3 Reactions, Interactions & Cycles

Themes
Earth and atmosphere, hydrological cycle, rock cycle, water phases, chemical reactions, nitrogen cycle

Note-taking skills
Lecture cues

Adverbs
Of degree, opinion, frequency, manner

Formality
Noun phrases
Confusing words

References
Why and how we use them

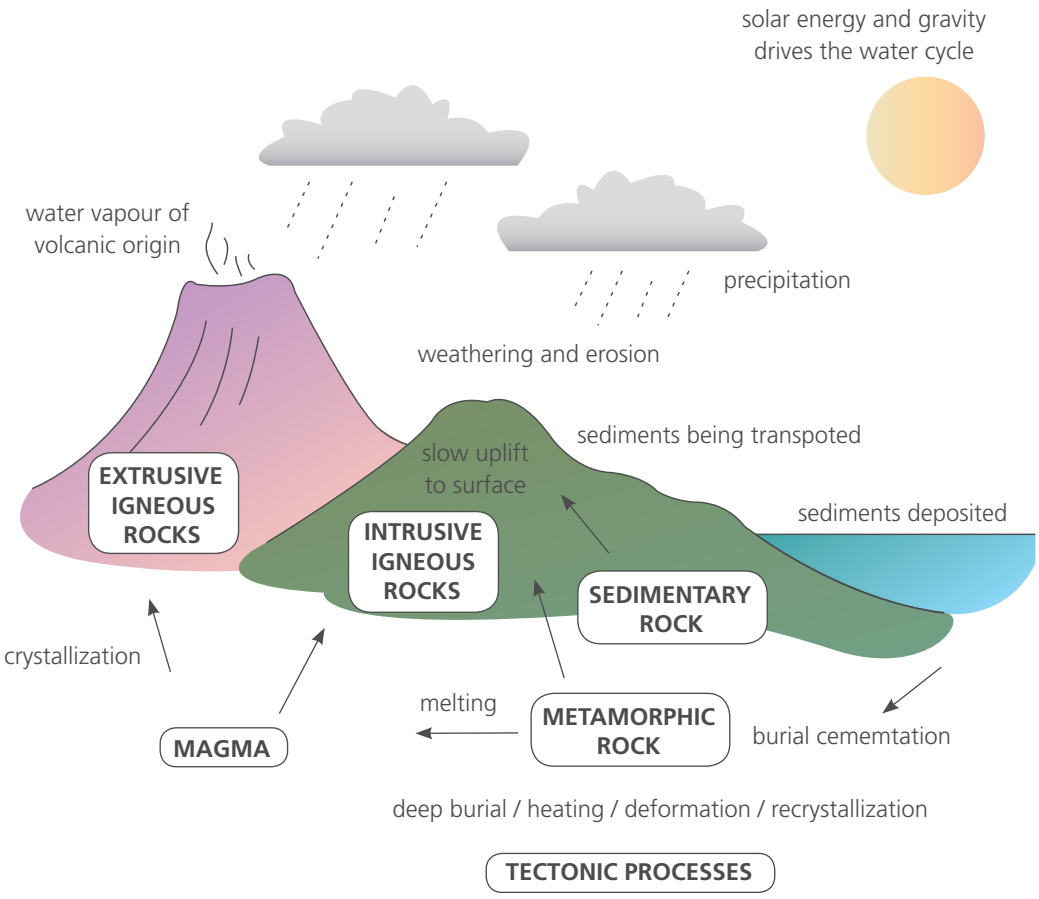
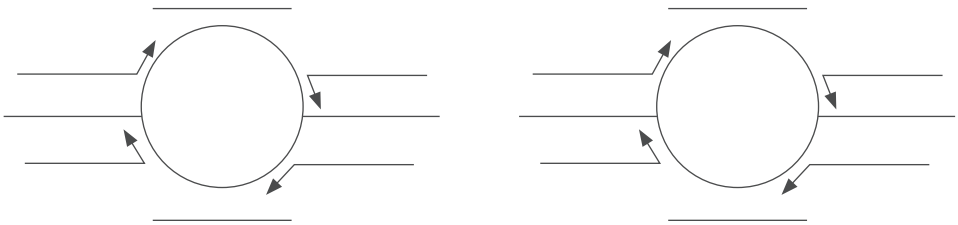


Figure 1 Reactions, interactions and cycles on Earth and its atmosphere

Discussion

Task 1 Look at Figure1, and in pairs try to identify at least two cycles, physical or chemical ones, suggesting how atmosphere, water and soil interact.



Lecture cues signposting language

Good lecturers tend to use signposting language in order to help their students follow what is being said, understand the lecture's structure, purpose and content.

