

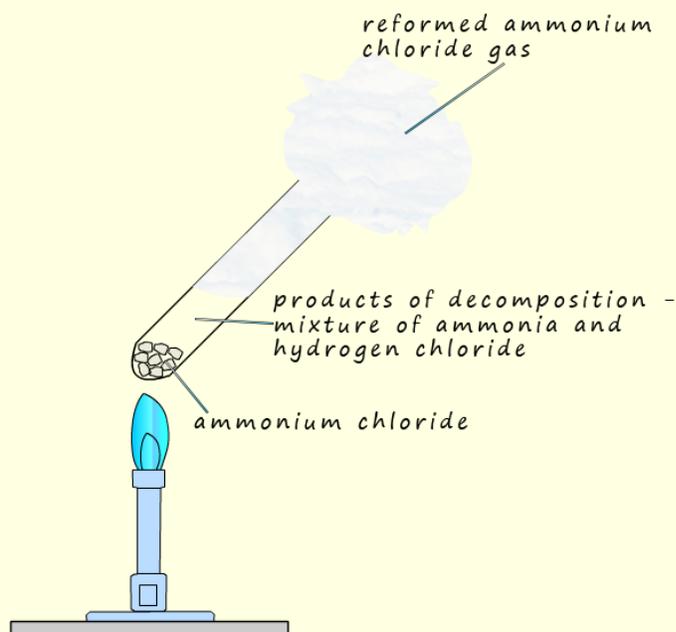
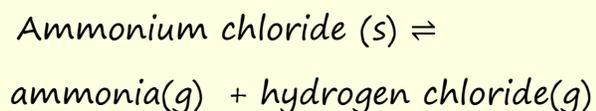
# Le Chatelier's Principle



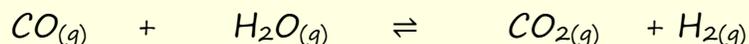
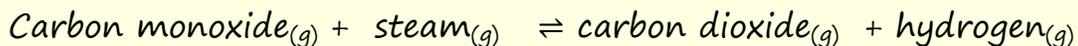
Henri Le Chatelier      dynamic equilibrium

Answer all the questions below and then check your answers

1. What does the " $\rightleftharpoons$ " symbol mean when you see it in an equation?
2. What is the difference between an exothermic and an endothermic reaction?
3. In many chemical reactions you hear chemists talking about "the system" and the surroundings, what do they mean by the phrases "the system" and the "surroundings"?
- a. What is the difference between a reaction in a closed and open system?
4. What do we mean when we say the system has achieved dynamic equilibrium?
5. Ammonium chloride is a colourless solid that when heated in a boiling tube over a Bunsen burner undergoes thermal decomposition according to the equation:



- a. Explain why this reversible reaction as shown will never achieve equilibrium.
- b. How is the reformed ammonium chloride gas being made?
6. The reaction between carbon monoxide and steam is often called the water-gas reaction. It is a common reaction in industry, it is used as a method of producing large amounts of hydrogen gas. The reaction can be shown as:



- a. Use your knowledge of Le Chatelier's principle to explain how the equilibrium will change when:
- more carbon monoxide is added.
  - hydrogen gas is removed
  - carbon dioxide gas is removed.
- b. The forward reaction is exothermic.
1. What will happen to the amount of hydrogen gas in the equilibrium mixture if the temperature of the system is raised?
- c. What effect will increasing the pressure have on the concentration of gases at equilibrium?

7. In the blast furnace used to produce iron the following reaction happens:



a. Use your knowledge of Le Chatelier's principle to explain how the equilibrium will change when:

i. The  $\text{CO}_2$  is removed.

ii. More solid iron oxide is added

# Le Chatelier's Principle

## Answers

1. What does the " $\rightleftharpoons$ " symbol mean when you see it in an equation?

*Reaction is reversible*

2. What is the difference between an exothermic and an endothermic reaction?

*Exothermic reaction releases heat energy to the surroundings*

*Endothermic reaction removes heat energy from the surrounding*

3. In many chemical reactions you hear chemists talking about "the system" and "the surroundings", what do they mean by the phrase "the system" and "the surroundings"?

