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January 2009

Chemistry

Assessment Unit A2 1

assessing

Module 4: Further Organic, Physical and
Inorganic Chemistry

[A2C11]

FRIDAY 9 JANUARY, AFTERNOON

StudentBounty.com

71

Candidate Number



A2C11

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**. 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 **13(c)**.

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	

Total Marks	
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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 as illustrated on the answer sheet.

- 1 The rate of decomposition of ethanal at 500 °C is given by the equation below:

$$\text{rate} = k [\text{ethanal}]^2$$

What are the units of k ?

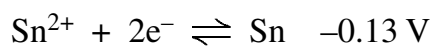
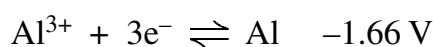
- A s^{-1}
B $\text{mol dm}^{-3} \text{s}^{-1}$
C $\text{mol}^{-1} \text{dm}^3 \text{s}^{-1}$
D $\text{mol}^2 \text{dm}^{-6} \text{s}^{-1}$
- 2 An organic compound, X, gives an orange crystalline product with 2,4-dinitrophenylhydrazine, but does not give a precipitate on heating with Fehling's solution. Which one of the following formulae is that of X?
- A HCHO
B $\text{C}_6\text{H}_5\text{CH}_2\text{CHO}$
C CH_3COCH_3
D $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$
- 3 A gaseous mixture of 1.0 g of hydrogen and 2.8 g of nitrogen has a total pressure of 660.0 kPa at a particular temperature. What is the partial pressure of hydrogen in the mixture?
- A 110.0 kPa
B 220.0 kPa
C 440.0 kPa
D 550.0 kPa

- 4 Which one of the following oxides has a molecular structure as distinct from structure?
- A Al_2O_3
 - B Cl_2O_7
 - C Na_2O
 - D SiO_2
- 5 How many moles of ethanoyl chloride would react with one mole of glucose, assuming that glucose can be represented by the formula $\text{CH}_2\text{OH}(\text{CHOH})_4\text{CHO}$?
- A 1
 - B 4
 - C 5
 - D 6
- 6 Which one of the following alcohols, all with molecular formula $\text{C}_5\text{H}_{12}\text{O}$, could **not** be produced by the reduction of an aldehyde or a ketone?
- A 2-methylbutan-1-ol
 - B 2-methylbutan-2-ol
 - C 3-methylbutan-1-ol
 - D 3-methylbutan-2-ol
- 7 An aqueous solution containing 1 mol of $\text{S}_2\text{O}_3^{2-}$ ions reduces 4 mol of Cl_2 molecules. Which one of the following is a product of the reaction? Note that water is a reactant.
- A S
 - B SO_2
 - C SO_3^{2-}
 - D SO_4^{2-}

8 A 0.20 g sample of a monobasic acid requires 8.0 cm³ of 0.40 mol dm⁻³ sodium hydroxide solution for complete reaction. Which one of the following is the relative molecular mass of the acid?

- A 62.5
- B 250.0
- C 625.0
- D 640.0

9 Pain is often felt when a piece of aluminium foil touches an amalgam filling in a tooth because an electrical current briefly flows. The amalgam contains tin. The standard electrode potentials are:



Which one of the following statements concerning the resulting cell is correct?

- A Aluminium ions are produced from the foil.
- B The aluminium foil acts as the positive electrode.
- C The e.m.f. of the cell is + 1.79 V.
- D Tin ions are discharged into the saliva in the mouth.

10 An aqueous solution of ammonium chloride has a pH less than 7 because

- A the ammonium ions donate protons to water molecules.
- B the chloride ions combine with hydrogen ions to form hydrochloric acid.
- C aqueous ammonium chloride is unstable and evolves ammonia gas leaving hydrochloric acid.
- D the ammonium ions combine with hydroxide ions to form ammonium hydroxide leaving an excess of hydrogen ions.

Section B

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

- 11 The extent of the manufacture of sulphuric acid was a major indicator of the wealth of a nation. Today the consumption of oil or ferrous metals shows the economic development of industrial nations. Sulphuric acid, however, remains a chemical that the developed world still needs.

(a) Explain the use of sulphuric acid in the agricultural industry.

