

**CH 12 PRACTICE TEST with ANSWERS****Matching**

*Match each item with the correct statement below.*

- |                      |                        |
|----------------------|------------------------|
| a. actual yield      | e. limiting reagent    |
| b. percent yield     | f. mass                |
| c. theoretical yield | g. number of molecules |
| d. excess reagent    | h. volume              |

- \_\_\_\_\_ 1. This quantity can always be used in the same way as moles when interpreting balanced chemical equations.
- \_\_\_\_\_ 2. This is conserved only in reactions where the temperature is constant and the number of moles of gaseous reactants is the same as that of gaseous products.
- \_\_\_\_\_ 3. This is conserved in every ordinary chemical reaction.
- \_\_\_\_\_ 4. the reactant that determines the amount of product that can be formed in a reaction
- \_\_\_\_\_ 5. the maximum amount of product that could be formed from given amounts of reactants
- \_\_\_\_\_ 6. the reactant that is not completely used up in a reaction
- \_\_\_\_\_ 7. the amount of product formed when a reaction is carried out in the laboratory
- \_\_\_\_\_ 8. the ratio of the actual yield to the theoretical yield

**Multiple Choice**

*Identify the choice that best completes the statement or answers the question.*

- \_\_\_\_\_ 9. The calculation of quantities in chemical equations is called \_\_\_\_\_.  
a. stoichiometry                      c. percent composition  
b. dimensional analysis              d. percent yield
- \_\_\_\_\_ 10. If 1 egg and 1/3 cup of oil are needed for each bag of brownie mix, how many bags of brownie mix do you need if you want to use up all 3 eggs and 1 cup of oil?  
a. 1    c. 3  
b. 2    d. 4
- \_\_\_\_\_ 11. What is conserved in the reaction shown below?  
$$\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$$
  
a. mass only                              c. mass, moles, and molecules only  
b. mass and moles only                d. mass, moles, molecules, and volume
- \_\_\_\_\_ 12. What is conserved in the reaction shown below?  
$$\text{N}_2(\text{g}) + 3\text{F}_2(\text{g}) \rightarrow 2\text{NF}_3(\text{g})$$
  
a. atoms only                            c. mass and atoms only  
b. mass only                              d. moles only

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- \_\_\_\_\_ 13. In every chemical reaction, \_\_\_\_\_.  
a. mass and molecules are conserved                      c. mass and atoms are conserved  
b. moles and liters are conserved                      d. moles and molecules are conserved
- \_\_\_\_\_ 14. In a chemical reaction, the mass of the products \_\_\_\_\_.  
a. is less than the mass of the reactants  
b. is greater than the mass of the reactants  
c. is equal to the mass of the reactants  
d. has no relationship to the mass of the reactants
- \_\_\_\_\_ 15. In any chemical reaction, the quantities that are preserved are \_\_\_\_\_.  
a. the number of moles and the volumes  
b. the number of molecules and the volumes  
c. mass and number of atoms  
d. mass and moles
- \_\_\_\_\_ 16. The first step in most stoichiometry problems is to \_\_\_\_\_.  
a. add the coefficients of the reagents                      c. convert given quantities to volumes  
b. convert given quantities to moles                      d. convert given quantities to masses
- \_\_\_\_\_ 17. In the reaction  $2\text{CO}(g) + \text{O}_2(g) \rightarrow 2\text{CO}_2(g)$ , what is the ratio of moles of oxygen used to moles of  $\text{CO}_2$  produced?  
a. 1:1    c. 1:2  
b. 2:1    d. 2:2
- \_\_\_\_\_ 18. Which of the following is true about the total number of reactants and the total number of products in the reaction shown below?  
 $\text{C}_5\text{H}_{12}(l) + 8\text{O}_2(g) \rightarrow 5\text{CO}_2(g) + 6\text{H}_2\text{O}(g)$   
a. 9 moles of reactants chemically change into 11 moles of product.  
b. 9 grams of reactants chemically change into 11 grams of product.  
c. 9 liters of reactants chemically change into 11 liters of product.  
d. 9 atoms of reactants chemically change into 11 atoms of product.
- \_\_\_\_\_ 19. Which of the following is an INCORRECT interpretation of the balanced equation shown below?  
 $2\text{S}(s) + 3\text{O}_2(g) \rightarrow 2\text{SO}_3(g)$   
a. 2 atoms S + 3 molecules  $\text{O}_2 \rightarrow$  2 molecules  $\text{SO}_3$   
b. 2 g S + 3 g  $\text{O}_2 \rightarrow$  2 g  $\text{SO}_3$   
c. 2 mol S + 3 mol  $\text{O}_2 \rightarrow$  2 mol  $\text{SO}_3$   
d. none of the above
- \_\_\_\_\_ 20. How many moles of aluminum are needed to react completely with 1.2 mol of FeO?  
 $2\text{Al}(s) + 3\text{FeO}(s) \rightarrow 3\text{Fe}(s) + \text{Al}_2\text{O}_3(s)$   
a. 1.2 mol    c. 1.6 mol  
b. 0.8 mol    d. 2.4 mol

21. Calculate the number of moles of  $\text{Al}_2\text{O}_3$  that are produced when 0.60 mol of Fe is produced in the following reaction.

$$2\text{Al}(s) + 3\text{FeO}(s) \rightarrow 3\text{Fe}(s) + \text{Al}_2\text{O}_3(s)$$
  - 0.20 mol
  - 0.40 mol
  - 0.60 mol
  - 0.90 mol

