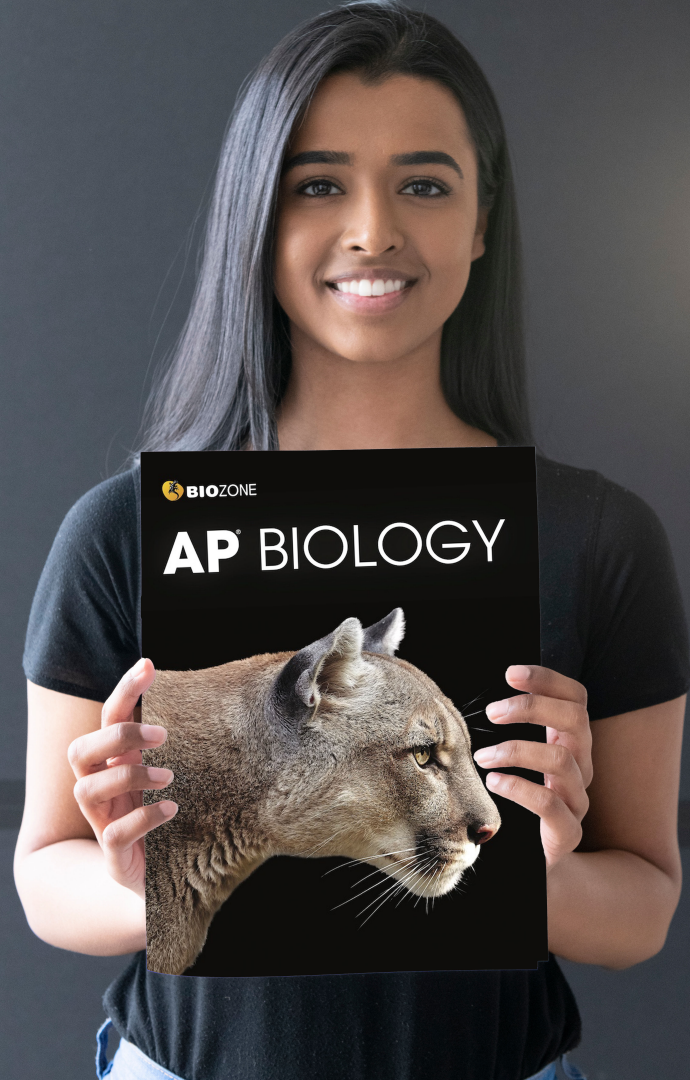
# Why are BIOZONE resources unique?

- A reputation for **scientific rigor** ...  
... but our information is **accessible**.
- **Graphical delivery** of science concepts.
- **Chunked text**.
- Students interact directly with material:  
**forms a record of work**
- **Reinforces understanding**.
- **Easy revision**.
- **Self grading and answer refinement**.



# Advantages of the BIOZONE approach

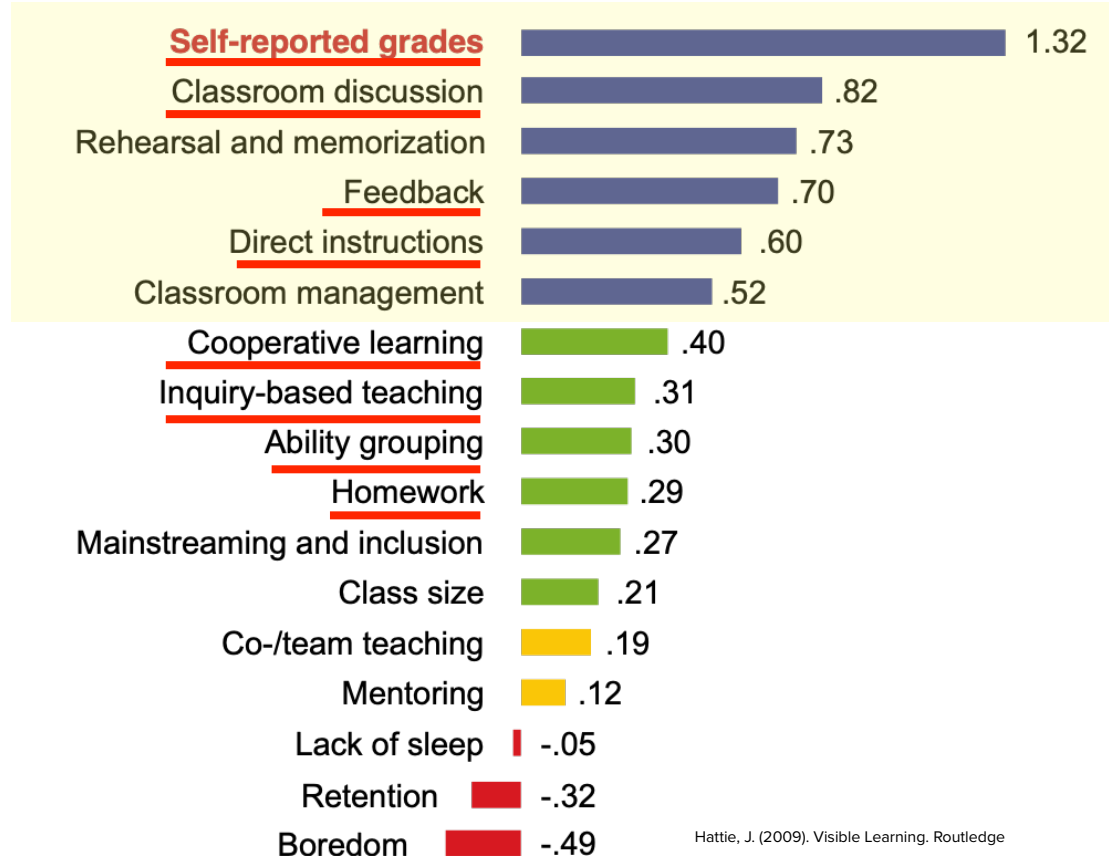
- Student ownership and engagement
- Empowers students to be fully involved in their learning journey
- Flexible delivery modes
- Regular updates:
  - Content
  - Pedagogy
  - Features
  - Support tools



# Pedagogical tools

- Where does the data come from?  
A synthesis of >1,500 meta studies involving over 90,000 individual studies and 300 million students.
- BIOZONE products incorporate many of the factors shown to positively influence student achievement.

## Influences on student achievement



# SUPPORT & DIFFERENTIAL INSTRUCTION

# Reading and ELL Support

## Reading support:

Chunked text  
increase accessibility.

Highly visual pages to reduce volume of text.

## English language support

BIOZONE WORLD:

Translation into 150 languages including Spanish

English and Spanish Glossary (some titles)



# Translation

## Digital platform

Translation into 150 languages

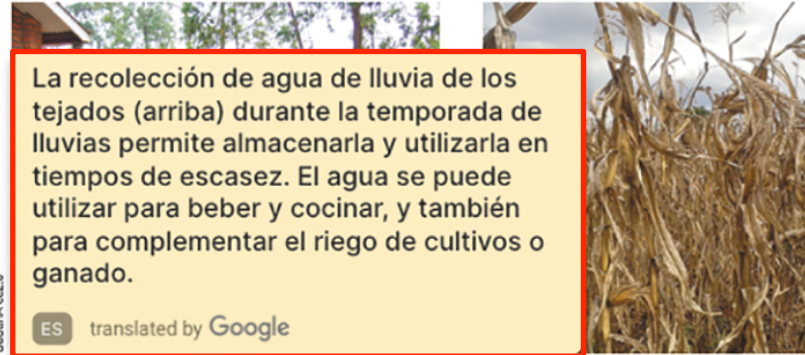
Dual language view

...disease, which can place the lives of these people in jeopardy. The effects of drought in developing nations can be widespread and affect a large proportion of a country.

- ▶ In more developed countries, such as the US, the effects of drought are mostly limited to farmers, as these nations have other industries to support them. However, the current, prolonged western United States drought is affecting not only the country's agricultural production, but also the urban water supply, and it is driving up the cost of food.

### Preparation and preparedness can reduce the impact of drought

- ▶ Drought is sometimes called a creeping **natural hazard** because it is possible to plan ahead to reduce its impact. Often, being well prepared costs less money than an emergency response, such as supplying aid. The UN has established to provide information and strategies to help African countries cope with drought. Some of these strategies are described below.



Rainwater harvesting from rooftops (above) during the rainy season allows water to be stored and used in times of shortage. The water can be used for drinking and cooking, and also to supplement the watering of crops or livestock.

In areas of Kenya, the use of drought-resistant strains of sorghum and other crops has seen harvest yields double. Yields can also be increased by using modern maturing crops, or through planting traditional crops which are quite resilient to a range of conditions, e.g. poor soil.

# Glossary

## Building scientific literacy

140

### 59 Feedback in Earth's Systems

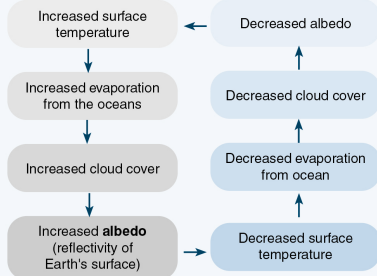
**Key Question:** What feedback systems operate on Earth, and how do they affect the climate?

#### Feedback on Earth

Feedback occurs when the output of a system is used as input in that system. On Earth, there are many feedback systems, both negative and positive, operating at the same time. **Negative feedback** systems tend to stabilize a system around a mean (average condition) whereas **positive feedback** tends to increase a departure from the mean.

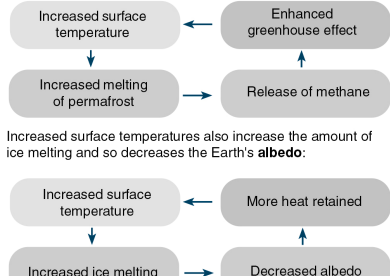
#### Negative feedback in nature

Feedback systems can be complex and the result of many interacting factors. The diagram below illustrates a simplified negative feedback system involving the production of clouds. Clouds reflect incoming sunlight back into space so have the effect of lowering the Earth's surface temperature.



#### Positive feedback in nature

Positive feedback systems on Earth tend to drive large scale changes to environments and the climate. The current increase in CO<sub>2</sub> in the atmosphere is driving numerous positive feedback systems. The diagram below illustrates the effect of methane (a greenhouse gas) release from permafrost. As the Earth warms, the permafrost melts, releasing methane which in turn causes the Earth to warm further.



Increased surface temperatures also increase the amount of ice melting and so decreases the Earth's **albedo**.

320

## English/Spanish Glossary

**meteorite:** A fragment of rock or iron from outer space that has survived both passage through the Earth's atmosphere and impact with Earth's surface.

**meteorito:** Un fragmento de roca o hierro del espacio exterior que ha sobrevivido tanto al paso a través de la atmósfera de la Tierra como al impacto con la superficie de la Tierra.

**migration:** Movement from one place to another.  
**migración:** Movimiento de un lugar a otro.

**mineral:** Naturally occurring compound with an ordered structure.  
**mineral:** Compuesto natural con una estructura ordenada.

**negative feedback:** A mechanism where a change the output of a system acts to oppose changes to the input of a system (prevents deviation from the norm).

**comentarios negativos:** Un mecanismo en el que un cambio en la salida de un sistema actúa para oponerse a los cambios en la entrada de un sistema (evita la desviación de la norma).

**newton (N):** Unit of force. The force required to accelerate a 1kg object by 1 m/s<sup>2</sup>

**newton (N):** Unidad de fuerza. La fuerza requerida para acelerar un objeto de 1 kg en 1 m/s<sup>2</sup>

**Newton's law of gravitation:** A rule stating that all matter in the universe

**oceanic crust:** Part of Earth's crust that is rich in basalt, relatively dense, and geologically young. Found under ocean basins.  
**corteza oceánica:** Parte de la corteza terrestre que es rica en basalto, relativamente densa y geológicamente joven. Se encuentra bajo las cuencas oceánicas.

**oil:** A liquid fossil fuel formed by intense

heat and pressure on the remains of ancient, dead marine organisms.

**aceite:** Un combustible fósil líquido formado por el intenso calor y la presión sobre los restos de antiguos organismos marinos muertos.

**orbit:** The path an object takes in space, going around another object.  
**órbita:** La ruta que toma un objeto en dando a otro objeto.

**negative feedback:** A mechanism where a change the output of a system acts to oppose changes to the input of a system (prevents deviation from the norm).

**comentarios negativos:** Un mecanismo en el que un cambio en la salida de un sistema actúa para oponerse a los cambios en la entrada de un sistema (evita la desviación de la norma).

the liquid part of the Earth that surrounds the inner core and the magnetic

**o:** La parte líquida del planeta que rodea el núcleo interno y el campo magnético.

**longitudinal seismic wave:** A wave that travels through the Earth's interior. Also called a P wave. It is able to travel through both solid and liquid media.

**onda sísmica longitudinal:** Una onda que viaja a través de los medios sólidos y líquidos. También llamada onda P. Es capaz de viajar a través de medios sólidos y líquidos.

**orbital body:** A celestial body that orbits the Earth or another celestial body.

**plate tectonics:** The theory that the Earth's crust is divided into plates that move and interact with each other.

**plate tectonics:** La teoría que describe cómo se mueven y interactúan las placas de la corteza terrestre.

**interstellar:**

**observation:** The activity of watching or recording what is happening in a given, often experimental, setting.  
**observación:** La actividad de observar o registrar lo que está sucediendo en un entorno dado, a menudo experimental.

# Math & science practices support

Dedicated chapter

Need help icon

identifies support for math and skills components of an activity.

NEED HELP?



**Key Question:** How does water allow rocks in the solid lithosphere and asthenosphere to melt into liquid magma?

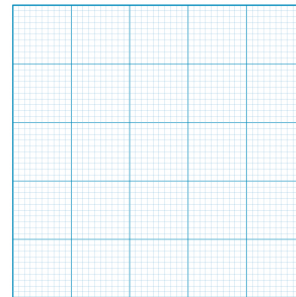
- ▶ The lithosphere and asthenosphere are solid; they are not liquid or molten. Yet volcanoes located above a hot spot or a subduction zone spew out molten lava (molten rock above ground), and magma (molten rock below ground) oozes out of fissures along mid-ocean ridges.
- ▶ This implies that special conditions must be encountered for magma to form. Three conditions that cause the local melting of rocks and the formation of magma chambers are:
  1. Heat: the most obvious, but not the most important cause.
  2. Decreased pressure: as hot material rises towards the crust, pressure on it decreases, allowing particles more room to move about. Decreased pressure causes magma to form at mid ocean ridges.
  3. Addition of water: **water** disrupts the bonds in rocks and lowers their melting point. This can be modeled using ice and salt (NaCl). In this model, ice acts as the rock in the mantle and salt as the water held inside the rock. The addition of water is responsible for magma forming at subduction zones.

Sodium chloride and water solution



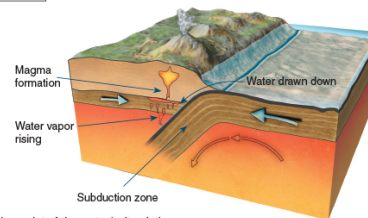
- ▶ Several solutions were made using fresh water and sodium chloride salt to produce concentrations of 0 g/L, 50 g/L, 100 g/L, 150 g/L, 200 g/L, and 250 g/L.
- ▶ These were poured into identical beakers and placed into a freezer at  $-50^{\circ}\text{C}$ . The temperature of each solution was measured to record its freezing (and thus melting) point.
- ▶ The results are shown below:

Solution concentration (g/L)	Freezing/melting point ( $^{\circ}\text{C}$ )
0	0
50	-3
100	-6.5
150	-10.9
200	-16.5
250	-24.5



Water and plate tectonics

- ▶ As a tectonic plate descends in a subduction zone, it drags down water-laden sediment and rocks. The rocks are heated and squeezed, and at a depth of about 100 km the water is driven out and begins to rise through the rock as vapor.
- ▶ As it rises, the vapor encounters hotter rocks above, that are close to their melting point. The water vapor enters these rocks, lowering their melting point and producing magma.



