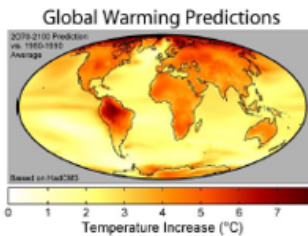# Biodiversity L80-87

Factors affecting food security

Enough food is needed to feed a changing population

- Increasing birth rate.
- Changing diets in developing countries.
- New pests and pathogens affecting farming.
- Environmental changes e.g. famine when rains fail.
- Cost of agriculture input.
- Conflicts (war) affecting water of food availability

Global warming

Levels of CO_2 and methane in the atmosphere are increasing.

Decreased land availability from sea level rise, temperature rise damages delicate habitats, extreme weather events harm populations of plants and animals.

There is a global consensus about global warming and climate change based on systematic reviews of thousands of peer reviewed publications.

Global warming

Global Warming Predictions

Temperature Increase (°C)

Food production (biology only)

AQA GCSE ECOLOGY PART 2

Maintaining biodiversity

Human activity can have a positive impact on biodiversity

Scientists and concerned citizens

Put in place programmes to reduce the negative impacts of humans on ecosystems and biodiversity

- Breeding programmes for endangered species.
- Protection and regeneration of rare habitats.
- Reintroduction of field margins and hedgerows in agricultural areas where farmers grow only one type of crop.
- Reduction of deforestation and CO_2 emissions by some governments.
- Recycling resources rather than dumping waste in landfill.

Some of the programmes potentially conflict with human needs for land use, food production and high living standards.

Farming techniques

Increasing efficiency of food production

Reduce energy waste, limiting movement, control temperature, high protein diet to increase growth.

Sustainable fisheries

Fish stocks in oceans are declining

Maintain/grow fish stocks to a sustainable level where breeding continues or certain species may disappear. By controlling net size, fishing quotas.

Some people have concerns about the treatment of animals.

Biotechnology

Meeting the demands of a growing population

Fungus *Fusarium* to produce mycoprotein. Requires glucose syrup, aerobic conditions. Biomass is harvested and purified.

GM bacterium produces insulin to treat diabetes.

GM crops to provide more/nutritional food (golden rice).

Biodiversity L80-87

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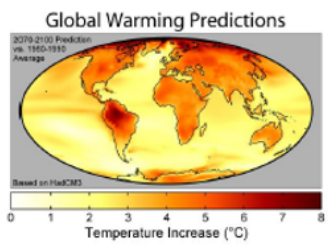- Conflicts (war) affecting water of food availability

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Global Warming Predictions

2070-2100 Prediction vs. 1960-1990 Average

Based on HadCM3

Temperature Increase (°C)

Global warming

Food production (biology only)

AQA GCSE ECOLOGY PART 2

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AQA GCSE HOMEOSTASIS AND RESPONSE part 1

The Eye (Bio only)

Sense organ containing receptors sensitive to light intensity and colour

Structures of the eye

Retina	Light sensitive cell layer.
Optic nerve	Carries impulse to brain.
Sclera	Protects the eye.
Cornea	Transparent layer that covers the pupil and iris.
Iris	Pigmented layer, controls size of pupil.
Ciliary muscles	Controls thickness of lens.
Suspensory ligaments	Connects lens to ciliary muscles.

The iris can dilate the pupil (aperture) to let in more light in dim conditions

Labels: suspensory ligament, sclera, retina, cornea, optic nerve, iris, ciliary muscles

Accommodation is the process of changing the shape of the lens to focus

Near object	Far object
Ciliary muscles contract, suspensory ligaments loosed, lens get thicker, light is more refracted.	Ciliary muscles relax, suspensory ligaments pulled tight, lens pulled thin, light is only slightly refracted.

Hyperopia (long sightedness)	Myopia (short sightedness)
Treated using a convex lens so the light is focused on the retina.	Treated using a concave lens so light is focused on the retina.

New technologies now include hard/soft contact lens, laser surgery to change the shape of the cornea and a replacement lens in the eye.

Human control systems include

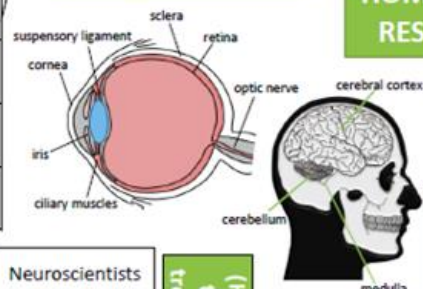|	
Cells called receptors	Detect stimuli (changes in environment).
Coordination centres	e.g. brain, spinal cord and pancreas that receive information from receptors.
Effectors	Muscles or glands, which bring about responses to restore optimum levels.

The human nervous system

Enables humans to react to their surroundings and to co-ordinate their behaviour

Labels: brain, spinal cord, nerves

Information from receptors passes along cells (neurones) as electrical impulses to the central nervous system (CNS)

The CNS is the brain and the spinal cord.

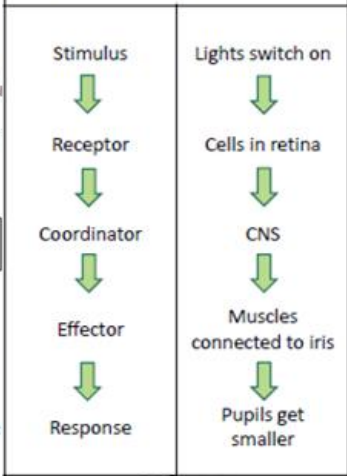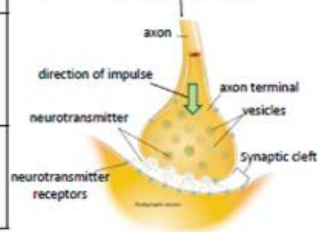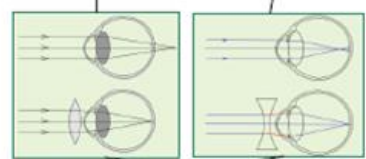Coordinates the response of effectors; muscles contracting or glands secreting hormones

The Brain (Bio only)

The brain controls complex behaviour. It is made of billions of interconnected neurones.

Labels: cerebral cortex, cerebellum, medulla

Neuroscientists have been able to map regions of the brain by studying patients with brain damage, electrical stimulation and MRI.

