



Chemistry Assessment

Task 3 Term 2 2012

Theory

General Instructions

- Reading time – 2.5 minutes
- Working time – 50 minutes
- Write using black or blue pen
- Write your Student Number at the top of pages 6 and 7.
- Board-approved calculators may be used
- A data sheet and a periodic table are provided at the back of the paper.

Total Marks – 38

Part A – 7 marks

- Attempt Questions (1-7)
- Allow about 10 minutes for this part

Part B – 31 marks

- Attempt Questions (8-14)
- Allow about 40 minutes for this part

Part A: Multiple Choice: 7 marks
Attempt Questions (1-7)
Allow about 10 minutes for this part

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9
A B C D

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A B C D

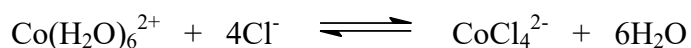
If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.

A B C D
correct
↑

Multiple Choice

▶ Mark your answers for the multiple choice questions on the multiple choice grid on page 6

1. Which of the following molecules is a halon ?
- (A) CHClF
 - (B) CBr₂F₂
 - (C) CFC₃
 - (D) C₂H₄Cl₂
2. Which pollutants form as a result of lightning strikes and bushfires?
- (A) NO_x and SO₃
 - (B) CO, CO₂ and C
 - (C) CO and NO_x
 - (D) SO₂ and CO₂
3. Purple-red crystals of cobalt chloride hexahydrate are dissolved in pure ethanol. The forward reaction is exothermic and the equilibrium is given by the following equation.

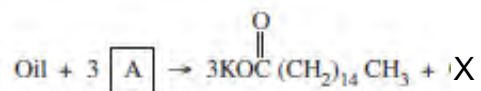


The CoCl_4^{2-} ion is blue and the $\text{Co}(\text{H}_2\text{O})_6^{2+}$ is pink-red.

Which of the following describes the equilibrium shift and the colour change when heat is added.

- (A) The equilibrium will shift left and the solution will turn blue.
- (B) The equilibrium will shift left and the solution will turn pink-red.
- (C) The equilibrium will shift right and the solution will turn blue.
- (D) The equilibrium will shift right and the solution will turn pink-red.

4. Which response correctly identifies A and X in the following equation?



	A	X
(A)	NaOH	ethanol
(B)	NaOH	glycerol
(C)	KOH	ethanol
(D)	KOH	glycerol

5. In the electrolysis of aqueous sodium chloride, the products at the electrodes can be identified using a variety of tests.

Which of the following test shows the correct result?

- (A) Pop test at the anode.
- (B) Blue litmus turns red at the cathode
- (C) Pop test at the cathode.
- (D) Red litmus turns blue at the anode
6. A student was given a water-soluble solid sample to analyse. The student tested an aqueous solution of the sample and obtained the following result:

<i>Test Reagent</i>	<i>Result</i>
sodium chloride solution	colourless solution
magnesium chloride solution	white precipitate
phenolphthalein	pink

Which of the following is the likely solid sample?

- (A) Magnesium hydroxide
- (B) Ammonium chloride
- (C) Lead (II) nitrate
- (D) Sodium hydroxide

7. Water quality can be determined using several indices. Match the water quality indicator with the technique for its determination and the expected result for water with a better quality.

	(A)	(B)	(C)	(D)
<i>Concentration of ions (Pb, Hg, Cd)</i>	AAS	AAS	Acid-base titration	Acid-base titration
	good when low	good when high	good when high	good when low
<i>Biochemical oxygen demand</i>	Oxygen electrode	Oxygen electrode	EDTA Titration	EDTA Titration
	good when low	good when high	good when low	good when high
<i>Dissolved oxygen</i>	Oxygen electrode	Oxygen electrode	EDTA Titration	EDTA Titration
	good when high	good when high	good when low	good when high
<i>Total dissolved solids</i>	Gravimetric analysis	Gravimetric analysis	Conductivity meter	Conductivity meter
	good when low	good when high	good when low	good when high

