

Stress Management Application

Problem:

How can Le Chatelier's principle be used to predict the direction in which a system in equilibrium will shift when conditions are altered?

Materials:

1.0 M CuCl_2
0.1 M AgNO_3
NaCl crystals
water bath set-up or hot plate
ice
common laboratory glassware

Hazard Warning:

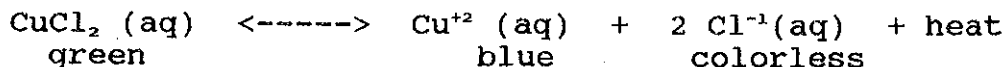
Safety goggles and lab aprons must be worn throughout this experiment. AgNO_3 and CuCl_2 are both possible skin irritants. Be sure to wash your hands thoroughly before leaving the laboratory.

Procedure:

Equilibrium can exist only under conditions of constant temperature, pressure and volume. If one of these factors is altered, the equilibrium is momentarily upset. The effect of changes in reaction conditions upon a system at equilibrium was studied by Henri Le Chatelier. The principle developed by Le Chatelier as a result of many observations is stated below:

"When a stress is placed on a system in equilibrium (by changing temperature, pressure, volume, or concentration), the system will adjust to remove the stress and to restore equilibrium in the system."

In this experiment you will use Le Chatelier's principle to predict the direction a system will shift in order to restore equilibrium. The equilibrium system you will study is shown below:



Begin by placing about 5 mL of CuCl_2 solution into 5 separate test tubes. You will be changing the conditions in each test tube by either altering the temperature or by adding another chemical to the equilibrium system. Before you begin, study the table below and the equilibrium equation above. Complete the column in which you are asked to predict the change which will occur. To make your predictions, look carefully at the change or stress listed in the table. Using your knowledge of Le Chatelier's principle, state whether the color will become more green, more blue, or whether no color change will occur. Remember, you must complete your predictions before you begin

experimenting.

| Stress | Predicted Change | Observed Change |
|---------------------------------------|------------------|-----------------|
| Control | | |
| Heating | | |
| Cooling | | |
| Adding $\text{Ag}^+ \text{NO}_3^-$ | | |
| Adding $\text{Na}^+ \text{Cl}^-$ | | |

Once your predictions have been completed, begin experimenting with this system. You will need to use the following:

hot water bath
ice water bath
0.1 M AgNO_3
NaCl crystals

Devise your own procedure for testing each of the "stresses" listed above. Record the actual changes observed in the above table under "Observed Change".

Summing Up:

1. What effect does heating the solution have on the color? From this color change, what can you infer about the change in concentration of CuCl_2 ion and of the Cu^{+2} ion? Indicate in which direction the reaction is shifting in this step (left to right or right to left?)
2. Use the Le Chatelier's principle to explain the color change caused by cooling the solution. Indicate in which direction the reaction is shifting in this step (left to right or right to left?)
3. When adding sodium chloride to the equilibrium system, which ion do you think was affecting the equilibrium, sodium or chloride? How did this affect the concentration of CuCl_2 and of the Cu^{+2} ion?
4. When AgNO_3 was added to the equilibrium system, what precipitate was formed? Why did the color of the solution become more blue? Write a balanced reaction to represent this chemical change.