(HT) The complexity and delicacy of the brain makes investigating and treating brain disorders very difficult

**The brain has different regions that carry out different functions.**

Cerebral cortex	Largest part of the human brain. Higher thinking skills e.g. speech, decision making.
Cerebellum	Balance and voluntary muscle function e.g. walking, lifting.
Medulla	Involuntary (automatic) body functions e.g. breathing, heart rate.

Treating brain damage and disease

e.g. Lobotomy – cutting part of the cerebral cortex

Benefit: thought to alleviate the symptoms of some mental illnesses.

Risks: bleeding in the brain, seizures, loss of brain function. Procedure was abandoned in the 1950s due to risk.

Typical motor neurone. Labels: dendrites, cell body, nucleus, axon with insulating sheath, axon terminal

Synapse (gap where two neurones meet).

Labels: axon, direction of impulse, neurotransmitter, axon terminal, vesicles, synaptic cleft, neurotransmitter receptors

Stimulus	Lights switch on
Receptor	Cells in retina
Coordinator	CNS
Effector	Muscles connected to iris
Response	Pupils get smaller

Reflex arc

Receptor	Detect stimuli.
Sensory neurone	Long axon carries impulse from receptor to spinal cord.
Synapse	Gap where neurones meet. Chemical message using neurotransmitter.
Relay neurone	Allows impulses to travel between sensory and motor neurones in the spinal cord.
Motor neurone	Long axon carries impulse from receptor to effector.
Effector	Muscle or gland that carries out response.

Labels: spinal cord, sensory neurone, motor neurone, Action, pain receptors, muscle (effector), Source of heat
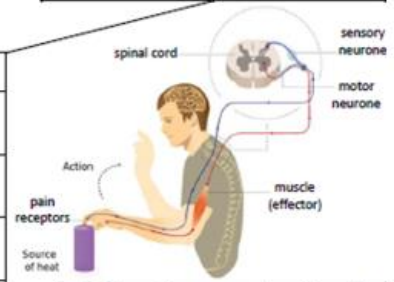
Reflex actions are automatic and rapid; they do not involve the conscious part of the brain and can protect humans from harm.

Response to internal and external change

Controls in the human body

Blood glucose concentration	These automatic control systems may involve nervous responses or chemical responses.
Body temperature	
Water levels	

The regulation of internal conditions of a cell or organism to maintain optimum conditions for function.

Homeostasis maintains optimal conditions for enzyme action and all cell functions.

Homeostasis

Water and nitrogen balance (Biology only)

If body cells lose or gain too much water by osmosis they do no function efficiently.	*Uncontrolled water/ion urea loss*	Water exhaled in lungs, water, ions and urea in sweat.
	Controlled water/ion/urea loss	Via the kidneys in urine.

Kidney failure is treated by organ transplant or dialysis.

Kidney function	*Maintain water balance of the body.*	Produce urine by filtration of the blood and selective reabsorption of glucose, ions and water.

A dialysis machine removes urea from the blood by diffusion while maintaining ion and glucose levels.

(HT only) ADH	*Acts on kidney tubules to control water levels.*	Released by pituitary gland when blood is too concentrated. Water is reabsorbed back into the blood from the kidney tubules **(NEGATIVE FEEDBACK).**

(HT only) digestion of proteins results in excess amino acids. In the liver they are de-aminated to form toxic ammonia which is converted to urea

Monitoring body temperature

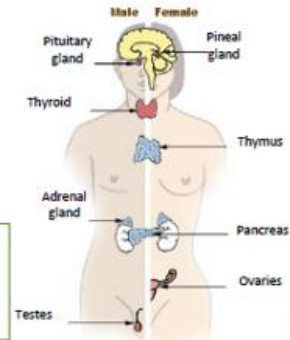| *Thermoregulatory centre*	Contains receptors sensitive to the temperature of the blood.
Skin	Contains temperature receptors, sends nervous impulses to the thermoregulatory centre.

Thermoregulatory centre (hypothalamus)

Control of body temperature (Biology only)

Body temperature

Too high	Blood vessels dilate (vasodilation), sweat produced from sweat glands.
Too low	Blood vessels constrict (vasoconstriction), sweating stops, muscles contract (shivering).

(HT) Thermal energy is lost from blood near the surface of the skin, sweat evaporates transferring thermal energy.

(HT) Thermal energy loss at the surface of the skin is reduced, respiring muscles cells transfer chemical to thermal energy.

AQA GCSE HOMEOSTASIS AND RESPONSE PART 2

Human endocrine system

Male Female
Pituitary gland, Pineal gland, Thyroid, Thymus, Adrenal gland, Pancreas, Ovaries, Testes

Endocrine system

Composed of glands which secrete chemicals called hormones directly into the bloodstream.	The blood carries the hormone to a target organ where is produces an effect. Compared to the nervous system effects are slower but act for longer.

Pituitary gland

'Master gland'; secretes several hormones into the blood	Stimulates other glands to produce hormones to bring about effects.

Control of blood glucose concentration

Negative feedback (HT only)

Adrenaline	Produced in adrenal glands, increases breathing/heart rate, blood flow to muscles, conversion glycogen to glucose. Prepares body for 'fight or flight'.
Thyroxine	Produced in the thyroid gland, stimulates the basal metabolic rate. Important in growth and development.

Blood glucose concentration	
Monitored and controlled by the pancreas	
Too high	(HT only) Too low
Pancreas produces the hormone insulin, glucose moves from the blood into the cells. In liver and muscle cells excess glucose is converted to glycogen for storage.	Pancreas produces the hormone glucagon that causes glycogen to be converted into glucose and released into the blood.

Diabetes	
Type 1	Type 2
Pancreas fails to produce sufficient insulin leading to uncontrolled blood glucose levels. Normally treated by insulin injection.	Obesity is a risk factor. Body cells no longer respond to insulin. Common treatments include changing by diet and increasing exercise.

Increasing thyroxine levels prevent the release of thyroid stimulating hormone which stops the release of thyroxine.

(HT) Rising glucose levels inhibit the release of glucagon in a negative feedback system. Insulin is released to reduce glucose levels and which cause the pancreas to release glucagon

AQA GCSE HOMEOSTASIS AND RESPONSE PART 3

Hormones are used in modern reproductive technologies to treat infertility

FSH and LH are used as 'fertility drugs' to help someone become pregnant in the normal way

In Vitro Fertilisation (IVF) treatment.

