Test: Equilibrium

SCH4U 2004-2005

Name: _____

Multiple Choice (K/U: 10)

The next two questions refer to the equation below, which shows bromine dissolving in water. Assume that the reaction is at equilibrium.

$$Br_{2(aq)} + H_2O_{(l)} \rightleftharpoons H^{+1}_{(aq)} + Br^{-1}_{(aq)} + HBr_{(aq)}$$

red — *colourless*

1. What observation would you expect if dilute acid such as hydrochloric acid were added to the system at equilibrium?

A. No observable change.
B. The solution would become colourless.
C. The solution would become red.
D. The solution would become green.

2. Which one of the following would **not** cause the reaction to shift to the right?

A. Addition of Br^- ions to the system.
B. Decreasing the pH.
C. Addition of Br_2.
D Addition of H_2O.
E Decreasing HBr.

3. The equation below shows carbon and hydrogen reacting to form methane.

$$C_{(s)} + 2H_{2(g)} \rightleftharpoons CH_{4(g)} + 75\ kJ$$

If the reaction has reached equilibrium, how could you increase the yield of methane?

A. Decrease the temperature.
B. Decrease the pressure.
C. Add a suitable catalyst.
D. Both A and C above.
E. Decrease the amount of carbon.

The next two questions refer to the following information.
When dilute hydrochloric acid is added to a solution of potassium chromate, $CrO_4^{-2}{}_{(aq)}$, a solution of potassium dichromate, $Cr_2O_7^{-2}{}_{(aq)}$, is produced. This is an example of a reversible reaction where there are no visible changes to the colour of the solution formed once equilibrium has been reached.

$$2\ CrO_4^{-2}{}_{(aq)} + 2H^{+1}{}_{(aq)} \rightleftharpoons Cr_2O_7^{-2}{}_{(aq)} + H_2O_{(l)} + 42\ kJ$$

4. Which one of the following would not favour the forward reaction?
A. Addition of more potassium chromate.
B. Increasing the concentration of hydrochloric acid.
C. Decreasing the temperature of the solution.
D. Addition of water.

5. What would you expect to happen to the colour of this solution if dilute sodium hydroxide is added?
A. The solution would become more intensely orange due to the forward reaction being favoured.
B. The solution would become yellow due to the reverse reaction being favoured.
C. The solution would remain orange due to the fact that sodium hydroxide is not one of the reacting species in this reaction.
D. The solution would become colourless due to the forward reaction producing more water molecules.

6. Nitrogen dioxide is a dark brown gas, which can decompose to form colourless dinitrogen tetroxide. The mixture of these two gases will eventually reach equilibrium.

$$2\ NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$$

Which of the following statements is **not** true?

A. At equilibrium, both of these reactions have ceased.
B. At equilibrium the colour of the gas mixture would remain constant.
C. At equilibrium, the rate of decomposition of NO_2 to N_2O_4 equals its rate of formation.
D. At equilibrium, the quantities of NO_2 and N_2O_4 remain the same.

7. The equilibrium constant, *Kc*, for the reaction:

$$2\ H_{2(g)} + O_{2(g)} \rightleftharpoons 2\ H_2O_{(g)}$$

is equal to 2×10^{81} at 25 ^{O}C. This value suggests that:

A. this reaction favours the forward reaction slightly more than the reverse reaction.
B. this reaction favours the reverse reaction slightly more than the forward reaction.
C. this reaction virtually goes to completion with little reversal.
D. this reaction virtually does not proceed forward and largely favours the reactants.

8. Consider the reaction: $2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$

What would happen to the value of *Kc*, in the above reaction, if the pressure of the N_2O_4 is doubled?

A. *Kc* would not be affected.
B. *Kc* would be halved.
C. *Kc* would be doubled.
D. *Kc* would increase by a factor of 4.

9. Consider the reaction of iodine and chlorine for which the enthalpy of reaction is - 27 kJ.

$$I_{2(aq)} + Cl_{2(aq)} \rightleftharpoons 2\ ICl_{(g)} \qquad ?H = -27\ kJ$$

At 25^0C, $K_C = 1.6 \times 10^5$. If the temperature increased to 100 ^{0}C, what changes (if any) will be observed?

A. K_c will increase
B. no changes
C. [ICl] will increase
D. $[I_2]$ will increase

10. The value of the equilibrium constant for the reaction:

$$2NH_3 \rightleftharpoons N_2 + 3H_2$$

is 2.5×10^{-9} at 25^oC. The value of the equilibrium constant for the **reverse** reaction at the same temperature is:

A. 2.5×10^{-9}
B. 4.0×10^{8}
C. 2.0×10^{4}
D. 4.0×10^{9}

Multiple Choice Answers

1	2	3	4	5	6	7	8	9	10

Application (16)

1. The equilibrium constant for the following reaction is 0.110

$$2\ ICl_{(g)} \rightleftharpoons I_{2(g)} + Cl_{2(g)} \qquad Kc = 0.110$$

Calculate all the equilibrium concentrations if 0.33 mol of iodine chloride gas, $ICl_{(g)}$, is placed in a 1.00 L vessel and the reaction is allowed to reach equilibrium. 5

2. The following reaction occurs readily at 425 ^{O}C:

$$2\ NO_{(g)} + Cl_{2(g)} \rightleftharpoons 2NOCl_{(g)} \qquad Kc = 14.9$$

The equilibrium constant, *Kc*, is 14.9 at this temperature.
Suppose a reaction vessel at this temperature contained these three gases at the following concentrations: [NO] = 0.0500 mol/L, [Cl_2] = 0.100 mol /L, [NOCl] = 0.100 mol/L

(a) Show that the system is not at equilibrium. 3

(b) Predict the shift that the reaction would take to establish equilibrium. Briefly justify your answer. 3

3. In air at 25 ^{O}C and 101.1 kPa, the N_2 concentration is 0.0330 mol/L and the O_2 concentration is 0.00810 mol/L. The reaction:

$$N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$$

has $Kc = 4.80 \times 10^{-31}$ at 25 ^{O}C. Taking the N_2 and O_2 concentrations above as initial values, calculate the concentration of NO gas when equilibrium is established at 25 ^{O}C. 5