Edexcel GCSE Biology

Your notes

Cycles within Ecosystems

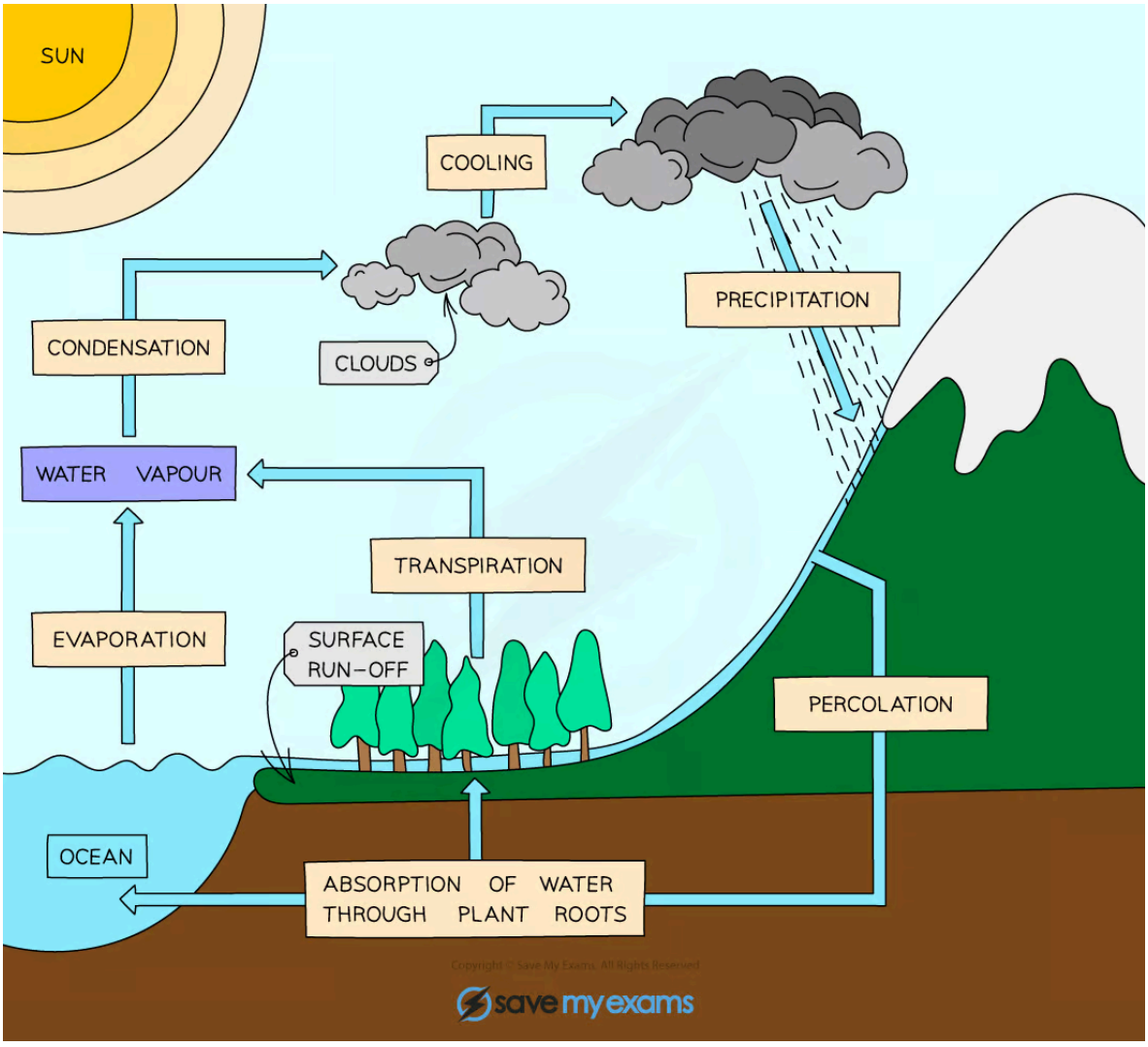
Contents

The Water Cycle

Your notes

The Water Cycle

- Water molecules move between various locations – such as rivers, oceans and the atmosphere – by specific processes
- This is possible because water changes state at a relatively low temperature