Involves giving a mother FSH and LH to stimulate the maturation of several eggs

The eggs are collected from the mother and fertilised by sperm from the father in a laboratory.
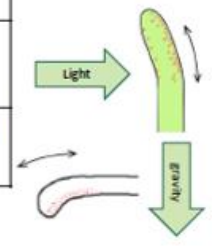
The fertilised eggs develop into embryos.

At the stage when they are tiny balls of cells, one or two embryos are inserted into the mother's uterus (womb).

The use of hormone to treat infertility (HT only)

| Potential disadvantages of IVF | Emotional and physical stress. |
| | Success rates are not high. |
| | Multiple births risk to mother and babies. |

Contraception

Fertility can be controlled by hormonal and non hormonal methods	Oral contraceptives	Contain hormones to inhibit FSH production so that no eggs mature.
	Injection, implant, skin patch	For slow release of progesterone to inhibit the maturation and release of eggs for months or years.
	Barrier methods	Condoms or diaphragms which prevent sperm reaching the egg.
	Intrauterine devices	Prevent implantation of an embryo or release a hormone.
	Spermicidal agents	Kill or disable sperm.
	Abstaining	Avoiding intercourse when an egg may be in the oviduct.
	Surgery	Male or female sterilisation.

Plants produce hormones to coordinate and control growth

Plant responses using hormones (auxins)

Light (phototropism)	Light breaks down auxins and they become unequally distributed in the shoot. The side with the highest concentration of auxins has the highest growth rate and the shoot grows toward the light.
Gravity (geotropism or gravitropism)	Gravity causes an unequal distribution of auxins. In roots the side with the lowest concentration has the highest growth rate and the root grows in the direction of gravity.
	In new shoots from a seedling the unequal distribution of auxins causes the shoot to grow away from gravity.

(HT only) Gibberellins are important in initiating seed germination.

(HT only) Ethene controls cell division and ripening of fruits.

Plant hormones

Use of plant hormones (HT only)

| Plant growth hormones are used in agriculture and horticulture | Auxins | Weed killers, rooting powders, promoting growth in tissue culture. |
| | Ethene | Control ripening of fruit during storage and transport. |
| | Gibberellins | End seed dormancy, promote flowering, increase fruit size. |

Hormones in human reproduction

During puberty reproductive hormones cause secondary sexual characteristics to develop

Oestrogen (main female reproductive hormone)	Testosterone (main male reproductive hormone)
Produced in the ovaries. At puberty eggs being to mature releasing one every 28 days – ovulation.	Produced in the testes stimulation sperm production.
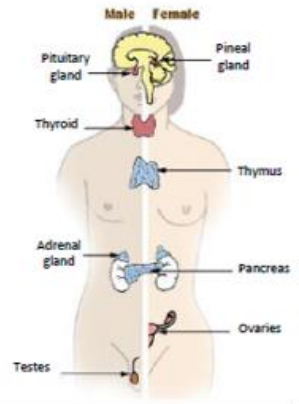
(HT only) a graph of hormone levels over time
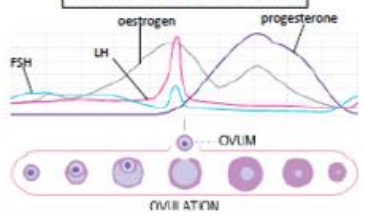
Menstrual cycle	Follicle stimulating hormone (FSH)	Causes maturation of an egg in the ovary.	(HT) FSH stimulates ovaries to produce oestrogen.
	Luteinising hormone (LH)	Stimulates release of an egg.	(HT) Oestrogen stops FSH production and stimulates LH production in pituitary gland.
	Oestrogen and progesterone	Maintain uterus lining.	

Male   Female

Pineal gland, Pituitary gland, Thyroid, Thymus, Adrenal gland, Pancreas, Ovaries, Testes

C5 Chemical Changes

Displacement reactions and metal extraction

	most reactive	
potassium		K
sodium		Na
calcium		Ca
magnesium		Mg
aluminium		Al
carbon		C
zinc		Zn
iron		Fe
tin		Sn
lead		Pb
hydrogen		H
copper		Cu
silver		Ag
gold		Au
platinum	least reactive	Pt

Reactivity depends on tendency to form metal ion

A and C are Cations (Positive Ions)
B and D are Anions (Negative Ions)
Double Displacement Reaction

HT: OILRIG
Oxidation **I**s **L**oss of electrons
Reduction **I**s **G**ain of electrons

Metal + Oxygen → Metal Oxide

Metal + Water → Metal Hydroxide + hydrogen

Metal + acid → Metal salt + Hydrogen

Reactions of acids

Acid+metal → salt + hydrogen
Acid + alkali → salt + water
Acid + insoluble base → salt + water
Acid + carbonate → salt + water + carbon dioxide

HT: OILRIG
e.g. $2HCl + Mg \rightarrow MgCl_2 + H_2$
Magnesium is oxidised
$Mg \rightarrow Mg^{2+} + 2e^-$

Hydrochloric Acid → Chlorides
HCl

Nitric Acid → Nitrates
HNO_3

Sulphuric Acid → Sulphates
H_2SO_4

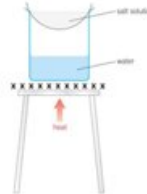## RP: Preparation of a dry sample of a soluble salt
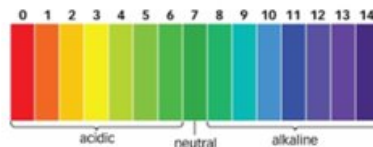
Choose correct acid

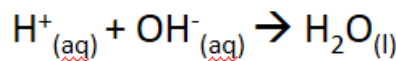Add base to excess

warm
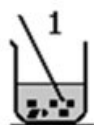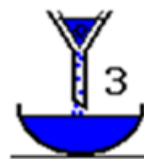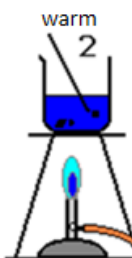
Filter off excess

Evaporate off water

Neutralisation

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14
acidic   neutral   alkaline

