Student Number	
Mark /34	

Chemistry Assessment

Task 3 Term 2 2008

Theory

Chemical Monitoring
Industrial Chemistry

General Instructions
for Theory and Research

- Reading time – 5 minutes
- Working time – 65 minutes
- Write using black or blue pen
- Write your Student Number at the top of this page and on the response sheets on pages 5, 7, 9
- Board-approved calculators may be used

A data sheet and a periodic table are provided at the back of the paper.

Total Marks – 34

Part A – 6 marks– pages .3 – 4

- Attempt Questions .1-6
- Allow about **5** minutes for this part

Part B – 28 marks – pages 6 - 10

- Attempt Questions 7-12
- Allow about 30 minutes for this part

Part A: Multiple Choice: 6 marks
Attempt Questions 1-6
Allow about 5 minutes for this part

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

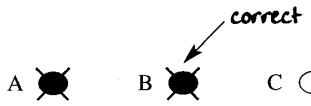
Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

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.



▸ **Mark your answers for Questions .1-6 in the multiple choice grid on page .5**

1. Which species does not contain a coordinate covalent bond?

   (A) Ozone
   (B) water
   (C) hydronium ion
   (D) ammonium ion

2. Which species is the most reactive?

   (A) ozone
   (B) oxygen
   (C) the oxide ion
   (D) the oxygen free radical

3. Which pair gives a correct name for a CFC and a halon?

	CFC	Halon
(A)	1,2-dichloro-1,1,1-trifluoroethane	1-bromo-2,2-difluoroethane
(B)	Tetrafluoromethane	1,1-dibromo-2,2-dichloromethane
(C)	1,1,1-chloro-2,2,2-fluoroethane	1,1,1-bromo-2,2,2-fluoroethane
(D)	Dichlorodifluoromethane	Dibromodifluoromethane

4. Which of the following is used as a catalyst when sulfuric acid is produced in the contact process?

   (A) Fe_3O_4

   (B) V_2O_5

   (C) Pt

   (D) MnO_2

5. In which decade did Fritz Haber develop the industrial process to produce ammonia?

(A) 1890s

(B) 1900s

(C) 1920s

(D) 1940s

6. Cobalt chloride hexahydrate ($Co(H_2O)_6Cl_2$ is dissolved in pure ethanol. The solution is a deep blue colour. The equilibrium is

$$Co(H_2O)_6^{2+}\ (eth) + 4\ Cl^-\ (eth) \rightleftharpoons CoCl_4^{2-}\ (eth) + 6\ H_2O\ (eth)$$

The $CoCl_4^{2-}$ ion is deep blue in colour and the $Co(H_2O)_6^{2+}$ is pink-red. in colour in pure ethanol Which of the following describes and explains the colour change when a small amount of water is added?

(A) The solution will go colourless because the water will dilute it.

(B) The colour will turn a deeper blue as equilibrium shifts right.

(C) The solution stays the same colour as water has no effect on the position of equilibrium.

(D) The solution will becomes less blue and more pink-red as the equilibrium shifts left.

Student Number:.....

Part A . Answer grid for multiple choice questions **Total ...../6**

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

Part B 28 marks
Attempt Questions 7 – 12
Allow about 30 minutes for this part
Show all relevant working in questions involving calculations.

Question 7 (5 marks) **MARKS**

Some students set out to measure the sulfate content of a sample of lawn fertilizer.
They:

- ◊ weighed 2.00g of the fertilizer
- ◊ dissolved the fertilizer in water
- ◊ added excess barium chloride solution.
- ◊ filtered, washed and then air-dried the precipitate.

The manufacturer of the fertilizer claims that it contains 60% sulfate by mass.

(a) If this is correct, what is the maximum mass of barium sulfate the students could obtain? Include a balanced net ionic equation. **3**

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(b) (i)What is the most likely reason in the students' procedure for obtaining a mass of barium sulfate that is higher than this amount? **1**

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(ii) How could the students modify their procedure to solve this problem? **1**

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Student Number .....

MARKS

Question 8 (5 marks)

CFCs can cause the removal of ozone from the atmosphere.

