Rewarding Learning

Centre Number	
71	

Candidate Number

ADVANCED
General Certificate of Education
January 2010

Chemistry

Assessment Unit A2 1

assessing

Module 4: Further Organic, Physical and Inorganic Chemistry

[A2C11]

A2C11

THURSDAY 21 JANUARY, AFTERNOON

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 fifteen** questions.
Answer **all ten** questions in **Section A**. Record your answers by marking the appropriate letter in the answer sheet provided. Use only the spaces numbered 1 to 10. Keep in sequence when answering.
Answer **all five** 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 90.
Quality of written communication will be assessed in question **11(a)**.
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 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	
Total Marks	

Section A

For each of the 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 illustrated on the answer sheet.

1 Which one of the following always has units?

A K_a
B K_c
C pH
D pK_a

2 A compound gave a precipitate with 2,4-dinitrophenylhydrazine, but did **not** reduce acidified potassium dichromate. To which class of compounds does it belong?

A alkenes
B aldehydes
C ketones
D esters

3 Which one of the following oxides dissolves in water to form an alkaline solution?

A sodium oxide
B phosphorus pentoxide
C silicon dioxide
D sulphur trioxide

4 Which one of the following compounds reacts with propanoic acid to form propanoyl chloride?

A chlorine
B chloropropane
C hydrogen chloride
D thionyl chloride

5 Which one of the following molecules exhibits optical isomerism?

A $CH_3CH=CHCH_3$
B $CH_3CH_2COCH_3$
C $CH_3CH_2CHClCH_3$
D $CH_3CH_2CH(CH_3)CH_3$

6 How many isomers are there of C_4H_{10}?

A 1
B 2
C 3
D 4

7 Overall, the rate of reaction between X and Y is third order. Which one of the following equations is **not** correct?

A Rate = $k[X]^0[Y]^3$
B Rate = $k[X]^1[Y]^2$
C Rate = $k[X]^1[Y]^3$
D Rate = $k[X]^2[Y]^1$

8 Which one of the following carbohydrates is a polysaccharide?

A amylose
B fructose
C glucose
D maltose

9 Which one of the following represents the units for a rate constant of a third order reaction?

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

10 Which one of the following observations about the reaction between sodium and concentrated sulphuric acid is correct?

A A red solid is formed
B A light brown gas is formed
C A strong smelling gas is produced
D A colourless solution remains

Section B

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

11 The manufacture of sulphuric acid remains as important today as when Liebig (the inventor of the condenser) wrote in 1843, "We may fairly judge the commercial prosperity of a country from the amount of sulphuric acid it consumes".

(a) Using equations, describe the manufacture of concentrated sulphuric acid from sulphur, explaining the conditions used.

_____

_____

_____

_____

_____

_____

_____

_____[5]

Quality of written communication [2]

(b) State the problem caused by possible sulphur dioxide emissions during the manufacture of sulphuric acid.

_____[1]

(c) Explain **one** major use of sulphuric acid.

_____

_____[2]

12 Hydrogen cyanide, HCN, is a colourless liquid with a boiling point of 26 °C. It is a highly toxic substance; 50 mg of hydrogen cyanide will cause death within a few seconds.

(a) Calculate the lethal dose (50 mg) of hydrogen cyanide in moles.

_____

_____

_____ [3]

(b) Draw a dot and cross diagram of the structure of hydrogen cyanide, showing the outer electrons only.

[2]

(c) Hydrogen cyanide is manufactured by passing a mixture of ammonia and methane over a platinum catalyst. The reaction is endothermic.

$$NH_3(g) + CH_4(g) \rightleftharpoons HCN(g) + 3H_2(g)$$

(i) Suggest why the reaction is carried out at 1000 °C.

_____

_____

_____ [2]

(ii) Explain if a high pressure should be used in the manufacture of hydrogen cyanide.

_____

_____ [2]

(iii) If ammonia (0.2 mol) and methane (0.2 mol) are placed in a 1 dm^3 container and heated to 500 °C, it is found that 0.1 mol of hydrogen cyanide and 0.3 mol of hydrogen are produced at one atmosphere pressure. Calculate the equilibrium constant, K_c, for the reaction under these conditions and state its units.

