Rewarding Learning

Centre Number

71

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2011

Chemistry

Assessment Unit AS 2

assessing

Module 2: Organic, Physical and Inorganic Chemistry

[AC122]

AC122

FRIDAY 24 JUNE, 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 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**. Write your answers in the spaces provided in this question paper.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.
Quality of written communication will be assessed in question **12(b)**.
In Section A all questions carry equal marks, i.e. **two** marks for each question.
In Section B the figures in brackets printed down the right-hand side of the pages indicate the marks awarded to each question or part question.
A Periodic Table of Elements (including some data) is provided.

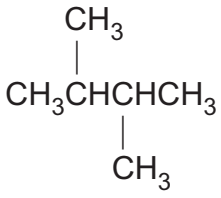
For Examiner's use only	
Question Number	Marks
Section A	
1–10	
Section B	
11	
12	
13	
14	
15	
16	
Total Marks	

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 Which one of the following is the IUPAC name for the hydrocarbon shown below?



A 1,4-dimethylbutane
B 2,3-dimethylbutane
C 1,4-dimethylhexane
D 2,3-dimethylhexane

2 1.4 g of an alkene gives 3.8 g of a dichloroalkane on reaction with chlorine. Which one of the following is the molecular formula of the alkene?

A C_2H_4
B C_3H_6
C C_4H_8
D C_6H_{12}

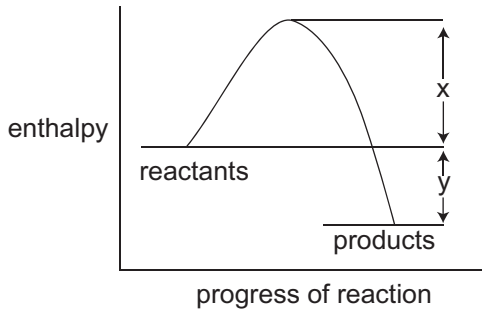
3 Which one of the following lists the products of hydrolysis of chloromethane with "heavy water", D_2O?
(The symbol D represents an atom of deuterium, an isotope of hydrogen)

A $CH_3OH + HCl$
B $CH_3OH + DCl$
C $CH_3OD + HCl$
D $CH_3OD + DCl$

4 The enthalpy change for the combustion of graphite is $-393.5\,kJ\,mol^{-1}$ and that of diamond is $-395.4\,kJ\,mol^{-1}$.
Which one of the following is the enthalpy change for the reaction C(graphite) → C(diamond)?

A $-1.9\,kJ\,mol^{-1}$
B $+1.9\,kJ\,mol^{-1}$
C $-788.9\,kJ\,mol^{-1}$
D $+788.9\,kJ\,mol^{-1}$

5 The energy level diagram for a reversible reaction is shown below.



Which one of the following is correct?

A The activation energy of the forward reaction is x
B The activation energy of the reverse reaction is y
C The forward reaction is endothermic
D The enthalpy change for the reverse reaction is y–x

6 The reaction of bromine with water can be represented by the following equation:

$$Br_2 + H_2O \rightleftharpoons Br^- + OBr^- + 2H^+$$

Which one of the following reagents would move the equilibrium position to the right?

A nitric acid
B sodium carbonate
C sodium bromide
D sulfuric acid

7 What is the number of moles of oxygen required for the complete combustion of one mole of butane?

A 5.5
B 6
C 6.5
D 7

8 When bromobutane is prepared by the reaction of butanol with concentrated hydrobromic acid in the presence of concentrated sulfuric acid which one of the following is **not** found in the reaction flask?

A bromine
B butanol
C butane
D hydrogen bromide

9 The mechanism of the reaction between ethene and hydrogen bromide is

A electrophilic addition.
B electrophilic substitution.
C nucleophilic addition.
D nucleophilic substitution.

10 In ethanol the attractions between adjacent molecules are

A covalent bonds only.
B hydrogen bonds only.
C hydrogen bonds and van der Waals forces only.
D van der Waals forces only.

Section B

Answer **all six** questions in the spaces provided.

11 Complete the following table:

Formula	Name
SCN^-	
	potassium dichromate
CHI_3	
	thionyl chloride

[4]

12 Crude petroleum is the major source of hydrocarbons. They are obtained by fractional distillation.

Whilst the use of petroleum products is of major benefit to mankind there are many environmental problems caused by the spillage and combustion of hydrocarbons. The recent spillage of crude petroleum onto the shores of the USA was a serious event in world economics.

(a) What are the products from the incomplete combustion of hydrocarbons?

_____ [2]

(b) Discuss the environmental problems associated with spillage and the combustion of hydrocarbons.

