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VCE Chemistry 2005 Equilibrium Test Unit 3

Time allowed: 50 minutes
Total marks: 40

SECTION A
Contains 12 multiple choice questions

SECTION B
4 Extended response questions

Suggested Answers to this test are given in a separate file

Student Name…….

VCE Chemistry 2005 Equilibrium Test Unit

SECTION A

MULTIPLE CHOICE ANSWER SHEET

Instructions:

For each question choose the response that is correct or best answers the question.
Circle the chosen response on this answer sheet.
Only circle **one** response for each question.

Question 1.	A	B	C	D
Question 2.	A	B	C	D
Question 3.	A	B	C	D
Question 4.	A	B	C	D
Question 5.	A	B	C	D
Question 6.	A	B	C	D
Question 7.	A	B	C	D
Question 8.	A	B	C	D
Question 9.	A	B	C	D
Question 10.	A	B	C	D
Question 11.	A	B	C	D
Question 12.	A	B	C	D

VCE Chemistry 2005 Equilibrium Test Unit 3
SECTION A - [12 marks, 15 minutes]

This section contains 12 multiple choice questions.
For each question choose the response that is correct or best answers the question.
Indicate your answer on the answer sheet provided.
*(Choose only **one** answer for each question.)*

Question 1
The reaction between nitrogen and oxygen gases to form nitrogen(II) oxide can be described by the chemical equation

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

The activation for the forward reaction would be

A. the energy required to break the bonds in the nitrogen and oxygen molecules.
B. the energy required to ionise the nitrogen and oxygen molecules.
C. the difference between the energy required to break the bonds in the nitrogen and oxygen molecules and the energy released when the nitrogen(II) oxide molecules form.
D. the energy released when the nitrogen and oxygen molecules react with each other.

Question 2
An endothermic reaction is best described as a chemical reaction

A. where the energy of the products is lower than the energy of the reactants.
B. where energy has to be added to the system for the reaction to proceed.
C. where the energy involved in breaking the bonds in the reactants is greater than the energy involved in forming the bonds in the products.
D. where the energy involved in breaking the bonds in the reactants is less than the energy involved in forming the bonds in the products.

Question 3
Hydrogen reacts with chlorine to form hydrogen chloride according to the chemical equation

$$H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$$

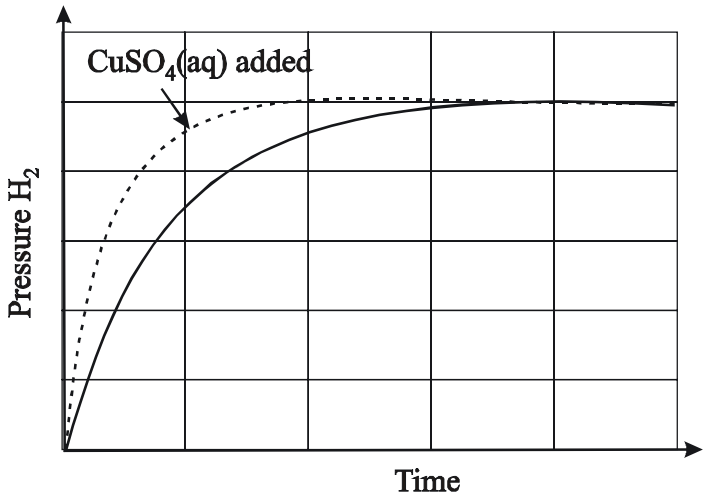
A mixture of hydrogen and chlorine gases, each with an initial concentration of 0.15 M, were allowed to react and reach equilibrium, at which time the hydrogen chloride concentration was found to be 0.12 M. What is the value of the equilibrium constant, K, for this reaction?

A. 0.64
B. 16
C. 1.3
D. 1.8

Question 4
A student measured the pH of a sample of pure water and found it to be 7.2. Which of the following could not be a plausible explanation for the observed result?

A. The temperature was lower than 25 °C as the ionisation of water is an endothermic reaction.
B. The glassware used had not been thoroughly rinsed after it was washed with an anionic detergent.
C. The temperature was lower than 25 °C as the ionisation of water is an exothermic reaction.
D. The pH meter had not been calibrated correctly.

Question 5
Zinc reacts with dilute hydrochloric acid to produce hydrogen gas. The graph below shows the pressure of hydrogen gas when equal amounts of zinc and acid reacted at constant temperature in the absence and presence of a trace amount of aqueous copper(II) sulfate solution.



Which of the following statements best explains the role of the copper(II) sulfate in this reaction?

