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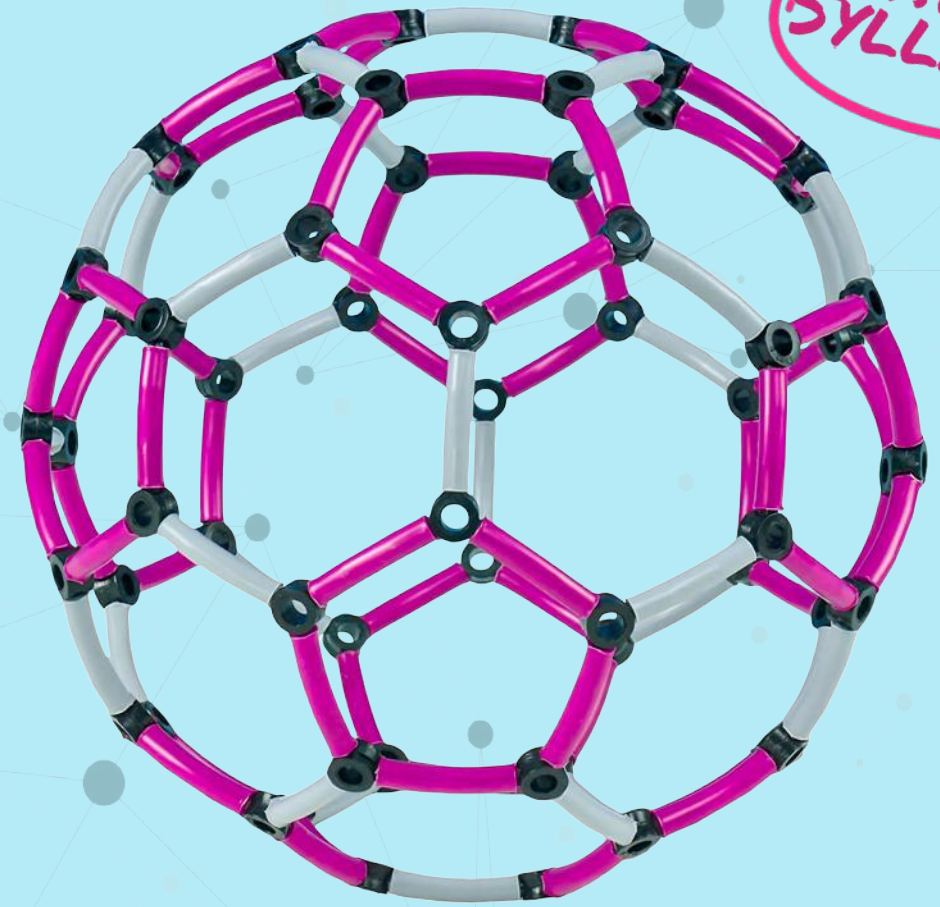
# AS Chemistry

LATEST SYLLABUS



## Unit 2 Classified Past Papers

SCAN ME

# 7. GROUPS 1 & 2

## SECTION B

**Answer ALL the questions. Write your answers in the spaces provided.**

**1** Magnesium oxide, known as magnesia, can be produced by the thermal decomposition of magnesium carbonate.

The equation for the reaction is

$$MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$$

*(a) Other Group 2 carbonates also undergo thermal decomposition.

State and explain the trend in thermal stability of carbonates down Group 2.

**(4)**

**Thermal stability increases down the group**

**Because ionic radius increases as you go down the group**

**This results in less polarisation (distortion) of the carbonate ion**

**And less weakening of the covalent bonds (C-O) within the carbonate ion**

*(c) State why carrying out a flame test is **not** an appropriate way to confirm the presence of magnesium ions in the sample of magnesia.

**(1)**

**Magnesium ions give no flame colour**

**OR**

**Energy is emitted with Mg ions is outside of the visible region**

**(Total for Question 1 = 15 marks)**

**3** This question is about halogenoalkanes.

(a) A student investigates the relative rate of hydrolysis of three halogenoalkanes.

The student mixes 5 $cm^3$ of ethanol with five drops of halogenoalkane. This mixture is warmed to 50 °C in a water bath. The student adds 5 $cm^3$ of aqueous silver nitrate, also heated to 50 °C, to the halogenoalkane. The time taken for a precipitate to form is recorded in a table.

| Halogenoalkane | Time taken for a precipitate to form /s |
|---|---|
| $CH_3CH_2CH_2CH_2Cl$ | 120 |
| $CH_3CH_2CH_2CH_2Br$ | 62 |
| $CH_3CH_2CH_2CH_2I$ | 20 |

(i) Explain why ethanol is added to each halogenoalkane.

