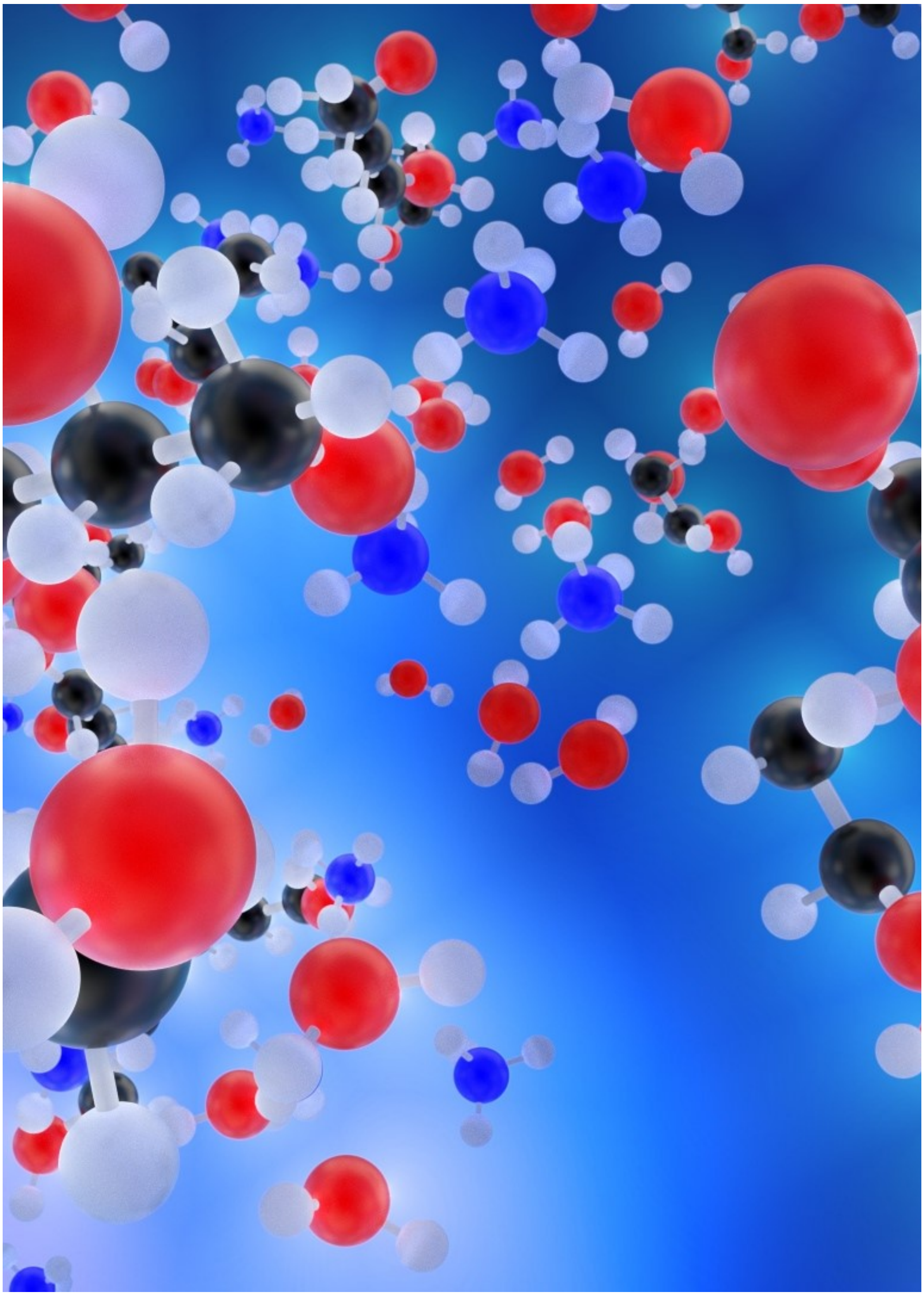
A-level Chemistry



Heathfield School Ascot

SPECIFICATION CONTENT - OCR A

http://www.ocr.org.uk/qualifications/as-a-level-gce-chemistry-a-h032-h432-from-2015/

AS CHEMISTRY (H032)