Some of the cues you should be looking for during a lecture are listed below. What phrases would you expect to hear?

PURPOSE OF LECTURE CUES	SIGNPOSTING LANGUAGE
set the scene	
prepare students of what's coming up next or give overview	
check whether administration matters are understood, resolved or met	
ask rhetorical questions i.e. for emphasis	
provide historical background	
provide demonstrations and examples	
analyse, compare and contrast theories, practices, viewpoints or evidence	
use facts and figures, graphs and charts to present, analyse or provide evidence	
signal the end of the lecture and/or summarise key points	

Listening

Task 2 Listen to the lecture, identify the lectures cues provided by the speaker and complete the above table. Did the lecturer digress from the main theme? What phrases indicated that?

Reading

Task 3 Read the script of the lecture and write a question that sums up the content of each paragraph.

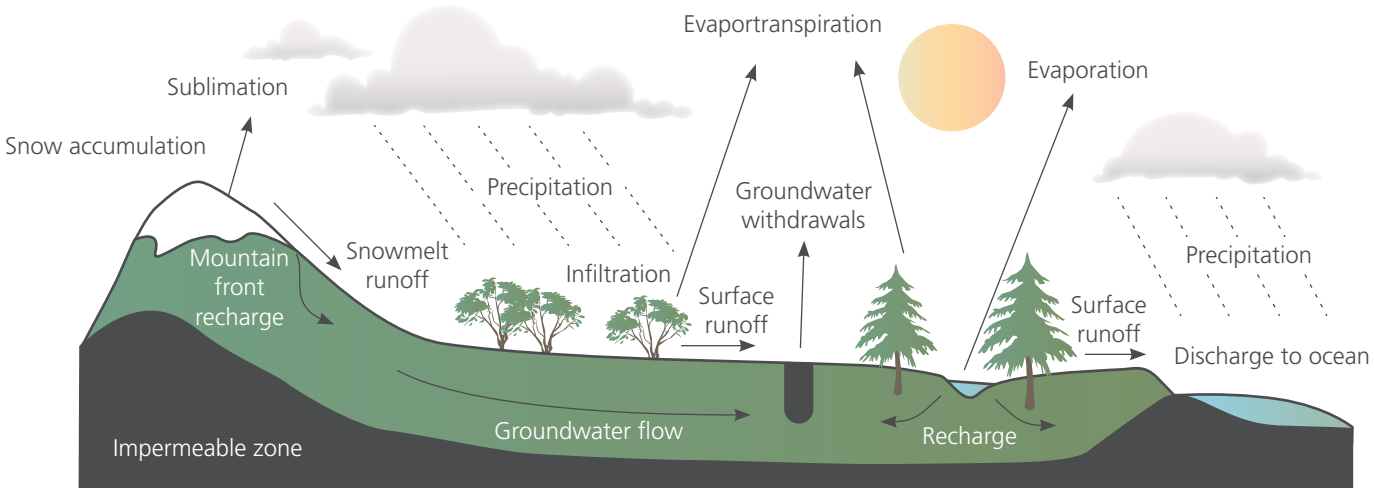


Figure 2 Schematic representation of the hydrological cycle (Pagano and Sorooshian, 2002)

OK everyone…Right… Has everyone got a copy of the handout? … Shall we make a start then? What I'd like to talk about today is Earth and its atmosphere and in particular how air, soil and water interact.

In fact, as the focus of today's lecture is on physical and chemical cycles and interactions, I'm going to divide the lecture into six parts: First, I am going to talk about the hydrological cycle and its observed trends, then I am going to draw upon the interaction of sea water and soil, rock cycle, nitrogen cycle and carbon cycle.

So, does any of you know what hydrological means? That's right… Hydro derives from the Greek word for water. The **hydrological** cycle demonstrates and reinforces the constant cycling of elements through the environment. It is a conceptual model that describes the storage and movement of water between the biosphere, atmosphere, lithosphere, and the hydrosphere. It moves from one reservoir to another by processes like: evaporation, condensation, precipitation, deposition, runoff, infiltration, sublimation, transpiration, and groundwater flow. Figure 2 illustrates this point.

You might be interested to know that, as Shiklomanov and Penkova (2003) observed, human alteration of the landscape and riverine

systems considerably affect how the hydrologic cycle might change, from small watershed to large river basin scales. You don't need to write this down but Lins (2005) provided a thorough analysis of trends in the hydrologic cycle indicating that precipitation over global land areas increased about 2% during the twentieth century, and that the streamflow also exhibited widespread increase.