A. The SO_4^{2-}(aq) ions have formed sulfuric acid which is a stronger acid.
B. The added Cu^{2+}(aq) ions remove any impurities from the surface of the zinc metal.
C. The SO_4^{2-}(aq) ions prevent the formation of any impurities on the surface of the zinc while it is reacting.
D. The Cu^{2+}(aq) ions have lowered the activation energies for both the forward and reverse reactions.

Question 6
The Haber process for the production of ammonia from nitrogen and hydrogen can be described by the chemical equation,

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad \Delta H = -92 \text{ kJ mol}^{-1}$$

Which of the following would **not** improve the equilibrium yield for this reaction?

A. Lowering the temperature that the reaction was carried out at.
B. Increasing the amount of hydrogen in the reaction mixture.
C. Increasing the pressure that the reaction was carried out at.
D. Using a platinum catalyst in the reaction.

Question 7
What would be the final pH of a solution prepared by diluting 50.0 mL of 0.200 M aqueous sodium hydroxide solution with pure water so that the total volume was 10.0 L?

A. 11
B. 3
C. 12
D. 2

Question 8
A significant equilibrium that occurs in living systems can be described by the chemical equation,

$$H_2O(l) + CO_2(g) \rightleftharpoons H_2CO_3(aq) \rightleftharpoons HCO_3^-(aq) + H^+(aq)$$

What would be the effect on the pH of the blood as it passes through the lungs?

A. The pH would increase as the carbon dioxide concentration increases.
B. The pH would increase as the carbon dioxide concentration decreases.
C. The pH would decrease as the carbon dioxide concentration increases.
D. The pH would decrease as the carbon dioxide concentration decreases.

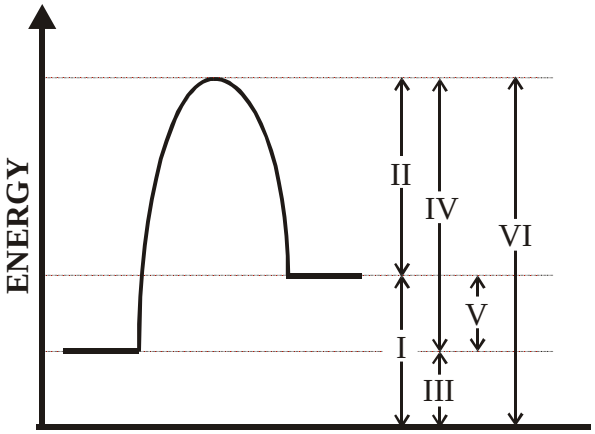
Question 9
Flour dust will ignite explosively when blown into a flame, whereas a similar mass of flour in an open crucible will burn much slower when ignited. The best explanation for these observations is that

A. the dust has a lower activation energy so the reaction proceeds at a much faster rate.
B. there is more oxygen available to react with the dust and this increases the rate of reaction.
C. the temperature is higher in the flame and this increases the rate of reaction.
D. in the dust the particles have a larger surface area to react with the oxygen so the reaction proceeds at a faster rate.

Question 10
Benzoic acid, C_6H_5COOH, is a weak acid. The pH of a 0.010 M aqueous solution of this acid would be approximately equal to

A. 3.1
B. 2.0
C. 1.8
D. 6.8

Question 11
The annotated energy profile for a reaction is shown in the diagram below.



The activation energy for the reverse reaction and the energy change for the reaction are respectively described by

A. VI and V.
B. IV and V.
C. II and V.
D. VI and II.

Question 12
For an exothermic chemical reaction, which of the following best describes how the rate of the forward reaction changes as it reaches equilibrium?

A. The rate of the forward reaction keeps decreasing as the reactants are consumed.
B. The rate of the forward reaction increases as a result of the heat being released by the reaction.
C. The rate of the forward reaction decreases to zero as it approaches equilibrium.
D. The rate of the forward reaction decreases until it is equal to the rate of the reverse reaction.

End of Section A

SECTION B - [28 marks, 35 minutes]
This section contains four questions, numbered 1 to 4.
All questions should be answered in the spaces provided.
The mark allocation and approximate time that should be spent on each question are given.

Question 1 - [9 marks, 11 minutes]

a. The gas phase reduction of water vapour by carbon monoxide can be described by the chemical equation,

$$CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$$

1.0 mole of carbon monoxide was mixed with an equal amount of water vapour in a 20.0 L flask at 800 °C and allowed to reach equilibrium. The concentration of hydrogen at equilibrium was found to be 0.036 M.

i. Write an expression for the equilibrium constant for this reaction.

1 mark

ii. Calculate the value of the equilibrium constant for this reaction at 800 °C.