Student Number

Part A . Answer grid for multiple choice questions

- | | | | | |
|----|-----|-----|-----|-----|
| 1. | A O | B O | C O | D O |
| 2. | A O | B O | C O | D O |
| 3. | A O | B O | C O | D O |
| 4. | A O | B O | C O | D O |
| 5. | A O | B O | C O | D O |
| 6. | A O | B O | C O | D O |
| 7. | A O | B O | C O | D O |

Total:/7

Part B**Attempt Questions 8 - 14****Allow about 40 minutes for this part**

▶ *Show all relevant working in questions involving calculations.*

Question 8 (6 marks)

During the school holidays, a student was chosen to plan and perform an experiment, as part of a government team to monitor the level of chromium ion of a creek near her school. It is suspected that the creek water is increasingly being polluted with chromium ion from treated sewage from a nearby plant as this ion and other heavy metal ions are not degraded in the normal sewage treatment processes.

Read the following steps that the student followed.

The student:

1. Collected a single water sample in the exact middle of the creek, after thoroughly rinsing the screw cap jar container with creek water,
2. Prepared a range of standard solutions of chromium ion. The range of concentration of standard solutions prepared included the approximate concentration of chromium ion which was determined previously by the government team.
4. Tested each standard solution concentration several times with the AAS.
5. Calculated the average AAS result for each concentration of standard solution.
6. Tested the sample of creek water several times with AAS.
7. Calculated the average AAS result for the creek water.
8. Constructed a calibration curve from which the concentration of chromium ion in the creek water was read off.
9. Reported the concentration of chromium ion in the creek water as read off from the calibration curve.

Question 8 continues next page

Question 9 (4 marks)

A commercial fertilizer used in pineapple production has a typical composition of about 11% S and 21% nitrogen, with some of the nitrogen present as urea and the sulfur as ammonium sulfate.

- (a) What exact volume of 0.025 mol L^{-1} barium chloride will be required to precipitate the sulfate in a 5.0 g sample of this commercial fertilizer?

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- (b) What experimental limitation contributes to the error in this determination?

1

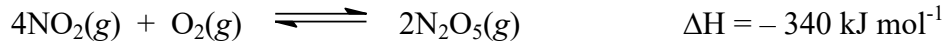
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Question 10 (5 marks)

The formation of dinitrogen pentoxide from nitrogen dioxide is an equilibrium reaction, as shown below.

At 175°C, $K = 8.00$



(a) Write an equilibrium expression for the reaction.

1

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(b) A reaction vessel containing a mixture of NO_2 , O_2 and N_2O_5 was sampled at 175°C, and the following concentrations measured.

<i>Species</i>	<i>Concentration (molL⁻¹)</i>
NO_2	1.55
O_2	0.75
N_2O_5	1.25

Determine whether the system is at equilibrium. Include a calculation in your answer.

2

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(c) Use Le Chatelier's principle to explain the shift in equilibrium position when the temperature is increased to 250°C.

2

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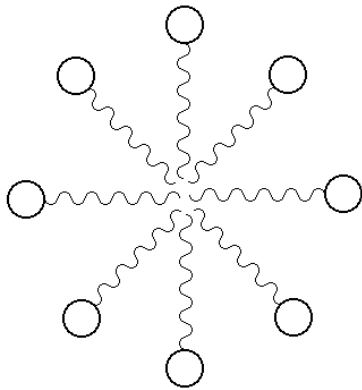
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Question 11 (6 marks)

A micelle, represented by the diagram, can form when soaps are used to clean up oily deposits.