**(1)**

As a solvent for polar and non- polar molecules (both aqueous silver nitrate and halogenoalkanes)

(ii) Complete the equation for the hydrolysis of 1-iodobutane, $CH_3CH_2CH_2CH_2I$.

**(1)**

$CH_3CH_2CH_2CH_2I + H_2O \rightarrow$ CH3CH2CH2CH2OH + HI

(iii) Give the **name** of the organic product which forms in each of these hydrolysis reactions.

**(1)**

Butan-1-ol

(iv) Classify the type and mechanism of the reaction occurring when halogenoalkanes undergo hydrolysis, under the conditions described in this investigation.

**(2)**

Nucleophilic substitution

*(v) Describe and explain the trend in the rates of hydrolysis of the three halogenoalkanes.

**(3)**

Rates of hydrolysis increases down the group
As the C–X bond energies decrease in strength
So bonds break more easily

**(Total for Question 3 = 8 marks)**

*(vi) State how the bond polarities of carbon-halogen bonds vary.

Explain why bond polarity does not determine the rate of this reaction.

(2)

**The carbon-halogen bond polarity decreases from chlorine to iodine**

**The rate depends on the carbon- halogen bond strength**

**which decreases from chlorine to iodine**

**(b)** When these halogenoalkanes are heated separately with concentrated potassium hydroxide in ethanol, the same gaseous organic product forms.

(i) Give the structural formula for this organic product.

(1)

**CH3CH2CH=CH2**

(ii) State the type of reaction which occurs.

(1)

**elimination**

(iii) Give a chemical test for this organic product and state the colour change that occurs.

(2)

Test **bromine water**

Colour change **orange to colourless**

**(c)** All three halogenoalkanes undergo substitution reactions with ammonia. The initial reaction forms butylamine, $CH_3CH_2CH_2CH_2NH_2$.

(i) Write the equation for the initial reaction of 1-iodobutane with ammonia. State symbols are not required.

(1)

**2NH3 + CH3CH2CH2CH2I → CH3CH2CH2CH2NH2 + NH4I**

(ii) The butylamine formed also reacts with the 1-iodobutane in a further substitution reaction.

Suggest a structural formula for the product of this reaction.

(1)

**(CH3CH2CH2CH2)2NH**

**(Total for Question 6 = 15 marks)**

**7** This is a question about halogenoalkanes.

(a) Halogenoalkanes can react with hydroxide ions in different ways depending on the conditions used. Using 1-chloro-1-fluoroethane, $CH_3CHClF$, as an example of a halogenoalkane, the following reaction could occur in aqueous solution.

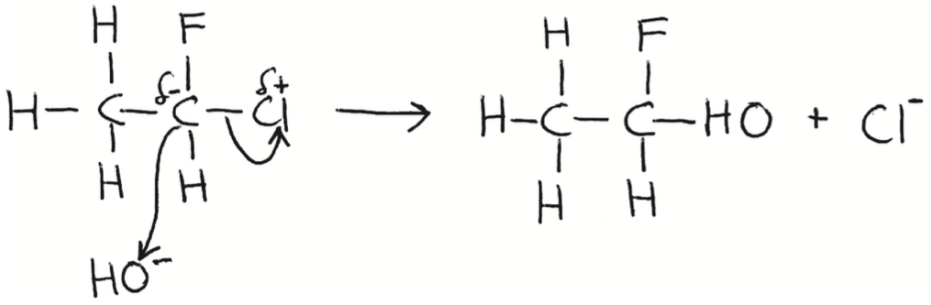
$$CH_3CHClF + OH^- \rightarrow CH_3CHOHF + Cl^-$$

(i) Suggest why it is unlikely that the fluorine atom in $CH_3CHClF$ would be substituted by the hydroxide ion.

**(1)**

C-F bond is stronger than C-Cl, so it is harder to break

*(ii) A student attempted to draw the reaction mechanism for the reaction in (a)(i), but made a total of three errors.



Identify these errors and state how they should be corrected.

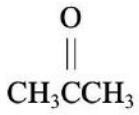
**(3)**

First error The C-Cl dipole is the wrong way round

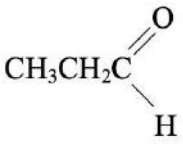
Second error The arrow goes from the carbon to the oxygen of the hydroxide ion but should be the other way around

Third error The carbon bond to the hydroxy group should be to the oxygen and not to the hydrogen

**10** Which of the following features is shown by the mass spectra of propanone and propanal?



**propanone**



**propanal**

| | | *m/e* of the molecular ion | Fragmentation pattern |
|---|---|---|---|
| ☐ | **A** | same | same |
| ☒ | **B** | same (isomers) | different |
| ☐ | **C** | different | same |
| ☐ | **D** | different | different |

**11** Which of the following values for the mass/charge ratio for singly charged ions would be present in the mass spectrum of propanal, $CH_3CH_2CHO$, but not of propanone, $CH_3COCH_3$?

