# DF.a-u - Developing Fuels | DF1-11

## DF.Q Exam questions from past papers

| Explain why the C=O double bond is shorter than the C–O single bond (2) | * there are more electrons between the atoms in the double bond (1) * giving greater attraction between the bonded atoms (1) |
| --- | --- |
| Explain why biofuels are regarded as a sustainable energy source and why they are often describes as ‘carbon neutral’ (3) | * Comes from crops which can be regrown (1) * Plants take in CO2 for photosynthesis (1) which balances out roughly with CO2 produced on burning (1) |
| When biodiesel burns it produces less carbon monoxide than similar fuels made from crude oil.  Explain why less carbon monoxide is produced and why this is desirable? | Oxygen atom in structure allows more complete combustion therefore carbon dioxide produced (1) which is more fuel efficient (1) and this is desirable as CO is toxic (1)  Compare  C2H5OH + 3O2 -> 2CO2 + 3H2O (ethanol)  C2H6 + 3.5O2 -> 2CO2 + 3H2O (ethane) |
| Why can’t the enthalpy change for a thermal decomposition reaction be measured directly? | As thermal decomposition requires heat |
| Why can bond enthalpies not be used to estimate ΔH1? (1)  2NaHCO3 (s) -> Na2CO3 (s) + CO2 (g) + H2O (l) | NaHCO3 and Na2CO3 are ionic so not all bonds are covalent (1) |
| Calculate its energy density? | * Mr of C8H16 = 112 * Moles in one kg = 1000/112 = 8.93 * KJ per kg = 8.93 x 5300 = 47329 * = 47000 KJ per kg |
| Explain whether the accuracy in the student’s calculated value for Δc*H* may or may not be improved by heating for longer.? | * Less accurate due to greater heat losses * More accurate due to smaller % uncertainty in temperature change or mass of fuel burnt |
| A sample of gas, volume V, has its temperature raised from 0°C to 20°C. The pressure remains constant. What is the new volume? And method how? | C   * v=nRT/p * 1x8.314x273/1 = 2269 * 1x8.314x293/1 = 2436 * 2436/2269= 1.07 |
| Why are many bond enthalpies describes as averages and Explain the meaning of **average** in this context | * B and based on several molecules   *Don't say many/several compounds as 2023 MS said ignore* |

## **DF.a - Formulae, equations and amount of substance | DF2 | DF8 |**

| What is the equation linking mol (n), volume of gas (dm3), and molar gas volume (24d m3)? |  |
| --- | --- |
| What is 25cm3 equal to? | 25g and 25ml |
| What is the conversion framework between the 4 cubic units? | Remember: **mm**m m**cd**onalds **m**ilkshake |
| What is the ideal gas equal and what is each unit measured in at RTP where possible ? | p = 101kPa  V = 24x10-3m3  n = mol  R = 8.314 J K-1  T = 298K  *Don’t use pV=nRT for RTP use molar gas volume equation this was just an example* |
| What is 1 atm pressure in pascals? | 101kPa or 101000Pa |

## **DF.b-c - Bonding and structure | DF6 | DF9 |**

| What are the 3 wedges for the shape of molecules? | 1. Solid line is a bond on the plane of the paper 2. Solid wedge/triangle is a bond that comes out of the plane of paper 3. Dotted line is a bond going into the plane of the paper |
| --- | --- |
| What is a 𝛑 bond (with diagram e.g., ethene) | The sideways overlapping of p-orbitals  Draw the full reaction with the arrows |
| What is the σ bond? | The overlap of orbitals directly between atoms    *The overlap of s orbital and s orbitals or s orbitals and p orbitals* |
| How to calculate how many 𝛑 or σ bonds a compound has? And how many does Ethene have? | * Pi bonds is the number of double or triple bonds * Sigma bonds is the number of single, double and triple bonds * Ethane has 1 pi bond and 5 sigma bonds |

