

## Activity 14 – Mole Worksheet

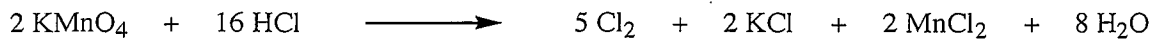
Name Key  
Section \_\_\_\_\_ Date \_\_\_\_\_

### Questions and Problems

Solve the following problems, showing at least some of your work and making sure your answer is clearly boxed off. Your final answer will include the correct number of significant figures and the units. Use scientific notation if the answer is greater than 1000 or less than 1. Note: Make sure you have the correct chemical formula before doing any calculations. You will need a periodic table for this exercise.

1. A sample of mercury (II) bromide weighs 7.56 g.
  - a. What is the molar mass of mercury (II) bromide?
  
  
  
  
  
  
  
  
  
  
  - b. How many moles are in this sample?
  
2. What is the mass of 0.81 mol of ammonium carbonate?
  
  
  
  
  
  
  
  
  
  
3. How many *molecules* are contained in 8.25 mol of chlorine gas?
  - a. How many *atoms* are contained in 8.25 mol of chlorine gas?
  
  
  
  
  
  
  
  
  
  
4. Calculate the percent by mass of barium in barium sulfate.
  
  
  
  
  
  
  
  
  
  
5. What is the mass of  $4.2 \times 10^{23}$  molecules of carbon dioxide?

6. Use the following equation to solve the following problems:

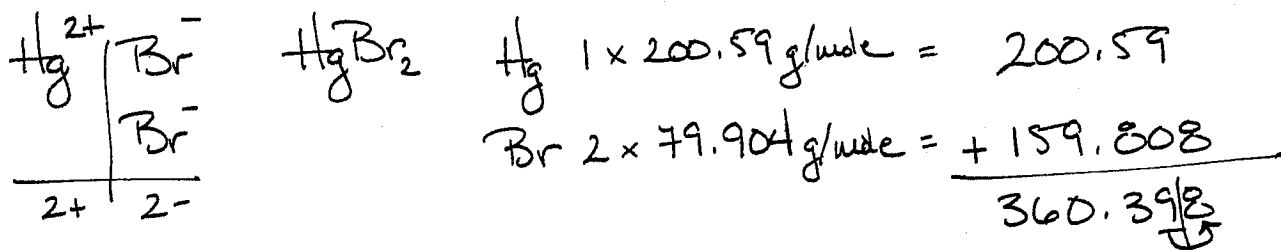


- a. How many moles of HCl are required to react completely with 1.00 mole of  $\text{KMnO}_4$ ?
  
  
  
  
  
  
  
  
  
  
  - b. How many moles of chlorine will be produced by 25.0 moles of  $\text{KMnO}_4$ ?
  
  
  
  
  
  
  
  
  
  
  - c. How many moles of water will be produced if 40. g of HCl are completely reacted with excess potassium permanganate?
  
  
  
  
  
  
  
  
  
  
  - d. What is the maximum mass of manganese(II) chloride that will be produced if 40. g of HCl are completely reacted with excess potassium permanganate?
7. A water solution of sulfuric acid ( $\text{H}_2\text{SO}_4$ ) has a density of 1.67 g/mL and is 75 percent  $\text{H}_2\text{SO}_4$  by mass. How many moles of  $\text{H}_2\text{SO}_4$  are contained in 500. mL of this solution?

# Activity 14 - Mole Worksheet Key

1. A sample of Mercury(II) bromide weighs 7.56g.

a. What is the molar mass of Mercury(II) bromide?



$\text{HgBr}_2 = 360.40 \text{ g/mole}$

b. How many moles are in this sample?

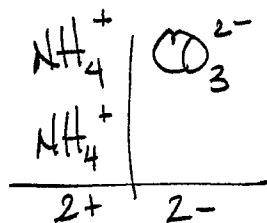
Road Map:  $\text{g} \rightarrow \text{moles}$

$$7.56 \text{ g HgBr}_2 \times \frac{1 \text{ mole HgBr}_2}{360.40 \text{ g HgBr}_2} = 0.02097669 \text{ mole}$$

$0.0210 \text{ mole HgBr}_2$

2. What is the ~~molar~~ mass of 0.81 mole of ammonium carbonate?

Road Map:  $\text{mole} \rightarrow \text{g}$



$\text{N}$	$2 \times 14.00674 = 28.01348$
$\text{H}$	$8 \times 1.00794 = 8.06352$
$\text{C}$	$1 \times 12.011 = 12.011$
$\text{O}$	$3 \times 15.9994 = + 47.9982$
	$96.08620$