[2]

(b) In the Contact process, sulphuric acid is manufactured from sulphur. Write three equations for the reactions occurring in this process.

[3]

(c) Sulphur dioxide is prevented from escaping to the atmosphere during the process. Explain the precautions taken against the emission of sulphur dioxide and why they are needed.

[2]

(d) Concentrated sulphuric acid reacts with copper metal.

(i) Write an equation for the reaction

_____ [1]

(ii) Using oxidation numbers, explain why the reaction can be regarded as a redox reaction.

 _____ [3]

(e) The strength of an acid is related to the value of the oxidation number of the central atom in the acid.

Explain, using this theory, whether sulphuric acid is stronger than thiosulphurous acid, $\text{H}_2\text{S}_2\text{O}_3$.

 _____ [2]

(f) A solution of sulphuric acid reacts with aqueous barium chloride.

(i) Write an ionic equation for the reaction including state symbols.

_____ [2]

(ii) Describe what would be observed.

 _____ [2]

- (iii) Calculate the mass, in milligrams, of barium sulphate produced if 19.0 cm³ of 0.01 M sulphuric acid is added to 50 cm³ of a barium chloride solution with a concentration of 0.16 g dm⁻³.

[4]

12 The invention of the pH scale is credited to the Danish biochemist Sørensen whilst working for Carlsberg on problems connected with the brewing of lager. Control of acidity was essential. Continually referring to the hydrogen ion concentration was tedious and he suggested the use of a pH scale as a more convenient measure of acidity.

(a) The acidity in lager is caused by weak acids. Explain the term **weak acid**.

_____ [2]

(b) When exposed to air, lagers and beers turn sour and the pH decreases. Suggest what causes this to happen.

_____ [2]

(c) A lager investigated by Sørensen had a hydrogen ion concentration of $5.10 \times 10^{-8} \text{ mol cm}^{-3}$. Calculate the pH of this lager.

_____ [2]

(d) pH values depend on the temperature at which they are measured because of the variation of the ionic product of water with temperature, as shown in the table below.

Temperature/K	$K_w/\text{mol}^2 \text{ dm}^{-6}$
298	1.0×10^{-14}
333	5.6×10^{-14}

(i) Write an equation for the ionic product of water.

_____ [1]

(ii) Deduce whether the dissociation of water is an exothermic or endothermic process. Explain your reasoning.

_____ [2]

(e) Lagers and beers are produced by the fermentation of sugars and starches.

(i) Name a monosaccharide sugar.

_____ [1]

(ii) Name the **two** types of polymer in starch.

_____ [1]

(f) The carbon dioxide produced in the brewing process may be collected by dissolving in water under pressure. The carbonic acid and the hydrogencarbonate ion produced are involved in an equilibrium reaction which acts as a buffer system.

(i) Using an equilibrium equation, explain the result of adding separately an acid and an alkali to this buffer system.

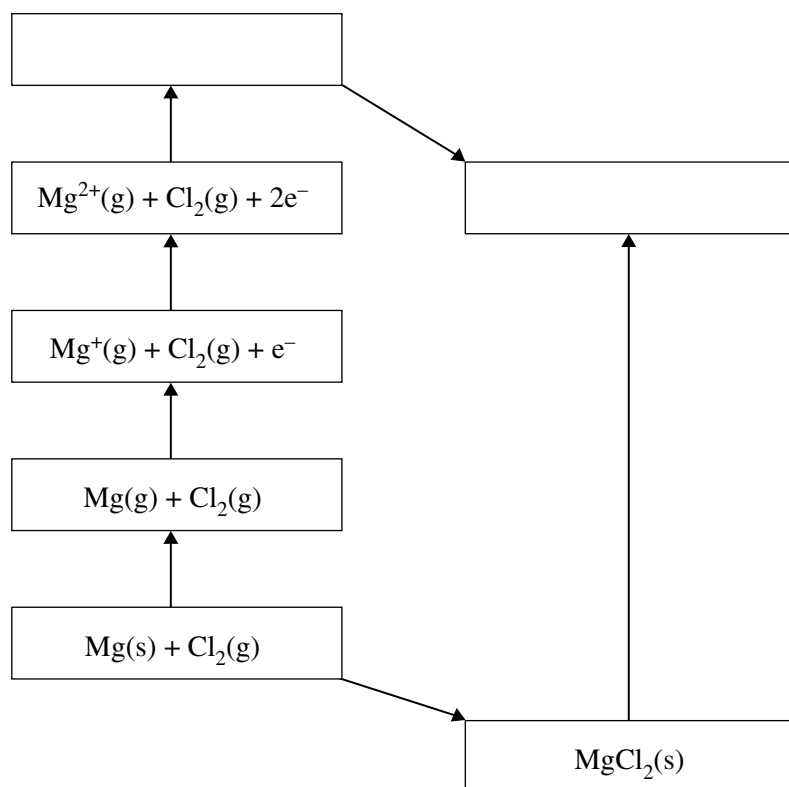
 _____ [2]