## **DF.d-g - Energetics | DF1 | DF2 | DF4 |**

| What is the conversion factor between Kelvin and Celsius? | Add 273 to C to get K |
| --- | --- |
| What is an exothermic reaction? | A reaction that gives out energy and heat the surroundings |
| What is an endothermic reaction? | A reaction that takes in energy and cools the surroundings |
| Breaking bonds is… because… (remember Bending) | * Endothermic * Energy is put into the system * Remember Bendo   *Atoms becomes less stable as they have no bonds and lots of energy* |
| Making bonds is… because.. (remember Mexico) | * Exothermic * Energy is released to the surroundings * Remember Mexo   *Despite the little energy needed to make a bond, the molecules becomes more stable when bonded and thus releases energy* |
| Draw and label the energy profile diagram for an exothermic reaction with no activation energy | * ΔH is negative as energy is exiting the system to surroundings and thus exothermic * Taking up to be the positive direction we have the arrow pointing downwards |
| Draw and label the energy profile diagram for an endothermic reaction with no activation energy | * ΔH is positive as energy is entering the system from the surroundings and thus endothermic * Taking up to be the positive direction we have the arrow pointing upwards |
| How is energy transferred calculated or SHC)? | [q=mcΔT] Energy transferred (J) = **mass** x specific heat capacity x temperature change  (Mass of the substance that changes temperature e.g. water in combustion not the fuel)  *Also for some questions you are given the volume of a substance like 5cm3 and 0.1moldm-3 for an aqueous substance DONT FORGET that 5cm3 = 5g do not convert into moles then times by RFM to get mass* |
| How is enthalpy change calculated? | +-ΔH = q/n (Moles of the limiting reactant)  *The plus or minus depend on whether the reaction was exothermic or endothermic*  *CHECK FORM THE TEMPERATURE CHANGE IF THE REACTION IS EXOTHERMIC OR ENDOTHERMIC unless stated in the question* |
| What are the general standard conditions that allows us to compare enthalpy changes? | * A specific temperature normally chosen as 298K (25℃) * A standard pressure of 1 atm (equal to 101kpa or 1.01x105 Nm-2) * A standard concentration of 1 moldm-3 for solutions |
| Define Standard states? | The physical state of a substance under standard conditions. This may be a pure solid liquid or gas |
| Define (Standard) enthalpy change for a reaction ΔrH⦵? | The enthalpy change when molar quantities of reactants as stated in the equation react together under standard conditions |
| Define (Standard) enthalpy change of combustion ΔC*H*⦵298? | The enthalpy change that occurs when one mole of a substance is burnt completely in oxygen under standard conditions in standard states |
| Define the (standard) enthalpy change of formation? Δf*H*⦵298? | The enthalpy change when one mole of a compound is formed from its elements under standard conditions in standard states |
| Define the (standard) enthalpy change of neutralisation Δneut*H*⦵298? | The enthalpy change when one mole of hydrogen ions react with one mole of hydroxide ions to form one mole of water under standard conditions and in solutions containing 1 mol dm-3 |
| Describe limitations with techniques for measuring enthalpy changes of an Exothermic reaction through calorimetry? | * Heat loss to the surroundings * Heat loss to the calorimeter * Non standard conditions * Specific heat capacity of the container is not included |
| Describe limitations with techniques for measuring enthalpy changes of an Endothermic reaction through calorimetry? | * Heat gained from the surroundings * Heat gained from the colorimeter * Non standard conditions * Specific heat capacity of the container is not included |
| What are the limitations and reasons why our calculated answer for the enthalpy change using calorimetry with a spirit burner and a calorimeter is “too low”? | * Heat loss to surroundings * Heat loss to the calorimeter * Non standard conditions * Evapouration of the fuel * Evapouration of the water * Incomplete combustion |
| What does Hess’ law state? | The enthalpy change for any reaction is independent of the route taken |
| Define Specific Heat Capacity? | The amount of energy needed to raise the temperature of 1g of a substance by 1K |
| What is the equation to calculate Δf*H,* ΔrH and ΔC*H* using Hess’s Law energy cycles and draw the hess cycle to calculate the enthalpy change of formation of methane using the enthalpy change of combustion with state symbols and boxes? | ΔH1 = ΔH2 - ΔH3 |
| What is the enthalpy change of formation of any element Δf*H*? | Zero |
| Why is a polystyrene cup used in calorimetry compared to glass? | Better insulator |
| Why do we extrapolate graphs in calorimetry or in any enthalpy change calculation where a graph is drawn? | To get correct values for cooling and heat loss |
| What is the average bond enthalpy of oxygen in combustion enthalpy cycles? | Zero because you can't burn oxygen in oxygen |
| Define average bond enthalpies? | The average quantity of energy needed to break a particular bond |
| What is ΔHr equal to? (using bond enthalpies)? | ΔH°r = ∑ΔH bonds broken - ∑ΔH bonds made |
| Why is the data book value for bond enthalpies different from calculated values? | * Average bond enthalpies * Non standard states (depending on the question bond enthalpies are supposed to be in a gaseous state)   *Some allow not stirring, incomplete reaction, evaporation of water but not incomplete combustion or all reactants reacted* |
| What are methods of improving the accuracy of an enthalpy change of combustion reaction (depending on the question and the method the student has used? State 4 | * Use a Bomb calorimeter (Removes error in heat loss, better conductivity) * Use a copper can (better thermal conductor/ lower SHC) * Draft shield (less heat loss to the surroundings) * Fit the spirit burner with a cap ( reduced loss of fuel **before** burning) * Digital thermometer (better accuracy idk) * Put a lid on the calorimeter (to reduce heat loss to the surroundings) * Measure water using measuring cylinder or volumetric pipette ( less uncertainty/ more accurate than a beaker) * Stir water throughout heating (ensures even distribution of heat) * Decrease the distance between the flame and the bottom of can/beaker (less heat lost to the surroundings) * Lag (sides of) calorimeter (less heat loss to the surroundings) * Oxygen enriched atmosphere (more complete combustion) |
| Why can’t the enthalpy change for a thermal decomposition reaction be measured directly? | As thermal decomposition requires heat |
| Why can bond enthalpies not be used to estimate ΔH1? (1)  2NaHCO3 (s) -> Na2CO3 (s) + CO2 (g) + H2O (l) | NaHCO3 and Na2CO3 are ionic so not all bonds are covalent (1) |
| Why can ‘enthalpy change of formation’ not be measured directly? | Many different compounds can form from the same constituent elements |

