AQA Trilogy Science

SAMUEL WARD ACADEMY TRUST

Paper 1 Chemistry topics

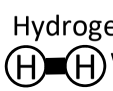
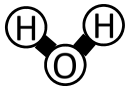
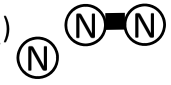
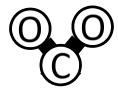
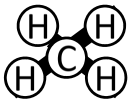
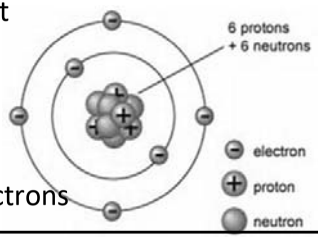
- Atoms, molecules and moles
  - Atomic structure
  - The periodic table
  - Structure and bonding
  - Chemical calculations
- Chemical changes and energy changes
  - Chemical changes
  - Electrolysis
  - Energy changes

Paper 2 Chemistry topics

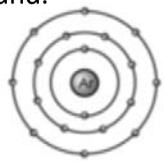
- Rates, equilibrium and organic chemistry
  - Rates and equilibrium
  - Crude oil and fuels
- Analysis and the Earth's resources
  - Chemical analysis
  - The Earth's atmosphere
  - The Earth's resources

CASTLE MANOR · CHURCHILL SCHOOL · NEWMARKET ACADEMY · SAMUEL WARD · SYBIL ANDREWS ACADEMY · TGS

Key points to learn

1. Atom	Smallest part of an element that can exist
	Hydrogen atoms (4H) 
2. Molecule	Two or more atoms chemically bonded
	Hydrogen molecule (H_2)  Water molecule (H_2O) 
3. Element	Only one type or atom present. Can be single atoms or molecules
	Both examples of the Nitrogen element (N_2) (N) 
4. Compound	Two or more different elements chemically bonded
	Carbon dioxide (CO_2)   Methane (CH_4)
5. Nuclear atom model	• Electrons orbit • Protons and neutrons in nucleus • Number of protons = electrons 
6. Nucleus	The centre of the atom. Contains neutrons and protons
7. Proton	Charge of +1. Mass of 1. Found inside the nucleus
8. Neutron	Charge of 0. Mass of 1. Found inside the nucleus
9. Electron	Charge of -1. Mass of almost 0. Found orbiting around the nucleus

Key points to learn

10. Mixture	Two or more chemicals not chemically bonded
11. Separation techniques	Used to separate mixtures. Ones you need to know: Filtration - get an insoluble solid from a liquid Crystallisation - get a soluble solid from a liquid by evaporating liquid off Distillation - get a pure liquid from a mixture of liquids Chromatography - separate mixtures of coloured compounds
12. Electron energy levels	Where electrons are found. The shells can each hold this many electrons maximum: 2,8,8 
13. Periodic Table	A list of all the elements in order or atomic number. Columns called **Groups**. Rows called **Periods**
14.Conservation of mass	In a chemical reaction the total mass of reactants = total mass of products
15. Mass number	Number of neutrons + protons ⇨ $^{11}_{5}B$ *6 Neutrons + 5 Protons*
16. Atomic number	Number of protons ⇨ *5 Protons*
17. Isotope	Same number of protons different number of neutrons
18. Ion	Atom where number of protons is not equal to electrons (+'ve or –'ve)
19 Plum pudding atom model	Early model: ball of positive charge with electrons in it 

Trilogy C1: Atomic structure

Part of: Atomic structure and the periodic table

Knowledge Organiser

Big picture (Chemistry Paper 1)

- Atoms, molecules and moles
  - Atomic structure
  - The periodic table
  - Structure and bonding
  - Chemical calculations
- Chemical changes and energy changes
  - Chemical changes
  - Electrolysis
  - Energy changes

Background

Atoms are the building blocks of us, our world and our universe. Everything that we can touch is made of atoms.