Acids produce H^+ ions
Alkalis produce OH^- ions

$$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$$

HT: Strong and Weak acids

Concentration of hydrogen ions in mol/dm³	pH
0.10	1.0
0.010	2.0
0.0010	3.0
0.00010	4.0

Strong and weak acids

Strong Acid   Weak Acid

Electrolysis

..of molten:

Cathode (-ve)   Anode (+ve)
Electrolyte
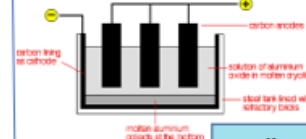● Negative non-metal ion
● Positive metal ion
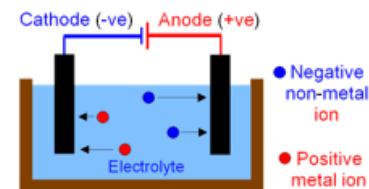
Higher:
At the cathode
$Pb^{2+} + 2e^- \rightarrow Pb$

Higher:
At the anode
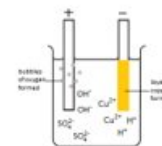$2Br^- \rightarrow Br_2 + 2e^-$
or
$2Br^- - 2e^- \rightarrow Br_2$

..to extract aluminium:

Oxygen goes to anode → CO_2 (needs replacing)

carbon anodes
carbon lining as cathode
solution of aluminium oxide in molten cryolite
steel tank lined with refractory bricks
molten aluminium collects at the bottom

Cyolite reduces the melting point

..of solutions:

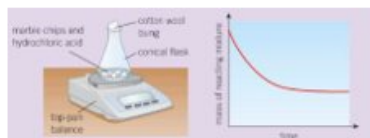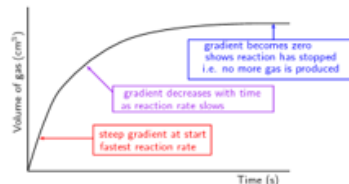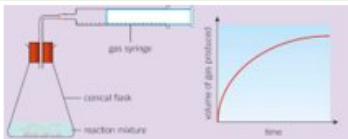| At the anode:	At the cathode:
Halide (Gp7) Oxygen	Least reactive

Measuring Rate

To measure the rate of a reaction you can:
- **Measure how fast the reactants are used up**
- **Measure how fast the products are made**
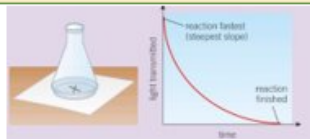
e.g. Measure mass lost due to gas formed


e.g. Measure volume of gas made

- gradient becomes zero shows reaction has stopped i.e. no more gas is produced
- gradient decreases with time as reaction rate slows
- steep gradient at start fastest reaction rate

Rate = volume of gas ÷ time

cm^3/s

e.g. Measure time for insoluble product to form

Collision theory

C8 Rates and Equilibrium

For a reaction to happen reactants must:
collide with **enough energy**
(activation energy)
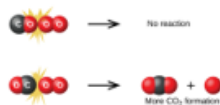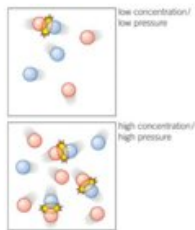

A successful collision is one that leads to a reaction

So to increase the rate of a reaction you must either
- **Increase the frequency of collisions**
- **Increase the energy of the collisions**
- **Decrease the energy needed for a collision to be successful**

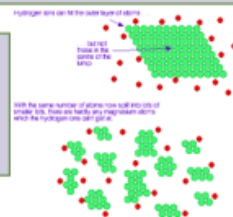# Factors affecting rate

Concentration and Pressure

More particles in the same space.
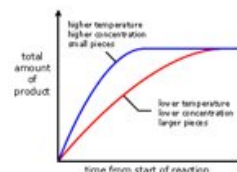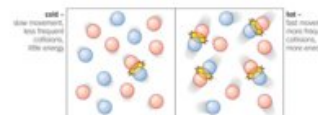**More frequent collisions**

Surface area

More particles available to react.
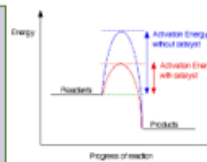**More frequent collisions**

Temperature

Particles move faster.
So they **collide more frequently**.
Particles collide **with more energy**.
So more of the collisions are **successful**.

Catalysts

Lower the energy needed for successful collisions. (Activation energy)
Not used up.
Biological catalysts are called **enzymes**

Reversible reactions

Can go in both directions.
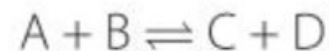
$$A + B \rightleftharpoons C + D$$

If a reaction is exothermic in one direction it is endothermic in the other direction.

endothermic (in forward reaction)
hydrated copper(II) $\rightleftharpoons$ anhydrous copper(II) + water
sulfate (blue) sulfate (white)
$CuSO_4.5H_2O$ $\rightleftharpoons$ $CuSO_4$ + $5H_2O$
exothermic (in reverse reaction)
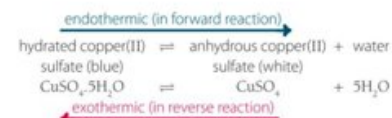
In a **closed system** (where nothing can get in or out) an **equilibrium** is reached where the **rate of reaction is the same in both directions**.

At equilibrium:
- Rate of forward reaction = rate of reverse reaction.
- Mount of products and reactants don't change.

forward reaction:
$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$
rates are equal at equilibrium
reverse reaction:
$2SO_3(g) \rightarrow 2SO_2(g) + O_2(g)$

Chemical Calculations Knowledge Organiser

Section 1: Key Terms

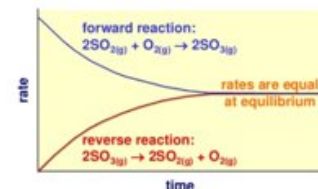|	
1 Relative atomic mass	Usually expressed as A_r this is the mass number of an element.
2 Relative formula mass	Usually expressed as M_r this is the mass number of all the elements in a compound combined.
3 Mole	The relative atomic mass of an element or formula mass of compound in grams.
4 Avogadro constant	The amount of atoms, molecules or ions in 1 mole of a substance. The number is always 6.022×10^{23}.
5 Limiting reactant	A reactant that stops the reaction from happening as it is all used up.
6 Percentage yield	The actual mass of a product divided by the theoretical yield, times by 100.
7 Atom economy	The relative mass of the product wanted over the relative mass of all the products formed, times by 100.
8 Concentration	The amount of a solute over the amount of solution.
9 Titration	A technique to find out the concentrations of an unknown substance.

