Atomic Structure and Properties
1.1 Moles and Molar Mass
Worksheet Key

1) How many moles of acetic acid, CH_3COOH, are contained within 24.71g of acetic acid?

$$24.71g\ CH_3COOH \times \frac{1\ mol\ CH_3COOH}{60.06g\ CH_3COOH} = 0.4114\ mol\ CH_3COOH$$

2) How many moles of sodium carbonate, Na_2CO_3, are contained by 57.3 g of sodium carbonate?

$$57.3\ g\ Na_2CO_3 \times \frac{1\ mol\ Na_2CO_3}{105.99\ g\ Na_2CO_3} = 0.541\ mol\ Na_2CO_3$$

3) How many moles of sulfuric acid, H_2SO_4, are contained by 157 g of sulfuric acid?

$$157\ g\ H_2SO_4 \times \frac{1\ mol\ H_2SO_4}{98.09\ g\ H_2SO_4} = 1.60\ mol\ H_2SO_4$$

4) How many grams of NaOH are contained within 0.785 moles of NaOH?

$$0.785\ mol\ NaOH \times \frac{40.00g\ NaOH}{1\ mol\ NaOH} = 31.4g\ NaOH$$

5) How many grams of C_6H_6 are present in 12.70 moles of C_6H_6?

$$12.70\ mol\ C_6H_6 \times \frac{78.12\ g\ C_6H_6}{1\ mol\ C_6H_6} = 992.1\ g\ C_6H_6$$

6) How many grams of CCl_4 are present in 2.67 moles of CCl_4?

$$2.67\ mol\ CCl_4 \times \frac{153.81\ g\ CCl_4}{1\ mol\ CCl_4} = 411\ g\ CCl_4$$

7) How many carbon atoms are contained in 84.3 g of ethyne (C_2H_2)?

$$84.3g\ C_2H_2 \times \frac{1\ mol\ C_2H_2}{26.04g\ C_2H_2} \times \frac{2\ mol\ C}{1\ mol\ C_2H_2} \times \frac{6.022 \times 10^{23}\ atoms\ C}{1\ mol\ C}$$
$$= 3.90 \times 10^{24}\ atoms\ C$$

8) How many ethyne molecules are contained in 84.3 g of ethyne (C_2H_2)?

$$84.3 \text{ g } C_2H_2 \times \frac{1 \text{ mol } C_2H_2}{26.04 \text{ g } C_2H_2} \times \frac{6.022 \times 10^{23} \text{ molecules } C_2H_2}{1 \text{ mol } C_2H_2}$$
$$= 1.95 \times 10^{24} \text{ molecules } C_2H_2$$

9) How many $C_6H_{12}O_6$ molecules are contained in a 100.0 g sample of $C_6H_{12}O_6$?

$$100.0 \text{ g } C_6H_{12}O_6 \times \frac{1 \text{ mol } C_6H_{12}O_6}{180.18 \text{ g } C_6H_{12}O_6} \times \frac{6.022 \times 10^{23} \text{ molecules } C_6H_{12}O_6}{1 \text{ mol } C_6H_{12}O_6}$$
$$= 3.342 \times 10^{23} \text{ molecules } C_6H_{12}O_6$$

10) How many carbon atoms are contained in a 734 g sample of $C_6H_{12}O_6$?

$$734 \text{ g } C_6H_{12}O_6 \times \frac{1 \text{ mol } C_6H_{12}O_6}{180.18 \text{ g } C_6H_{12}O_6} \times \frac{6.022 \times 10^{23} \text{ molecules } C_6H_{12}O_6}{1 \text{ mol } C_6H_{12}O_6}$$
$$\times \frac{6 \text{ C atoms}}{1 \text{ molecule } C_6H_{12}O_6} = 1.47 \times 10^{25} \text{ atoms C}$$

11) How many moles of lithium are present in a sample that contains 2.45×10^{87} formula units of Li_2SO_4?