_____

_____

_____

_____[3]

(d) Hydrogen cyanide dissolves in water to form a weakly acidic solution. It has a dissociation constant of 4.9×10^{-10} at 25 °C. Alkalis react with hydrogen cyanide to form salts known as cyanides.

(i) Write an equation for the formation of sodium cyanide from hydrogen cyanide.

_____[1]

(ii) Explain why an aqueous solution of sodium cyanide is alkaline.

_____

_____[2]

(iii) Using equations, explain how a mixture of sodium cyanide and hydrogen cyanide is able to act as a buffer.

_____

_____

_____

_____[2]

(iv) Calculate the pH of the buffer solution formed when 200 cm^3 of a 0.5 mol dm^{-3} solution of hydrogen cyanide is added to 200 cm^3 of a 1.0 mol dm^{-3} solution of sodium cyanide.

_____

_____

_____

_____ [3]

(e) Hydrogen cyanide reacts with propanone to form an addition product known as a cyanohydrin. The reaction is catalysed by sodium hydroxide.

(i) Write the equation for the reaction between hydrogen cyanide and propanone.

_____ [2]

(ii) Draw a flow scheme to illustrate the mechanism for the reaction.

[3]

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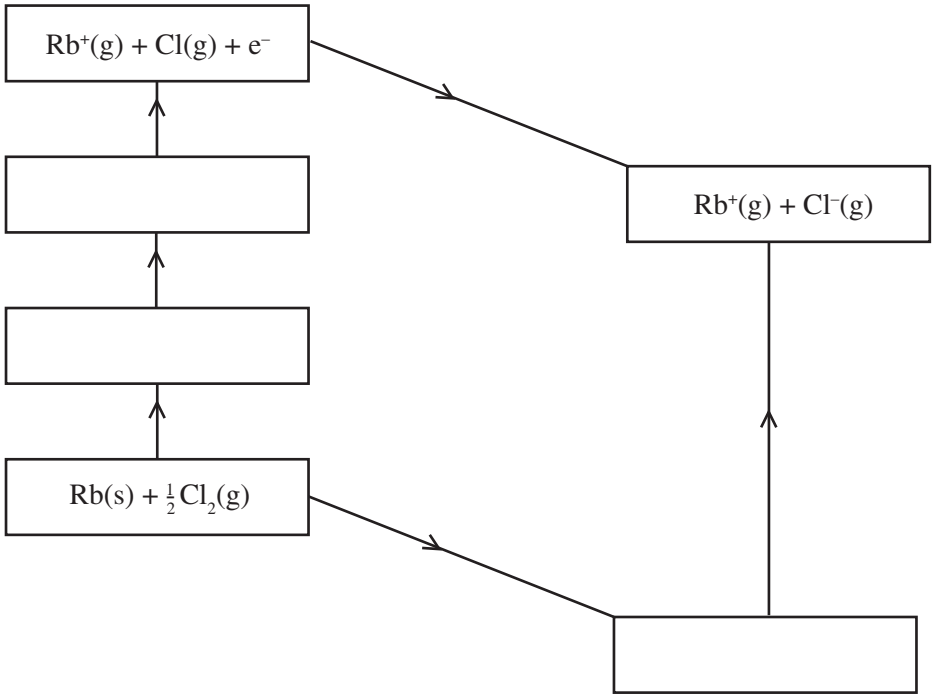
(Questions continue overleaf)

13 The partially completed Born–Haber cycle for rubidium chloride is shown below.



(a) (i) Complete the empty boxes. [2]

(ii) Using the data below, calculate the enthalpy of formation for rubidium chloride.

	kJ mol^{-1}
First ionisation energy of rubidium	+403
Enthalpy of atomisation of rubidium	+81
Bond enthalpy of chlorine (Cl_2)	+242
Electron affinity of chlorine	–348
Lattice enthalpy of rubidium chloride	+685

_____

_____ [2]

(b) The lattice enthalpies for Group I chlorides are listed below.

Chloride	Lattice enthalpy, kJ mol^{-1}
lithium chloride	848
sodium chloride	780
potassium chloride	711
rubidium chloride	685
caesium chloride	661

Suggest why the lattice enthalpy decreases as you descend the group.

_____

_____[1]

(c) The flame colour of rubidium is red, which led it to be named after the Latin word *rubidos*, which means red.

(i) Name another element which gives a red flame colour.