$(\text{NH}_4)_2\text{CO}_3 = 96.086 \text{ g/mole}$

2. Cont.

$$0.81 \text{ mole } (\text{NH}_4)_2\text{CO}_3 \times \frac{96.086 \text{ g } (\text{NH}_4)_2\text{CO}_3}{1 \text{ mole } (\text{NH}_4)_2\text{CO}_3} = 77.82966 \text{ g}$$
$$= \boxed{78 \text{ g } (\text{NH}_4)_2\text{CO}_3}$$

3. How many molecules are contained in 8.25 mole of Chlorine gas?

Chlorine gas is one of the diatomic elements (HOFBrINCl).  
 $\Rightarrow \text{Cl}_2$

Road Map: mole  $\rightarrow$  molecule

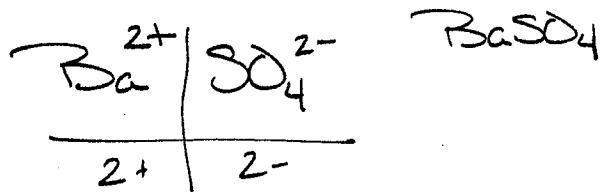
$$8.25 \text{ mole } \text{Cl}_2 \times \frac{6.022 \times 10^{23} \text{ molecules } \text{Cl}_2}{1 \text{ mole } \text{Cl}_2} = 4.96815 \times 10^{24} \text{ molecule}$$
$$= \boxed{4.97 \times 10^{24} \text{ molecules } \text{Cl}_2}$$

a. How many atoms are contained in 8.25 mol of Chlorine gas?

Road Map: mole  $\text{Cl}_2 \rightarrow$  molecule  $\text{Cl}_2 \rightarrow$  atom  $\text{Cl}$

$$8.25 \text{ mole } \text{Cl}_2 \times \frac{6.022 \times 10^{23} \text{ molecule } \text{Cl}_2}{1 \text{ mole } \text{Cl}_2} \times \frac{2 \text{ atoms } \text{Cl}}{1 \text{ molecule } \text{Cl}_2} = 9.9363 \times 10^{24} \text{ atoms}$$
$$= \boxed{9.94 \times 10^{24} \text{ atoms } \text{Cl}}$$

4. Calculate the percent by mass of barium in barium sulfate.



$$\% \text{ by mass} = \frac{\text{mass part}}{\text{mass whole}} \times 100\%$$

$$\left. \begin{array}{l} \text{part} = \text{Ba}^{2+} \\ \text{whole} = \text{BaSO}_4 \end{array} \right\} \begin{array}{l} \text{Choose an easy quantity} \\ \text{Such as 1 mole} = \text{mass 1 mole} \end{array}$$

$$\frac{\text{Ba}^{2+}}{\text{BaSO}_4} \times 100 = \frac{137.327 \text{ g Ba}^{2+}}{265.457 \text{ g BaSO}_4} \times 100 = 51.7322956\%$$

need molar mass

$$= \boxed{51.7323\% \text{ by mass}}$$

$$1 \text{ Ba} \times 137.327 \text{ g/mole} = 137.327$$

$$1 \text{ S} \times 32.066 \text{ g/mole} = 64.132$$

$$4 \text{ O} \times 15.9994 \text{ g/mole} = 63.9976$$

$$\frac{137.327}{265.4566} = 265.457 \text{ g/mole}$$

5. What is the mass of  $4.2 \times 10^{23}$  molecules of Carbon dioxide?

Road Map molecules  $\text{CO}_2 \rightarrow$  mole  $\text{CO}_2 \rightarrow$  g  $\text{CO}_2$

Info needed: Molar mass  $\text{CO}_2$

$$1 \text{ C} \times 12.011 = 12.011$$

$$2 \text{ O} \times 15.9994 = +31.9988$$

$$\frac{44.0098}{\downarrow \uparrow} = 44.010 \text{ g/mole } \text{CO}_2$$

$$4.2 \times 10^{23} \text{ molecule } \text{CO}_2 \times \frac{1 \text{ mole } \text{CO}_2}{6.022 \times 10^{23} \text{ molecule } \text{CO}_2} \times \frac{44.010 \text{ g } \text{CO}_2}{1 \text{ mole } \text{CO}_2} =$$

$$= 30.6944537 \text{ g } \text{CO}_2$$

$$= \boxed{31 \text{ g } \text{CO}_2}$$

6. Use the following equation to solve the following problems:



a. How many moles of HCl are required to react completely with 1.00 mole  $\text{KMnO}_4$ ?