22. How many moles of glucose,  $\text{C}_6\text{H}_{12}\text{O}_6$ , can be "burned" biologically when 10.0 mol of oxygen is available?

$$\text{C}_6\text{H}_{12}\text{O}_6(s) + 6\text{O}_2(g) \rightarrow 6\text{CO}_2(g) + 6\text{H}_2\text{O}(l)$$
  - 0.938 mol
  - 1.67 mol
  - 53.3 mol
  - 60.0 mol

23. Hydrogen gas can be produced by reacting aluminum with sulfuric acid. How many moles of sulfuric acid are needed to completely react with 15.0 mol of aluminum?

$$2\text{Al}(s) + 3\text{H}_2\text{SO}_4(aq) \rightarrow \text{Al}_2(\text{SO}_4)_3(aq) + 3\text{H}_2(g)$$
  - 0.100 mol
  - 10.0 mol
  - 15.0 mol
  - 22.5 mol

24. When iron rusts in air, iron(III) oxide is produced. How many moles of oxygen react with 2.4 mol of iron in the rusting reaction?

$$4\text{Fe}(s) + 3\text{O}_2(g) \rightarrow 2\text{Fe}_2\text{O}_3(s)$$
  - 1.2 mol
  - 1.8 mol
  - 2.4 mol
  - 3.2 mol

25. At STP, how many liters of oxygen are required to react completely with 3.6 liters of hydrogen to form water?

$$2\text{H}_2(g) + \text{O}_2(g) \rightarrow 2\text{H}_2\text{O}(g)$$
  - 1.8 L
  - 3.6 L
  - 2.0 L
  - 2.4 L

26. Which type of stoichiometric calculation does not require the use of the molar mass?

  - mass-mass problems
  - mass-volume problems
  - mass-particle problems
  - volume-volume problems

27. The equation below shows the decomposition of lead nitrate. How many grams of oxygen are produced when 11.5 g  $\text{NO}_2$  is formed?

$$2\text{Pb}(\text{NO}_3)_2(s) \rightarrow 2\text{PbO}(s) + 4\text{NO}_2(g) + \text{O}_2(g)$$
  - 1.00 g
  - 2.00 g
  - 2.88 g
  - 32.0 g

28. Iron(III) oxide is formed when iron combines with oxygen in the air. How many grams of  $\text{Fe}_2\text{O}_3$  are formed when 16.7 g of Fe reacts completely with oxygen?

$$4\text{Fe}(s) + 3\text{O}_2(g) \rightarrow 2\text{Fe}_2\text{O}_3(s)$$
  - 12.0 g
  - 23.9 g
  - 47.8 g
  - 95.6 g

- \_\_\_\_\_ 29. When glucose is consumed, it reacts with oxygen in the body to produce carbon dioxide, water, and energy. How many grams of carbon dioxide would be produced if 45 g of  $C_6H_{12}O_6$  completely reacted with oxygen?
- a. 1.5 g c. 11 g  
b. 1.8 g d. 66 g
- \_\_\_\_\_ 30. Aluminum reacts with sulfuric acid to produce aluminum sulfate and hydrogen gas. How many grams of aluminum sulfate would be formed if 250 g  $H_2SO_4$  completely reacted with aluminum?
- $2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$
- a. 0.85 g c. 450 g  
b. 290 g d. 870 g
- \_\_\_\_\_ 31. Mercury can be obtained by reacting mercury(II) sulfide with calcium oxide. How many grams of calcium oxide are needed to produce 36.0 g of Hg?
- $4HgS(s) + 4CaO(s) \rightarrow 4Hg(l) + 3CaS(s) + CaSO_4$
- a. 1.80 g c. 10.1 g  
b. 7.56 g d. 13.4 g
- \_\_\_\_\_ 32. How many moles of  $H_3PO_4$  are produced when 71.0 g  $P_4O_{10}$  reacts completely to form  $H_3PO_4$ ?
- $P_4O_{10}(s) + 6H_2O(l) \rightarrow 4H_3PO_4(aq)$
- a. 0.063 5 mol c. 4.00 mol  
b. 1.00 mol d. 16.0 mol
- \_\_\_\_\_ 33. How many grams of  $H_3PO_4$  are produced when 10.0 moles of water react with an excess of  $P_4O_{10}$ ?
- $P_4O_{10}(s) + 6H_2O(l) \rightarrow 4H_3PO_4(aq)$
- a. 1.22 g c. 147 g  
b. 6.7 g d. 653 g
- \_\_\_\_\_ 34. How many liters of hydrogen gas are needed to react with  $CS_2$  to produce 2.50 L of  $CH_4$  at STP?
- $4H_2(g) + CS_2(l) \rightarrow CH_4(g) + 2H_2S(g)$
- a. 2.50 L c. 7.50 L  
b. 5.00 L d. 10.0 L
- \_\_\_\_\_ 35. Which conversion factor do you use first to calculate the number of grams of  $CO_2$  produced by the reaction of 50.6 g of  $CH_4$  with  $O_2$ ? The equation for the complete combustion of methane is:
- $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$
- a. 1 mol  $CH_4$ /16.0 g  $CH_4$  c. 16.0 g  $CH_4$ /1 mol  $CO_2$   
b. 2 mol  $O_2$ /1 mol  $CO_2$  d. 44.0 g  $CO_2$ /2 mol  $CO_2$
- \_\_\_\_\_ 36. Which of the following statements is true about the following reaction?
- $3NaHCO_3(aq) + C_6H_8O_7(aq) \rightarrow 3CO_2(g) + 3H_2O(l) + Na_3C_6H_5O_7(aq)$
- a. 22.4 L of  $CO_2(g)$  are produced for every liter of  $C_6H_8O_7(aq)$  reacted.  
b. 1 mole of water is produced for every mole of carbon dioxide produced.  
c.  $6.02 \times 10^{23}$  molecules of  $Na_3C_6H_5O_7(aq)$  are produced for every mole of  $NaHCO_3(aq)$  used.  
d. 54 g of water are produced for every mole of  $NaHCO_3(aq)$  produced.

