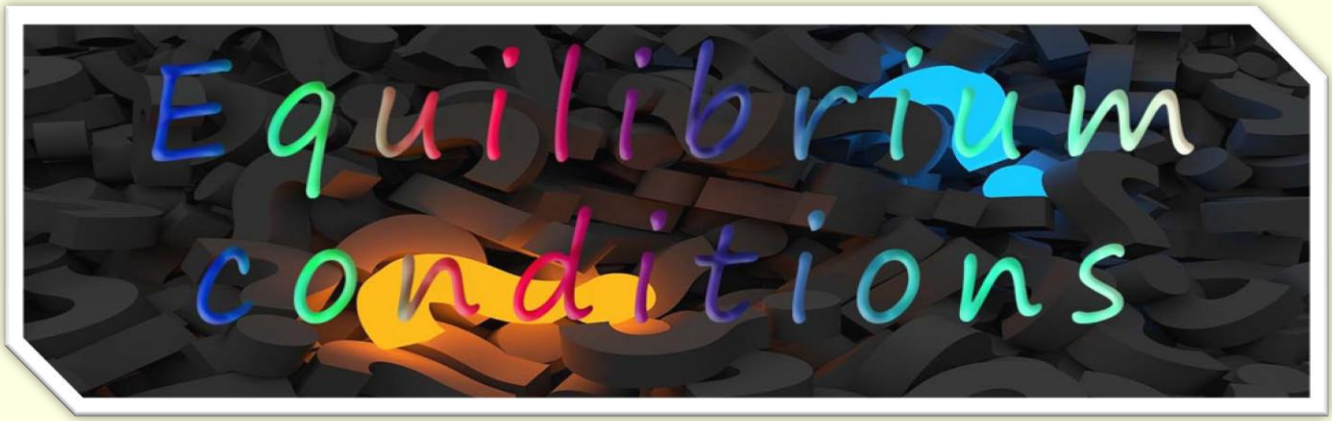

Answer all the questions below as fully as you can then check your answers

1. What is a reversible reaction?

i. If a reversible reaction has achieved dynamic equilibrium what does this mean? How can you tell when a reaction has achieved dynamic equilibrium?

2. If a chemical reaction is said to go to completion, what does this mean?

3. When we discuss the conditions in which a chemical reaction takes place, the phrases open and closed systems are often used. Explain the difference between an open and a closed system.

4. The equation is for the synthesis of ammonia by the Haber process:

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

i. Write an expression for K_c, the equilibrium constant for this reaction.
ii. Calculate the units for this equilibrium constant.

5. The hydrogen needed for Haber process is obtained by reacting carbon monoxide with steam. An equation for this reaction is given below:

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

i. Write an expression for K_c, the equilibrium constant for this reaction and give its units.

6. Write out expression for K_c for each of the following reactions and give the units for K_c in each case.

i. $A + B \rightleftharpoons C + D$

ii. $A + B \rightleftharpoons 2C + D$

iii. $2A + 2B \rightleftharpoons C + D$

7. If one reaction had an equilibrium constant of 10^{10} and another reaction had an equilibrium constant of 10^{-10}, how would these reaction differ from each other?

8. If the equilibrium constant k_c for the reaction below is 10.

$$A + B \rightleftharpoons C + D$$

What is the equilibrium constant for the following reaction?

$$C + D \rightleftharpoons A + B$$

Answers

1. What is a reversible reaction?
   One where the products can be turned back into the reactants.

i. If a reversible reaction has achieved dynamic equilibrium what does this mean? How can you tell when a reaction has achieved dynamic equilibrium?
   The rate of the forward and reverse reactions are the same. The macroscopic properties (properties such as colour, density) DO NOT CHANGE WITH TIME.

2. If a chemical reaction is said to go to completion, what does this mean?
   All the reactants are turned into products.

3. When we discuss the conditions in which a chemical reaction takes place, the phrases open and closed systems are often used. Explain the difference between an open and a closed system.
   A closed system is one where no matter (gases, liquids or solids) is added to the reaction, most of the reactions which we carry out are in open test-tubes and beakers which can exchange matter with the atmosphere. By simply placing a bung or stopper in the test-tube the reaction can be carried out in a closed rather than an open system.

4. The equation is for the synthesis of ammonia by the Haber process:

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

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

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

ii. Calculate the units for this equilibrium constant.

$$K_c = \frac{(\text{mol dm}^{-3})\,(\text{mol dm}^{-3})}{(\text{mol dm}^{-3})\,(\text{mol dm}^{-3})\,(\text{mol dm}^{-3})\,(\text{mol dm}^{-3})}$$

$$K_c = \frac{1}{(\text{mol dm}^{-3})\,(\text{mol dm}^{-3})} = \text{mol}^2\,\text{dm}^{-6}$$

5. The hydrogen needed for Haber process is obtained by reacting carbon monoxide with steam. An equation for this reaction is given below:

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

i. Write an expression for K_c, the equilibrium constant for this reaction and give its units.

$$K_c = \frac{[CO_2]\,[H_2]}{[CO]\,[H_2O]} = \frac{(\text{mol dm}^{-3})\,(\text{mol dm}^{-3})}{(\text{mol dm}^{-3})\,(\text{mol dm}^{-3})}$$

Kc has no units as they all cancel!

6. Write out expression for K_c for each of the following reactions and give the units for K_c in each case.

i. $A + B \rightleftharpoons C + D$

$$K_c = \frac{[C]\,[D]}{[A]\,[B]} = \frac{(\text{mol dm}^{-3})\,(\text{mol dm}^{-3})}{(\text{mol dm}^{-3})\,(\text{mol dm}^{-3})}$$

K_c has no units

ii. $A + B \rightleftharpoons 2C + D$

$$K_c = \frac{[C]^2\,[D]}{[A]\,[B]} = \frac{(\text{mol dm}^{-3})\,(\text{mol dm}^{-3})\,(\text{mol dm}^{-3})}{(\text{mol dm}^{-3})\,(\text{mol dm}^{-3})}$$

K_c has units of mol dm^{-3}

iii. $2A + 2B \rightleftharpoons C + D$

$$K_c = \frac{[C]^2\,[D]}{[A]^2\,[B]^2} = \frac{(\text{mol dm}^{-3})\,(\text{mol dm}^{-3})}{(\text{mol}^2\,\text{dm}^{-6})\,(\text{mol}^2\,\text{dm}^{-6})}$$

K_c has units of $\text{mol}^{-2}\,\text{dm}^{6}$

7. If one reaction had an equilibrium constant of 10^{10} and another reaction had an equilibrium constant of 10^{-10}, how would these reaction differ from each other?

If k_c is very large then the reaction can be considered to essentially go to completion. If K_c is very small then the reaction essentially fails to start, it is almost entirely made up of reactants and no products.

8. If the equilibrium constant k_c for the reaction below is 10.

$$A + B \rightleftharpoons C + D$$

What is the equilibrium constant for the following reaction?

$$C + D \rightleftharpoons A + B$$

The equilibrium constant for the reverse reaction is simply $1/k_c$, so in this case it is 1/10 or 0.1