



Student Name:

Class: Austin/Cooper

2018

MODULE 5 TOPIC TEST

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 40 mins
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Use the Data Sheet and Periodic Table provided
- Use the Multiple-Choice Answer Sheet provided
- Write your name at the top of this page and on the Multiple-Choice Answer Sheet

Total marks – 35

This paper has two parts, Part A and Part B

Part A – 5 marks

- Attempt Questions 1-5
- Allow about 5 minutes for this part

Part B – 30 marks

- Attempt Questions 6 - 12
- Allow about 35 minutes for this part

This paper consists of 10 pages.

Attempt Questions 1- 5

Use the multiple-choice answer sheet provided for Questions 1-5.

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

 A  B  C  D 

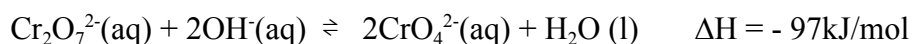
A  B  C  D 

A  B  C  D 

Questions 2 and 3 relate to the following system:

Potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) is an orange crystalline solid while potassium chromate (K_2CrO_4) is a yellow crystalline solid. In both cases it is the anions that are coloured.

In aqueous solutions an equilibrium exists between these anions:



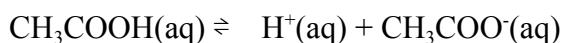
2 Explain the shift in equilibrium for the above reaction when sodium hydroxide is added

- (A) The system shifts right to use up the excess sodium hydroxide and the reaction appears darker orange.
- (B) The system shifts right to use up the excess sodium hydroxide and the reaction appears more yellow.
- (C) The system shifts left to use up the excess sodium hydroxide and the reaction appears darker orange.
- (D) The system shifts left to use up the excess sodium hydroxide and the reaction appears more yellow

3 Explain the shift in equilibrium for the above reaction when the reaction is heated.

- (A) The system shifts right to favour the endothermic reaction.
- (B) The system shifts right to favour the exothermic reaction.
- (C) The system shifts left to favour the endothermic reaction.
- (D) The system shifts left to favour the exothermic reaction.

4 Acetic acid exists in aqueous equilibrium.



Which of the following will occur if dilute hydrochloric acid is added?

- (A) The equilibrium constant will get larger.
- (B) The equilibrium constant will get smaller.
- (C) The acetate ion concentration will decrease.
- (D) The acetate ion concentration will increase

5 When lead nitrate and sodium sulfate are mixed the result would be:

- (A) A precipitate of sodium nitrate.
- (B) A precipitate of lead sulfate.
- (C) A precipitate of lead nitrate.
- (D) No precipitate would form.

2018 END OF MODULE 5 ASSESSMENT TASK

Part B – 30 marks

Attempt Questions 6 -12

Allow about 35 minutes for this part

Answer the questions in the spaces provided. Show all relevant working in questions involving calculations.

Question 6 (2 marks)

Marks

- (a) Identify two driving forces of a chemical reactions

1

.....

.....

- (b) What is the value of ΔG° for a reaction at equilibrium?

1

.....

Question 7 (7 marks)**Mark
s**

Nitrogen monoxide (NO) is a colourless gas. It reacts with oxygen to form nitrogen dioxide (NO₂), a brown gas.

- (a) Write a balanced equation to represent this equilibrium reaction (include states) **1**

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- (b) Explain how increasing the volume of the reaction flask will affect the position of equilibrium. **3**

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- (c) Describe an experiment you could carry out to determine if the above reaction is endothermic or exothermic. Describe the observations you would expect. **3**

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Question 8 (1 marks)**Mark
s
1**

Write an equilibrium expression for the reaction



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Question 9 (4 marks)**Mark
s
4**

Hydrogen sulfide can be produced by heating sulfur and hydrogen according to the equation:



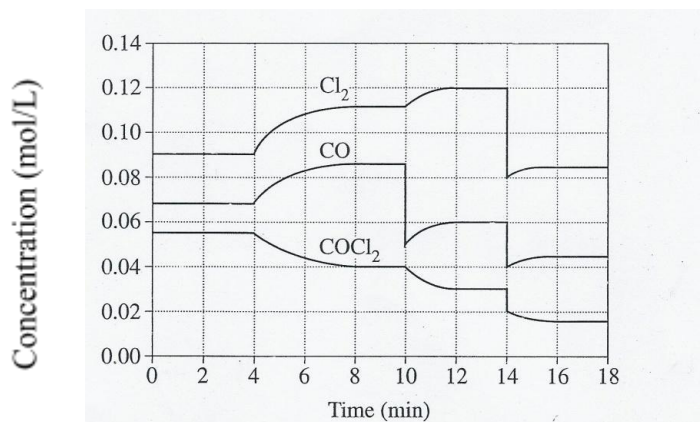
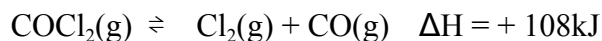
3 moles of H_2 and 2 moles of S_2 were placed in a 2L container. At equilibrium 1.45 mol of H_2S was present

Calculate the equilibrium constant for this reaction.

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Question 10 (6 marks)**Marks**

The graph below shows the variation in concentration of reactant and products as a function of time for the following system.



- (a) Identify two of the time intervals when the reaction is at equilibrium. 1

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- (b) What happened to the system at 4 minutes? Explain your choice using evidence from the graph. 3

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Question 10 continued**Marks**

- (c) What happened to the system at 10 minutes? Explain your choice using evidence from the graph.

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Question 11 (4 marks)**Marks**

- (a) Write an equation to show the dissociation of potassium chloride when it is added to water.

1

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- (b) Explain, at a particle level, the dissolution of potassium chloride in water making reference to the type bonds and/or forces present before and after dissolution.

3

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Question 12 (6 marks)**Marks**

Barium sulfate (BaSO_4) is considered insoluble in water.

- (a) Calculate the concentration of sulfate ions present at 25°C . Hint: Refer to the data sheet for the value of K_{sp} **1**

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- (b) Predict whether a precipitate will form when 0.050g of barium sulfate is added to 500mL of water at 25°C . **3**

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- (c) Barium sulfate is dissolved in water and then in a solution of barium nitrate. **2**
What effect will dissolving the barium sulfate in barium nitrate have on the solubility of the barium sulfate? Explain

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Student Name: Memo

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2018

MODULE 5 TOPIC TEST

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Part A – 5 marks

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Part B – 30 marks

- Attempt Questions 6 - 12
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This paper consists of 10 pages.

Part A – 5 marks

Attempt Questions 1- 5

Allow about 5 minutes for this part

Use the multiple-choice answer sheet provided for Questions 1-5.

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

A ☒ B ☒ C ☐ D ☐
 correct

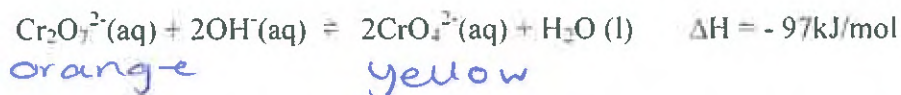
1 In a system at equilibrium

- (A) The rate of the forward reaction equals the rate of the reverse reaction.
- (B) The concentration of reactants equals the concentration of products.
- (C) All concentrations are equal.
- (D) The addition of a catalyst increases the yield of a product.

Questions 2 and 3 relate to the following system:

Potassium dichromate ($K_2Cr_2O_7$) is an orange crystalline solid while potassium chromate (K_2CrO_4) is a yellow crystalline solid. In both cases it is the anions that are coloured.

In aqueous solutions an equilibrium exists between these anions:



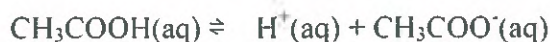
2 Explain the shift in equilibrium for the above reaction when sodium hydroxide is added

- (A) The system shifts right to use up the excess sodium hydroxide and the reaction appears darker orange.
- ☒ (B) The system shifts right to use up the excess sodium hydroxide and the reaction appears more yellow.
- (C) The system shifts left to use up the excess sodium hydroxide and the reaction appears darker orange.
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3 Explain the shift in equilibrium for the above reaction when the reaction is heated.

