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| Protons | Isotopes |
| Neutrons | 1st Ionisation energy |
| Electrons | 2nd Ionisation energy |
| Atomic (proton) number | Factors affecting ionisation energy: |

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| Isotopes are atoms with the same number of protons but different numbers of neutrons. Electrons decide the chemical properties of an element. Isotopes have the same electronic arrangement, so they have the same chemical properties. | Relative mass is 1 and has a charge of +1 |
| The first ionisation energy is the energy required to form 1 mole of positive gaseous ion from 1 mole of gaseous atoms. | Relative mass is 1 and has a charge of 0 |
| The second ionisation energy is the energy required to from 1 mole of di-positive gaseous ion from 1 mole of positive gaseous ions | Relative mass is 1 over 2000 and has a charge of -1. |
| •Nuclear charge •Distance from nucleus (atomic radius) •Shielding | Is the number of protons in the nucleus, all atoms of the same element have the same proton number. |

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| Nuclear charge | Relative atomic mass: |
| Distance from nucleus (atomic radius) | Relative isotopic mass |
| Shielding | Relative molecular mass |
| Trends of 1st Ionisation energies: | Mass Spectrometer |

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| Relative atomic mass is the average mass of an atom based on the c-12 carbon atom with a value of 12. | The more protons in the nucleus, the more positively charged the nucleus, so the attraction for the electrons is greater. |
| Relative isotopic mass is the average mass of an isotope based on the c-12 carbon atom with a value of 12. | The closer the electron to the nucleus the stronger the charge/attraction. The closer the nucleus the electron is the smaller the atomic radius. |
| Relative molecular mass is the average mass of a molecule or formula unit based on the c-12 carbon atom with a value of 12. | When the number of electrons between the outer electron and the nucleus increase, the outer electrons feel less attraction towards the nucleus, this is due to shielding. |
| The mass spectrometer can be used to find out the relative atomic mass, relative molecular mass, molecular structure etc. It has 5 stages. Vaporisation, this is where the sample is turned into a gas using an electric heater; Ionisation, the particles are bombarded with high energy electrons, removing an outer electron making them positive ions; Acceleration, an electric field is used to accelerate positive ion; Deflection, A magnetic field is used to deflect positive ions, the lighter ions are deflected more and finally detection, the magnetic field is slowly increased, so different ions can be detected and a mass spectrometer produced. | The ionisation energy down a group decrease because as you go down a group the shielding increases because the number of shells and electrons between the outer electron and nucleus increases. The ionisation energy across a period generally increase because the proton number in the nucleus is increasing so there is a strong attraction for electrons which are in the same shell. Across a period the ionisation energy will go up and down, and ionisation energy of an element will increase. |

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| Moles | Percentage yield: |
| Empirical formula: | Titrations: |
| Molecular formula: | Percentage error: |
| Theoretical yield: | Atom economy: |

Percentage yield of a product is never 100% because the actual yield is never the same as the theoretical yield because some product may be lost. Percentage yield is actual yield ÷ theoretical yield times 100.

•Number of moles = number of particles ÷ Avogadro's constant (6 times 10 to the power of 23). •Number of moles = mass of a substance ÷ molar mass. •Number of moles = concentration times volume in cm cubed ÷ 1000. •Number of moles = volume in decimetres cubed ÷ 24 or volume in centimetres cubed ÷ 24000

Allows you to work out how much acid is needed to neutralise an alkali. Methyl orange turns yellow to red when adding acid to an alkali. Phenolphthalein, turns from red/pink to colourless when adding an acid to an alkali.

Empirical formula is the smallest whole number ratio of atoms in a molecule.

work out the percentage error in titration it is error ÷ reading times 100.

Molecular formula is the actual number of atoms in a molecule.

Tells you how wasteful a product is, atom economy is a measure of the proportion on reactant atoms that becomes part of the desired product. To work out atom economy percentage is the molecular formula of the desired product ÷ the sum of molecular masses of all products times 100. Addition reactions have 100% atom economy; substitution reactions have a lower atom economy.

The theoretical yield is the mass of the products that should have been formed. Theoretical yield is number of moles of the product times molar mass of the product.

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| Ionic bonding: | Dative covalent bonds: |
| Ionic radius: | Giant molecular structure: |
| Isoelectronic ions: | Diamonds: |
| Covalent bonds: | Graphite: |

A dative covalent bond is a covalent bond but both the shared electrons come from just one of the atoms. A double bond comes from 2 shared electrons, and a triple bond results from 3 shared electrons.

Ionic bonding is the bonding between cat ions and an ions. The electrostatic attraction that holds the positive and negative ions together is very strong. Ionic compounds form giant ionic lattice structures. A lattice is a regular structure and it is giant because it is the same repeat unit over and over again. Ionic compounds conduct electricity when molten or dissolved, ionic compounds have high melting points and dissolve in water.

