OZ.a-u - The Ozone story | OZ1-8 |

OZ.Q Exam questions from past papers

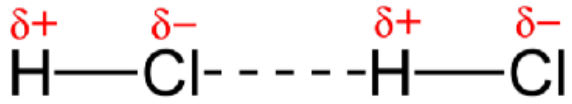
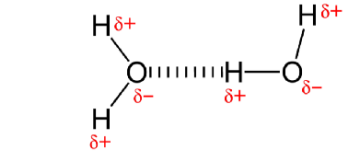
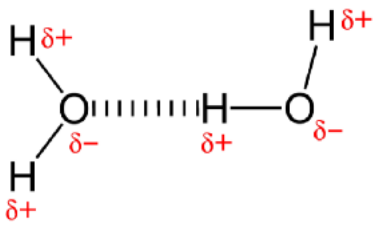
(c) Some haloalkanes act as greenhouse gases that absorb infrared radiation in the troposphere. Give the source of this infrared radiation. ..... [1] Some haloalkanes act as greenhouse gases that absorb infrared radiation in the troposphere. Give the source of this infrared radiation. (1)?	Earth or sun's energy (solar energy) *The 'sun' may not be allowed in this case*
(ii) One frequency absorbed by ozone is 1.25×10^{15} Hz. Calculate the enthalpy of the strongest bond that can be broken by this frequency. bond enthalpy = ... kJ mol^{-1} **[4]** One frequency absorbed by ozone is $1.25x10^{15}$ Hz Calculate the enthalpy of the strongest bond that can be broken by this frequency?	Recall and selection of appropriate constant from data sheet for $\Delta E = 6.63 \times 10^{-34} \times 1.25 \times 10^{15}$ ✔ $= 8.29 \times 10^{-19} / 8.2875 \times 10^{-19}$ (J) ✔ multiply by N_A and divide by 1000 $= 8.29 \times 10^{-19} \times 6.02 \times 10^{23} / 1000$ ✔ nthalpy = 499/500 (kJ mol^{-1})✔ ● E=hf ● $E_n \times N_A = E_N$ ● $E_N / 1000 = E^N$ ● 1.25x10 x 6.63x10-34 = 8.29x10-19 ● (8.29x10-19 / 1000) x 6.02x1023 = 499 kJmol^{-1} ● (hxfxN_A / 1000)
AT23ii (i) Name the type of electromagnetic radiation that is emitted from the Earth's surface. ..... [1] Name the type of EMR that is emitted from the Earth surface	AT23ii Infrared (radiation) ✓ 1 ALLOW 'IR' Infrared radiation
Some students set out to investigate the rate of hydrolysis of 1-bromobutane. They mix 1-bromobutane with sodium hydroxide solution and measure the conc of hydroxide ions after certain times at 51 degrees? Suggest the procedure the students use to follow the reaction? (3) and how did they maintain the temperature at 51 degrees (1)	● Quench the solution taking certain volume of solution at set intervals of time (1) ● Cool down the samples in ice water (1) ● Do a titration for each sample to find the concentration of hydroxide ions (1) ● By using a water bath

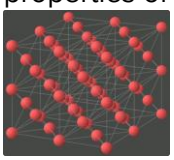
3 Which statement correctly describes the boiling points of fluoroethane and iodoethane? A Fluoroethane has the higher boiling point because it forms hydrogen bonds. B Fluoroethane has the higher boiling point because the C–F bond is stronger than C–I. C Iodoethane has the higher boiling point because it forms the stronger instantaneous dipole–induced dipole bonds. D Iodoethane has the higher boiling point because the C–I bond is less polar than C–F. Your answer ☐ [1] Which statement correctly describes the boiling points of fluoroethane and iodoethane?	● C ● (As iodoethane the molecule has overall more electrons and a bigger sized molecule than Fluoroethane -> stronger id-id forces -> stronger attraction -> higher bp) ● The id-id forces of the overall molecule would have a greater effect on bp than the pd-pd forces of the C- halogen bond 3 C
Both oxygen and chlorine atoms react with ozone in the stratosphere. Describe and compare the roles of oxygen and chlorine atoms in the breakdown of ozone and their relative effects. Include equations where appropriate. (6)	Role of oxygen ● Oxygen atoms/radicals react with ozone ● $O + O_3 \rightarrow 2O_2$ Role of chlorine ● Chlorine radicals react with ozone ● $Cl + O_3 \rightarrow ClO + O_2$ ● ClO reacts with oxygen atoms regenerating the chlorine radical ● $ClO + O \rightarrow Cl + O_2$ ● Overall reaction is the removal of ozone ● $O + O_3 \rightarrow 2O_2$ ● The chlorine radical is in a catalytic cycle Comparison of relative effects ● One O atom can only remove one ozone molecule ● One Cl atom can remove many ozone molecules

