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General Certificate of Education  
2018

Centre Number

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Candidate Number

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# Chemistry

## Assessment Unit AS 2

*assessing*

Further Physical and Inorganic  
Chemistry and an Introduction to  
Organic Chemistry



[SCH22]

\*SCH22\*

FRIDAY 25 MAY, MORNING

### TIME

1 hour 30 minutes.

### INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Answer **all fourteen** questions.

Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter on the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.

Answer **all four** questions in **Section B**. **You must answer the questions in the spaces provided.**

**Do not write outside the boxed area on each page or on blank pages.**

Complete in black ink only. **Do not write with a gel pen.**

### INFORMATION FOR CANDIDATES

The total mark for this paper is 90.

Quality of written communication will be assessed in Question **14(a)(ii)**.

In Section A all questions carry equal marks, i.e. **one** mark for each question.

In Section B the figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

A Periodic Table of Elements, containing some data, is included with this question paper.

11382



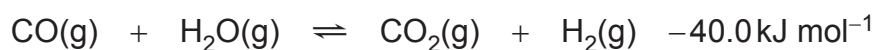
\*20SCH2201\*

## Section A – Multiple Choice

Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.

Each multiple choice question is worth 1 mark.

1 Carbon monoxide reacts with steam as follows:



Which change will shift the position of equilibrium to the right-hand side of the equation?

- A Decrease in pressure
  - B Decrease in temperature
  - C Increase in pressure
  - D Increase in temperature
- 2 Which compound has the highest boiling point?
- A Butan-1-ol
  - B Butan-2-ol
  - C 2-methylpropan-2-ol
  - D Pentane
- 3 Which of the following molecules can show a strong absorption peak at  $1750 \text{ cm}^{-1}$  in an infrared spectrum?
- A  $\text{C}_4\text{H}_8$
  - B  $\text{C}_4\text{H}_{10}$
  - C  $\text{C}_4\text{H}_8\text{O}$
  - D  $\text{C}_4\text{H}_{10}\text{O}$

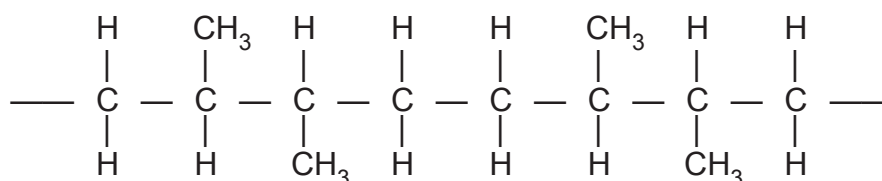


- 4 Neutralisation of  $25.0 \text{ cm}^3$  of  $2.0 \text{ mol dm}^{-3}$  sodium hydroxide by  $50.0 \text{ cm}^3$  of  $1.0 \text{ mol dm}^{-3}$  hydrochloric acid resulted in an  $8.0 \text{ }^\circ\text{C}$  increase in temperature.

The enthalpy of neutralisation for this reaction is

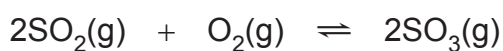
- A  $-16.8 \text{ kJ mol}^{-1}$ .
- B  $-25.2 \text{ kJ mol}^{-1}$ .
- C  $-33.6 \text{ kJ mol}^{-1}$ .
- D  $-50.4 \text{ kJ mol}^{-1}$ .

- 5 Part of a polymer chain is shown below.



Which monomer produces this polymer?

- A But-1-ene
  - B But-2-ene
  - C Methylpropene
  - D Propene
- 6 Sulfur trioxide is produced by the reversible reaction between sulfur dioxide and oxygen.



What are the units of the equilibrium constant,  $K_c$ , for the forward reaction?

- A  $\text{mol dm}^{-3}$
- B  $\text{mol}^{-1} \text{ dm}^3$
- C  $\text{mol}^2 \text{ dm}^{-6}$
- D  $\text{mol}^{-2} \text{ dm}^6$



- 7 Ethanoic acid can be produced by the oxidation of butane.



The atom economy for ethanoic acid is

- A 22%.
- B 52%.
- C 67%.
- D 87%.
- 8 Which statement correctly describes the boiling points of fluoroethane and iodoethane?
- A Fluoroethane has a higher boiling point because it forms hydrogen bonds.
- B Fluoroethane has a higher boiling point because the C-F bond is stronger than the C-I bond.
- C Fluoroethane has a lower boiling point because it has weaker van der Waals' forces between the molecules.
- D Fluoroethane has a lower boiling point because the C-F bond is more polar than the C-I bond.