Giant molecular structures have a large network of covalent bonds. Giant molecular structures are diamonds, graphite and silicon 4 oxide. This is because carbon and silicon can form four strong covalent bonds.

Ionic radius is the size of an ion. The ionic radius increases as you go down a group. This is because the groups have the same charge, so the ionic radius increases as the atomic number increases; this is because electron shells are being added.

Diamonds is the hardest known substance, it is made up of carbon atoms, and each carbon atom is covalently bonded to four other carbons. They arrange themselves in a tetrahedral shape. Diamonds are good thermal conductors because vibrations travel easily through the stiff lattice. It has a very high melting point, it can't conduct electricity because all the outer electrons are held in localised bonds and it doesn't dissolve in any solvent.

Isoelectronic ions are ions of different atoms with the same number of electrons, the ionic radius of a set of ions decrease as the atomic number increases.

Graphite is an allotrope, (different forms of the same element in the same state) of carbon. Graphite's structure means it has different properties from diamond. Weak bonds between the layers in graphite are easily broken so layers can slide over each other; delocalised electrons are free to move along the layers carrying an electric current around; layers held together by weak Van der Waals forces; graphite is less dense because the layers are far apart; because of the strong covalent bonds, graphite has a high melting point and it is insoluble in any solvent.

A covalent bond is the sharing of electrons between two atoms this happens when two atoms approaches each other and their electron clouds overlap and electron density is greatest between the nuclei. *Covalent bonds can be sigma bonds. An overlap of s-orbitals giving the highest possible electron density or covalent bonds can be pi bonds, and overlap of 2 electrons in the p orbitals. Pi bonds are weaker than sigma bonds and are more reactive.

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| Metallic bonding: | Chain Isomers: |
| Periodic trends: | Positional isomers: |
| Homologus series: | Functional group isomers: |
| Alkanes and Alkenes | Alkanes: |

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| Chain isomers have a different arrangement of the carbon skeleton, some are straight and some are branched. | A metal is made up of an array of cations and delocalised electrons. The electrostatic force between the oppositely charged particles is the metallic bond. The more delocalised electrons the stronger the bond so the higher the melting point, no bonds holding specific ions together so metals are malleable and ductile, delocalised electrons can carry a current and metals are insoluble, except in liquid metals. |
| Positional isomers have the same skeleton and same functional group, the difference is that the group is attached to a different carbon atom. | Atomic radius decreases across a period, as the protons increase, the positive charge of the nucleus increases meaning the electrons are pulled closer to the nucleus, making the atomic radius smaller, electro negativity increases across a period, ionisation energies generally increase across a period. There is a drop of 1st ionisation energies betweens groups 2 and 3 because group 2's outer shell is in the 2s orbital but group 3's outer shell is in the 2p orbital and 2p has a slightly higher energy than the 2s. Drop of 1st ionisation energies betweens groups 5 and 6, the outer electrons for both elements come are in the same sub-shell so do not differ in shielding or atomic radius but electron repulsion between the 2 electrons in the outer shells make it easier to remove electrons. Melting and boiling points for metals increase across the period; this is because metallic bonds get stronger because the number of delocalised electrons increase, decreasing ionic radius leading to higher change density which at |
| Functional group isomers have the same atoms arranged into different functional groups. | A group of compounds can be represented by the same general formula is the homologus series. The general formula can be used to work out the molecular formula. Each successive members of a homologus series differs by a $CH_2$ group. |
| Alkanes are saturated hydrocarbons; every carbon has 4 single bonds with other atoms. It is impossible for the carbon to make more than 4 bonds. *Alkanes have a tetrahedral shape around each carbon with a bond angle of 109.5. *Alkane's burn completely in oxygen, if you burn oxygen and alkanes, carbon dioxide and water is produced. This is a combustion reaction and is exothermic. Combustion happens in gases so liquid alkanes would be vaporised into gases first. | Alkanes = $C_nH_{2n+2}$. Alkenes = $C_nH_{2n}$ and Alcohols = $C_nH_{2n+1}O$ H •Meth is 1 carbon •Eth is 2 carbons •Prop is 3 carbons, •But is 4 carbons •Pent is 5 carbons •Hex is 6 carbons •Hept is 7 carbons •Oct is 8 carbons •Non is 9 carbons •Dec is 10 carbons. |

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| Fractional distillation: | Heterolytic fission: |
| Cracked: | Homolytic fission: |
| Thermal cracking: | Free radical substitution reaction: |
| Reforming: | Alkenes: |