To get back to the point, although most elements are relatively immobile, water remains the most effective natural solvent and it initiates in the form of rain or soil solution, initiates the **weathering** (i.e. **disintegration**) of soil and its transportation in the form of rain or soil solution. In fact, rivers constitute major **erosion agents** and they contribute greatly towards the immediate recycling and transport of **continental** material to the oceans.

As such, weathering and erosion determine the composition and concentration of **riverborne** material. The former involves the **in situ** disintegration of the parent rock material whereas the latter just implies migration of the material from the site of weathering. Two types of processes prevail. Physical (mechanical) weathering entails the rock matrix being **fragmented with the proviso** that the chemical **integrity** of the original material is not altered. The parent rock interacts with natural waters to produce weathered **residues** with compositions that are not similar to the original rock matrix. This involves chemical weathering.

When it comes to water sources, it is generally supported by research (*Pagano and Sorooshian, 2002*) that ocean water is mainly a byproduct of the lithospheric solidification of rock. Yet, the cycle of water does not cease here; the transport of terrestrial salts in weathered sediments by leaching (Figure 3) and stream runoff also account for the dissolved constituents present in sea water. Seawater is a mixture of water and various such salts. In fact, chlorine, sodium, magnesium, calcium, potassium, and sulfur account for 99 % of the salts in seawater. The presence of organisms in sea water

invariably upsets the established **chemical equilibria** and modifies the concentration of several constituents. The extent of this effect is determinant on the pH and the free ion activity of the micronutrients (nitrogen, phosphorus, silicon). At the same time, **depletion** of the nutrients, supersaturation of dissolved oxygen and pH increase are attributed to photosynthesis while organic **debris** produced in the surface waters falls through the water column and is **decomposed**.

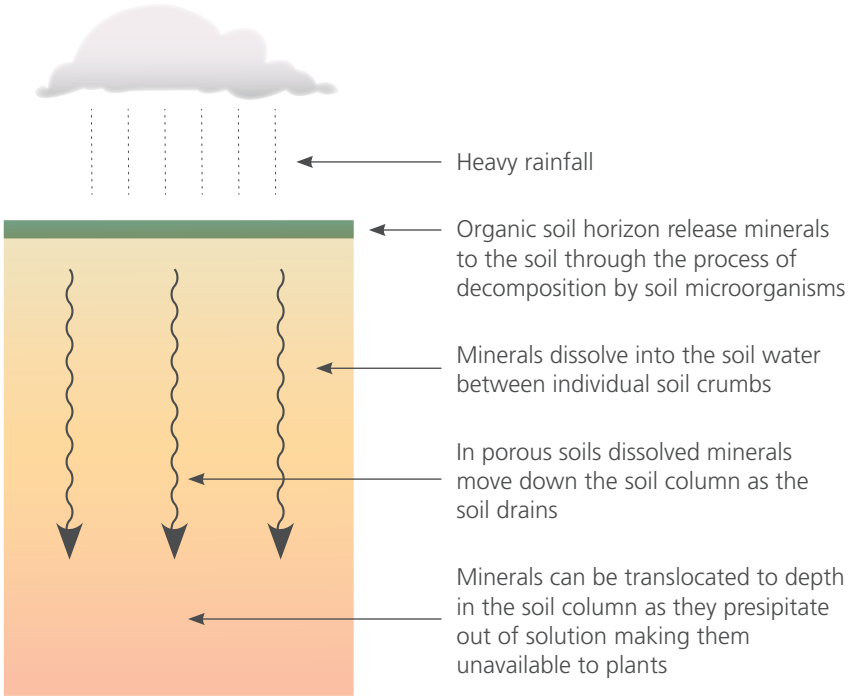


Figure 3 Visual representation of leaching and leachate

Another source of water is volcanic eruptions which incidentally accounts for water being the driving force regarding soil formation. Actually, the formation of nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) in the atmosphere caused by volcanic eruptions leads to acidification. Although the concentration of acids, such as nitric and sulphuric acid (HNO3 and H2SO4) is only slight, atmospheric oxidation of NO_2 and SO_2 causes formation of strong acids. Then, they are removed from the air by rainfall and cause soil erosion.

