Chemistry 30

# Solutions 60

## I. Multiple Choice 20

| | | | |
|---|---|---|---|
| 1. A | 6. B | 11. A | 16. B |
| 2. A | 7. B | 12. C | 17. A |
| 3. C | 8. B | 13. D | 18. C |
| 4. C | 9. A | 14. B | 19. D |
| 5. B | 10. D | 15. B | 20. B |

## II. Short Answer 35

1. Calculate the concentration (molarity) of a solution prepared by dissolving 12.00 grams of potassium chloride, KCl, in water, for a total solution volume of 250.0 mL. **3**

***Molar mass of KCl = 74.6 g/mol***

$$M = \frac{\text{mol}}{\text{L}} = \frac{12.0\ \text{g}}{1} \times \frac{\text{mol}}{74.6\ \text{g}} \times \frac{1}{0.250\ \text{L}} = 0.643\ \text{M}$$

2. Calculate the mass of $AgNO_3$ required to make 200 mL of 0.40 M silver nitrate solution. ***3***

***Molar mass of $AgNO_3$ is 169.9 g/mol***

$$g = \frac{169.9\ \text{g}}{\text{mol}} \times \frac{0.40\ \text{mol}}{1} \times \frac{0.200\ \text{L}}{1} = 13.6\ \text{g}$$

3. What volume of a 1.44 M solution of potassium sulfide ($K_2S$) contains 113.0 g of $K_2S$? **3**

***Molar mass of $K_2S$ = 110.3 g/mol***

$$\text{L} = \frac{\text{L}}{1.44\ \text{mol}} \times \frac{\text{mol}}{110.3\ \text{g}} \times \frac{113.0\ \text{g}}{1} = 0.712\ \text{L}$$

4. A solution is prepared by adding enough water to 5.88 g of calcium hydroxide, $Ca(OH)_2$ to make a solution volume of 0.750 L.

a) Write a balanced equation for the dissociation reaction. **1**

**$Ca(OH)_2 \rightarrow Ca^{2+} + 2\ OH^-$**

b) Calculate the concentration of the calcium hydroxide solution. **3**

$$\text{M} = \frac{\text{mol}}{\text{L}} = \frac{5.88\ \text{g}}{1} \times \frac{\text{mol}}{74.1\ \text{g}} \times \frac{1}{0.750\ \text{L}} = 0.106\ \text{M}$$

c) Determine the concentration of the calcium ions, $Ca^{2+}$, and hydroxide ions, $OH^-$. **2**

$[Ca^{2+}] = [Ca(OH)_2] = 0.106$ M

$[OH^-] = 2 \times [Ca(OH)_2] = 0.212$

5. What volume of a 2.00 M NaOH stock solution would you require in order to prepare 250 mL of a 0.600 M NaOH solution? ***3***

**$M_1V_1 = M_2V_2$**

**$(2.0 \frac{\text{mol}}{\text{L}})(V_1) = (0.600\ \frac{\text{mol}}{\text{L}})(0.250\ \text{L})$**

**$V_1 = 0.075$ L or 75 mL**

6. A contaminated sample of water contains 325 ppm of lead ions, $Pb^{2+}$.
Calculate the concentration of lead ions in mol • $L^{-1}$. Show all work. ***2***

**Molar mass of Pb = 207.2 g/mol**

$$\frac{\text{mol}}{\text{L}} = \frac{325\ \text{g}}{10^6\,\text{g}} = \frac{325\ \text{g}}{10^6\,\text{mL}} = \frac{325\ \text{g}}{10^3\,\text{L}} \times \frac{\text{mol}}{207.2\ \text{g}} = \frac{325\ \text{mol}}{2.07 \times 10^5\,\text{L}} = 1.57 \times 10^{-3}\,\text{M}$$

7. A calcium nitrate solution, $Ca(NO_3)_2$, is mixed with an ammonium sulfate solution, $(NH_4)_2SO_4$.

   a. Write a **balanced** equation for this reaction. You must indicate the physical state of all participants. This will include predicting any precipitates that might form.

   $$Ca(NO_3)_{2(aq)} + (NH_4)_2SO_{4(aq)} \rightleftharpoons CaSO_{4\,(s)} + 2\ NH_4NO_{3\,(aq)}$$

   b. Write the ***net ionic equation*** for this reaction. ***2***

   $$Ca^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightleftharpoons CaSO_{4\,(s)}$$

8. Write the equations for the reactions that occur when each of the following electrolytes is dissolved in water AND the solubility product expressions

| Compound | Balanced Dissociation Equation | $K_{sp}$ Expression |
|---|---|---|
| $Ba(OH)_2$ | $Ba(OH)_{2(s)} \rightleftharpoons Ba^{2+}_{(aq)} + 2\ OH^-_{(aq)}$ | $K_{sp} = [Ba^{2+}][OH^-]^2$ |
| $Na_2CO_3$ | $Na_2CO_{3(s)} \rightleftharpoons 2\ Na^+_{(aq)} + CO_3^{2-}{}_{(aq)}$ | $K_{sp} = [Na^+]^2[CO_3^{2-}]$ |

9. At a certain temperature a saturated solution of calcium carbonate, $CaCO_3$, has a concentration of $7.1 \times 10^{-5}$ mol • $L^{-1}$. Calculate the value of $K_{sp}$ of calcium carbonate. **3**

$$CaCO_3 \rightleftharpoons Ca^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)}$$

$$[CaCO_3] = [Ca^{2+}] = [CO_3^{2-}] = 7.1 \times 10^{-5}\ M$$

$$K_{sp} = [Ca^{2+}][CO_3^{2-}] = (7.1 \times 10^{-5})(\ 7.1 \times 10^{-5}) = 5.04 \times 10^{-9}$$

10. Calculate the concentrations of barium ions, $Ba^{2+}$, and sulfate ions, $SO_4^{2-}$, in a saturated aqueous solution of barium sulfate, $BaSO_4$, in which the value of $K_{sp}$ is $1.1 \times 10^{-10}$.

$BaSO_4 \rightleftharpoons Ba^{2+} + SO_4^{2-}$

$[BaSO_4] = [Ba^{2+}] = [SO_4^{2-}] = x$

$K_{sp} = [Ba^{2+}]\,[SO_4^{2-}]$

$1.1 \times 10^{-10} = x^2$

$x = [Ba^{2+}] = [SO_4^{2-}] = 1.05 \times 10^{-5}$ M

11. You are given a solution that contains the following anions

$I^-$ $CO_3^{2-}$ $SO_4^{2-}$

You wish to separate these ions by causing one, and only one, ion to precipitate out of solution at a time. In order to do so you are provided with the following cations in solution (all are nitrate compounds):

$Ba^{2+}$ $Fe^{3+}$ $Pb^{2+}$.

In what order should you add these solutions in order to remove one anion at a time from the original solution, by precipitation? Give the formulas of the three precipitates that you will be forming. ***4***

| | **$I^-$** | **$CO_3^{2-}$** | **$SO_4^{2-}$** |
|---|---|---|---|
| **$Ba^{2+}$** | sol | ppt | ppt |
| **$Fe^{3+}$** | sol | ppt | sol |
| **$Pb^{2++}$** | ppt | ppt | ppt |

First add $Fe^{3+}$ to form the precipitate $Fe_2(CO_3)_3$

Second add $Ba^{2+}$ to form the precipitate $BaSO_4$

Third add $Pb^{2+}$ to form the precipitate $PbI_2$