CHEMISTRY

SOLUTIONS

TYPES OF SOLUTIONS

A solution is a ***Homogeneous Mixture***. This means that it has just one phase or "uniform" throughout. Most solutions are a mixture of two substances: The ***Solvent*** and the ***Solute***

SOLVENT:

SOLUTE:

Ex: Salt (a solute) will dissolve in Water (a solvent) to make a solution of saltwater.

Aqueous Solution: Any solution where water is the solvent.

Solubility and Saturation

Solubility is the ability of the solvent to dissolve the solute. This is accomplished by way of attractive forces. If the forces of the solvent are stronger than those of the solute, then the solute will dissolve.

There comes a point however, when the solvent can't dissolve any more solute. At this point, the solution is ***SATURATED***.

Solubility can be increased by raising the temperature of the solvent and can be decreased by lowering the temperature of the solvent. This implies, that a saturated solution can become unsaturated and dissolve more solute if it is heated (warm water will dissolve more salt than cold water). If the solution is cooled, the opposite happens (unsaturated becomes saturated).

CHEMISTRY

SOLUTIONS

THE CONCENTRATION OF SOLUTIONS

- The concentration of a solution depends on the amount of solute in a given amount of solvent. There are many different ways to measure the concentration of a solution:

Mass/Volume Percent

Mass/Volume percent is usually of the form *g/100mL* and can be calculated using the following formula:

$$\text{Mass/Volume Percent} = \frac{\text{Mass of Solute (in g)}}{\text{Volume of Solution (in mL)}} \times 100\%$$

Ex 1. *A pharmacist adds 2.0 mL of distilled water to 4.0 g of a powdered drug. The final volume is 3.0 mL. What is the concentration of the drug in g/100mL of solution?*

CHEMISTRY

SOLUTIONS

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Ex 2. An aqueous solution of $CaCl_2$ has a total mass of 23.47 g. The solution is then boiled to remove all the water and leaves a 4.58 g mass of $CaCl_2$. What is the concentration of the solution in g/100g?

CHEMISTRY

SOLUTIONS

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Ex 3. Rubbing alcohol is commonly used as an antiseptic for small cuts. It is sold as a 70% (v/v) solution of isopropyl alcohol in water. What volume of isopropyl alcohol is used to make 500 mL of rubbing alcohol?

CHEMISTRY

SOLUTIONS

Molar Concentration

The most useful unit of concentration in chemistry is molar concentration. Molar concentration is the number of moles of solute dissolved in 1 L of solvent and is referred to as ***Molarity***. The formula for calculating molarity is:

$$\text{Molar Concentration (in mol/L)} = \frac{\text{Amount of Solute (in mol)}}{\text{Volume of Solution (in L)}}$$

Ex. 5 A saline solution contains 0.90 g of NaCl dissolved in 100 mL of solution. What is the molarity of the solution?

Ex. 6 A solution of $CaSO_4$ has a concentration of 1.53 mol/L. A student takes 65 mL of this solution and evaporates it. What mass (in g) is left in the evaporating dish?

CHEMISTRY

SOLUTIONS

Pg. 381

Practice Problems

41. Find the molar concentration of each saline solution.
- **a.** 0.60 mol NaCl(s) dissolved in 0.40 L of solution
- **b.** 0.90 g NaCl(s) dissolved in 100 mL of solution

42. What volume of 0.25 mol/L solution can be made using 14 g of sodium hydroxide?

43. Calculate the molar concentration of each solution.
- **a.** 14 g of copper(II) sulfate, $CuSO_4(s)$, dissolved in 70 mL of solution
- **b.** 5.07 g of sucrose, $C_{12}H_{22}O_{11}(s)$, dissolved in 23.6 mL of solution
- **c.** 1.1 g of calcium nitrate, $Ca(NO_3)_2(s)$, dissolved in 70 mL of solution

44. At 20°C, a saturated solution of calcium sulfate, $CaSO_4(aq)$, has a concentration of 0.0153 mol/L. A student takes 65 mL of this solution and evaporates it. What mass of solute should be left in the evaporating dish?

45. Find the mass of solute in each aqueous solution.
- **a.** 28 mL of 0.045 mol/L calcium hydroxide, $Ca(OH)_2(aq)$
- **b.** 50 mL of 4.0 mol/L acetic acid, $CH_3COOH(aq)$
- **c.** 5.31 L of 0.675 mol/L ammonium phosphate, $(NH_4)_3PO_4(aq)$

46. Calculate the molar concentrations of the ions in each solution.
- **a.** 18 g of sodium sulfate, $Na_2SO_4(s)$, dissolved in 210 mL of solution
- **b.** 15 g of ammonium phosphate, $(NH_4)_3PO_4(s)$, dissolved in 98 mL of solution
- **c.** 20 mg of calcium phosphate, $Ca_3(PO_4)_2(s)$, dissolved in 1.7 L of solution

47. A student dissolves 28.46 g of silver nitrate, $AgNO_3(s)$, in water to make 580 mL of solution. Find the molar concentration of the solution.

48. Formalin is an aqueous solution that is made by dissolving formaldehyde gas, HCHO(g), in water. A saturated formalin solution has a concentration of about 37% (m/v). This concentration is used to preserve biological specimens. Calculate the molar concentration of 37% (m/v) formalin.

49. What volume of a 0.555 mol/L aqueous solution contains 12.8 g of sodium carbonate, $Na_2CO_3(aq)$?

50. Zinc oxide, ZnO(s), has a solubility of 0.16 mg/100 mL in water at 30°C. Find the molar concentration of a saturated solution of zinc oxide at 30°C.

41. **a.** 1.5 mol/L
b. 0.2 mol/L
42. 1.4 L
43. **a.** 1 mol/L
b. 0.628 mol/L
c. 0.1 mol/L
44. 0.14 g
45. **a.** 0.093 g
b. 10 g
c. 534 g
46. **a.** $Na^+(aq) = 1.2$ mol/L; $SO_4^{2-}(aq) = 0.60$ mol/L
b. $NH_4^+(aq) = 3.1$ mol/L; $PO_4^{3-}(aq) = 1.0$ mol/L
c. $Ca^{2+}(aq) = 1 \times 10^{-4}$ mol/L; $PO_4^{3-}(aq) = 8 \times 10^{-5}$ mol/L
47. 0.29 mol/L
48. 12 mol/L
49. 218 mL
50. 2.0×10^{-5} mol/L