_____

_____

_____

_____

_____

_____

_____

_____

_____ [5]

Quality of written communication [2]

13 The table below shows some information about the Group II elements.

	magnesium	**calcium**	**strontium**	**barium**
atomic number	12	20	38	56
atomic radius/nm	0.160	0.197	0.215	
density/g cm^{-3}	1.74	1.54	2.6	3.5

(a) Explain why none of the Group II elements are found on the Earth's surface as free elements.

_____

_____ [1]

(b) Use the atomic number to determine the electronic configuration of calcium.

_____ [1]

(c) The atomic radius of the Group II elements shows a trend as the group is descended.

(i) Explain why the atomic radius increases down the group.

_____

_____ [1]

(ii) Suggest whether the values of the atomic radii of the Group I elements are larger or smaller than those of the Group II elements.

_____

_____ [2]

(iii) Predict a value for the atomic radius of barium.

_____ [1]

(iv) Use the values in the table to suggest why barium has the highest density of the group.

_____

_____ [2]

(d) All of the Group II elements form ions from their atoms.

(i) If the symbol for a Group II element is M what is the symbol for its ion?

_____ [1]

(ii) Explain what is meant by the term **first ionisation energy**.

_____

_____ [1]

(iii) Write the equation for the first ionisation energy of magnesium including state symbols.

_____ [2]

(e) The density of the Group II elements relative to water indicates whether the metal should float or sink as it is reacting.

(i) State and explain whether calcium floats or sinks.

_____

_____ [2]

(ii) State **two** further observations when calcium reacts with water.

_____

_____ [2]

(iii) Write the equation for the reaction of calcium with water.

_____ [2]

(iv) Draw a labelled diagram, to show how the gas given off when calcium reacts with water can be collected. Use a test tube and a beaker.

[3]

(f) Barium carbonate is roasted with carbon to produce barium oxide according to the equation below.

$$BaCO_3 \rightarrow BaO + CO_2$$

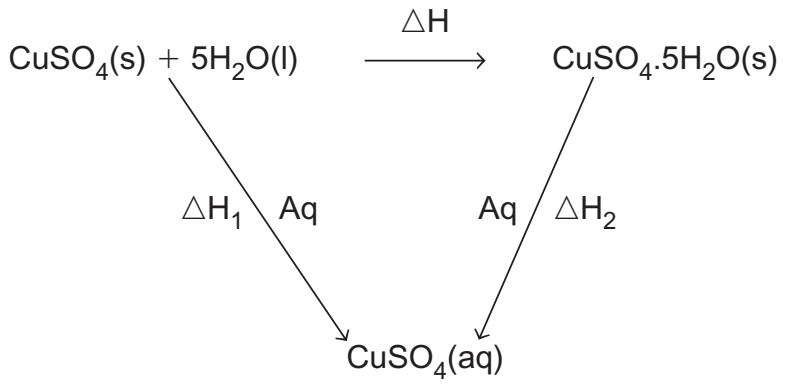
Calculate the atom economy of the reaction.

_____

_____

_____ [3]

14 The following diagram shows the enthalpy changes that occur during the determination of the enthalpy change of the reaction of copper(II) sulfate with water to form copper(II) sulfate pentahydrate i.e.



(a) (i) 8.0 g of anhydrous copper(II) sulfate ($CuSO_4$) added to 100 g of water caused the temperature to rise by 1.2 °C. Calculate the enthalpy change, $\triangle H_1$.
(Assume that the specific heat capacity of water is $4.2\,J\,g^{-1}\,°C^{-1}$.)

_____

_____ [1]

(ii) 12.5 g of hydrated copper(II) sulfate ($CuSO_4.5H_2O$) added to 100 g of water caused the temperature to fall by 1.4 °C. Calculate the enthalpy change $\triangle H_2$.
(Assume that the specific heat capacity of water is $4.2\,J\,g^{-1}\,°C^{-1}$.)

_____

_____ [1]

(b) State Hess's law.

_____

_____ [2]

(c) Use the values calculated in parts **(a)(i)** and **(a)(ii)** to calculate the molar enthalpy of reaction $\triangle H$.

_____

_____

_____ [3]

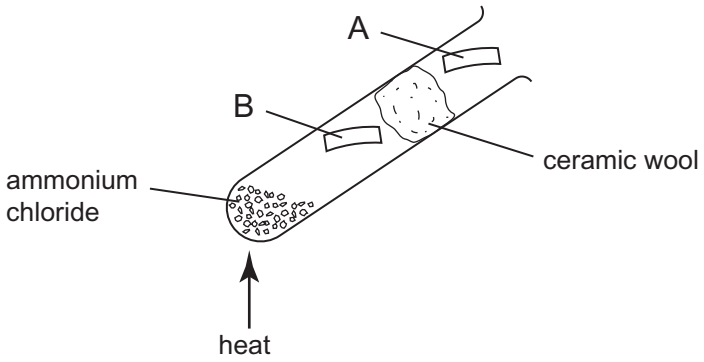
(d) At the end of the experiment a test was carried out to show that the solution produced contained Cu^{2+} ions.