37. How many liters of  $\text{NH}_3$  are needed to react completely with 30.0 L of NO (at STP)?  
 $4\text{NH}_3(g) + 6\text{NO}(g) \rightarrow 5\text{N}_2(g) + 6\text{H}_2\text{O}(g)$   
 a. 5.0 L c. 7.5 L  
 b. 20.0 L d. 120.0 L
38. When 0.1 mol of calcium reacts with 880 g of water, 2.24 L of hydrogen gas form (at STP). How would the amount of hydrogen produced change if the volume of water was decreased to 440 mL (440 g)?  
 a. Only one half the volume of hydrogen would be produced.  
 b. The volume of hydrogen produced would be the same.  
 c. The volume of hydrogen produced would double.  
 d. No hydrogen would be produced.
39. Glucose,  $\text{C}_6\text{H}_{12}\text{O}_6$ , is a good source of food energy. When it reacts with oxygen, carbon dioxide and water are formed. How many liters of  $\text{CO}_2$  are produced when 126 g of glucose completely react with oxygen?  
 $\text{C}_6\text{H}_{12}\text{O}_6(s) + 6\text{O}_2(g) \rightarrow 6\text{CO}_2(g) + 6\text{H}_2\text{O}(l) + 673 \text{ kcal}$   
 a. 4.21 L c. 15.7 L  
 b. 5.33 L d. 94.1 L
40. Calcium oxide, or lime, is produced by the thermal decomposition of limestone in the reaction  $\text{CaCO}_3(s) \xrightarrow{\Delta} \text{CaO}(s) + \text{CO}_2(g)$ . What mass of lime can be produced from  $1.5 \times 10^3$  kg of limestone?  
 a.  $8.4 \times 10^5$  kg c. 8.4 kg  
 b.  $8.4 \times 10^2$  kg d. none of the above
41. When two substances react to form products, the reactant which is used up is called the \_\_\_\_\_.  
 a. determining reagent c. excess reagent  
 b. limiting reagent d. catalytic reagent
42. Which of the following is NOT true about limiting and excess reagents?  
 a. The amount of product obtained is determined by the limiting reagent.  
 b. A balanced equation is necessary to determine which reactant is the limiting reagent.  
 c. Some of the excess reagent is left over after the reaction is complete.  
 d. The reactant that has the smallest given mass is the limiting reagent.
43. How many grams of chromium are needed to react with an excess of  $\text{CuSO}_4$  to produce 27.0 g Cu?  
 $2\text{Cr}(s) + 3\text{CuSO}_4(aq) \rightarrow \text{Cr}_2(\text{SO}_4)_3(aq) + 3\text{Cu}(s)$   
 a. 14.7 g c. 33.2 g  
 b. 18.0 g d. 81.5 g
44. How many grams of beryllium are needed to produce 36.0 g of hydrogen? (Assume an excess of water.)  
 $\text{Be}(s) + 2\text{H}_2\text{O}(l) \rightarrow \text{Be}(\text{OH})_2(aq) + \text{H}_2(g)$   
 a. 4.00 g c. 162 g  
 b. 36.0 g d. 324 g

- \_\_\_\_\_ 45. How many liters of NH<sub>3</sub>, at STP, will react with 5.3 g O<sub>2</sub> to form NO<sub>2</sub> and water?  

$$4\text{NH}_3(\text{g}) + 7\text{O}_2(\text{g}) \rightarrow 4\text{NO}_2 + 6\text{H}_2\text{O}(\text{g})$$
 a. 0.004 23 L                                      c. 3.03 L  
 b. 2.12 L    d. 6.49 L
- \_\_\_\_\_ 46. How many liters of chlorine gas can be produced when 0.98 L of HCl react with excess O<sub>2</sub> at STP?  

$$4\text{HCl}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{Cl}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$$
 a. 0.98 L    c. 3.9 L  
 b. 0.49 L    d. 2.0 L
- \_\_\_\_\_ 47. Identify the limiting reagent and the volume of CO<sub>2</sub> formed when 11 L CS<sub>2</sub> reacts with 18 L O<sub>2</sub> to produce CO<sub>2</sub> gas and SO<sub>2</sub> gas at STP.  

$$\text{CS}_2(\text{g}) + 3\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{SO}_2(\text{g})$$
 a. CS<sub>2</sub>; 5.5 L CO<sub>2</sub>                                      c. CS<sub>2</sub>; 11 L CO<sub>2</sub>  
 b. O<sub>2</sub>; 6.0 L CO<sub>2</sub>                                      d. O<sub>2</sub>; 27 L CO<sub>2</sub>
- \_\_\_\_\_ 48. What is the maximum number of grams of PH<sub>3</sub> that can be formed when 6.2 g of phosphorus reacts with 4.0 g of hydrogen to form PH<sub>3</sub>?  