- (A) The system shifts right to favour the endothermic reaction.
- (B) The system shifts right to favour the exothermic reaction.
- ☒ (C) The system shifts left to favour the endothermic reaction.
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- (A) A precipitate of sodium nitrate.
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- (D) No precipitate would form.

2018 END OF MODULE 5 ASSESSMENT TASK

Part B – 30 marks

Attempt Questions 6 -12

Allow about 35 minutes for this part

Answer the questions in the spaces provided. Show all relevant working in questions involving calculations.

Question 6 (2 marks)

Marks

- (a) Identify two driving forces of a chemical reactions

1

..... entropy + enthalpy both correct = (1)

- (b) What is the value of ΔG° for a reaction at equilibrium?

..... $\Delta G^\circ = 0$ (1)

1

Question 7 (7 marks)**Marks**

Nitrogen monoxide (NO) is a colourless gas. It reacts with oxygen to form nitrogen dioxide (NO₂), a brown gas.

- (a) Write a balanced equation to represent this equilibrium reaction (include states)

1

- (b) Explain how increasing the volume of the reaction flask will affect the position of equilibrium.

3

- (1) an increase in volume equals a decrease in pressure
According to Le Chatelier the system
(1) will shift to counteract the change hence increase the pressure $\therefore$ shifts
(1) left as more gaseous moles

- (c) Describe an experiment you could carry out to determine if the above reaction is endothermic or exothermic. Describe the observations you would expect.

3

- Take three test tubes (closed) containing the equilibrium mixture
- Place one in a hot water bath, one in ice and leave one at room temp.
- Observe the changes in colour, more brown means shifts right, less brown means shifts left.

Question 8 (1 marks)

Marks
1

Write an equilibrium expression for the reaction



$$K = \frac{[\text{NOBr}]^2}{[\text{NO}]^2 [\text{Br}_2]}$$

Question 9 (4 marks)

Marks
4

Hydrogen sulfide can be produced by heating sulfur and hydrogen according to the equation:



3 moles of H_2 and 2 moles of S_2 were placed in a 2L container. At equilibrium 1.45 mol of H_2S was present

Calculate the equilibrium constant for this reaction.

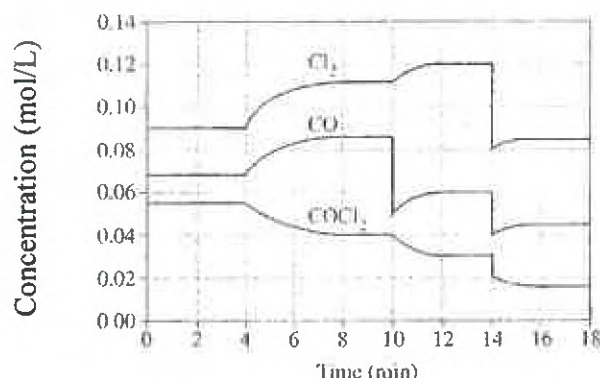
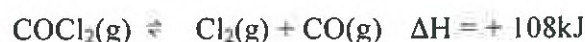
$$\begin{array}{rcccl}
 & 2\text{H}_2\text{(g)} & + & \text{S}_2\text{(g)} & \rightleftharpoons & 2\text{H}_2\text{S(g)} \\
 & 2 & & 1 & & 2 \\
 \text{I} & \checkmark 3 & & 2 & \checkmark & 0 \checkmark \\
 \text{C} & 1.45 & & 0.725 & & 1.45 \\
 \text{E} & 1.55 & & 1.275 & & 1.45 \checkmark \\
 [\] & \frac{1.55}{2} & & \frac{1.275}{2} & & \frac{1.45}{2} \\
 & = 0.775 & & = 0.6375 & & 0.725
 \end{array}$$

$$\begin{aligned}
 K &= \frac{[\text{H}_2\text{S}]^2}{[\text{H}_2]^2 [\text{S}_2]} \\
 &= \frac{(0.725)^2}{(0.775)^2 (0.6375)} = 1.37
 \end{aligned}$$

Question 10 (6 marks)

Marks

The graph below shows the variation in concentration of reactant and products as a function of time for the following system.