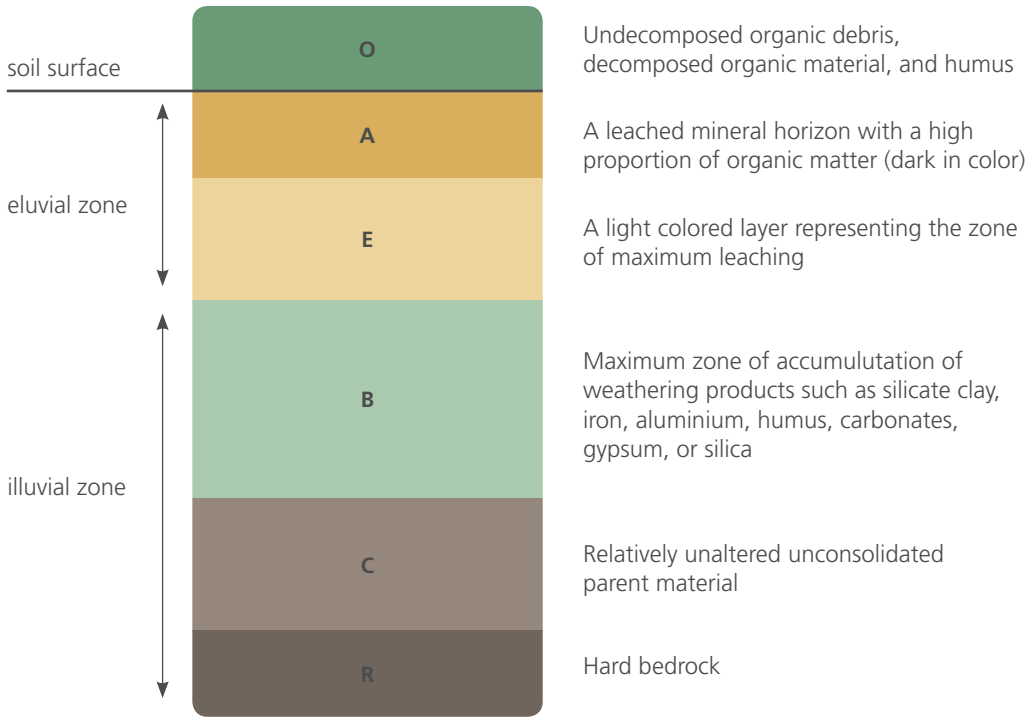


Figure 4 Visual representation of leaching and soil horizons

This brings me to my next point….Soil formation. Soil is an elaborate cluster of solid, liquid and gaseous phases, integrated physically and chemically. The most heterogeneous component, that of solid matter, comprises inorganic particles of silica, **silicate clay**, metal oxides of several sizes, and other minor components all associated with organic material. Here, you can a schematic representation of soil horizons (Figure 4). Starting from the top, we can see the surface layers, the topsoil, the subsoil, the parent material and the bedrock underneath. By the way, there are many more horizons than these ones…

According to Baldwin (1962) the concept of the rock cycle was originally attributed to James Hutton, from the eighteenth century *Father of Geology*. Formation of soil is thanks to the **modification** of geological material over eons. Biological, topological and climatic parameters interact with the parent material and cause this modification. As such, rocks can be classified as igneous, sedimentary and metamorphic. Granite, an igneous rock, is attributable to the

solidification of molten magma erupted by volcanoes and often deemed as the primary material of soil formation. Weathering accounts primarily for the physical and chemical breakdown and redistribution of **igneous** rock such as granite. **Sedimentary** rocks are formed from the deposition of weathering products of other rocks. Not surprisingly, the influence of heat and/or pressure on igneous or sedimentary rock reinforces the ongoing precipitation of the rock material and gives rise to **metamorphic** rocks. … *[this section of lecture content is removed]*… Well, that more or less wraps thing up for today. Remember to submit your report on the platform by next Thursday.

References

1 Baldwin B. (1962) The rock cycle. *Journal of Geological Education*, Vol. 10, No. 1, pp. 9-12.

2 Bothe H. et al. (2007) *The Biology of the Nitrogen Cycle.* Elsevier publication: The Netherlands.

3 Lins H.F. (2005) Observed Trends in Hydrologic Cycle Components of Hydrological Sciences, section 197, In M G Anderson, 2005. *Encyclopaedia of Hydrological sciences.*

4 Pagano T. and Sorooshian S. (2002) Hydrologic cycle in Volume 1: The Earth system: physical and chemical dimensions of global environmental change. In Mac Cracken and Perry (Eds.) (2002) *Encyclopaedia of Global environmental change. pp 450-464*.

5 Shiklomanov I.A. and Penkova N.V. (2003) Methods for assessing and forecasting global water use and water availability. *In World Water Resources at the Beginning of the 21st Century*, Shiklomanov I.A. and Rodda J.C. (Eds.), Cambridge University Press: Cambridge, pp. 27–44.

6 Stevenson. F. J. and Cole M.A. (1999) *Cycles of Soils: Carbon, Nitrogen, Phosphorus, Sulfur, Micronutrients* Wiley: New York.

Task 4 In groups, read the references used by the lecturer and identify the types of sources used. Why is the lecturer using them?

Task 5 In pairs, complete the table after you work out the pattern this lecturer follows for the selected referencing style. Is the pattern and formatting always the same? Why? Why not?