MODULE 1 — DEVELOPMENT OF PRACTICAL SKILLS

- Skills of planning, implementing, analysis and evaluation

MODULE 2 — FOUNDATIONS IN CHEMISTRY

- Atoms, compounds, molecules and equations
- Amount of substance
- Acid–base and redox reactions
- Electrons, bonding and structure

MODULE 3 — PERIODIC TABLE AND ENERGY

- The periodic table and periodicity
- Group 2 and the halogens
- Qualitative analysis
- Enthalpy changes
- Reaction rates and equilibrium (qualitative)

MODULE 4 – CORE ORGANIC CHEMISTRY

- Basic concepts
- Hydrocarbons
- Alcohols and haloalkanes
- Organic synthesis

AS Chemistry A (H032) - First Exam June 2016					
ASSESSMENT OVERVIEW					
Paper			**Marks**	**Duration**	**Weighting**
Paper 1	**Breadth in chemistry**		**70**	1 hr 30 mins	50%
	Section A	Multiple choice	20		
	Section B	Structured questions and extended response questions covering theory and practical skills	50		
Paper 2	**Depth in chemistry**		**70**	1 hr 30 mins	50%
	Structured questions and extended response questions, covering theory and practical skills		70		

Recommended reading for enrichment

Letters to a Young Scientist by Edward O. Wilson

The Chemistry of Life (Penguin Press Science) Steven Rose

The Periodic Table: Primo Levi

You <u>must</u> read at least one of these books over the Summer vacation and produce a book report

This is compulsory

Task 1 - "Chemistry In the news"

Over the summer holidays read the science sections in broadsheet newspapers and see how many different chemistry related stories you see. You should keep a journal and make a note of any stories you read online. Focus on stories related to 'new materials' and their possible applications.

You should include at least **five** entries and have a few pages on each including <u>your</u> reflections on each item

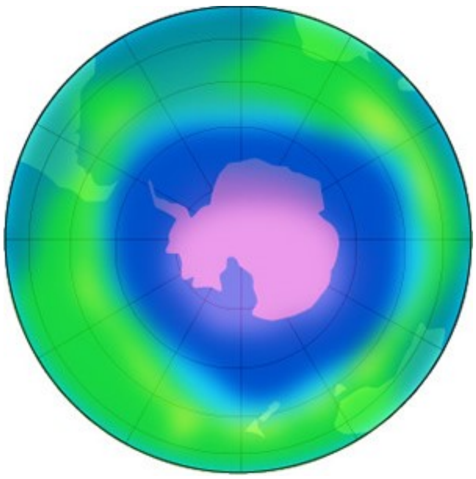
Task 1 is compulsory

Task 2 - Read the article on the next page

- What are catalysts and how did they contribute to the depletion of ozone.
- How was the hole in the ozone layer discovered?
- How does its discovery relate to Task 3?

  This should take up about a page of A4

Task 2 is compulsory



Task 3 - For enrichment

- Funding chemistry is full of dilemmas - how far should society allow scientists to pursue research with no direct link to financial outcomes?
- Write an "op-ed" piece for an audience of your peers. You should aim to use specific examples in your essay

Homogeneous catalysts

Article: Adapted from resources.schoolscience.co.uk/johnsonmatthey

How a homogeneous catalyst works

In homogeneous catalysis the reactants, products and catalyst are all in the same phase. Often the reactants, products and catalyst are all dissolved in the same solvent. Due to environmental considerations this solvent is often water. In these situations the catalyst may be a transition metal ion catalysing a redox reaction.

Transition metals

The transition metal ion catalyses the original reaction by providing an alternative route between reactants and products that has a lower activation enthalpy. It can do this because transition metals (TM) can form stable compounds in more than one oxidation state and the transition metal ions can therefore readily move between oxidation states. During the catalysed reaction the transition metal ion is oxidised by one reactant to a higher oxidation state. This is then reduced back to the original form by reaction with the other reactant. The reactants are therefore converted to the same products as are formed without the catalyst. The only difference is that the reactants are converted into products more quickly.

reactant 1 + TM ion in low oxidation state $\rightarrow$ product + TM ion in high oxidation state

reactant 2 + TM ion in high oxidation state $\rightarrow$ product + TM ion in low oxidation state

Examples of homogeneous reactions

The reaction between hydrogen peroxide and 2,3-dihydroxybutanedioate ions

Hydrogen peroxide, H_2O_2, oxidises the 2,3-dihydroxybutanedioate ions, $C_4H_4O_6^{2-}$, in potassium sodium 2,3–dihydroxybutanedioate (also known as potassium sodium tartrate or Rochelle salt) to carbon dioxide, methanoate ions, $HCOO^-$, and water.