OZ.a-d - Bonding & Structure | OZ6 | OZ7 |

What are CFCs, what are they used as and why?	● Chlorofluorocarbons (thus containing only carbon, chlorine, and fluorine) ● Use as propellants, aerosols and refrigerants because they were non toxic, not flammable and not reactive
Define electronegativity?	The ability of an atom to attract electrons (1) in a covalent bond (1) towards itself
What is a dipole?	An uneven distribution of charge

When can you tell a bond is polar?	Generally if the two atoms bonded together are of different elements its polar (except for carbon-hydrogen)
How can you work out if a molecule is symmetrical?	Generally if it has no lone pairs and the same bonding pairs then its symmetrical (like 2 C-Cl bonds and 2 C-F bonds on a carbon) *You may have to rotate it in different planes to confirm this (i.e. CH_2F_2 the F_2 does not have to be opposite each other & can be next to each other thus the molecule would have a dipole)*
How can a molecule be nonpolar yet contain polar bonds? (2)	As its symmetrical (1) so dipoles cancel each other out (1)
Describe instantaneous dipole - induced dipole (id-id) interactions?	Electron movements create an unequal distribution of charge (electrons) (1) -> instantaneous dipole (1) -> induces a dipole in a nearby molecule (1) leading to attraction
Why do the strength of instantaneous dipole - induced dipole (id-id) interactions increase down groups?	The number of electrons increases -> stronger dipoles (due to stronger charges) -> stronger attraction *This is why oxygen has a higher b.p than hydrogen*
What are the strongest to the weakest intermolecular forces?	1. Hydrogen bonds 2. Permanent dipole- permanent dipole interactions (pd-pd) 3. Permanent dipole - induced dipole interactions (pd-id) 4. Instantaneous dipole- induced dipole interactions (id-id) [Sometimes referred to as london dispersion forces]
Why does electronegativity and ionisation energy increase across periods?	● Greater nuclear charge -> reduced atomic radius -> greater attraction -> harder to remove ● During this shielding stays the same
Why do electronegativities and ionisation energies decrease down groups?	● Increase atomic radius and more shells -> more shielding -> less attraction -> easier to remove ● Increase in shielding outweighs the increase in proton number and thus nuclear charge
How does having a longer straight chain (no branches) molecule affect boiling point?	● The molecule can pack closer together and so more (id-id) instantaneous dipole-induced dipole forces which requires more energy to overcome these forces (or high temperature) -> boiling point increases
How does having a branched molecule affect boiling point?	● The molecule can not pack together as close which weakens the (id-id) instantaneous dipole-induced dipole forces -> less energy is needed to overcome the forces (or lower temperature) -> boiling point