(a) Write balanced equations to show how reactions involving a CFC and ozone can cause the removal of ozone from the atmosphere. **3**

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(b) Outline reasons why the reactions occur in the stratosphere? **2**

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MARKS

Question 9 (5 marks)

(a) Identify ONE use of sulfuric acid in industry. **1**

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(b) Summarise the steps involved in the Frasch Process and identify a property of sulfur that allows it to be extracted from mineral deposits in this way. **4**

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Question 10 (3 marks)

During your practical work you performed a first hand investigation to qualilitatively analyse an equilibrium reaction.

(a) Give an equation for the reaction in your investigation. **1**

……*eliminated*.……

(b) Based on one set of observations from your first hand investigation, provide an explanation that this is an equilibrium reaction **2**

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Student Number .....

MARKS

Question 11 (5 marks)

Consider the following information.

$$N_2(g) + O_2(g) \rightleftharpoons 2\,NO(g)$$

Temperature ^0C	***K***
427	5×10^{-13}
827	4×10^{-8}
1227	1×10^{-3}

(a) Write an expression for the equilibrium constant for this reaction. **1**

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(b) At 427^0C, a 1.00 L vessel contained 0.13 $molL^{-1}$ N_2 and 0.27 $molL^{-1}$ O_2.
Calculate the concentration of NO. Show all working. **2**

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(c) Identify the forward reaction as exothermic or endothermic and explain in terms of Le Chatelier's Principle. **2**

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MARKS

Question 12 (5 marks)

The Haber Process is an example of an industrial process in which reactant conditions are constantly monitored.

Identify the industrial conditions used to produce ammonia and explain the temperatures and pressures. **5**

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End of Test

Student Number	
Mark /34	

Chemistry Assessment

Task 3 Term 2 2008

Theory

Chemical Monitoring
Industrial Chemistry

ANSWERS

General Instructions
for Theory and Research

- Reading time – 5 minutes
- Working time – .65 minutes
- Write using black or blue pen
- Write your Student Number at the top of this page and on the response sheets on pages and
- Board-approved calculators may be used

A data sheet and a periodic table are provided at the back of the paper.

Total Marks – 34

Part A – 6 marks– pages .....

- Attempt Questions .1-6
- Allow about **5** minutes for this part

Part B – 28 marks – pages .....

- Attempt Questions
- Allow about **.....** minutes for this part

Part A: Multiple Choice: 6 marks
Attempt Questions 1-6
Allow about 5 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 ○

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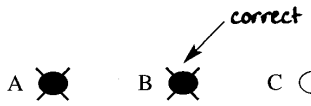

▸ **Mark your answers for Questions .1-6 in the multiple choice grid on page .....**

1. Which species does not contain a coordinate covalent bond?

(A) Ozone
(B) water
(C) hydronium ion
(D) ammonium ion

Outcome :H13

2. Which species is the most reactive?

(A) ozone
(B) oxygen
(C) the oxide ion
(D) the oxygen free radical

Outcome :H6

3. Which pair gives a correct name for a CFC and a halon?

	CFC	Halon
(A)	1,2-dichloro-1,1,1-trifluoroethane	1-bromo-2,2-difluoroethane
(B)	Tetrafluoromethane	1,1-dibromo-2,2-dichloromethane
(C)	1,1,1-chloro-2,2,2-fluoroethane	1,1,1-bromo-2,2,2-fluoroethane
(D)	**Dichlorodifluoromethane**	**Dibromodifluoromethane**

Outcome: H9, H13

4. Which of the following is used as a catalyst when sulfuric acid is produced in the contact process?

(A) Fe_3O_4

(B) V_2O_5

(C) Pt

(D) MnO_2

5. In which decade did Fritz Haber develop the industrial process to produce ammonia?

(A) 1890s

(B) 1900s

(C) 1920s

(D) 1940s

6. Cobalt chloride hexahydrate ($Co(H_2O)_6Cl_2$ is dissolved in pure ethanol. The solution is a deep blue colour. The equilibrium is

$$Co(H_2O)_6^{2+}\ (eth) + 4\ Cl^-\ (eth) \rightleftharpoons CoCl_4^{2-}\ (eth) + 6\ H_2O\ (eth)$$

The $CoCl_4^{2-}$ ion is deep blue and the $Co(H_2O)_6^{2+}$ is pink-red. in pure ethanol Which of the following describes and explains the colour change when a small amount of water is added?

