

## Stoichiometry – Sheet #2

1. In the reaction shown here, what mass of iron is needed to react completely with 32.0 g of sulfur?  
 $\text{Fe} + \text{S} \rightarrow \text{FeS}$

$$\left( \frac{32.0 \text{ g S}}{32.066 \text{ g/mol}} \right) \left( \frac{1 \text{ mol Fe}}{1 \text{ mol S}} \right) \left( 55.847 \frac{\text{g}}{\text{mol}} \right) = 55.7 \text{ g Fe}$$

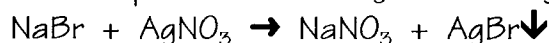
2. When zinc reacts with sulphuric acid, as shown here, what mass of hydrogen is produced from 31.8 g of zinc?  
 $\text{Zn} + \text{H}_2\text{SO}_4 \rightarrow \text{ZnSO}_4 + \text{H}_2 \uparrow$

$$\left( \frac{31.8 \text{ g Zn}}{65.38 \text{ g/mol}} \right) \left( \frac{1 \text{ mol H}_2}{1 \text{ mol Zn}} \right) \left( 2.01588 \frac{\text{g}}{\text{mol}} \right) = 0.980 \text{ g H}_2$$

3. What mass of sulphurous acid can be produced when 128 g of sulfur dioxide combines with water?  
 $\text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_3$

$$\left( \frac{128 \text{ g SO}_2}{64.0648 \text{ g/mol}} \right) \left( \frac{1 \text{ mol H}_2\text{SO}_3}{1 \text{ mol SO}_2} \right) \left( 82.08 \frac{\text{g}}{\text{mol}} \right) = 164 \text{ g H}_2\text{SO}_3$$

4. Silver bromide can be precipitated by the reaction of silver nitrate with sodium bromide. What mass of precipitate can be produced starting with 34.3 g of sodium bromide?

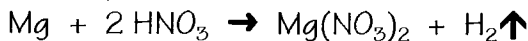


$$\left( \frac{34.3 \text{ g NaBr}}{102.894 \text{ g/mol}} \right) \left( \frac{1 \text{ mol AgBr}}{1 \text{ mol NaBr}} \right) \left( 187.772 \frac{\text{g}}{\text{mol}} \right) = 62.6 \text{ g AgBr}$$

5. Hydrochloric acid is added to 50.0 g of iron(II) sulfide. What mass of hydrogen sulfide is produced?  
 $\text{FeS} + 2 \text{HCl} \rightarrow \text{FeCl}_2 + \text{H}_2\text{S} \uparrow$

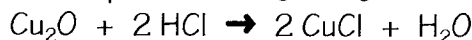
$$\left( \frac{50.0 \text{ g FeS}}{87.913 \text{ g/mol}} \right) \left( \frac{1 \text{ mol H}_2\text{S}}{1 \text{ mol FeS}} \right) \left( 34.082 \frac{\text{g}}{\text{mol}} \right) = 19.4 \text{ g H}_2\text{S}$$

6. How much nitric acid is needed to react completely with 25.0 g of magnesium in the following reaction?



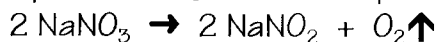
$$\left( \frac{25.0 \text{ g Mg}}{24.305 \text{ g/mol}} \right) \left( \frac{2 \text{ mol HNO}_3}{1 \text{ mol Mg}} \right) \left( 63.0128 \frac{\text{g}}{\text{mol}} \right) = 130. \text{ g HNO}_3$$

7. How much copper(I) chloride can be produced beginning with 75.0 g of copper(I) oxide?



$$\left( \frac{75.0 \text{ g Cu}_2\text{O}}{143.0914 \text{ g/mol}} \right) \left( \frac{2 \text{ mol CuCl}}{1 \text{ mol Cu}_2\text{O}} \right) \left( 98.999 \frac{\text{g}}{\text{mol}} \right) = 104 \text{ g CuCl}$$

8. What volume of oxygen gas (at STP) is produced by the decomposition of 100.0 g of sodium nitrate?



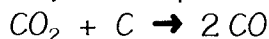
$$\left( \frac{100.0 \text{ g NaNO}_3}{84.995 \text{ g/mol}} \right) \left( \frac{1 \text{ mol O}_2}{2 \text{ mol NaNO}_3} \right) \left( 22.4 \frac{\text{L}}{\text{mol}} \right) = 13.2 \text{ L O}_2$$