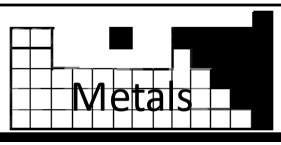
The Periodic Table organises them into a way that helps us make sense of the physical world.

Even though they make everything atoms are mostly (99.9%) empty space. If an atom was as big as Wembley, the nucleus would be pea-sized.

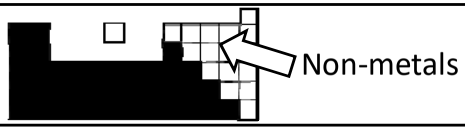
Additional information

A great deal of this topic is also covered in your Paper 1, Physics lessons during Electricity and Radioactivity.

Key points to learn

1. Chemical symbol	An abbreviated name for every element. Maximum of two letters always starts with a capital letter
2 Reactivity	How easily an element will react
3. Group	Columns in the Periodic Table. Elements in the same group have similar properties
	Tells you how many electrons that atom has in its outer shell
4. Period	Rows in the periodic table
	Tells you how many electron shells that atom has
5. Mass number	Number of neutrons + protons *4 Neutrons + 3 Protons* $^{7}_{3}Li$
6. Atomic number	Number of protons *3 Protons*
7. Ion	Atom where number of protons is not equal to electrons (+'ve or –'ve)
8. Mendeleev	Scientist who placed elements in proton number order and left gaps for undiscovered elements
9. Metals	Have delocalised (free) electrons that can move
	Atoms lose electrons and become positive (+'ve) ions
	

Key points to learn

10. Non-metals	Have electrons that cannot move
	Nearly always gain electrons and become (negative -'ve) ions
	
11. Group 0 Noble gases	He, Ne, Ar, Kr, Xe, Rn
	Unreactive: full outer shell
	Boiling point increases as you go down the group
12. Group 1 Alkali metals	Li, Na, K, Rb, Cs, Fr
	Very reactive: only one electron in their outer shell
	Reactivity increases as you go down the group
	React with oxygen to give metal oxides eg MgO
	React with water to give metal hydroxide (alkali) and hydrogen eg MgOH
	React with chlorine to give metal chloride eg MgCl
13. Group 7 Halogens	F, Cl, Br, I
	Melting and boiling point increase as you go down group
	Reactivity decreases as you go down the group
	A more reactive halogen will displace a less reactive one

Trilogy C2: The Periodic Table

Part of: Atomic structure and the periodic table

Knowledge Organiser

Big picture (Chemistry Paper 1)

- Atoms, molecules and moles
  - Atomic structure
  - The periodic table
  - Structure and bonding
  - Chemical calculations
- Chemical changes and energy changes
  - Chemical changes
  - Electrolysis
  - Energy changes

Background

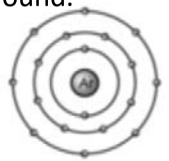
The periodic table is amazing because it allows us to predict and explain the properties of elements even before they are discovered.

Maths skills

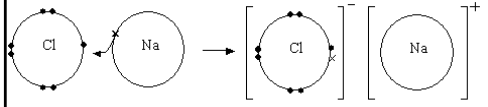
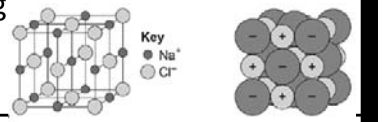
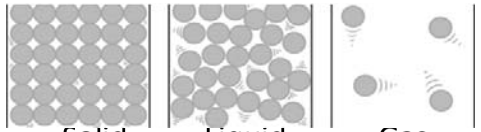
Losing –'ve charge makes you more +'ve.
Gaining –'ve charge makes you more –'ve.