$$\text{P}_4(\text{g}) + 6\text{H}_2(\text{g}) \rightarrow 4\text{PH}_3(\text{g})$$
 a. 0.43 g    c. 270 g  
 b. 6.8 g    d. 45 g
- \_\_\_\_\_ 49. Methane and hydrogen sulfide form when hydrogen reacts with carbon disulfide. Identify the excess reagent and calculate how much remains after 36 L of H<sub>2</sub> reacts with 12 L of CS<sub>2</sub>.  

$$4\text{H}_2(\text{g}) + \text{CS}_2(\text{g}) \rightarrow \text{CH}_4(\text{g}) + 2\text{H}_2\text{S}(\text{g})$$
 a. 3 L CS<sub>2</sub>    c. 9 L CS<sub>2</sub>  
 b. 6 L CS<sub>2</sub>    d. 12 L H<sub>2</sub>
- \_\_\_\_\_ 50. Metallic copper is formed when aluminum reacts with copper(II) sulfate. How many grams of metallic copper can be obtained when 54.0 g of Al react with 319 g of CuSO<sub>4</sub>?  

$$\text{Al} + 3\text{CuSO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + 3\text{Cu}$$
 a. 21.2 g    c. 162 g  
 b. 127 g    d. 381 g
- \_\_\_\_\_ 51. Which statement is true if 12 mol CO and 12 mol Fe<sub>2</sub>O<sub>3</sub> are allowed to react?  

$$3\text{CO}(\text{g}) + \text{Fe}_2\text{O}_3(\text{s}) \rightarrow 2\text{Fe}(\text{s}) + 3\text{CO}_2(\text{g})$$
 a. The limiting reagent is CO and 8.0 mol Fe will be formed.  
 b. The limiting reagent is CO and 3.0 mol CO<sub>2</sub> will be formed.  
 c. The limiting reagent is Fe<sub>2</sub>O<sub>3</sub> and 24 mol Fe will be formed.  
 d. The limiting reagent is Fe<sub>2</sub>O<sub>3</sub> and 36 mol CO<sub>2</sub> will be formed.

- \_\_\_\_\_ 52. Which of the following would be the limiting reagent in the reaction shown below?  
 $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$   
a. 50 molecules of  $\text{H}_2$   
b. 50 molecules of  $\text{O}_2$   
c. Neither a nor b is limiting.  
d. Both a and b are considered limiting reagents.
- \_\_\_\_\_ 53. When an equation is used to calculate the amount of product that will form during a reaction, then the value obtained is called the \_\_\_\_\_.  
a. actual yield  
b. percent yield  
c. theoretical yield  
d. minimum yield
- \_\_\_\_\_ 54. Which of the following is NOT true about "yield"?  
a. The value of the actual yield must be given in order for the percent yield to be calculated.  
b. The percent yield is the ratio of the actual yield to the theoretical yield.  
c. The actual yield may be different from the theoretical yield because reactions do not always go to completion.  
d. The actual yield may be different from the theoretical yield because insufficient limiting reagent was used.
- \_\_\_\_\_ 55. Which of the following is NOT a reason why actual yield is less than theoretical yield?  
a. impure reactants present  
b. competing side reactions  
c. loss of product during purification  
d. conservation of mass
- \_\_\_\_\_ 56. Lead nitrate can be decomposed by heating. What is the percent yield of the decomposition reaction if 9.9 g  $\text{Pb}(\text{NO}_3)_2$  are heated to give 5.5 g of  $\text{PbO}$ ?  
 $2\text{Pb}(\text{NO}_3)_2(\text{s}) \rightarrow 2\text{PbO}(\text{s}) + 4\text{NO}_2(\text{g}) + \text{O}_2(\text{g})$   
a. 44%  
b. 56%  
c. 67%  
d. 82%
- \_\_\_\_\_ 57. Hydrogen gas is produced when zinc reacts with hydrochloric acid. If the actual yield of this reaction is 85%, how many grams of zinc are needed to produce 112 L of  $\text{H}_2$  at STP?  
 $\text{Zn}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{ZnCl}_2(\text{s}) + \text{H}_2(\text{g})$   
a. 95 g  
b. 180 g  
c. 280 g  
d. 380 g
- \_\_\_\_\_ 58. In a particular reaction between copper metal and silver nitrate, 12.7 g Cu produced 38.1 g Ag. What is the percent yield of silver in this reaction?  
 $\text{Cu} + 2\text{AgNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{Ag}$   
a. 56.7%  
b. 77.3%  
c. 88.2%  
d. 176%

**Short Answer**

59. If a tricycle factory ordered 33,432 wheels in 2002 and used all of them, how many tricycles did the factory produce?

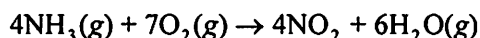
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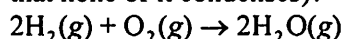
60. If a total of 13.5 mol of  $\text{NaHCO}_3$  and 4.5 mol of  $\text{C}_6\text{H}_8\text{O}_7$  react, how many moles of  $\text{CO}_2$  and  $\text{Na}_3\text{C}_6\text{H}_5\text{O}_7$  will be produced?



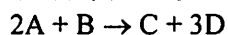
61. If 8.00 mol of  $\text{NH}_3$  reacted with 14.0 mol of  $\text{O}_2$ , how many moles of  $\text{H}_2\text{O}$  will be produced?



