

Chapter 1: Stoichiometry

1. The atomic mass of C is 12.011 u. How many moles of C are there in a 3.50 g sample of carbon?

- * a. 0.291 moles
- b. 0.374 moles
- c. 1.00 moles
- d. 3.43 moles
- e. 3.50 moles

$$n = \frac{m}{MM} = \frac{3.50}{12} = 0.291$$

2. The formula mass of $\text{Ni}(\text{H}_2\text{O})_6\text{Cl}_2$ is

- a. 157.69 u
- b. 193.00 u
- c. 227.61 u
- * d. 237.69 u
- e. 296.83 u

$$1\text{Ni}=58.7, 12\text{H}=12, 6\text{O}=6 \times 16=96, 2\text{Cl}=2 \times 35.5=71 \quad \text{MM} = 58.7 + 12 + 96 + 71 = 237.69 \text{ u}$$

3. If the atomic mass of gold is 196.9665 u, how many grams of gold are in 0.150 mol Au?

- a. 7.62×10^{-4} g
- * b. 29.5 g
- c. 29.54498 g
- d. 7.61551×10^{-4} g
- e. 0.903 g

$$m = n \times \text{MM} = 0.150 \times 196.9665 = 29.5 \text{ g}$$

4. How many molecules of carbon dioxide (CO_2) are in 154.0 grams of carbon dioxide?

- a. 3.499
- * b. 2.107×10^{24}
- c. 4.214×10^{24}
- d. 9.274×10^{25}
- e. 4.081×10^{27}

$$n = \frac{m}{MM} = \frac{154}{44} \quad n \times N_A = 154 \times 6.02 \times 10^{23} / 44 = 2.107 \times 10^{24}$$

5. A sample of $\text{Ca}_3(\text{PO}_4)_2$ contains 3.51 moles of calcium ions. How many moles of $\text{Ca}_3(\text{PO}_4)_2$ are in that sample?

- a. 3.55 moles
- b. 0.491 moles
- c. 10.5 moles
- * d. 1.17 moles

e. 3.51×10^{21} moles

1 mol $\text{Ca}_3(\text{PO}_4)_2$ contains 3 mol Ca
? mol 3.51 mol Ca
 $N = 3.51 \times 1 / 3 = 1.17 \text{ mol}$

6. What is the percent, by mass, of chromium in K_2CrO_4 ? Use a periodic table to find the atomic masses.

- * a. 26.776 %
- b. 31.763 %
- c. 40.268 %
- d. 42.241 %
- e. 51.996 %

$\% \text{Cr} = (n \times \text{MM}_{\text{Cr}} / \text{MM}_{\text{K}_2\text{CrO}_4}) \times 100 = [(1 \times 52 / (2 \times 39 + 1 \times 52 + 4 \times 16))] \times 100 = 26.773\%$

7. A sample of $\text{Ni}(\text{CO})_4$, a toxic transition-metal complex, has 5.23×10^{24} atoms of carbon. How many atoms of Ni does it contain?

- a. 6.02×10^{23} atoms
- b. 1.50×10^{23} atoms
- c. 1/4 atom
- d. 20.9×10^{23} atoms
- * e. 1.31×10^{24} atoms

1 mol $\text{Ni}(\text{CO})_4$ contain 4 mol C and 1 mol Ni
 $4 \times 6.02 \times 10^{23}$ atoms $1 \times 6.02 \times 10^{23}$ atoms
 5.23×10^{24} atoms ??
 $? = 5.23 \times 10^{24} / 4 = 1.31 \times 10^{24}$ atoms

8. A sample of sulfolane, $\text{C}_4\text{H}_8\text{O}_2\text{S}$, contains 5.00×10^{24} atoms. How many moles of sulfolane are in the sample?

- a. 0.120 moles
- * b. 0.554 moles
- c. 1.81 moles
- d. 8.30 moles
- e. 3.33×10^{23} moles

1 mol $\text{C}_4\text{H}_8\text{O}_2\text{S}$ contains $(4+8+2+1)$ moles of atoms = 15 moles = $15 \times 6.02 \times 10^{23}$ atoms
?? mol 5.00×10^{24} atoms

$?? = 5.00 \times 10^{24} / (15 \times 6.02 \times 10^{23}) = 0.554 \text{ mol}$

9. A sample of $\text{C}_7\text{H}_5\text{N}_3\text{O}_4$ has a mass of 7.81 g. What is the mass of oxygen in this sample?

