

## Stoichiometry

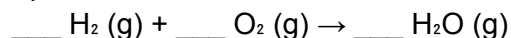
1.) In the reaction  $\text{___ C}_2\text{H}_6 + \text{___ O}_2 \rightarrow \text{___ CO}_2 + \text{___ H}_2\text{O}$

- How many oxygen molecules react with 6 mol of  $\text{C}_2\text{H}_6$ ?
- How many  $\text{H}_2\text{O}$  molecules are produced when 12 mol of  $\text{C}_2\text{H}_6$  react?
- How many moles of oxygen molecules are needed to produce 18 mol of  $\text{CO}_2$ ?
- How many moles of  $\text{CO}_2$  are produced when 13 mol of  $\text{C}_2\text{H}_6$  are used up?

2.) In the reaction  $\text{___ Fe} + \text{___ H}_2\text{O} \rightarrow \text{___ Fe}_3\text{O}_4 + \text{___ H}_2$

- How many molecules of  $\text{Fe}_3\text{O}_4$  are produced when 12 mol of Fe react?
- How many moles of Fe are required to produce 16 mol of  $\text{H}_2$ ?
- How many  $\text{H}_2$  molecules are made when 40 mol of  $\text{Fe}_3\text{O}_4$  are produced?
- How many moles of  $\text{H}_2\text{O}$  are required to react with 14.5 mol of Fe?

3.) How many moles of  $\text{H}_2\text{O}$  are produced when 9.6 mol of  $\text{O}_2$  (g) react according to the equation:



4.) Consider the equation  $\text{___ I}_2 \text{ (g)} + \text{___ F}_2 \text{ (g)} \rightarrow \text{___ IF}_5 \text{ (g)} + \text{___ I}_4\text{F}_2 \text{ (g)}$

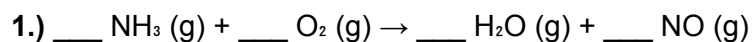
- How many moles of  $\text{I}_4\text{F}_2$  (g) are produced by 5.40 mol of  $\text{F}_2$  (g)?
- How many moles of  $\text{F}_2$  (g) are required to produce 4.50 mol of  $\text{IF}_5$  (g)?
- How many moles of  $\text{I}_2$  (g) are required to react with 7.60 mol of  $\text{F}_2$  (g)?

5.) A student decomposes some hydrogen peroxide,  $\text{H}_2\text{O}_2$ , according to the following reaction:

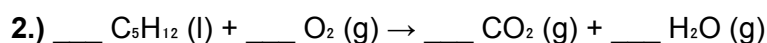


If a total of 0.125 mol of reactants and products are involved in the reaction, how many moles of  $\text{O}_2$  are produced

## More Stoichiometry



- a.) What mass of NO (g) is produced when 2.00 g of NH<sub>3</sub> (g) are reacted with excess O<sub>2</sub> (g)?
- b.) What mass of H<sub>2</sub>O (g) is produced when 4.00 g of O<sub>2</sub> (g) are reacted with excess NH<sub>3</sub> (g)?
- c.) What volume of NH<sub>3</sub> (g) at STP is required to react with 3.00 g of O<sub>2</sub>?
- d.) What volume of NH<sub>3</sub> (g) at STP is required to react with 0.750 g of H<sub>2</sub>O (g)?



- a.) What mass of CO<sub>2</sub> (g) is produced when 100.0 g of C<sub>5</sub>H<sub>12</sub> (l) is burned?
- b.) What mass of O<sub>2</sub> is required to produce 60.0 g of H<sub>2</sub>O (l)?
- c.) What mass of C<sub>5</sub>H<sub>12</sub> (l) is required to produce 90.0 g of CO<sub>2</sub> (g) at STP?
- d.) What volume of O<sub>2</sub> (g) at STP is required to produce 70.0 g of CO<sub>2</sub> (g)?
- e.) What volume of O<sub>2</sub> (g) at STP is required to produce 48.0 g of CO<sub>2</sub> (g)?
- f.) What mass of H<sub>2</sub>O (l) is made when the burning of C<sub>5</sub>H<sub>12</sub> gives 106 g of CO<sub>2</sub> (g) at STP?