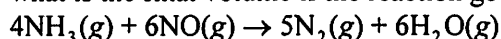
62. If 8.6 L of  $\text{H}_2$  reacted with 4.3 L of  $\text{O}_2$  at STP, what is the volume of the gaseous water collected (assuming that none of it condenses)?



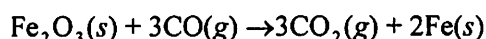
63. What is the mole ratio of D to A in the generic chemical reaction?



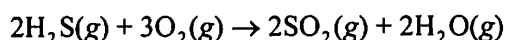
64. Assuming STP and a stoichiometric amount of  $\text{NH}_3$  and  $\text{NO}$  in an expandable container originally at 15 L, what is the final volume if the reaction goes to completion?



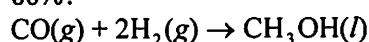
65. How many grams of  $\text{CO}$  are needed to react with an excess of  $\text{Fe}_2\text{O}_3$  to produce 209.7 g  $\text{Fe}$ ?



66. How many liters of  $\text{O}_2$  are needed to react completely with 45.0 L of  $\text{H}_2\text{S}$  at STP?

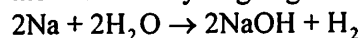


67. If 5.0 g of  $\text{H}_2$  are reacted with excess  $\text{CO}$ , how many grams of  $\text{CH}_3\text{OH}$  are produced, based on a yield of 86%?



68. For the reaction  $2\text{Na}(s) + \text{Cl}_2(g) \rightarrow 2\text{NaCl}(s)$ , how many grams of  $\text{NaCl}$  could be produced from 103.0 g of  $\text{Na}$  and 13.0 L of  $\text{Cl}_2$  (at STP)?

69. Solid sodium reacts violently with water, producing heat, hydrogen gas, and sodium hydroxide. How many molecules of hydrogen gas are formed when 48.7 g of sodium are added to water?



70. The decomposition of potassium chlorate yields oxygen gas. If the yield is 95%, how many grams of  $\text{KClO}_3$  are needed to produce 10.0 L of  $\text{O}_2$ ?

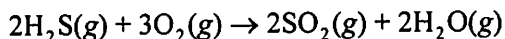




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71. Consider the following reaction:



If  $\text{O}_2$  was the excess reagent, 8.3 mol of  $\text{H}_2\text{S}$  were consumed, and 137.1 g of water were collected after the reaction has gone to completion, what is the percent yield of the reaction?

### Essay

72. Describe an experience you've had making or building something where the amount of each ingredient or building block came in fixed ratios.
73. A chemical problem may be presented to you in units of moles, mass, or volume. Which one of these can be directly used in your arithmetic no matter what the conditions are?
74. What is the importance of the coefficients in a balanced chemical reaction?
75. What is the general procedure for solving a stoichiometric problem?
76. When a mixture of sulfur and metallic silver is heated, silver sulfide is produced. What mass of silver sulfide is produced from a mixture of 3.0 g Ag and 3.0 g  $\text{S}_8$ ?
- $$16\text{Ag}(s) + \text{S}_8(s) \rightarrow 8\text{Ag}_2\text{S}(s)$$
77. In which kind of stoichiometric calculation can the steps involving conversion to and from moles be omitted? Explain why it is possible to do so.
78. What is the limiting reagent when 150.0 g of nitrogen react with 32.1 g of hydrogen?
- $$\text{N}_2(g) + 3\text{H}_2(g) \rightarrow 2\text{NH}_3(g)$$
79. A 500-g sample of  $\text{Al}_2(\text{SO}_4)_3$  is reacted with 450 g of  $\text{Ca}(\text{OH})_2$ . A total of 596 g of  $\text{CaSO}_4$  is produced. What is the limiting reagent in this reaction, and how many moles of excess reagent are unreacted?
- $$\text{Al}_2(\text{SO}_4)_3(aq) + 3\text{Ca}(\text{OH})_2(aq) \rightarrow 2\text{Al}(\text{OH})_3(s) + 3\text{CaSO}_4(s)$$
80. Assuming no errors were made in measuring the yield, can the percent yield of a chemical reaction be greater than 100%?

## CH 12 PRACTICE TEST with ANSWERS

### Answer Section

#### MATCHING

- |                      |             |         |             |
|----------------------|-------------|---------|-------------|
| 1. ANS: G            | PTS: 1      | DIF: L1 | REF: p. 356 |
| OBJ: 12.1.2          | STA: Ch.3.d |         |             |
| 2. ANS: H            | PTS: 1      | DIF: L1 | REF: p. 357 |
| OBJ: 12.1.2          | STA: Ch.4.c |         |             |
| 3. ANS: F            | PTS: 1      | DIF: L1 | REF: p. 357 |
| OBJ: 12.1.2   12.1.3 | STA: Ch.3.d |         |             |
| 4. ANS: E            | PTS: 1      | DIF: L1 | REF: p. 369 |
| OBJ: 12.3.1          |             |         |             |
| 5. ANS: C            | PTS: 1      | DIF: L1 | REF: p. 369 |
| OBJ: 12.3.1          |             |         |             |
| 6. ANS: D            | PTS: 1      | DIF: L1 | REF: p. 372 |
| OBJ: 12.3.2          |             |         |             |
| 7. ANS: A            | PTS: 1      | DIF: L1 | REF: p. 372 |
| OBJ: 12.3.2          |             |         |             |
| 8. ANS: B            | PTS: 1      | DIF: L1 | REF: p. 372 |
| OBJ: 12.3.2          | STA: Ch.3.f |         |             |

