# Edexcel
# AS Chemistry
# Units 1 & 2

Edexcel GCE Student Conference 2006

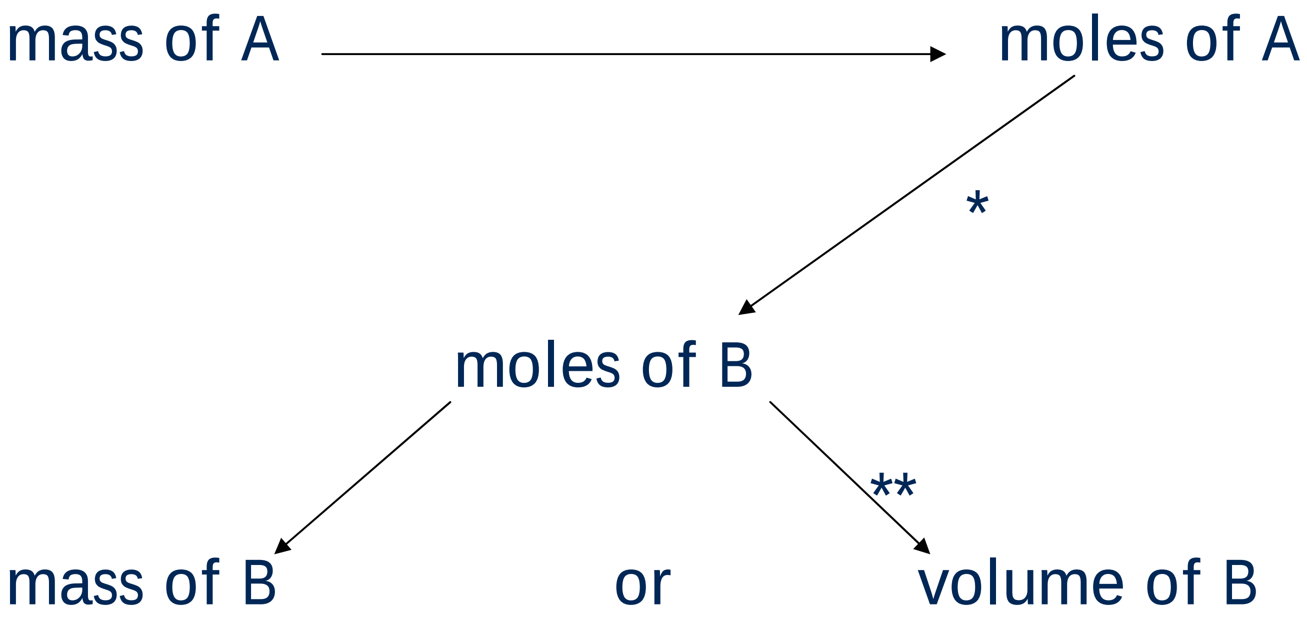
# 1st Ionisation energy
# Trends down a group

- Number of protons increases.
- Number of inner shielding electrons increases by the same number.
- More shells so bigger atomic radius.
- Therefore 1$^{st}$ IE decreases (down the Group).

# Calculations

moles = mass / molar mass

moles = volume / molar volume




* Use stoichiometry of equation

** Multiply moles by molar volume

(a) Calculate the mass of sodium chloride that can be made from 92 g of sodium. (2)

$2Na + Cl_2 \longrightarrow 2NaCl$

Moles of 2Na = 92/46 = 2

As they react in a 1:1 ratio, moles of NaCl = 2

Mass of sodium chloride = 2 x 58.5 = 117 g

How many marks?

(b) Calculate the volume of chlorine that is needed to react with the 92 g of sodium [molar volume under the conditions of the experiment = 24 $dm^3$ $mol^{-1}$].

# Shapes of molecules

Valence shell *electron pair* repulsion theory

- State the number of sigma bond pairs.
- State the number of lone pairs.
- State that these electron pairs (*not* bonds and *not* atoms) repel to a position of maximum separation (*not* maximum repulsion).
- If lone pair present, state that lone pair/bond pair repulsion is greater than bond pair/bond pair repulsion, thus reducing the bond angle.

# Question

Draw the ammonia molecule, $NH_3$, making its three-dimensional shape clear. Mark in the bond angle on your diagram. Explain why ammonia has this shape and this bond angle.

# Intermolecular forces

## Hydrogen bonding

- Only occurs if there is H bonded to O, N or F in the molecule.

- Caused by electrostatic force between the (small sized) $\delta$- oxygen, nitrogen or fluorine and (extremely small) $\delta$+ hydrogen.

- Is normally the strongest type of intermolecular force.

# Other intermolecular forces

1. **Induced dipole/induced dipole** (also called dispersion or London or van der Waals)

- These exist between all covalent molecules.