(ii) Calculate how many grams of sodium ethanoate must be added to 500 cm³ of 0.01 mol dm⁻³ ethanoic acid to produce a buffer solution of pH 5.8.

$$K_a(\text{CH}_3\text{COOH}) = 1.86 \times 10^{-5} \text{ mol dm}^{-3}$$

 _____ [4]

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



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

(ii) Using the data below, calculate the lattice enthalpy for magnesium chloride.

	kJ mol⁻¹
First ionisation energy of magnesium	+738
Second ionisation energy of magnesium	+1451
Enthalpy of atomisation of magnesium	+148
Enthalpy change of formation of magnesium chloride	−641
Enthalpy of atomisation of chlorine	+121
Electron affinity of chlorine	−348

_____ [2]

(iii) Explain, in terms of electrostatic forces and using magnesium chloride as an example, what is meant by the term **lattice enthalpy**.

 _____ [2]

(iv) The lattice enthalpies of the magnesium halides calculated using the Born–Haber cycle are shown below.

Magnesium halide	Theoretical lattice enthalpy
Magnesium fluoride	+2913
Magnesium bromide	+2097
Magnesium iodide	+1944

Suggest, using the enthalpy values in the Born–Haber cycle, why the lattice enthalpies decrease.

_____ [2]

(b) Magnesium chloride has ionic bonding as described in the Born–Haber cycle. Show the formation of magnesium chloride from magnesium and chlorine atoms using dot and cross diagrams.

[3]

(c) Magnesium iodide reacts with both sulphuric acid and phosphoric acid. Compare and contrast these reactions giving experimental observations and theoretical explanations. Equations are not required.

 _____ [5]

Quality of written communication [2]

14 Natural fats and oils are generally a mixture of various esters of glycerol containing more than one kind of fatty acid, which may be saturated or unsaturated. A table of some oils and fats is shown below.

Oil/fat	Percentage of total fatty acids by mass		
	saturated	monounsaturated	polyunsaturated
Coconut oil	93	6	1
Sunflower oil	11	19	70
Lard	44	46	10
Peanut oil	21	49	30

(a) (i) Explain why it is important to have a mixture of saturated and unsaturated oils/fats in a balanced diet.

_____ [2]

(ii) Suggest the meaning of the term **monounsaturated** fatty acid.

_____ [2]

(iii) Name an unsaturated fatty acid found in some natural fats and oils.

_____ [1]

(iv) Give the systematic name for glycerol, which reacts with fatty acids to form oils and fats.

_____ [2]

(b) A sample containing 1.20 g of oil, containing a *mixture* of unsaturated triglycerides is saponified by 3.30×10^{-3} mol potassium hydroxide. A second sample, also containing 1.20 g of the same oil, is found to react completely with 5.38×10^{-3} mol hydrogen in the presence of a catalyst.

(i) Calculate the number of moles of the triglycerides in the oil.

_____ [1]

(ii) Calculate the average relative molecular mass of the triglycerides in the oil.

_____ [1]

(iii) Calculate the average number of carbon–carbon double bonds per fatty acid molecule in the original triglycerides.

_____ [1]

(iv) Name the catalyst used in the hydrogenation.

_____ [1]

(v) Suggest how you could show that the hydrogenated glyceride contains no carbon–carbon double bonds.

 _____ [3]

THIS IS THE END OF THE QUESTION PAPER
