

What is the molar mass of the following compounds? Be sure to include units! (4 points each)

1. NaCl  $\text{Na } 22.990 \times 1 = 22.990$

$\text{Cl } 35.453 \times 1 = 35.453$

$+ 58.443 \text{ g/mol}$

2.  $\text{H}_2\text{S}$   $\text{H } 1.0079 \times 2 = 2.0158$

$\text{S } 32.065 \times 1 = 32.065$

$+ 34.0808 \text{ g/mol}$

3.  $\text{Fe}_3(\text{PO}_4)_2$

$\text{Fe } 55.845 \times 3 = 167.535$

$\text{P } 30.974 \times 2 = 61.948$

$\text{O } 15.999 \times 8 = 127.992$

4.  $(\text{NH}_4)_2\text{S}$

$\text{N } 14.007 \times 2 = 28.014$

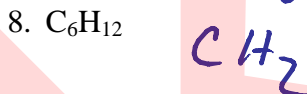
$\text{H } 1.0079 \times 8 = 8.0632$

$\text{S } 32.065 \times 1 = 32.065$

$+ 357.475 \text{ g/mol}$

$68.1422 \text{ g/mol}$

What is the empirical formula for the following molecular formulas (3 points each)



Answer the following questions. Be sure to include units in your answer! (5 points each)

9. How many atoms are in 29.4 amu of calcium?  $40.078 \text{ amu} = 1 \text{ atom Ca}$   
 $\frac{29.4 \text{ amu}}{40.078 \text{ amu}} = 0.734 \text{ atoms}$

10. How many atoms are in 489 amu of sulfur?  $32.065 \text{ amu} = 1 \text{ atom S}$   
 $\frac{489 \text{ amu}}{32.065 \text{ amu}} = 15.3 \text{ atoms}$

11. How many atoms in 12.9 moles of lithium?  $6.022 \times 10^{23} \text{ atoms} = 1 \text{ mole}$   
 $\frac{12.9 \text{ moles}}{1 \text{ mol}} \times 6.022 \times 10^{23} \text{ atoms} = 7.77 \times 10^{24} \text{ atoms}$

12. How many atoms in 895 moles of lithium?  $6.022 \times 10^{23} \text{ atoms} = 1 \text{ mole}$   
 $\frac{895 \text{ moles}}{1 \text{ mole}} \times 6.022 \times 10^{23} \text{ atoms} = 5.39 \times 10^{26} \text{ atoms}$

13. How many moles are in 35.9 grams of zinc?  $65.39 \text{ g} = 1 \text{ mole}$

$$\frac{35.9 \text{ g Zn}}{65.39 \text{ g}} \times 1 \text{ mole} = 0.549 \text{ mole Zn}$$

14. How many moles are in 5.90 grams of helium?  $4.0026 \text{ g} = 1 \text{ mole}$

$$\frac{5.90 \text{ g He}}{4.0026 \text{ g}} \times 1 \text{ mole} = 1.47 \text{ mole He}$$

15. How many moles are present if there are  $1.7 \times 10^{27}$  atoms of lithium?  $6.022 \times 10^{23} \text{ atoms} = 1 \text{ mole}$

$$\frac{1.7 \times 10^{27} \text{ atoms}}{6.022 \times 10^{23} \text{ atoms}} \times 1 \text{ mole} = 2823 \text{ moles Li}$$

16. How many moles are present if there are  $5.7 \times 10^{15}$  atoms of sodium?  $6.022 \times 10^{23} \text{ atoms} = 1 \text{ mole}$

$$\frac{5.7 \times 10^{15} \text{ atoms}}{6.022 \times 10^{23} \text{ atoms}} \times 1 \text{ mole} = 9.465 \times 10^{-9} \text{ mole}$$

17. How many grams are in 278 amu of carbon?  $1.66 \times 10^{-24} \text{ g} = 1 \text{ amu}$

$$\frac{278 \text{ amu}}{1 \text{ amu}} \times 1.66 \times 10^{-24} \text{ g} = 4.61 \times 10^{-22} \text{ g}$$

18. How many grams are in 893 amu of sulfur?  $1.66 \times 10^{-24} \text{ g} = 1 \text{ amu}$

$$\frac{893 \text{ amu}}{1 \text{ amu}} \times 1.66 \times 10^{-24} \text{ g} = 1.48 \times 10^{-21} \text{ g}$$