(a) Give the name of a soap that could form this micelle. 1

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(b) Use labels on the diagram to show the parts of the components of the micelle that allow soaps to clean up oily deposits. 2

(c) Explain the cleaning action of soaps. 3

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Question 12 (2 marks)

Identify the products at the anode and the cathode during the electrolysis of molten sodium chloride. 2

Anode

Cathode



Student Number	
Mark /	

Chemistry Assessment

Task 3 Term 2 2012

Theory

ANSWERS

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Outcomes: H9

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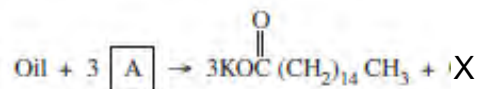


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Outcome(s):H13,H14

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<i>Total dissolved solids</i>	Gravimetric analysis	Gravimetric analysis	Conductivity meter	Conductivity meter
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Outcome(s):H13,H14

Student Number

Part A . Answer grid for multiple choice questions

- | | | | | |
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6. Tested the same sample of creek water several times with AAS. Calculated the average of the AAS result for the creek water.
7. Constructed a calibration curve from which the concentration of chromium ion in the creek water was read off.
8. Reported the concentration of chromium ion in the creek water as read off from the calibration curve.

Evaluate the validity and the reliability of the above determination. (6 marks)

Outcome(s):H11, H12, H13,H14

Sample Answer:

The determination is not valid (JV) because only one site in the creek was sampled. There could be differences in the level of chromium in various parts of the creek since it is a dynamic system and poor mixing of the water may be present.(JV1)

At the same time, the aim of the experiment was to monitor the chromium concentration but only one determination was done.(JV2)

The determination is not reliable (JR) because although several replicates of the same samples were passed through the AAS, the actual experiment was only done once with several portion of the same sample passed through the AAS. (JR1). What was obtained here is the reliability of the AAS instrumentation and not the reliability of the determination.(JR2)

Marking Guidelines

<i>Criteria</i>	<i>Mark(s)</i>
<i>Evaluation of the reliability (1) Two reasons for the reliability judgement (2) Evaluation of validity(1) Two reasons for judgement of validity(2)</i>	<i>6</i>
<i>Evaluation of the reliability (1) One correct reason for the reliability judgement (1) Evaluation of validity(1) Two reasons for judgement of validity(2)</i>	<i>5</i>
<i>Evaluation of the reliability (1) One reason for the reliability judgement (1) Evaluation of validity(1) One reasons for judgement of validity(1)</i>	<i>4</i>
<i>Evaluation of the reliability (1) No reason given for reliability or no reason given for validity judgement Evaluation of validity</i>	<i>3</i>
<i>Evaluation of the reliability (1) No reason given for reliability and no reason given for validity judgement Evaluation of validity (1)</i>	<i>2</i>
<i>Correct evaluation of validity and reliability, no reason given</i>	<i>1</i>

Question 9 (4 marks)

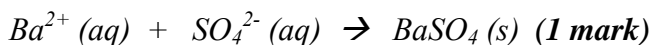
A commercial fertilizer used in pineapple production has a typical composition of about 11% S and 21% nitrogen, with some of the nitrogen present as urea and the sulfur as ammonium sulfate.

- (a) What exact volume of 0.025 mol L^{-1} barium chloride will be required to determine the sulfur content as sulfate of a 5.0 g sample of this commercial fertilizer? (3 marks)

Sample answer

$$\text{moles } \text{SO}_4^{2-} = \text{moles } \text{S} = \frac{\text{mass S}}{\text{atomic mass S}} = \frac{0.11 \times 5.0}{32.07} = 0.0171499 \text{ moles (1 mark)}$$

The reaction is:



$$\text{moles } \text{Ba}^{2+} = C \times V = \text{moles } \text{SO}_4^{2-} = 0.0171499$$

$$V = \frac{\text{moles } \text{Ba}^{2+}}{C} = \frac{0.0171499}{0.025} = 0.68599 \approx 686 \text{ mL (1 mark)}$$

- (b) What experimental limitation contributes to the error in this determination? (1 mark)

Outcomes:H13,H11, H10

Sample answer:

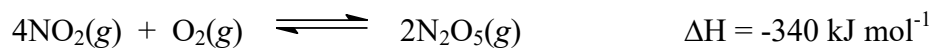
Any of the following:

- ▶ *difficulty in filtering the fine precipitate of BaSO_4*
- ▶ *uncertainty introduced with the use of agar solution to coagulate the precipitate*
- ▶ *difficulty in completely and accurately drying the BaSO_4 precipitate*

<i>Criterion</i>	<i>Mark</i>
<i>any of the possible source of error</i>	<i>1</i>

Question 10 (5 marks)

The formation of dinitrogen pentoxide from nitrogen dioxide is an equilibrium reaction, as shown below.
At 175°C, $K = 8.00$



- (a) Write an equilibrium expression for the reaction. (1 mark)

$$K = \frac{[\text{N}_2\text{O}_5]^2}{[\text{NO}_2]^4 [\text{O}_2]} \quad 1 \text{ mark}$$

- (b) A reaction vessel containing a mixture of NO_2 , O_2 and N_2O_5 was sampled at 175°C, and the following concentrations measured.

Species	Concentration (molL^{-1})
NO_2	1.55
O_2	0.75
N_2O_5	1.25

Determine whether the system is at equilibrium. Include a calculation in your answer.(2 marks)

$$\begin{aligned} Q &= \frac{[\text{N}_2\text{O}_5]^2}{[\text{NO}_2]^4 [\text{O}_2]} \\ &= 1.25^2 / (1.55^4 \times 0.75) \\ &= 0.36 \end{aligned}$$

$Q < K$, so the system is not at equilibrium

Marking Criteria	Mark
Correct calculation and identifies system not at equilibrium as $Q < K$	2
Correctly calculates Q or correct calculation from incorrect K expression	1

Outcomes: H10

- (c) Use Le Chatelier's principle to explain the shift in equilibrium position when the temperature is increased to 250°C. (2 marks)

Sample answer

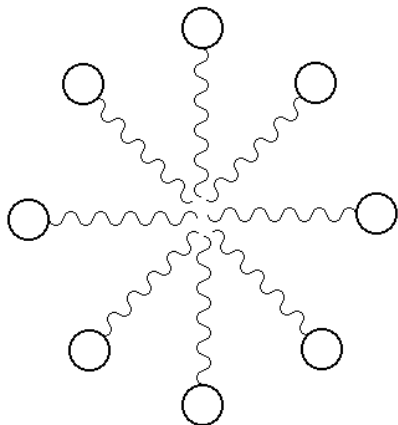
When the temperature is increased, equilibrium will shift to oppose the change, i.e., to remove added heat. The reaction that uses heat is the endothermic reaction ie the reverse reaction. Equilibrium will shift to the left.

<i>Marking Criteria</i>	<i>Mark</i>
Explains using Le Chatelier's principle the correct shift for the temperature change.	2
Identifies forward reaction as exothermic or reverse reaction as endothermic OR Explains using Le Chatelier's principle but fails to identify correct shift.	1

Outcomes:H7,H8

Question 11 (6 marks)

A micelle, represented by the diagram, can form when soaps are used to clean up oily deposits.