1	Authors name	Baldwin
2	Initials of First and/or Middle name	B.
3		
4		
5		

Task 6 Identify the in-text citations used by the lecturer. In pairs, work out the formatting rules that apply to citations. Are there any other alternatives?

Vocabulary building

Task 7 Match the following terms with their definition: organic matter / weathered / matrix / leaching / interaction / modification / re-cemented.

- making (liquid) pass through soil, ore, ash etc.
- living matter
- a slight change or improvement
- having an effect on each other
- covered again with cement
- having its shape changed due to temperature, rain and/or wind.
- mass of rock in which minerals are found in the ground.

Task 8 Match the verbs below with the words or phrases they can be used with.

a	Pollutant	the rock
b	Initiate	chemical integrity
c	Disintegrate	emissions
d	Retain	the weathering
e	Upset	organic debris
f	Deplete	the modification
g	Produce	molten magma
h	Effect	the nutrients
i	Solidify	the established equilibrium

Task 9 Use the words or phrases listed above that best fit each space. Not all words are used.

a Rainfall, strong winds and thawing ..... of igneous rocks.

b Rocks which have been fragmented from weathering might ..... their .....

c Geological and climatic processes ..... of the composition of soil.

d On combustion, ... of sulphur dioxide can alter the composition of air.

e Water is the driving force of the rock cycle since it ..... its weathering.

f Igneous rocks are the outcome of volcanic eruptions. After the ....., the ..... layers are ..... and the geological materials are modified.

g Chemical disintegration brings forth several changes and upsets .....

Task 10 In pairs, complete the table with appropriate nouns verbs or adjectives.

VERB	NOUN	ADJECTIVE
		associated
modify		
		composed
lead (to)		
		deposited
	origin	
depend		
distinguish		
		derivative
		dispersed

Task 11 Use the words listed in the table to fill in the gaps. Not all the words are used.

a Weathered rocks are ..... in the oceanic ground.

b Atmospheric and geological processes constantly ..... the soil material.

c Layers that make up soil are ..... Thus, we can denote them according to their composition.

d The ..... of igneous rocks is caused by the wind. They are distributed till they settle to the bottom of the oceans.

e The heat and pressure on sedimentary material ..... to an uplift of metamorphic rocks.

f The properties of each horizon ..... on its formation process.

g Soil is composed of inorganic components, which are all ..... to an extent with organic ones.

Word choice: CONFUSING WORDS

Some general academic words can be confusing in a scientific context either because they sound similar or because they have very similar connotations.

Task 12 Choose one of the following words to complete the gaps.

a (Far, by far)
Weathered feldspars are ..... the most common in igneous rocks.

b (Alter, modify)
The complex system of soil is constantly ..... due to geological processes, pressure, heat, and weathering.
Before sedimentary rocks are turned into metamorphic ones, their overall structure has .....

c (Derive from, originate from)
It is not certain whether the material that constitutes the C horizon ..... from horizons A and B.
The coarse-grained material ..... from free silica.

d (Range, disperse)
Horizons (layers of precipitated soil) in profile ..... according to their physical and chemical processes. The depth of a horizon also varies; it can ..... from a few centimetres to over a meter.
The wind ..... the rocks which precipitate and become deposited sediments.

e (Prevail, lead)

As far as soil composition is concerned, inorganic particles ..... upon organic ones.

f (Precipitate, compact)

Sediments after being transported and deposited they gradually ..... Then, in order to form sedimentary rock they ..... due to pressure and heat.

g (formation, creation)

The oxidation of Nitrogen and sulfur lead to the ..... of atmospheric acids.

Atmospheric acids lead to the ..... of several bio-hazards.

Grammar

Adverbs

Position of adverbs of place, time, manner, degree, frequency, certainty and viewpoint:

- Adverbs of manner, place and time are generally put at the end of the sentence in the given order: manner-place-time. Yet, in chemistry papers, adverbs of manner tend to follow the verb:

  The sample was collected three months **ago**. (time)
  All the in-vitro measurements were taken **locally**. (place)
  This non-corrosive monomer reacts **favourably** with most polyolefins. (manner)

- Opinion adverbs are often put at the beginning of a sentence or after the verb:

  Surprisingly, the figures dropped.

  Mango peel extract exhibits **remarkably** potent antioxidant properties.

- Adverbs of degree, frequency and certainty are put after the verb to be and after auxiliary verbs. They go before all other verbs.

Most anti-viral drugs are **normally** used as viral nucleic acid synthesis inhibitors.

Unclear instructions **occasionally** upset operations.

One-Pot synthesis is **highly** demanded.

The concentration of prevalent volatile organic compounds varied **considerably** in urban micro-environments.