(A) The solution will go colourless because the water will dilute it.

(B) The colour will turn a deeper blue as equilibrium shifts right.

(C) The solution stays the same colour as water has no effect on the position of equilibrium.

(D) The solution will becomes less blue and more pink-red as the equilibrium shifts left.

Student Number:.....

Part A . Answer grid for multiple choice questions **Total .....**

1.	A O	B •	C O	D O
2.	A O	B O	C O	D •
3.	A O	B O	C O	D •
4.	A O	B •	C O	D O
5.	A O	B •	C O	D O
6.	A O	B O	C O	D •

Student Number .....

Part B 28 marks
Attempt Questions 7 – 12
Allow about .25 minutes for this part
Show all relevant working in questions involving calculations.

Question 7 (5 marks) **MARKS**

Some students set out to measure the sulfate content of a sample of lawn fertilizer.
They:

- ◊ weighed 2.00g of the fertilizer
- ◊ dissolved the precipitate in water
- ◊ added excess barium chloride solution.
- ◊ filtered, washed and then air-dried the precipitate.

The manufacturer of the fertilizer claims that it contains 60% sulfate by mass.

(a) If this is correct, what is the maximum mass of barium sulfate the students could obtain? Include a balanced net ionic equation. **3**

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(b) (i)What is the most likely reason in the students' procedure for obtaining a mass of barium sulfate that is higher than this amount? **1**

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(ii) How could the students modify their procedure to solve this problem? **1**

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Outcomes H10,H11

Sample Answer

(a) $Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow BaSO4_{(s)}$

60% of the fertilizer = 60/100 X 2.00 =1.2g

No. of moles of sulfate in 1.2g = 1.2/96 = 0.0125

No. of moles of $BaSO_4$ = 0.0125
Mass of $BaSO_4$ = 0.0125 X (137.3 + 96)
= 2.92g

(b)(i) the barium sulfate may not be completely dry
(ii) dry the barium sulfate sample in the oven until constant mass.

Marking Guidelines

Criteria	***Marks***
• Balanced net ionic equation • Correctly calculates the number of moles of sulfate • Correctly calculates the mass of barium sulfate • Correct reason for the mass being higher • Correct solution for previous answer	5
4 of above	4
3 of above	3
2 of above	2
1 of above	1

Question 8 (5 marks)

CFCs can cause the removal of ozone from the atmosphere.

(a) Write balanced equations to show how reactions involving a CFC and ozone can cause the removal of ozone from the atmosphere. **3**

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MARKS

(b) Outline reasons why the reactions occur in the stratosphere? **2**

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Outcomes H4, H6, H13

Sample Answer:

(a)

$$CCl_2F_{2(g)} \xrightarrow{U.V} CClF_{2(g)} + Cl_{(g)}$$

$$Cl_{(g)} + O_{3(g)} \rightarrow ClO_{(g)} + O_{2(g)}$$

$$ClO_{(g)} + O_{(g)} \rightarrow Cl_{(g)} + O_{2(g)}$$

(b) Highest concentration of ozone in this region of the atmosphere and ultra violet light available to break the chlorine atom off the CFC.

Criteria	***Marks***
• 3 relevant equations • States two reasons for reactions occurring in stratosphere	5
• 3 relevant equations • States one reason or 2 correct equations and two reasons	4
3 of above	3
2 of above	2
1 of above	1

MARKS

Question 9 (5 marks)

(a) Identify ONE use of sulfuric acid in industry. **1**

……..

Answer:

e.g. production of fertilizers, pickling steel, manufacturing explosives etc

(b) Summarise the steps involved in the Frasch Process and identify a property of sulfur that allows it to be extracted from mineral deposits in this way. **4**

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Sample answer

A narrow bore hole is dug down into the sulfur bed. A series of concentric pipes are sunk down into the hole. Pressurised superheated water is injected into the hole to melt the sulfur and form an emulsion with the water. Compressed air is also injected and the sulfur emulsion is forced up the third tube to the surface where it is collected in vats. The water separates from the sulfur on cooling.

A property that allows sulfur to be extracted in this way is its low melting point.