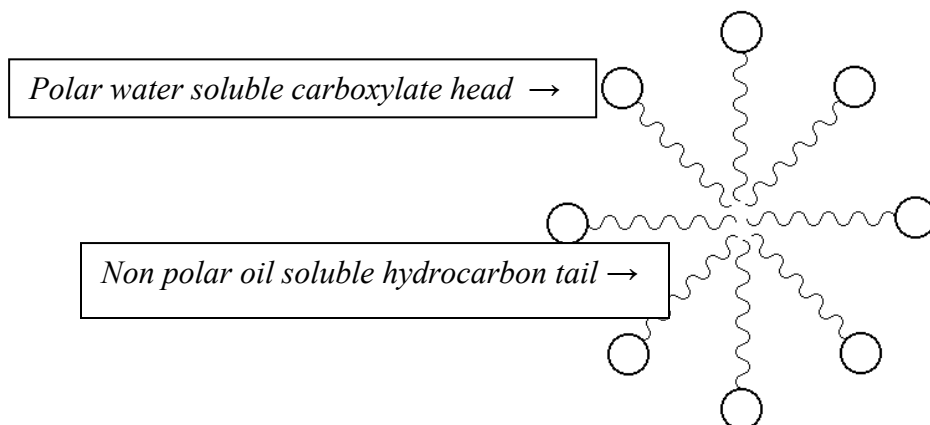


- (a) Give the name of a soap that could form this micelle. (1 mark)

Sample answer, sodium stearate (1 mark)

Outcomes:H9

- (b) Use labels on the diagram to show the parts of the components of the micelle that allow soaps to clean up oily deposits. (2 marks)



Marking Criteria	Mark
Detailed labels of both parts of the soap anion	2
Detailed label of one part of the soap anion OR Identification of the two parts of the anion	1

Outcomes:H9

- (c) Explain the cleaning action of soaps. (3 marks)

Sample answer

The non-polar hydrocarbon tail forms dispersion forces with non-polar oil molecules and the tails embed themselves in the oil droplet. The polar water soluble carboxylate head of the anion can form H-bonds with polar water molecules and stay on the surface of the oil droplet. Agitation causes the oil to lift off the surface and form a micelle. Because of the polar heads on the outside of the micelle, the droplets don't combine but stay dispersed forming an emulsion. The oil has been removed from the surface, leaving it clean

Marking Criteria	Mark
Describes the cleaning action of soaps, outlining the functions of both ends of the anion and the formation of an emulsion.	3
Outlines the cleaning action of soaps, identifying the function of either end of the soap anion	2
Identifies one aspect of the cleaning action of soaps.	1

Outcomes:H9

Question 12 (2 marks)

Identify the products at the anode and the cathode during the electrolysis of molten sodium chloride.

Anode *chlorine gas*

Cathode *liquid sodium*

<i>Marking Criteria</i>	<i>Mark</i>
Correct products and states	2
Correct products OR One correct product and state OR Correct products and states at incorrect electrodes	1

Outcomes:H7**Question 13** (3 marks)

Identify three factors that affect the concentration of a range of ions in solution in natural bodies of water eg. rivers and oceans. (3 marks)

Outcome(s): H8

Sample Answer : Any 3 of the following : heavy rain /flooding, pH of rain water, leaching of rocks and soils, water temperature, differential solubility of rocks and soil minerals, rate of evaporation, agriculture, aquatic organisms, industrial effluent. Any other correct answer not in this list will be considered.

Marking Criteria

Criteria	Mark
Identify 3 correct	3
Identify 2 correct	2
Identify 1 correct	1

Question 14 (5 marks)

Identify two alternative chemicals used to replace CFCs and evaluate the effectiveness of their use as a replacement for CFCs. (5 marks)

Outcome(s): H1 , H5*Sample Answer :*

1st replacement – HCFC hydrochlorofluorocarbon; a temporary substitute until a better can be found; contain C-H bonds which are susceptible to attack by reactive radicals/atoms in the troposphere and decompose to a significant extent here thus not much reach the stratosphere thus ozone destroying capacity is less than CFCs. If they reach the stratosphere, they can still destroy ozone because they contain chlorine.

2nd replacement – HFCs hydrofluorocarbons contain C-H bond so decompose in the troposphere ; no C-Cl bonds so do not form Cl atoms in stratosphere thus ozone destroying capacity is zero BUT more expensive than CFCs and less efficient but protects stratosphere.

Marking Criteria

<i>Criteria</i>	<i>Mark</i>
Identify 2 replacements and evaluates both	5
Identifies 2 replacements and discusses both or evaluates one	4
Identifies 2 and discusses 2 in detail (no evaluation	3
Identifies 2(1) and discusses 1 in detail	2
Identifies 2 replacements	1

End of Theory Test