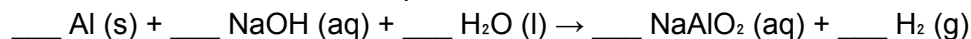
3.) Tetraethyl lead, Pb(C<sub>2</sub>H<sub>5</sub>)<sub>4</sub>, is an “antiknock” ingredient which was added to some gasoline. Tetraethyl lead burns according to this equation:



- a.) What volume of O<sub>2</sub> (g) at STP is consumed when 100.0 g of PbO (s) are formed?
- b.) How many molecules of CO<sub>2</sub> are formed when  $1.00 \times 10^{24}$  molecules of tetraethyl lead are burned?
- c.) How many molecules of H<sub>2</sub>O are formed when 135 g of O<sub>2</sub> react?
- d.) What volume of O<sub>2</sub> (g) at STP, in mL, is required to react with  $1.00 \times 10^{23}$  molecules of tetraethyl lead?

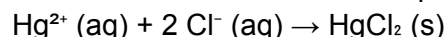
## Molarity

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: balance the equation)

3.) A technician analyzes a sample of water from a mine's tailings pond for mercury. After treatment, a 25.0 mL water sample reacts with 15.4 mL of 0.0148 M  $\text{Cl}^-$  solution.

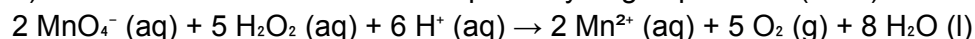


- What is the molar concentration of mercury in the water sample?
- What mass of  $\text{HgCl}_2$  is formed in the reaction?

4.) A 0.10 mL sample of saturated  $\text{Ca(OH)}_2$  solution reacts with 23.5 mL of 0.0156 M HCl.

- What is the molarity of  $\text{Ca(OH)}_2$  in the saturated solution?
- What mass of  $\text{Ca(OH)}_2$  is dissolved in 250.0 mL of the saturated solution?

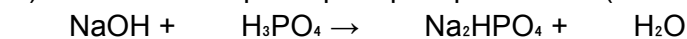
5.) A student titrates a 2.00 mL sample of hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) solution:



The solution is labeled as "3.00% by volume" = 1.24 M  $\text{H}_2\text{O}_2$ .

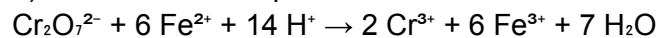
- What volume of 0.0496 M  $\text{MnO}_4^-$  is required for the titration?
- What volume of  $\text{O}_2$  (g) at STP is produced during the reaction?

6.) A 1.00 mL sample of pure phosphoric acid ( $\text{H}_3\text{PO}_4$ ) is titrated with 43.8 mL of 0.853 M NaOH.



- What is the molar concentration of pure  $\text{H}_3\text{PO}_4$ ?
- Calculate the density of pure  $\text{H}_3\text{PO}_4$ .

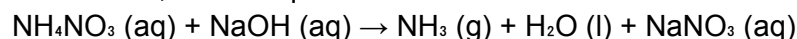
7.) The iron in a sample of iron ore is converted to  $\text{Fe}^{2+}$  and titrated with dichromate:



A 25.0 mL sample of  $\text{Fe}^{2+}$  requires 17.6 mL of 0.125 M dichromate.

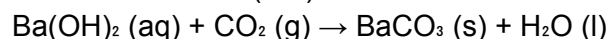
- What is the molarity of  $\text{Fe}^{2+}$ ?
- What mass of iron is present in the 25.0 mL sample?

8.) A chemist dissolves 15.5 g of pure  $\text{NH}_4\text{NO}_3$  and dilutes it to 500.0 mL. They titrate 10.0 mL of this solution, and it requires 25.0 mL of NaOH.



- What is the molarity of NaOH they should use?
- What volume of  $\text{NH}_3$  (g) at STP is produced?

9.) The  $\text{CO}_2$  content of a 10.0 L sample of air at STP is determined by bubbling it through 25.0 mL of 0.0538 M  $\text{Ba(OH)}_2$ .



- a.) How many moles of  $\text{Ba}(\text{OH})_2$  are present in the solution?
- b.) The remaining  $\text{Ba}(\text{OH})_2$  is titrated with 23.0 mL of 0.104 M HCl. How many moles of  $\text{Ba}(\text{OH})_2$  remain?
- c.) How many moles of  $\text{Ba}(\text{OH})_2$  reacted with  $\text{CO}_2$ ?
- d.) How many moles of  $\text{CO}_2$  are in the air sample?
- e.) How many litres of  $\text{CO}_2$  at STP are in the 10.0 L air sample? What percentage of the air is  $\text{CO}_2$ ?