#### MULTIPLE CHOICE

- |                      |             |         |             |
|----------------------|-------------|---------|-------------|
| 9. ANS: A            | PTS: 1      | DIF: L1 | REF: p. 354 |
| OBJ: 12.1.1          | STA: Ch.3.d |         |             |
| 10. ANS: C           | PTS: 1      | DIF: L1 | REF: p. 354 |
| OBJ: 12.1.1          |             |         |             |
| 11. ANS: D           | PTS: 1      | DIF: L1 | REF: p. 356 |
| OBJ: 12.1.2   12.1.3 | STA: Ch.3.d |         |             |
| 12. ANS: C           | PTS: 1      | DIF: L1 | REF: p. 356 |
| OBJ: 12.1.2   12.1.3 | STA: Ch.3.d |         |             |
| 13. ANS: C           | PTS: 1      | DIF: L1 | REF: p. 356 |
| OBJ: 12.1.2   12.1.3 | STA: Ch.3.d |         |             |
| 14. ANS: C           | PTS: 1      | DIF: L1 | REF: p. 356 |
| OBJ: 12.1.2          | STA: Ch.3.d |         |             |
| 15. ANS: C           | PTS: 1      | DIF: L1 | REF: p. 356 |
| OBJ: 12.1.2          | STA: Ch.3.d |         |             |
| 16. ANS: B           | PTS: 1      | DIF: L1 | REF: p. 356 |
| OBJ: 12.1.2          | STA: Ch.3.d |         |             |
| 17. ANS: C           | PTS: 1      | DIF: L1 | REF: p. 356 |
| OBJ: 12.1.2          | STA: Ch.4.c |         |             |
| 18. ANS: A           | PTS: 1      | DIF: L2 | REF: p. 356 |
| OBJ: 12.1.2          | STA: Ch.3.d |         |             |
| 19. ANS: B           | PTS: 1      | DIF: L2 | REF: p. 356 |
| OBJ: 12.1.2          | STA: Ch.3.a |         |             |

20.	ANS: B OBJ: 12.2.1	PTS: 1 STA: Ch.3.d	DIF: L1	REF: p. 359   p. 360
21.	ANS: A OBJ: 12.2.1	PTS: 1 STA: Ch.3.d	DIF: L1	REF: p. 359   p. 360
22.	ANS: B OBJ: 12.2.1	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 359   p. 360
23.	ANS: D OBJ: 12.2.1	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 359   p. 360
24.	ANS: B OBJ: 12.2.1	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 359   p. 360
25.	ANS: A OBJ: 12.2.2	PTS: 1 STA: Ch.3.d	DIF: L1	REF: p. 363   p. 364   p. 365   p. 366
26.	ANS: D OBJ: 12.2.2	PTS: 1 STA: Ch.3.d	DIF: L1	REF: p. 365
27.	ANS: B OBJ: 12.2.2	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 360   p. 361   p. 362
28.	ANS: B OBJ: 12.2.2	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 360   p. 361   p. 362
29.	ANS: D OBJ: 12.2.2	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 360   p. 361   p. 362
30.	ANS: B OBJ: 12.2.2	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 360   p. 361   p. 362
31.	ANS: C OBJ: 12.2.2	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 360   p. 361   p. 362
32.	ANS: B OBJ: 12.2.2	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 360   p. 361   p. 362
33.	ANS: D OBJ: 12.2.2	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 360   p. 361   p. 362
34.	ANS: D OBJ: 12.2.2	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 363   p. 364   p. 365   p. 366
35.	ANS: A OBJ: 12.2.2	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 360   p. 361   p. 362
36.	ANS: B OBJ: 12.2.2	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 363   p. 364   p. 365   p. 366
37.	ANS: B OBJ: 12.2.2	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 363   p. 364   p. 365   p. 366
38.	ANS: B OBJ: 12.2.2	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 363   p. 364   p. 365   p. 366
39.	ANS: D OBJ: 12.2.2	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 363   p. 364   p. 365   p. 366
40.	ANS: B OBJ: 12.2.2	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 363   p. 364   p. 365   p. 366
41.	ANS: B OBJ: 12.3.1	PTS: 1	DIF: L1	REF: p. 369
42.	ANS: D OBJ: 12.3.1	PTS: 1	DIF: L1	REF: p. 369

43.	ANS: A OBJ: 12.3.1	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 371
44.	ANS: C OBJ: 12.3.1	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 371
45.	ANS: B OBJ: 12.3.1	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 371
46.	ANS: B OBJ: 12.3.1	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 371
47.	ANS: B OBJ: 12.3.1	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 371
48.	ANS: B OBJ: 12.3.1	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 371
49.	ANS: A OBJ: 12.3.1	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 371
50.	ANS: B OBJ: 12.3.1	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 371
51.	ANS: A OBJ: 12.3.1	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 369
52.	ANS: B OBJ: 12.3.1	PTS: 1	DIF: L2	REF: p. 369
53.	ANS: C OBJ: 12.3.2	PTS: 1	DIF: L1	REF: p. 372
54.	ANS: D OBJ: 12.3.2	PTS: 1	DIF: L1	REF: p. 372
55.	ANS: D OBJ: 12.3.2	PTS: 1	DIF: L1	REF: p. 373
56.	ANS: D OBJ: 12.3.2	PTS: 1 STA: Ch.3.f	DIF: L2	REF: p. 375
57.	ANS: D OBJ: 12.3.2	PTS: 1 STA: Ch.3.d	DIF: L2	REF: p. 374
58.	ANS: C OBJ: 12.3.2	PTS: 1 STA: Ch.3.f	DIF: L2	REF: p. 375

