Worksheet 5: Stoichiometry 1 Key

1. 1 mole N₂O₅ has 2 moles of N. This is similar to saying that every bike has two wheels. Use this as a conversion for numbers 2-3. It's name is dinitrogen pentoxide.

2. 2 moles N₂O₅ × (2 moles N/1 mole N₂O₅) = 4 moles N [just like 2 bikes have 4 wheels]

3. 8.6 moles N₂O₅ × (2 moles N/1 mole N₂O₅) = 17 moles N [it’s hard to have 8.6 bikes, but remember a mole is a really big number of things. It is possible to have 0.25 of a dozen, right?]

4. How many moles of N in 8.6 g N₂O₅?
   \[
   \frac{8.6 \text{ g } N_2O_5}{108.02 \text{ g } N_2O_5} = \frac{0.16 \text{ mol } N}{1 \text{ mol } N_2O_5}
   \]

5. How many Pb atoms are in 1.00×10⁻⁹ g of Pb metal?
   \[
   \frac{1.00 \times 10^{-9} \text{ g } Pb}{207.2 \text{ g } Pb} = \frac{2.91 \times 10^{12} \text{ Pb atoms}}{6.022 \times 10^{23} \text{ Pb atoms}}
   \]

6. a. How many g are in 1 mol Na₂CO₃ (name this compound also)
   \[
   \frac{2 \times (22.99) + 1 \times (12.01) + 3 \times (16.00)}{105.99 \text{ g/mol } Na_2CO_3} = 105.99 \text{ g/mol } Na_2CO_3
   \]
   sodium carbonate

   b. How many moles of H₂SO₄ are present in 45.8 g of the substance? (name?)
   \[
   \frac{45.8 \text{ g } H_2SO_4}{98.09 \text{ g } H_2SO_4} = \frac{0.467 \text{ mol } H_2SO_4}{1 \text{ mol } H_2SO_4}
   \]
   sulfuric acid

7. How many moles of oxygen atoms are present in 125 g of sodium nitrate?
   \[
   \frac{125 \text{ g } NaNO_3}{85.00 \text{ g } NaNO_3} = \frac{1.49 \text{ mole } NaNO_3}{1 \text{ mole } NaNO_3}
   \]
   \[
   \frac{13 \text{ mole } O \text{ atoms}}{1 \text{ mole } NaNO_3} = 13 \text{ mole } O \text{ atoms}
   \]

   Use this equation for 8 & 9: \( C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H2O(g) \)

8. How many moles of water will form when:
   a. 2.15 moles of propane (C₃H₈) react with excess oxygen?
   \[
   \frac{2.15 \text{ mol } C_3H_8}{1 \text{ mol } C_3H_8} = \frac{8.60 \text{ mol } H_2O}{4 \text{ mol } H_2O}
   \]
   \[
   \frac{1 \text{ mol } C_3H_8}{44.09 \text{ g } C_3H_8} = 11.9 \text{ mol } H_2O
   \]

   b. 131 g of propane reacts with excess oxygen?
   \[
   \frac{131 \text{ g } C_3H_8}{44.09 \text{ g } C_3H_8} = \frac{11.9 \text{ mol } H_2O}{4 \text{ mol } H_2O}
   \]

9. What mass of carbon dioxide, in grams, forms when:
   a. 1.00 moles of propane react with excess oxygen?
   \[
   \frac{1.00 \text{ mol } C_2H_8}{1 \text{ mol } C_2H_8} = \frac{132 \text{ g } CO_2}{3 \text{ mol } CO_2}
   \]
   \[
   \frac{44.01 \text{ g } CO_2}{44.01 \text{ g } CO_2} = 3 \text{ mol } CO_2
   \]

   b. 453.6 g of propane reacts with excess oxygen?
   \[
   \frac{453.6 \text{ g } C_3H_8}{44.09 \text{ g } C_3H_8} = \frac{1358 \text{ g } CO_2}{1 \text{ mol } C_3H_8}
   \]
   \[
   \frac{3 \text{ mol } CO_2}{44.01 \text{ g } CO_2} = 1358 \text{ g } CO_2
   \]
10. Like many metals, manganese reacts with fluorine gas to make a salt:

First balance the equation!

\[ 2 \text{ Mn(s)} + 3 \text{ F}_2(\text{g}) \rightarrow 2 \text{ MnF}_3(\text{s}) \]

a. If 3.70 mol Mn is reacted with excess F₂, how many mol of MnF₃ will form?

\[
\frac{3.70 \text{ mol Mn}}{2 \text{ mol MnF}_3} = 3.70 \text{ mol MnF}_3
\]

b. If 1.25 \times 10^{-3} \text{ mol of MnF}_3 form, how many mol of F₂ was consumed?

\[
\frac{1.25 \times 10^{-3} \text{ mol MnF}_3}{3 \text{ mol F}_2} = 0.00188 \text{ mol F}_2
\]

c. How many g of MnF₃ can be made from 1.67 g of F₂?