9 The table shows standard enthalpy changes of formation.

compound	$\text{NH}_4\text{NO}_3(\text{s})$	$\text{H}_2\text{O}(\text{g})$	$\text{CO}_2(\text{g})$
$\Delta H_f / \text{kJ mol}^{-1}$	-366	-242	-394

Which is the standard enthalpy change for the following reaction?



- A  $-270 \text{ kJ mol}^{-1}$
- B  $+270 \text{ kJ mol}^{-1}$
- C  $+630 \text{ kJ mol}^{-1}$
- D  $-630 \text{ kJ mol}^{-1}$

10 The first reaction that occurs when a car airbag is set off is:



When 3.25 g of  $\text{NaN}_3$  decomposes

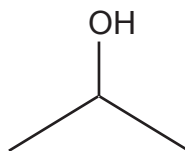
- A  $1.80 \text{ dm}^3$  of nitrogen is formed.
- B 2.30 g of sodium is formed.
- C  $3.60 \text{ dm}^3$  of nitrogen is formed.
- D 5.35 g of products are formed.



## Section B

Answer all **four** questions in this section.

- 11 Isopropyl alcohol is used as a hand sanitiser and as a cleaning agent for electronic equipment.



isopropyl alcohol

- (a) Give the IUPAC name for isopropyl alcohol.

\_\_\_\_\_ [1]

- (b) (i) Propan-1-ol is a **structural isomer** of isopropyl alcohol. Explain this term.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

- (ii) Ethyl methyl ether ( $\text{CH}_3\text{CH}_2\text{OCH}_3$ ) is a structural isomer of isopropyl alcohol.

Explain, using intermolecular forces, why the boiling point of this isomer is lower than isopropyl alcohol.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [3]



(c) Isopropyl alcohol can be oxidised using acidified potassium dichromate(VI).

(i) Draw the skeletal formula of the organic product formed.

[1]

(ii) Name the type of compound formed.

[1]

(iii) Explain how infrared spectroscopy could be used to show that the oxidation reaction was complete.

[1]

(d) Oxidation of 1.50 g of isopropyl alcohol gives 1.0 g of the organic product. Calculate the percentage yield of this reaction.

[3]

[Turn over



(e) Isopropyl alcohol is completely soluble in water.

(i) Explain why isopropyl alcohol is soluble in water.

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[2]

(ii) Suggest why the addition of sodium chloride to an aqueous solution of isopropyl alcohol causes the alcohol to become less soluble.

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[1]







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**[Turn over**



\*20SCH2209\*

**12** Calcium is present in teeth in the form of calcium phosphate. This salt does not react with water although the element calcium does react forming a gas.

**(a)** Write the formula of calcium phosphate.

\_\_\_\_\_ [1]

**(b) (i)** Write an equation for the reaction of calcium with water.

\_\_\_\_\_ [2]

**(ii)** Explain why, using the same mass of strontium in place of calcium, the volume of gas produced when strontium reacts with water is less under the same conditions.

\_\_\_\_\_  
\_\_\_\_\_ [1]

**(iii)** Suggest another difference that would be observed in the reaction with water when strontium is used in place of calcium. Explain your answer.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

**(c)** The Group II metal oxides can be formed from the metal hydroxides.

**(i)** How would you convert calcium hydroxide to calcium oxide?

\_\_\_\_\_ [1]

**(ii)** State and explain the trend in thermal stability of the Group II hydroxides as the Group is descended.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [3]



(d) What chemical property of magnesium oxide makes it suitable for indigestion remedies?

\_\_\_\_\_ [1]

(e) Magnesium sulfate is an important compound in horticulture. Industrially, the sulfates of magnesium and calcium are produced by reacting dolomite rock with excess sulfuric acid.



(i) Other than a temperature change, suggest **two** observations during this reaction.

\_\_\_\_\_  
\_\_\_\_\_ [2]

(ii) Compare the solubility of magnesium sulfate with calcium sulfate in water.

\_\_\_\_\_  
\_\_\_\_\_ [1]

(iii) The solubility of magnesium sulfate at two temperatures is given in the table below. In a batch process, a saturated solution of magnesium sulfate at 70 °C contained 100 tonnes of water. Use the table to calculate the mass of solid magnesium sulfate obtained when this solution is cooled to 20 °C.

temperature / °C	solubility / g per 100 g of water
20	35.1
70	59.2

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

[Turn over



- (f) 2.50 g of hydrated magnesium sulfate crystals ( $\text{MgSO}_4 \cdot x\text{H}_2\text{O}$ ) were heated to constant mass. The anhydrous solid has a mass of 1.22 g. Calculate the value of  $x$  and hence deduce the formula for the hydrated salt.