## Dilutions

1. How much concentrated 18 M sulfuric acid is needed to prepare 200 mL of a 6.0 M solution?

2. How much concentrated 12 M hydrochloric acid is needed to prepare 100 mL of a 2.0 M solution?

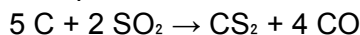
3. To what volume should 25 mL of 15 M nitric acid be diluted to prepare a 3.0 M solution?

4. To how much water should 50. mL of 12 M hydrochloric acid be added to produce a 4.0 M solution?

5. To how much water should 100. mL of 18 M sulfuric acid be added to prepare a 1.5 M solution?

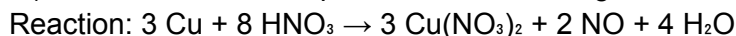
## Limiting Reagent

1a) What mass of CS<sub>2</sub> is produced when 17.5 g of C are reacted with 39.5 g of SO<sub>2</sub> according to the equation:



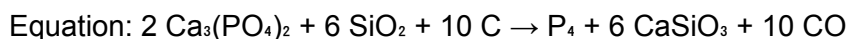
1b) What mass of the excess reactant will be left over?

2a) What mass of NO is produced when 87.0 g of Cu are reacted with 225 g of HNO<sub>3</sub>?



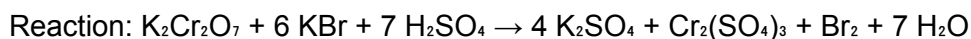
2b) What mass of the excess reactant will be left over?

3a) What mass of P<sub>4</sub> is produced when 41.5 g of Ca<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>, 26.5 g of SiO<sub>2</sub>, and 7.80 g of C are reacted?



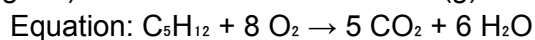
3b) How many grams of each excess reactant will remain unreacted?

4a) What mass of Br<sub>2</sub> is produced when 25.0 g of K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>, 55.0 g of KBr, and 60.0 g of H<sub>2</sub>SO<sub>4</sub> are reacted?



4b) How many grams of each excess reactant will remain unreacted?

5. What volume of CO<sub>2</sub> (g) at STP can be made when 0.0250 L of C<sub>5</sub>H<sub>12</sub> (l) (density = \_\_\_\_ g/mL) is reacted with 40.0 L of O<sub>2</sub> (g) at STP?

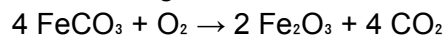


6. If 50.0 mL of 0.100 M HCl is allowed to react with 30.0 mL of 0.200 M NaOH, which is the reactant in excess?
7. If 0.250 g of Ba(OH)<sub>2</sub> is mixed with 15.0 mL of 0.125 M HBr, what mass of BaBr<sub>2</sub> can be formed?

## Percentage Yield

1.)

The roasting of siderite ore,  $\text{FeCO}_3$ , produces iron(III) oxide:



A 35.0 g sample of siderite ore produces 22.5 g of  $\text{Fe}_2\text{O}_3$ .

What is the percentage yield of the reaction?

2.)

The reaction  $\text{SiO}_2 + 4 \text{HF} \rightarrow \text{SiF}_4 + 2 \text{H}_2\text{O}$  produces 2.50 g of  $\text{H}_2\text{O}$  when 12.20 g of  $\text{SiO}_2$  is treated with excess HF.

- a) What mass of  $\text{SiF}_4$  is formed?
- b) What mass of  $\text{SiO}_2$  is left unreacted?
- c) What is the percentage yield of  $\text{SiF}_4$ ?

3.)

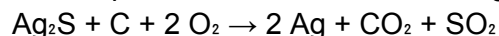
When 5.00 kg of malachite ore containing 4.30%  $\text{Cu}_2(\text{OH})_2\text{CO}_3$  is heated, the product is copper(II) oxide:



If the reaction has an 84.0% yield, how many grams of CuO are produced?

4.)

A mine produces silver ore named argentite,  $\text{Ag}_2\text{S}$ . The ore is smelted:



A 152.6 g sample of pure  $\text{Ag}_2\text{S}$  produces 117.4 g of pure silver.

What is the percentage yield of the smelting process?