_____[1]

(ii) Describe how you would carry out a flame test using rubidium oxide.

_____

_____

_____

_____[3]

14 Vegetable oils are triglycerides formed by the esterification of glycerol with long chain organic acids such as oleic and stearic acids.

(a) Draw the structure of glycerol.

[1]

(b) Explain the term **esterification**.

_____

_____[2]

(c) The iodine value is a measure of the degree of unsaturation of an oil.

(i) Define the term **iodine value**.

_____

_____[2]

(ii) The iodine value of a vegetable oil was determined using the following procedure:

"0.9 g of oil was added to 11.0 cm^3 of Wij's solution. The mixture was left to stand in the dark for 30 minutes. Then 20 cm^3 of 10% potassium iodide solution were added and the iodine formed reacted with 6.0 cm^3 of 0.1 M sodium thiosulphate solution. The blank titration required 46.0 cm^3 of the sodium thiosulphate solution."

Calculate the iodine value of the vegetable oil.

_____

_____

_____

_____

_____[3]

(iii) Explain why fats and oils formed from a mixture of stearic and oleic acids have lower iodine values than those formed from oleic acid only.

_____

_____[1]

(d) Vegetable oils can be burnt and yield products similar to those formed by the combustion of hydrocarbons.

(i) Name the products of the complete combustion of alkanes or vegetable oils.

_____[2]

(ii) Name **one** product formed by their incomplete combustion.

_____[1]

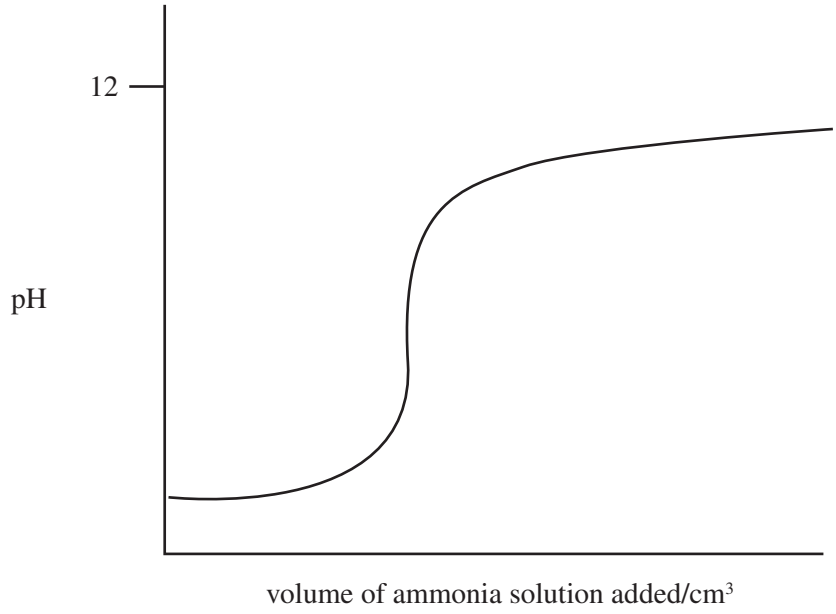
(iii) Explain the environmental problems associated with the combustion of organic materials.

_____

_____

_____[2]

15 The titration curve for the reaction of 0.1 M sulphuric acid with 0.2 M ammonia solution is shown below.



(a) (i) Write the equation for the reaction of sulphuric acid with ammonia.

_____ [2]

(ii) Explain why ammonia is regarded as a Lowry–Brønsted base in this reaction.

_____ [1]

(b) (i) Name a suitable indicator for the titration.

_____ [1]

(ii) Using the titration curve, explain why this indicator is suitable.

_____

_____ [1]

(c) Estimate the pH reached by the titration curve when a very large excess of ammonia solution has been added.
K_b ammonia = 1.8×10^{-5} for $NH_3(aq) + H_2O(l) \rightleftharpoons OH^-(aq) + NH_4^+(aq)$

_____

_____

_____

_____ [4]

(d) Ammonia reacts with ethanoic acid to form ammonium ethanoate.

(i) Write an equation for the reaction.

_____ [1]

(ii) Explain why it is not feasible to measure an accurate end point in the titration of ammonia with ethanoic acid.

_____

_____ [2]

THIS IS THE END OF THE QUESTION PAPER