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[3]





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**(Questions continue overleaf)**

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**[Turn over**



\*20SCH2213\*

13 Propene is an important building block for a large number of chemicals. At low temperatures, propene will react with chlorine in an electrophilic addition reaction.

(a) (i) Explain the term **electrophile**.

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[2]

(ii) Draw a flow scheme to show the mechanism for the reaction between propene and chlorine using curly arrows.

[4]

(b) At 500 °C in the presence of ultraviolet light, propene will react with chlorine in a similar way to the reaction of propane with chlorine radicals. The product formed is allyl chloride ( $\text{CH}_2=\text{CHCH}_2\text{Cl}$ ).

Outline the mechanism of the reaction between propene and chlorine giving equations for the initiation, propagation and termination steps.

Initiation equation \_\_\_\_\_

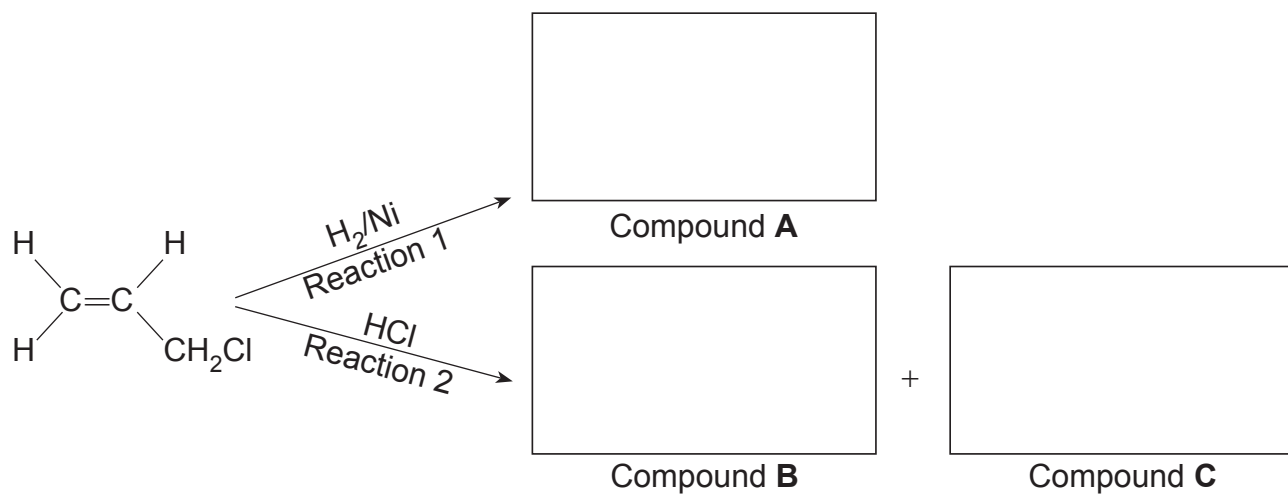
Propagation equations \_\_\_\_\_

\_\_\_\_\_

Termination equation \_\_\_\_\_ [4]



(c) (i) Two reactions of allyl chloride are shown. Fill in the structures of Compounds **A**, **B** and **C**. More of compound **B** is formed than compound **C**.



[3]

(ii) Explain why compounds **B** and **C** are not formed in equal amounts.

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[2]

(iii) Compound **B** reacts slowly in humid conditions to form compound **D** which contains the following percentage masses: C, 40.0%; H, 7.0%; O, 53.0%. The relative formula mass of the compound is 90. Deduce the molecular formula of compound **D**.

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[3]

[Turn over



(d) Allyl chloride will undergo an hydrolysis reaction with aqueous sodium hydroxide similar to halogenoalkanes.

(i) Draw the structural formula of the organic product formed in this reaction. Show **all** the bonds present.

[2]

(ii) Name the inorganic product formed during this hydrolysis reaction.

[1]

(e) Allyl chloride has a structural isomer which exists as geometrical isomers. Draw and label these geometrical isomers.

[3]





(f) Allyl chloride is highly flammable. When it burns, one of the products formed is a corrosive gas.

(i) Define the term **molar gas volume**.