1. Use the tabulated data above to graph the melting point of the water/salt solutions:
2. Describe the shape of the graph:
3. Explain why water lowers the melting point of rocks:

## 80 Water's Role in the Melting of Rocks

**Key Question:** How does water allow rocks in the solid lithosphere and asthenosphere to melt into liquid magma?

- The lithosphere and asthenosphere are solid; they are not liquid or molten. Yet volcanoes located above a hot spot or a subduction zone spew out molten lava (molten rock above ground), and magma (molten rock below ground) oozes out of fissures along mid-ocean ridges.
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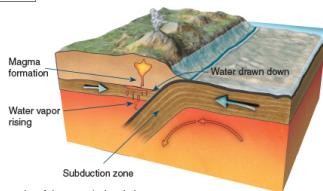
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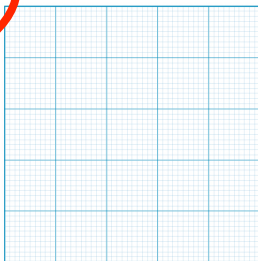
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- Use the tabulated data above to graph the melting point of the water/salt solutions:
- Describe the shape of the graph:
- Explain why water lowers the melting point of rocks:



## 4 Useful Concepts

**Key Question:** What useful concepts are there?

### Energy

- Energy is the ability of a system to do work or be transferred between systems and take different forms, but it cannot be created or destroyed. The amount of energy in a closed system before and after a transformation. Energy is measured in joules (J).
- Energy can be classified as potential (stored) or kinetic (movement) (right).
- Energy can be transformed. For example, the top of a hill has gravitational potential energy. As the ball rolls down the hill, the ball loses gravitational potential energy and gains kinetic energy. Some of this energy is also lost as heat and sound as it rolls.

### Light

- Visible light is part of the spectrum of electromagnetic radiation. Visible light is defined as the electromagnetic spectrum with a wavelength between 400 and 700 nanometers. Light waves do not appear blue, while light at 700 nm appears red. The speed of light in a vacuum at around 299,792,458 m/s.
- The speed of light is sometimes called the speed limit. Nothing that we know of can travel faster than the speed of light. This speed limit is a paradox occurring, e.g. arriving somewhere before you leave.

1. What is energy?
2. What are the two main types of energy?
  - (a) \_\_\_\_\_
  - (b) \_\_\_\_\_
3. Energy cannot be created or destroyed.

4. What kind of energy is light? \_\_\_\_\_
5. (a) What is the wavelength of blue light? \_\_\_\_\_  
(b) What is the wavelength of red light? \_\_\_\_\_
6. Why is the universal speed limit of the speed of light? \_\_\_\_\_

## 6 Tables and Graphs

**Key Question:** How can we use tables and graphs to provide a way to organize and visualize data in a way that helps to identify trends?

- Tables and graphs** are ways to present data and they have different purposes. Tables provide an accurate record of numerical values and allow you to organise your data so that relationships and trends are apparent.
- Graphs provide a visual image of trends in the data in a minimum of space. It is useful to plot your data as soon as possible, even during your experiment, as this will help you to evaluate your results as you proceed and make adjustments, as necessary, e.g. to the sampling interval.
- The choice between graphing or tabulating in the final report depends on the type and complexity of the data, and the information that you want to convey. Sometimes, both are appropriate.

### Presenting data in tables

Table 1: Population, land area, and calculated population density in four US states.

State	Population	Land area (km <sup>2</sup> )	Population density (people km <sup>-2</sup> )
Alabama	4,871,547	135,754	35.9
Florida	20,636,975	170,307	121.2
Montana	1,032,949	380,847	2.7
Texas	27,469,114	695,662	39.5

- Tables provide a way to systematically record and condense a large amount of information. They provide an accurate record of numerical data and allow you to organise your data, making it easier to see patterns, trends, or anomalies.
- Table titles, and row and column headings must be clear and accurate so the reader knows exactly what the table is about.
- Columns can be added for calculated values such as density, rate, and summary statistics, e.g. mean and standard deviation. For large data sets, it is often the summary statistic, e.g. mean temperature each year, that is plotted.
- Summary statistics make it easier to identify trends and compare different treatments. Rates are useful in making multiple data sets comparable, e.g. if recordings were made over different time periods.

1. Describe the advantages of using a table to present information: \_\_\_\_\_

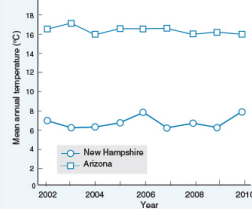
2. What is the benefit of including summary information, e.g. means or processed data, on a table? \_\_\_\_\_

3. What are the main advantages of presenting data in a graph? \_\_\_\_\_

4. Why might you include both graphs and tables in a final report? \_\_\_\_\_

### Presenting data in graphs

Fig. 1: Mean annual temperature in New Hampshire and Arizona



- Graphs are a good way of visually showing trends, patterns, and relationships without taking up too much space. Complex data sets tend to be presented as a graph rather than a table.
- Presenting graphs properly requires attention to a few basic details, including correct orientation and labeling of the axes, accurate plotting of points, and a descriptive, accurate title.





# Extension

- **Extension material:**
  - Identified in Teacher's Edition with red flag
  - Tagged in Resource Hub
  - Challenge questions

ADVANCED  
LEARNING

## EARTH AND SPACE SCIENCES FOR NGSS

[Chapter 1 Introduction](#)

[Chapter 2 The Universe and its Stars](#)

[The Universe and its Stars - Challenge Question](#)

[12 Studying the Universe](#)

[13 Studying Stars](#)

[14 The Known Universe](#)

[BIOZONE Resource Hub](#) / [Chapter 2 The Universe and its Stars](#) / [The Sun](#)

## The Sun

[The Sun infographic](#)

[The Sun Lab](#)

[The Sun Lab](#) Teacher Resource

[Science Learning Hub: What fuels the Sun?](#)

[Sun structure](#)

### ★ Challenge question:

Every point of light is a galaxy. The image covers 0.05 of a degree of sky. How many galaxies are there in the sky?



# Environmental Science

# ENVIRONMENTAL SCIENCE



## At a glance

- **Print, digital, and blended** delivery options
- Comprehensive resource
- **New and updated** content, case studies and data analysis tasks
- New **assessments**
- Expanded **teacher support** resources
- **Translation tool**  
digital platform: 150 languages

# ENVIRONMENTAL SCIENCE

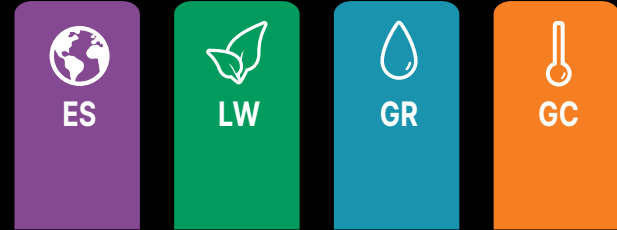


## Chapters

1. The Earth's Systems
2. Ecosystems
3. Populations
4. Investigating Ecosystems
5. Land and Water
6. Energy
7. Pollution
8. Conservation
9. Climate Change
10. Science Practices

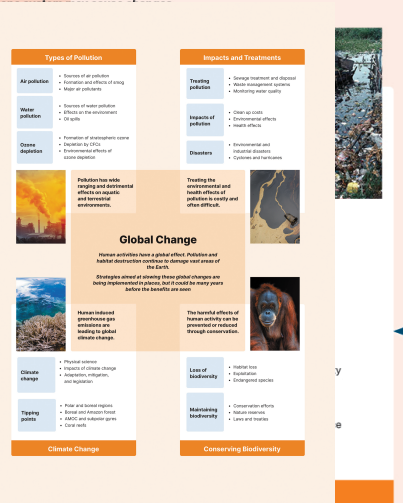
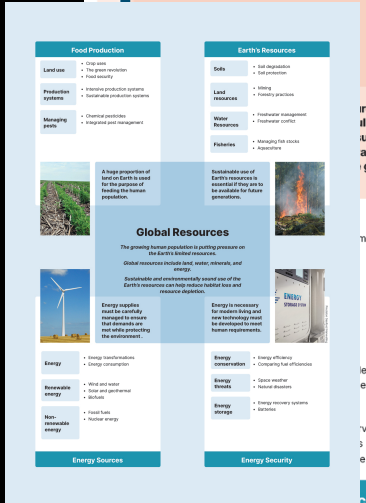
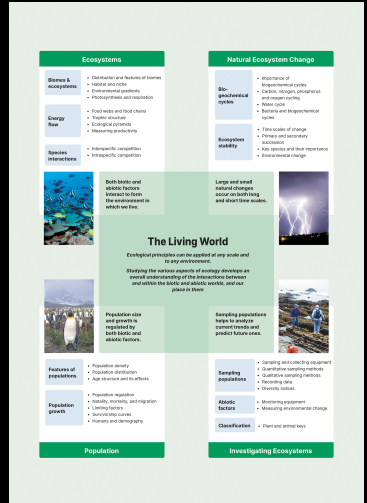
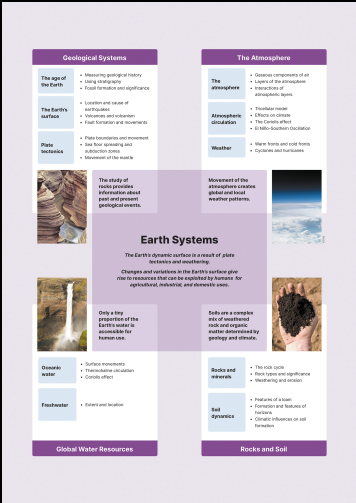
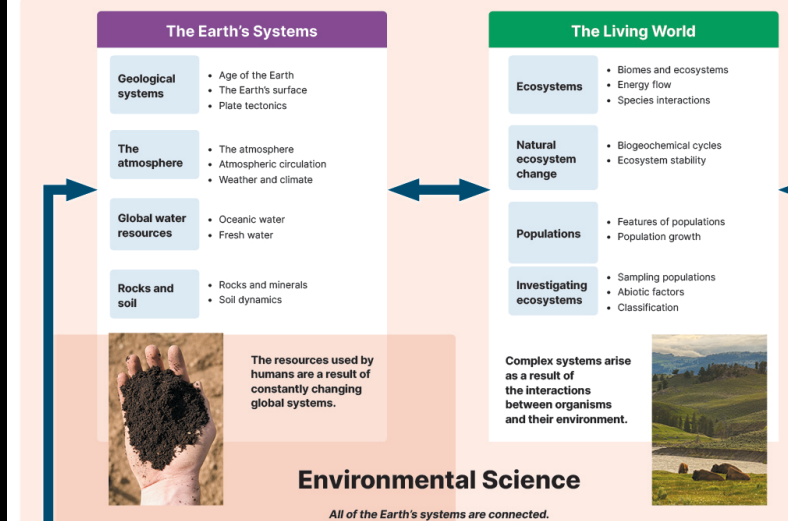
# Navigation & delivery

- Four sections, identified by colored tabs:
  - The Earth's Systems
  - The Living World
  - Global Resources
  - Global Change
  
- Flexible delivery order



# Concept maps

- Content maps for navigation & orientation
- Course overview map
- Four section maps



# ON TOP OF THE WORLD

The Himalayas are a broad band of mountains forming a boundary between the Indian subcontinent to the South and the Tibetan plateau to the North. In geological terms, they are young mountains, having begun forming around 50 million years ago. The collision between two tectonic plates on which they sit continues to shape them today as one plate pushes against the other. Earthquakes are also relatively frequent in this seismically active area of Earth. There are more than 100 peaks exceeding 7,200 m in elevation, including Mount Everest (8,848.86 m). Mount Everest's height places its peak in the upper troposphere where it is exposed to the jet stream, with winds reaching 160 km/h.



## Highest weather station in the world

In May 2022, a weather station was installed on Mt Everest at 8,810 m. It is the highest weather station in the world. At such heights, temperatures can drop to  $-40^{\circ}\text{C}$ . Because the peak sits in the jet stream, wind speeds are commonly over 100 km/h, and wind gusts of over 250 km/h have been recorded there. The plume on this photo is snow and ice blasted off the summit by high winds.



## Metamorphism

The Himalayas illustrate various parts of the cycling of Earth's rocks. Pressure created during uplift of the mountains has metamorphosed limestones into marble, and sandstone, and mudstones into schist. The mountains undergo constant erosion via glaciers and weathering but, overall, are rising faster than they are being eroded.

Limestone

Marble

Schist

## The composition of a giant

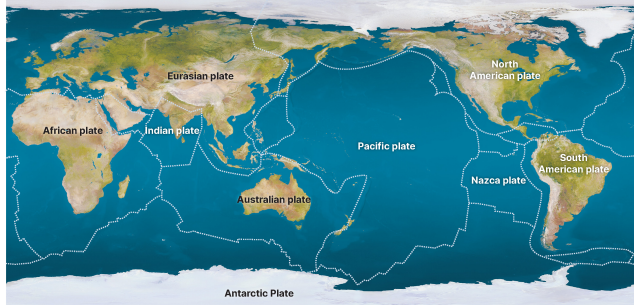
Mt Everest itself is composed of limestone, marble and schist. Limestone rocks from near the top of the mountain were once marine sediments laid down around 500 million years ago. The rocks contain marine fossils, including trilobites, brachiopods, ostracods, and crinoids. Beneath the upper band of limestone, the pressure exerted by mountain building transformed limestone into marble, found in the 'yellow band', shown left.

## Q Take a Deeper Look

- ▶ What geological processes build mountains?
- ▶ What reasons might there be for the Himalayas being, on average, so much higher than other mountains ranges around the world?
- ▶ What evidence is there for the age of the rocks that make up Mount Everest and the Himalayas?

**Key Idea:** Convection currents in the mantle cause the movement of the tectonic plates. Evidence from earthquakes, volcanoes, and land formations has helped formulate the theory of plate tectonics, which describes the large scale movement of the Earth's crustal

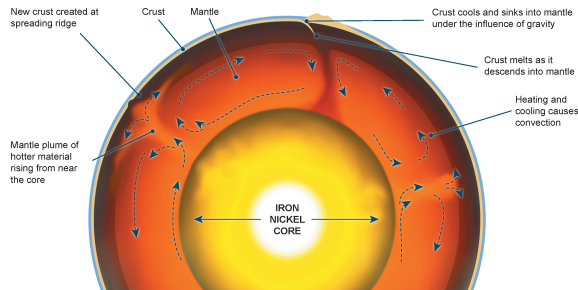
plates. The key principle of the theory is that the rigid plates are able to ride on the fluid-like underlying **asthenosphere**. The energy for this movement comes from dissipation of heat from the mantle. It is the movement of the plates that produces phenomena such as earthquakes and volcanism.



- The evidence for past plate movements has come from several sources: mapping of plate boundaries, the discovery of sea floor spreading, measurement of the direction and rate of plate movement, and geological evidence such as the distribution of ancient mountain chains, unusual deposits, and fossils. The size of the plates is constantly changing, with some expanding and some getting smaller. The extent of the tectonic plates is shown in the diagram above. The Pacific plate is by far the largest, measuring 103 million km<sup>2</sup>.

#### The mechanism of plate movement

- The relatively cool lithosphere covers the hotter, plastic, and more fluid asthenosphere. Heat from the mantle drives two kinds of asthenospheric movement: convection and mantle plumes. Plate motion is partly driven by the weight of cold, dense plates sinking into the mantle at trenches. This heavier, cooler material, sinking under the influence of gravity, displaces heated material, which rises as mantle plumes.
- The movements of the tectonic plates puts the brittle rock of the crust under strain, creating faults where rocks fracture and slip past each other. Earthquakes are caused by energy release during rapid slippage along faults. Consequently, the Earth's major earthquake (and volcanic) zones occur along plate boundaries.

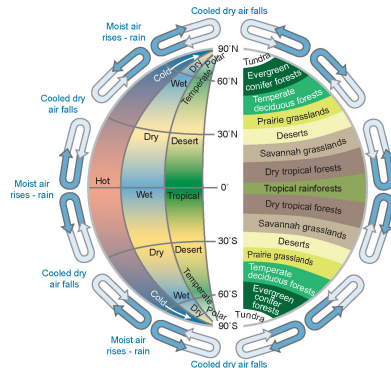


**Key Idea:** The circulation of the Earth's atmosphere produces large and specific climatic areas on either side of the equator. **Biomes** represent large areas with the same or similar climate and vegetation characteristics. These biomes exist in part because of the arrangement of weather conditions around the planet. The Earth is circled in the northern and southern

hemispheres by three air cells. The interaction of these cells plays a major role in the formation of biomes. The cells form areas of rising or descending air, affecting the amount of rainfall. Surface features, such as oceans and mountain ranges, affect the final positions and size of these biomes but four general areas in each hemisphere can be identified.