9. What volume of oxygen (at STP) is produced when 75.0 g of water is decomposed by electrolysis?



$$\left( \frac{75.0 \text{ g H}_2\text{O}}{18.01528 \text{ g/mol}} \right) \left( \frac{1 \text{ mol O}_2}{2 \text{ mol H}_2\text{O}} \right) \left( 22.4 \frac{\text{L}}{\text{mol}} \right) = 46.6 \text{ L O}_2$$

10. What volume of carbon dioxide is required to produce 50.0 L of carbon monoxide according to the following reaction?



$$\left( \frac{50.0 \text{ L CO}}{22.4 \text{ L/mol}} \right) \left( \frac{1 \text{ mol CO}_2}{2 \text{ mol CO}} \right) \left( 22.4 \frac{\text{L}}{\text{mol}} \right) = 25.0 \text{ L CO}_2$$

11. When aluminum is heated in oxygen, aluminum oxide is formed. What mass of aluminum oxide can be obtained from 25.0 g of aluminum?



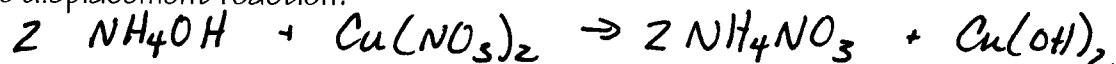
$$\left( \frac{25.0 \text{ g Al}}{26.98154 \text{ g/mol}} \right) \left( \frac{2 \text{ mol Al}_2\text{O}_3}{4 \text{ mol Al}} \right) \left( 101.961 \text{ g/mol} \right) = 47.2 \text{ g Al}_2\text{O}_3$$

12. When steam is passed over iron, hydrogen gas and iron(III) oxide are formed. What mass of steam would be needed to react completely with 100.0 g of iron?



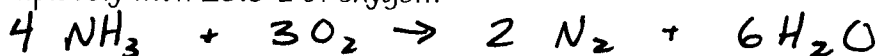
$$\left( \frac{100.0 \text{ g Fe}}{55.847 \text{ g/mol}} \right) \left( \frac{3 \text{ mol H}_2\text{O}}{2 \text{ mol Fe}} \right) \left( 18.01528 \text{ g/mol} \right) = 48.39 \text{ g H}_2\text{O}$$

13. What mass of ammonium hydroxide is needed to react completely with 75.0 g of copper(II) nitrate in a double displacement reaction?



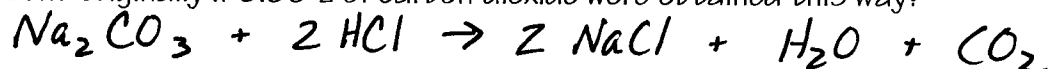
$$\left( \frac{75.0 \text{ g Cu}(\text{NO}_3)_2}{187.5558 \text{ g/mol}} \right) \left( \frac{2 \text{ mol NH}_4\text{OH}}{1 \text{ mol Cu}(\text{NO}_3)_2} \right) \left( 35.0458 \text{ g/mol} \right) = 28.0 \text{ g NH}_4\text{OH}$$

14. When ammonia is burned in oxygen, nitrogen gas and water are produced. What volume of ammonia will react completely with 25.0 L of oxygen?



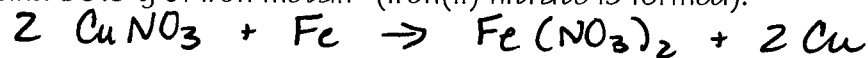
$$\left( \frac{25.0 \text{ L O}_2}{22.4 \text{ L/mol}} \right) \left( \frac{4 \text{ mol NH}_3}{3 \text{ mol O}_2} \right) \left( 22.4 \text{ L/mol} \right) = 33.3 \text{ L NH}_3$$

15. When sodium carbonate reacts with hydrochloric acid, the carbonic acid that is formed immediately breaks down into carbon dioxide and water. What mass of sodium carbonate would have been present originally if 5.00 L of carbon dioxide were obtained this way?