## DF.h-j - Kinetics | DF5 |

| Define Catalyst? | A substance which speeds up a reaction and can be recovered chemically unchanged at the end |
| --- | --- |
| Define Catalysis | The process of speeding up a chemical reaction using a catalyst |
| Define Catalyst Poison | A substance that **stops** a catalyst functioning properly |
| Define Heterogeneous Catalyst and its benefits and drawbacks? | The catalyst and the reactants are in different physical states   * Can be easily separated * Reactions only take place on the catalyst’s surface |
| Define Homogeneous Catalyst and its benefits and drawbacks? | The catalyst and the reactants are in the same physical states   * It means more molecules can react * It means separating molecules at the end harder |
| Define Cracking? | Breaking up larger long chain molecules into smaller more useful molecules |
| Explain the simple model of the function of a heterogeneous catalyst? (4) | 1. Reactants get adsorbed onto the catalyst surface      1. Bonds weaken and break in the reactants 2. New bonds form products      1. Products diffuse off the surface of the catalyst (desorbed) |
| Explain how a catalyst increases the rate of a chemical reaction & what do they do? (1)? | It provides an alternative reaction pathway of lower activation energy without being used up |
| How does a catalyst poison work? | It is more readily adsorbed than the reactants and so reduces the surface area of catalyst and so reactants cannot bond to its surface |

