

Stoichiometry worksheet

1. Consider the following equation:

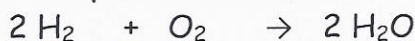


What mass of nitric acid, HNO_3 , is necessary to obtain 6 moles of water?

G

$$6 \text{ mol H}_2\text{O} \times \frac{4 \text{ mol HNO}_3}{2 \text{ mol H}_2\text{O}} \times \frac{63.02 \text{ g HNO}_3}{1 \text{ mol HNO}_3} = 800 \text{ g HNO}_3$$

2. Using the equation below, answer the following questions.



a- If 4.0 moles of H_2 gas are reacted, how many grams of water would be produced?

G

$$4.0 \text{ mol H}_2 \times \frac{2 \text{ mol H}_2\text{O}}{2 \text{ mol H}_2} \times \frac{18.02 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 72 \text{ g H}_2\text{O}$$

b- If 2.45×10^2 molecules of oxygen gas are available, how many moles of H_2 would react with it?

G

$$2.45 \times 10^2 \text{ molec O}_2 \times \frac{1 \text{ mol O}_2}{(6.02 \times 10^{23}) \text{ molec O}_2} \times \frac{2 \text{ mol H}_2}{1 \text{ mol O}_2} = 8.14 \times 10^{-22} \text{ mol H}_2$$

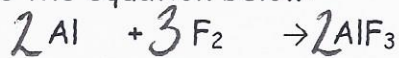
3. What would the final volume be of water when a 5.5 M solution is needed to react with 12 g of HCl ? The equation that represents the reaction follows.



$$12 \text{ g HCl} \times \frac{1 \text{ mol HCl}}{36.46 \text{ g HCl}} \times \frac{1 \text{ mol H}_2\text{O}}{1 \text{ mol HCl}} = \frac{0.329127811 \text{ mol}}{5.5} = \frac{55 \text{ mol}}{\text{L}}$$

$$= 0.060 \text{ L}$$

4. a- Balance the equation below:



b- How many moles of aluminum react with 4.5 moles of fluorine?

$$4.5 \text{ mol F}_2 \times \frac{2 \text{ mol Al}}{3 \text{ mol F}_2} = 3.0 \text{ mol Al}$$

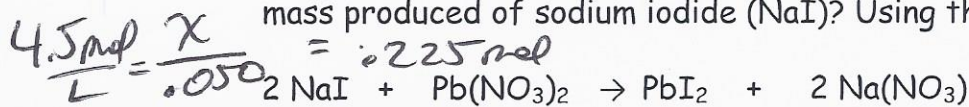
c- If 42 g of aluminum fluoride, AlF_3 are produced, what mass of aluminum is reacted with aluminum fluoride?

$$42 \text{ g AlF}_3 \times \frac{1 \text{ mol AlF}_3}{83.98 \text{ g AlF}_3} \times \frac{2 \text{ mol Al}}{2 \text{ mol AlF}_3} \times \frac{26.98 \text{ g Al}}{1 \text{ mol Al}} = 13 \text{ g Al}$$

d- How many moles of fluorine will take part in the above reaction to produce 33.6 g of aluminum fluoride?

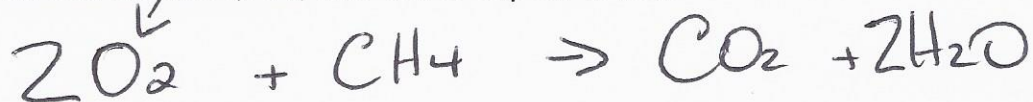
$$33.6 \text{ g AlF}_3 \times \frac{1 \text{ mol AlF}_3}{83.98 \text{ g AlF}_3} \times \frac{3 \text{ mol F}_2}{2 \text{ mol AlF}_3} = 0.600 \text{ mol F}_2$$

5. Kim uses 50 mL of $\text{Pb}(\text{NO}_3)_2$ at a concentration of 4.5 mol/L, what is the mass produced of sodium iodide (NaI)? Using the following equation:



$$0.225 \text{ mol Pb}(\text{NO}_3)_2 \times \frac{2 \text{ mol NaI}}{1 \text{ mol Pb}(\text{NO}_3)_2} \times \frac{149.89 \text{ g NaI}}{1 \text{ mol NaI}} = 70 \text{ g NaI}$$