Road Map mole  $\text{KMnO}_4 \rightarrow$  mole HCl

$$1.00 \text{ mole } \text{KMnO}_4 \times \frac{16 \text{ mole HCl}}{2 \text{ mole } \text{KMnO}_4} = \boxed{8.00 \text{ mole HCl}}$$

\* watch sig figs here

b. How many moles of chlorine will be produced by 25.0 moles  $\text{KMnO}_4$ ?

Road Map mole  $\text{KMnO}_4 \rightarrow$  mole  $\text{Cl}_2$

$$25.0 \text{ mole } \text{KMnO}_4 \times \frac{5 \text{ mole } \text{Cl}_2}{2 \text{ mole } \text{KMnO}_4} = \boxed{62.5 \text{ mole } \text{Cl}_2}$$

c. How many moles of water will be produced if 40. g of HCl are completely reacted with excess potassium permanganate?

Road map: g HCl  $\rightarrow$  mole HCl  $\rightarrow$  moles  $\text{H}_2\text{O}$

Required Info: molar mass HCl

$$1\text{H} \times 1.00794 = 1.00794$$

$$1\text{Cl} \times 35.4527 = 35.4527$$

$$\frac{36.46064 \text{ g/mole}}{1} = 36.4606 \text{ g/mole HCl}$$

6c. cont.

$$40. \text{ g HCl} \times \frac{1 \text{ mole HCl}}{36.4606 \text{ g HCl}} \times \frac{8 \text{ mole H}_2\text{O}}{16 \text{ mole HCl}} = 0.54853733 \text{ mole}$$

count  
calc error

$$= \boxed{0.55 \text{ mole H}_2\text{O}}$$

d. What is the maximum mass of manganese(II) chloride that will be produced if 40. g of HCl are completely reacted with excess potassium permanganate?

Road Map:  $\text{g HCl} \rightarrow \text{mole HCl} \rightarrow \text{mole MnCl}_2 \rightarrow \text{g MnCl}_2$

Required Info: molar mass HCl from previous and molar mass of  $\text{MnCl}_2$

$$1 \text{ Mn} \times 54.93805 = 54.93805$$

$$2 \text{ Cl} \times 35.4527 = +70.9054$$

$$125.84345 = 125.8434 \text{ g/mole MnCl}_2$$

\* Round even

$$40. \text{ g HCl} \times \frac{1 \text{ mole HCl}}{36.4606 \text{ g HCl}} \times \frac{2 \text{ mole MnCl}_2}{16 \text{ mole HCl}} \times \frac{125.8434 \text{ g MnCl}_2}{1 \text{ mole MnCl}_2} = 17.2574505 \text{ g}$$

$$= \boxed{17 \text{ g MnCl}_2}$$



7. A water solution of Sulfuric acid ( $\text{H}_2\text{SO}_4$ ) has a density of  $1.67 \text{ g/mL}$  and is  $75\%$   $\text{H}_2\text{SO}_4$  by mass. How many moles of  $\text{H}_2\text{SO}_4$  are contained in  $500. \text{ mL}$  of this solution.

- This one is complicated by the fact that we are dealing with a solution and not a pure material. The percent by mass is a conversion factor to convert the mass of the whole (solution) into the mass of the part (just the  $\text{H}_2\text{SO}_4$ ).

Road Map:  $\text{mL Solution} \rightarrow \text{g Solution} \rightarrow \text{g H}_2\text{SO}_4 \rightarrow \text{moles H}_2\text{SO}_4$

Required Info: density solution ✓  
 % by mass  $\frac{75 \text{ g H}_2\text{SO}_4}{100 \text{ g Solution}}$  ✓  
 molar mass  $\text{H}_2\text{SO}_4$

$$2 \text{ H} \times 1.00794 = 2.01588$$

$$1 \text{ S} \times 32.066 = 32.066$$

$$4 \text{ O} \times 15.9994 = 63.9976$$

$$\frac{98.07948}{98.07948} = 98.079 \text{ g/mole H}_2\text{SO}_4$$

$$500. \text{ mL Sol} \times \frac{1.67 \text{ g Sol}}{1 \text{ mL Sol}} \times \frac{75 \text{ g H}_2\text{SO}_4}{100 \text{ g Sol}} \times \frac{1 \text{ mole H}_2\text{SO}_4}{98.079 \text{ g H}_2\text{SO}_4} = 6.385159$$

$$= \boxed{6.4 \text{ mole H}_2\text{SO}_4}$$