Module 1: **Basic Concepts and Hydrocarbons**

* + - 2.1.1 – **Basic Concepts**

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| **Nomenclature and Formula Representation** | |
| Use the empirical Formula and molecular formula |  |
| Understand that the general formula is the simplest algebraic formula. |  |
| Define the *structural formula* and the *displayed formula* |  |
| Draw the Skeletal Formula |  |
| **Functional groups, organic reactions and isomerism;** | |
| Define *functional group* and *Homologous series* |  |
| Use the general formula of a homologous series to predict the formula of any member of the series. |  |
| State the names of the first ten members of the alkanes homologous series. And use IUCAP rules for nomenclature |  |
| Define *structural* *isomers* and *stereoisomers* |  |
| Determine the possible structural formulae and/or stereoisomers of an organic molecule. |  |
| **Reaction mechanisms, percentage yield and atom economy.** | |
| Describe the two different types of covalent bond fission |  |
| Describe a ‘curly arrow’ as the movement of an electron pair, showing either breaking or formation of a covalent bond; |  |
| Outline reaction mechanisms, using diagrams, to show clearly the movement of an electron pair with ‘curly arrows’; |  |
| Explain the atom economy of a reaction as: molecular mass of the desired products/sum of molecular masses of all products (x100) |  |
| Carry out calculations to determine the atom economy and percentage yield of reactions |  |
| Describe the benefits of developing chemical processes with a high atom economy in terms of fewer waste materials; |  |

Targets –

What went well -

* 2.1.2 – **Alkanes**

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| **Hydrocarbons From Crude Oil** | |
| Define a *Hydrocarbon* |  |
| State that alkanes and cycloalkanes are saturated hydrocarbons; |  |
| State and explain the tetrahedral shape around each carbon atom in alkanes |  |
| Explain, in terms of van der Waals’ forces, the variations in the boiling points of alkanes with different carbon-chain length and branching; |  |
| **Hydrocarbons As Fuel** | |
| Describe the combustion of alkanes, leading to their use as fuels in industry, in the home and in transport; |  |
| Explain, using equations, the incomplete combustion of alkanes in a limited supply of oxygen and outline the potential dangers arising from production of CO in the home and from car use; |  |
| Describe the use of catalytic cracking to obtain more useful alkanes and alkenes; |  |
| Explain that the petroleum industry processes straight-chain hydrocarbons into branched alkanes and cyclic hydrocarbons to promote efficient combustion; |  |
| Compare the advantages and disadvantages of fossil fuels |  |
| Understand the substitution reaction of alkanes |  |
| Define the term *radical* |  |

Targets –

What went well -

2.1.3 – **Alkenes**

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| **Properties of Alkenes** | | |
| State that alkenes and cycloalkenes are unsaturated hydrocarbons; | |  |
| Describe the overlap of adjacent p-orbitals to form a Pi-bond; | |  |
| State and explain the trigonal planar shape around each carbon in the C=C of alkenes | |  |
| **Addition Reactions** | | |
| Describe addition reactions of alkenes, eg. ethene and propene with hydrogen, halogens, hydrogen halides, and steam |  | |
| Define the term *electrophile* |  | |
| Describe how heterolytic fission leads to the mechanism of electrophilic addition in alkenes |  | |
| **Polymers and industrial importance of alkenes** | | |
| Describe the addition polymerisation of alkenes |  | |
| Deduce the repeat unit of an addition polymer obtained from a given monomer; |  | |
| Identify the monomer that would produce a given section of an addition polymer; |  | |
| Outline the use of alkenes in the industrial production of organic compounds: |  | |
| Outline the processing of waste polymers |  | |
| Outline the role of chemists in minimizing environmental damage |  | |

Targets –

What went well -

Module 2: **Alcohols, Halogenoalkanes and Analysis**

2.2.1 – **Alcohols**

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| **Properties of alcohols and the preparation of ethanol** | |
| Explain, in terms of hydrogen bonding, the water solubility and the relatively low volatility of alcohols |  |
| Describe the industrial production of ethanol by: Fermentation from sugars, and the reaction of ethene with steam in the presence of an acid catalyst; |  |
| Outline, for alcohols: the use of ethanol in alcoholic drinks and as a solvent in the form of methylated spirits, and the use of methanol as a petrol additive to improve combustion |  |
| **Reactions, including oxidation, esterification and elimination.** | |
| Classify alcohols into primary, secondary and  tertiary alcohols; |  |
| Describe the oxidation and combustion of alcohols |  |
| Describe the esterification of alcohols with carboxylic acids in the presence of an acid catalyst; |  |
| Describe elimination of H2O from alcohols in the presence of an acid catalyst and heat to form alkenes. |  |

Targets –

What went well -

2.2.2 **– Halogenoalkanes**

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| **Substitution reactions and uses** | |
| Describe the hydrolysis of halogenoalkanesas a substitution reaction |  |
| Define the term *Nucleophile* |  |
| Explain the rates of hydrolysis of primary halogenoalkanes in terms of the relative bond enthalpies of carbon–halogen bonds |  |
| Describe the mechanism of nucleophilic substitution in the hydrolysis of primary halogenoalkanes with hot aqueous alkali |  |
| **Uses of Halogenoalkanes** | |
| Outline the uses of chloroethene and tetrafluoroethene to produce the plastics PVC and PTFE |  |
| Explain that CFCs: were developed as aerosols, refrigerants, and in air-conditioning because of their low reactivity, volatility and non-toxicity, yet they have caused environmental damage to the ozone layer |  |
| Outline the role of green chemistry in minimising damage to the environment by  promoting biodegradable alternatives to CFCs |  |

