Name: _____
Hour: ____ Date: _____

Chemistry: *Quantitative Relationships in Chemical Equations*

When we balance a chemical equation, we are satisfying the law of conservation of mass; that is, we are making sure that there are the same number of atoms of each element on both sides of the equation. The coefficients we place in front of the substances in an equation are very important because they tell us the mole ratio of the substances in that reaction. For instance, the balanced equation…

hydrogen gas + oxygen gas → liquid water

$2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(l)$

can be thought of in terms of…

2 moles $H_2(g)$ + 1 mole $O_2(g)$ → 2 moles $H_2O(l)$

Directions:

A. Balance each equation.
B. *Solve the problems, assuming that you have excess of the other reactant(s).*

1. ____ $Ca(s)$ + ____ $N_2(g)$ → ____ $Ca_3N_2(s)$

   a. How many moles of Ca_3N_2 can be made from 16.8 moles of Ca?

   b. If you need to make 34.4 moles of Ca_3N_2, how many moles of N_2 will you need?

2. ____ $Fe(s)$ + ____ $O_2(g)$ → ____ $Fe_3O_4(s)$

   a. How many moles of O_2 will react with 42.5 moles of Fe?

   b. If you need to make 1.56 moles of Fe_3O_4, how many moles of Fe will you need?

3. ____ $FeCl_2(aq)$ + ____ $KOH(aq)$ → ____ $Fe(OH)_2(s)$ + ____ $KCl(aq)$

   a. How many moles of KOH will react with 86.2 moles of $FeCl_2$?

   b. If you need to make 12.4 moles of KCl, how many moles of $FeCl_2$ will you need?

4. ____ $Cu(s)$ + ____ $O_2(g)$ → ____ $Cu_2O(s)$

a. How many moles of Cu_2O can be made from 25.6 moles of Cu?

b. How many moles of O_2 does it take to produce 214 moles of Cu_2O?

5. ____ $K(s)$ + ____ $Cl_2(g)$ + ____ $O_2(g)$ → ____ $KClO_3(s)$

a. How many moles of $KClO_3$ can be made from 89 moles of O_2?

b. If you have 24.6 moles of Cl_2, how many moles of $KClO_3$ can you produce?

6. ____ $NH_3(g)$ + ____ $H_2S(g)$ → ____ $(NH_4)_2S(s)$

a. How many moles of $(NH_4)_2S$ can be made from 15.8 moles of NH_3?

b. If you have 462 moles of NH_3, how many moles of H_2S do you need?

7. ____ $Al_2O_3(s)$ + ____ $H_2SO_4(aq)$ → ____ $Al_2(SO_4)_3(aq)$ + ____ $H_2O(l)$

a. How many moles of $Al_2(SO_4)_3$ can be made from 6.3 moles of H_2SO_4?

b. How many moles of Al_2O_3 does it take to make 7.2 moles of H_2O?

c. If you have 588 moles of Al_2O_3, how many moles of $Al_2(SO_4)_3$ can you produce?

Answers:

1a. 5.6 mol Ca_3N_2
1b. 34.4 mol N_2
2a. 28.3 mol O_2
2b. 4.68 mol Fe
3a. 172.4 mol KOH
3b. 6.2 mol $FeCl_2$
4a. 12.8 mol Cu_2O
4b. 107 mol O_2
5a. 59.3 mol $KClO_3$
5b. 49.2 mol $KClO_3$
6a. 7.9 mol $(NH_4)_2S$
6b. 231 mol H_2S
7a. 2.1 mol $Al_2(SO_4)_3$
7b. 2.4 mol Al_2O_3
7c. 588 mol $Al_2(SO_4)_3$

KEY

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When we balance a chemical equation, we are satisfying the law of conservation of mass; that is, we are making sure that there are the same number of atoms of each element on both sides of the equation. The coefficients we place in front of the substances in an equation are very important because they tell us the mole ratio of the substances in that reaction. For instance, the balanced equation…

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can be thought of in terms of…

2 moles $H_2(g)$ + 1 mole $O_2(g)$ → 2 moles $H_2O(l)$

Directions:

C. Balance each equation.

D. *Solve the problems, assuming that you have excess of the other reactant(s).*

1. __**3**_ $Ca(s)$ + ____ $N_2(g)$ → ____ $Ca_3N_2(s)$

a. How many moles of Ca_3N_2 can be made from 16.8 moles of Ca?

$$x\ \text{mol}\ Ca_3N_2 = 16.8\ \text{mol}\ Ca\left(\frac{1\ \text{mol}\ Ca_3N_2}{3\ \text{mol}\ Ca}\right) = 5.6\ \text{mol}\ Ca_3N_2$$

b. If you need to make 34.4 moles of Ca_3N_2, how many moles of N_2 will you need?

$$x\ \text{mol}\ N_2 = 34.4\ \text{mol}\ Ca_3N_2\left(\frac{1\ \text{mol}\ N_2}{1\ \text{mol}\ Ca_3N_2}\right) = 34.4\ \text{mol}\ N_2$$

2. __**3**_ $Fe(s)$ + __**2**_ $O_2(g)$ → ____ $Fe_3O_4(s)$

a. How many moles of O_2 will react with 42.5 moles of Fe?

$$x\ \text{mol}\ O_2 = 42.5\ \text{mol}\ Fe\left(\frac{2\ \text{mol}\ O_2}{3\ \text{mol}\ Fe}\right) = 28.3\ \text{mol}\ O_2$$

b. If you need to make 1.56 moles of Fe_3O_4, how many moles of Fe will you need?