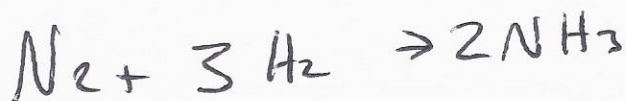
6. a- Write a balanced equation for the combustion of methane gas (CH_4) to form carbon dioxide (CO_2) and water vapour (H_2O).



b- If 124.5 g of CO_2 is produced, how many moles of CH_4 must have been reacted?

$$124.5 \text{ g CO}_2 \times \frac{1 \text{ mol CO}_2}{44.01 \text{ g CO}_2} \times \frac{1 \text{ mol CH}_4}{1 \text{ mol CO}_2} = 2.829 \text{ mol CH}_4$$

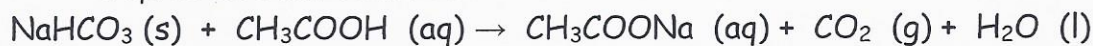
7. a- Write a balanced equation for the reaction of nitrogen gas (N_2) and hydrogen gas (H_2) to produce ammonia gas (NH_3).



- b- If 212.5 g of ammonia gas is produced, how many molecules of hydrogen gas must have reacted with the nitrogen?

$$212.5g NH_3 \times \frac{1 \text{ mol } NH_3}{17.04g NH_3} \times \frac{3 \text{ mol } H_2}{2 \text{ mol } H_2} \times \frac{6.02 \times 10^{23} \text{ molec } H_2}{1 \text{ mol } H_2} = 1.126 \times 10^{25} \text{ molec } H_2$$

8. 120 mL of CH_3COONa is used to produce H_2O . If 9.81g of H_2O is made, what is the concentration of CH_3COONa used? The following equation represents the reaction:



$$9.81g H_2O \times \frac{1 \text{ mol } H_2O}{18.02g H_2O} \times \frac{1 \text{ mol } CH_3COONa}{1 \text{ mol } H_2O} = \frac{0.544395117 \text{ mol}}{0.12 L}$$

4.5 M

9. Solid copper can be prepared from copper oxide by reacting with ammonia, according to the following unbalanced equation:



How many moles of ammonia (NH_3) are needed to obtain 9.0 moles of copper (Cu)?

$$9.0 \text{ mol } Cu \times \frac{2 \text{ mol } NH_3}{3 \text{ mol } Cu} = 6.0 \text{ mol } NH_3$$

10. Iron (Fe) and carbon monoxide (CO) are produced when iron oxide (Fe₂O₃) reacts with carbon (C). Write a balanced equation for this reaction.



You would like to produce 50 mol of iron, what mass of iron oxide is required?

$$50 \text{ mol Fe} \times \frac{1 \text{ mol Fe}_2\text{O}_3}{2 \text{ mol Fe}} \times \frac{159.7 \text{ g Fe}_2\text{O}_3}{1 \text{ mol Fe}_2\text{O}_3} = 4000 \text{ g Fe}_2\text{O}_3$$

11. 300 mL of NaI whose concentration is 3 mol/L are reacted with Pb(NO₃)₂ in order to obtain the precipitate PbI₂. Calculate the moles of PbI₂ obtained.

$$\frac{3 \text{ mol}}{\text{L}} \times \frac{\text{L}}{0.3 \text{ L}} = 9 \text{ mol} \quad 2 \text{ NaI} + \text{Pb}(\text{NO}_3)_2 \rightarrow \text{PbI}_2 + 2 \text{ Na}(\text{NO}_3)$$

$$9 \text{ mol NaI} \times \frac{1 \text{ mol PbI}_2}{2 \text{ mol NaI}} = 4.5 \text{ mol PbI}_2$$

12. When a solution of aluminum hydroxide, Al(OH)₃, reacts with a solution of sulfuric acid, H₂SO₄, the result is a salt, aluminum sulphate, Al₂(SO₄)₃ and water, H₂O.

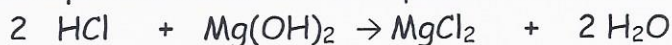
The reaction is seen by the following unbalanced equation:



What mass of aluminum hydroxide is required to produce 100.0 g of aluminum sulphate?

$$100.0 \text{ g Al}_2(\text{SO}_4)_3 \times \frac{1 \text{ mol Al}_2(\text{SO}_4)_3}{342.17 \text{ g Al}_2(\text{SO}_4)_3} \times \frac{2 \text{ mol Al}(\text{OH})_3}{1 \text{ mol Al}_2(\text{SO}_4)_3} \times \frac{78.01 \text{ g Al}(\text{OH})_3}{1 \text{ mol Al}(\text{OH})_3} = 45.60 \text{ g Al}(\text{OH})_3$$