*The system is the reacting chemicals*

*The surroundings are the boiling tubes, beakers, classroom, lab, everything else - the universe!*

a. What is the difference between a reaction in a closed and open system?

*In a closed system nothing enters or escapes - mostly means no gases are given off, or reactions take place in sealed vessels, in an open system substances can leave and enter the reaction.*

4. What do we mean when we say the system has achieved dynamic equilibrium?

*Rate of the forward and reverse reactions in a reversible reaction are the same.*

*The concentrations/amounts of reactants and products do not change with time.*

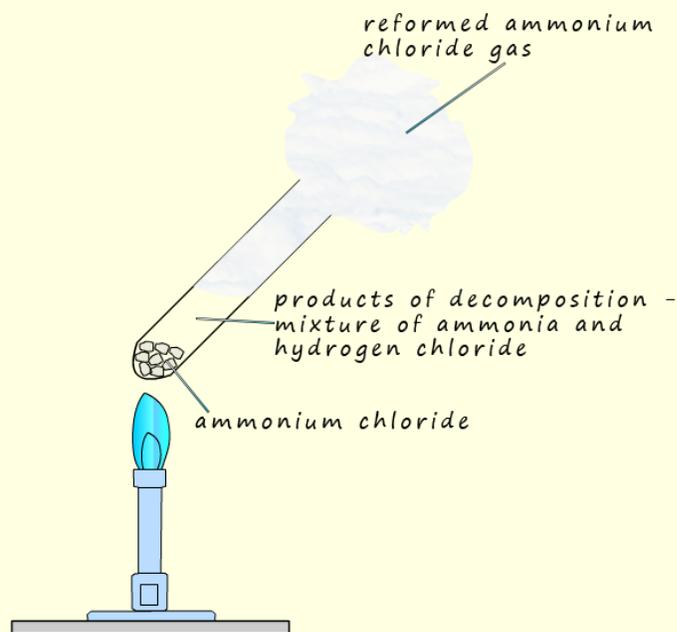
5. Ammonium chloride is a colourless solid that when heated in a boiling tube over a Bunsen burner undergoes thermal decomposition according to the equation:



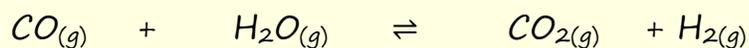
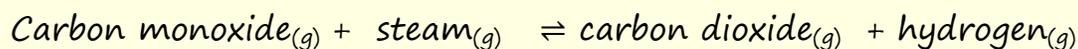
- a. Explain why this reversible reaction shown will never achieve equilibrium.

It is taking place in an open system - substances are leaving the boiling tube, can only achieve equilibrium in a closed system

- b. How is the reformed ammonium chloride gas being made? Products are basic (ammonia gas) and acidic hydrogen chloride), they react and turn back in reactant, solid ammonium chloride



6. The reaction between carbon monoxide and steam is often called the water-gas reaction. It is a common reaction in industry, it is used as a method of producing large amounts of hydrogen gas. The reaction can be shown as:



- a. Use your knowledge of Le Chatelier's principle to explain how the equilibrium will change when:
- i. more carbon monoxide is added. Equilibrium position shift to the right hand side, more  $\text{CO}_2$  and hydrogen are produced.

- ii hydrogen gas is removed -equilibrium position shifts to the right hand side to replace removed hydrogen.
  - iii carbon dioxide gas is removed. Equilibrium position shifts to the right hand side to replace removed carbon dioxide.
- b. The forward reaction is exothermic.
- 1 What will happen to the amount of hydrogen gas in the equilibrium mixture if the temperature of the system is raised? More reactants are made, equilibrium position shifts to the left hand side, less hydrogen in equilibrium mixture of gases, the endothermic reaction removes heat introduced.
  - c. What effect will increasing the pressure have on the concentration of gases at equilibrium? None, equal number of moles of gas on reactant and product side of the equation.
7. In the blast furnace used to produce iron the following reaction happens:



- a. Use your knowledge of Le Chatelier's principle to explain how the equilibrium will change when:
  - i. The  $\text{CO}_2$  is removed. More products, reaction equilibrium position shifts to right hand side to replace removed carbon dioxide gas.
  - ii. More solid iron oxide is added, No change in equilibrium position, because the iron oxide is a solid adding more does not change the "concentration" of the solid present.