Section 2: Working out relative atomic masds and relative formula mass

You can calculate the relative atomic mass A_r of an element given the percentage abundance of its isotopes, for example, copper has two isotopes,

^{63}Cu (abundance = 69%) and ^{65}Cu (31%).

To work out the relative atomic mass of copper from this data, imagine you had 100 copper atoms. 69 copper atoms would have a relative mass of 63, and the other 31 copper atoms would have a mass of 65. then calculate the mean relative mass of these 100 atoms :

A_r of Cu = $\frac{(69 \times 63) + (31 \times 65) = 63.5}{100}$

You also need to know how to work out the relative formula mass of more complex ionic compounds such as aluminium sulfate, $Al_2(SO_4)_3$

Aluminium has an A_r of 27, the A_r of sulfur is 32, and the A^r of oxygen is 16. in this case you must multiply any atoms within the brackets by the sub-script number after the brackets. This means that the M_r of aluminium sulphate is.

$(27 \times 2) + (32 \times 3) + (16 \times 12) = 54 + 96 + 192 = 342$

Section 3—Mole calculations

Moles from masses

Chemists prefer to use the mole when describing relative numbers of particles (atoms, molecules, or ions) in a certain mass of substance.

They use the equation:

$$\text{Number of moles} = \frac{\text{mass (g)}}{A_r} \quad \text{or} \quad \frac{\text{mass (g)}}{M_r}$$

Masses form moles

Sometimes you will have to work out the mass of a substance from a given number of moles.

By re-arranging:

$$\text{Number of moles} = \frac{\text{mass (g)}}{A_r} \quad \text{or} \quad \frac{\text{mass (g)}}{M_r}$$

You can calculate the mass of a certain number of moles of substance using the equation:

$$\text{Mass (g)} = \text{number of moles} \times A_r \quad \text{or} \quad \text{number of moles} \times M_r$$

Section 4—Equations

$$\text{Percentage yield} = \frac{\text{actual mass of product produced}}{\text{Maximum theoretical mass of product possible}} \times 100\%$$

Percentage atom =	relative formula mass of the desired product from equation	
economy	Sum of the relative formula masses of the reactants from equation	X 100%

$$\text{Concentration (g/dm}^3\text{)} = \frac{\text{amount of solute (g)}}{\text{Volume of solution (dm}^3\text{)}}$$

Section 5—Worked Examples

When lead is extracted from its ore, galena, the first stage is the roasting of lead sulphide, PbS, to convert it to lead oxide, PbO. The lead oxide is then reduced to form lead metal. The balanced symbol equation for the first stage, with state symbols is:

$$2Pb(s) + 3O_2(g) \qquad 2PbO(s) + 2SO_2(g)$$

Calculate the percentage atom economy of this first stage in the process of extracting lead.

(A_r values: Pb = 207, S = 32,) = 16)

Solution

$$\% \text{ atom economy} = \frac{\text{Relative formula mass of the Desired product from equation}}{\text{Sum of the relative formula masses of the reactants from equation}} \times 100\%$$

$$= \frac{M_r (2PbO)}{[M_r (2PbS) + M_r (3O_2)]} \times 100\%$$

$$= \frac{2 \times (207 + 16)}{[2 \times (207 + 32)] + [3 \times (16 \times 2)]} \times 100\%$$

$$= \frac{2 \times (207 + 16)}{[2 \times (207 + 32)] + [3 \times (16 \times 2)]} \times 100\%$$

$$= \frac{446}{(478 + 96)} \times 100\%$$

$$= 77.7\%$$

Limestone is mainly made of calcium carbonate. In the production of calcium oxide, crushed lumps of limestone are heated in a rotating lime kiln. The calcium carbonate decomposes to make calcium oxide, and carbon dioxide gas is given off. A company processes 200tonnes of limestone a day. It collects 98.0 tonnes of calcium oxide, the useful product. What is the percentage yield of the reaction in the kiln, assuming limestone contains only calcium carbonate? (A_r values: Ca = 40, C = 12, O = 16)

Solution

Calcium carbonate $\longrightarrow$ calcium oxide + carbon dioxide

$$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$$
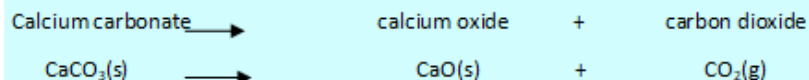
Work out the relative formula masses of CaO_3 and CaO:

$$M_r \text{ of } CaCO_3 = 40 + 12 + (16 \times 3) = 100$$

$$M_r \text{ of } CaO = 40 + 165 \qquad = 56$$

So the balanced symbol equation tells you that 100 tonnes of $CaCO_3$ could make 56 tonnes of CaO, assuming 100% yield.

Therefore 200 tonnes of CaO_3 could make a maximum of (56 x 2) tonnes of CaO = 112tonnes (theoretical yield in this case).

$$\text{So percentage yield} = \frac{\text{Mass of product produced}}{\text{Maximum mass of product possible}} \times 100\%$$

$$= \frac{98.0}{112} \times 100\% = 87.5\%$$

Section 6—Titration (Required Practical)

A titration is carried out using a number of steps:

1. If the sample is a solid, it is **weighed** using an accurate balance, and then **dissolved** to make up a known volume of solution (usually $100 cm^3$).

2. A **pipette** is used to measure accurately a volume of this solution - for example, $10 cm^3$. A safety pipette filler is used to draw solution into the pipette. This is emptied into a **conical flask**.

3. A few drops of an **indicator** may be added to the conical flask. This will show a change of colour when the titration is complete.

4. A second chemical is placed in a **burette**. This other solution is of a chemical that will react with the synthesised chemical sample in the conical flask. Often the solution in the burette is an **acid or alkali**, and it must be of a precise, known concentration.

5. The solution from the burette is run into the conical flask. The solution is added one drop at a time, with swirling to mix the solutions as the end-point is approached. Eventually, a colour change shows that the correct amount has been added to react completely with the synthesised chemical in the sample.