## DF.k - Inorganic chemistry and the periodic table | DF10 | DF11 |

| What are the causes and effects of Carbon particulates (Carbon soot)? | * Burning fuels, incomplete combustion and therefore * respiratory problems, global dimming |
| --- | --- |
| What are the causes and effect of CxHy? | * Unburnt fuel from petrol engines, plants and therefore * photochemical smog |
| What are the causes and effects of CO? | * Incomplete combustion and therefore * toxic/poisonous (causing respiratory problems) * photochemical smog |
| What are the cause and effects of CO2? | * Complete combustion and therefore * greenhouse gas causing global climate change |
| What are the cause and effects of NOx? | * N2 from the air reacts with oxygen from the air in high temperatures and therefore * Photochemical smog, acid rain |
| What is the way of reducing NOx that is produced | * Using a catalytic converter to produce nitrogen   2NO (g) -> N2 (g) + O2 (g) |
| What is the balanced equation for catalysing CO and NO in a catalytic converter**?** | 2CO + 2NO -> N2 + 2CO2  *NO2 is not a product* |
| What are the causes and effect of SOx? | * Burning of fuels containing sulfur impurities (and volcanoes ) therefore * Acid rain |
| What is the way of reducing SO2 that is produced | * By using fuels with low concentration of sulfur impurities * In a power plant by spraying an alkali to neutralise the sulphur dioxide |

## DF.l-m - Organic functional groups | DF3 | DF5 | DF6 |

| What is the general formula of the alkenes? | CnH2n |
| --- | --- |
| What is the general formula of the alkanes? | CnH2n+2 |
| What is the general formula of the alcohols? | CnH2n+1OH |
| Define arenes/aromatic compounds? | Compounds that contain one more benzene rings |
| Define aliphatic compounds? | Compounds that do not contain any benzene rings |
| Define functional group? | Modifiers that are responsible for the characteristic chemical reactions of molecules |
| Define Homologous series? | A family of compounds with the same functional group yet each successive member differs in the addition of a -CH2- group |
| Define Hydrocarbon? | A compound consisting of only hydrogen and carbon atoms |
| Define Saturated and unsaturated? | * Saturated means only single carbon-carbon bond * Unsaturated means a double or triple carbon-carbon bonds (e.g., C=C and C≡C   Remember, s in saturated for single bond |
| Test for unsaturated compounds? | Add bromine water which turns the solution from orange to colourless.  *Check to see whether bromine water is being added to a compound or vice versa as the colour change may be switched its not always orange to colourless - Mr Harbage*  *Also check to see if its bromine water (orange) or bromine liquid (red) easy mistake* |
| Difference between displayed and skeletal formulae? | * Displayed - every bond is drawn * Skeletal - carbon to hydrogen and carbon to carbon bonds arent drawn   Every bond means -OH should be drawn as -O-H |
| What are the first 5 Alkyl groups? | Methyl, Ethyl, Propyl, Butyl, Pentyl |
| What are the first 3 prefixes used during naming branched alkanes? | Di- tri- tetra- |
| Functional group,prefix, and suffix of an alcohol? | * Functional group: -OH * Prefix: hydroxy- (dihydroxy-) * Suffix: -ol (-diol) [more common] |
| Functional group and prefixes of haloalkanes? | * Functional group: C-X (e.g. C-Cl) * Prefix: fluoro-, chloro-, bromo-, iodo- |
| Functional group, prefix and suffix of arenes? | * Functional group: * Prefix: phenyl- * Suffix: -benzene |
| What takes precedence when naming with branched chains? Name the e.g. bond | * Functional groups * E.g., 3-methylbut-1-ene is right, 2-methylbut-3-ene is wrong |