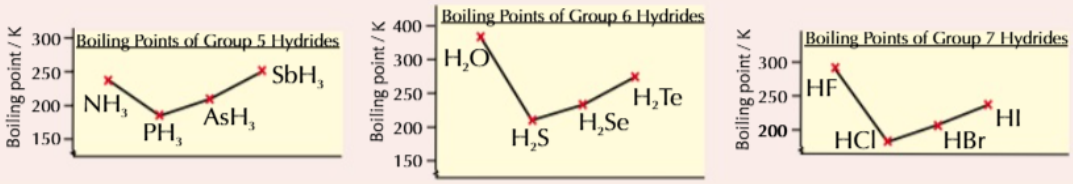
	decreases
How does the size of a molecule/atom affect (id-id) instantaneous dipole - induced dipole forces?	Bigger molecule/atom -> more (id-id) instantaneous dipole - induced dipole forces -> more electrons would instantaneously be more to one side of the molecule creating a bigger dipole
How do Permanent dipole-permanent dipole interactions arise for a 'general' molecule? (2)  	Two atoms with different electronegativity cause permanent dipoles (1) the permanent dipoles attract forming a bond (1)
Which will have a higher b.p, HF, HCl or HI and why?	HF -> stronger permanent dipole - dipole interactions (due to the difference in electronegativity being greater) which requires more energy to overcome
What is a hydrogen bond?  *The bond is represented by a dashed line and the line must be parallel to the covalent bond from the hydrogen.*	The attraction between a partially positive hydrogen atom and the lone pair of electrons on a partially negative atom (FON) on a different molecule and the hydrogen atom is bonded to an partially negative atom (FON) *When describing and explaining mention how the bonds are polar due to one atom being more electronegative than another and which atoms are partially charged*
Draw a hydrogen bond of two water molecules? And name the 3 features of a hydrogen bond	 *The bond is represented by a dashed line and the line must be parallel to the covalent bond from the hydrogen.* ● Hydrogen atom bonded to a FON ● 180 degree bond ● Partial charges on atoms
Which electronegative elements will hydrogen bonding happen with and why?	Fluorine, oxygen and nitrogen -> they are the most electronegative and most dense in electrons. (Remembered as FON) *Chlorines electron density is too low due to its extra shell*
Give 3 reasons why water has a higher m.p and b.p to structurally similar compounds? i.e. Water (liquid): Mr = 18 and Methane (gas): Mr = 16	1. Hydrogen bonding provide it with stronger intermolecular forces 2. Forms up to 4 hydrogen bonds 3. Oxygen is the second most electronegative element meaning stronger hydrogen bonds

Describe and explain the 2 anomalous properties of ice? 	1. Ice is less dense than water as the molecules are held further apart by hydrogen bonds in an open lattice 2. Ice has a higher m.p than expected as hydrogen bonds provides it with strong intermolecular forces *For the same number of water molecules ice takes up more space than liquid water leading to a lower density of ice*
How does a compound having hydrogen bonding effect viscosity?	The compound would have a higher viscosity

Hydrogen Bonds *Affect How a Substance* **Behaves**

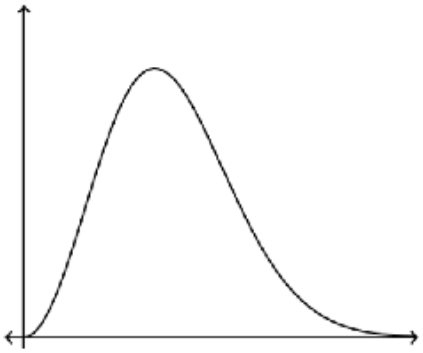
1) Hydrogen bonds are the **strongest** type of intermolecular bonds and have a huge effect on the properties of substances.
2) Substances that form hydrogen bonds have **high melting and boiling points** because a lot of **energy** is required to overcome the intermolecular bonds.

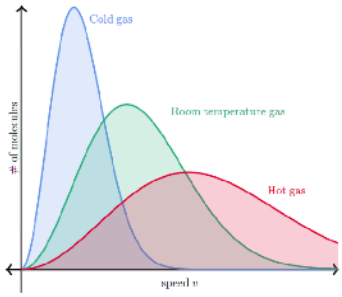
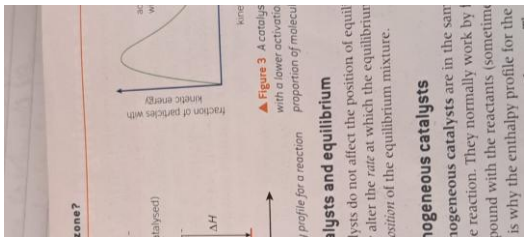
Hydrides of **nitrogen, oxygen** and **fluorine** generally have the **highest boiling points** if you compare them with other hydrides in their groups, because of the **extra energy** needed to break the hydrogen bonds.