The water cycle

- **Water enters the atmosphere as water vapour in one of two processes**

- Energy from the Sun heats the Earth's surface and water **evaporates** from oceans, rivers and lakes
- **Transpiration** from plants releases water vapour into the air

- **The warmer air of the lower atmosphere rises, taking the water vapour with it**
  - The moist air cools down as it rises
  - Water vapour **condenses** back into liquid water, forming **clouds**
- **Water returns to earth in the form of precipitation**
  - As the water droplets in the cloud get **bigger and heavier**, they begin to fall as **rain, snow and sleet**
  - This is called **precipitation**

The importance of the water cycle

- All life on earth depends upon water for a variety of reasons, this includes **photosynthesis**
- The water cycle, therefore, is a fundamental process for all living things as it distributes fresh water globally providing us with clean water for drinking

Dealing with drought

- In some areas, drought may become an issue as it means that populations living in those areas would not have access to the **potable water** they require
- One way to manage this is through **desalination** of salty water such as sea water
  - Desalination means removing the **excess mineral ions** (salts) from the water to make it drinkable
  - There are several ways of removing these salts
    - **Distillation** - saline water is **boiled,** the water vapour is funnelled through a tube before it is **condensed** and the pure water is collected
    - **Reverse osmosis** - saline water is forced at **high pressure** through a **partially permeable** membrane which filters out all the mineral ions leaving pure water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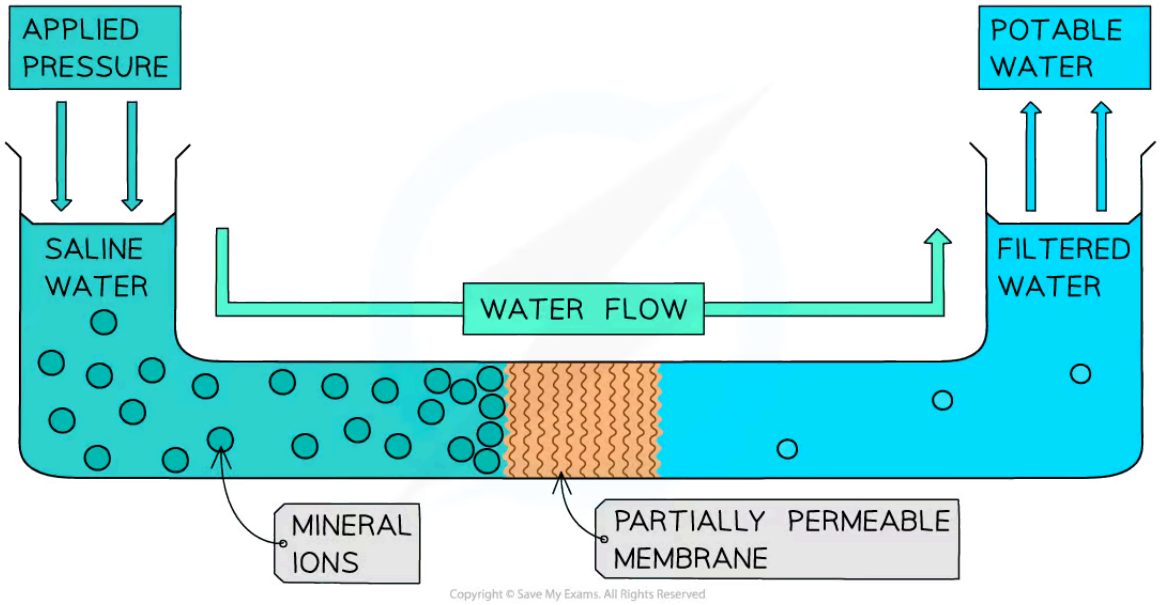


