Chemistry 20 - Unit 4 - Solution Stoichiometry

Name: _____

1) Some antacid products contain aluminium hydroxide to neutralize excess stomach acid. Determine the volume of 0.10 mol/L stomach acid (assumed to be $HCl_{(aq)}$) that can be neutralized by 912 mg of aluminium hydroxide in an antacid tablet.

$$Al(OH)_{3(aq)} + 3HCl_{(aq)} \rightarrow 3H_2O_{(l)} + AlCl_{3(aq)}$$

$m = 912\,mg$ $\quad$ $0.10\,M$

$M = 78.01\,g/mol$ $\quad$ $V = ?$

$$n_{Al(OH)_3} = 912\,mg \times \frac{1\,mol}{78.01\,g} = 11.7\,mmol$$

$$n_{HCl} = 11.7\,mmol \times \frac{3}{1} = 35.1\,mmol$$

$$V_{HCl} = 35.1\,mmol \times \frac{1\,L}{0.10\,mol} = \boxed{351\,mL}$$

2) Slaked lime can be added to an aluminium sulfate solution in a water treatment plant to clarify the water. Fine particles in the water stick to the precipitate produced. Calculate the volume of 0.0250 mol/L calcium hydroxide solution required to react completely with 25.0 mL of 0.125 mol/L aluminium sulfate solution.

$$Al_2(SO_4)_{3(aq)} + 3Ca(OH)_{2(aq)} \rightarrow 3CaSO_{4(s)} + 2Al(OH)_{3(s)}$$

$25.0\,mL$ $\quad$ $V = ?$

$0.125\,M$ $\quad$ $0.0250\,M$

$$n_{Al_2(SO_4)_3} = \frac{0.125\,mol}{1\,L} \times 25.0\,mL = 3.13\,mmol$$

$$n_{HCl} = 3.13\,mmol \times \frac{3}{1} = 9.38\,mmol$$

$$V_{HCl} = 9.38\,mmol \times \frac{1\,L}{0.0250\,mol} = \boxed{375\,mL}$$

3) Sulfuric acid is produced on a large scale from readily available raw materials. One step in the industrial production of sulfuric acid is the reaction of sulfur trioxide with water. Calculate the amount concentration of sulfuric acid produced by the reaction of 10.0 Mg of sulfur trioxide with an excess quantity of water to produce 7.00 kL of acid.

$$SO_{3(g)} + H_2O_{(l)} \rightarrow H_2SO_{4(aq)}$$

$10.0\,Mg = 10.0 \times 10^6\,g$ $\quad$ $C = ?$

$M = 80.07\,g/mol$ $\quad$ $V = 7.00\,kL$

$7.00 \times 10^3\,L$

$$n_{SO_3} = 10.0 \times 10^6\,g \times \frac{1\,mol}{80.07\,g} = 1.25 \times 10^5\,mol$$

$$n_{H_2SO_4} = 1.25 \times 10^5\,mol \times \frac{1}{1} = 1.25 \times 10^5\,mol$$

$$C_{H_2SO_4} = 1.25 \times 10^5\,mol \times \frac{1}{7.00 \times 10^3\,L} = \boxed{17.8\,M}$$

4) 5.844 x 10^4 milligrams of sodium chloride are dissolved in 2.50 L of water. This mixture then reacts with a 0.350 mol/L lithium sulfide solution. What is mass of lithium chloride produced in this reaction?

$$2\,NaCl_{(aq)} + Li_2S_{(aq)} \rightarrow 2\,LiCl_{(aq)} + Na_2S_{(aq)}$$

5.844×10^4 mg, 0.350 M, m = ??

58.44 g, M = 58.44 g/mol, M = 42.39 g/mol

$$n_{NaCl} = 58.44\,g \times \frac{1\,mol}{58.44\,g} = 1.000\,mol$$

$$n_{LiCl} = 1.000\,mol \times \frac{2}{2} = 1.000\,mol$$

$$m_{LiCl} = 1.000\,mol \times \frac{42.39\,g}{mol} = \boxed{42.39\,g}$$

5) 35.50 mL of 15.0 mmol/L acetic acid reacts with 12.50 grams of solid baking soda (sodium hydrogen carbonate.). What is the volume of gas produced in this reaction?

(Assume SATP, and you may need to look up this chemical reaction)

$$CH_3COOH_{(aq)} + NaHCO_{3(s)} \rightarrow NaCH_3COO_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$

15.0 mmol/L, 12.50 g, 0.03550 L, M = 84.01 g/mol

$$n_{NaHCO_3} = 12.50\,g \times \frac{1\,mol}{84.01\,g} = 0.1488\,mol \text{ (Excess)}$$

$$n_{CH_3COOH} = \frac{15.0\,mmol}{L} \times 0.03550\,L = 0.533\,mmol \text{ (Much smaller Limiting)}$$

$$n_{CO_2} = 0.533\,mmol \times \frac{1}{1} = 0.533\,mmol$$

$$V_{CO_2} = \frac{nRT}{P} = \frac{(0.533\,mmol)(8.3145)(298.15\,K)}{(100.00\,kPa)} = \boxed{13.2\,mL}$$