Additional information

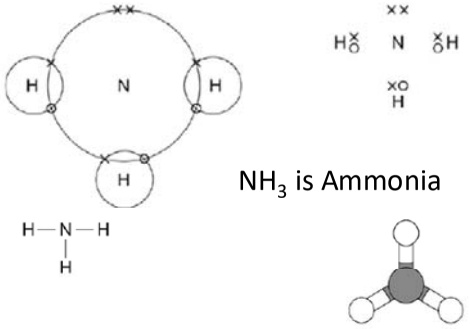
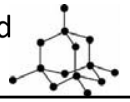
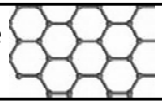
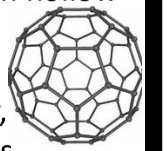
Remember Electron energy levels	Where electrons are found. The shells can each hold this many electrons maximum: 2,8,8



Key points to learn

1. Chemical bonds	Hold molecules together. Can be ionic, covalent or metallic
2. Ionic bonding	Metal + Non metal
	Metal loses electrons and becomes a positive ion. Non metal gains the electrons and becomes a negative ion
	
3. Giant ionic structures	Drawing salt (NaCl) 
	High melting and boiling points
	Conduct electricity when melted or dissolved in water
4. Metallic bonding	Metal + Metal
	Giant structures with free electrons moving throughout
5. Conductors	Metals conduct electricity because they have free electrons
6. Graphite	Non-metal that conducts electricity
7. Alloys	A mixture of different metals. Which are then harder
8. States of matter	

Key points to learn

9. Covalent bonding	Non-metal + Non metal
	Atoms share electrons
	Four different ways of drawing NH_3  NH_3 is Ammonia
10. Giant covalent structures	Examples are diamond and silicon dioxide 
	Solids. Very high melting points
11. Small molecules	Usually gases or liquids. Do not conduct electricity
12. Polymers	Long chain molecules linked by strong covalent bonds
13. Particle theory	Particles are held together by intermolecular forces that get weaker as particles gain energy
14. State symbols	(s) solid; (l) liquid; (g) gas; (aq) aqueous solution
15. Graphene	A single layer of graphite used in electronics 
16. Fullerenes	Molecules of carbon with hollow shapes  Used in nanotechnology, electronics and materials

Trilogy C3: Structure and bonding

Part of: Bonding, structure and the properties of matter

Knowledge Organiser

Big picture (Chemistry Paper 1)

- Atoms, molecules and moles
  - Atomic structure
  - The periodic table
  - Structure and bonding
  - Chemical calculations
- Chemical changes and energy changes
  - Chemical changes
  - Electrolysis
  - Energy changes

Background

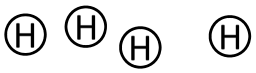
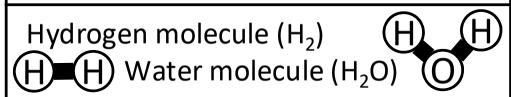
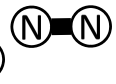
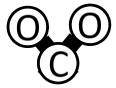
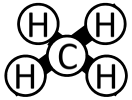
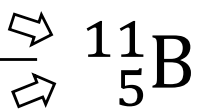
Chemical reactions are a crucial part of all our lives. Without them the Universe as we know it could not exist.

This topic considers the three type of chemical bonds. All involve atoms trying to fill or empty their outer shells. Together these bonds are responsible for the wide range of different properties we see around us.

Additional information

You need to be clear which elements are metals and non-metals (see C2: Periodic table) also a good knowledge of the electron energy levels will help (see C1: Atomic structure).

Key points to learn

1. Atom	Smallest part of an element that can exist
	Hydrogen atoms (4H) 
2. Molecule	Two or more atoms chemically bonded
	Hydrogen molecule (H_2)  Water molecule (H_2O)
3. Element	Only one type or atom present. Can be single atoms or molecules
	Both examples of the Nitrogen element (N_2) (N) 
4. Compound	Two or more different elements chemically bonded
	Carbon dioxide (CO_2)  Methane (CH_4) 
5. Mass number	Number of neutrons + protons *6 Neutrons + 5 Protons*
6. Atomic number	Number of protons  *5 Protons*
7. Relative Atomic Mass	A_r The mass number of an atom. Eg A_r of O is 16 and H is 1
8. Relative Formula Mass	M_r The mass of all the atoms of a molecule added together. Eg M_r of H_2O is (2 x 1) + 16 = 18
9. Mole	An amount where either the A_r or M_r is written in grams. Eg one mole of water has a mass of 18g
10. Solute	Solid that has been dissolved

