Integrated concepts of equilibrium

Psychology, Psychotherapy

Experiment No. 9 INTEGRATED CONCEPTS OF EQUILIBRIUM RESULTS AND DISCUSSION

A system in equilibrium can be affected by the addition of another reagent leading to a change in chemical equation with a new equilibrium constant. An overall reaction is the sum of two or more reaction steps with different equilibrium constants. The overall equilibrium constant, Coverall, is the product of the equilibrium constants of the individual reaction step. If a reaction step is reversed, the equilibrium constant is set into its reciprocal.

If a reaction step is multiplied by a common coefficient n, the new equilibrium constant is raised to the nth. The first part of the experiment dealt with the equilibrium reaction Cu(OH)2(s)? Cu2+(aq) + 2OH-(aq). 0. 10 M Cu(NO3)2 and 0. 10 M NaOH were reacted together in seven test tubes to form the solid Cu(OH)2, a blue precipitate. Distilled water was added to the first test tube. This served as the control. When 6. 0 M H2C2O4 was added to the second test tube, the precipitate turned cloudy blue. The new equilibrium can be attributed to the formation of the solid CuC2H4 which is cloudy blue in color, and the ionization of H2C2O4.

The addition of Zn dust in the third test tube resulted into a gray-brown precipitate. The mechanisms in this reaction are the dissociation of Cu(OH)2(s), redox of Cu2+ and Zn, and precipitation of Zn(OH)2, leading to an overall reaction of Cu(OH)2(s) + Zn(s)? Zn(OH)2(s) + Cu(s). When 6. 0 M HNO3 was added to the fourth test tube, the precipitate disappeared. The H+ ions from the complete dissociation of HNO3 neutralize the OH- ions. This results in the shifting of the system to the right. The addition of 6. 0 M NH3 in the fifth test tube caused the formation of the deep blue $[Cu(NH_3)_4]^{2+}$ complex.

The new equilibrium was established from the dissociation reaction of $Cu(OH)_2$ and NH_3, and the formation of the complex $[Cu(NH_3)_4]^{2+}$. 1. 0 M Na_3PO_4 was added to the sixth test tube and formed a light blue precipitate. The basic PO^{3-} hydrolyzes to form OH^- and HPO_4^{2-}. The increase in OH^- ions caused the system to shift to the left and formed more $Cu(OH)_2(s)$. In the seventh test tube, the addition of $Cu(NO_3)_2$ caused to form a cloudy turquoise precipitate. The addition of a common ion Cu^{2+} caused the formation of more solid.

The cloudy supernate suggested that the solubility of a slightly soluble ionic compound is lowered in the presence of a common ion. In the second part of the experiment, saturated NaCl was put into three test tubes and in each, three different reagents were added. The initial equilibrium reaction was NaCl(s)? $Na^+(aq) + Cl^-(aq)$. The addition of 95% ethanol resulted in a clear supernate and very minimal white precipitate. Ionic compounds such a NaCl dissolve in polar solvents like ethanol. The addition of concentrated HCl resulted in the formation of more white precipitate, due to the addition of a common ion Cl^-.

When $MgSO_4$ was added, there was no visible reaction. This is due to the displacement reaction of the two solids forming aqueous solutions of $MgCl_2$ and Na_2SO_4.

ANSWERS TO QUESTIONS

A. test tube 1 Cu(OH)2(s) ?? Cu2+(aq) + 2OH-(aq) Ksp= 2. 20x 10-20 K_eq=[? Cu? ^(2+)]? [? OH? ^-]? ^2

B. test tube 2 Cu(OH)2(s) ?? Cu2+(aq) + 2OH-(aq) Ksp= 2. 20x 10-20 H2C2O4 (aq) ?? HC2O4-(aq) + H+(aq) Ka= 6. 5x10-2 HC2O4-(aq) ?? C2O42-(aq) + H+(aq) Ka= 6. 1x10-5 Cu(OH)2(s) + H2C2O4 (aq)?? Cu2+(aq) + C2O42-(aq) + 2H2O(l) Keq= 8. 23x10-26

C. test tube 3 Cu(OH)2(s) ?? Cu2+(aq) + 2OH-(aq) Ksp= 2. 20x 10-20 Cu2+(aq) + Zn(s) ?? Zn2+(aq) + Cu(s) Kredox= 3. 46x1034 Zn2+(aq) + 2OH-(aq) ?? Zn(OH)2 (aq) Ksp= 5. 435x1013 Cu(OH)2(s) + Zn(s) ?? Zn(OH)2 (aq) + Cu(s) Keq= 4. 137x1028

D. test tube 4 Cu(OH)2(s) ?? Cu2+(aq) + 2OH-(aq) Ksp= 2. 20x 10-20 2HNO3(aq) ? 2H+(aq) + 2NO3 (aq) Ka=? Cu(OH)2(s) + 2HNO3 (aq) ? Cu2+(aq) + 2NO3 (aq) + 2H2O(l)Keq=?

E. test tube 5 Cu(OH)2(s) ?? Cu2+(aq) + 2OH-(aq) Ksp= 2. 20x 10-20 Cu2+(aq) + 4 NH3(aq) ?? Cu(NH3)4]2+(aq) Kf= 5. 0x1013 Cu(OH)2(s) + 4 NH3(aq) ?? [Cu(NH3)4]2+(aq) + 2OH-(aq) Keq= 1. 1x10-6

F. test tube 6 3Cu(OH)2(s) ?? 3Cu2+(aq) + 6OH-(aq) Ksp= 1. 0648x 10-59 2H3PO4 (aq) ?? 2H+(aq) + 2H2PO4-(aq) Ksp= 5. 625x10-5 2H2PO4-(aq) ?? 2H+(aq) + 2HPO42-(aq) Ksp= 3. 844x10-15 2HPO42-(aq) ?? 2H+(aq) + 2PO43-(aq)¬ Ksp= 2. 304x10-27 3Cu(OH)2(s) +2H3PO4 (aq) ?? Cu3(PO4)2(s) + 6H2O(l)Keq? 0

A. Test tube 1

B. Test tubes 6, 5, 3, and 2 C. Test tube 5 D. Test tubes 7, 6, 4, 3, and 2 E. Test tube 7, and 2 F. Test tube 6, 5, and 3

In test tube 1, the addition of ethanol to the solution produced little precipitate. It is because ethanol is capable of hydrogen-bonding with water, thus, depriving the Na^+ and Cl^- ions of water molecules to " hydrate" them. On the other hand, adding HCl produced a greater amount of precipitate because it completely ionizes into H^+ and Cl^- ions. Because Cl^- is part of one side of the dissolution process, the equilibrium shifted to the side favoring the reformation of NaCl crystals. Lastly, the addition of $MgSO_4$ does not affect the system because none of its constituent ions were present in the equilibrium reaction of NaCl.