



Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education

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

Assessment

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 sixteen** 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 six** 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 **15(c)(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.

12526

Assessment Level of Control:

Tick the relevant box (✓)

Controlled Conditions	
Other	



20SCH2201

Section A

For each of the following questions only **one** of the lettered responses (A – D) is correct. **Select the correct response in each case and mark its code letter by connecting the dots as illustrated on the answer sheet.**

- 1 Damage to the ozone layer allows more
 - A infrared radiation to escape from the atmosphere.
 - B infrared radiation to reach the Earth's surface.
 - C ultraviolet radiation to escape from the atmosphere.
 - D ultraviolet radiation to reach the Earth's surface.

- 2 Which is the electronic configuration of a Group II ion?
 - A $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$
 - B $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
 - C $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$
 - D $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$

- 3 The intermolecular forces present in alcohols are
 - A hydrogen bonds.
 - B hydrogen bonds and dipole-dipole attractions.
 - C hydrogen bonds and van der Waals' forces.
 - D hydrogen bonds, dipole-dipole attractions and van der Waals' forces.



4 When excess calcium is added to water the

- A solution formed turns cloudy.
- B solution formed turns blue litmus paper red.
- C gas given off relights a glowing splint.
- D gas given off turns limewater milky.

5 Which molecule has the highest boiling point?

- A C_2H_4
- B C_2H_6
- C $\text{C}_2\text{H}_5\text{OH}$
- D $\text{C}_2\text{H}_5\text{Cl}$

6 Which is the empirical formula of a hydrocarbon containing 82.8%, by mass, of carbon?

- A C_2H_5
- B C_4H_5
- C C_4H_{10}
- D C_5H_4

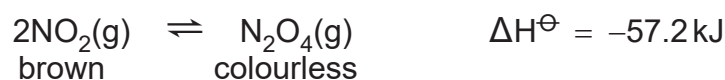
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7 Which halogenoalkane will **not** damage the ozone layer?

- A $\text{CH}_3\text{CH}_2\text{F}$
- B $\text{CH}_2\text{ClCH}_2\text{F}$
- C $\text{CHCl}_2\text{CH}_2\text{F}$
- D $\text{CHCl}_2\text{CHF}_2$

8 For the following equilibrium



which statement is correct?

- A Increasing the temperature makes the mixture lighter coloured
 - B Increasing the pressure makes the mixture darker coloured
 - C The equilibrium mixture is coloured
 - D The equilibrium mixture is colourless
- 9 Which molecule has the greatest number of lone pairs of electrons?
- A CH_3CHO
 - B $\text{CH}_3\text{CH}_2\text{Cl}$
 - C $\text{CH}_3\text{CH}_2\text{OH}$
 - D CH_2CH_2



10 Which structure can **not** be formed in the polymerisation of chloroethene, CH_2CHCl ?

- A $-\text{CHClCH}_2\text{CHClCH}_2-$
- B $-\text{CH}_2\text{CHClCHClCH}_2-$
- C $-\text{CHClCH}_2\text{CH}_2\text{CHCl}-$
- D $-\text{CH}_2\text{CCl}_2\text{CH}_2\text{CH}_2-$

[Turn over



Section B

Answer **all six** questions in this section

11 Decane is an alkane found in petrol.

(a) Decane has ten carbon atoms. Write the formula of decane.

_____ [1]

(b) State **three** pollutants which are formed when petrol is burned.

_____ [3]

(c) Decane can undergo thermal cracking to form a molecule of hexane and a molecule of an alkene. The alkene exhibits geometric isomerism.

(i) Define the term **geometric isomerism**.

_____ [1]

(ii) Write the equation for the thermal cracking of decane.

_____ [1]

(iii) Draw and identify the geometric isomers of the alkene formed.

[2]





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12 (a) Calcium and barium are found in Group II of the Periodic Table.

Explain why calcium and barium are described as s-block elements.

_____ [1]

(b) The table below shows the first ionisation energies for the Group II elements.

element	first ionisation energy /kJ mol ⁻¹
beryllium	900
magnesium	740
calcium	590
strontium	550
barium	500

(i) Write the equation, including state symbols, for the first ionisation energy of calcium.

_____ [1]

(ii) Explain the trend in the first ionisation energies of the Group II elements.

_____ [2]



- (c) State and explain the change in thermal stability of the Group II carbonates as the group is descended.

[3]

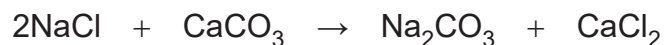
- (d) Calcium and barium both react with water. Write an equation for the reaction of barium with water.

[2]

[Turn over



- 13 Sodium carbonate, Na_2CO_3 , is manufactured from concentrated brine and limestone. The overall equation for the process is:



- (a) (i) Calculate the percentage atom economy for the production of sodium carbonate, giving your answer to one decimal place.