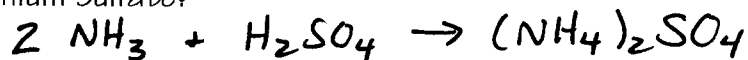
$$\left( \frac{5.00 \text{ L CO}_2}{22.4 \text{ L/mol}} \right) \left( \frac{1 \text{ mol Na}_2\text{CO}_3}{1 \text{ mol CO}_2} \right) \left( 105.98874 \text{ g/mol} \right) = 23.7 \text{ g Na}_2\text{CO}_3$$

16. What mass of copper metal can be obtained by the single replacement reaction between copper(I) nitrate and 30.0 g of iron metal? (Iron(II) nitrate is formed).



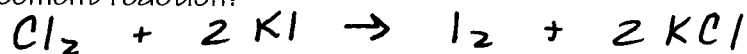
$$\left( \frac{30.0 \text{ g Fe}}{55.847 \text{ g/mol}} \right) \left( \frac{2 \text{ mol Cu}}{1 \text{ mol Fe}} \right) \left( 63.546 \frac{\text{g}}{\text{mol}} \right) = 68.3 \text{ g Cu}$$

17. What mass of sulfuric acid will be needed to react completely with 35.5 g of ammonia in the production of ammonium sulfate?



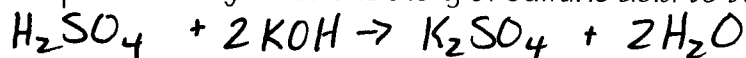
$$\left( \frac{35.5 \text{ g NH}_3}{17.03052 \text{ g/mol}} \right) \left( \frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol NH}_3} \right) \left( 98.079 \frac{\text{g}}{\text{mol}} \right) = 102 \text{ g H}_2\text{SO}_4$$

18. What volume of chlorine gas will be needed to react completely with 85.8 g of potassium iodide in a single replacement reaction?



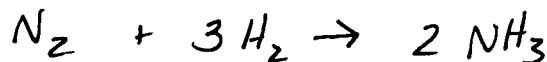
$$\left( \frac{85.8 \text{ g KI}}{166.0028 \text{ g/mol}} \right) \left( \frac{1 \text{ mol Cl}_2}{2 \text{ mol KI}} \right) \left( 22.4 \frac{\text{L}}{\text{mol}} \right) = 5.79 \text{ L Cl}_2$$

19. In the neutralization reaction between sulphuric acid and potassium hydroxide, how much potassium sulfate can be produced if you have 150.0 g of sulfuric acid to begin with?



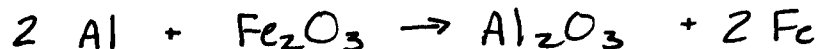
$$\left( \frac{150.0 \text{ g H}_2\text{SO}_4}{98.079 \text{ g/mol}} \right) \left( \frac{1 \text{ mol K}_2\text{SO}_4}{1 \text{ mol H}_2\text{SO}_4} \right) \left( 174.2602 \frac{\text{g}}{\text{mol}} \right) = 266.5 \text{ g K}_2\text{SO}_4$$

20. What volume of nitrogen gas is needed to react completely with 150.0 L of hydrogen in the production of ammonia?



$$\left( \frac{150.0 \text{ L H}_2}{22.4 \text{ L/mol}} \right) \left( \frac{1 \text{ mol N}_2}{3 \text{ mol H}_2} \right) \left( 22.4 \frac{\text{L}}{\text{mol}} \right) = 50.0 \text{ L N}_2$$

21. What mass of aluminum metal is needed to replace all of the iron from 27.8 g of iron(III) oxide?



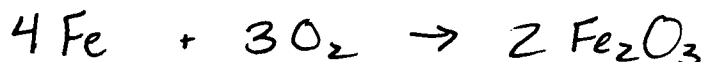
$$\left( \frac{27.8 \text{ g Fe}_2\text{O}_3}{159.6922 \text{ g/mol}} \right) \left( \frac{2 \text{ mol Al}}{1 \text{ mol Fe}_2\text{O}_3} \right) \left( 26.98154 \frac{\text{g}}{\text{mol}} \right) = 9.39 \text{ g Al}$$

22. What volume of chlorine gas will react with antimony in order to produce 58.9 g of antimony(III) chloride?



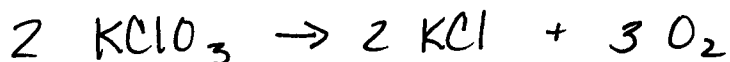
$$\left( \frac{58.9 \text{ g SbCl}_3}{228.109 \text{ g/mol}} \right) \left( \frac{3 \text{ mol Cl}_2}{2 \text{ mol SbCl}_3} \right) \left( 22.4 \text{ L/mol} \right) = 8.68 \text{ L Cl}_2$$