Reverse osmosis can be used for desalination of sea water

Your notes

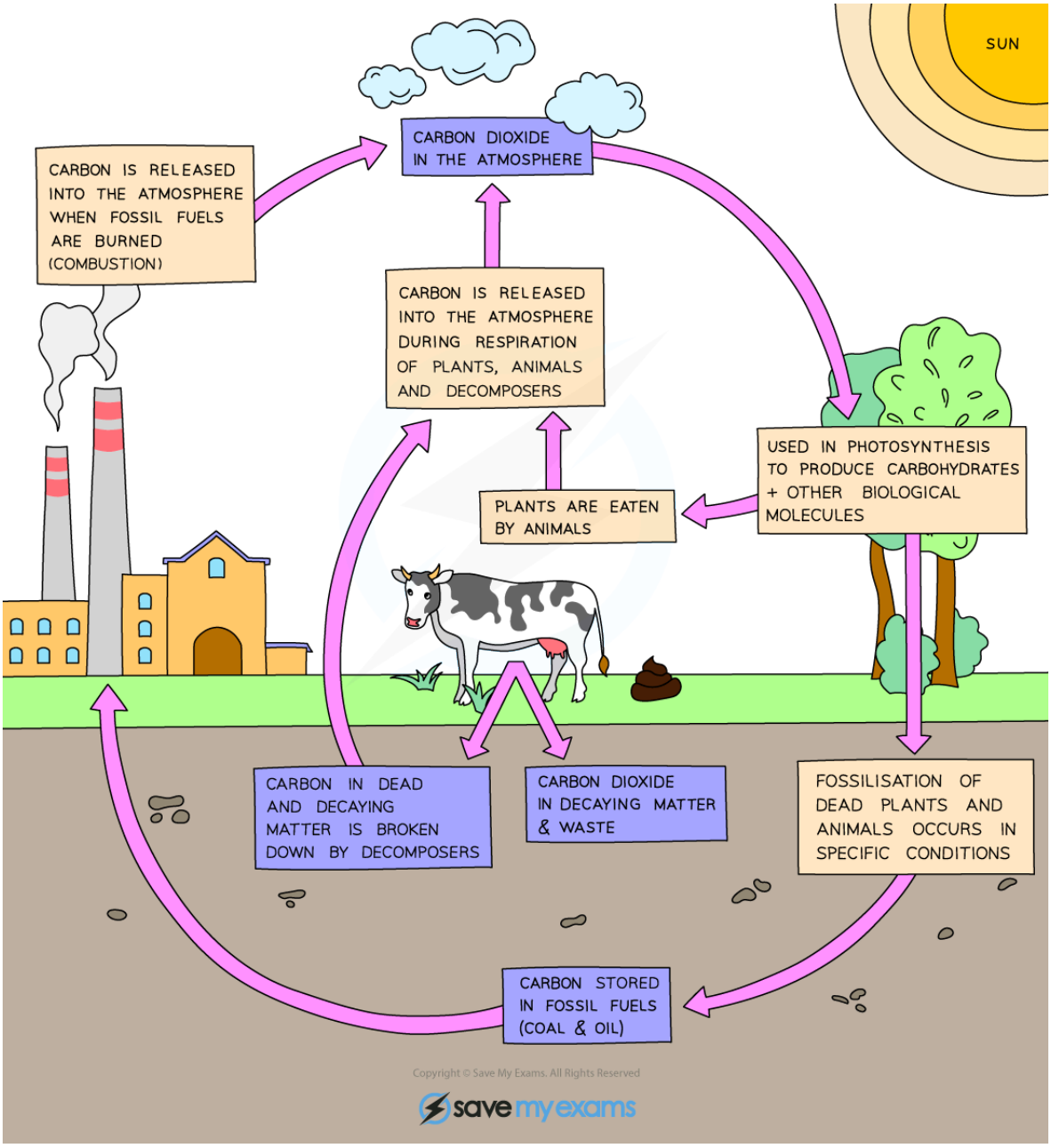
The Carbon Cycle


Your notes

The Carbon Cycle

- Nutrients such as **carbon** and **nitrogen** are not endless resources, and so, they need to be **recycled** in order to allow new organisms to be made and grow
  - **Carbon** is taken out of the atmosphere in the form of **carbon dioxide** by plants to be used for photosynthesis
  - It is passed on to animals (and microorganisms) by **feeding**
  - It is returned to the atmosphere in the form of **carbon dioxide** by plants, animals and **microorganisms** as a result of r**espiration**
  - If animals and plants die in conditions where **decomposing microorganisms** are not present the carbon in their bodies can be converted, over millions of years and significant pressure, into **fossil fuels**
  - When fossil fuels are burned (the process is known as **combustion**), the carbon combines with oxygen and **carbon dioxide is released** into the atmosphere
    - **Increased use of fossil fuels** is contributing to an increase in the carbon dioxide content of the atmosphere
  - In addition, **mass deforestation** is **reducing the amount of producers** available to take carbon dioxide out of the atmosphere by photosynthesis
    - This problem is exacerbated by the fact that in many areas of the world, deforestation is taking place for land rather than for the trees themselves, and as such they are **burnt down, releasing yet more carbon dioxide into the atmosphere**

Your notes



The carbon cycle

The importance of the carbon cycle

- Carbon is a component of all **organic molecules**, many of which are essential for life on earth, such as **glucose**