Describe how you would use aqueous ammonia to test and confirm the presence of Cu^{2+}.

_____

_____ [2]

15 Crystals of ammonium chloride were heated in a test tube as shown below.



The pH paper placed at A turns blue and the pH paper placed at B turns red.

The ammonium chloride, when heated, dissociates to form an equilibrium mixture.

$$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$$

(a) (i) Explain why the pH paper changes to a blue colour at A.

_____ [1]

(ii) Explain why the pH paper changes to a red colour at B.

_____ [1]

(b) Suggest the purpose of the ceramic wool.

_____ [1]

(c) Heat is needed to decompose the ammonium chloride. Explain whether the forward reaction is exothermic or endothermic.

_____

_____ [2]

(d) Ammonium chloride dissolves in water to form aqueous ammonium and chloride ions.

$$NH_4Cl(s) + Aq \longrightarrow NH_4^+(aq) + Cl^-(aq)$$

(i) Describe how you would test for aqueous ammonium ions.

_____

_____ [3]

(ii) Describe how you would test for aqueous chloride ions.

_____

_____ [3]

(e) Ammonium chloride is quite soluble in water, 37.2 g dissolve in 100 cm^3 of water at 20 °C. Calculate the maximum volume of ammonia gas that could be obtained from this solution at 20 °C and one atmosphere pressure.

_____

_____

_____ [3]

16 The structure of t-butyl chloride (tertiary chlorobutane) one of the isomers of the chlorobutanes is shown below.

$(CH_3)_3CCl$

t-butyl chloride

(a) Deduce the systematic name for t-butyl chloride

_____ [2]

(b) There are three other isomers of t-butyl chloride which are known. They are shown in the table below.

butyl chloride	structure	boiling point/°C
t-butyl chloride	$(CH_3)_3CCl$	51–52
n-butyl chloride	$CH_3CH_2CH_2CH_2Cl$	78–79
sec-butyl chloride	$CH_3CH_2CHClCH_3$	68–70
iso-butyl chloride	$(CH_3)_2CHCH_2Cl$	68–69

(i) What is the general formula for chloroalkanes?

_____ [1]

(ii) What is the general molecular formula for the chlorobutanes?

_____ [1]

(iii) Suggest, in terms of intermolecular forces, why the boiling point of t-butyl chloride is so different from the other chlorobutanes.

_____

_____ [2]

(iv) Explain what is meant by the term **isomer**.

_____

_____ [2]

(v) Suggest the meaning of the term **sec**.

_____ [1]

(c) t-butyl chloride is easily made from the corresponding alcohol according to the following reaction.

$$(CH_3)_3COH + HCl \rightarrow (CH_3)_3CCl + H_2O$$

The preparation is carried out in a separating funnel. 25 g of t-butyl alcohol and 85 cm^3 of concentrated hydrochloric acid (an excess) are shaken from time to time over 20 minutes. The mixture is allowed to stand for a few minutes and the lower acid layer removed. The crude t-butyl chloride is washed with sodium hydrogencarbonate solution and then with water. Anhydrous calcium sulfate is swirled with the t-butyl chloride in a conical flask. The liquid is decanted, 2–3 chips of porous porcelain added and distilled to collect 28 g of t-butyl chloride at 51–52 ºC.

(i) After each shaking the separating funnel is inverted and the tap opened. Explain the reason for this procedure.

_____ [1]

(ii) Explain why the t-butyl chloride is shaken with sodium hydrogencarbonate solution.

_____ [1]

(iii) Explain why the t-butyl chloride is shaken with water.

_____ [1]

(iv) Explain why the t-butyl chloride is swirled with anhydrous calcium sulfate.

_____ [1]

(v) Explain why porous porcelain is added before distillation.

_____ [1]

(vi) Calculate the percentage yield of t-butyl chloride.

_____

_____

_____

_____ [3]

(d) When added to water t-butyl chloride undergoes "spontaneous solvation". Hydrolysis immediately occurs to produce the alcohol. Compare the speed of this hydrolysis to that of n-butyl chloride and suggest why there is such a difference in speed.

_____

_____

_____

_____ [3]

THIS IS THE END OF THE QUESTION PAPER

111331