Key points to learn

11. Isotope	Same number of protons different number of neutrons
12. Numbers in reaction equations	Big numbers in front of a chemical tell us how many molecules/atoms of that chemical there are
13. Balancing equations	The number of atoms in the reactants must equal the number of atoms in the products
	Steps to balance an equation 1) $Mg + O_2 \rightarrow MgO$ *Needs another O on product side* 2) $Mg + O_2 \rightarrow \mathbf{2}MgO$ *Only add big numbers in front* *Now needs more Mg on reactants* 3) $\mathbf{2}Mg + O_2 \rightarrow 2MgO$ *Only add big numbers in front*
	The table you will have drawn to help Mg: ~~1~~ 2 → ~~1~~ 2 O: 2 → ~~1~~ 2
14. Chemical reaction	Reactants → Products *'turn into'*
Conservation 15 of mass	In a chemical reaction the total mass of reactants = total mass of products
16 If mass seems to be lost/gained	Conservation of mass always applies but sometimes the mass of a gas being used/made is missed
17. Concentration	The mass of solute in a given volume of solution
	Concentration = mass of solute [g] / volume of solution [dm^3] [g/dm^3]
18. Solution	Liquid containing dissolved solute

Trilogy C4: Chemical calculations

Part of: Quantitative chemistry

Knowledge Organiser

Big picture (Chemistry Paper 1)

- Atoms, molecules and moles
  - Atomic structure
  - The periodic table
  - Structure and bonding
  - Chemical calculations
- Chemical changes and energy changes
  - Chemical changes
  - Electrolysis
  - Energy changes

Background

Want to make enough pancakes for everyone? Then you need to know quantities. Chemical reactions are the same (cooking is a chemical reaction!). This topic explores in more detail.

Maths skills

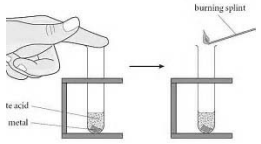
Steps to balance an equation:

1. Write down the symbols of each element then count how many are on each side of the equation
2. Leave Hydrogen and Oxygen till last if it's complicated
3. Start with an element that appears in the least molecules first (usually a metal)
4. Only add big numbers to the left of each chemical. You can't change molecules

Key points to learn

1 Chemical reaction	Reactants → Products *'turn into'*
2 Oxidation	Losing electrons (or gaining oxygen)
3 Reduction	Gaining electrons (or losing oxygen)
4. OiL RiG	Oxidation is Loss of electrons Reduction is Gain of electrons
5 Reactivity Series	List of metals with most reactive at top and least reactive at bottom The most reactive metals are most likely to lose electrons
6. Metals and oxygen	**Metal + Oxygen → Metal Oxide** Eg Iron + oxygen → iron oxide
7. Metals and water	**Metal + Water → Metal + Hydrogen hydroxide** Eg Sodium + Water → Sodium + Hydrogen hydroxide
8. Metals and acid	**Metal + Acid → Metal salt + hydrogen** Eg Zinc + Hydrochloric acid → Zinc + Hydrogen chloride
9. Metal carbonates and acids	**Metal + Acid → Metal + Water + Carbon carbonate salt dioxide** Eg Lead + Nitric → Lead + Water + Carbon carbonate acid nitrate dioxide
10. Metal salts	• Hydrochloric acid makes …chloride • Sulfuric acid makes ….sulfate • Nitric acid makes …nitrate
11. State symbols	(s) solid; (l) liquid; (g) gas; (aq) aqueous solution