- a. 31.2 g
- * b. 2.56 g

- c. 3.20×10^{23} g
- d. 64.0 g
- e. 1.75 g

$$1 \text{ mol } C_7H_5N_3O_4 = (7 \times 12 + 5 \times 1 + 3 \times 14 + 4 \times 16) = 195 \text{ g} \quad \text{contains 4 mol O} = 4 \times 16 \text{ g O}$$

$$7.81 \text{ g} \qquad \qquad \qquad ?? \text{ g}$$

$$?? = 7.81 \times 4 \times 16 / 195 = 2.56 \text{ g}$$

10. Which one of the following is definitely **not an** empirical formula?

- a. $C_{12}H_{16}O_3$
- b. $C_{12}H_{22}O_{11}$
- c. $C_3H_8O_2$
- d. $C_4H_{12}N_2O$
- * e. $C_6H_{12}O_4$

Because can be divided by whole number (by 2) $C_3H_6O_2$

11. A compound has an empirical formula of CH_2Cl . An independent analysis gave a value of 99.0 for its molar mass. What is the molecular formula of the compound?

- a. CH_2Cl
- * b. $C_2H_4Cl_2$
- c. $C_2H_2Cl_4$
- d. $C_3H_6Cl_3$
- e. $C_3H_3Cl_6$

$$R.F = MM_{\text{compound}} / MM_{\text{empirical formula}} = 99 / (12 \times 1 + 2 \times 1 + 1 \times 35.5) = 2$$

$$(CH_2Cl)_2 = C_2H_4Cl_2$$

12. Magnetite is a binary compound containing only iron and oxygen. The percent, by weight, of iron is 72.36%. What is the empirical formula of magnetite?

- a. FeO
- b. FeO_2
- * c. Fe_3O_4
- d. Fe_2O_3
- e. Fe_2O_5

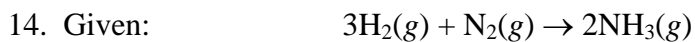
$$100 - 72.36 = 27.64\% \text{ O}$$

Fe	O
72.360g	27.64g
72.36/55.8	27.64/16

13. Zinc metal reacts with aqueous hydrochloric acid to give an aqueous solution of zinc chloride and hydrogen gas. Select the correct balanced chemical equation for this reaction.

- a. $Zn(s) + HCl(aq) \rightarrow 3ZnCl(aq) + H_2(g)$
- b. $Zn(s) + HCl(g) \rightarrow ZnCl(aq) + H(g)$

- * c. $\text{Zn(s)} + 2\text{HCl(aq)} \rightarrow \text{ZnCl}_2\text{(aq)} + \text{H}_2\text{(g)}$
- d. $2\text{Zn(s)} + 4\text{HCl(aq)} \rightarrow 2\text{ZnCl}_2\text{(aq)} + \text{H}_2\text{(g)}$
- e. $2\text{Zn(s)} + \text{HCl(aq)} \rightarrow 2\text{ZnCl}_2\text{(aq)} + \text{H}_2\text{(g)}$



If the reaction starts with 0.500 mol of H_2 , how many atoms of hydrogen in the compound NH_3 would you expect to make?

- a. 3.01×10^{23} atoms
- * b. 6.02×10^{23} atoms
- c. 12.04×10^{23} atoms
- d. 1 atom
- e. 6 atoms

3 mol H_2 gives 2 mol NH_3

0.5 mol ??

$n = 0.5 \times 2 / 3 = 0.333$ mol NH_3

1 mol NH_3 contains 3 mol H

0.333 mol ??

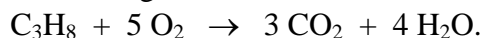
$n = 0.333 \times 3 = 1$ mol

$N = n \times N_A = 1 \times 6.02 \times 10^{23} = 6.02 \times 10^{23}$ atoms of H

15. In a chemical reaction, $3 \text{C}_2\text{H}_6\text{O} + 1 \text{PCl}_3 \rightarrow 3 \text{C}_2\text{H}_5\text{Cl} + 1 \text{H}_3\text{PO}_3$, when the equation is balanced the sum of the coefficients of the reactants and products should be

- a. 4
- b. 5
- c. 6
- d. 7
- * e. 8

16. You are given the balanced chemical equation:



If 0.3818 moles of C_3H_8 and 1.718 moles of O_2 are allowed to react, and this is the only reaction which occurs, theoretically how many moles of water should be produced?