- (a) Identify two of the time intervals when the reaction is at equilibrium.

1

0-4 min, 8-10 min, 12-14 min
16-18 min

(any two correct)

- (b) What happened to the system at 4 minutes? Explain your choice using evidence from the graph.

3

The system was heated.

According to Le Chatelier the system would shift right to favour the endothermic reaction (to counteract the change). This can be seen by a decrease in the conc. of COCl_2 and an increase in conc. Cl_2 and CO .

Question 10 continued

Marks

- (c) What happened to the system at 10 minutes? Explain your choice using evidence from the graph.

2

change [CO was removed from the system as shown by a sharp drop in concentration of CO. The system then shifted right to counteract the change increasing concentration of CO & Cl₂ and decreasing conc. of COCl₂ as shown in the graph.

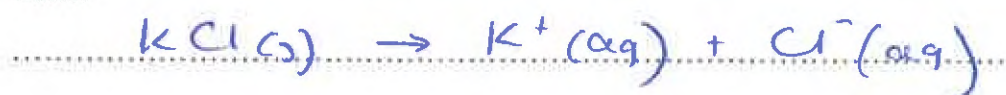
explain [

Question 11 (4 marks)

Marks

- (a) Write an equation to show the dissociation of potassium chloride when it is added to water.

1



- (b) Explain, at a particle level, the dissolution of potassium chloride in water making reference to the type bonds and/or forces present before and after dissolution.

3

When KCl is placed in water, water molecules surround the ionic lattice that is KCl. H₂O forms an ion-dipole interaction with the K⁺ and Cl⁻ ions which overcomes the electrostatic attraction present in the lattice between K⁺ and Cl⁻ ions breaking the ions out of the lattice. Each ion is surrounded by many water molecules.

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9

bonds present before ✓
ion-dipole ✓
explain dissolution ✓

Question 12 (6 marks)

Marks

Barium sulfate (BaSO_4) is considered insoluble in water.

- (a) Calculate the concentration of sulfate ions present at 25°C . Hint: Refer to the data sheet for the value of K_{sp}

1

$$K_{sp} = 1.08 \times 10^{-10}$$

$$\text{BaSO}_4(s) \rightleftharpoons \text{Ba}^{2+}_{(aq)} + \text{SO}_4^{2-}_{(aq)}$$

$$s^2 = 1.08 \times 10^{-10}$$

$$\therefore s = 1.04 \times 10^{-5} \text{ mol/L}$$

- (b) Predict whether a precipitate will form when 0.050g of barium sulfate is added to 500mL of water at 25°C .

3

$$m(\text{BaSO}_4) = 0.05\text{g}$$

$$n(\text{BaSO}_4) = \frac{0.05}{137.3 + 32.07 + 16 \times 4} = \frac{0.05}{233.37}$$

$$= 2.14 \times 10^{-4} \text{ mol}$$

$$C = \frac{2.14 \times 10^{-4}}{0.5} = 4.28 \times 10^{-4} \therefore > 1.04 \times 10^{-5} \therefore \text{ppt}$$

- (c) Barium sulfate is dissolved in water and then in a solution of barium nitrate. What effect will dissolving the barium sulfate in barium nitrate have on the solubility of the barium sulfate? Explain

2

Dissolving barium sulfate in barium nitrate will decrease the solubility of barium sulfate as Ba^{2+} is a common ion. Increasing $[\text{Ba}^{2+}]$ will shift equilibrium of $\text{BaSO}_4(s) \rightleftharpoons \text{Ba}^{2+}_{(aq)} + \text{SO}_4^{2-}_{(aq)}$ left $\therefore$ decreasing ions in solution.