- Their strength depends (mainly) on the number of *electrons* in the molecule (*not* their mass).

2. **Permanent dipole/dipole forces**

- These exist between *polar* molecules.

- They are weaker than induced dipole forces.

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# Melting and boiling

**Particles have to be separated**

- Ionic solids have high melting points because of the large amount of energy required to overcome the ionic attractions.
- Covalent molecular substances have much lower melting/boiling temperatures because the intermolecular forces (*not* covalent bonds) are much weaker than ionic attractions.
- Giant covalent substances have high melting points as strong covalent bonds have to be broken.
- Metals have fairly strong forces between positive ions and delocalised electrons.

- Magnesium and chlorine are both in Period 3 of the Periodic Table. Explain why magnesium metal has a higher melting point than chlorine (3).

Identify the forces: compare their strengths and relate to energy required.

Magnesium is a metal and has strong electrostatic forces of attraction between its atoms and the delocalised electrons. It requires more energy to break these bonds and so a higher temperature is needed to melt it than with chlorine, which has weak covalent bonds holding it together.

How many marks?

# Enthalpy

- Know your definitions (at least 3 easy marks per paper) – always per mole.
- Know standard conditions (1 atm pressure and a stated, usually 25°C, temperature).
- $\Delta H$ negative = exothermic reaction.
- Bond making is always exothermic, therefore negative values.

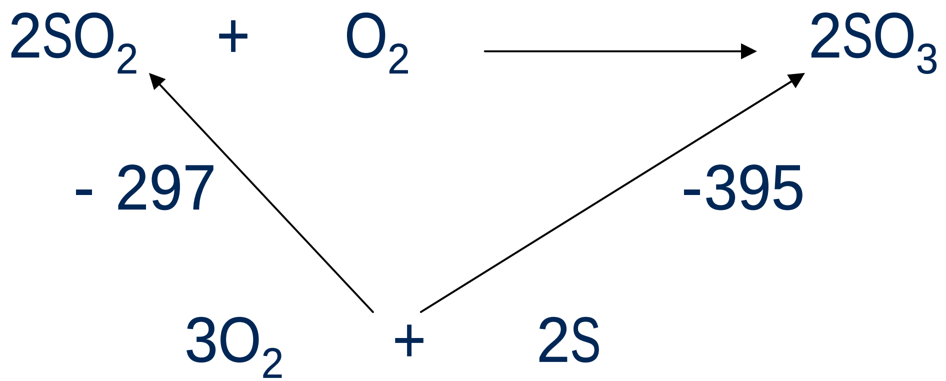
• For calculations of $\Delta H_{reaction}$ from $\Delta H_{formation}$ you may use:

$$\Delta H_r = \Sigma\, \Delta H_f \text{ of products} - \Sigma\, \Delta H_f \text{ of reactants}$$

Calculate $\Delta H$ for the reaction: $2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$

given the following enthalpies of formation / kJ mol$^{-1}$

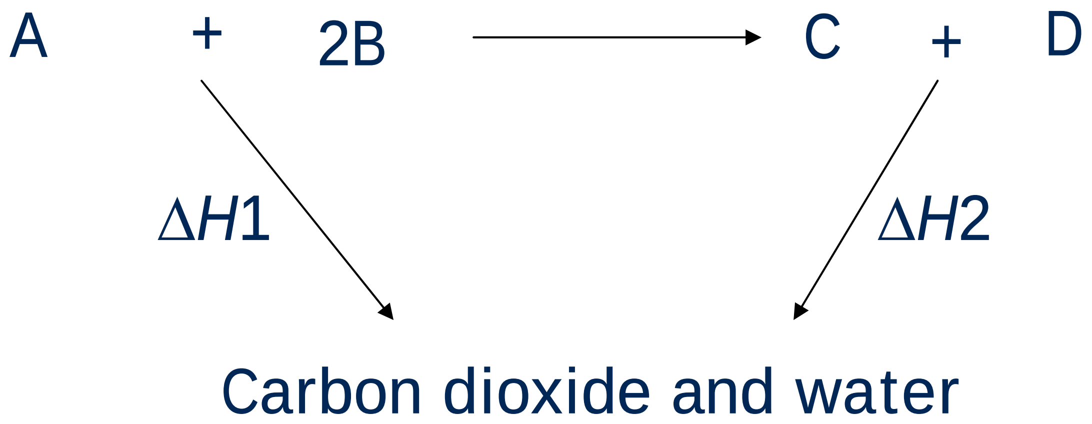
$SO_2(g) = -297$; $SO_3(g) = -395$; $O_2(g) = 0$




$\Delta H_r = -(-297) + (-395) = -98$ kJ mol$^{-1}$

How many marks?