6. The volume of solution added from the burette is noted. The titration results can then be used to calculate the amount of the synthesised chemical in the sample, and therefore find its purity.
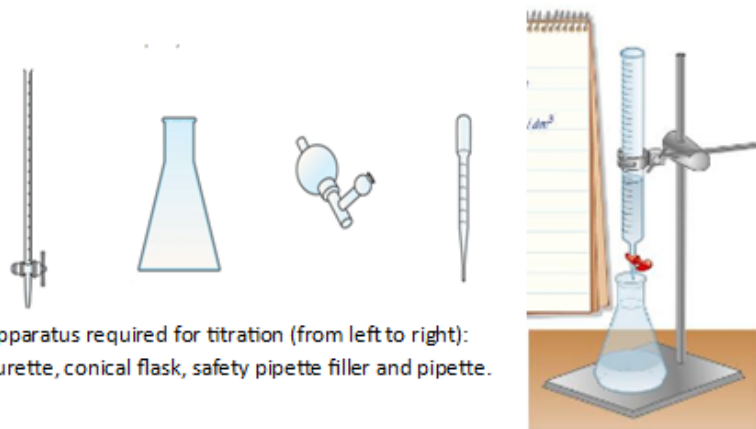
Apparatus required for titration (from left to right):
burette, conical flask, safety pipette filler and pipette.

Section 7—Titration Calculations

You should be able to use **titration** results to calculate the concentration of an **acid** or **alkali**. If several runs have been carried out, any irregular titres should be ignored before calculating the **mean** titre.

Example

$27.5 cm^3$ of $0.2 mol/dm^3$ hydrochloric acid is needed to titrate $25.0 cm^3$ of sodium hydroxide solution. What is the concentration of the sodium hydroxide solution?

Step 1: Convert all volumes to dm^3

$27.5 cm^3 = 27.5 \div 1000 = 0.0275 dm^3$

$25.0 cm^3 = 25.0 \div 1000 = 0.025 dm^3$

Step 2: Calculate the number of moles of the substance where the volume and concentration are known

number of moles = concentration × volume

number of moles of hydrochloric acid = $0.2 \times 0.0275 = 0.0055$ mol (5.5×10^{-3} mol)

Step 3: Calculate the unknown concentration

We can say that 0.0055 mol of acid will react with 0.0055 mol of alkali

concentration of alkali = moles ÷ volume = $0.0055 \div 0.025 = $ **$0.22 mol/dm^3$**

A quick check

You can check your answer using this quick method (but which misses out the chemical understanding that may attract full marks).

unknown concentration = known concentration × $\frac{volume\ of\ known}{volume\ of\ unknown}$

In the example above, this would be:

unknown concentration = $0.2 \times {}^{27.5}/_{25.0} = $ **$0.22 mol/dm^3$**

	Knowledge		Key words
1	fractional distillation is a way to separate liquids from a mixture of liquids by boiling off the substances at different temperatures, then condensing and collecting the liquids	1	**alkane** saturated hydrocarbon with the general formula C_nH_{2n+2}, for example, methane, ethane, and propane
2	Saturated hydrocarbon describes a hydrocarbon with only single bonds between its carbon atoms. This means that it contains as many hydrogen atoms as possible in each molecule	2	**Alkene** unsaturated hydrocarbon which contains a carbon–carbon double bond. Its general formula is C_nH_{2n}, for example, ethene, C_2H_4
3	unsaturated hydrocarbon a hydrocarbon whose molecules contains at least one carbon–carbon double bond	3	**cracking** the reaction used in the oil industry to break down large hydrocarbons into smaller, more useful one
4	functional group is an atom or group of atoms that give organic compounds their characteristic reactions	4	**double bond** a covalent bond made by the sharing of two pairs of electrons
5	addition polymerisation is a type of reaction where monomers join together, end to end, to form long polymer chains. The polymer produced is called an addition polymer	54	**flammable** easily ignited and capable of burning rapidly
6	Condensation polymerisation involves monomers with two functional groups. When these types of monomers react they join together, usually losing small molecules such as water, and so the reactions are called condensation reactions	6	**hydrocarbon** a compound containing only hydrogen and carbon
7	monomers are small reactive molecules that react together in repeating sequences to form a very large molecule (a polymer)	7	**Viscosity** the resistance of a liquid to flowing or pouring; a liquid's 'thickness'
8	nucleotides the basic repeating units, or monomers, that join together to form DNA	8	**fraction** hydrocarbons with similar boiling points separated from crude oi
9	Alkenes are more reactive than alkanes and react with bromine water, which is used as a test for alkenes	9	**homologous series** a group of related organic compounds that have the same functional group
10	Some properties of hydrocarbons depend on the size of their molecules, including boiling point, viscosity and flammability. These properties influence how hydrocarbons are used as fuels	10	**polymer** a substance made from very large molecules made up of many repeating units
11	Cracking can be done by various methods including catalytic cracking and steam cracking.The products of cracking include alkanes and another type of hydrocarbon called alkenes.	11	**Amino acids** have two different functional groups in a molecule. Amino acids react by condensation polymerisation to produce polypeptides
12	Alkenes are used to produce polymers and as starting materials for the production of many other chemicals.	12	**DNA** (deoxyribonucleic acid) a large organic molecule that encodes genetic instructions for the development and functioning of living organisms and viruses
13	Many useful materials on which modern life depends are produced by the petrochemical industry, such as solvents, lubricants, polymers, detergents	13	