#### Earth's climate and biomes

- Biomes are closely related to the major air cells that circle the Earth and are reflected in the northern and southern hemispheres.
- The Earth's biomes are the largest, geographically-based, biotic communities that can be conveniently recognized.
- Biomes are large areas where the vegetation type shares a particular suite of physical requirements.
- Terrestrial biomes are recognized for all the major climatic regions of the world. They are classified by their predominant vegetation type. Biomes are closely related to the major air cells that circle the Earth and are reflected in the northern and southern hemispheres.



#### Biomes and landscapes

Climate is heavily modified by the landscape. Where there are large mountain ranges, wind is deflected upwards causing rain on the windward side and a rain shadow on the leeward side. The biome that results from this is considerably different from the one that may have appeared with no wind deflection. Large expanses of ocean and flat land also change the climate by modifying air temperatures and the amount of rainfall.



- Explain why the pattern of biomes is reflected in the northern and southern hemispheres:

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- What kind of features might prevent these patterns from matching exactly?

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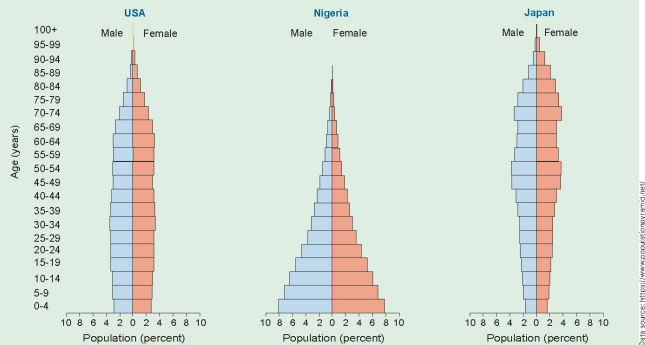
## 68 Population Age Structure

**Key idea:** The age structure of a population refers to the relative proportion of individuals in each age group in the population. Population age structure shows how many individuals are in each age group in a **population**. Populations can be classified according to specific age categories, e.g. years, life stage, e.g. egg, larvae, pupae, or size class, e.g. height or diameter in plants. A higher proportion of reproductive and pre-reproductive individuals indicates greater growth

potential than in a population dominated by older individuals. Age structures are often shown as pyramids (below). The proportions of individuals in each category are plotted with the youngest individuals at the pyramid's base. The number of individuals moving from one age class to the next influences the age structure of the population from year to year. The loss of an age class can influence a population's viability and can even lead to population collapse (next page).

### Age structures in human populations 2023

Population pyramids are useful tools for visualizing the age structure of a population and the ratios of males to females. The graphs show at a glance if a population is growing, declining, or stationary, and the information can be used to predict trends and plan for services in the future, e.g. more aged-care facilities in countries with an ageing population. The population pyramids below show three different population structures.



Data source: <https://www.cso.gov.au/india/>

#### Stationary (USA):

Stable populations are characterized by an even, pillar shape pyramid, reflecting the population is neither growing or declining. There are relatively equal numbers of individuals at each age category and ratios of males and females remains fairly constant too. This pyramid structure is typical of developed countries where birth rates are low and the overall quality of life is high.

#### Expansive (Nigeria):

Rapidly growing populations are characterized by a classic triangle shape. The birth rate is high so the base of the pyramid is broad, reflecting the high number of young individuals within the population. Life expectancy is often lower, so fewer individuals live to old age. This pyramid structure is common in developing countries where access to health care and support services may be limited.

#### Constrictive (Japan):

Declining populations have a small base of young and are top heavy, reflecting a higher proportion of older individuals. This shape occurs because the birth rate is low and a high proportion of the people live to be very elderly. This pyramid is common in developed countries with high levels of education and where excellent health care and other services are available to a large proportion of the population.

1. How does population distribution differ between a stationary age pyramid and constrictive age pyramid?

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2. Carry out some research to find out what age structure pyramid the country you live in shows. Write the answer here:

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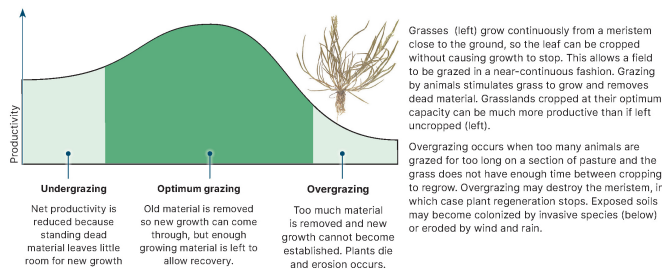
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## 105 Managing Rangelands

**Key Idea:** Careful management of grazing animals on rangelands is necessary to preserve the natural environment and reduce environmental damage. **Rangelands** are large, relatively undeveloped areas populated by grasses, grass-like plants, and scrub. They are usually semi-arid to arid areas and include grasslands, tundra, scrublands, coastal scrub, alpine areas, and savanna. Globally, rangelands cover around 50% of the Earth's land

surface. The US has about 3.1 million km<sup>2</sup> of rangeland, of which 1.6 million km<sup>2</sup> is privately owned. Rangelands cover 80% of Australia, mostly as the outback, but only 3% of Australia's population live in rangeland areas. Rangelands are often used to graze livestock such as sheep and cattle but, because they occur in low-rainfall areas, they do not regenerate rapidly. Careful management is required to prevent damage and soil loss as a result of overgrazing.



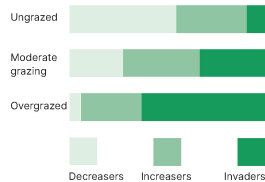
Grasses (left) grow continuously from a meristem close to the ground, so the leaf can be cropped without causing growth to stop. This allows a field to be grazed in a near-continuous fashion. Grazing by animals stimulates grass to grow and removes dead material. Grasslands cropped at their optimum capacity can be much more productive than if left uncropped (left).

Overgrazing occurs when too many animals are grazed for too long on a section of pasture and the grass does not have enough time between cropping to regrow. Overgrazing may destroy the meristem, in which case plant regeneration stops. Exposed soils may become colonized by invasive species (below) or eroded by wind and rain.

#### Effect of grazing on plant species composition

Intensive grazing causes changes in the species composition. Species that perform better under grazing will increase their range, while others will reduce their range. Grazing also opens gaps in plant distribution which allows invasive species to establish or increase in range.

Total net primary production and efficiency of grazed and ungrazed grasslands		
	Net production (kcal/m <sup>2</sup> )	Efficiency %
Grazed	Desert	0.13
	Shortgrass plains	0.80
	Mixed grasslands	0.51
Ungrazed	Prairie	0.77
	Desert	0.16
	Shortgrass plains	0.57
	Mixed grasslands	0.47
	Prairie	0.44



1. Explain how carefully managed grazing on a rangeland can increase its productivity: \_\_\_\_\_

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2. Describe the effect of grazing on the diversity of rangeland plants: \_\_\_\_\_

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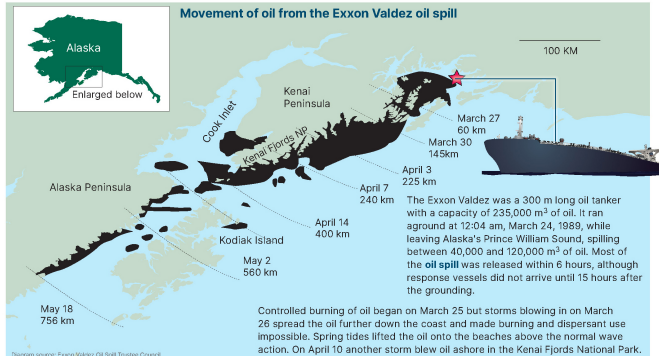


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## 158 Effect of Oil Spills

**Key Idea:** Accidental oil spills have occurred during the history of oil extraction, causing widespread and long-lasting damage to the aquatic ecosystems and organisms nearby. Oil is arguably one of the most important chemicals in human economics. It provides power for transport and electricity, and the raw materials for many consumer products, including plastics. Billions of dollars a year are spent on removing it from the ground and billions more made in revenue from its sale.



There were several causes of the disaster. The crew of the Exxon Valdez had not had their mandatory rest period and were fatigued. They had also failed to maneuver the ship correctly (probably due to fatigue), and the radar system that could have informed the crew of a collision had not been repaired and was not operating.

The clean-up operation was made more difficult by the remote location of the oil spill. Food, equipment, and shelter had to be brought in for up to 11,000 workers, along with fuel and dispersant equipment and vehicles. The clean-up stopped in September due to the approach of the Alaskan winter, but was restarted in April 1990.

357 sea otters were treated after the spill, at an estimated cost of US\$51,000 per otter. Fisheries in the area were closed, including black cod and Pacific herring. It is estimated that around 87% of the herring's spawning grounds were oiled. Mollusks were found to contain higher than normal levels of aromatic chemicals after the spill.

Approximately a quarter of a million seabirds, 2800 sea otters, 300 harbor seals, 250 bald eagles, 22 killer whales, and countless fish were killed in the first weeks of the spill. Oil was still found 20 years later, not far beneath the surface of many of the affected beaches, despite one of the biggest clean-up operations in US history.

- (a) Explain how the Exxon Valdez spill could have been avoided: \_\_\_\_\_  
\_\_\_\_\_
- (b) Describe some of the effects of the spill: \_\_\_\_\_  
\_\_\_\_\_
- (c) Explain why the clean up of this spill was particularly difficult: \_\_\_\_\_  
\_\_\_\_\_

However, crude oil is a very toxic substance and removing it from reservoirs is fraught with difficulty and danger. Some of the biggest, man-made **environmental disasters** have occurred because of the search for and transport of oil. Oil tankers carry huge volumes of crude oil over the seas and are some of the largest ships afloat. As a result, there is enormous potential for disaster if one is grounded. The grounding of the Exxon Valdez is one of the most infamous examples.

## 172 Habitat Fragmentation

**Key Idea:** Habitat fragmentation is detrimental to ecosystems as it reduces species diversity, disrupts gene flow, and increases the likelihood of species extinction.

**Habitat fragmentation** is a major concern for global biodiversity. **Human activities** such as urbanization and road construction are encroaching upon natural areas, resulting in a loss of **species** diversity. This loss not only affects the stability and resilience of **ecosystems** but also hinders their ability to adapt to environmental changes.

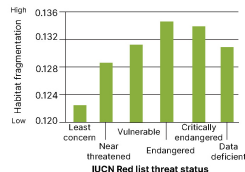
Habitat fragmentation, whether caused by natural processes or human activities, leads to the separation of species **populations**. This division prevents them from interacting with each other, which can ultimately result in their local **extinction**. This occurs because a population becomes isolated and too small to effectively breed or experience inbreeding, and the flow of genes between fragmented areas stops. If this pattern persists across fragmented habitats, it can ultimately lead to the complete extinction of the species.

### Habitat fragmentation and biodiversity

- Habitat fragmentation is the process by which large habitats become divided up into smaller ones, usually with areas of completely changed (and often uncrossable) land between them. This can happen naturally (e.g. lava flows dividing areas of forest) but more often it occurs as a result of human activities.
- Habitat fragmentation can be a driver of evolution, creating greater biodiversity by separating species' populations. However, this is usually a response of smaller organisms, such as insects and small lizards in island ecosystems.
- Usually habitat fragmentation causes a loss of biodiversity, especially in larger animals that are territorial or require large areas of land to find food. Habitat fragmentation reduces population sizes and can reduce gene flow because individuals are unable to move easily between habitat fragments. This can lead to inbreeding because access to mates is limited.
- Invasive** plant species are more able to invade fragments due to more open edges, which often provide disturbed land where they can easily become established.
- The degree of fragmentation of a species' habitat is a significant predictor of the likelihood of a species going extinct. The **IUCN** (International Union for Conservation of Nature) lists species from least concern to critically endangered (see activity 176). When the species in these categories are matched against the degree of their habitat's fragmentation a clear pattern emerges (right).



### Fragmentation vs IUCN status



- The mountain gorilla lives in just two separated groups in the hills of Rwanda, Uganda, and DRC. Fragmentation of surrounding land due to farming, deforestation for firewood, and demand for living space are creating challenges for the remaining apes. Explain how fragmentation increases the risk of mountain gorilla extinction: \_\_\_\_\_  
\_\_\_\_\_



- The Texas ocelot, *Leopardus pardalis*, is an endangered wild cat that was once found across Texas and is important to the ecosystem. Two small populations are isolated from each other due to surrounding farm and human occupied land. Giving reasons, suggest what effect human activity might have on the biodiversity of the Texas ocelot ecosystems? \_\_\_\_\_  
\_\_\_\_\_

# 186 What's the Concern for Climate Change?

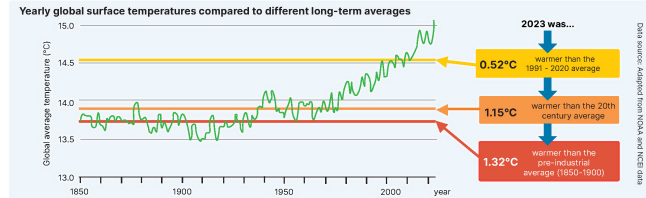
**Key Idea:** Climate change is happening now, and our responses will determine future impacts.

Over the past two centuries, human activities and industrialization have led to a rise in **greenhouse gas** levels in the atmosphere, affecting the climate. In more recent times, the term 'Anthropocene' has been used to describe the current geological epoch. This term, although not officially recognized as a geologic designation, highlights the influence of human-induced changes on the climate, known as **anthropogenic** forcing. Notably, **global warming** has been a prominent consequence of these activities, with the Earth's average surface temperature increasing by at least 1.19°C in 2024 compared to the mid-19th century.

To determine the precise average global temperature, data is collected from (100,000 plus) weather stations worldwide, along with weather balloons, ships, buoys, radars, and satellites that record daily temperature variations. This data is used to calculate an **average global temperature**. The average temperature is then compared with pre-industrial temperature data, obtained before substantial industrial source greenhouse gas **emissions**. The recent rise in the global average means specific regions are encountering notably higher and more harmful temperature extremes. Unprecedented heatwaves in **polar** areas and regions already struggling from human habitation are driving certain Earth systems towards irreversible tipping points.

## The world is warming - What's the big deal about 1.5°C anyway?

Many students may have heard about a **1.5°C** global warming 'line in the sand' not to be overtaken in order to prevent the worst impacts of climate change. Yet, despite the seemingly small '1.5°C' target, exceeding this threshold can activate **tipping points** in the climate system, causing irreversible changes due to **positive feedback cycles** that intensify the initial warming effects. The significance of global temperature rise lies in its potential to disrupt ecosystems, weather patterns, and cause **sea level rise**, highlighting the urgent need to address anthropogenic climate forcing to mitigate these impacts.



- The image below shows a visual representative of the last 200 years of global temperature change, using the average from 1961-2010 as a measuring stick. Blue is colder, the darkest over 0.7°C colder, and the red is warmer, again the darker colors showing an extreme of over 0.7°C warmer. In a small group, discuss the implications of the data presented as a means to raise awareness of climate change. Record your thoughts below:

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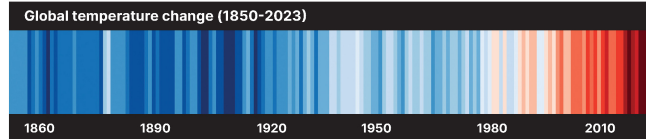
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- Two sets of data that change in proportion to each other, either negatively or positively, show correlation. However, this does not necessarily imply causation, where changes in one factor causes changes in another. Suggest how scientists might show causation between global temperature rise and anthropogenic-only climate forcing:

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# 193 Ocean Acidification

**Key Idea:** Ocean acidification is occurring because higher CO<sub>2</sub> concentrations are lowering the pH of the water. More CO<sub>2</sub> in the atmosphere is resulting in increased quantities of it dissolving in the ocean surface waters. This lowers the pH of the water through the formation of carbonic acid and H<sup>+</sup> ions and is known as **ocean acidification**. The

ocean pH is the lowest that it has been in nearly 25 million years, becoming 30% more acidic in the past 200 years (although it is still above pH 7). Changes in ocean pH reduce the calcification rate of many species, including coral reefs and shelled molluscs. This limits their ability to form and maintain skeletal structures such as shells.

▶ The pH of the oceans has fluctuated throughout geological history but has usually remained at around pH 8.1 - 8.2. Recent studies have measured current ocean pH at around 8.1. A drop in 0.1 pH represents a 25% increase in acidity of the water.

▶ The oceans act as a **carbon sink**, absorbing much of the CO<sub>2</sub> produced from burning fossil fuels on Earth. When CO<sub>2</sub> reacts with water, it forms carbonic acid (H<sub>2</sub>CO<sub>3</sub>), which decreases the pH of the oceans.

