Solutions

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1. Water

- Water is a polar covalent compound, it has hydrogen bonds between molecules.
- Liquid, colorless, odorless and tasteless, freezes at 0°C and boils at 100°C.
- Reacts with active metals (Li, K, Ca, Na, Mg,) easily, and reacts with moderately active metals (Mn, Zn, Cr, Fe, Ni, Sn, Pb) at high temperature, and does not react with inactive metals (Cu, Hg, Ag, Pt, Au).

  $2Na + 2H_2O \rightarrow 2NaOH + H_2 \uparrow$

  $3Fe + 4H_2O + temp. \rightarrow Fe_3O_4 + 4H_2 \uparrow$
- Electrolyze as follows $2H_2O$ + Electricity → $2H_2\uparrow + O_2\uparrow$
- **Water can be purified**
  - Filtration of big particles,
  - Chlorination $Cl_2 + H_2O \leftrightarrow HCl + HClO$
  - Elemination of suspended particles through addition of aluminum salt and lime water.

    $Al_2(SO_4)_3 + 3Ca(OH)_2 \rightarrow 2Al(OH)_3 \downarrow + 3CaSO_4$
  - Decantation
  - Filtration with sand
  - Chlorination again.
- **Two types of water hardness**,
  - Temporarily (because of $Ca(HCO_3)_2$, $Mg(HCO_3)_2$), can be eliminated with boiling or using Na_2CO_3 or $Ca(OH)_2$.
  - Permanently (because of $CaSO_4$, $MgSO_4$, $CaCl_2$, $MgCl_2$), can be eliminated by using Na_2CO_3.

2. Solutions

- Homogeneous mixtures of two or more substances. There are two parts in solutions; solvent and solute(s).
- **Solubility** is the maximum amount of solute dissolved in 100 g of water to make a saturated solution at 25°C.
- **Saturated solution** contains maximum amount of solute dissolved, **unsaturated solution** contains less amount of solute than it can dissolve.
- **Dilution** is simply adding solvent to more concentrated solution to make it dilute solution.
- **Electrolytic solutions** dissolve in water and produce ions such as NaCl, Na_2CO_3, HNO_3, H_2SO_4, NaOH ...etc. are able to cunduct electricity.
- **Non electrolytic solutions** dissolve in water but do not produce ions such as sugar, iodine, alcohol oxygen gas ...etc are unable to conduct electricity.
- Degree of dissociation is calculated by number dissolved molecules to total number of molecules.
- Strong electrolytes dissolve by 30-100%, medium electrolytes by 3-30% and non electrolytes by 0-3%.
- All soluble salts (NaCl, KNO_3, LiBr), strong acids (HNO_3, H_2SO_4, HCl, $HClO_4$, HBr, HI) and alkaline bases (NaOH, KOH, LiOH, $Ba(OH)_2$, $Ca(OH)_2$)are strong electrolytes.
- H_3PO_4 and H_2SO_3 are moderately strong electrolytes.
- Water, weak acids (H_2CO_3, H_2SiO_3, HNO_2, HCN, HF, CH_3COOH), insoluable bases ($Cu(OH)_2$, $Fe(OH)_3$) and NH_4OH are non electrolytes**.**
- Dissociation reactions of weak and non electrolytes are reversible.

  $H_2CO_3 \leftrightarrow H^+ + HCO_3^-$ 1st step

  $HCO_3^- \leftrightarrow H^+ + CO_3^{2-}$ 2nd step

- In ionic reactions there are three possibilties, might produce water, a gas or a precipitate.

  $Na_2SO_4 + BaCl_2 \rightarrow BaSO_4 \downarrow + 2NaCl$

  $KOH + HCl \rightarrow KCl + H_2O$

  $Na_2S + HCl \rightarrow NaCl + H_2S \uparrow$

3. Types of Concentratios

A. Percent Concentration by Mass:

$\omega = \frac{m_{solute}}{m_{solution}} x100$, $m_{solution} = \rho_{solution} x V_{solution}$

B. Molar Concentration:

$\boldsymbol{C = \frac{n}{V}}$, $\boldsymbol{mol/L}$

4. Some solutions in life

- 2% $NaHCO_3$ solution used in gargle,
- 10% NaCl solution used in vegetable preservation
- 20% sugar solution used in compote.
- 1% $KMnO_4$ solution in disinfection
- 9% CH_3COOH solution used in food such as in salads
- 70% CH_3COOH solution used in vegetable preservation
- 5% I_2 solution in alcohol used in disinfection of wounds.

5. Review Questions

Example 1

One of the methods for bleaching the teeth is based on the chemical removal of the outer layer with a solution of 20% by mass of hydrochloric acid.

Calculate the volume of hydrochloric acid solution with a molar concentration of 10 mol/L HCl to prepare a solution of 400 mL hydrochloric acid with a density of 1.1 g/mL and 20% HCl by mass.

Example 2

One component of the "Acidanon", used to lower the acidity of the gastric juice to treat gastritis, is aluminum hydroxide.

A 133.5 g of 10% $AlCl_3$ solution reacted with a 300 mL of 0.2 mol/L concentration of KOH solution.

Calculate the number of “Acidanon" tablets can be prepared from the precipitate obtained above reaction if one tablet contains 0.26 g aluminum hydroxide.

Example 3

Magnesium chloride is used as coagulant in preparation of cheese “tofu” – a plant product from soy milk that is very popular in all kitchens of the world.

A 280 g sample of technical magnesium with 10% impurities was treated with 2-L of 1.5 mol/L hydrochloric acid solution. Calculate the mass of the magnesium chloride obtained.

Example 4

Natural deodorants contain sodium carbonate which absorbs efficiently sweat and zinc oxide which has antiseptic properties. For sensitive skin it is recommended to use deodorants in which the level of zinc oxide is at least twice higher than that of sodium carbonate.

A 200 g mixture of zinc oxide and sodium carbonate was treated with concentrated hydrochloric acid. As a result 11.2 L at STP a gas was obtained.

A. Calculate the mass percent of each component in the mixture.
B. Considering the calculated mass parts, determine if the deodorant obtained from this mixture is enough for sensitive skin.

Example 5

Calcium chloride is added to marinades to conserve tomatoes and cucumbers to avoid deformation of vegetables as a result of heat treatment.

As a result of the reaction between hydrochloric acid with a 80 g sample of limestone, 15.68 L of carbon dioxide at STP is eliminated.

A. Determine the percentage of calcium carbonate in the sample of limestone.
B. Calculate, if calcium chloride obtained is enough for the preparation of 75 kg marinades with 0.1% $CaCl_2$ by mass.

Example 6

The beneficial effect of saline baths has been known since ancient times. Sodium chloride removes fatigue, and magnesium sulphate has therapeutic action, relieving rheumatic pain. The predominance in the saline mixture of one of the components determines the effect of the bath received.

A "VitaSAL" bath sample of 300 g, made up of sodium chloride and magnesium sulfate, was dissolved in water and the solution obtained was treated with excess barium nitrate. As a result, a white precipitate with a mass of 466 g was obtained.

A. Calculate the mass percent of each component in the mixture.

B. Based on the calculated parts, determine whether "VitaSAL" can be recommended as a therapeutic bath salt.