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| In heterolytic fission two different substances are formed – positive charged cat ions and negatively charged an ions. | Crude oil is vaporised at 350 degrees Celsius. The largest hydrocarbons won't vaporise as their boiling points are too high. As the crude oil vapour goes up the fractioning column it gets cooler and because of the different chain lengths, each fraction condenses at different temperatures. Fuel, wax, grease and are at the bottom and petrol and gases at the top. |
| Homolytic fission is the formation of 2 free radicals. Free radicals are particles that have an unpaired electron making them very reactive. | Heaving fractions from the column are cracked to make them smaller. Cracking involves breaking ling chains into smaller hydrocarbons by breaking the C-C bonds. |
| Halogens react with alkanes in photochemical reactions, which are started by UV lights. A hydrogen atom is substituted by Cl2 or Br2. *Free radical substitution reaction mechanism has three stages: •Initiation reaction: Free radicals are produced under UV light, this is homolytic fission. •Propagation reaction: In propagation free radicals are used up and produce one free radical and a molecule. •Termination reaction: Two free radicals join together to make a stable molecule. | Thermal cracking takes place at high temperatures (1000 degrees) and at high pressures or 70atmospheres. It produces a lot of alkanes which is used to make heaps of valuable products such as polymers. E.g.: Poly (ethene) which is made from ethene. |
| Alkenes are unsaturated hydrocarbons. Alkenes have at least one C double bond C bond. They can make extra bonds with atoms in addition reactions. *Alkenes are oxidised by acidified potassium manganate 7. *Alkenes are more reactive than alkanes because there are two pairs of electrons in the C double bond C bond, meaning it has a really high electron density. | Converting alkenes into arenes is called reforming and uses a catalyst such as platinum on aluminium oxide. |

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| Electrophilic addition reactions: | Stereoisomerism: |
| Electrophiles | E isomers: |
| Test for Alkenes | Z isomers: |
| E Z isomerism: | Cis: |

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| Stereoisomerism has the same structural formula but different arrangements, because of lack of rotation around the double bond, alkenes can have stereoisomerism. Alkanes DO NOT!! *If two double bonded carbon atoms have different atoms or groups attached to them, you get an E or Z isomer. | An electrophilic addition reaction happens to alkenes. In Electrophilic addition the double bond opens up and the other atoms are attached to each of its carbons. The double bonds have plenty of electrons that are attacked by an electrophile. The double bond is also nucleophilic, it's attracted to places without enough electrons. |
| E isomers are the same group or atom across the double bond. | Electrophiles are electron pair acceptors. They are positively charged ions such as H+. |
| Z isomers are the same group on the same side of the double bond. | Bromine reacts with alkenes by electrophilic addition. Bromine water which is orange when it reacts with alkenes it decolourises. Also a test for C double bond C bonds. |
| Cis is the same as Z. The groups are on the same side of the double bond. | E Z isomerism is a form of stereoisomerism. |

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| Trans: | Polymers: |
| Polymers: | Enthalpy: |
| Monomers: | Exothermic |
| Addition polymerisation: | Endothermic: |

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| Polymers can be used in Teflon pans, plastic windows, plastic crates , bags, bottles etc. however it is very un-reactive which makes it hard to dispose of. They are non bio-degradable. | Trans is the same as E. The groups are on opposite sides of the c double bond c bond. *If all four of the groups are different, then you base the E Z on the highest priority. If the higher priority is on the same side it is a Z, if it is on opposite sides it's an E isomer. |
| When a chemical reaction occurs some bonds are broken and some are made by changing the energy. *Enthalpy change (delta H) is the heat energy transferred in a reaction at a constant pressure. The units of enthalpy change are kJ mol minus 1. | Polymers are double bonds in alkenes can open up and join together to make long chains. |
| Exothermic reactions give energy out. The enthalpy change is negative. | Small individual alkenes are monomers. |
| Endothermic reactions energy is absorbed from the surroundings. The enthalpy change is positive. | Addition polymerisation is an alkene monomer becoming a polymer. For example poly (ethene) is made by the addition polymerisation of ethene. |

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| Standard enthalpy change of reaction, delta H r: | Standard enthalpy change of atomisation, delta H at: |
| Standard enthalpy change of formation, delta H f: | Standard Conditions |
| Standard enthalpy change of combustion, delta H c: | Hess’ Law: |
| Standard enthalpy change of neutralisation, delta H neut: | |

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| Is the enthalpy change when 1 mole of gaseous atoms is formed from the element in its standard state. | Is the enthalpy change when the reaction occurs in the molar quantities shown in the chemical equation, under standard conditions in their standard state. |
| Standard conditions are at 1 atmosphere pressure and 25 degrees temperature | : Is the enthalpy change when 1 mole of a compound is formed from its elements in their standard state, under standard conditions. E.g. Carbon (gas) + Oxygen (gas) = Carbon dioxide (gas) |
| Hess' law is that the total enthalpy change of a reaction is always the same, no matter which route is taken. | Is the enthalpy change when 1 mole of a substance is completely burned in oxygen under standard conditions. |
| | Is the enthalpy change when 1 mole of water is formed the neutralisation of hydrogen ions and hydroxide ions under standard conditions. |