▶ H<sub>2</sub>CO<sub>3</sub> dissociates into HCO<sub>3</sub><sup>-</sup> and H<sup>+</sup> ions. CO<sub>3</sub><sup>2-</sup> ions from the ocean waters react with the extra H<sup>+</sup> ions to form more HCO<sub>3</sub><sup>-</sup> ions. This process lowers the CO<sub>3</sub><sup>2-</sup> ions available to shell-making organisms, leading to thinner and deformed shells.

### The link between ocean temperature and CO<sub>2</sub> absorption

- Since pre-industrial times, the oceans have absorbed up to 30% of total **anthropogenic CO<sub>2</sub> emissions**, reducing the impacts of **climate change** but resulting in their increased acidification.
- Warmer oceans hold less CO<sub>2</sub> and become net CO<sub>2</sub> emitters rather than net carbon sinks that the cold oceans are - the warmer surface water can 'hold' less dissolved CO<sub>2</sub>, so the excess gas is released into the air above.
- Additionally, the increasing temperature reduces the mixing of ocean waters, so acidified water remains trapped under a warmer band of water, reducing nutrient and oxygen mixing.

- Data indicates the oceans were less alkaline (more acidic) than they are today, such as 25 mya. Why is the current acidification so concerning?

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## 116 Did You Get It?

1. Describe some issues that can arise by applying chemical pesticides to crop plants and soils:

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2. What actions taken by individuals would have the greatest impact on reducing in-home water consumption?

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3. Describe some ways in which a city could develop in sustainability:

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4. Examine the graph on the right:

- (a) What oil crop uses the most land area to produce one metric ton?

---

- (b) What oil crop uses the least land area to produce one metric ton and suggest what might be the reason for this?

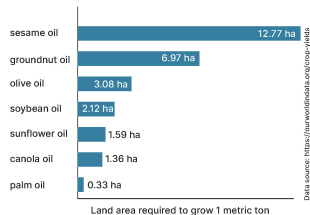
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5. Suggest what has taken place to affect the landscape shown in the photo (right). What are some of the environmental consequences of this land use?

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Assessment tasks conclude each chapter

## Summative Assessment

### Ch 1: The Earth's Systems

Student name: \_\_\_\_\_

Class: \_\_\_\_\_

20

1. Earthquakes normally occur along plate boundaries. Measuring the depth of these earthquakes can give an idea of the shape of the boundary and how the plate are interacting. The data below, left shows earthquake depths for the Tonga Trench in the Pacific Ocean and along the coast of Chile.

- (a) Plot a scatter graph of the data on the grid provided:

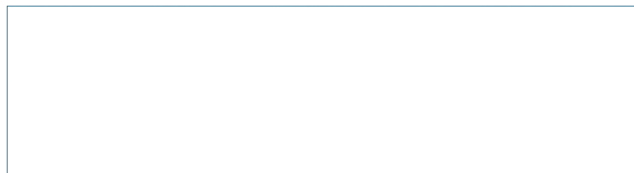
Tonga trench	
Longitude (°W)	Depth (km)
176.2	270
175.8	115
175.7	260
175.4	250
176.0	160
173.9	60
174.9	50
179.2	650
173.8	50
177.0	350
178.8	580
177.4	420
178.0	520
177.7	560
177.7	465
179.2	670
175.1	40
176.0	220



- (b) Add a line of best fit through the data points:

- (c) What type of plate boundary appears to be present at the locations plotted?

- (d) Draw a diagram in the space below to show the how the layers of the Earth are moving at the Tonga Trench:



2. The diagram below shows the layers of the Earth. Add labels to the layers including their name and whether they are solid or liquid to complete the diagram.

Additional assessment tasks can be downloaded by teacher as “unseen” tests

## 126 Wind Power

**Key Idea:** Wind power provides a relatively simple and scalable way to produce electricity.

Wind power has been used for centuries to provide the mechanical energy to pump water or run milling machinery. Today, it is mainly used to produce electricity. Wind power is becoming increasingly reliable and cost effective as the technology develops and turbines are able to operate in a range of conditions and wind speeds. In fact **wind energy** is

### Wind turbine

Heat exchanger cools the generator and gear box.

Gearbox maintains constant speed of rotation in the drive-shaft.

Generator produces electricity.

Adjustable blades optimize the energy gained from the wind.

Gears controlling turbine yaw (to face into wind).



one of the cheapest types of energy to build, maintain, and use. Globally, wind power is steadily increasing in generation capacity, but wind is a variable energy provider. There can be problems matching output to demand, such as during seasonal demands and low (or extremely high) winds. This means systems for managing and distributing electricity will be required as well as backup or base load electricity supplies, e.g. hydro or geothermal power.



**Wind farms** often cover large areas of land but turbines can be designed to operate at sea and, on a smaller scale, along highway edges. The scalability of **wind turbines** makes them simple to install in many locations, with turbine sizes ranging from a few metres to over 200 metres in diameter.



At the end of 2022, the power output from wind turbines was around 7% of global electricity production. Global installed capacity was more than 800 GW. Electricity generation from wind is rising every year.

1. A typical wind turbine produces around 2.3 MW. The average house uses 30 kWh of energy per day (a kilowatt hour is the equivalent of 1000 joules of energy per second (1kW) running for 1 hour). Calculate the following:

(a) The minimum number of wind turbines required to power a town of 20,000 households:

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(b) Wind turbines cost around \$1.3 million per MW of energy production to build. What will be the cost of (a) above?

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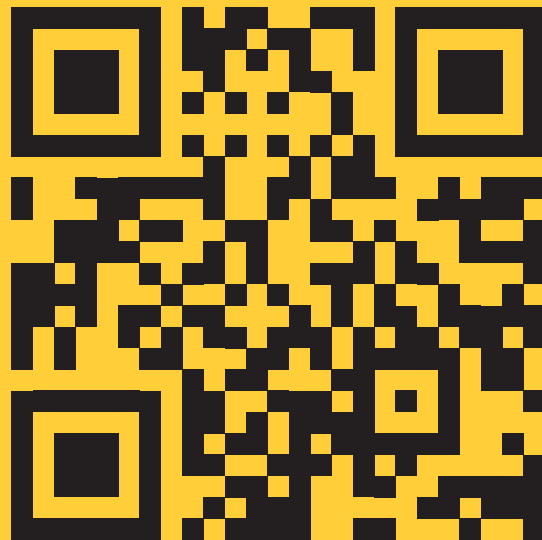
(c) The cost of building, running, and maintaining wind turbines over their 20 year lifetimes is about \$50 per MWh. What could the 20,000 households using the wind turbines above expect to pay in dollars per year for the use of electricity provided by the wind turbines?

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(d) Why can households actually expect to have to pay a lot more than this? \_\_\_\_\_



# QR codes

Two types of QR codes:

- Yellow link to 3D models
- Blue link to live data sets  
good for easily accessing up-to-date information that changes rapidly



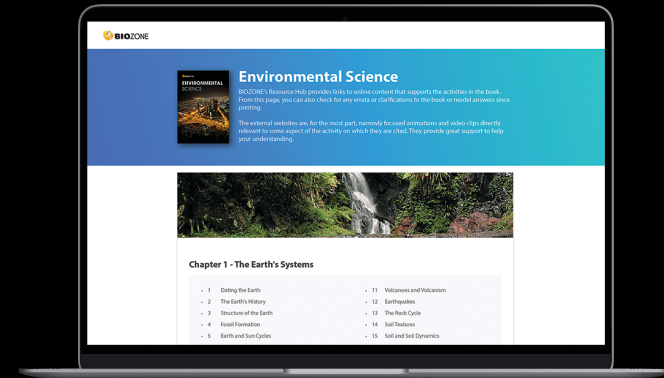
# Teacher resources



Teacher's Edition  
with answers  
Print & digital

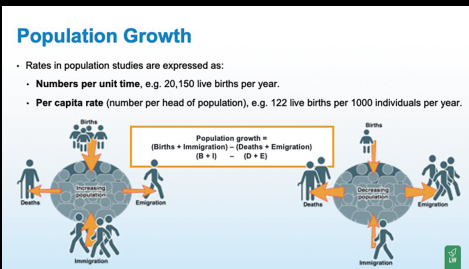
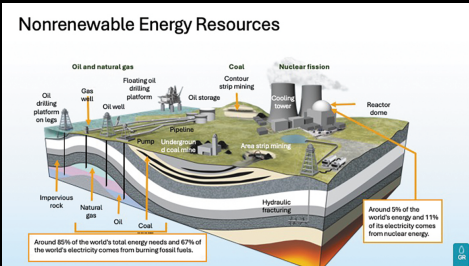


Classroom Guide  
features / delivery



Resource Hub  
engagement / extension  
Print & digital users

# Teacher resources



Presentation Slides  
Digital platform

### BIOZONE Environmental Science Teaching Planner

Chapter 1 The Earth's Systems Activity: 1. Dating the Earth Lesson time: 30 min Date: / /

Learning Outcomes	Lesson Suggestions								
<ul style="list-style-type: none"> <li>Calculate the half-life of some substances that can be dated to date the Earth and to date rocks.</li> <li>Explain the difference between radiometric and relative dating.</li> </ul>	<p>The activity discusses the methods of radiometric and relative dating to accurately determine the age of the Earth and rocks, with a focus on uranium decay and zircon crystals.</p> <p><b>Prior knowledge:</b> Awareness of the types of elements involved in radiometric dating, such as uranium-238 decaying into lead-206 and uranium-235 decaying into lead-207. Understanding the concept of geological relative dating, which states that deeper rock layers are older than shallower layers. Basic understanding of isotopes, particularly in the context of radiometric dating, where the ratios of different isotopes can be used to determine the age of a sample.</p>								
<table border="1"> <thead> <tr> <th>Classroom Learning Ideas</th> <th>Literacy</th> <th>Scaffolding</th> <th>Extension</th> </tr> </thead> <tbody> <tr> <td>Provide a hands-on activity where students can simulate the decay of potassium-40 into calcium and argon to understand the concept of half-life.</td> <td>Have students create timelines showing the process of radioactive decay and the concept of half-life visually.</td> <td>Offering guided practice problems with long to short solutions to demonstrate how to calculate half-life and determine the age of rocks using the given ratio of atoms. Encouraging students for similar questions on the activity. Providing additional resources, such as videos or articles, that explain radiometric dating in simple terms.</td> <td>Investigating the applications of radiometric dating beyond Earth, such as dating meteorites or moon rocks, to understand how these techniques are used in planetary science.</td> </tr> </tbody> </table>	Classroom Learning Ideas	Literacy	Scaffolding	Extension	Provide a hands-on activity where students can simulate the decay of potassium-40 into calcium and argon to understand the concept of half-life.	Have students create timelines showing the process of radioactive decay and the concept of half-life visually.	Offering guided practice problems with long to short solutions to demonstrate how to calculate half-life and determine the age of rocks using the given ratio of atoms. Encouraging students for similar questions on the activity. Providing additional resources, such as videos or articles, that explain radiometric dating in simple terms.	Investigating the applications of radiometric dating beyond Earth, such as dating meteorites or moon rocks, to understand how these techniques are used in planetary science.	<p><b>Key terms:</b> sedimentary, decay, half-life, isotopes, radiometric dating, superposition</p>
Classroom Learning Ideas	Literacy	Scaffolding	Extension						
Provide a hands-on activity where students can simulate the decay of potassium-40 into calcium and argon to understand the concept of half-life.	Have students create timelines showing the process of radioactive decay and the concept of half-life visually.	Offering guided practice problems with long to short solutions to demonstrate how to calculate half-life and determine the age of rocks using the given ratio of atoms. Encouraging students for similar questions on the activity. Providing additional resources, such as videos or articles, that explain radiometric dating in simple terms.	Investigating the applications of radiometric dating beyond Earth, such as dating meteorites or moon rocks, to understand how these techniques are used in planetary science.						
<p><b>Assessment</b></p> <ul style="list-style-type: none"> <li>Short answer questions</li> <li>Calculating half-lives</li> </ul>	<p><b>Instructional Materials and Resources</b></p> <p>Links to Science practices: <b>Activity 221 Working with numbers</b></p> <p>Link to more Classroom Learning Ideas: <b>TP 1. Dating the Earth</b></p>								

Teacher Planner  
Teacher notes  
Pacing Guide  
Differentiation

### Summative Assessment

Student name: \_\_\_\_\_ Class: \_\_\_\_\_

#### CE1 The Earth's Systems

1. Earthquakes usually occur along plate boundaries. Measuring the depth of these earthquakes can give an idea of the shape of the boundary and how the plates are moving. The table below will show earthquake depths for the Tonga Trench in the Pacific Ocean and along the coast of Chile.

(a) Plot a scatter graph of the data on the grid provided.

Depth (m)	Year
176.2	270
176.9	115
176.2	284
176.4	235
176.0	200
175.9	60
176.9	50
176.2	692
177.0	50
177.2	250
176.8	580
177.4	600
176.0	123
177.0	660
177.2	484
176.2	670
176.1	40
176.0	220

(b) Add a line of best fit.

(c) What type of plate tectonic boundary is this?

(d) Does a change in depth of the Tonga Trench indicate a change in the shape of the boundary?

2. The diagram below shows the layers of the Earth. Add labels to the layers to complete the diagram.

3. The diagram right shows the Pacific plate and the Nazca plate. You will notice that the Nazca plate is moving towards the Pacific plate along their boundaries.

(a) How would you expect to find volcanoes on this diagram?

(b) Explain why volcanoes form in the places you have indicated in (a).

(c) Explain why convergent plate boundaries are also destructive plate boundaries.

(d) Explain why divergent plate boundaries are also constructive plate boundaries.

5. Identify the two images of the volcano below on either side of the photograph.

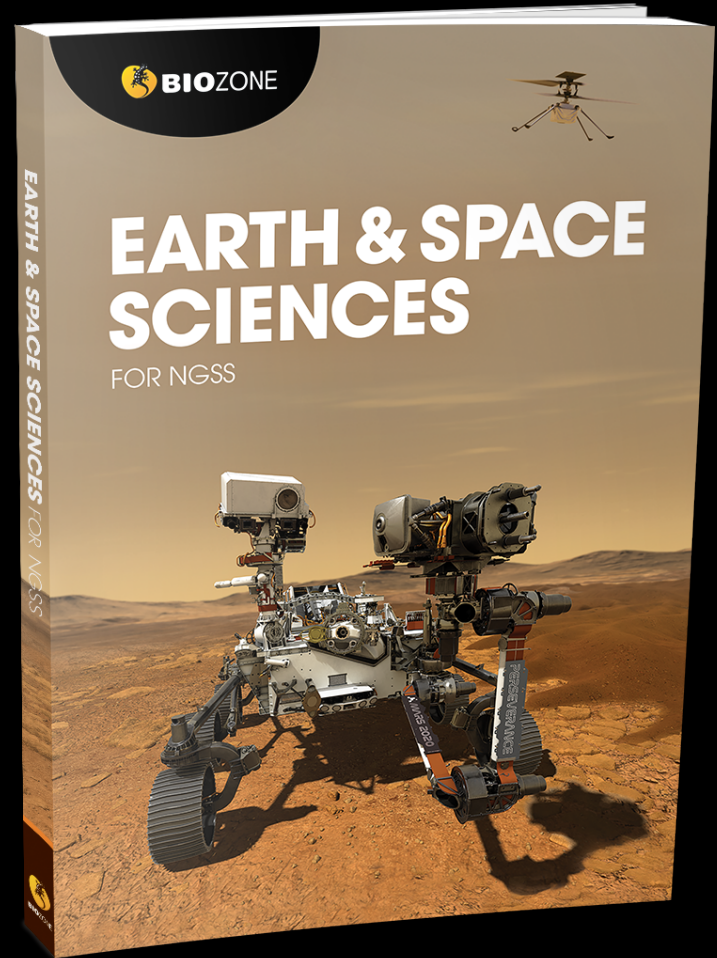
6. Complete the diagram below.