- The Carbon cycle is a key process which allows the movement of carbon between global reservoirs including the
  - Atmosphere
  - Biomass
  - Ocean
  - Soil
- The **balance of carbon** between these reservoirs is fundamental due to the role that carbon plays in sustaining life
  - If the balance is disrupted, somewhere along the way **organisms** will suffer
  - **Global warming** is an large scale example of the effect which may be seen if the global carbon balance is disrupted

Examiner Tips and Tricks

The carbon cycle is simple:

- Carbon is taken out of the atmosphere by photosynthesis
- It is passed on to animals and decomposers by feeding
- It is returned by respiration; in plants, in animals and in decomposing microorganisms
- In addition, it is returned (in increasing amounts) by the combustion of fossil fuels

You should be able to identify what each arrow represents in any diagram of the carbon cycle.

Your notes

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The Nitrogen Cycle

- The nitrogen cycle shows how nitrogen is recycled in ecosystems
- Plants and animals require nitrogen in order to produce **proteins** and **nucleic acids** (DNA and RNA)
- About 78% of the atmosphere is actually **nitrogen gas** but plants and animals **cannot** access the nitrogen in this gaseous form
  - Instead, they rely on certain **bacteria** to convert the nitrogen gas into **nitrogen-containing compounds**, which can be taken up by plants
- The nitrogen cycle shows this conversion, as well as how the nitrogen in the nitrogen-containing compounds is then passed between trophic levels or between living organisms and the non-living environment