Key points to learn

12. Displacement reaction	A more reactive metal will displace a less reactive metal from a chemical compound
	Eg $CuCl_2 + Zn \rightarrow ZnCl_2 + Cu$ 
13. Ion	Atom where number of protons is not equal to electrons (+'ve or –'ve)
Neutralisation reaction	Acid + Alkali → Metal + Water salt
14	
15. pH scale	1 – Strong acid 7 – Neutral 14 – Strong alkali
16. Universal indicator	• Turns red in strong acid • Turns green in neutral • Turns purple in strong alkali
17. Acids	Contains H^+ ions. Opposite of a base
18. Base	Usually contains OH^- ions. Opposite of an acid
19. Alkali	A base that has dissolved in water
20. Test for hydrogen	Hydrogen makes a squeaky 'pop' when lit with a splint 
21. Test for carbon dioxide	If you bubble carbon dioxide through limewater it will turn milky (cloudy white)  *Colourless → milky*
22. Ionic equation	Ions making neutral product Eg $Cu^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Cu(OH)_{2\ (s)}$

Trilogy C5: Chemical Changes

Part of: Chemical Changes

Knowledge Organiser

Big picture (Chemistry Paper 1)

- Atoms, molecules and moles
  - Atomic structure
  - The periodic table
  - Structure and bonding
  - Chemical calculations
- Chemical changes and energy changes
  - Chemical changes
  - Electrolysis
  - Energy changes

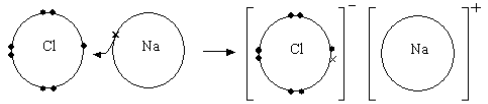
Background

In the past, scientists would discover reactions by trial and error. This was time-consuming and dangerous. Today we can use patterns to predict the outcomes of a whole range of reactions. This has allowed us to develop new materials and understand reactions that happen inside all living things.

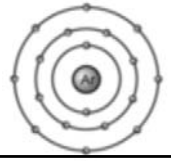
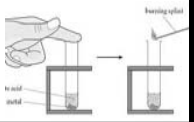
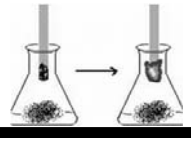
Additional information

You need to be able to work out how many electrons an atom wants to lose or gain using the periodic table group number. This will be its ion charge.

Key points to learn

1. Electrolysis	Breaking down a substance using electricity
2. Electrolyte	The ionic compound that is broken down in electrolysis.
	Must be an ionic compound in liquid form (either molten or dissolved in water)
3. Electrode	Connected to the power supply
4. Anode	The +'ve electrode
5. Cathode	The –'ve electrode
6. Ion	Atom where number of protons is not equal to electrons (+'ve or –'ve)
7. Positive (+'ve) ions	Metals and hydrogen. Collect at the cathode (-'ve electrode)
8. Negative (-'ve) ions	Non-metals except hydrogen. Collect at the anode (+'ve electrode)
9. Ionic bonding	Metal + Non metal
	Metal loses electrons and becomes a positive ion. Non metal gains the electrons and becomes a negative ion.
	 $Cl + Na \rightarrow NaCl$
10. Group	Column number in the Periodic Table. Tells you how many electrons in outer shell of atom. Used to work out charge of ion

Key points to learn

11. Half equations	Equation showing what happens to electrons at each electrode Eg Lead ions gaining 2 electrons at the cathode to be come lead atoms $Pb^{2+} + 2e^- \rightarrow Pb$
12. Oxidation	Losing electrons (or gaining oxygen)
13. Reduction	Gaining electrons (or losing oxygen)
14. OiL RiG	Oxidation is Loss of electrons Reduction is Gain of electrons
15. Electron shells	Where electrons are found. The shells can each hold this many electrons maximum: 2,8,8 
16. Aluminium	Obtained from molten bauxite ore
	Extracted by electrolysis mixed with cryolite to reduce melting temperature
17. Cryolite	Used to extract aluminium
18. Ore	Rock containing enough metal to be worth extracting
19. Brine	Salt water (sodium chloride solution)
	Can be separated using electrolysis to produce chlorine, hydrogen and sodium hydroxide
20. Test for hydrogen	Hydrogen makes a squeaky 'pop' when lit with a splint 
21. Test for oxygen	Oxygen will relight a glowing splint. 