☐ **A** 15

☒ **B** 29

☐ **C** 43

☐ **D** 58

CH3CH2

**12** Propanal, $CH_3CH_2CHO$, and propanone, $CH_3COCH_3$, are isomers, but only propanal has a significant peak in its mass spectrum at mass/charge ratio

☐ **A** 15

☒ **B** 29

☐ **C** 43

☐ **D** 58

**13** Two ketones, $CH_3COCH_2CH_2CH_3$ and $CH_3CH_2COCH_2CH_3$, both have $M_r = 86$. Which peak due to fragmentation into singly charged ions would you expect to be present in the mass spectrum of one but not the other?

☐ **A** 71

☐ **B** 57

☒ **C** 43

☐ **D** 29

CH2CH2CH3
or CH3CO
either way it is 43
which is not available in the other isomer

**2** The correct sequence for the processes that occur in a mass spectrometer is

- [x] **A** vaporization, ionization, acceleration, deflection and detection.
- [ ] **B** vaporization, acceleration, ionization, deflection and detection.
- [ ] **C** ionization, vaporization, acceleration, deflection and detection.
- [ ] **D** ionization, vaporization, deflection, acceleration and detection.

**(Total for Question = 1 mark)**

**3** Which of the following ions would be deflected **most** in a mass spectrometer?

- [ ] **A** $^{35}Cl^+$
- [ ] **B** $^{37}Cl^+$
- [x] **C** $^{37}Cl^{2+}$
- [ ] **D** $(^{35}Cl—^{37}Cl)^+$

Lowest Mass/charge Ratio

**(Total for Question = 1 mark)**

**4** In a mass spectrum of butane, $C_4H_{10}$, where would a peak be seen for the molecular ion if it had a charge of 2+?

- [x] **A** 29
- [ ] **B** 56
- [ ] **C** 58
- [ ] **D** 60

$(4 \times 12 + 10) \div 2 = 29$

**(Total for Question = 1 mark)**

**5** Which types of bonds and molecules absorb infrared radiation?

| | Type of bond | Type(s) of molecule |
|---|---|---|
| ☐ **A** | non-polar | non-polar only |
| ☐ **B** | polar | non-polar only |
| ☐ **C** | polar | polar only |
| ☒ **D** | polar | non-polar and polar |

**(Total for Question = 1 mark)**

**51** When 100 $cm^3$ of 2.0 mol $dm^{-3}$ sodium hydroxide solution is added to 100 $cm^3$ of 2.0 mol $dm^{-3}$ sulfuric acid (an excess) to form sodium sulfate, the temperature rise is 12.5 °C.

Energy transferred (J) = mass × 4.2 × temperature change

What is the enthalpy change of the reaction in kJ $mol^{-1}$?

**Mass = 100 + 100 = 200**
**ΔT = 12.5**
**n = 100/1000 x 2 = 0.2**

☒ **A** $\Delta H = -\dfrac{200 \times 4.2 \times 12.5}{0.4}$

☒ **B** $\Delta H = -100 \times 4.2 \times 12.5 \times 0.4$

☒ **C** $\Delta H = -\dfrac{200 \times 4.2 \times 12.5}{0.2}$

☒ **D** $\Delta H = -100 \times 4.2 \times 12.5 \times 0.2$

**52** The enthalpy changes of two reactions are

$2Fe(s) + 1\frac{1}{2}O_2(g) \rightarrow Fe_2O_3(s) \quad \Delta H^{\ominus} = -824\ kJ\ mol^{-1}$

$C(s) + \frac{1}{2}O_2(g) \rightarrow CO(g) \quad \Delta H^{\ominus} = -110\ kJ\ mol^{-1}$

For the reaction

$Fe_2O_3(s) + 3C(s) \rightarrow 2Fe(s) + 3CO(g)$

the enthalpy change is

**Fe2O3 → 2Fe + 1.5O2**
**x 3 3C + 1.5O2 → 3CO**
**-(-824) + 3 x (-110)**

☒ **A** −494 kJ $mol^{-1}$

☑ **B** +494 kJ $mol^{-1}$

☒ **C** −714 kJ $mol^{-1}$

☒ **D** +714 kJ $mol^{-1}$

**53** Which change would have a **negative** $\Delta H$ value?

☑ **A** $Cl(g) + e^- \rightarrow Cl^-(g)$

☒ **B** $Cl_2(g) \rightarrow 2Cl(g)$ **atomisation**

☒ **C** $Na(s) \rightarrow Na(l)$ **melting**

☒ **D** $Na(g) \rightarrow Na^+(g) + e^-$ **ionisation**

(d) The reaction of calcium carbonate with hydrochloric acid has the following standard molar enthalpy change.