Task 13 Read the text carefully and answer the questions.

a What kind of adverbs are they? What's their word order?

b What other adverbs are used by the lecturer?

Task 14 Put the adverbs in the correct place in the sentence. Sometimes more than one answer is possible.

a Dalton's theory has been used to explain a vast number of observations. (successfully)

b All the mass of an atom is due to the neutrons and protons. (virtually)

c The chemical properties of an element depend on the numbers of protons and electrons, not the number of neutrons. (mainly)

d Figures are given within a range expected to work. (normally)

e Minerals that contain uranium or thorium are radioactive. (invariably)

f The properties of some substances are discovered in accidental ways. (Occasionally)

g Integer is an approved name for n. (officially)

h When two plates collide, stresses may be released in an earthquake. (suddenly)

Adverbs of degree

Scientists often use a variety of adverbs in order to describe the different degrees or the scale of what is being observed as accurately as possible. They frequently use some of the following words:

considerably	greatly	roughly
dramatically	hardly	significantly
extremely	highly	substantially
fairly	little	thoroughly
fully	minimally	virtually

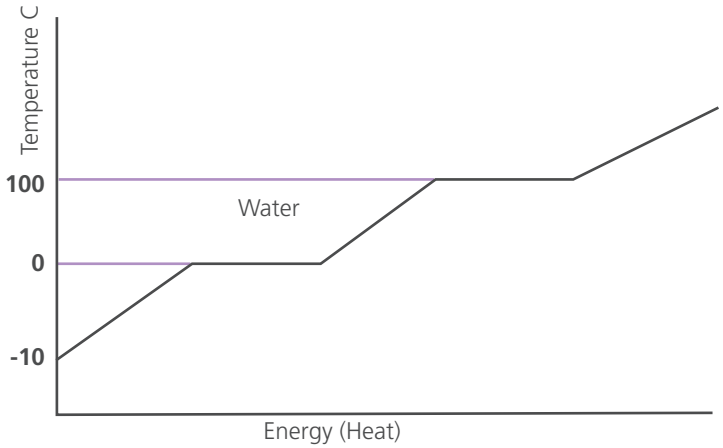
Task 15 Use the scale below to arrange the adverbs of degree from the least to the greatest. Put synonyms in the same numbers.

Water Phases

Here is a diagram for the heating phases of water, a handy way of summarising a great deal of information. We will use the diagram of water at 1 atm pressure as an example.

Listening

Task 6 Look at the diagram, listen to the lecture and take notes.



Task 17 Listen again and say whether the following statements are true or false. Correct the false ones.

1 The melting point is the temperature at which ice (a solid) changes to water (liquid).

2 The boiling point is the temperature at which a liquid changes to a solid.

3 The condensation point is the temperature at which a gas changes into a solid.

4 The freezing point is the temperature at which a gas changes to a liquid.

5 The sublimation point is the temperature at which a solid changes to a gas.

6 The melting point is the temperature that reaches absolute zero.

Scientific writing generally features more nouns than verbs since using nouns tends to make your writing more formal. Nouns are often used to describe trends, properties or general processes or introduce the topic in a paragraph. Notice the differences in style.

The degradation of VOC greatly increases the chance of formation of secondary pollutants and a subsequent deterioration of air quality.

When VOCs degrade, they fend to form secondary pollutants which deteriorate air quality.

The ability of thermoplastic polymers to melt and re-harden has been exploited in many different processing methods.

Thermoplastic polymers can melt and re-harden. This has been exploited in many different processing methods.

Task 18 Complete the missing words in the table.

VERB	NOUN
sublime	
condense	
evaporate	
freeze	
melt (into)	
vaporize	
boil	
change	
solidify	

Task 19 Complete the following sentences with the missing noun.

According to the literature, the ..... (extrude) process is generally accompanied by fibre fracture.

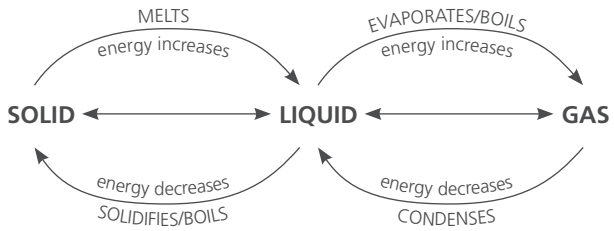
Consideration of this method is preferable when the processing method and high mechanical ..... (resist) and good dimensional ..... (stable) are taken into account.

The sheer ..... (vary) of renewable raw materials and the ..... (diverse) of their chemical structures leads to a wide range of applications.

The successful FT-Raman spectroscopy application for the ..... (identify) of carotenoids in food products without any preliminary sample ..... (prepare) is evident in the literature.