13. Use the equation below to solve questions a and b.



a- If 650 g of water was produced, how many molecules of magnesium hydroxide Mg(OH)_2 must have reacted?

$$650\text{g} \times \frac{1 \text{ mol H}_2\text{O}}{18.02 \text{ g H}_2\text{O}} \times \frac{1 \text{ mol Mg(OH)}_2}{2 \text{ mol H}_2\text{O}} \times \frac{6.02 \times 10^{23} \text{ molec Mg(OH)}_2}{1 \text{ mol Mg(OH)}_2}$$

$$= 1.01 \times 10^{25} \text{ molec Mg(OH)}_2$$

b- If 5.3×10^9 molecules of water are available, how many moles of HCl react with it?

$$5.3 \times 10^9 \text{ molec H}_2\text{O} \times \frac{1 \text{ mol H}_2\text{O}}{(6.02 \times 10^{23}) \text{ molec H}_2\text{O}} \times \frac{2 \text{ mol HCl}}{2 \text{ mol H}_2\text{O}} = 8.5 \times 10^{-15} \text{ mol HCl}$$

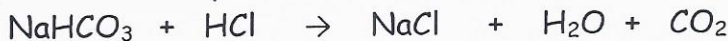
14. 75 mL of BaCl_2 is used to produce BaCrO_4 . If 12 g of BaCrO_4 is made, what is the concentration of the BaCl_2 used? The following equation represents the reaction:



$$12 \text{ g BaCrO}_4 \times \frac{1 \text{ mol BaCrO}_4}{253.33 \text{ g BaCrO}_4} \times \frac{1 \text{ mol BaCl}_2}{1 \text{ mol BaCrO}_4} = \frac{0.047369044 \text{ mol}}{0.075 \text{ L}}$$

$$= 0.63 \text{ mol/L}$$

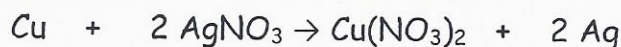
15. How many L of a 7.0 M solution of HCl are needed to react with 9.85 g of CO_2 ? The equation that represents the reaction follows.



$$9.85 \text{ g CO}_2 \times \frac{1 \text{ mol CO}_2}{44.01 \text{ g CO}_2} \times \frac{1 \text{ mol HCl}}{1 \text{ mol CO}_2} = 0.22381277 \text{ mol} = \frac{7.0 \text{ mol}}{\text{L}}$$

$$= 0.32 \text{ L}$$

16. Use the equation below to answer questions a and b.



a- If 4.33×10^7 molecules of Ag are available, how many moles of silver nitrate AgNO_3 would react with it?

$$4.33 \times 10^7 \text{ molecules Ag} \times \frac{1 \text{ mol Ag}}{(6.02 \times 10^{23}) \text{ molecules Ag}} \times \frac{2 \text{ mol AgNO}_3}{2 \text{ mol Ag}} = 7.19 \times 10^{-17} \text{ mol AgNO}_3$$

b- If 450.0 g of copper nitrate $\text{Cu}(\text{NO}_3)_2$ was produced, how many Ag atoms must have reacted with the copper nitrate?

$$450.0 \text{ g Cu}(\text{NO}_3)_2 \times \frac{1 \text{ mol Cu}(\text{NO}_3)_2}{187.50 \text{ g Cu}(\text{NO}_3)_2} \times \frac{2 \text{ mol Ag}}{1 \text{ mol Cu}(\text{NO}_3)_2} \times \frac{(6.02 \times 10^{23}) \text{ atoms Ag}}{1 \text{ mol Ag}} = 2.890 \times 10^{24} \text{ Ag atoms}$$

17. Kim neutralizes 250 mL of HCl at a concentration of 4.5 mol/L using $\text{Ca}(\text{OH})_2$ according to the following equation: $2\text{HCl} + \text{Ca}(\text{OH})_2 \rightarrow \text{CaCl}_2 + 2\text{H}_2\text{O}$

What is the mass of the CaCl_2 that will be left in the beaker?

$$n = C \times V$$
$$\frac{4.5 \text{ mol}}{\text{L}} \cdot 25 \text{ L} = 1.125 \text{ mol}$$

$$1.125 \text{ mol HCl} \times \frac{1 \text{ mol CaCl}_2}{2 \text{ mol HCl}} \times \frac{110.978 \text{ g CaCl}_2}{1 \text{ mol CaCl}_2} = 62 \text{ g CaCl}_2$$