$$2.45 \times 10^{87} \text{ formula units } Li_2SO_4 \times \frac{1 \text{ mol } Li_2SO_4}{6.022 \times 10^{23} \text{ formula units } Li_2SO_4} \times \frac{2 \text{ mol Li}}{1 \text{ mol } Li_2SO_4}$$
$$= 8.14 \times 10^{63} \text{ mol Li}$$

12) A helium balloon contains 0.143 moles of He.
    a. How many grams of helium are in the balloon?

$$0.143 \text{ mol He} \times \frac{4.00 \text{ g He}}{1 \text{ mol He}} = 0.572 \text{ g He}$$

    b. How many helium atoms are in the balloon?

$$0.143 \text{ mol He} \times \frac{6.022 \times 10^{23} \text{ atoms He}}{1 \text{ mol He}} = 8.61 \times 10^{22} \text{ atoms He}$$

13) Consider a 47.35 g pure sample of Al_2O_3.

    a. How many moles of Al_2O_3 are in the sample?

$$47.35 \text{ g } Al_2O_3 \times \frac{1 \text{ mol } Al_2O_3}{101.96 \text{ g } Al_2O_3} = 0.4644 \text{ mol } Al_2O_3$$

    b. How many moles of Al^{3+} ions are in the sample?

$$0.4644 \text{ mol } Al_2O_3 \times \frac{2 \text{ mol } Al^{3+}}{1 \text{ mol } Al_2O_3} = 0.9288 \text{ mol } Al^{3+}$$

    c. How many moles of O^{2-} ions are in the sample?

$$0.4644 \text{ mol } Al_2O_3 \times \frac{3 \text{ mol } O^{2-}}{1 \text{ mol } Al_2O_3} = 1.393 \text{ mol } O^{2-}$$

    d. How many formula units of Al_2O_3 are in the sample?

$$47.35 \text{ g } Al_2O_3 \times \frac{1 \text{ mol } Al_2O_3}{101.96 \text{ g } Al_2O_3} \times \frac{6.022 \times 10^{23} \text{ formula units } Al_2O_3}{1 \text{ mol } Al_2O_3}$$
$$= 2.797 \times 10^{23} \text{ formula units } Al_2O_3$$

    e. How many Al^{3+} ions are in the sample?

$$47.35 \text{ g } Al_2O_3 \times \frac{1 \text{ mol } Al_2O_3}{101.96 \text{ g } Al_2O_3} \times \frac{6.022 \times 10^{23} \text{ formula units } Al_2O_3}{1 \text{ mol } Al_2O_3}$$
$$\times \frac{2 \; Al^{3+} \text{ ions}}{1 \text{ formula unit } Al_2O_3} = 5.593 \times 10^{23} \; Al^{3+} \text{ ions}$$

    f. How many O^{2-} ions are in the sample?

$$47.35 \text{ g } Al_2O_3 \times \frac{1 \text{ mol } Al_2O_3}{101.96 \text{ g } Al_2O_3} \times \frac{6.022 \times 10^{23} \text{ formula units } Al_2O_3}{1 \text{ mol } Al_2O_3}$$
$$\times \frac{3 \; O^{2-} \text{ ions}}{1 \text{ formula unit } Al_2O_3} = 8.390 \times 10^{23} \; O^{2-} \text{ ions}$$

14) How many grams of H_2O are there in 1.0 mole of H_2O?

$$18 \text{ g}$$

15) How many oxygen atoms are contained in 12.7 g of zinc sulfate, $ZnSO_4$?

$$12.7 \text{ g ZnSO}_4 \times \frac{1 \text{ mol ZnSO}_4}{161.46 \text{ g ZnSO}_4} \times \frac{4 \text{ mol O}}{1 \text{ mol ZnSO}_4} \times \frac{6.022 \times 10^{23} \text{ atoms O}}{1 \text{ mol O}}$$

$$= 1.89 \times 10^{23} \text{ atoms O}$$