Trilogy C6: Electrolysis

Part of: Chemical Changes

Knowledge Organiser

Big picture (Chemistry Paper 1)

- Atoms, molecules and moles
  - Atomic structure
  - The periodic table
  - Structure and bonding
  - Chemical calculations
- Chemical changes and energy changes
  - Chemical changes
  - Electrolysis
  - Energy changes

Background

Electrolysis is important to our lives as allows us to obtain reactive metals from their ores. It is likely to become even more important over the next 10 years as we separate hydrogen from water for use in fuel cells.

Maths skills

Balance the charges on both sides of a half equation. You can only add big numbers in front of the number of the electrons

eg $2O^{2-} - 4e^- \rightarrow O_2$

Additional information

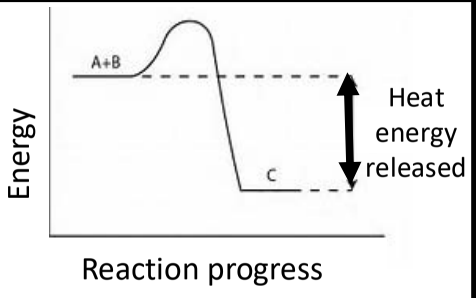
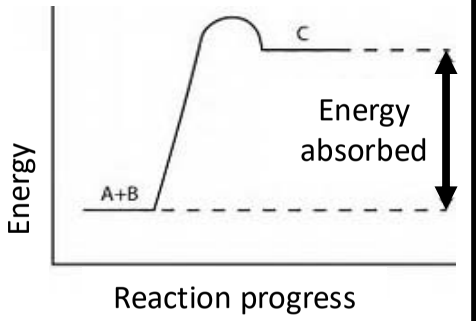
You need to be able to work out how many electrons an atom wants to lose or gain using the group number. This will be its ion charge.

Trilogy C7: Energy Changes

Part of: Energy Changes

Knowledge Organiser

Key points to learn

1. Exothermic reaction	One that transfers energy to the surroundings so the temperature of the surroundings increases
	
	Used in handwarmers and self-heating cans
	Examples: combustion, respiration, oxidation, neutralisation
2. Endothermic reaction	One that absorbs energy from the surroundings so the temp. of the surroundings decreases
	
	Used in cold packs for injuries
	Examples: Photosynthesis, thermal decomposition, citric acid and sodium hydrogen carbonate

Key points to learn

3. Reactant	Used in a reaction
4. Product	Made in a reaction
5. Conservation of energy	Energy is never created or destroyed it is just transferred from one form to another
6. Activation Energy	Is the energy required to start a reaction
7. Catalyst	Chemical which speeds up a reaction without being used itself
	Reduces the activation energy required to start a reaction
8. Breaking and making bonds	This is what happens during a chemical reaction
	Require energy in to break bonds (Endothermic)
	Energy is released when bonds are made (Exothermic)
	Bonds between different atoms need different amounts of energy

Additional information

- Collision theory: chemical reactions occur when particles collide with enough energy
- Chemical reactions are all due to electrons moving or being shared
- An enzyme is a biological catalyst
- *Higher Tier content is written in italics*

Big picture (Chemistry Paper 1)

- Atoms, molecules and moles
  - Atomic structure
  - The periodic table
  - Structure and bonding
  - Chemical calculations
- Chemical changes and energy changes
  - Chemical changes
  - Electrolysis
  - **Energy changes**

Background

The interaction of particles in chemical reactions often involves transfers of energy. These produce heating or cooling effects that are used in a range of everyday applications.

Maths skills

- *Using bond energies, calculate energy difference in a reaction eg*

$2H_2 + O_2 \rightarrow 2H_2O$

Reactants bond energy (kJ/mol)

$(2x436) + 498) = 1370$

Products bond energy (kJ/mol)

$2x(2x464) = 1856$

Energy released (kJ/mol)

1370-1856 = –486 kJ/mol

Therefore exothermic

Bond	Bond energy (kJ/mol)
H-H	436
O=O	498
H-O	464