\_\_\_\_\_ [1]

(ii) 1.50 g of this corrosive gas occupies a volume of 0.986 dm<sup>3</sup> at 293 K and 1 atmosphere pressure. Use this information to calculate the relative molecular mass of the gas and suggest its identity.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [3]





(b) Ethanol is a liquid at room temperature. It is increasingly used as a fuel.

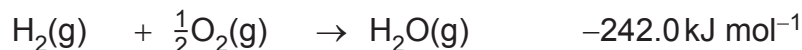
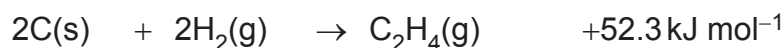
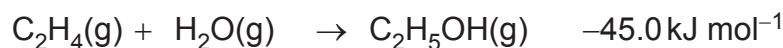
- (i) Give the equation, including state symbols, for the standard molar enthalpy of formation of ethanol.

\_\_\_\_\_ [2]

- (ii) Suggest why this standard enthalpy change cannot be measured directly.

\_\_\_\_\_  
\_\_\_\_\_ [1]

- (iii) Using the enthalpy changes below, calculate the enthalpy change of formation of gaseous ethanol.



\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [3]

- (c) (i) Give the equation for the standard enthalpy of combustion of ethanol.

\_\_\_\_\_ [2]

- (ii) Using bond enthalpies explain why enthalpy changes of combustion are negative.

\_\_\_\_\_  
\_\_\_\_\_ [2]



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<b>For Examiner's use only</b>	
<b>Question Number</b>	<b>Marks</b>
<b>Section A</b>	
1–10	
<b>Section B</b>	
11	
12	
13	
14	
<b>Total Marks</b>	

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\*20SCH2220\*

## General Information

1 tonne =  $10^6$  g

1 metre =  $10^9$  nm

One mole of any gas at 293 K and a pressure of 1 atmosphere ( $10^5$  Pa) occupies a volume of  $24 \text{ dm}^3$

Avogadro Constant =  $6.02 \times 10^{23} \text{ mol}^{-1}$

Planck Constant =  $6.63 \times 10^{-34} \text{ Js}$

Specific Heat Capacity of water =  $4.2 \text{ J g}^{-1} \text{ K}^{-1}$

Speed of Light =  $3 \times 10^8 \text{ ms}^{-1}$

## Characteristic absorptions in IR spectroscopy

Wavenumber/ $\text{cm}^{-1}$	Bond	Compound
550–850	C–X (X = Cl, Br, I)	Haloalkanes
750–1100	C–C	Alkanes, alkyl groups
1000–1300	C–O	Alcohols, esters, carboxylic acids
1450–1650	C=C	Arenes
1600–1700	C=C	Alkenes
1650–1800	C=O	Carboxylic acids, esters, aldehydes, ketones, amides, acyl chlorides
2200–2300	C≡N	Nitriles
2500–3200	O–H	Carboxylic acids
2750–2850	C–H	Aldehydes
2850–3000	C–H	Alkanes, alkyl groups, alkenes, arenes
3200–3600	O–H	Alcohols
3300–3500	N–H	Amines, amides

## Proton Chemical Shifts in Nuclear Magnetic Resonance Spectroscopy (relative to TMS)

Chemical Shift	Structure	
0.5–2.0	–CH	Saturated alkanes
0.5–5.5	–OH	Alcohols
1.0–3.0	–NH	Amines
2.0–3.0	–CO–CH	Ketones
	–N–CH	Amines
	$\text{C}_6\text{H}_5$ –CH	Arene (aliphatic on ring)
2.0–4.0	X–CH	X = Cl or Br (3.0–4.0) X = I (2.0–3.0)
4.5–6.0	–C=CH	Alkenes
5.5–8.5	RCONH	Amides
6.0–8.0	– $\text{C}_6\text{H}_5$	Arenes (on ring)
9.0–10.0	–CHO	Aldehydes
10.0–12.0	–COOH	Carboxylic acids

These chemical shifts are concentration and temperature dependent and may be outside the ranges indicated above.

# Data Leaflet

## Including the Periodic Table of the Elements

For the use of candidates taking  
Advanced Subsidiary and  
Advanced Level Examinations

**Copies must be free from notes or additions of any kind. No other type of data booklet or information sheet is authorised for use in the examinations**

# gce a/as examinations chemistry

For first teaching from September 2016  
For first award of AS Level in Summer 2017  
For first award of A Level in Summer 2018  
Subject Code: 1110