Additional assessments



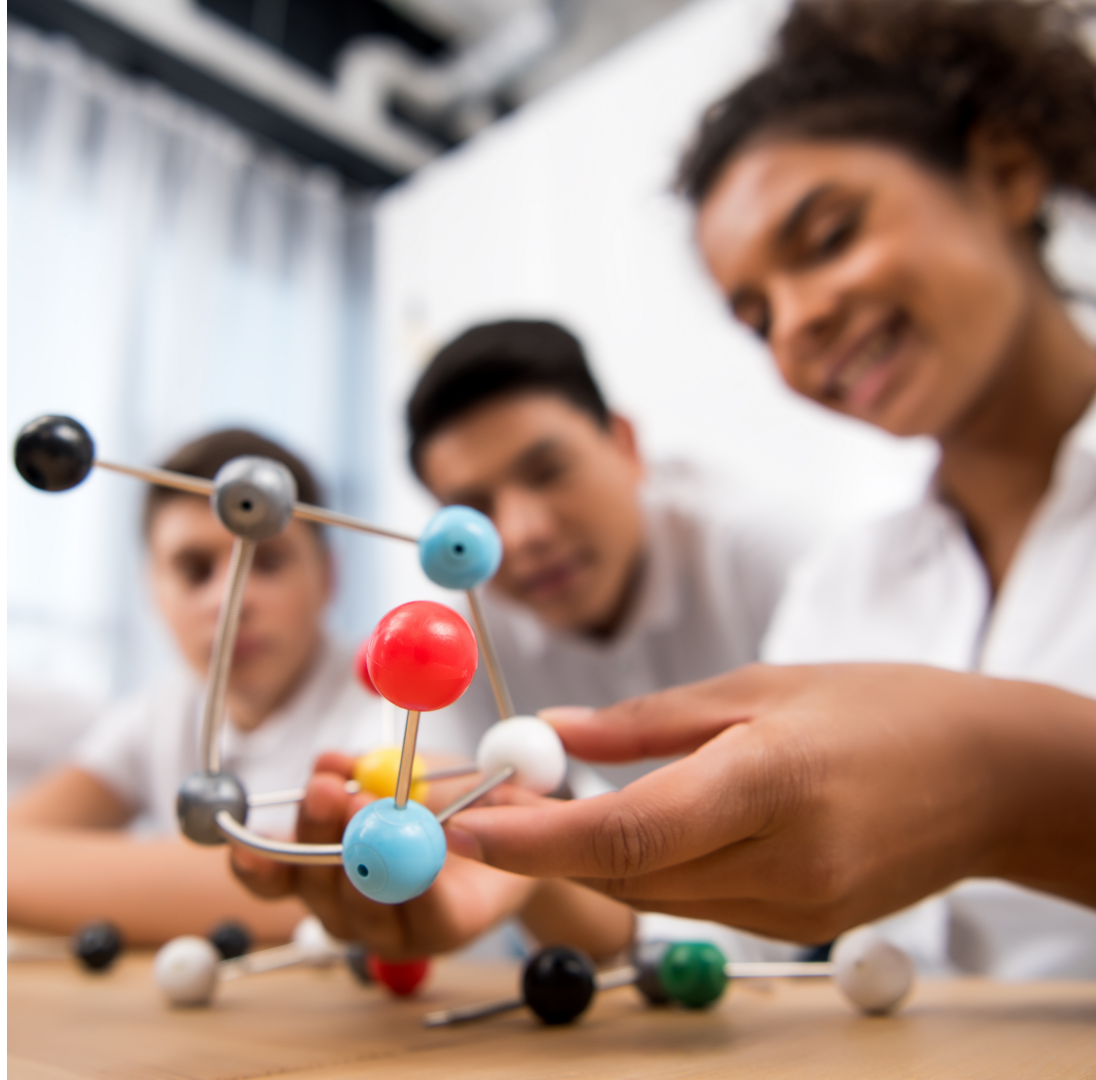


# Earth and Space Sciences



# Curriculum specific features

- **Three dimensions** form the cornerstone of the title.
- Scaffolded delivery of content using the **5Es Instructional Model**.
- Strongly based in **inquiry**.
  - Students engage with **phenomena** to ask and answer questions.
- **Assessments** inbuilt.
- **Common Core State Standards** inbuilt.
- **Teacher Toolkit**

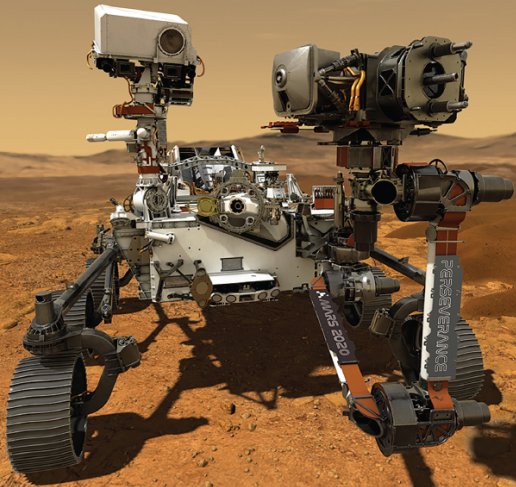


# STRUCTURE



# EARTH & SPACE SCIENCES

FOR NGSS



## EARTH & SPACE SCIENCES FOR NGSS

1. **Science Practices**
2. The Universe and Its Stars
3. Earth and the Solar System
4. The History of Planet Earth
5. Earth Materials and Systems
6. Plate Tectonics
7. The Roles of Water in Earth's Surface Processes
8. Weather, Climate and Biogeology
9. Natural Resources
10. Natural Hazards
11. Human Impacts on Earth Systems
12. Global Climate Change

# Chapter structure

## CHAPTER INTRODUCTION

- Identifies the activities relating to the guiding questions.

## ANCHORING PHENOMENON

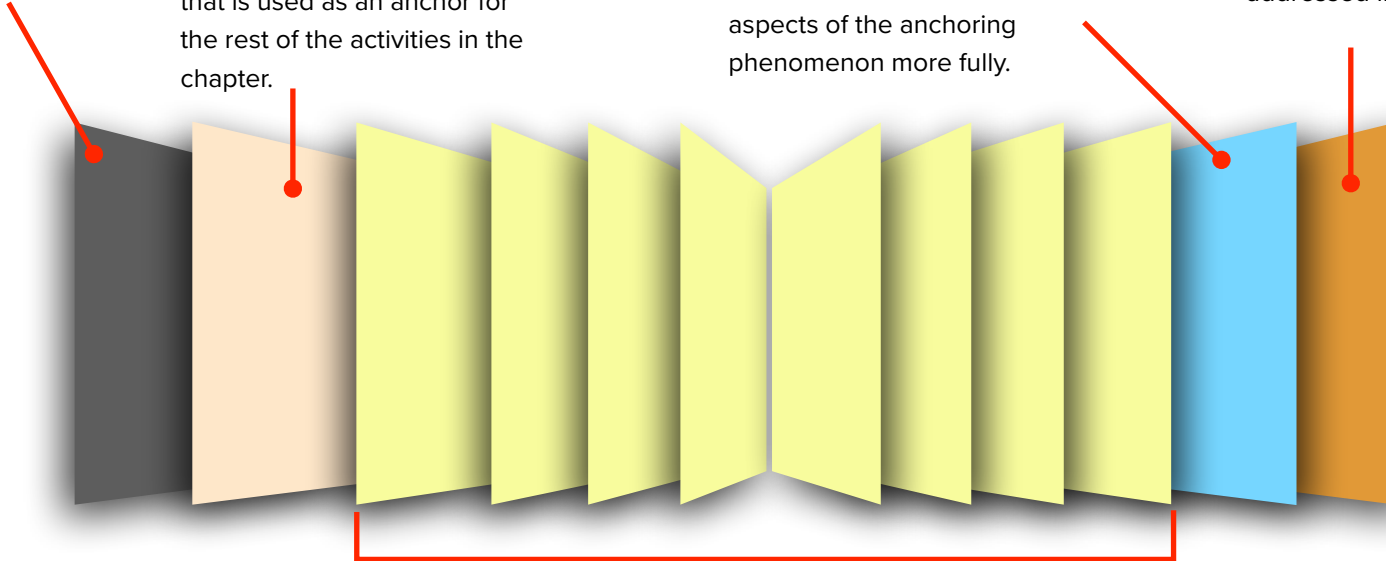
- The first activity is an anchoring phenomenon.
- It introduces a phenomenon that is used as an anchor for the rest of the activities in the chapter.

## ANCHORING PHENOMENON REVISITED

- Once they have completed the activities in the chapter, students should be able to explain various aspects of the anchoring phenomenon more fully.

## SUMMATIVE ASSESSMENT

- This can be used as a formal assessment of the performance expectations addressed in the chapter.



## ACTIVITY PAGES

- Scaffolded delivery of content using the 5Es instructional model
- Questions within activities are designed for students to demonstrate understanding

# Chapter Introductions

## Student Introduction

## Teacher Introduction

## Teacher Notes

176

### CHAPTER 7

## The Roles of Water in the Earth's Surface Processes



### Anchoring Phenomenon

Lets Go Spelunking: What processes helped to form the Mammoth Caves?

Activity number

76 85

### Why is water so important?

- 1 Link the properties of water, such as bonding, density, and state, to its structure. Draw a model of water molecules bonded to ions. **77**



- 2 Interpret information in a hydrologic cycle model to explain how water moves around the Earth. Correctly label and identify features in a model representing a hydrologic cycle. **78**

### What processes allow rock to continuously form and reform?

- 3 Using information from a rock cycle model, identify the three main classification groups of rocks. Explain how select rocks have been formed. Investigate properties, including density, of select rocks. Use a rock key to identify select rocks. **79**



- 4 Graph and analyze different concentrated ionic solutions and their respective melting points. Explain how water can lower the melting point of rocks, as part of the rock cycle. **80 86**

- 5 Distinguish between weathering and erosion. Describe how weathering is able to break down rocks, as part of the rock cycle. Explain how erosion is able to break down rocks, as part of the rock cycle. **81 86**

- 6 Investigate the process of frost wedging in a fair test. Critique the frost wedging model for how well it represents the actual process. **82**



- 7 Investigate the process of erosion using a model of water flow through river channels. Model the process of fossilization. Describe how erosion and deposition in flood plains contribute to productive agricultural areas. **83 86**

- 8 Link the moisture content of soil to erosion rate. **84 86**



176

### CHAPTER 7

## The Roles of Water in the Earth's Surface Processes



### Anchoring Phenomenon

Lets Go Spelunking: What processes helped to form the Mammoth Caves?

Activity number

76 85

### Why is water so important?

- 1 Link the properties of water, such as bonding, density, and state, to its structure. Draw a model of water molecules bonded to ions [SEP-2] [SEP-4] [ESS2.C] [CCC-6]. **77**



- 2 Interpret information in a hydrologic cycle model to explain how water moves around the Earth. Correctly label and identify features in a model representing a hydrologic cycle [SEP-2] [SEP-4] [ESS2.C] [CCC-6]. **78**

### What processes allow rock to continuously form and reform?

- 3 Using information from a rock cycle model, identify the three main classification groups of rocks. Explain how select rocks have been formed. Investigate properties, including density, of select rocks. Use a rock key to identify select rocks [SEP-2] [SEP-3] [ESS2.C] [CCC-6] [HS-ESS2-5]. **79**



- 4 Graph and analyze different concentrated ionic solutions and their respective melting points. Explain how water can lower the melting point of rocks, as part of the rock cycle [SEP-2] [SEP-4] [ESS2.C] [CCC-6]. **80 86**

- 5 Distinguish between weathering and erosion. Describe how weathering, including physical, chemical, and biological, is able to break down rocks, as part of the rock cycle. Explain how erosion, including water, wind, and glacial, is able to break down rocks, as part of the rock cycle [SEP-2] [ESS2.C] [CCC-6]. **81 86**

- 6 Investigate the process of frost wedging in a fair test. Critique the frost wedging model for how well it represents the actual process [SEP-1] [SEP-2] [SEP-3] [ESS2.C] [CCC-6] [HS-ESS2-5]. **82**



- 7 Investigate the process of erosion using a model of water flow through river channels. Model the process of fossilization. Describe how erosion and deposition in flood plains contribute to productive agricultural areas [SEP-1] [SEP-2] [SEP-3] [ESS2.C] [CCC-6] [HS-ESS2-5]. **83 86**

- 8 Link the moisture content of soil to erosion rate [SEP-4] [ESS2.C] [CCC-6]. **84 86**



Disciplinary Core Idea  
ESS2.C

Teachers  
Notes

## 7. The Roles of Water in the Earth's Surface Processes



### Anchoring phenomenon

The anchoring phenomenon, "Lets Go Spelunking" introduces a geological feature most students may have read about, or even personally experienced visiting: Mammoth caves. The spectacular Mammoth Cave system in Kentucky provides the context for asking students to consider the various processes leading to its formation, and the different ways that water has contributed to those processes.

### Why is water so important?

- This could begin with a small group activity, where students make suggestions about different properties of water and a possible explanation. Alternatively, each group could be handed a card from the teacher with one writer property, and the group has to make suggestions, before pinning back up for a whole class discussion. Molecules, or plastic molecule models, are useful at this stage, to show the structure of a water molecule, and the bonding between several molecules.
- It is likely that many students will be familiar with the water cycle (and/or the solid-liquid-gas triangle, however, this is an opportunity to review the terms evaporation, transpiration, and precipitation. The glass bowl water cycle model image can be used as a standalone question, or students could set up this model in class, or teachers could set up a demonstration, if time allows

### What processes allow rock to continuously form and reform?

- The rock cycle image has space around it for students to annotate and add examples of extra rocks, either after the investigation, or through extension research. The sample of rocks offered to the students should contain limestone, to link to the anchoring phenomenon, and at least two or more other types, preferably from each rock category (sedimentary, volcanic, and metamorphic). Basic instructions are given for the investigation method, but to meet [HS-ESS2-5] more closely, they can be rewritten out on paper with more detail to account for how students are going to collect reliable and accurate data. Students need to consider limitations of their method, and then make adjustments to (refine) their original investigation steps.
- Students may need to review the Earth's structure once more to re-familiarize themselves with the terms lithosphere, asthenosphere, mantle, and magma. The key understanding is the difference in state, solid or liquid, between rock and magma, and how water contributes. Many students may not understand that melting point of a substance, like rocks, is determined by more than just ambient temperature.
- Students can use a classification chart to distinguish between the different types of weathering and erosion. For extension, some students may like to construct a larger mind map on blank paper, and add details or drawings around the different categories.
- The frost wedging investigation can be made with smaller containers if space in a freezer is limited. Another alternative is for some students (or teachers) to conduct the experiment at home and take photos to share with other class members. The method is intentionally minimal, so students can be extended by adding further detail to ensure accuracy and reliability of the results.
- The erosion processes investigation is more convenient to conduct outside, such as at a sandpit close to a water hose and sand/soil, or an area that is easy to clean. Students may need to repeat the model several times to ensure the water flow is adequate enough to achieve a river channel, but not so strong that it destroys the entire tray of sand/soil. The second half of the activity then links the erosion and deposition cycle to a fertile agricultural area, the Great Gage Valley. If there is a suitable flood plain close by that the students are familiar with, this could also be included as an example for the students. Students can be extended with a research project on the history of Great Gage Valley, or another suitable example, and how human activities have interfered with the erosion and deposition cycles.
- Students consider variable soil moisture and the influence on soil erosion in this activity. The sustainability of soil, and the link to agricultural practices, will be covered in more depth in subsequent chapters.

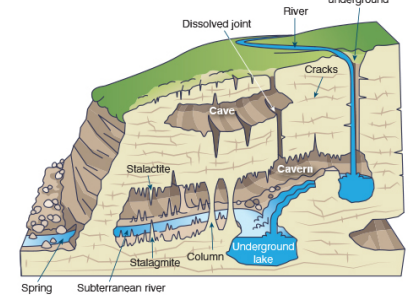
# Anchoring Phenomena

- Begin every chapter
- Familiar to students, but cannot be fully explained
- Encompass chapter content
  
- **Two purposes:**
  - Engage students
  - Teachers identify misconceptions and knowledge gaps

**Key Question:** What processes helped to form the Mammoth Caves?



- ▶ At Mammoth Cave National Park in Kentucky there is an underground limestone cave system, with around 640 km mapped out, and over 1000 km yet to be discovered by spelunkers, a term for cave explorers.
- ▶ The cave system started to form around 10 million years ago. It sits within the large Green River drainage basin, so was exposed to river water, along with slightly acidic rainwater, and ground water seeping through the rock.
- ▶ The cave system contains huge caverns, underground lakes, and sinkholes in which streams suddenly disappear into caves containing underground lakes.
- ▶ Mammoth Caves have stalactites, mineral formations that hang from the cave's ceilings, and stalagmites extending from the ground upwards.
- ▶ The oldest rocks that form the deep cave structure were laid down around 320 million years ago, on the site of a huge inland sea. On top of that are three other layers, or formations, that are successively younger.