19. How many molecules of  $\text{CF}_4$  are in 15 moles of  $\text{CF}_4$ ?  $6.022 \times 10^{23} \text{ molecules} = 1 \text{ mole}$

$$\frac{15 \text{ mole}}{1 \text{ mole}} \times 6.022 \times 10^{23} \text{ molecules} = 9.033 \times 10^{24} \text{ molecules}$$

20. How many molecules of  $\text{BaF}_2$  are in 15 moles of  $\text{BaF}_2$ ?  $6.022 \times 10^{23} \text{ molecules} = 1 \text{ mole}$

$$\frac{15 \text{ moles}}{1 \text{ mole}} \times 6.022 \times 10^{23} \text{ molecules} = 9.033 \times 10^{24} \text{ molecules}$$

21. How many moles of  $\text{CF}_4$  do I have if I have  $5.98 \times 10^{27}$  molecules of  $\text{CF}_4$ ?  $6.022 \times 10^{23} \text{ molecules} = 1 \text{ mole}$

$$\frac{5.98 \times 10^{27} \text{ molecules}}{6.022 \times 10^{23} \text{ molecules}} \times 1 \text{ mole} = 9.93 \times 10^3 \text{ moles}$$

22. How many moles of  $\text{BaF}_2$  do I have if I have  $3.67 \times 10^5$  molecules of  $\text{BaF}_2$ ?  $6.022 \times 10^{23} \text{ molecules} = 1 \text{ mole}$

$$\frac{3.67 \times 10^5 \text{ molecules}}{6.022 \times 10^{23} \text{ molecules}} \times 1 \text{ mole} = 6.09 \times 10^{-19} \text{ moles}$$

Answer the following questions. Be sure to include units in your answer! (6 points each)

23. What is the mass in grams of 23.5 moles of  $\text{CF}_4$ ?  $88.003 \text{ g} = 1 \text{ mole}$

$$\begin{array}{l} \text{C } 12.011 \times 1 = 12.011 \\ \text{F } 18.998 \times 4 = 75.992 \\ \hline 88.003 \end{array}$$

$$\frac{23.5 \text{ moles}}{1 \text{ mole}} \times 88.003 \text{ g} = 2068 \text{ g CF}_4$$

24. What is the mass in grams of 8.90 moles of  $\text{BaF}_2$ ?  $175.326 \text{ g} = 1 \text{ mole}$

$$\begin{array}{l} \text{Ba } 137.33 \times 1 = 137.33 \\ \text{F } 18.998 \times 2 = 37.996 \\ \hline 175.326 \end{array}$$

$$\frac{8.9 \text{ moles}}{1 \text{ mole}} \times 175.326 \text{ g} = 1560 \text{ g BaF}_2$$

25. How many atoms are in 14.0 grams of silver?  $107.87 \text{ g} = 1 \text{ mole}$ ,  $1 \text{ mole} = 6.022 \times 10^{23} \text{ atoms}$

$$\frac{14 \text{ g Ag}}{107.87 \text{ g}} = 0.129785853 \text{ moles}$$

$$\frac{0.129785853 \text{ moles}}{1 \text{ mole}} \times 6.022 \times 10^{23} \text{ atoms} = 7.82 \times 10^{22} \text{ atoms}$$

26. How many atoms are in 289.9 grams of sodium?  $22.990 \text{ g} = 1 \text{ mole}$ ,  $1 \text{ mole} = 6.022 \times 10^{23} \text{ atoms}$

$$\frac{289.9 \text{ g Na}}{22.99 \text{ g}} = 12.60983036 \text{ moles}$$

$$\frac{12.60983036 \text{ moles}}{1 \text{ mole}} \times 6.022 \times 10^{23} \text{ atoms} = 7.594 \times 10^{24} \text{ atoms}$$

27. How many grams do  $4.3 \times 10^{20}$  atoms of boron weigh?  $6.022 \times 10^{23} \text{ atoms} = 1 \text{ mole}$ ,  $10.811 \text{ g} = 1 \text{ mole}$

$$\frac{4.3 \times 10^{20} \text{ atoms}}{6.022 \times 10^{23} \text{ atoms}} = 0.000714048 \text{ mole}$$

$$\frac{0.000714048 \text{ mole}}{1 \text{ mole}} \times 10.811 \text{ g} = 0.0077196 \text{ g}$$