OZ.e-h - Kinetics | OZ4 | OZ5 |

Define Activation enthalpy?	The minimum energy required of particles to collide to start a reaction
How does concentration affect the rate of reaction?	Increasing concentration -> more particles per unit volume -> more collisions per unit time -> increased rate of reaction *If the question explicitly says double concentration, say double particles and thus double frequency of successful collisions*
How does temperature affect the rate of reaction? With example. **(v)** Ammonia is not often made at temperatures below 473 K. This is because the equilibrium is established too slowly at lower temperatures. Explain why the rate of a reaction increases with temperature. .... [2]	Increasing temperature -> more particles collide with kinetic energy greater than the activation enthalpy (1) -> more collisions per unit time (1) -> increased rate of reaction *Allow more frequent successful collisions* **(c)** **(v)** Molecules/particles move faster/have more energy ✓ More (frequent) collisions with energy greater than activation enthalpy/E_a ✓ | **2** | **1.2** | "Atoms" **CON** first marking point **ALLOW** more successful collisions ✓

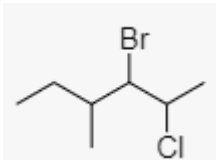
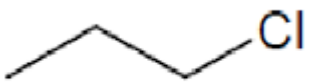
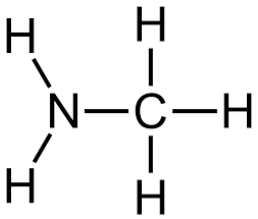
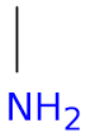
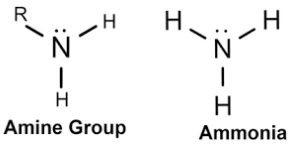
How does surface area affect the rate of reaction?	Increasing surface area -> more sites are exposed -> more collisions per unit time(1) -> increased rate of reaction (1)
How does pressure affect the rate of reaction?	Increasing pressure -> more particles per unit volume -> more collisions per unit time -> increased rate of reaction
How and why does a catalyst affect the rate of reaction	Adding a catalyst provides an alternate route of lower activation energy -> more successful collisions per unit time increasing the rate of reaction (of both reactions) *Note: Catalyst does not get used up*
What happens to the equilibrium position and the effect on K_c if a catalyst is added and WHY is a catalyst USED for equilibrium reactions? **(b)** A catalyst of iron and chromium is used. State why a catalyst is used, giving its effect on K_c. .... **[2]**	● No change as it increases the rate of reaction for both reactions (1) ● The time at which an equilibrium is achieved is reduced (1) *Do not refer to the alternate route of lower E_A* b — speeds up achievement of equilibrium **OR** speeds up both (forward and back) reactions ✓ — no effect on K_c (AW) ✓ — 2 Can score this alternative for the first marking point while explaining effect on K_c **Examiner's Comments** Most candidates knew that a catalyst had no effect on Kc and some were able to extend their knowledge that catalysts speed up reactions to say that equilibrium would be reached faster.
What is the key idea behind the 'Maxwell Boltzmann Distribution'?	Particles gain or lose energy in collisions with others and thus travel at different speeds
Give the key features of the 'Boltzmann Distribution'	● It starts at the origin because no particles have no energy ● The peak (E_{mp}) is the most probable energy (which is different from the mean) ● It never meets the x-axis as there is no maximum energy for particles  *The area under the graph represents the number of molecules.*

What does the 'Maxwell Boltzmann Distribution' look like at different temperatures and why? And draw 2 different diagrams with temp diff	Increasing the temperature shifts the distribution towards more particles having higher energies (more than any E_a) and wider range of energies due to more frequent collisions  *The area under the graph represents the number of molecules.* The x -axis is also energy / kinetic energy of the molecules
Draw the Enthalpy profile for an exothermic reaction with and without the use of a homogeneous catalyst and the boltzmann distribution for both	