\[
\frac{1.67 \text{ g F}_2}{38.00 \text{ g F}_2} = \frac{111.94 \text{ g MnF}_3}{2 \text{ mol MnF}_3} = 3.28 \text{ g MnF}_3
\]

11. Write equations for the following:

a. In a gaseous reaction, hydrogen sulfide (common name for dihydrogen sulfide) burns in oxygen to form sulfur dioxide and water vapor.

\[ 2 \text{ H}_2\text{S(g)} + 3 \text{ O}_2 (\text{g}) \rightarrow 2 \text{ SO}_2 (\text{g}) + 2 \text{ H}_2\text{O(g)} \]

b. Hydrogen gas is passed over powdered iron (II) oxide. Iron metal and water vapor form.

\[ \text{H}_2 (\text{g}) + \text{FeO(s)} \rightarrow \text{Fe(s)} + \text{H}_2\text{O(g)} \] balanced

c. Iron (II) chloride can be converted to iron (III) fluoride by reacting it with chlorine trifluoride gas. Chlorine gas is also produced in this reaction.

\[ 2 \text{ FeCl}_2 + 2 \text{ ClF}_3 (\text{g}) \rightarrow 2 \text{ FeF}_3 + 3 \text{ Cl}_2 (\text{g}) \]

12. Calculate for rxns above:

a. How many grams of oxygen will react with 3.22 g hydrogen sulfide?

\[
\frac{3.22 \text{ g H}_2\text{S}}{2 \text{ mol H}_2\text{S}} \cdot \frac{3 \text{ mol O}_2}{1 \text{ mol H}_2\text{S}} \cdot \frac{32.00 \text{ g O}_2}{1 \text{ mol O}_2} = 4.53 \text{ g O}_2
\]

b. How many grams of iron metal are formed if 16.754 g of iron (II) oxide reacts with excess hydrogen gas?

\[
\frac{16.754 \text{ g FeO}}{1 \text{ mol FeO}} \cdot \frac{1 \text{ mol Fe}}{55.845 \text{ g Fe}} = 0.3023 \text{ g Fe}
\]

c. How many grams of chlorine gas will be produced if 27 g of iron (II) chloride reacts with excess chlorine trifluoride?

\[
\frac{27 \text{ g FeCl}_2}{2 \text{ mol FeCl}_2} \cdot \frac{3 \text{ mol Cl}_2}{1 \text{ mol FeCl}_2} \cdot \frac{70.90 \text{ g Cl}_2}{1 \text{ mol Cl}_2} = 3.90 \text{ g Cl}_2
\]

\[
\frac{126.8 \text{ g FeCl}_2}{2 \text{ mol FeCl}_2} \cdot \frac{1 \text{ mol FeO}}{1 \text{ mol FeCl}_2} = 0.23 \text{ g FeO}
\]
Extra Mass–Mole ratios

13. Calculate the molar mass of dinitrogen tetraiodide, phosphorus pentachloride, and aluminum phosphate.
   \[ \text{N}_2\text{I}_4: 535.62 \text{ g/mol} \]
   \[ \text{PCl}_5: 208.22 \text{ g/mol} \]
   \[ \text{AlPO}_4: 121.95 \text{ g/mol} \]

14. How many mol of Ne is in 89.7 g of this gas? [Ne has no known compounds; it seems to be inert.]
   \[ \frac{89.7 \text{ g Ne}}{20.18 \text{ g Ne}} = 4.44 \text{ mole Ne} \]

15. How many mol of Hg atoms are in 1.63 \times 10^{-2} \text{ g of the metal?} [Hg is liquid at room temperature]
   \[ \frac{1.63 \times 10^{-2} \text{ g Hg}}{200.59 \text{ g Hg}} = 8.13 \times 10^{-5} \text{ mol Hg} \]

16. How many oxygen atoms (in an actual number) are in 7.42 \times 10^{-14} \text{ moles of ozone [O}_3\text{] molecules?}
   \[ \frac{7.42 \times 10^{-14} \text{ moles O}_3}{1 \text{ mol O}_3} = 6.022 \times 10^{23} \text{ O atoms} \]
   \[ = 1.34 \times 10^{11} \text{ O atoms} \]

17. What mass, in g, of lead is present in 5.29 \times 10^{-3} \text{ mol of the metal?}
   \[ \frac{5.29 \times 10^{-3} \text{ mol Pb}}{207.2 \text{ g Pb}} = 1.10 \text{ g Pb} \]

18. What mass, in mg, of sodium sulfate is present in 4.51 \times 10^{-4} \text{ mol of this compound?}
   \[ \frac{4.51 \times 10^{-4} \text{ mol Na}_2\text{SO}_4}{142.05 \text{ g Na}_2\text{SO}_4} = 0.0641 \text{ g Na}_2\text{SO}_4 \]

19. How many moles of ammonium carbonate corresponds to 8.715 g of this compound?
   \[ \frac{8.715 \text{ g (NH}_4\text{)}_2\text{CO}_3}{96.09 \text{ g (NH}_4\text{)}_2\text{CO}_3} = 0.0907 \text{ moles (NH}_4\text{)}_2\text{CO}_3 \]