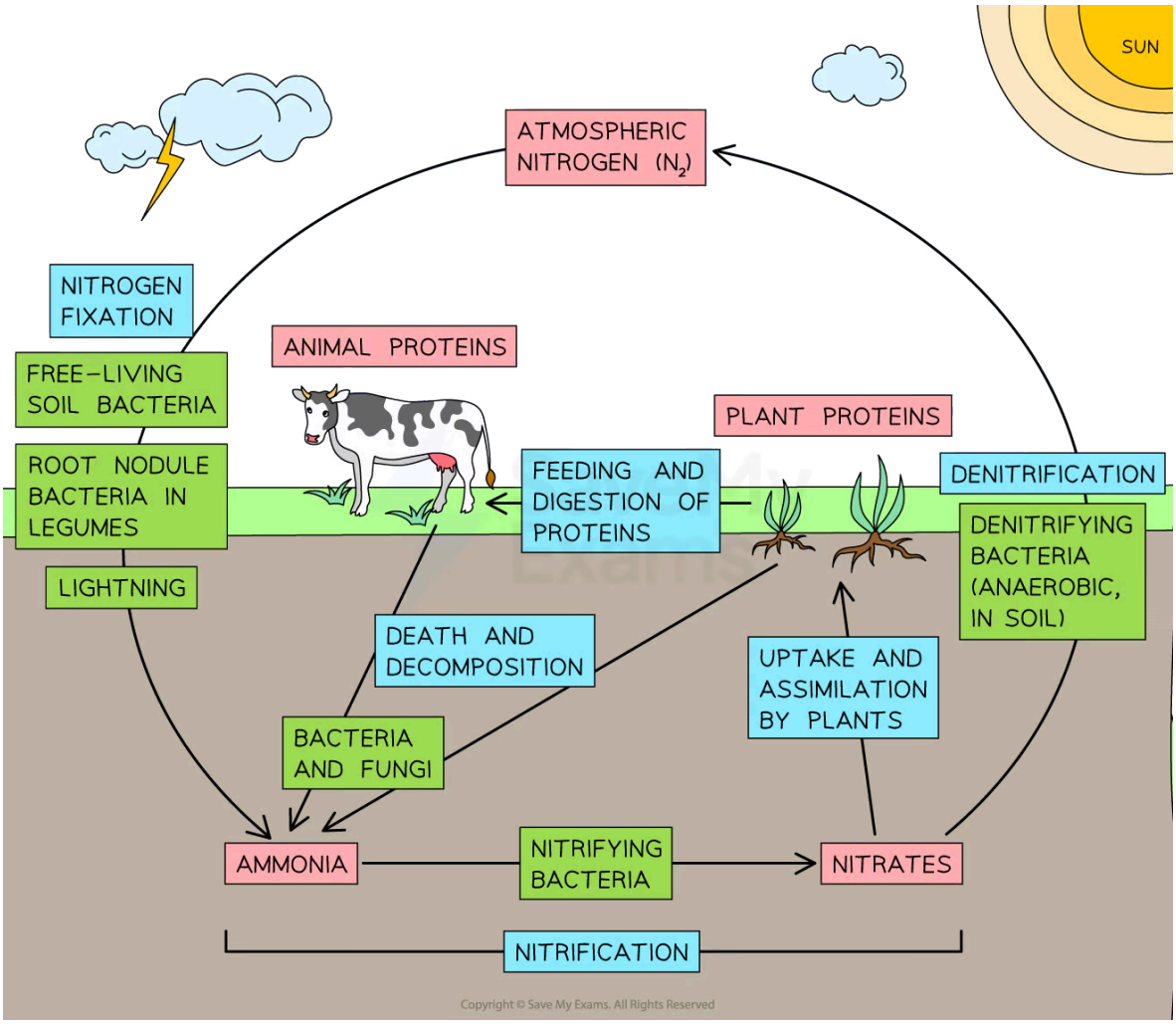
The role of bacteria in the nitrogen cycle

- There are **four** key processes in the nitrogen cycle that are carried out by **different types of bacteria**
- **Nitrogen fixation**:
  - **Nitrogen fixing bacteria** convert N_2 gas into ammonium compounds, which can then be converted to usable **nitrates**
    - Nitrogen fixing bacteria can be free-living in the soil or can live within the root nodules of some plants
  - **Lightning** can also split the bond between the two N atoms, turning them into nitrous oxides like N_2O and NO_2 that dissolve in rainwater and leach into the soil
- **Ammonification**:
  - Nitrogen compounds in **waste products** (e.g. urine and faeces) and **dead organisms** are converted into **ammonia** by **saprobionts**
    - These are decomposers, e.g. fungi and bacteria
  - This ammonia forms **ammonium ions** in the soil
- **Nitrification**:
  - The ammonium ions in the soil are converted by **nitrifying bacteria** into nitrogen compounds that can be used by plants, known as **nitrates**
    - Initially, nitrifying bacteria convert ammonium ions into **nitrites**

- Different nitrifying bacteria then convert these nitrites into **nitrates**

- **Denitrification**:
  - Denitrifying bacteria use **nitrates** in the soil during **respiration**
  - This process produces **nitrogen gas**, which returns to the **atmosphere**
  - This process occurs in **anaerobic** conditions (when there is little or no oxygen available, such as in waterlogged soil)

Your notes



The nitrogen cycle involves nitrogen fixation, decomposition, nitrification and denitrification

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Decomposition & Decay

- **Temperature, water and availability of oxygen** affect the rate of decay of biological material
- Decomposition (also known as decay or rotting) is the breaking down and digestion of biological material (**waste products** and **dead organisms**) by organisms called decomposers
- Decomposers include microorganisms (**bacteria** and **fungi**) and **detritus feeders**
- Decomposition is a crucial process as it ensures that materials such as carbon and mineral ions are **recycled** and **returned** to the environment
  - Remember, there is a finite (fixed) number of elements on Earth, new atoms cannot be created out of nothing!
- The **rate of decay** is the **speed** that **decomposers** break down biological material and is affected by three key factors:

Factors Affecting Rate of Decay Table

Your notes

Factor	How factor affects the rate of decay
Temperature	• At warmer temperatures, **enzymes** involved in decomposition can work at a faster rate, increasing the rate of decay. • If the temperature is too high, these enzymes will **denature** and the rate of decay will decrease. • At low temperatures, the enzymes involved in decomposition work slowly, decreasing the rate of decay — this is why we keep food in a fridge.
Water	• Decomposers require water to survive (water being essential for certain biological processes). • Many decomposers also function by **secreting enzymes** onto decaying biological matter and **absorbing** the **products** of this chemical digestion – without water these reactions cannot occur. • As water availability decreases, so does the rate of decay.
Availability of oxygen	• Oxygen is needed by many decomposers for **aerobic respiration** – without oxygen, they cannot survive. • For these decomposers, the rate of decay decreases as oxygen availability decreases. • However, some microorganisms can **respire anaerobically** (they don't require oxygen to survive), resulting in **anaerobic decay** (such as in biogas generators).

Uses of decomposition

- **Compost** can be used as a **natural fertiliser**
- Gardeners and farmers try to provide **optimum conditions** (warmth, moisture and an oxygen supply) for **rapid decay** of waste biological material (eg. waste plant matter)
- The **compost** produced is used as a **natural fertiliser** for growing garden plants or crops
- Once the compost is spread onto the soil, it is broken down further by decomposing **microorganisms** (bacteria and fungi) and detritivores (eg. earthworms and woodlice)

- This ensures the **recycling of minerals** (such as magnesium and nitrates) that can then be absorbed by plants to be used for growth (magnesium is used to make chlorophyll, nitrates to make amino acids)


Your notes

Slowing down decomposition

- Food can be preserved by storing it in conditions which do not allow decomposition e.g. low temperature, no oxygen or no water
  - **At low temperatures**, such as in a **fridge**, activity and reproduction of microorganisms and the chemical reactions involved in decomposition occur very slowly
    - In a **freezer,** this activity is stopped completely
  - The **sterile conditions** used to create **tinned food** and the way that the food is sealed, prevents access for microorganisms
  - **Vacuum packed food** has all the **air removed** which means that microorganisms can not respire and therefore cannot grow or reproduce
  - **Dried foods** lack the **water** required by microorganisms for survival and reproduction
    - Similarly storing food in brine or sugar solutions causes water to move out of microorganisms by **osmosis** so they do not have the water that they require

Calculating the rate of Decay

- When studying rates of decay, you should be able to:
  - Calculate rate changes in the decay of biological material
  - Translate information between numerical and graphical form
  - Plot and draw appropriate graphs selecting appropriate scales for the axes

Worked Example

A student is investigating rate changes in the decay of milk. They incubated milk at three different temperatures and recorded the pH every 24 hours. Their results table is shown below.Calculate the rate of change in pH of the milk in each 24 hour period for each of the three temperatures.Draw a graph of the results.

Your notes

	0 hours	24 hours	48 hours	72 hours
10 °C	6.5	6.3	6.2	5.9
20 °C	6.5	6.0	5.4	4.7
30 °C	6.5	5.0	4.7	4.7

TO CALCULATE THE RATE OF CHANGE WE FIRST NEED TO WORK OUT HOW MUCH THE pH VALUE CHANGED OVER EACH 24 HOUR PERIOD. THIS IS CALCULATED BY FINDING THE DIFFERENCE BETWEEN THE CURRENT pH VALUE AND THE PREVIOUS pH VALUE:

NO CHANGE AT 0 HOURS AS NO TIME HAS PASSED SO THE pH HAS NOT CHANGED

CURRENT pH VALUE

PREVIOUS pH VALUE

CHANGE IN pH VALUE

	0 hours	24 hours	48 hours	72 hours
10 °C		6.5 – 6.3 = 0.2	6.3 – 6.2 = 0.1	6.2 – 5.9 = 0.3
20 °C		6.5 – 6.0 = 0.5	6.0 – 5.4 = 0.6	5.4 – 4.7 = 0.7
30 °C		6.5 – 5.0 = 1.5	5.0 – 4.7 = 0.3	4.7 – 4.7 = 0