1. In groups, discuss what type of rock you think the big open caverns, containing the stalactites and stalagmites, in Mammoth Caves are made from, and how might you know that? Record a summary of your group's ideas below:

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2. How do you think the Mammoth Caves might have formed? Use the space below to develop a flow chart of the processes you think might be involved in forming Mammoth Caves (you may not decide to use all four steps):

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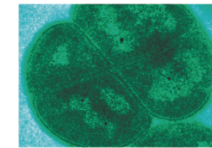
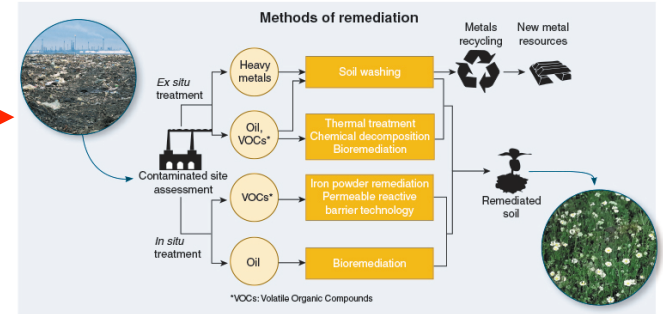


# Activity design

- Key Question.
- Introductory information
- Scaffolded information
- Question
- Tab system
  - Resource Hub content
  - Three dimensions identified

**Key Question:** How can new technologies help to remediate contaminated sites?

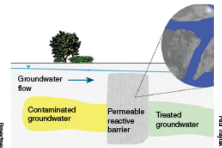
- ▶ Land that has been used for industry, such as mining, must be remediated when the **resource** runs out. **Remediation** is the removal of contaminants in order to make the area safe for human use.
- ▶ The method of remediation used depends on the extent and type of contamination (below). For example, polluted top soil can be removed and treated off-site, or plants and bacteria may be placed *in situ* to absorb and break down the contaminants. A treated area is monitored over many years to ensure that no further leaching of contaminants occurs. The remediated land can then be used for other purposes.



Bioremediation is the use of biological techniques to extract contaminants. Bacteria have great potential to do this and a number have been genetically engineered to digest contaminants. One such bacteria is *Deinococcus radiodurans*. It is one of the most radiation resistant organisms known and has been engineered to digest mercury and toluene in radioactive waste.



Technologies to remove contaminants can be quite simple. In areas with petroleum-based contaminants, water can be purified using activated carbon (highly granulated carbon). Contaminants adhere to the carbon granules and its very high surface area allows for a high rate of adsorption. Activated carbon is commonly used in household water purifiers.



Permeable reactive barriers are new technologies that are a cost effective way of treating contaminated water *in situ*. The barrier is placed between the contaminated site and the groundwater. Water can move through the barrier from the site to the groundwater, but contaminants are either blocked or neutralized by the barrier.

1. Explain the purpose of environmental remediation: \_\_\_\_\_
2. Describe a technology for environmental remediation: \_\_\_\_\_





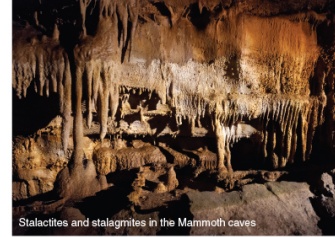
# Anchoring Phenomenon Revisited

- Revisited at end of chapter
- Students should be able to fully explain Anchoring Phenomenon
- Formative assessment
- Identify material to revisit before progressing

**Key Question:** What processes helped to form the Mammoth Caves?



In this chapter you have seen how water plays a role in developing the Earth's surface features, like the vast Mammoth Cave system encountered in the anchoring phenomenon. You should now be able to better describe the process involved in the cave system formation, and the interaction between water and rocks.



Stalactites and stalagmites in the Mammoth caves

1. (a) What type of rock is the caverns of the Mammoth Caves formed from?

\_\_\_\_\_

(b) How could we test to distinguish this rock type from igneous rocks, such as basalt or granite?

\_\_\_\_\_

(c) What is the type of weathering that formed the Mammoth Caves?

\_\_\_\_\_

2. At the start of the chapter, you developed a flow chart of how you thought the Mammoth Cave system may have formed. You will now refine this flow chart by creating a simple annotated diagram below, using the correct scientific vocabulary, as well as any rock cycle processes and the type of weathering leading to the Mammoth Cave formation.

# Practical Investigations

- Practical Investigations are clearly identified in green boxes.
  - Investigative phenomena
  - Promote collaboration
  - Enhance communication
  - Develop laboratory skills
- Investigations use equipment commonly found in high school laboratories and classrooms.
  - No special kits are required.**
- Equipment list is provided.

## Appendix 2: Equipment List

### 1: Science Practices

**INVESTIGATION 1.1**  
Investigating surface area and dissolving time

Per student/pair  
Limestone (CaCO<sub>3</sub>) chips  
1 mol/L HCl  
3 x 200 mL beakers  
Timer  
Electronic balance  
Mortar and pestle

### 2: The Universe and its Stars

**INVESTIGATION 2.1**  
Modelling expansion

Per student/pair  
Rubber bands  
Thumb tacks

**INVESTIGATION 2.2**  
Measuring the size of the Sun

Per student/pair  
Aluminum foil  
Push pin  
Card (to make a frame for the foil)  
Ruler

### 3: Earth and the Solar System

**INVESTIGATION 3.1**  
Elliptical orbits

Per pair/group  
String (15 cm)  
Two thumbtacks  
Pencil  
Corkboard or card

**INVESTIGATION 3.2**  
Modelling orbits 1

Per pair  
1 bowl  
4-5 balls of various sizes  
4-5 clothes pegs  
Sheet of material to cover bowl

**INVESTIGATION 3.3**  
Modelling orbits 2

Per student/pair  
Computer

**INVESTIGATION 3.4**  
Parallax

Per group of four  
Protractor (a 180° is easiest to use)  
Corkboard or thick card  
Tape  
Push pins  
Plastic straw  
Measuring tape

### 4: The History of Planet Earth

**INVESTIGATION 4.1**  
Modelling half-lives

Per pair/group  
M&M's®  
Lidded container

### 5: Earth Materials and Systems

**INVESTIGATION 5.1**  
Modelling ice sheet melting

Per pair/group  
2 x Florence or Erlenmeyer flasks  
Black paint  
Aluminum foil  
Ice cubes  
2 x thermometers  
60W tungsten lamp (optional)  
Timer

### 6: Plate Tectonics

**INVESTIGATION 6.1**  
Continental drift

Per student/pair  
Scissors  
Tape or paste

**INVESTIGATION 6.2**  
Modelling drift over time

Per student/pair  
Scissors  
Tape or paste

### 7: The Roles of Water in the Earth's Surface Processes

**INVESTIGATION 7.1**  
Determining properties of rocks

Per pair/group  
Samples of sedimentary, igneous, and metamorphic rock  
Graduated cylinder  
Electronic balance

**INVESTIGATION 7.2**  
Investigating frost wedging

Plaster of paris  
3 x balloons  
Graduated cylinder  
3 x Disposable containers  
Freezer

### INVESTIGATION 7.3

Modelling the process of erosion

Per group  
1 x plastic tray (at least A3 in size) with a water inlet and outlet  
Hose and connectors  
Substrate (gravel, silt, sand, clay)  
Large rocks  
Vegetation

### 8: Weather, Climate, and Biogeography

**INVESTIGATION 8.1**  
Measuring energy

Per student/pair  
Torch  
Clamp stand  
Protractor  
Grid paper

### INVESTIGATION 8.2

Modelling carbon cycle changes

Per student/pair  
Computer  
Spreadsheet application e.g. Excel

### 9: Natural Resources

**INVESTIGATION 9.1**  
Investigating soil types 1

Per student/pair  
Samples of sand, silt, and clay.  
Measuring cylinders  
Stirring rods

### INVESTIGATION 9.2

Investigating soil types 2

Per student/pair  
Three different soil samples.  
Measuring cylinders  
Stirring rods

### 12: Global Climate Change

**INVESTIGATION 12.1**  
Investigating how dry ice affects pH

Per pair/group  
250 mL conical flasks  
Universal indicator  
Dry ice  
1 Mol/L NaOH

# TEACHER SUPPORT MATERIALS



# Teacher's Edition

Replica of the Student Edition with:

- Print and digital
- Classroom Guide in place
- Model answers in place

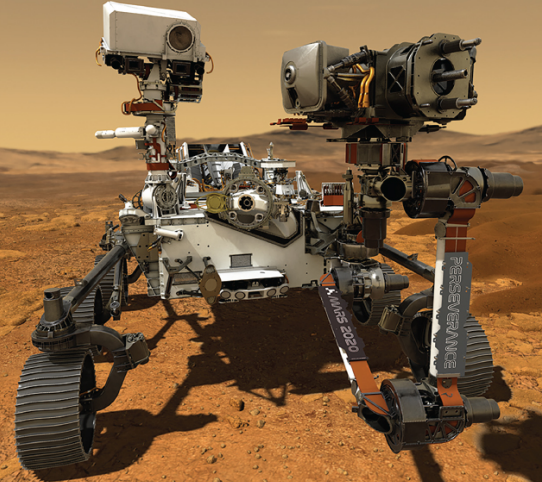
 **BIOZONE**

TEACHER'S EDITION



# EARTH & SPACE SCIENCES

FOR NGSS



# BIOZONE WORLD: Teacher's version

## Introduce, unpack, review answers

- Has answers in place.
- Has additional resources inbuilt
- Project on a shared screen.
- Introduce the topic.
- Wrap up a session.
- Review answers by toggling show/hide buttons

**BIOZONE ALPHA**

Earth And Space Sciences For NGSS > Chapter 12: Global Climate Change > 151 Ocean Acidification > Activity

### 151 Ocean Acidification

**Key Question:** How does the increasing amount of carbon dioxide in the atmosphere affect the pH of the ocean?

The pH of the oceans has fluctuated throughout geologic history, but has always remained at around pH 8.1 – 8.2. Recent studies have measured current ocean pH at around 8.0.

The oceans act as a carbon sink, absorbing much of the CO<sub>2</sub> produced from burning fossil fuels. When CO<sub>2</sub> reacts with water it forms carbonic acid (H<sub>2</sub>CO<sub>3</sub>), which decreases the pH of the oceans.

H<sub>2</sub>CO<sub>3</sub> dissociates into HCO<sub>3</sub><sup>-</sup> and H<sup>+</sup> ions. CO<sub>3</sub><sup>2-</sup> ions from the ocean waters react with the extra H<sup>+</sup> ions to form more HCO<sub>3</sub><sup>-</sup> ions. This process lowers the CO<sub>3</sub><sup>2-</sup> ions available to shell-making organisms, leading to thinner and deformed shells.

Atmospheric carbon dioxide (CO<sub>2</sub>)

Water (H<sub>2</sub>O)

Carbonic acid (H<sub>2</sub>CO<sub>3</sub>)

Hydrogen ions (H<sup>+</sup>)

Carbonate ions from the sea (CO<sub>3</sub><sup>2-</sup>)

Bicarbonate ions (HCO<sub>3</sub><sup>-</sup>)

Deformed shells

pH of ocean surface

Year

Change of -0.09 pH units

1. (a) What does the term "ocean acidification" mean?

(b) Describe the trend in ocean pH since the 1850s:

2. What do you think is causing this?

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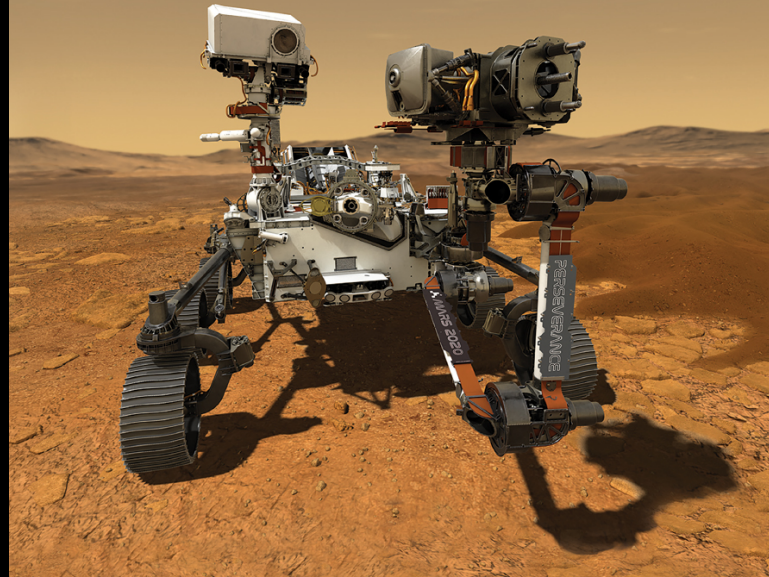
# Classroom Guide

- Pedagogical tools and features explained
- Teacher toolkit resources
- Suggestions for using the resources including:
  - Collaborative learning in the classroom
  - Differentiated instruction
  - Practicals
  - Assessments



# EARTH & SPACE SCIENCES

FOR NGSS

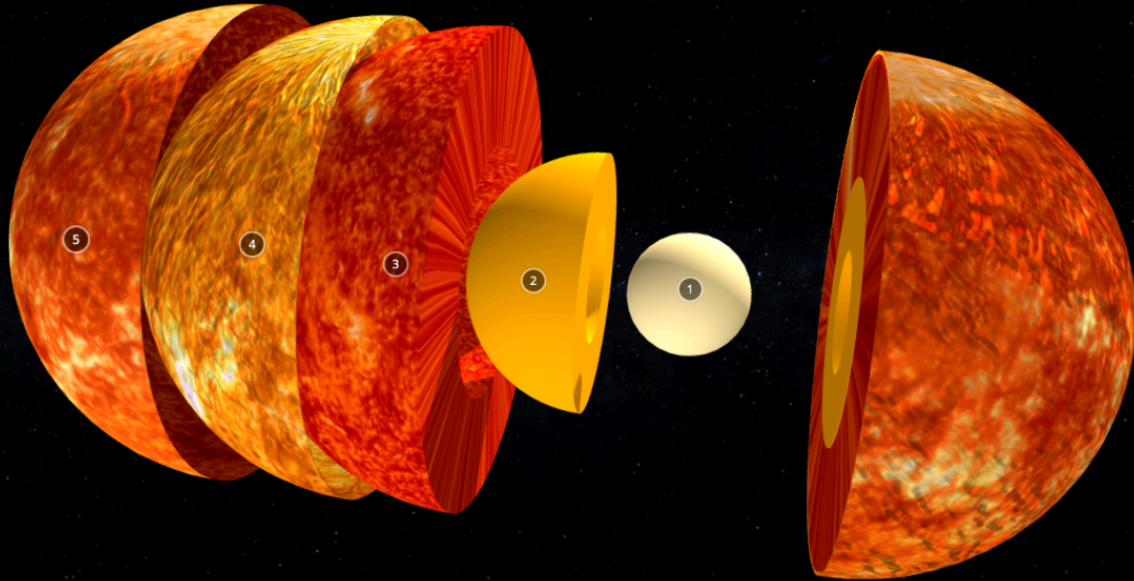




# Resource Hub

## Curated materials

- Curated materials support the content of the worktext.
  - FREE resource for teachers and students
  - Print and digital users
- |               |                |
|---------------|----------------|
| • Articles    | • Games        |
| • Videos      | • Spreadsheets |
| • Simulations | • 3D Models    |
| • Animations  | • And more...  |
- Resources to engage all students
  - Resources to extend Gifted & Talented students



# Presentation Slides

- Presentation style slides.
- Inbuilt into BIOZONE WORLD  
Pop up automatically with an activity.
- Present to your students using a projector or interactive whiteboard.

## The Components of Biodiversity



**Genetic diversity** is the total number of genetic characteristics in a species.  
Genetic diversity is an important consideration in studies of biodiversity.  
Species with high genetic diversity (low inbreeding) are generally less susceptible to disease and extinction.

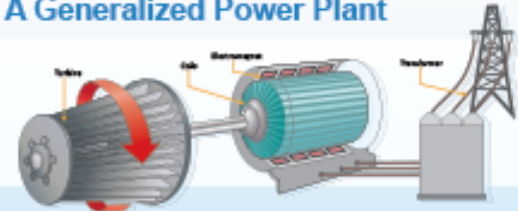
### Examples

- + Coyotes have a high level of genetic diversity due to their abundance, wide distribution across North America, and hybridizations with gray wolves.