Writing

Task 20 Look at the diagram and using as many nouns as possible write a description of the changes of state that water can go through if the changes of temperature are as follows:



- -10…0…100
- -10…100
- 100…0…-10

Use the diagram and some of the phrases below in your report:

The temperature reaches 10 degrees

The water remains at 100 C as….

When/After/By the time the temperature increases up to…/drops down to…

As more heat/energy is removed/supplied, it is observed that…

It is discernible that…

Listening

Nitrogen cycle

Task 21 Listen to the description of the nitrogen cycle and complete the missing nouns that describe different states, processes and stages during the cycle.

1 The nitrogen cycle is vital for organisms, it is a key ..... in amino acids and nucleic acids.

2 As it contains lots of nutrients, nitrogen is widely used as an organic ..... Ammonia is one of the most common elements containing nitrogen.

3 A variety of nitrogen fixing bacteria facilitate the ..... of atmospheric nitrogen gas into ammonia and into the ammonium ion.

4 Plants' ..... of ammonium and absorption is achieved through ammonification.

5 Nitrification involves the ..... of Nh4+ ions to No2- ions by microorganisms in order to acquire energy.

6 ..... of inorganic nitrogen in arid climates will lead to ..... of No2 in the soil.

7 In moist climates, where ..... exceeds evapo-transpiration, No3 leaching may occur.

8 Several factors determine the rate of denitrification; water ..... in soil, temperature and ..... of decomposable organic matter.