_____ [2]

- (ii) The process produces 1.0 tonne of sodium carbonate from 1.0 tonne of limestone with excess brine. Calculate the percentage yield.

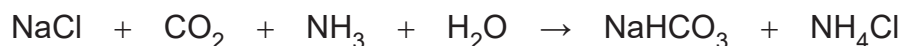
_____ [3]

- (b) The process takes place in four stages.

Stage I The limestone is calcined at $950 - 1100^\circ\text{C}$.



Stage II Carbon dioxide is passed through concentrated aqueous brine and ammonia.



Stage III The sodium hydrogencarbonate is filtered off and the ammonium chloride solution is reacted with calcium oxide.



Stage IV The sodium hydrogencarbonate is calcined at $160 - 230^\circ\text{C}$.



- (i) Suggest what is meant by the term **calcined**.

_____ [1]



(ii) Suggest why ammonia is not added continuously throughout the process.

[1]

(c) The enthalpy change for the overall process can be calculated using Hess's Law and standard enthalpy of formation, $\Delta_f H^\ominus$, values.

(i) State **Hess's Law**.

[2]

(ii) Explain what is meant by the term **standard enthalpy of formation**, $\Delta_f H^\ominus$.

[2]

(iii) Use the standard enthalpy of formation values from the table below to calculate the enthalpy change for the overall chemical equation for the process.

compound	$\Delta_f H^\ominus / \text{kJ mol}^{-1}$
NaCl	-411
CaCO ₃	-1207
Na ₂ CO ₃	-1131
CaCl ₂	-795

[2]

[Turn over



- 14** Sulfuric acid is manufactured by the Contact process. Sulfur is burned to form sulfur dioxide. The sulfur dioxide is passed into a catalytic chamber and reacts with oxygen to form sulfur trioxide.



- (a) (i)** Name the catalyst used in the catalytic chamber.

_____ [1]

- (ii)** State the conditions of temperature and pressure used.

_____ [2]

- (iii)** State and explain the effect of increasing the temperature on the yield of sulfur trioxide and the rate of the reaction.

Yield: _____

Rate: _____

_____ [4]



- (iv) State and explain the effect of increasing the pressure on the yield of sulfur trioxide and the rate of the reaction.

Yield: _____

Rate: _____

_____ [4]

- (v) Write an expression for the equilibrium constant for this reaction and state its units.

_____ [2]

[Turn over]



(b) (i) Complete the diagram below to draw the Maxwell–Boltzmann distribution of energies for molecules in a gaseous mixture by:

- labelling the axes.
- drawing a curve, labelled A, to represent the distribution of energies.
- marking and labelling the activation energy for the uncatalysed reaction, E_a , and the catalysed reaction, $E_{a(\text{cat})}$.



[3]

(ii) Draw a second curve on the diagram above, labelled B, to show the distribution of energies when the temperature is lowered.

[2]





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20SCH2215

15 1-chloro-2-methylpropane, $(\text{CH}_3)_2\text{CHCH}_2\text{Cl}$, is one of two organic products produced by the reaction of hydrogen chloride with 2-methylpropene.

(a) (i) Name and draw the mechanism for forming 1-chloro-2-methylpropane.

Name: _____

Mechanism:

[5]

(ii) 2-chloro-2-methylpropane is also formed during the preparation. State and explain which product will be formed in the greater quantity.

[2]

(b) 1-chloro-2-methylpropane reacts with potassium cyanide.

(i) Write the equation for the reaction.

_____ [1]

(ii) Give the IUPAC name of the organic product formed in the reaction.

_____ [1]



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16 (a) Butane and butan-1-ol are both used as fuels.

(i) Write the equations for the complete combustion of butane and butan-1-ol.

_____ [2]

(ii) The enthalpy of combustion of butane is $-2877 \text{ kJ mol}^{-1}$ and that of butan-1-ol is $-2674 \text{ kJ mol}^{-1}$. Explain, in terms of bonds, the difference in the enthalpies of combustion.

_____ [2]

(b) (i) Draw the structure and give the IUPAC name of the secondary alcohol which is an isomer of butan-1-ol.

_____ [2]

(ii) Draw the structure and give the IUPAC name of the tertiary alcohol which is an isomer of butan-1-ol.

_____ [2]



- (c) Oxidation can be used to distinguish between the secondary and tertiary alcohols identified in (b)(i) and (b)(ii).

Name a suitable oxidising agent and state the conditions needed. Give the observations in each case.

[4]

- (d) Infrared spectroscopy can be used to distinguish between butanone and butanoic acid.

- (i) Explain how infrared absorption arises in molecules.

[1]

- (ii) Explain how infrared spectroscopy could be used to distinguish between butanone and butanoic acid.

[2]

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