- a. 1.336 moles
- * b. 1.374 moles
- c. 1.527 moles
- d. 1.718 moles
- e. 3.426 moles

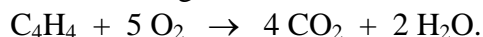
C_3H_8 + 5O_2
1 mol 5 mol
0.3818 mol 1.718 moles
 $0.3818/1$ $1.718/5$
0.3818 > 0.3436

smaller no is L.R O_2 is limiting reactant



$$?? = 1.718 \times 4 / 5 = 1.3744 \text{ mol}$$

17. You are given the balanced chemical equation:



If 0.3618 moles of C_4H_4 are allowed to react with 1.818 moles of O_2 , and this is the only reaction which occurs, what is the maximum mass of water that could be produced?

- a. 11.02 g
- * b. 13.04 g
- c. 13.20 g
- d. 19.64 g
- e. 65.50 g



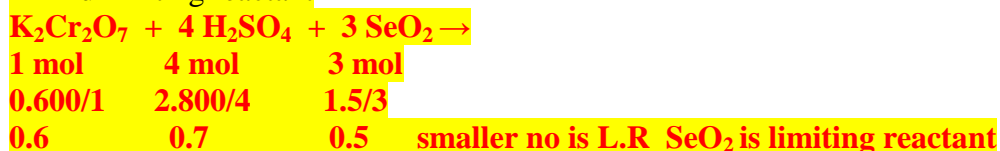
$$?? = 0.3618 \times 2 \times 18 / 1 = 13.05 \text{ g H}_2\text{O}$$

18. The left side of a balanced chemical equation is: $\text{K}_2\text{Cr}_2\text{O}_7 + 4 \text{ H}_2\text{SO}_4 + 3 \text{ SeO}_2 \rightarrow$

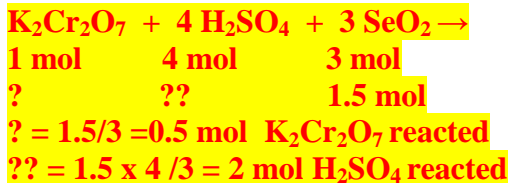
If 0.600 moles of $\text{K}_2\text{Cr}_2\text{O}_7$, 2.800 moles of H_2SO_4 and 1.500 moles of SeO_2 are brought together and allowed to react, then

- a. H_2SO_4 is the limiting reagent
- b. $\text{K}_2\text{Cr}_2\text{O}_7$ is the limiting reagent
- c. there are 1.300 moles of H_2SO_4 in excess
- * d. there are 0.800 moles of H_2SO_4 in excess
- e. there are 0.300 moles of SeO_2 in excess

1- find limiting reactant



2- Calculate the reacted



3- Calculate the unreacted (excess)

$$\begin{array}{l} 0.6 - 0.5 = 0.1 \text{ mol K}_2\text{Cr}_2\text{O}_7 \text{ excess} \\ 2.8 - 2 = 0.8 \text{ mol H}_2\text{SO}_4 \text{ excess} \end{array}$$

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19. In a chemical equation, $\text{AsF}_3 + \text{C}_2\text{Cl}_6 \rightarrow \text{AsCl}_3 + \text{C}_2\text{Cl}_2\text{F}_4$, the theoretical yield of $\text{C}_2\text{Cl}_2\text{F}_4$ was calculated to be 1.86 moles. If the percent yield in the reaction was 77.2%, how many grams of $\text{C}_2\text{Cl}_2\text{F}_4$ were actually obtained?
- a. 222 grams
 - b. 231 grams
 - * c. 245 grams
 - d. 318 grams
 - e. 412 grams

$$\begin{array}{l} \text{Percent yield\%} = (\text{Actual yield} / \text{theoretical yield}) \times 100 \\ \text{Actual yield} = \text{theoretical yield} \times \text{Percent yield} / 100 \\ = 1.86 \times 77.2 / 100 = 1.44 \text{ mol} \\ M = n \times M_m = 1.44 \times (2 \times 12 + 2 \times 35.5 + 4 \times 19) = 245 \text{ g} \end{array}$$