Marking criteria	Marks
• Provides a complete description of the Frasch process (underground deposits of elemental sulfur, melting and mobilizing it with superheated water, piping it to the surface) AND identifies a property of sulfur	4
• Identifies a property of sulfur and describes two features of the Frasch process. • Describes three features of the Frasch process.	3

• Identifies a property of sulfur and describes one feature of the Frasch process. • Describes two features of the Frasch process.	2
• Identifies a property of sulfur OR • Describes one feature of the Frasch process	1

Outcomes H8

Question 10 (2 marks)

During your practical work you performed a first hand investigation to qualilitatively analyse an equilibrium reaction.

(a) Give an equation for the reaction in your investigation.

…… …… **1**

$Fe^{3+} + SCN^- \leftrightarrows FeSCN^{2+}$

(b) Based on one set of observations from your first hand investigation, provide an explanation that this is an equilibrium reaction **2**

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Sample answer

When $FeCl_3$ was added the solution turned a deeper blood red colour as the equilibrium shifted to the right to use up the extra Fe^{3+} ions.

Marking criteria	Marks
• Provides ONE set of observations for this first hand investigation AND provides an explanation for the observation.	2
• Provides ONE set of observations for this first hand investigation OR • Provides an explanation without a description.	1

Outcomes **H8, H14**

Question 11 (5 marks)

Consider the following information.

$$N_2\,(g) + O_2(g) \leftrightarrows 2NO(g)$$

Temperature ^0C	K
427	5×10^{-13}
827	4×10^{-8}
1227	1×10^{-3}

(a) Write an expression for the equilibrium constant for this reaction. **1**

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Answer:

$$K = \frac{[NO]^2}{[N_2][O_2]}$$

MARKS

(b) At 427^0C, a 1.00L vessel contained 0.13 $molL^{-1}$ N_2 and 0.27 $molL^{-1}$ O_2.
Calculate the concentration of NO. Show all working. **2**

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Sample Answer

$$K = \frac{[NO]^2}{[N_2][O_2]}$$

$K \times [N_2] \times [O_2] = [NO]^2$

$5 \times 10^{-13} \times 0.13 \times 0.27 = [NO]^2$

$[NO] = 1.32 \times 10^{-7}$

Marking criteria	Marks
• Calculates the [NO] with relevant working	2
• Correctly substitutes numbers into K expression from (a), forgets to find the square root. • Incorrectly substitutes numbers then calculates K	1

(c) Identify the forward reaction as exothermic or endothermic and explain in terms of Le Chatelier's Principle. **2**

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Sample Answer

An increase in temperature will favour the reaction that uses heat, ie the endothermic reaction. As temperature increases, K increases, so [NO] has increased. The forward reaction has been favoured and equilibrium has shifted to the right. The forward reaction is endothermic.

Marking criteria	Marks
• Identifies the forward reaction as endothermic and links Le Chateliers explanation to increasing K	2
• Links endothermic reaction to increasing K • Explains endothermic shift without linking to K	1

Outcomes **H7, H8, H10, H12, H13, H14**

Question 12 (5 marks)

The Haber Process is an example of an industrial process in which reactant conditions are constantly monitored.

Identify the industrial conditions used to produce ammonia and explain the temperatures and pressures. **5**

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Sample Answer

Conditions *:* *Catalyst* Fe_3O_4, *Temperature* 400 - 550 ^{0}C, *Pressure* 15 - 35 MPa.

The Haber process is exothermic and will shift right in low temperatures, however, equilibrium will be reached very slowly. Moderate temperatures will allow the reaction to proceed at faster rate and equilibrium will be reached sooner.

The ratio of gases in the reaction is 4:2. An increase in pressure will favour the reaction that exerts less pressure ie the forward reaction, so equilibrium will shift right and make more ammonia.

Marking criteria	Marks
• Explains in detail the pressure and temperatures and identifies the conditions used.	4-5
• Identifies the three conditions AND outlines two conditions • Identifies the three conditions AND explains one condition	3
• Identifies the three conditions AND outlines one condition • Explains one condition • Outlines two conditions	2
• Identifies the three conditions • Outlines one condition	1

Outcomes H1, H2, H3, H4, H7, H8, H10

End of Test