$$x\ \text{mol}\ Fe = 1.56\ \text{mol}\ Fe_3O_4\left(\frac{3\ \text{mol}\ Fe}{1\ \text{mol}\ Fe_3O_4}\right) = 4.68\ \text{mol}\ Fe$$

3. ____ $FeCl_2(aq)$ + __**2**_ $KOH(aq)$ → ____ $Fe(OH)_2(s)$ + __**2**_ $KCl(aq)$

a. How many moles of KOH will react with 86.2 moles of $FeCl_2$?

$$x\ \text{mol}\ KOH = 86.2\ \text{mol}\ FeCl_2\left(\frac{2\ \text{mol}\ KOH}{1\ \text{mol}\ FeCl_2}\right) = 172.4\ \text{mol}\ KOH$$

b. If you need to make 12.4 moles of KCl, how many moles of $FeCl_2$ will you need?

$$x\ \text{mol}\ FeCl_2 = 12.4\ \text{mol}\ KCl\left(\frac{1\ \text{mol}\ FeCl_2}{2\ \text{mol}\ KCl}\right) = 6.2\ \text{mol}\ FeCl_2$$

4. __4_ $Cu(s)$ + ____ $O_2(g)$ → __2_ $Cu_2O(s)$

a. How many moles of Cu_2O can be made from 25.6 moles of Cu?

$$x\ \text{mol}\ Cu_2O = 25.6\ \text{mol}\ Cu\left(\frac{2\ \text{mol}\ Cu_2O}{4\ \text{mol}\ Cu}\right) = 12.8\ \text{mol}\ Cu_2O$$

b. How many moles of O_2 does it take to produce 214 moles of Cu_2O?

$$x\ \text{mol}\ O_2 = 214\ \text{mol}\ Cu_2O\left(\frac{1\text{mol}\ O_2}{2\ \text{mol}\ Cu_2O}\right) = 107\ \text{mol}\ O_2$$

5. __2_ $K(s)$ + ____ $Cl_2(g)$ + __3_ $O_2(g)$ → __2_ $KClO_3(s)$

a. How many moles of $KClO_3$ can be made from 89 moles of O_2?

$$x\ \text{mol}\ KClO_3 = 89\ \text{mol}\ O_2\left(\frac{2\ \text{mol}\ KClO_3}{3\ \text{mol}\ O_2}\right) = 59.3\ \text{mol}\ KClO_3$$

b. If you have 24.6 moles of Cl_2, how many moles of $KClO_3$ can you produce?

$$x\ \text{mol}\ KClO_3 = 24.6\ \text{mol}\ Cl_2\left(\frac{2\ \text{mol}\ KClO_3}{1\text{mol}\ Cl_2}\right) = 49.2\ \text{mol}\ KClO_3$$

6. __2_ $NH_3(g)$ + ____ $H_2S(g)$ → ____ $(NH_4)_2S(s)$

a. How many moles of $(NH_4)_2S$ can be made from 15.8 moles of NH_3?

$$x\ \text{mol}\ (NH_4)_2S = 15.8\ \text{mol}\ NH_3\left(\frac{1\text{mol}\ (NH_4)_2S}{2\ \text{mol}\ NH_3}\right) = 7.9\ \text{mol}\ (NH_4)_2S$$

b. If you have 462 moles of NH_3, how many moles of H_2S do you need?

$$x\ \text{mol}\ H_2S = 462\ \text{mol}\ NH_3\left(\frac{1\text{mol}\ H_2S}{2\ \text{mol}\ NH_3}\right) = 231\ \text{mol}\ H_2S$$

7. ____ $Al_2O_3(s)$ + __3_ $H_2SO_4(aq)$ → ____ $Al_2(SO_4)_3(aq)$ + __3_ $H_2O(l)$

a. How many moles of $Al_2(SO_4)_3$ can be made from 6.3 moles of H_2SO_4?

$$x\ \text{mol}\ Al_2(SO_4)_3 = 6.3\ \text{mol}\ H_2SO_4\left(\frac{1\text{mol}\ Al_2(SO_4)_3}{3\ \text{mol}\ H_2SO_4}\right) = 2.1\text{mol}\ Al_2(SO_4)_3$$

b. How many moles of Al_2O_3 does it take to make 7.2 moles of H_2O?

$$x\ \text{mol}\ Al_2O_3 = 7.2\ \text{mol}\ H_2O\left(\frac{1\text{mol}\ Al_2O_3}{3\ \text{mol}\ H_2O}\right) = 2.4\ \text{mol}\ Al_2O_3$$

c. If you have 588 moles of Al_2O_3, how many moles of $Al_2(SO_4)_3$ can you produce?

$$x\ \text{mol}\ Al_2(SO_4)_3 = 588\ Al_2O_3\left(\frac{1\text{mol}\ Al_2(SO_4)_3}{1\text{mol}\ Al_2O_3}\right) = 588\ \text{mol}\ Al_2(SO_4)_3$$

Answers:

1a. 5.6 mol Ca_3N_2
1b. 34.4 mol N_2
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2b. 4.68 mol Fe
3a. 172.4 mol KOH
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6b. 231 mol H_2S
7a. 2.1 mol $Al_2(SO_4)_3$
7b. 2.4 mol Al_2O_3
7c. 588 mol $Al_2(SO_4)_3$