3 marks

b. The dissociation of chlorine molecules can be represented by the chemical equation,

$Cl_2(g) \rightleftharpoons 2Cl(g)$ $\quad K(298\ K) = 1.4\times10^{-38}\ M$ $\quad \Delta H = 242\ kJ\ mol^{-1}$

i. What information does the value of the equilibrium constant provide about the extent to which the forward reaction proceeds?

ii. Use either the general gas equation or molar volume of a gas at SLC to calculate the concentration of an ideal gas at SLC.

iii. Estimate the equilibrium concentration of atomic chlorine in a sample of gas at SLC.

iv. What would be the value for the equilibrium constant at 298 K for the reaction described by the chemical equation,

$$2Cl(g) \rightleftharpoons Cl_2(g)$$

1 + 1 + 2 + 1 = 5 marks

Question 2 - [5 marks, 6 minutes]
Chlorophenol, ClC_6H_5OH, is a weak acid with a dissociation constant of 2.95×10^{-9} M at 25 °C.

a. Write an appropriate chemical equation to show chlorophenol acting as an acid in an aqueous solution.

1 mark

b. Write an expression for the dissociation constant for chorophenol.

1 mark

c. An aqueous solution of chlorophenol has a pH of 5.3 at 25 °C. What is the concentration of chlorophenol in this solution?

2 marks

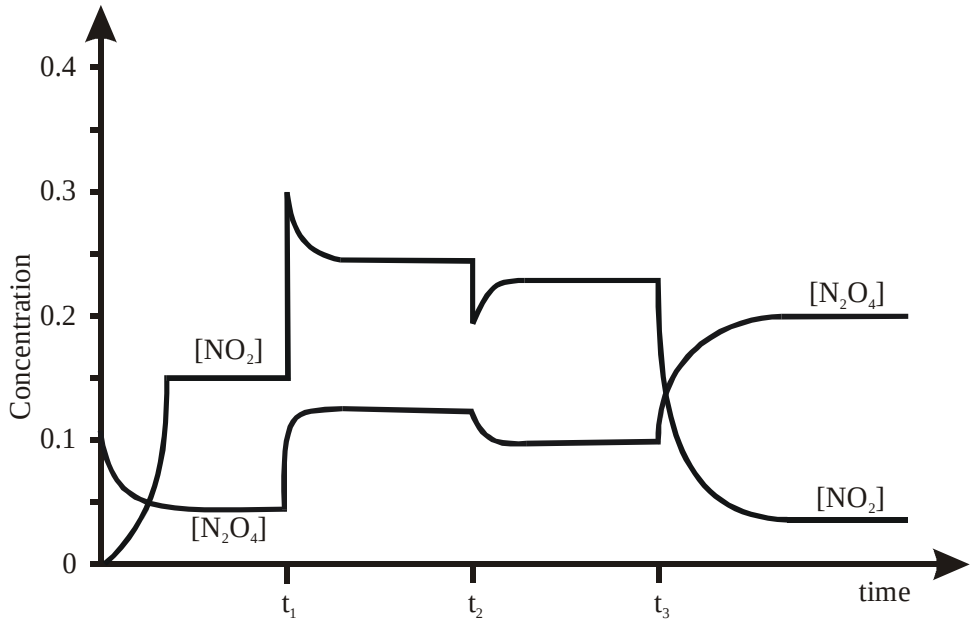
d. What would be the concentration of the hydroxide ion in this solution?

1 mark

Question 3 - [9 marks, 11 minutes]
Dinitrogen tetroxide, N_2O_4, decomposes to form nitrogen dioxide, NO_2, as described by the chemical equation,

$$N_2O_4(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H = 57 \text{ kJ mol}^{-1}$$

A sample of pure dinitrogen tetroxide, with a concentration of 0.12 M, was placed in a flask and allowed to reach equilibrium. The graph below shows how the concentrations of the two gases varied when some changes were made to the system.



a. How many times did the system reach equilibrium?

1 mark

b. i. What changes was made to the system at t_1?

ii. Give an explanation of how this change effected the position of equilibrium.

2 marks

c. i. What changes was made to the system at t_2?

ii. Give an explanation of how this change effected the position of equilibrium.

2 marks

d. i. What changes was made to the system at t_3?

ii. Give an explanation of how this change effected the position of equilibrium.

2 marks

e. i. Write an expression for the equilibrium constant, K, for this reaction.

ii. Determine the value of the equilibrium constant prior to the change at t_3.

2 marks

Question 4 - [5 marks, 6 minutes]
Limestone will readily react with dilute aqueous nitric acid solutions as described by the chemical equation,

$$CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + CO_2(g) + H_2O(l) \quad \Delta H = -16 \text{ kJ mol}^{-1}$$

a. Give three methods that could be used to increase the rate of carbon dioxide formation in the above reaction.

3 marks

b. Select two of the methods from a. above and explain using the particle model how these would increase the rate of carbon dioxide formation.

2 marks

End of Task