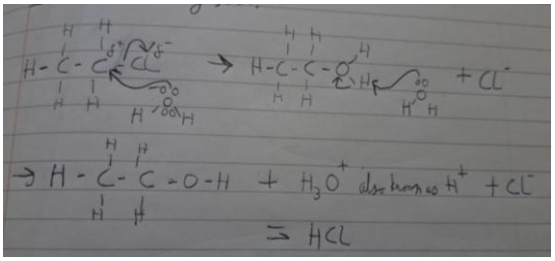
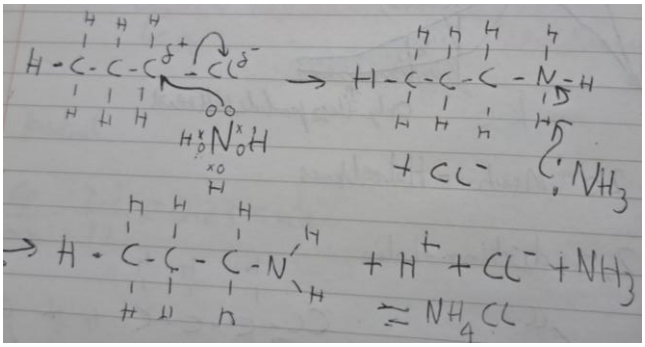
OZ.i - Inorganic chemistry & the periodic table | OZ1 |

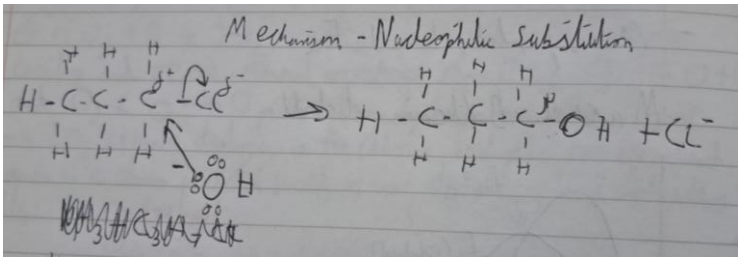
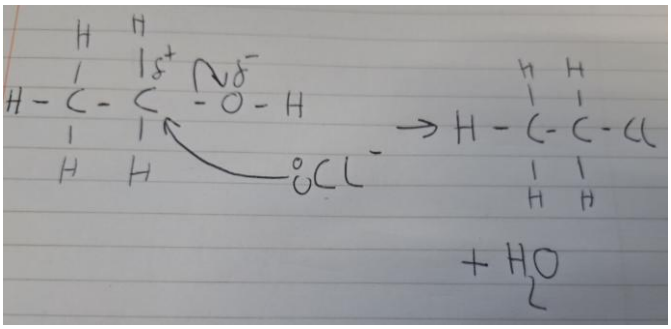
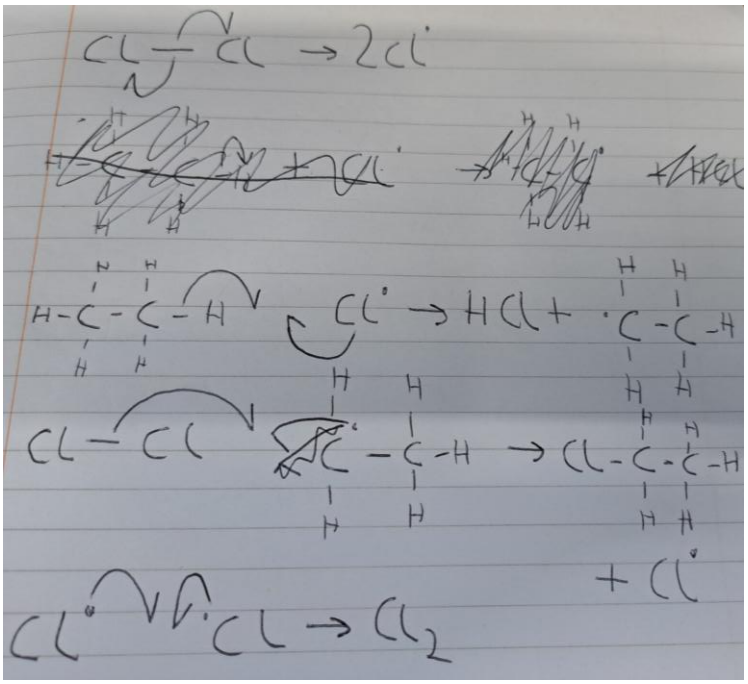
How would you convert 399 ppm to a percentage composition and ans?	$399/1x10^4$ = 0.0399% (399/1,000,000 x 100)
How would you convert 1x10-6 % to ppm and ans?	$1x10^{-6}$ x $1x10^4$ = 0.01 ppm (1x10-6/100 x 1,000,000))
The equation for calculating bond enthalpy from wavelength in one equation	• $E=(hxcxN_a)/\lambda x1000$ • Bond enthalpy = (planck's constant x speed of light x avogadro's number)/ wavelength x 1000
The equation for calculating bond enthalpy from frequency in one equation	$E=(hfxN_a)/1000$
The equation for calculating frequency from bond enthalpy in one equation	$f=(hfxN_a)/Ex10^3$