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20. The density of an object is the ratio of its mass to its volume. What is the derived SI unit for density?
- a. kg m/s^3
 - b. kg m/s
 - * c. kg/m^3
 - d. m/s^2
 - e. pounds per cubic inches

$$d = \text{mass/volume} = \text{kg/m}^3$$

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21. What is the number needed to complete the following: 1 dm = ___ m?
- a. 10
 - b. 20
 - c. 1
 - * d. 0.1
 - e. 0.01

$$1 \text{ dm} = 1 \times 10^{-1} \text{ m} = 0.1 \text{ m}$$

22. The SI base units of **temperature and mass**, respectively, are
- a. degree and gram.
 - * b. **kelvin and kilogram.**
 - c. Celsius and milligram.
 - d. degree and kilogram.
 - e. kelvin and gram.

23. The SI prefixes giga and micro, indicate respectively:

- * a. **10^9 and 10^{-6}**
- b. 10^{-9} and 10^{-6}
- c. 10^6 and 10^{-3}
- d. 10^3 and 10^{-3}
- e. 10^{-9} and 10^{-3}

24. A solution of sodium nitrite is prepared by mixing 3.25 g of NaNO_2 with 12.0 g of water. The percent, by mass, of NaNO_2 is:

- a. 28.0 %
- b. 23.3 %
- c. 27.0 %
- * d. **21.3 %**
- e. 37.1 %

$$\% \text{ w/w} = \text{mass of solute} \times 100 / \text{mass of solution} = 3.25 \times 100 / (3.25 + 12) = 21.3 \%$$

25. A solution of potassium nitrate is prepared by mixing 3.50 g of KNO_3 with 12.0 g of water. The percent, by mass, of KNO_3 is:

- * a. **22.6 %**
- b. 23.3 %
- c. 28.0 %
- d. 29.2 %
- e. 41.8 %

$$\% \text{ w/w} = \text{mass of solute} \times 100 / \text{mass of solution} = 3.5 \times 100 / (3.5 + 12) = 22.6 \%$$

26. A glucose solution is prepared by dissolving 5.10 g of glucose, $\text{C}_6\text{H}_{12}\text{O}_6$, in 110.5 g of water. What is the molality of the glucose solution?

- a. 0.283 *m*
- b. 0.000256 *m*
- c. 0.245 *m*
- * d. **0.256 *m***
- e. 0.351 *m*

$$m = n(\text{solute}) / \text{Mass of solvent (kg)} = m(\text{solute}) / \text{MM}(\text{solute}) \times \text{Mass of solvent (kg)}$$
$$m = 5.1 / (6 \times 12 + 12 \times 1 + 6 \times 16) \times 110.5 \times 10^{-3} = 0.256 \text{ m}$$

27. An aqueous solution of glycerol, $C_3H_8O_3$, is 48.0% glycerol by mass and has a density of 1.120 g mL^{-1} . Calculate the molality of the glycerol solution.

- a. 11.2 m
- b. 5.84 m
- c. 0.584 m
- d. 0.521 m
- * e. 10.0 m

$$m = n(\text{solute}) / \text{Mass of solvent (kg)} = m(\text{solute}) / \text{MM}(\text{solute}) \times \text{Mass of solvent (kg)}$$

$$48.0\% \text{ means } 48 \text{ g solute in } 100 \text{ g solution} \quad m(\text{solvent}) = 100 - 48 = 52 \text{ g}$$
$$m = 48 / (3 \times 12 + 8 \times 1 + 3 \times 16) \times 52 \times 10^{-3} = 10.0 \text{ m}$$

28. Consider a $0.900 \text{ M Al}(\text{NO}_3)_3$ solution. This solution has a nitrate ion concentration of:

- a. 0.300 M
- b. 0.900 M
- * c. 2.70 M
- d. 3.60 M
- e. 8.10 M

1 mol $\text{Al}(\text{NO}_3)_3$ contains 3 mol NO_3 ions

0.900 mol ?? mol

$$3 \times 0.900 = 2.7 \text{ mol}$$

29. Which is a concentration unit whose value changes if the temperature of an aqueous solution is changed?

- a. mole fraction
 - * b. molarity
 - c. molality
 - d. mass fraction
 - e. percent by weight
-