## Features of Populations



## A Generalized Power Plant



The capacity of an electricity generation plant refers to its instantaneous power output.

- \* For example, a plant rated at 3000 MW has the ability to produce 3000 megawatts (3000 megajoules per second) of electricity at any one point in time.

# Test Bank content

- Additional questions test DCI knowledge.
- Formatted to ingest directly into your own test software or LMS.
- Range of question types, including:
  - Multiple choice
  - Multiple response
  - True/False
  - Modified true/false
  - Numeric
  - Matching

The screenshot shows a web browser window displaying a Canvas LMS quiz. The browser tabs include 'Contact Sales or Requi...', 'Resource Library |', 'Home - PowerSch...', 'Powered by Khor...', 'eSchoolPlus Integr...', 'Import Content: Earth...', and 'Quiz: HS-ESS3 Earth...'. The address bar shows 'canvas.instructure.com/courses/5166384/quizzes/11782929/take?preview=1'. The page title is 'HS-ESS3 Earth and Human Activity - ESS3.D: Global Climate Change' and it indicates 'Started: Aug 17 at 7:10pm'. The main content area is titled 'Quiz Instructions' and contains three questions:

- Question 7** (1 pts): Why is it important to build and run computer simulations of the effect of carbon dioxide pollution on ocean pH change over the next 100 years? (Text entry field)
- Question 8** (1 pts): The isotopes of oxygen in ice cores can be used to calculate ancient surface temperature. (True/False)
- Question 9** (1 pts): Climate models are becoming more sophisticated. (True/False)

The right sidebar shows a 'Questions' list with links to questions 7 through 16 and a 'Time Elapsed: 4 Minutes, 1 Second' indicator. A help icon is visible in the bottom right corner.

# Question Library

- Embedded questions from the worktext are provided digitally as a **question library**.
- Question library allows you to:
  - Deliver the same questions from the print version to students via an online service.
  - Customize questions to suit reading ability.

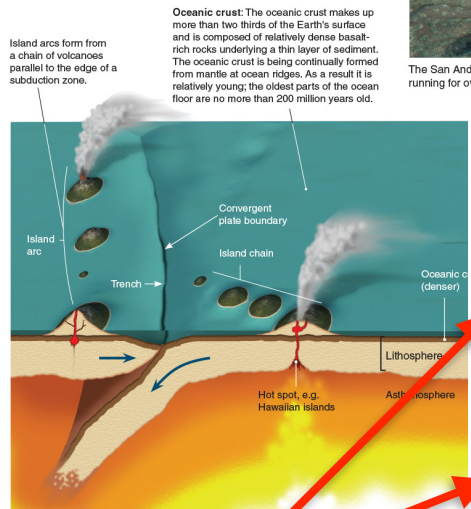
**NOTE:** Question Library is only available to schools/districts committing to multi-year adoptions

## Plate boundaries

► Plate boundaries are marked by well-defined zones of seismic and volcanic activity. Plate growth occurs at **divergent boundaries** along sea floor spreading ridges (e.g. the Mid-Atlantic Ridge and the Red Sea) whereas plate attrition (decrease) occurs at **convergent boundaries** marked by deep ocean trenches and subduction zones. Divergent and convergent zones make up approximately 80% of plate boundaries. The remaining 20% are called **transform boundaries**, where two plates slide past one another with no significant change in the size of either plate.



The San Andreas fault is a transform boundary running for over 1300 km through California.



**Oceanic crust:** The oceanic crust makes up more than two thirds of the Earth's surface and is composed of relatively dense basalt-rich rocks underlying a thin layer of sediment. The oceanic crust is being continually formed from mantle at ocean ridges. As a result it is relatively young; the oldest parts of the ocean floor are no more than 200 million years old.



2. Describe what is happening at each of the following plate boundaries and identify an example.
- (a) Convergent plate boundary: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
- (b) Divergent plate boundary: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
- (c) Transform plate boundary: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

# Pacing Guide

- Suggested delivery /timing
- Highlights vocabulary
- Highlights investigations
- Highlights assessment

## Chapter 1: Science Practices

These maths and science practices skills activities are integrated throughout chapters 2-12 where required.

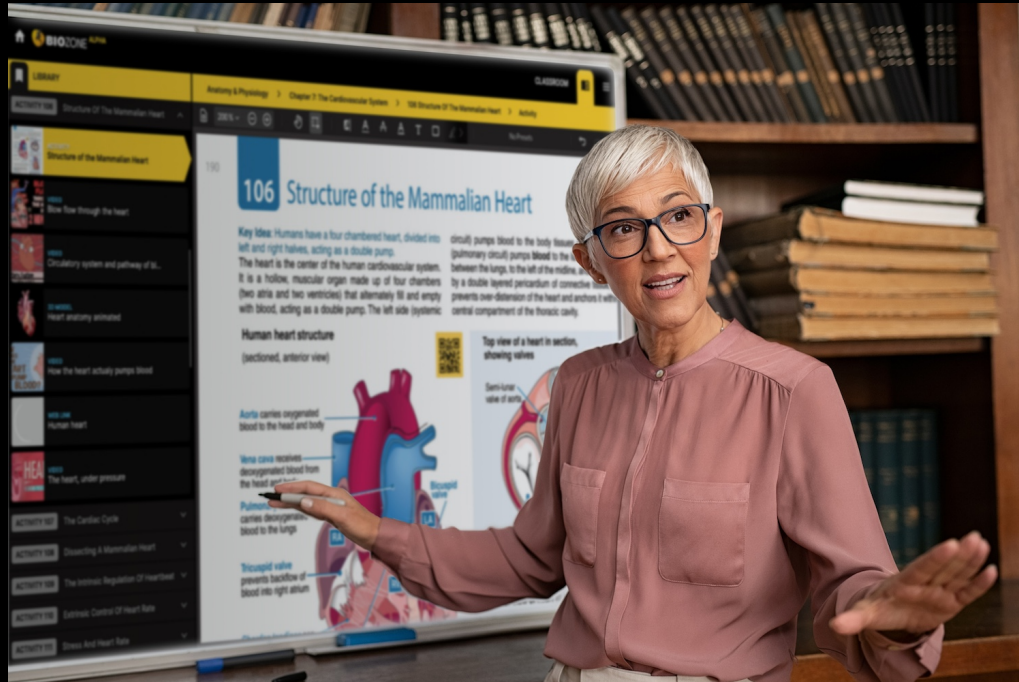
## Chapter 2: The Universe and Its Stars

Date	Duration Time / No. of periods	Activity number(s)	Notes	Lab / Practical activity	Formative or Summative Assessment
	2	11 12 1 & 4	<p>Anchoring Phenomenon: Hidden in Plain Sight.</p> <p>Key Question (KQ): What caused the Crab Nebula and what is hidden at its center?</p> <p>How can scientists and astronomers study different aspects of the universe by using various devices for gathering data?</p> <p>Vocab: EMS (electromagnetic spectrum), visible light, radio waves, infrared light, gamma rays, x-rays, ultraviolet light, VLT (very large telescope), HST (Hubble Space Telescope), VLA (Very Large Array), JWST (James Webb Space Telescope), ISIM (Integrated Science Instrument Module)</p>		<ul style="list-style-type: none"> <li>• What do your students already know about the topic?</li> <li>• Are there any gaps or misconceptions?</li> <li>• Cost / Benefit analysis of space telescopes with conclusions.</li> </ul>
	1	13 4	<p>KQ: How do we know what stars are made of?</p> <p>Vocab: parallax, magnitude, apparent v absolute magnitude, luminosity, parsec, absorption spectrum, electron orbitals, Kelvin temperature scale</p>	Use stairs to help students understand the quantized nature of electron orbitals.	<ul style="list-style-type: none"> <li>• Evaluate the spectra of one (or more) star(s) and describe the characteristics of the star(s).</li> </ul>
	1	14 5	<p>KQ: Where exactly are we in the universe, and what is its shape and size?</p> <p>Vocab: dark matter, dark energy</p>	Given various sizes for bodies in the universe, calculate approximate scale sizes and distances.	<ul style="list-style-type: none"> <li>• What do we know, and what do we theorize about, regarding the size and shape of the universe?</li> </ul>
	1	15 5	<p>KQ: How did the universe begin, and what events occurred as it formed?</p> <p>Vocab: singularity, Big Bang, gravity, electromagnetic force, weak nuclear force, strong nuclear force, photon, electron, positron, graviton, quarks, gluons, atomic nuclei, CMB (cosmic microwave background)</p>	If you were to create a timeline for the history of the universe, what is the smallest unit of time that you would want to mark? Why?	<ul style="list-style-type: none"> <li>• Identify and comment on any errors in the statement: "The universe was formed when a dense ball of material exploded into space, forming the universe we see today."</li> </ul>

*A single place of integration*

**BIOZONE**  **WORLD**

# Streamline classroom-based Collaborative Learning



**Teacher**  
introduces Activity

Brief class discussion  
to “unpack” the Activity’s  
**infographic** or **data**

*Breakout into small student groups*

**Student Group A**  
Discuss, then create consensus answers


**Student Group B**  
Discuss, then create consensus answers

**Student Group C**  
Discuss, then create consensus answers

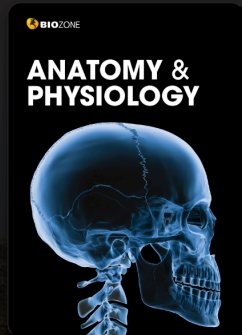
Students quickly report back via  
teacher-led discussion then  
**Self-grade** and **improve answers**

 **MY CLASSROOM**

-  **DASHBOARD**
- ASSIGNMENTS
- STUDENTS

 **CLASS SETTINGS**

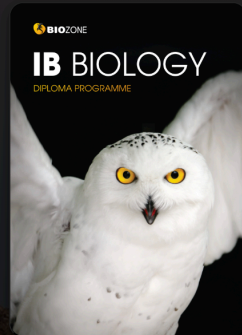
ANATOMY & PHYSIOLOGY



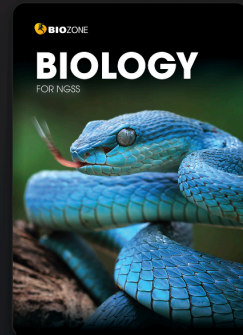
ENVIRONMENTAL SCIENCE



INTERNATIONAL BACCALAUREATE




STANDARD NGSS - BIO



STANDARD NGSS - ESS



**LAST ACTIVITY** 



**ACTIVITY**  
Gas Exchange Adaptations



LIBRARY

- ACTIVITY 130 Ocean Power
- ACTIVITY 131 Energy From Biomass
- ACTIVITY 132 Hydrogen Fuel Cells
- ACTIVITY 133 Comparing Fuel Choices
- ACTIVITY 134 Energy Conservation
- ACTIVITY 135 Energy Security
- ACTIVITY 136 Energy Storage

ACTIVITY Energy Storage

VIDEO Energy storage 101

- ACTIVITY 137 Rechargeable Batteries And Energy Storage
- ACTIVITY 138 Did You Get It?

- CHAPTER 7 Pollution
- CHAPTER 8 Conservation
- CHAPTER 9 Climate Change
- CHAPTER 10 Science Practices

Appendix  
IB BIOLOGY



## 136 Energy Storage

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**Key idea:** Energy storage is an important part of energy security and reliability. It is important on both small and large scales. We are familiar with energy storage on small scales, in the form of cells, e.g. AA (commonly but incorrectly called batteries) for portable devices such as torches or lead-acid batteries in cars. As **renewable energy** becomes more

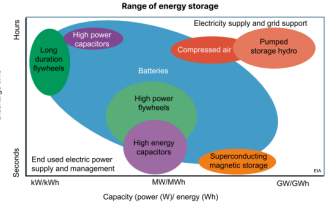
important, the storage of excess energy on a large scale also becomes important. This helps to add extra power to the grid times when power supply is not able to match increased demands, e.g. solar not working at night or a decrease in wind during certain times of day. Energy storage also provides energy security, protecting against the failure of a production facility and providing energy on demand.

### Energy storage and use

The type of energy storage needs to be matched to its use. In most large scale cases, energy storage deals with storing excess potential energy that cannot be stored naturally, or recovering potentially wasted energy. Small scale storage is useful for portable devices and is a convenient way of storing energy for personal use.



Pumped storage ponds can be used to store potential energy. During times when there is excess water in a dam, and energy demand is low, the excess water can be pumped uphill into storage ponds. The water can later be released through turbines to produce extra power when needed.



Batteries can be used in a domestic setting to store energy generated from home solar cells (or other generation devices). As domestic solar cells become more common there will be a greater desire to store excess power for use when the sun is not out, and so take greatest advantage of the solar cells.



Energy can also be stored in mechanical devices, including springs and flywheels. It can also be stored in pressurised vessels, such as air tanks. When the air pressure is released it can be used to power machinery. Compressed springs can release energy quickly to provide starting power for engines or spring loaded weapons (e.g. air rifles).



Excess energy can be stored in geological formations. Geological storage methods involve storage of **natural gas** and hydrogen, compressed air, pumped storage, and thermal storage. These can be stored in depleted gas reservoirs, mines, or purpose drilled boreholes. Geological storage has the potential to store many GWh of energy.

1. (a) Explain why there is a need for storing energy:
- (b) Explain why there is a need for several different ways of storing energy:



- Replicas of the printed books allow students to view content and answer questions online.
- Student view and teacher view.
- Direct access to:
  - Presentation slides
  - 3D models
  - Curated Videos
  - Websites

# Digital platform

- Activity content and order are the same as the print resources.
- Seamless transition between print and digital.
- Rostering capability.
- LMS integration.
- Digital resources inbuilt.

**LIBRARY**

**ACTIVITY 38** Diffusion In Cells

**ACTIVITY 39** Osmosis In Cells

**ACTIVITY 40** Diffusion And Cell Size

**ACTIVITY 41** Observing Diffusion In Cells

**ACTIVITY 42** Factors Affecting Membrane Permeability

**ACTIVITY 43** Active Transport

**ACTIVITY 44** What Is An Ion Pump?

**ACTIVITY 45** Specialization In Plant Cells

**ACTIVITY 46** Specialization In Animal Cells

**ACTIVITY 47** What Is DNA?

**ACTIVITY 48** Nucleotides

**ACTIVITY 49** DNA And RNA

**ACTIVITY 50** Modeling The Structure Of DNA

**ACTIVITY 51** Genes Code For Proteins

**ACTIVITY 52** Cracking The Genetic Code

**ACTIVITY 53** Amino Acids Make Up Proteins

**ACTIVITY 54** The Functional Structure Of Proteins

## 38 Diffusion in Cells

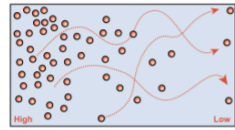
**Key Question:** What is diffusion, and what are the factors that affect the rate of diffusion of a particle from one point to another?

**What is diffusion?**

- Diffusion is the movement of particles from regions of high concentration to regions of low concentration. Diffusion is a passive process, meaning it needs no input of energy to occur. During diffusion, molecules move randomly about, becoming evenly dispersed.
- Most diffusion in biological systems occurs across membranes. Simple diffusion occurs directly across a membrane, whereas facilitated diffusion involves helper **proteins**. Neither requires the cell to expend energy.

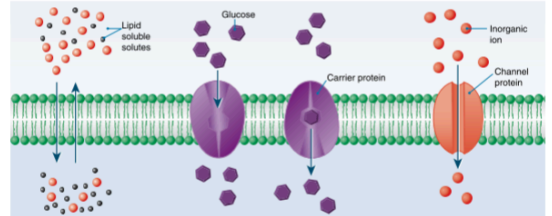
**Factors affecting the rate of diffusion**

Concentration gradient	Diffusion rate is higher when there is a greater concentration difference between two regions.
The distance moved	Diffusion occurs at a greater rate over shorter distances than over larger distances.
The surface area involved	The larger the area across which diffusion occurs, the greater the rate of diffusion.
Barriers to diffusion	Rate of diffusion is slower across thick barriers than across thin barriers.
Temperature	Rate of diffusion increases with temperature.



**Concentration gradient**

If molecules can move freely, they move from high to low concentration (down a concentration gradient) until evenly dispersed. Net movement then stops.



**Simple diffusion**  
Molecules move directly through the membrane without assistance and without any energy expenditure. Example: O<sub>2</sub> diffuses into the blood and CO<sub>2</sub> diffuses out.

**Facilitated diffusion by carriers**  
Carrier proteins allow large lipid-insoluble molecules that cannot cross the membrane by simple diffusion to be transported into the cell. Example: the transport of glucose into red blood cells.