Quantitative Chemistry Knowledge Organiser

Know the facts		Key words	
1	The law of conservation of mass states that no atoms are lost or made during a chemical reaction so the mass of the products equals the mass of the reactants.	1	**Avogadro constant** the number of atoms, molecules, or ions in a mole of any substance (i.e., 6.02×10^{-23} per mol)
2	In a balanced chemical equation, the sum of the relative formula masses of the reactants in the quantities shown equals the sum of the relative formula masses of the products in the quantities shown.	2	**mole** the amount of substance in the relative atomic or formula mass of a substance in gramThe symbol for the unit mole is mol
3	When a metal reacts with oxygen the mass of the oxide produced is greater than the mass of the metal	3	**concentration** the amount of a substance dissolved in a given volume of liquid
4	In thermal decompositions of metal carbonates carbon dioxide is produced and escapes into the atmosphere leaving the metal oxide as the only solid product.	4	**limiting reactant** the reactant in a chemical reaction that when used up causes the reaction to stop
5	The masses of reactants and products can be calculated from balanced symbol equations.Chemical equations can be interpreted in terms of moles $$Mg + 2HCl \rightarrow MgCl_2 + H_2$$ shows that one mole of magnesium reacts with two moles of hydrochloric acid to produce one mole of magnesium chloride and one mole of hydrogen gas.	5	**percentage yield** the actual mass of product collected in a reaction divided by the maximum mass that could have been formed in theory, multiplied by 100 The amount of a product obtained is known as the yield $$\% \, Yield = \frac{Mass \ of \ product \ actually \ made}{Maximum \ theoretical \ mass \ of \ product} \times 100$$
6	In a chemical reaction involving two reactants, it is common to use an excess of one of the reactants to ensure that all of the other reactant is used.	6	**relative formula mass M_r** the total of the relative atomic masses, added up in the ratio shown in the chemical formula, of a substance
7	The percentage atom economy of a reaction is calculated using the balanced equation for the reaction as follows: $$\frac{Relative \ formula \ mass \ of \ desired \ product \ from \ equation}{Sum \ of \ relative \ formula \ masses \ of \ all \ reactants \ from \ equation} \times 100\%$$	7	**relative atomic mass A_r** the average mass of the atoms of an element compared with carbon-12 (which is given a mass of exactly 12). The average mass must take into account the proportions of the naturally occurring isotopes of the element

Rates and Equilibrium Knowledge Organiser

Required Practical – Effect of concentration on rate

1—Increasing concentration will mean more particles available to react
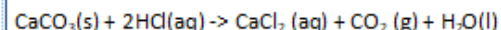
2 — This will mean more collisions

3—This will mean more successful collisions

4— Therefore a faster rate of reaction

Two ways:

Investigate the concentration of HCl with marble chips

$CaCO_3(s) + 2HCl(aq) -> CaCl_2 (aq) + CO_2 (g) + H_2O(l)$

You can find the rate of a reaction by plotting the volume of carbon dioxide gas given off as the reaction progresses over time. You can measure the volume of gas at regular time intervals. Alternatively, you might choose to time how long it takes to collect a fixed volume of gas.

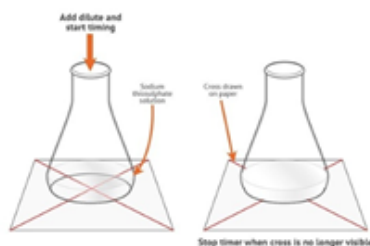**The reaction between sodium thiosulphate and dilute hydrochloric acid:**

$Na_2S_2O_3(aq) + 2HCl(aq) à 2NaCl(aq) + SO_2(aq) + S(s) + H_2O(l)$
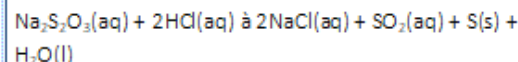
Your timing method should use the increasing cloudiness (turbidity) of the reaction mixture as the reaction proceeds.

Effect of conditions on rate

	Increase	Decrease
Temperature	Increase	Decrease
Rate	Increase—more kinetic energy, more chance of collisions	Decrease—less kinetic energy, less chance of collisions
Pressure/ concentration	Increase	Decrease
Rate	Increase, more particles to collide	Decrease, less particles to collide
Surface area	Increase	Decrease
Rate	More particles available to react	Less particles available to react
Catalyst	Present	Not Present
Rate	Faster, provides an alternative route with a lower activation energy	Slower

What happens when sodium thiosulphate and hydrochloric acid mix?

Add dilute and start timing

Sodium thiosulphate solution

Cross drawn on paper

Stop timer when cross is no longer visible

Keyword	Definition
1. Reversible	A reaction that can turn reactants into products and products into reactants.
2. Dynamic Equilibrium	A reaction in which the forwards and backwards reactions occur at the same rate and the concentrations of reactants and products are constant.
3. Forwards reaction	The reaction that is forming products from reactants.
4. Backwards reaction	The reaction that is forming reactants from products.
5. Exothermic	A reaction that releases heat energy to the surroundings.
6. Endothermic	A reaction that takes in heat energy to the surroundings.
7. Rate of reaction	Change in concentration of reactants or products over unit time
8. Catalyst	A substance that is not used up that provides an alternate pathway for a reaction with a lower activation energy, speeding up the rate of reaction
9. Collision theory	Reactions only occur when particles collide with **enough energy.**
10. Surface area	Area of surface that has particles available to react
11. Closed system	No conditions can be changed externally.

Rates and Equilibrium Knowledge Organiser

*Le Chatelier's principle – 1888

"If a change occurs to a system in dynamic equilibrium, the position of equilibrium shifts in a direction to oppose the change."

| Effect of conditions on equilibria		
Temperature	Increase	Decrease
Change in equilibrium	Moves in the endo-thermic direction	Moves in the exothermic direction
Pressure	Increase	Decrease
Change in equilibrium	Moves to the side with least moles	Moves to side with more moles
Concentration	Increase	Decrease
Change in equilibrium	Removes the sub-stance that you've added, moving the equilibrium in the opposite way	Makes more of the sub-stance you've removed
Catalyst	Present	Not Present
Change in equilibrium	No effect—however, will make it so the rate to reach equilibrium is faster	

Worked Example

An investigation was carried out to find how the concentration of dilute hydrochloric acid affected the rate of its reaction with calcium metal. The volume of hydrogen gas given off was monitored over 150 seconds using a gas syringe. One test was carried out using 0.167g of calcium with an excess of 1.00mol/dm³ dilute hydrochloric acid, and this was repeated using the same volume of 0.500mol/dm³ acid, also in excess. The results were plotted on a graph – see the two curves in the graph below.

a. use the results on the graph to find the initial rates of reaction, i.e. at the start when time = 0 seconds.

b. Draw a conclusion from part a.