**SHORT ANSWER**

59.	ANS: $\frac{33,432 \text{ wheels}}{3 \text{ wheels/tricycle}} = 11,144 \text{ tricycles}$	PTS: 1	DIF: L1	REF: p. 354	OBJ: 12.1.1
60.	ANS: 13.5 mol of CO <sub>2</sub> ; 4.5 mol of Na <sub>3</sub> C <sub>6</sub> H <sub>5</sub> O <sub>7</sub>	PTS: 1 STA: Ch.3.d	DIF: L1	REF: p. 359	OBJ: 12.2.1

61. ANS:  
12.0 mol of  $\text{H}_2\text{O}$

PTS: 1                      DIF: L2                      REF: p. 359                      OBJ: 12.2.1  
STA: Ch.3.d

62. ANS:  
 $8.6 \text{ L H}_2 / (22.4 \text{ L/1 mol}) \times 2 \text{ mol H}_2\text{O} / 2 \text{ mol H}_2 \times 22.4 \text{ L/1 mol} = 8.6 \text{ L H}_2\text{O}$

PTS: 1                      DIF: L2                      REF: p. 363                      OBJ: 12.2.2  
STA: Ch.3.d

63. ANS:  
3/2

PTS: 1                      DIF: L1                      REF: p. 359                      OBJ: 12.2.1  
STA: Ch.3.d

64. ANS:  
15 L of given reactants  $\times$  11 L of products/10 L of reactants = 16.5 L

PTS: 1                      DIF: L3                      REF: p. 363                      OBJ: 12.2.2  
STA: Ch.4.c

65. ANS:  
 $209.7 \text{ g Fe} \times 1 \text{ mol Fe} / 55.85 \text{ g Fe} \times 3 \text{ mol CO} / 2 \text{ mol Fe} \times 28.01 \text{ g CO} / 1 \text{ mol CO} = 157.8 \text{ g CO}$

PTS: 1                      DIF: L2                      REF: p. 371                      OBJ: 12.3.1  
STA: Ch.3.d

66. ANS:  
 $45.0 \text{ L H}_2\text{S} \times 1 \text{ mol H}_2\text{S} / 22.4 \text{ L H}_2\text{S} \times 3 \text{ mol O}_2 / 2 \text{ mol H}_2\text{S} \times 22.4 \text{ L O}_2 / 1 \text{ mol O}_2 = 67.5 \text{ L O}_2$

PTS: 1                      DIF: L3                      REF: p. 371                      OBJ: 12.3.1  
STA: Ch.4.c

67. ANS:  
Theoretical yield:  
 $5.0 \text{ g H}_2 \times 1 \text{ mol H}_2 / 2.0 \text{ g H}_2 \times 1 \text{ mol CH}_3\text{OH} / 2 \text{ mol H}_2 \times 32 \text{ g CH}_3\text{OH} / 1 \text{ mol CH}_3\text{OH}$   
 $= 40 \text{ g CH}_3\text{OH}$   
 $40 \text{ g CH}_3\text{OH} \times 86\% = 34 \text{ g CH}_3\text{OH}$

PTS: 1                      DIF: L3                      REF: p. 371                      OBJ: 12.3.1  
STA: Ch.4.c

68. ANS:  
 $13.0 \text{ L Cl}_2 \times 1 \text{ mol Cl}_2 / 22.4 \text{ L Cl}_2 = 0.580 \text{ mol Cl}_2$   
 $103.0 \text{ g Na} \times 1 \text{ mol Na} / 23 \text{ g Na} = 4.48 \text{ mol Na}$   
 $\text{Cl}_2$  is limiting reagent:  $0.580 \text{ mol Cl}_2 \times 2 \text{ mol NaCl} / 1 \text{ mol Cl}_2 = 1.16 \text{ mol NaCl}$   
 $1.16 \text{ mol NaCl} \times 58 \text{ g NaCl} / 1 \text{ mol NaCl} = 67.3 \text{ g NaCl}$

PTS: 1                      DIF: L3                      REF: p. 371                      OBJ: 12.3.1  
STA: Ch.3.d

69. ANS:

Assume the sodium is limiting:

$$48.7 \text{ g Na} \times 1 \text{ mol Na} / 23.0 \text{ g Na} \times 1 \text{ mol H}_2 / 2 \text{ mol Na} \times (6.02 \times 10^{23} \text{ molecules H}_2) / 1 \text{ mol H}_2$$

$$= 6.37 \times 10^{23} \text{ molecules H}_2$$

PTS: 1

DIF: L3

REF: p. 371

OBJ: 12.3.1

STA: Ch.3.d

70. ANS:

$$10.0 \text{ L} \times 100\% / 95\% = 10.5 \text{ L theoretical yield}$$

$$10.5 \text{ L O}_2 \times 1 \text{ mol O}_2 / 22.4 \text{ L O}_2 \times 2 \text{ mol KClO}_3 / 3 \text{ mol O}_2 \times 122.6 \text{ g KClO}_3 / 1 \text{ mol KClO}_3$$

