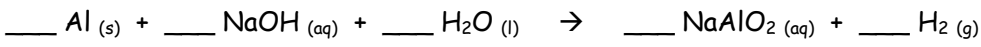
Stoichiometry & Molar Concentrations

Name - _____

1.) A student wants to put $50.0\ L$ of hydrogen gas at STP into a plastic bag by reacting excess aluminum metal with $3.00\ M$ of sodium hydroxide solution according to the reaction below. What volume of NaOH solution is required?



2.) What volume of $0.250\ M\ HCl$ is required to completely neutralize $25.0\ mL$ of $0.318\ M$ NaOH? (Hint - balanced equation?)

3.) A technician analyzes a sample of water from the "tailings" pond of a mine for the presence of mercury. After treating and concentrating the water sample, the technician carries out the titration reaction found below. A $25.0\ mL$ sample of the water containing mercury reacts with $15.4\ mL$ of $0.0148\ M$ Cl^-.

a.) What is the molar concentration of the mercury in the water sample?

b.) What mass of $HgCl_2$ is formed in the reaction?

4.) A $0.10\ mL$ sample of saturated solution of $Ca(OH)_2$ is reacted with $23.5\ mL$ of $0.0156\ M$ HCl.

a.) What is the molarity of the $Ca(OH)_2$ in the saturated solution?

b.) What mass of $Ca(OH)_2$ is dissolved in $250.0\ mL$ of saturated $Ca(OH)_2$ solution?

5.) A student titrates a $2.00\ mL$ sample of hydrogen peroxide solution, $H_2O_{2\ (aq)}$, according to the reaction

$$2\ MnO_4^-{}_{(aq)} + 5\ H_2O_{2\ (aq)} + 6\ H^+{}_{(aq)} \rightarrow 2\ Mn^{+2}{}_{(aq)} + 5\ O_{2\ (g)} + 8\ H_2O_{(l)}$$

The supply bottle of hydrogen peroxide is labelled as "3.00% by volume" ($3.00\ mL$ of H_2O_2 per $100\ mL$ of solution), which the student calculates to have $[H_2O_2] = 1.24\ M$.

a.) What volume of $0.0496\ M$ MnO_4^- is required for the titration?

b.) What volume of $O_{2\ (g)}$ at STP is produced during the reaction?

6.) A $1.00\ mL$ sample of pure phosphoric acid, H_3PO_4, is titrated with $43.8\ mL$ of $0.853\ M$ NaOH according to the reaction ___ NaOH + ___ H_3PO_4 → ___ Na_2HPO_4 + ___ H_2O

a.) What is the molar concentration of pure H_3PO_4?

b.) Calculate the density of pure H_3PO_4.

7.) The iron present in a sample of iron ore is converted to Fe^{+2} and titrated with the dichromate ion

$$Cr_2O_7^{-2} + 6\ Fe^{+2} + 14\ H^+ \rightarrow 2\ Cr^{+3} + 6\ Fe^{+3} + 7\ H_2O$$

When $17.6\ mL$ of $0.125\ M$ dichromate ion is required to react a $25.0\ mL$ sample of Fe^{+2} solution,

a.) What is the molarity of the Fe^{+2}?

b.) What mass of iron is present in the $25.0\ mL$ sample?

8.) Prior to analyzing a fertilizer sample containing NH_4NO_3, a chemist makes a test solution by dissolving $15.5\ g$ of pure NH_4NO_3 and diluting it to $500.0\ mL$. If the chemist wishes to carry out the titration reaction ___ $NH_4NO_{3\ (aq)}$ + ___ $NaOH_{(aq)}$ → ___ $NH_{3\ (g)}$ + ___ $H_2O_{(l)}$ + ___ $NaNO_{3\ (aq)}$

such that the reaction requires $25.0\ mL$ of NaOH when $10.0\ mL$ of the NH_4NO_3 solution is titrated,

a.) What is the molarity of the NaOH they should use?

b.) What volume of $NH_{3\ (g)}$ at STP would be produced?

9.) The CO_2 content of a $10.0\ L$ sample of air at STP is determined as follows. The air pumped through a flask containing $25.0\ mL$ of $0.0538\ M$ $Ba(OH)_2$, precipitating the CO_2 present as $BaCO_3$

___ $Ba(OH)_{2\ (aq)}$ + ___ $CO_{2\ (g)}$ → ___ $BaCO_{3\ (s)}$ + ___ $H_2O_{(l)}$

a.) How many moles of $Ba(OH)_2$ are present in the original $Ba(OH)_2$ solution?

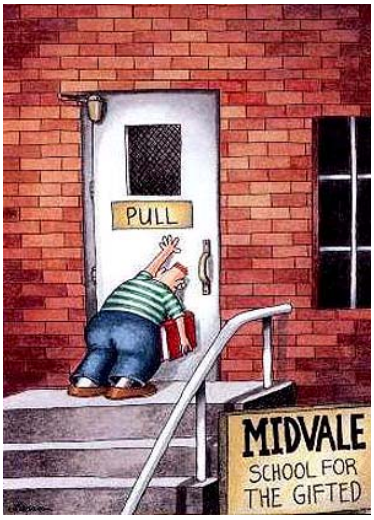
b.) Only a small amount of the $Ba(OH)_2$ present reacts with the added CO_2. The remaining unreacted $Ba(OH)_2$ is titrated with hydrochloric acid according to the equation

$Ba(OH)_2 + 2\ HCl \rightarrow BaCl_2 + 2\ H_2O$ If the titration requires $23.0\ mL$ of $0.104\ M$ HCl, how many moles of $Ba(OH)_2$ solution after reacting with the CO_2 in the air?

c.) How many moles of $Ba(OH)_2$ are reacted by the CO_2?

d.) How many moles of CO_2 are in the sample of air?

e.) How many litres of CO_2 at STP are contained in the $10.0\ L$ sample of air? What percentage of the air sample's volume is CO_2?



Answers – 1.) $2\ Al_{(s)} + 2\ NaOH_{(aq)} + 2\ H_2O_{(l)} \rightarrow 2\ NaAlO_{2\ (aq)} + 3\ H_{2\ (g)}$ $0.496\ L$

2.) $HCl + NaOH \rightarrow NaCl + H_2O$ $0.0318\ L$ 3a.) $0.00456\ M$ b.) $0.0310\ g$

4.) $Ca(OH)_2 + 2\ HCl \rightarrow CaCl_2 + 2\ H_2O$ a.) $1.83\ M$ b.) $33.9\ g$ 5a.) $0.0200\ L$ b.) $0.0556\ L$

6.) $2\ NaOH + H_3PO_4 \rightarrow Na_2HPO_4 + 2H_2O$ a.) $18.7\ M$ b.) $1830\ \frac{g}{L}$ 7a.) $0.528\ M$ b.) $0.737\ g$ 8a.) $0.155\ M$ b.) $0.0868\ L$

9a.) $0.00135\ mol$ b.) $0.00120\ mol$ c.) $0.000149\ mol$ d.) $0.000149\ mol$ e.) $0.00345\ L$