23. What mass of iron metal will be required to produce 20.8 g of iron(III) oxide in the reaction with pure oxygen?



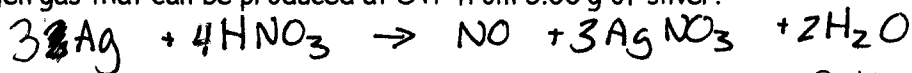
$$\left( \frac{20.8 \text{ g Fe}_2\text{O}_3}{159.6922 \text{ g/mol}} \right) \left( \frac{4 \text{ mol Fe}}{2 \text{ mol Fe}_2\text{O}_3} \right) \left( 55.847 \frac{\text{g}}{\text{mol}} \right) = 14.5 \text{ g Fe}$$

24. What mass of potassium chlorate is required in the preparation of 90.0 L of oxygen gas?



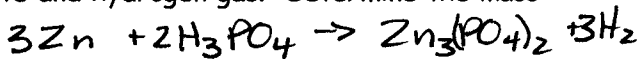
$$\left( \frac{90.0 \text{ L O}_2}{22.4 \text{ L/mol}} \right) \left( \frac{2 \text{ mol KClO}_3}{3 \text{ mol O}_2} \right) \left( 122.5495 \frac{\text{g}}{\text{mol}} \right) = 328 \text{ g KClO}_3$$

25. Silver reacts with nitric acid to form nitrogen monoxide, silver nitrate and water. Determine the volume of nitrogen gas that can be produced at STP from 5.00 g of silver.



$$\left( \frac{5.00 \text{ g Ag}}{107.8682 \text{ g/mol}} \right) \left( \frac{1 \text{ mol NO}}{3 \text{ mol Ag}} \right) (22.4 \text{ L/mol}) = \underline{0.346 \text{ L NO}}$$

26. Zinc reacts with phosphoric acid to produce zinc phosphate and hydrogen gas. Determine the mass of zinc required to produce 15.0 L of hydrogen gas at STP.



$$\left( \frac{15.0 \text{ L H}_2}{22.4 \text{ L/mol}} \right) \left( \frac{3 \text{ mol Zn}}{3 \text{ mol H}_2} \right) (65.38 \text{ g/mol}) = \underline{43.8 \text{ g Zn}}$$

27. During photosynthesis, a sweet potato plant combines carbon dioxide gas and water to produce sucrose ( $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ ) and oxygen gas. Determine the volume of carbon dioxide gas at STP required to produce 455 g of sucrose.



$$\left( \frac{455 \text{ g C}_{12}\text{H}_{22}\text{O}_{11}}{342.30008 \text{ g/mol}} \right) \left( \frac{12 \text{ mol CO}_2}{1 \text{ mol C}_{12}\text{H}_{22}\text{O}_{11}} \right) (22.4 \text{ L/mol}) = \underline{357 \text{ L CO}_2}$$

28. The charcoal briquettes used to cook in an outdoor grill are composed of 99% carbon. What volume of oxygen gas (at STP) is required when a 100.0 g briquette is burned to produce carbon dioxide?



$$(0.99)(100.0) = 99. \text{ g C} \quad \left( \frac{99.0 \text{ g C}}{12.011 \text{ g/mol}} \right) \left( \frac{1 \text{ mol O}_2}{1 \text{ mol C}} \right) (22.4 \text{ L/mol}) = \underline{185 \text{ L O}_2}$$

29.  $\text{NO}_2$  is a toxic gas that forms acid rain when mixed with water in the air. The major source of  $\text{NO}_2$  is the combustion of  $\text{N}_2$  in the cylinders of automobile engines. Determine the mass of  $\text{NO}_2$  produced from  $5.00 \times 10^8 \text{ dm}^3$  of  $\text{N}_2$ .



$$\left( \frac{5.00 \times 10^8 \text{ dm}^3 \text{ N}_2}{22.4 \text{ dm}^3/\text{mol}} \right) \left( \frac{2 \text{ mol NO}_2}{1 \text{ mol N}_2} \right) (46.0055 \text{ g/mol}) = \underline{2.05 \times 10^9 \text{ g NO}_2}$$