OZ.j - Organic functional groups | OZ6 | OZ8 |

Functional group and prefixes of haloalkanes? And Name this compound 	• Functional group: C-X (e.g. C-Cl) • Prefix: fluoro-, chloro-, bromo-, iodo- • Suffix -fluorine, -chlorine, -bromine, -iodine • 3-bromo-2-chloro,4-methylhexane  • *E,g., 1-chloropropane*
Functional group and suffix of amines? And name this compound  	• Functional group: R-NH_2  • Suffix: -amine • Methylamine • Aminomethane

OZ.k - Organic reactions | OZ6 | OZ8 |

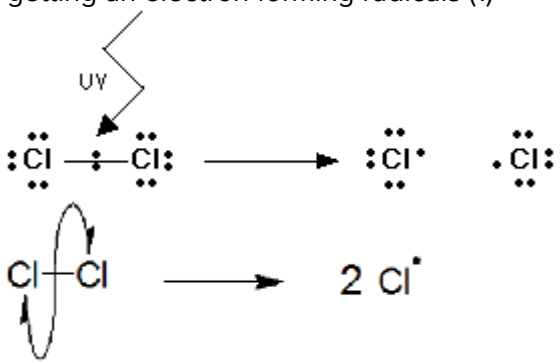
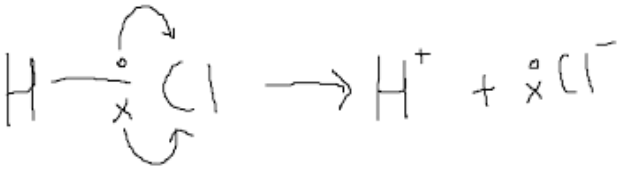
Draw the two step nucleophilic substitution of chloroethane with water as the nucleophile?	
Draw the two step nucleophilic substitution of 1-chloropropane with ammonia as the nucleophile?	

Draw the one step nucleophilic substitution of 1-chloropropane with hydroxide ions as the nucleophile?	
Draw the one step nucleophilic substitution of ethanol and HCl?	 *Picture wrong don't include charge on Cl and make sure the H and Cl and bonded together like H-Cl*
Draw the radical substitution mechanism for the initiation and potential propagation and termination steps in the presence of Cl_2 and C_2H_6 in the stratosphere?	

OZ.l-q - Reaction mechanisms | OZ3 | OZ5 | OZ8 |

Define substitution?	A reaction in which one atom or group in a molecule is replaced by another atom or group

Define nucleophile?	A molecule or negative ion which has a lone pair of electrons which it uses to form a new covalent bond to a partial positive (δ+) atom *Nucleophile means nucleus loving and can help you remember nucleophiles are attracted to areas of positive charge*
What is hydrolysis?	A **type of reaction** involving the splitting of a molecule by water
What 1 thing does the rate of the hydrolysis of haloalkanes depend on and how?	● The bond enthalpy (i.e. bond strength) of the carbon-halogen bond the weaker the faster *This factor affects the rate more than the polarity of the bonds*
How does the strength of the carbon-halogen bond vary between different haloalkanes and why?	● Bond enthalpy (i.e. bond strength) decreases for halogen further down the group -> broken more easily ● Due to decreased attraction between the bonding pair of electrons and the nuclei of bonding pairs due to increased shielding and atomic radius *This factor affects the bond strength more than the polarity of the bonds*
How can the rate of the hydrolysis of haloalkanes be measured and why?	● By adding silver nitrate solution and timing how long it takes for a precipitate to form ● The quicker it does the faster the rate of reaction ● As soon as the halide ion is formed from nucleophilic substitution it can react with the silver ion $Ag^+ (aq) + X^- \rightarrow AgX (s)$
Describe and explain how they can use aqueous silver nitrate in their investigation and what conclusions they should be able to make?	Method ● Dissolve Haloalkanes in ethanol in test tubes ● Stand in beaker of hot water ● Add solution of silver nitrate ● Start timing Explanation of step ● Ethanol used as a solvent ● Hot water needed as reaction too slow in cold ● Use equal amount of reactant for a 'fair test' Observation ● Precipitate forms ● Note time on first appearance Explanation of observations ● Ppt caused by halide ions reacting with silver ions