9 During denitrification, ... of oxygen in the soil is retarded or inhibited if the soil is **saturated** with water.

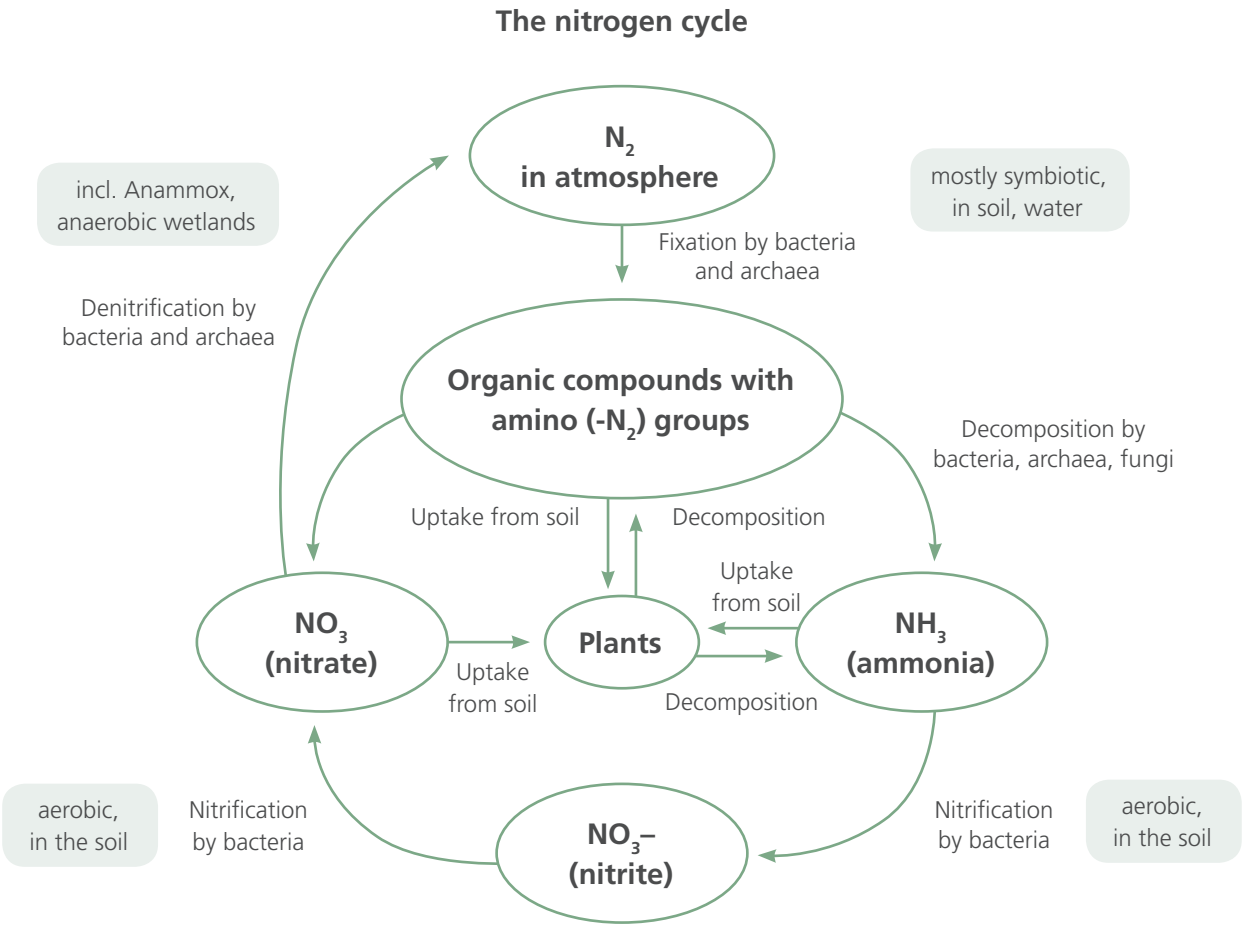


Figure 5 Visual representation of the Nitrogen cycle

Grammar

Present tenses: Avoiding the progressive aspect

Task 10 Read the following examples and say which phrase in bold is:

- The **present continuous** describes actions in progress or fixed arrangements for the near future.:

  I am conducting an experiment at the moment.

  I am seeing my doctor tomorrow.

- The **present simple** describes:

  **Habitual actions, permanent states and/or trends: e.g. Formed by a constant shifting of continental plates, sedimentary rocks grow at relatively constant rates.*

**Laws of nature: e.g. As for any liquid, the evaporation speed of a lake depends on the temperature of the liquid and its exposed surface area.*

**The purpose of experimental work, Scientific facts, definitions and instructions: e.g. The sublimation point is the temperature at which a solid changes to a gas.*

**Time expressions: usually, often, always, rarely, never, occasionally etc.: Arctic icebergs often resemble jagged floating mountains*

- **Stative verbs** describe a state and do not have a continuous form. Stative verbs are related to:

  Preferences and dislikes: like hate love prefer, detest, loath, resent

  Senses: see, hear, smell, taste, and feel

  Thinking/perception: Think, agree, expect, consider, believe etc.

  Emotions and feelings: feel, forgive, like, wish, hate etc.

  Other: appear, resemble, look, possess/ own, contain, be, belong, matter etc.

Task 22 **Present simple or present continuous? Put the verbs in brackets in the correct form.**

a A pure substance ..... (have) a sharp melting point. An impure substance ..... (contain) impurities and ..... (melt) at a lower temperature and over a range of temperature.

b Changes which ..... (take) place when materials are heated or cooled may be temporary (e.g. melting ice) or permanent (e.g. burning paper).

c How ..... we ..... (know) that intermolecular forces tend to bring order to the movements of molecules?

d When a change of state ..... (occur) there is an associated energy change.

e Authorities ..... now ..... (control) the use of CFCs as refrigerants, as these chemicals destroy the ozone layer.

f Industrial chemistry scientists ..... (believe) that extracting metals from metal ores, has now become an important industry worldwide.

g Bases ..... (taste) bitter and ..... (feel) slippery or soapy on fingers. Acids, on the other hand, have a sour taste.

h The state in which a substance ..... (exist) is the result of the competition between intermolecular forces, which ..... (keep) molecules together, and heat energy, which ..... (move) them apart.

i This reaction of quicklime and water is so vigorous! Look! It ..... so much heat that the whole desk is about to catch fire ! Fetch the fire extinguisher! Quick!

j From bottles and filters to vessels and cryoware, we ..... (design) and ..... (manufacture) products for use in biotech, life science and general laboratory applications.

k The products ..... (be) lighter in weight than glass and ..... (protect) against leakage, breakage, and contamination.

l If you ..... (practice) as a separation scientist you will be eager to know what ..... (happen) this year in the *Chromatographic society*.

m We ..... (currently/organise) a colloquium to be held in the Department of Chemistry at the University of Crete on 30th September 2005.

n Our lab ..... (launch) a new coating thickness analyser designed for enhanced performance.

o Our delegates ..... (demonstrate) and ..... (display) the latest equipment the first day of the integrated exhibition.

p The meeting ..... (comprise) lectures, posters and an exhibition.

q The Chromatographic society ..... (occupy) a privileged position in the world of separation technique conferences.

r At present, our team ..... (study) proteins which could potentially offer interesting new insights of drug targeting in type 2 diabetes.

s Industry ..... (look) more and more to outsourcing its analytical and testing needs to contract laboratories. This ..... (place) a need for flexible and error-free means of handling sample information and results on those laboratories.

t Viscous liquids often ..... (clog) and ..... (foul) conventional plate heat exchangers.

u GLC is a new Solvent evaporation system that ..... (reduce) the labor associated with sample determiners and ..... (eliminate) time-consuming sample handling.