**Facilitated diffusion by channels**  
Channel proteins (hydrophilic pores) in the membrane allow inorganic ions to pass through the membrane. Example: K<sup>+</sup> ions leaving nerve cells to restore membrane resting potential.

1. What is diffusion?  
+2. (a) How is facilitated diffusion different from simple diffusion?  
(b) How is it the same?

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SF LSI-A



LIBRARY

ACTIVITY 18 El Niño And La Niña

ACTIVITY El Niño and La Niña

VIDEO El Niño

ACTIVITY 19 Water

ACTIVITY 20 Ocean Circulation And Currents

ACTIVITY 21 Earth's Past Climate

ACTIVITY 22 Did You Get It?

CHAPTER 2 Ecosystems

CHAPTER 3 Populations

CHAPTER 4 Investigating Ecosystems

CHAPTER 5 Land And Water

CHAPTER 6 Energy

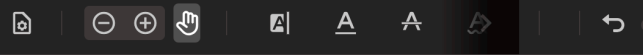
CHAPTER 7 Pollution

CHAPTER 8 Conservation

CHAPTER 9 Climate Change

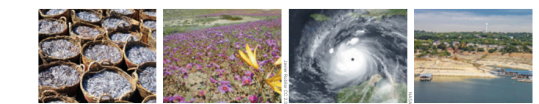
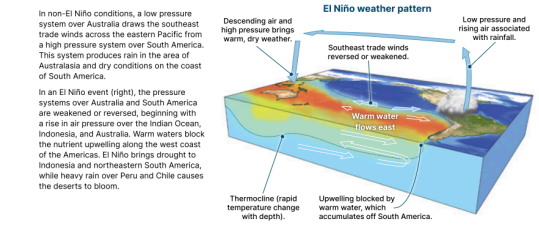
CHAPTER 10 Science Practices

Appendix



18 El Niño and La Niña

**Key Idea:** El Niño is a major climate pattern that affects the regions around the Pacific ocean. The El Niño-Southern Oscillation, which has a periodicity of three to seven years, is a climate cycle that occurs in the Pacific region. El Niño years cause a reversal of the normal climate regime and are connected to events such as the collapse of fisheries stocks, flooding in the Mississippi Valley, drought-induced crop failures and forest fires in Australia and Indonesia. An intensification of the normal situation, called La Niña, often occurs soon after an El Niño event.



During non-El Niño years, cool, nutrient-rich waters along the South American coast sustain huge populations of fish such as anchovy. During El Niño events, warm waters reduce nutrient supply, and fish populations either crash or move to feeding grounds elsewhere.

El Niño events bring more rain to deserts in parts of South America and Baja California. On the islands of the Gulf of California, plant cover increases from 0-4% during non-El Niño years to 54-100% during El Niño years. In Northern Chile, plant cover increases over five times during El Niño.

During La Niña, the southeastern trade winds intensify, blowing warm water closer to Asia than normal. Cold, nutrient rich waters well up along the coast of the Americas. Winter temperatures in the southern states are warmer than usual and the hurricane season is more severe.

La Niña conditions bring cold waters to the surface near the Americas. This tends to push the jet stream over North America further North. This results in droughts in the southern US and more rain and cooler temperatures in the Pacific Northwest.

- Describe the events that cause El Niño conditions and its effects on ocean circulation:
- Describe the effect of an El Niño year on:
  - The climate of the western coast of South America:
  - The climate of Indonesia and Australia:

- **Students can:**
  - Input answers into the platform for review and grading.
  - Add notes, draw on the page and highlight text passages.
- **Teachers can:**
  - View and show answers
  - Assign activities
  - Grade and return work
  - Force hand in

LIBRARY

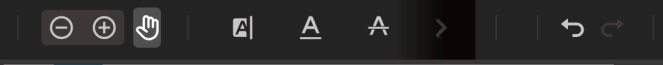
- CHAPTER 6 Energy
- CHAPTER 7 Pollution
  - INTRODUCTION Pollution
  - ACTIVITY 139 Types Of Pollution
  - ACTIVITY 140 Water Pollution
  - ACTIVITY 141 Nitrogen Pollution
  - ACTIVITY 142 Eutrophication And Water Quality
  - ACTIVITY 143 Biomagnification
  - ACTIVITY 144 Sewage Treatment
  - ACTIVITY 145 Waste Management
  - ACTIVITY 146 Reducing Waste
  - ACTIVITY 147 Plastics In The Environment

**ACTIVITY**  
Plastics in the Environment

**3D MODEL**  
Hawkesbill turtle

**WEB LINK**  
Our planet is choking on plastic

**WEB LINK**  
Plastic island



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## 147 Plastics in the Environment

**Key Idea:** The widespread presence of plastic waste is causing significant harm to ecosystems and the organisms that inhabit them. Almost every home and industry contains plastic: a synthetic substance that has only been introduced in the last 100 years. Plastic is widely used because it is convenient and easy to produce. However, its low cost of production also makes it easy to discard. Due to the ocean currents spreading the material, even the most remote parts of the world are now affected by plastic pollution. Currently, around 19-23 million tonnes of plastic are released into the environment each year as waste into lakes, rivers, and oceans. This problem will only be partially solved by plastic recycling. Instead, a shift to non-plastic products and the development of innovative breakdown processes that can tackle the issue of plastic permanence will be required.

**Plastic permanence is a problem**

- ▶ The problem with plastic is its stability. In nature, organic material is broken down by enzymes and microbes that have evolved over billions of years to deal with the chemical bonds found in nature. Plastic degradation is limited due to the difference of chemical bonds in most plastics compared to those found in nature. This results in only a small number of organisms capable of breaking down plastic.
- ▶ Plastics have a long-lasting presence in the environment, persisting for hundreds of years. The excessive disposal of plastic products over the past 50 years has led to significant environmental and waste management challenges.
- ▶ Environmental groups are collecting plastic from polluted areas, but the problem then becomes how to get rid of it completely.



Colorful, cheap plastic is in most homes.



Plastic pellets can be molded into products.



Waterway plastic pollution, Tamil Nadu

**Plastic is everywhere**  
The earliest forms of synthetic plastics, such as Bakelite (1909), cellophane (1912), PVC (1926), and teflon and nylon (1938), revolutionized many products. Mass use in medical supplies and shopping bags increased during the 1970s. Fleece clothing entered the market in 1993. In a relatively short time, plastic became an indispensable material: light, cheap to make, and waterproof. Shops offer a huge variety of plastic products, and nearly every food and drink is packaged in plastic.

**Plastics and health**  
The production of plastic from fossil fuels and other chemicals can have detrimental effects on the environment, including the emission of greenhouse gases. Elevated numbers of cancer cases have occurred in Louisiana near plastic production plants. Certain additives such as BPA, found in plastic, including children's toys, have been found to negatively impact both the reproductive and immune systems. Additionally, when waste plastic is incinerated, harmful fumes are released.

**Plastic pollution and water supply**  
Plastic waste in waterways that supply water for human use can make much of it unusable. India is one country with a significant plastic pollution problem, partly because of the concentrated population. In Tamil Nadu, above, the local government is attempting to solve their plastic pollution by importing several 'boom interceptors' from the Netherlands. However, without an effective recycling plan, this will just collect and move the plastic from one site to another.

1. Why are so many products used by humans made from plastic? The plastic is cheap to manufacture, is ideal for packaging food and drink, being waterproof and easy to sterilize. It can be molded into many different shapes. It is light to transport around.
2. Explain why plastics persist in the environment: The chemical bonds in plastics are not like those found in nature so there are very few organisms that can break the chemical bonds in plastic and degrade it.
3. Explain how plastic pollution can impact human communities: Plastic can be esthetically unpleasing and highly visible when discarded. The plastic can break down into small pieces that leach toxins (and forever chemicals) and be washed into the waterways, polluting drinking water and affecting taste. The plastic can block pipes. The plastic can impact the growth of plants and be ingested by farm animals, causing them harm.

- Perfect for introducing or reviewing content with students via shared screen.
- Teacher can **display model answers** when they want.
- Simply click the buttons on the teacher view to reveal the answers.
- Students can refine their own answers based on the model answers.

# Translation feature

- **Translation for 150 languages:** Realtime translation - highlight the English text to display text translation in the selected language.
- Once activated, pointing the mouse at a text block in the book page will show the translated version on a nearby pop-up panel.

The image shows a book page titled "Changes in Dentition" with a translation feature overlay. The page content includes:

## Changes in Dentition

Changes in **dentition** (the type, number, and arrangement of teeth) in our hominin ancestors can reveal information about their evolution. During early hominin evolution teeth (especially the molars) and jaws tended to be large. The paranthropines are the extreme example of this trend. Their diet of coarse vegetation required very large and powerful jaws and molars. During the course of the reduction in likely consequences of modern human an omnivore

### Early Hominins

Cambios en la dentición (el tipo, número y disposición de la dentición) dientes) en nuestros ancestros homínidos puede revelar información sobre su evolución. Durante la evolución temprana de los homínidos, los dientes (especialmente los molares) y las mandíbulas tendían a ser grandes. Las parantropinas son el ejemplo extremo de esta tendencia. Su dieta de vegetación basta. requería mandíbulas y molares muy grandes y potentes. Durante el

translated by Google

*Paranthropus africanus* *Homo erectus*

The translation feature is shown as a dark grey panel on the right side of the page. It is titled "TRANSLATION SETTINGS" and has a "TRANSLATION" toggle switch. Under the "LANGUAGE" section, a dropdown menu is open, showing a list of languages: Spanish (selected), English (Default), Arabic, Chinese (Simplified), Chinese (Traditional), French, German, Korean, Spanish, Tagalog (Filipino), Urdu, and Vietnamese. A red arrow points from the Spanish option in the dropdown menu to the translated text on the page.

LIBRARY

INTRODUCTION Energy

ACTIVITY 117 Using Energy Transformations

ACTIVITY 118 Global Energy Consumption

ACTIVITY 119 Non-Renewable Resources

ACTIVITY 120 Coal

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ACTIVITY 122 Oil Extraction

ACTIVITY 123 Environmental Issues Of Oil Extraction

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ACTIVITY 126 Wind Power

ACTIVITY Wind Power

VIDEO How do wind turbines work?

3D MODEL Wind turbine

ACTIVITY 127 Hydroelectricity

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ACTIVITY 130 Ocean Power

ACTIVITY 131 Energy From Biomass

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ACTIVITY 133 Comparing Fuel Choices

ACTIVITY 134 Energy Conservation

ACTIVITY 135 Energy Security

ACTIVITY 136 Energy Storage

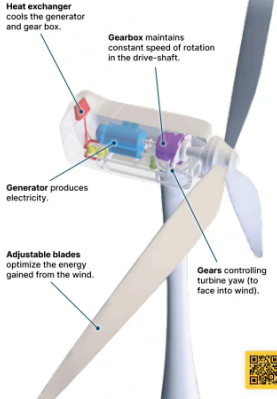
ACTIVITY 137 Rechargeable Batteries And Energy Storage

# 126 Wind Power

**Key Idea:** Wind power provides a relatively simple and scalable way to produce electricity. Wind power has been used for centuries to provide the mechanical energy to pump water or run milling machinery. Today, it is mainly used to produce electricity. Wind power is becoming increasingly reliable and cost effective as the technology develops and turbines are able to operate in a range of conditions and wind speeds. In fact **wind energy** is

one of the cheapest types of energy to build, maintain, and use. Globally, wind power is steadily increasing in generation capacity, but wind is a variable energy provider. There can be problems matching output to demand, such as during seasonal demands and low (or extremely high) winds. This means systems for managing and distributing electricity will be required as well as backup or base load electricity supplies, e.g. hydro or geothermal power.

### Wind turbine



**Wind farms** often cover large areas of land but turbines can be designed to operate at sea and, on a smaller scale, along highway edges. The scalability of **wind turbines** makes them simple to install in many locations, with turbine sizes ranging from a few metres to over 200 metres in diameter.



At the end of 2022, the power output from wind turbines was around 7% of global electricity production. Global installed capacity was more than 800 GW. Electricity generation from wind is rising every year.

1. A typical wind turbine produces around 2.3 MW. The average house uses 30 kWh of energy per day (a kilowatt hour is the equivalent of 1000 joules of energy per second (1kW) running for 1 hour). Calculate the following:
  - (a) The minimum number of wind turbines required to power a town of 20,000 households:
  - (b) Wind turbines cost around \$1.3 million per MW of energy production to build. What will the be the cost of (a) above?
  - (c) The cost of building, running, and maintaining wind turbines over their 20 year lifetimes is about \$50 per MWh. What could the 20,000 households using the wind turbines above expect to pay in dollars per year for the use of electricity provided by the wind turbines?
  - (d) Why can households actually expect to have to pay a lot more than this?



# Practical Investigations

- Short on time?
- Student results can't be used?
- Share the model answer data.
- Students still do the graphing and analysis of results.

**LIBRARY**

ACTIVITY 104 Stages In Photosynthesis

ACTIVITY 105 Investigating Photosynthetic Rate

**ACTIVITY**  
Investigating Photosynthetic Rate

**WEB LINK**  
Rate of Photosynthesis in Elodea (Si...)

**WEB LINK**  
SAPS: Measuring the rate of photosyn...

**VIDEO**  
Science Revision Video: Factors affe...

**VIDEO**  
Waterweed simulator

ACTIVITY 106 The Fate Of Glucose

ACTIVITY 107 Energy Transfer Between Systems

ACTIVITY 108 Energy From Glucose

ACTIVITY 109 Aerobic Cellular Respiration

ACTIVITY 110 Measuring Respiration

ACTIVITY 111 Review Your Understanding

ACTIVITY 112 Summing Up

**CHAPTER 6** Interdependence In Ecosystems

**CHAPTER 7** Energy Flow And Nutrient Cycles

**CHAPTER 8** The Dynamic Ecosystem

**CHAPTER 9** Social Behavior

**CHAPTER 10** Inheritance Of Traits

**CHAPTER 11** Variation Of Traits

109% No Presets

158 **105 Investigating Photosynthetic Rate**

**Key Question:** How does light intensity affect photosynthesis rate?

**Investigation 5.1** Measuring bubble production in *Cabomba*

See appendix for equipment list

- Fill a boiling tube 2/3 full with a 20°C solution of 1% sodium hydrogen carbonate (NaHCO<sub>3</sub>).
- Cut ~ 7 cm long piece of *Cabomba* stem (cut underwater). Place the *Cabomba* into the boiling tube (cut end up). Carefully push the *Cabomba* down.
- Place the boiling tube in a rack and position a lamp so that it will shine on the tube when switched on.
- To test the set-up, switch on the lamp for one minute to check that bubbles emerge freely from the stem. If they don't, you may have to recut the stem to open it.
- When you have checked your set-up, switch off the lamp and, **after 5 minutes**, use a stopwatch to record the number of bubbles emerging from the stem in one minute. Repeat.
- Use a ruler to mark out distances 0, 5, 10, 15, 20, and 25 cm from the boiling tube.
- Starting at 25 cm, move the lamp to each of the distances in turn and use a stopwatch to record the number of bubbles emerging from the stem in one minute. Run two tests at each distance and allow 5 minutes after moving to a new distance before recording (this allows for acclimation).
- Record your results in the table (right). Calculate the mean rate of gas production for each distance (and lamp OFF).
- After you have finished recording, remove the stopper from the tube and test the gas with a glowing splint. What happens?

Distance (cm)	Bubbles per minute		
	Test 1	Test 2	Mean
OFF	0	0	0
25	51	45	48
20	66	56	61
15	74	70	72
10	88	80	84
5	95	91	93
0	104	112	108

**NEED HELP?** See Activity 23

- Use your calculated means to draw a graph gas production vs light intensity (distance).
- What did your splint test tell you about the gas produced by the *Cabomba* plant? **NEED HELP?** See Activities 17 & 18
- From this experiment what can you say about photosynthesis, light, and the gas produced?
- How could you improve the design of this investigation?

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## STUDENT Access

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Digital interactive replica of the book:

- Students can view the book, add **annotations** and **markup**.
- Students can enter **answers online** and **submit** them to their teacher.
- Access embedded resources: **3D models, presentation slides**, curated OER **videos, weblinks**.

## TEACHER Access

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All the functions the student has plus:

- Teacher has access to **model answers** & can show/hide via display buttons.
- Teacher can **assign activities** to students.
- Force hand in.
- Teacher can **view, comment**, and **grade** student responses to questions.



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