YOU CAN NOW CALCULATE THE RATE OF CHANGE FOR EACH 24 HOUR PERIOD BY DIVIDING EACH CHANGE IN pH BY THE TIME TAKEN FOR THIS CHANGE TO OCCUR:

RATE OF CHANGE = CHANGE IN VALUE ÷ CHANGE IN TIME

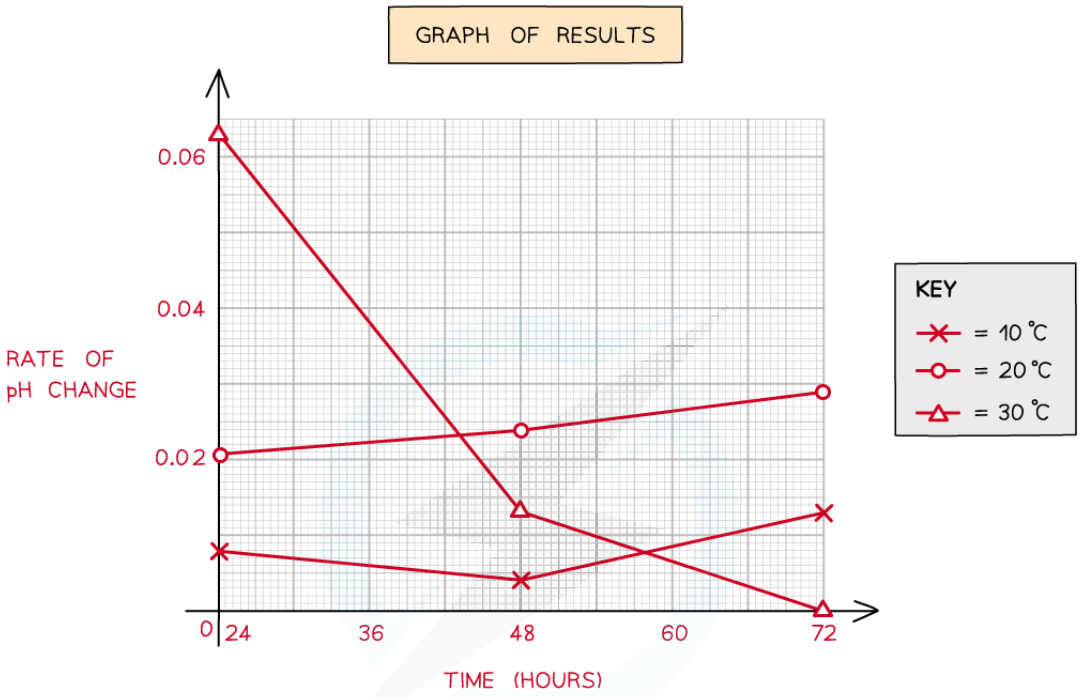
CHANGE IN pH VALUE

TIME TAKEN FOR CHANGE TO OCCUR

	24 hours	48 hours	72 hours
10 °C	0.2 ÷ 24 = 0.0083	0.1 ÷ 24 = 0.0042	0.3 ÷ 24 = 0.013
20 °C	0.5 ÷ 24 = 0.021	0.6 ÷ 24 = 0.025	0.7 ÷ 24 = 0.029
30 °C	1.5 ÷ 24 = 0.063	0.3 ÷ 24 = 0.013	0 ÷ 24 = 0

RATE OF CHANGE IN pH

Your notes



GRAPH TIPS:

- ENSURE YOUR GRAPH TAKES UP AT LEAST HALF THE SPACE YOU ARE GIVEN
- ENSURE AXES SCALES GO UP IN SUITABLE MULTIPLES
- ENSURE AXES HAVE LABELS AND UNITS
- ENSURE DATA POINTS ARE PLOTTED ACCURATELY
- INDEPENDENT VARIABLE ON x-AXIS
- DEPENDENT VARIABLE ON y-AXIS