## DF.n-o - Organic reactions | DF6 | DF10 |

| What is the hydration of alkenes and its reagents, catalyst and conditions? | * Forming alcohols from alkenes * Conditions: steam, phosphoric acid catalyst, around 300°C and 60 atm * Or concentrated sulfuric acid with water   E.g, C2H4 + H2O -> C2H5OH |
| --- | --- |
| Draw the hydration of ethene and water (steam) and its products using its full structural formula? |  |
| What is hydrogenation of alkenes and its reagents, catalyst and conditions? | * Forming alkanes from alkenes * Regent & conditions: Nickel catalyst and Hydrogen at 150°C and 5 atm * Or Regent & conditions: Platinum catalyst at RTP, 298K, 1 atm   E.g., C2H4 + H2 -> C2H6 |
| Draw the hydrogenation of ethene and hydrogen and its products using its full structural formula? |  |
| What is the reaction of an alkene with a hydrogen halide and its conditions | * Forming haloalkanes from alkenes * Conditions: RTP |
| Draw the halogenation (electrophilic addition reaction mechanism) between bromine and ethene? And the name of the compound form? | 1,2,di-bromoethane or 1,1,di-bromoethane |
| Draw the electrophilic addition reaction mechanism of ethene in bromine with the presence of chloride ions and draw and name the two possible products? |  |

## DF.p - Polymers | DF7 |

| Draw the polymerisation of monomers into a polymer? (e.g. but-1ene) |  |
| --- | --- |
| What conditions are required for polymerisation? | * High temperature * High pressure * A catalyst |

## DF.q - Organic Mechanics | DF6 |

| Where must curly arrows start? | At the centre of a bond or at a lone pair |
| --- | --- |
| Define addition reaction? | A reaction where two or more molecules react to form a single larger molecule |
| Define electrophile? | A **positive ion** or a molecule with a partial positive charge that will be attracted to a negatively charged region and react by accepting a **bonding pair of electrons** to form a **covalent bond**  *Think of ‘phile’ as meaning loving. It loves electrons* |
| Define carbocation (intermediate)? | An ion with a positively-charged carbon atom |

## DF.r-t - Isomerism | DF3 | DF9 |

| Define structural isomers? | Same molecular formula but a different structural formula E.g., |
| --- | --- |
| Define stereoisomers? | Same structural formula but different spatial arrangement of atoms |
| What is required for E-Z stereoisomerism to arise? | 1. A double C=C (which provides restricted rotation) 2. Two different groups coming of each carbon atom of the carbon - carbon bond |
| How to remember which E/Z stereoisomer is E or Z? | Z is the Zame Zide and E is the Epposite |
| How to remember which cis/trans stereoisomer is cis or trans? | Cis is the ciame cide and trans is the opposite (think transgender) |
| Which important bonds are freely rotating in organic chemistry? | Single C-C and C-H bonds |

## DF.u - Sustainability | DF11 |

| What are the advantages of using hydrogen as a fuel? (state 3) | * Renewable/sustainable * Can be stored and sent down pipelines * Can be used in internal combustion engines * Doesnt produce CO2, CO or hydrocarbons * More energy dense than petrol and so releases more energy per kg than petrol * Produced from fermentation [from MCQ A Level paper 1 2025] |
| --- | --- |
| What are the disadvantages of using hydrogen as a fuel? (state 3) | * Production from water depends on the use of electricity from fossil fuels * Oxides of nitrogen are still produced at high temperatures * Difficult to store as it requires a highly pressurised tank * More danger of explosion * Expensive |
| What are the advantages of using Biofuels as a fuel (state 3) | * Renewable/sustainable * Biodegradable * Avoids wasting/using up fossil fuels * Less CO is produced and reduced greenhouse gases through oxygen in its structure * Carbon neutral (although not allowed on some mark schemes due to transportation) you may say lower carbon footprint sometimes * Produced from fermentation [from MCQ A level paper 1 2025]   *Refer to the flashcard at the very top for debate ability of carbon neutrality* |
| What are the disadvantages of using Biofuels e.g Ethanol as a fuel (state 2) | * Expensive to convert existing petrol car engines to take fuels with a high concentration of ethanol * Land that could have been used to grow food is being used to make fuel this could cause food shortages in countries * Disposal of fermentation waste (environmental problem it causes)   *Allow ethanol has a lower enthalpy change of combustion than petrol* |

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