$$= 38.4 \text{ g KClO}_3$$

PTS: 1

DIF: L3

REF: p. 374

OBJ: 12.3.2

STA: Ch.3.d

71. ANS:

$$8.3 \text{ mol H}_2\text{S} \times 2 \text{ mol H}_2\text{O} / 2 \text{ mol H}_2\text{S} \times 18 \text{ g H}_2\text{O} / 1 \text{ mol} = 149.4 \text{ g H}_2\text{O theoretical yield}$$

$$\text{percent yield} = 137.1 \text{ g} / 149.4 \text{ g} \times 100\% = 92\%$$

PTS: 1

DIF: L3

REF: p. 373

OBJ: 12.3.2

STA: Ch.3.f

**ESSAY**

72. ANS:

Answers will vary. A sample answer includes building a model airplane. For each model, there will be two wings and three wheels. In order for the model to look correct or work properly, there must be a certain, unvarying number of wings and wheels.

PTS: 1

DIF: L2

REF: p. 354

OBJ: 12.1.1

73. ANS:

Moles can be directly used. The number of molecules or moles is the basic unit used in solving chemical problems. When the number of moles are known, the mass and volume can be determined.

PTS: 1

DIF: L2

REF: p. 357

OBJ: 12.1.2

STA: Ch.3.d

74. ANS:

The coefficients in a balanced chemical equation indicate the relative number of moles of reactants and products. From this information, the amounts of reactants and products can be calculated. The number of moles may be converted to mass, volume, or number of representative particles.

PTS: 1

DIF: L3

REF: p. 356

OBJ: 12.1.2

STA: Ch.3.d

75. ANS:

The coefficients from the balanced equation are used to write mole ratios. The mole ratios relate the moles of reactants to the moles of product. By multiplying the number of moles of the reactant by the mole ratio, you can determine the number of moles of the product.

PTS: 1  
STA: Ch.3.d

DIF: L2

REF: p. 359

OBJ: 12.2.1

76. ANS:

The limiting reagent is silver.

$$3.0 \text{ g Ag} \times 1 \text{ mol Ag} / 108 \text{ g Ag} = 0.03 \text{ mol Ag}$$

$$3.0 \text{ g S}_8 \times 1 \text{ mol S}_8 / 256 \text{ g S}_8 = 0.01 \text{ mol S}_8$$

$$0.03 \text{ mol Ag} \times 8 \text{ mol Ag}_2\text{S} / 16 \text{ mol Ag} \times 248 \text{ g Ag}_2\text{S} / 1 \text{ mol Ag}_2\text{S} = 3.72 \text{ g Ag}_2\text{S}$$

3.72 g of silver sulfide is produced.

PTS: 1  
OBJ: 12.2.2

DIF: L3  
STA: Ch.3.d

REF: p. 363 | p. 364 | p. 365 | p. 366

77. ANS:

Volume-volume conversions between gases do not require mole conversions. Molar volumes of all gases at STP are the same. The coefficients in a balanced equation indicate the relative number of moles and the relative volumes of interacting gases.

PTS: 1  
STA: Ch.4.c

DIF: L3

REF: p. 365

OBJ: 12.2.2

78. ANS:

$$150.0 \text{ g N}_2 \times 1 \text{ mol N}_2 / 28 \text{ g N}_2 = 5.36 \text{ mol N}_2$$

$$32.1 \text{ g H}_2 \times 1 \text{ mol H}_2 / 2 \text{ g H}_2 = 16.1 \text{ mol H}_2$$

$$5.36 \text{ mol N}_2 / 16.1 \text{ mol H}_2 = 1 \text{ mol N}_2 / 3 \text{ mol H}_2$$

There is no limiting reagent. The mole ratio of the reactants is exactly 1 mol N<sub>2</sub> to 3 mol H<sub>2</sub>.

PTS: 1  
STA: Ch.3.d

DIF: L3

REF: p. 370

OBJ: 12.3.1

79. ANS:

$$500 \text{ g Al}_2(\text{SO}_4)_3 \times 1 \text{ mol Al}_2(\text{SO}_4)_3 / 342 \text{ g Al}_2(\text{SO}_4)_3 \times 3 \text{ mol Ca(OH)}_2 / 1 \text{ mol Al}_2(\text{SO}_4)_3 \times 74 \text{ g Ca(OH)}_2 / 1 \text{ mol Ca(OH)}_2 = 325 \text{ g Ca(OH)}_2$$

$$450 \text{ g} - 325 \text{ g} = 125 \text{ g}$$

There are 125 g excess Ca(OH)<sub>2</sub>. Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub> is the limiting reagent.

$$125 \text{ g Ca(OH)}_2 \times 1 \text{ mol Ca(OH)}_2 / 74 \text{ g Ca(OH)}_2 = 1.69 \text{ mol Ca(OH)}_2$$

There are 1.69 mol Ca(OH)<sub>2</sub> remaining of unreacted excess reagent.

PTS: 1  
STA: Ch.3.d

DIF: L3

REF: p. 370

OBJ: 12.3.1

80. ANS:

No:  $\text{percent yield} = \text{actual yield} / \text{theoretical yield} \times 100\%$ . The theoretical yield is the maximum amount of product that could be formed from given amounts of products. The actual yield must be less than or equal to the theoretical yield.

PTS: 1

DIF: L3

REF: p. 372 | p. 373

OBJ: 12.3.2

STA: Ch.3.f