Targets –

What went well -

1.2.2 **– Modern Analytical Techniques**

Targets –

What went well -

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| **Infrared spectroscopy** | |
| State that absorption of infrared radiation causes covalent bonds to vibrate |  |
| Identify, using an infrared spectrum of an organic compound: an alcohol from an absorption peak of the O–H bond; an aldehyde or ketone from an absorption peak of the C=O bond; a carboxylic acid from an absorption peak of the C=O bond and a broad absorption peak of the O**\_**H bond |  |
| State that modern breathalysers measure ethanol in the breath by analysis using  infrared spectroscopy; |  |
| **Mass spectrometry** | |
| Outline the use of mass spectrometry: in the determination of relative isotopic masses, as a method for identifying elements, |  |
| Interpret mass spectra of elements in terms of isotopic abundances; |  |
| Use the molecular ion peak in a mass spectrum of an organic molecule to determine its molecular mass; |  |
| Use molecular ion peaks and fragmentation peaks to identify structures |  |

**Module 3 – Energy**

2.3.1 – **Enthalpy Changes**

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| **Enthalpy changes of reaction, combustion and formation;** | |
| Explain that some chemical reactions are accompanied by enthalpy changes that can be exothermic (Δ**H**, negative) or endothermic (Δ**H**, positive); |  |
| Describe the importance of oxidation as an exothermic process in the combustion of fuels and the oxidation of carbohydrates |  |
| Describe that endothermic processes require an input of heat energy, eg the thermal decomposition of calcium carbonate |  |
| Construct a simple enthalpy profile diagram for a reaction to show the difference in the enthalpy of the reactants compared with that of the products; |  |
| Define the term *Activation energy* |  |
| Define the terms *standard conditions*; *enthalpy change of reaction*; *enthalpy change of formation* and *enthalpy change of combustion* |  |
| **Bond enthalpies;** | |
| Explain exothermic and endothermic reactions in terms of enthalpy changes associated with the breaking and making of chemical bonds |  |
| Define and use the term *average bond enthalpy* |  |
| Calculate enthalpy changes of reactions using their average bond enthalpies |  |
| **Hess’ law and enthalpy cycles** |  |
| Use Hess’ law to construct enthalpy cycles and carry out calculations to determine: an enthalpy change of reaction from enthalpy changes of combustion; an enthalpy change of reaction from enthalpy changes of formation; an enthalpy change of reaction from an unfamiliar enthalpy cycle. |  |

Targets –

What went well -

2.3.2 – **Rates and Equillibrium**

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| **Collision theory, the Boltzmann distribution and catalysis;** | |
| Describe qualitatively, in terms of collisiontheory, the effect of concentration changes on the rate of a reaction; |  |
| Explain why an increase in the pressure of a gas, increasing its concentration, may increase the rate of a reaction involving gases |  |
| State that a catalyst speeds up a reaction without being consumed by the overall reaction |  |
| Explain that catalysts: (i) affect the conditions that are needed, often requiring lower temperatures and reducing energy demand and CO2 emissions from burning of fossil fuels, |  |
| **A qualitative study of reaction rates;** | |
| Explain qualitatively the Boltzmann distribution and its relationship with activation energy |  |
| Describe qualitatively, using the Boltzmann distribution, the effect of temperature changes on the proportion of molecules exceeding the activation energy and hence the reaction rate |  |
| **Dynamic equilibrium and le Chatelier’s principle.** |  |
| Explain that a dynamic equilibrium exists when the rate of the forward reaction is equal to the rate of the reverse reaction |  |
| State *le Chatelier’s principle* |  |

Targets –

What went well -

**Module 4 – Resources**

2.4.1 – **Chemistry in the Air**

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| **The “Greenhouse” Effect** | |
| Explain that infrared radiation is absorbed by C=O, O–H and C–H bonds in H2O, CO2 and CH4, and that these absorptions contribute to global warming |  |
| Explain that the ‘Greenhouse Effect’ of a given gas is dependent both on its atmospheric concentration and its ability to absorb infrared radiation |  |
| Outline the importance of controlling global warming resulting from atmospheric increases in greenhouse gases; |  |
| **The Ozone Layer** | |
| Explain that ozone is continuously being formed and broken down in the stratosphere by the action of ultraviolet radiation; |  |
| Describe and explain how the concentration of ozone is maintained in the ozone layer, including the role of ultraviolet radiation; outline the role of ozone in the absorption of harmful ultraviolet radiation and the essential benefit of this process for life on Earth |  |
| Understand that radicals, eg from CFCs, and NOx from thunderstorms or aircraft, may catalyse the breakdown of ozone by the following simple representation:  R + O3 \_ RO + O2  RO + O \_ R + O2 |  |
| **Controlling Pollution** | |
| Explain their formation from the internal combustion engine, |  |
| State environmental concerns from their toxicity and contribution to low-level ozone and photochemical smog; |  |
| Outline how a catalytic converter decreases carbon monoxide and nitrogen monoxide emissions from internal combustion engines |  |
| Outline the use of infrared spectroscopy in monitoring air pollution. |  |

Targets –

What went well -

2.4.2 **– Green Chemistry**

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| **Sustainability** | |
| Describe principles of chemical sustainability of :- | |
| Using industrial processes that reduce or eliminate hazardous chemicals and which involve the use of fewer chemicals, |  |
| Designing processes with a high atom economy that minimise the production of waste materials, |  |
| Using renewable resources such as plant-based substances |  |
| Seeking alternative energy sources such as solar energy, rather than consuming finite resources such as fossil fuels that will eventually be exhausted, |  |
| Explain that the apparent benefits may be offset by unexpected and detrimental side effects; |  |
| Explain the importance of establishing international cooperation to promote the reduction of pollution levels; |  |

Targets –

What went well -