# $\Delta H_r$ from $\Delta H_{combustion}$ data




Hess's Law gives $\Delta H_{reaction} + \Delta H_2 = \Delta H_1$

$\Delta H_1 = \Sigma\, \Delta H_c$ of reactants & $\Delta H_2 = \Sigma \Delta H_c$ of products

$\Delta H_r = \Sigma\, \Delta H_c$ of reactants - $\Sigma\, \Delta H_c$ of products

# $\Delta H_{reaction}$ from bond enthalpy data

- Work out which bonds are broken and add up the bond enthalpies: this is a positive number.

- Work out the bonds made and add up the bond enthalpies: this is a negative number.

- Add the two totals to give $\Delta H_{reaction}$

Methane burns in oxygen:

$CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(g)$

Calculate the enthalpy change for this reaction using the following bond enthalpies / kJ $mol^{-1}$:

C-H in methane = +435; O=O in oxygen = + 498; C=O in carbon dioxide = + 805; H-O in water = + 464

Bonds broken

Bonds made

$\Delta H$ =

# Kinetics

## Maxwell Boltzmann distribution

- *y*-axis is number (or fraction) of molecules, *x*-axis is energy.
- Start at origin, end asymptotically to *x*-axis.
- Skewed to the right.
- Higher T curve has peak lower and to the right.
- Activation energy well to the right of the peak.
- Effect of T: two curves, one $E_a$ line.
- Effect of catalyst: one curve, two $E_a$ lines.

- Explain the effect of an increase in temperature of the rate of reaction (3 marks + 1 if reference to graph required).

The kinetic energy of the molecules increases, so more have energy greater than the activation energy. (This is shown on the graph by a greater area to the right of the activation energy than with the lower temperature graph). There are more collisions that result in reaction.

How many marks?

- Explain the effect of a catalyst on the rate of reaction (3).

The catalyst lowers the activation energy of the reaction. This means that more molecules have energy greater than the activation energy and so there is a greater frequency of successful collisions.

How many marks?

# Equilibrium

Effect of an *increase* in temperature

- Position driven in the endothermic direction.
- Rate of reaction and hence rate of reaching equilibrium faster.

Effect of *increase* in pressure

- Position driven to side with fewer *gas* molecules.

Effect of adding catalyst

- None on position, but rate of reaching equilibrium faster.

- One stage in the manufacture of sulphuric acid is the reaction:

$$2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$$

Justify the choice of a temperature of 450°C for this exothermic process (3).

1. Higher temperature would …

2. Lower temperature would …

3. Therefore …

# Manufacture of aluminium

## Purification of bauxite

- Add conc aqueous NaOH to *react* with *amphoteric* $Al_2O_3$ to form a solution.
- *Basic* impurities ($Fe_2O_3$) left behind.

## Electrolysis of pure $Al_2O_3$

- Electrolyte is $Al_2O_3$ dissolved in molten cryolite (The cryolite is *not* added to lower the melting point of $Al_2O_3$.. It is the solvent).
- Cathode (graphite): $Al^{3+} + 3e^- \longrightarrow Al$
- Anode (graphite): oxygen produced which reacts with the anode to form $CO_2$ and so anode gets eaten away.

# Organic Chemistry
# Substitution reactions

## Alkanes (free radical substitution)

- Hydrogen atom out: halogen atom in – from $Cl_2$ or $Br_2$ in UV light

## Halogenoalkanes (nucleophilic substitution)

- Halogen atom out: OH in - from NaOH(aq)
  or CN in – from KCN
  or $NH_2$ in – from $NH_3$

## Alcohols

- OH group out: Cl atom in – from $PCl_5$

# Addition reactions of alkenes

$$CH_2{=}CH_2 + A\text{-}B \longrightarrow CH_2A\text{-}CH_2B$$

- + hydrogen: nickel catalyst and warm.
- + halogen: mix the alkene and the halogen at RTP (electrophilic addition).
- + hydrogen halides: mix gases at RTP (electrophilic addition).
- + potassium manganate(VII) ions – two OH groups add on, one to each carbon of the double bond.
- + other alkene molecules – polymerisation The repeat unit always has a skeleton of two carbon atoms.

# Oxidation and dehydration of alcohols

## Oxidation

Reagent: potassium dichromate(VI) in dilute acid.

- $1^o$ oxidised first to aldehyde (boil it off as it forms) or when heated under reflux to a carboxylic acid.
- $2^o$ oxidised to ketone when heated under reflux.
- $3^o$ not oxidised (potassium dichromate stays orange).

## Dehydration

Reagent: conc sulphuric.  Conditions: heat to $170^oC$.

All three types form alkenes.