Solution
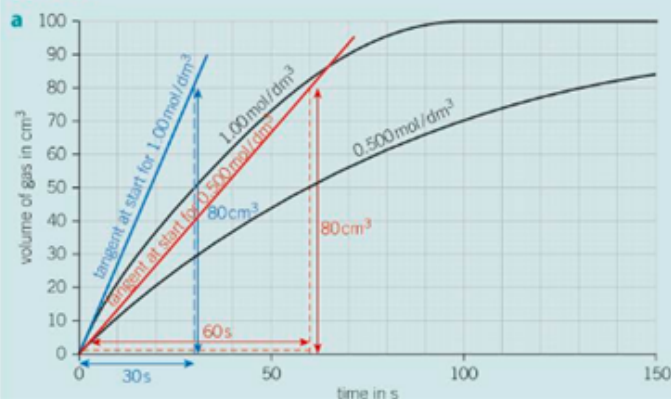
Draw tangents from the origin to work out the gradient (change in the y axis / change in the x axis)

Then do concentration/time = rate

The units for rate will depend on how you measure concentration: if it's measured in moldm³, then you will have divided this by seconds, so it would be moldm³/s

P10: Forces and Motion Knowledge Organiser (F)		PT65.1

Newton's Second Law	•The resultant force acting on an object is equal to its mass times its acceleration (F = ma) •Bigger resultant force gives a bigger acceleration •Bigger masses need bigger forces to get the same acceleration	Elastic Object	•An object that returns to its original shape when the forces deforming it (changing its shape) are removed
Mass, m	•The amount of matter in an object. •Measured in kilograms, kg.	Extension, e	•The increase in length from the original length •Measured in cm or m •Extension = new length – original length •Directly proportional to the force applied to the object
Weight, W	•The force acting on an object due to gravity. •Measured in Newtons, N.		
Gravitational Field Strength, g	•The force acting on an object per kilogram due to gravity. •Measured in N/kg •On Earth's surface, g is 9.8 N/kg	Limit of Proportionality	•Beyond the limit of proportionality, the extension stops being directly proportional to the force applied to the object. •A graph of F against x stops being a straight line
Acceleration Due to Gravity, g	•The acceleration experienced by an object caused by the gravitational field. •On Earth, this is 9.8 m/s²	Hooke's Law	•The extension of a spring is directly proportional to the force applied as long as the limit of proportionality is not exceeded •F = k x e
Terminal Velocity	•When the frictional force (drag) acting on an object falling through a fluid is equal to its weight, it has reached terminal velocity •The resultant force = 0 •Acceleration = 0	Spring Constant, k	•How 'stretchy' a spring is •The bigger the spring constant, the less stretchy it is
Stopping Distance	•Stopping distance = thinking distance + braking distance •Thinking distance is the distance travelled during the driver's reaction time. Affected by drugs, alcohol, tiredness, using a mobile phone (i.e. distraction) •Braking distance is the distance travelled during the time the braking force acts. Affected by road conditions and poor vehicle maintenance. •The faster a vehicle is travelling, the bigger the stopping distance because it travels further in the time taken to stop •The braking force can be calculated using F = ma		

Key Equations To Learn

Force, F	Force = spring constant x extension F = k x e

P10: Forces and Motion Knowledge Organiser (Physics) PT65.3

Newton's Second Law	•The resultant force acting on an object is equal to its mass times its acceleration ($F = ma$) •Bigger resultant force gives a bigger acceleration •Bigger masses need bigger forces to get the same acceleration
Inertia	• The tendency of an object to stay at rest or continue to travel in uniform motion (i.e. not accelerate)
Mass, m	•The amount of matter in an object. •Measured in kilograms, kg.
Weight, W	•The force acting on an object due to gravity. •Measured in Newtons, N.
Gravitational Field Strength, g	•The force acting on an object per kilogram due to gravity. •Measured in N/kg •On Earth's surface, g is 9.8 N/kg
Acceleration Due to Gravity, g	•The acceleration experienced by an object caused by the gravitational field. •On Earth, this is 9.8 m/s^2
Terminal Velocity	•When the frictional force (drag) acting on an object falling through a fluid is equal to its weight, it has reached terminal velocity •The resultant force = 0 •Acceleration = 0
Stopping Distance	•Stopping distance = thinking distance + braking distance •Thinking distance is the distance travelled during the driver's reaction time. Affected by drugs, alcohol, tiredness, using a mobile phone (i.e. distraction) •Braking distance is the distance travelled during the time the braking force acts. Affected by road conditions and poor vehicle maintenance. •The faster a vehicle is travelling, the bigger the stopping distance because it travels further in the time taken to stop •The braking force can be calculated using $F = ma$

Momentum, p	•Depends on the mass and velocity of an object. •Measured in kg m/s •It's a vector as it has size and direction
Law of Conservation of Momentum	•In a closed system, the total momentum before an event (like a collision or explosion) is equal to the momentum after. •$(m_A \times v_A) = -(m_B \times v_B)$ •When two objects push apart from each other (i.e. In an explosion), momentum is conserved. •This means that if the objects have different masses they move apart at different speeds and with equal and opposite momentum, meaning the total momentum is conserved. •When two objects recoil, $m_A v_A + m_B v_B = 0$
Impact force	•Impact force = change in momentum ÷ impact time •This means that the longer the impact time, the more the impact force is reduced. •Cars have crumple zones to increase the impact time and reduce the impact force •In a collision, the impact force depends on the mass, change in velocity and the length of impact time.
Car safety	•Safety helmets increase impact time, so reduce the impact force acting on someone's head, which helps to reduce injury. Crash mats and other cushioned surfaces do a similar job. •Seatbelts increase impact time and therefore reduce the decelerating force. They also spread the force out over the chest. •Airbags, side impact bars and collapsible steering wheels reduce the impact force acting on a person by increasing the impact time.

P10: Forces and Motion Knowledge Organiser (Physics)

Elastic Object	•An object that returns to its original shape when the forces deforming it (changing its shape) are removed
Extension, e	•The increase in length from the original length •Measured in cm or m •Extension = new length – original length •Directly proportional to the force applied to the object
Limit of Proportionality	•Beyond the limit of proportionality, the extension stops being directly proportional to the force applied to the object. •A graph of F against x stops being a straight line
Hooke's Law	•The extension of a spring is directly proportional to the force applied as long as the limit of proportionality is not exceeded •F = k x e
Spring Constant, k	•How 'stretchy' a spring is •The bigger the spring constant, the less stretchy it is

Key Equations To Learn	
Force, F	Force = spring constant x extension F = k x e
Momentum, p	Momentum = mass x velocity p = m x v