	Conclusion ● Shorter time means faster rate -> iodo (fastest), bromo then chloro ● Bond strengths increase in order
Define Bond fission?	Bonds breaking
Define free radicals?	A reactive species with one or more unpaired electrons
What is homolytic fission and what does it form? And draw the example of chlorine to forming radicals mechanism	When a covalent bond breaks (1) with each bonded atom getting an electron forming radicals (1) 
What is heterolytic fission?	When a covalent bond breaks (1) with one bonded atom getting both electrons forming ions (1) 
What are the 3 stages of radical substitution mechanism and explain how to identify each stage? Including the reagents/conditions to form radicals	● Initiation is where a non radical is broken via homolytic fission by high energy UV radiation to form radicals ● Propagation is where one radical is on both sides of the equation a radical used and produced to continue the reaction ● Termination is where two radicals react together to form a non radical *Allow for propagation that* a radical used and produced to continue the reaction *Allow for scientific explanation for initiation that it is an endothermic reaction as only bonds are broken and for termination that it is an exothermic reaction as only bonds are made*
Give 2 problems with synthesising (producing) haloalkanes by free radical substitution?	● Lots of termination steps lead to impurities (e.g., 2 $CH_3\cdot$ **)** ● Further substitution of termination products

Describe how CFCs lead to the destruction of ozone and explain why this is so effective?	● The weaker C-Cl bond is broken by homolytic fission under UV light forming Cl radicals which catalyses the breakdown of ozone ● Cl + O3 -> ClO + O2 ● ClO + O -> O2 + Cl ● The overall equation is O3 + O -> 2O2 ● The chlorine radical is reproduced causing a chain reaction

OZ.r - Sustainability | OZ2 |

Why is Ozone (O_3) in the stratosphere a good thing? (2)	● Absorbs high energy/frequency UV radiation from the sun ● Preventing skin cancer/cell mutation/ damage to DNA/ damage to eyes
Why is Ozone (O_3) in the troposphere a bad thing?	● Photochemical smog ● Respiratory problems ● Damages plants/ habitats ● Damages rubber *Allow specific breathing problems i.e asthma* *Some Mark Schemes have* eye problems
What does high UV radiation cause?	● Skin cancer/ sunburn/ damages skin ● Damages DNA/ causes mutations ● Damages eyes
Why is Ozone in the stratosphere and troposphere with NO2 a good/bad thing?	● In the stratosphere NO2 catalyses the breakdown of Ozone which is bad ● In the troposphere NO2 reacts with Ozone to form photochemical smog which is bad

OZ.s-u - Energy & Matter | OZ2 |

Which type of EMR needs to be absorbed for the transitional energy of a molecule to change?	Any
Which type of EMR needs to be absorbed for rotational energy to change?	Microwave radiation *Think about how a microwave rotates*
Which type of EMR needs to be absorbed for vibrational energy to change?	Infrared radiation
Which type of EMR needs to be absorbed for electronic energy to change?	Ultraviolet and visible light radiation

What kind of electronic changes occur when molecules absorb UV radiation? In order of increasing energy absorbed	1. Excited (electrons jumping to a higher energy level) 2. Ionisation (removing an electron from an atom) 3. Break bonds (in which photodissociation occurs and radicals are formed)
What is the principle radiation from the earth?	Infrared radiation
What is the principle radiation from the sun (solar energy)?	● Ultraviolet radiation ● Visible light