Speeding up the reaction

The reaction is slow, even when heated but it can be speeded up using cobalt(II) ions. The catalysed mixture starts off pink due to the presence of cobalt(II) ions. During the reaction the mixture turns green, indicating the presence of cobalt(III) ions. When the reaction is complete the mixture returns to a pink colour.

Reaction flow chart

2,3-dihydroxybutanedioate + Hydrogen peroxide + Co^{2+}

↓ Co^{2+} reduces hydrogen peroxide and gets oxidised to Co^{3+}

Intermediates + Co^{3+}

↓ Co^{3+} oxidises 2,3-dihydroxybutanedioate and gets reduced back to Co^{2+}

Carbon dioxide + methanoate + water + Co^{2+}

The reaction between peroxodisulfate(VI) ions and iodide ions

Peroxodisulfate(VI) ions and iodide ions react together in aqueous solution to form sulfate(VI) ions and iodine.

$$S_2O_8^{2-}(aq) + 2I^-(aq) \rightarrow 2SO_4^{2-}(aq) + I_2(aq)$$

Transition metal catalysts

This reaction is catalysed by a number of transition metal ions including Fe^{2+} and Fe^{3+}.

If a small amount of Fe^{2+} ions are added to the reaction mixture, they will reduce the peroxodisulfate(VI) ions to sulfate(VI) ions and will be oxidised to Fe^{3+} ions in the process.

$$2Fe^{2+}(aq) + S_2O_8^{2-}(aq) \rightarrow 2Fe^{3+}(aq) + 2SO_4^{2-}(aq)$$

The Fe^{3+} ions produced will oxidise iodide ions to iodine and will be reduced back to Fe^{2+} ions in the process.

$$2Fe^{3+}(aq) + 2I^-(aq) \rightarrow 2Fe^{2+}(aq) + I_2(aq)$$

The Fe^{2+} ions produced can reduce more peroxodisulfate(VI) ions and so the catalysed reaction can continue.

The CFC story

The depletion of the ozone layer has been linked to the release of chlorofluorocarbons (CFCs) into the atmosphere. These molecules were widely used as propellants for aerosols, as refrigerants, as cleaning solvents and as blowing agents for making expanded plastics.

The CFCs are very good for these uses, partly because the molecules are so inert. It is this very inertness, however, that causes the ozone problem. The molecules can persist in the atmosphere for a very long time, up to a hundred years, without being broken down as most molecules are. Eventually they will move to the upper atmosphere. Here they are no longer inert. The high energy ultra violet radiation from the sun breaks them down, releasing highly reactive chlorine atoms.

It is these chlorine atoms that catalyse the breakdown of ozone causing the 'hole' in the ozone layer over Antarctica.

Catalysing ozone removal

Step 1 In the stratosphere, CFCs are broken down by sunlight releasing very reactive chlorine atoms.

$$CF_3Cl + h\nu \rightarrow CF_3 + Cl$$

Step 2 The chlorine atoms react with ozone to produce chlorine oxide and dioxygen molecules.

$$Cl + O_3 \rightarrow ClO + O_2$$

Step 3 The chlorine oxide molecule is also very reactive and can react with oxygen atoms to regenerate the chlorine atom.

$$ClO + O \rightarrow Cl + O_2$$

Step 4 The chlorine atoms are involved in a catalytic cycle. It is estimated that one chlorine atom can remove about a million ozone molecules.

Free radicals

Chlorine and bromine atoms are also known as free radicals. Other free radicals in the stratosphere can also remove ozone. If we show a free radical by the general symbol X then the mechanism for the catalytic destruction of ozone is as follows

$$X + O_3 \rightarrow XO + O_2$$

$$XO + O \rightarrow X + O_2$$

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