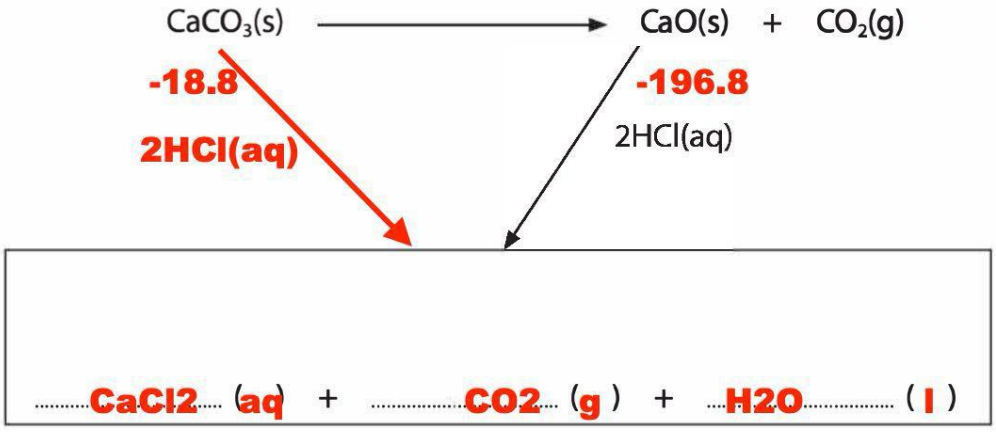
$$\Delta H^{\ominus} = -18.8 \text{ kJ mol}^{-1}$$

This value can be used, with the enthalpy change for the reaction of calcium oxide with hydrochloric acid, to determine the enthalpy change for the thermal decomposition of calcium carbonate. This cannot be measured directly.

(i) Complete the Hess energy cycle below by adding the missing arrow and entities.

Use the cycle, and the standard enthalpy change for the reaction of calcium oxide and hydrochloric acid (–196.8 kJ mol$^{-1}$), to determine the standard enthalpy change for the decomposition of calcium carbonate.

**(4)**




**−18.8 − −196.8 = +178**

Enthalpy change = ..... **+178** ..... kJ mol$^{-1}$

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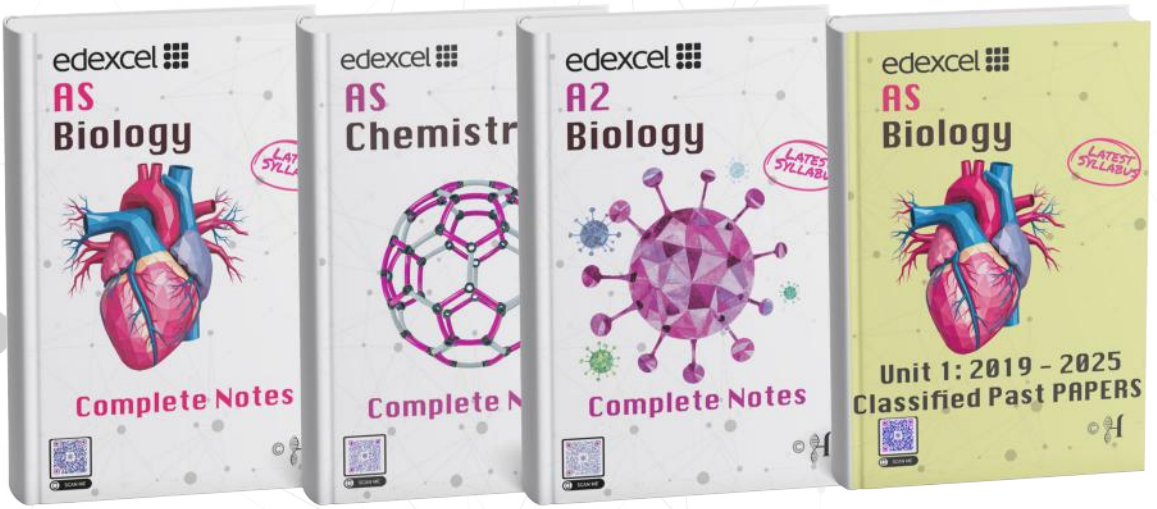


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