28. How many grams do  $1.8 \times 10^{29}$  atoms of silicon weigh?  $6.022 \times 10^{23} \text{ atoms} = 1 \text{ mole}$ ,  $28.086 \text{ g} = 1 \text{ mole}$

$$\frac{1.8 \times 10^{29} \text{ atoms}}{6.022 \times 10^{23} \text{ atoms}} = 2.989 \times 10^5 \text{ mole}$$

$$\frac{2.989 \times 10^5 \text{ mole}}{1 \text{ mole}} \times 28.086 \text{ g} = 8.395 \times 10^6 \text{ g}$$

Calculate the percent composition for each element in the compound (6 points each)

29.  $\text{BaCrO}_4$

$$\begin{array}{l} \text{Ba } 137.33 \times 1 = 137.33 \div 253.322 = .5421 \\ \text{Cr } 51.996 \times 1 = 51.996 \div 253.322 = .2053 \\ \text{O } 15.999 \times 4 = 63.996 \div 253.322 = .2526 \end{array}$$

$$\begin{array}{l} \text{Ba } 54.21\% \\ \text{Cr } 20.53\% \\ \text{O } 25.26\% \end{array}$$

30.  $(\text{NH}_4)_2\text{S}$

$$\begin{array}{l} \text{N } 14.007 \times 2 = 28.014 \div 68.1422 = .4111 \\ \text{H } 1.0079 \times 8 = 8.0632 \div 68.1422 = .1183 \\ \text{S } 32.065 \times 1 = 32.065 \div 68.1422 = .4706 \end{array}$$

$$\begin{array}{l} \text{N } 41.11\% \\ \text{H } 11.83\% \\ \text{S } 47.06\% \end{array}$$

31.  $\text{Ca}_3(\text{PO}_4)_2$

$$\begin{aligned}\text{Ca} & 40.078 \times 3 = 120.234 \div 374.17 = .3213 \\ \text{P} & 30.974 \times 2 = 61.948 \div 374.17 = .1656 \\ \text{O} & 15.999 \times 12 = 191.988 \div 374.17 = .5131\end{aligned}$$

Ca 32.13%

P 16.56%

O 51.31%

32.  $\text{Al}_2(\text{Cr}_2\text{O}_7)_3$

$$\begin{aligned}\text{Al} & 26.982 \times 2 = 53.964 \div 701.919 = .07688 \\ \text{Cr} & 51.996 \times 6 = 311.976 \div 701.919 = .4445 \\ \text{O} & 15.999 \times 21 = 335.979 \div 701.919 = .4787\end{aligned}$$

Al 7.69%

Cr 44.45%

O 47.87%

Solve the following problems: (10 points each)

33. If a compound contains 0.0938 grams of carbon and 0.00625 grams of hydrogen?

a. What is the empirical formula of the compound?

$$\begin{aligned}\frac{.0938 \text{ g C}}{12.011 \text{ g}} &= \frac{0.0078095}{.006201} = 1.25 \times 4 = 5 \\ \frac{.00625 \text{ g H}}{1.0079 \text{ g}} &= \frac{0.006201}{.006201} = 1 \times 4 = 4\end{aligned}$$



b. If the molar mass of the compound is approximately 128 grams/mole, what's the molecular formula?

$$\begin{aligned}\text{C} & 12.011 \times 5 = 60.055 \\ \text{H} & 1.0079 \times 4 = 4.0316 \\ & \frac{128}{64.0866} = 1.997 = 2\end{aligned}$$



34. If a compound contains 7.908 grams of carbon, 0.554 grams of hydrogen and 1.538 grams of nitrogen?

a. What is the empirical formula of the compound?

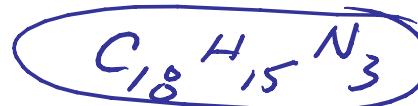
$$\begin{aligned}\frac{7.908 \text{ g C}}{12.011 \text{ g}} &= \frac{0.6584}{.1098} = 5.996 = 6 \\ \frac{.554 \text{ g H}}{1.0079 \text{ g}} &= \frac{0.5497}{.1098} = 5 \\ \frac{1.538 \text{ g N}}{14.007 \text{ g}} &= \frac{0.1098}{.1098} = 1\end{aligned}$$



b. If the molar mass of the compound is approximately 273 grams/mole, what's the molecular formula?

$$\begin{aligned}\text{C} & 12.011 \times 6 = 72.066 \\ \text{H} & 1.0079 \times 5 = 5.0395 \\ \text{N} & 14.007 \times 1 = 14.007 \\ & \frac{273}{91.1125} = 2.996 = 3\end{aligned}$$

$\frac{273}{91.1125} = 2.996 = 3$



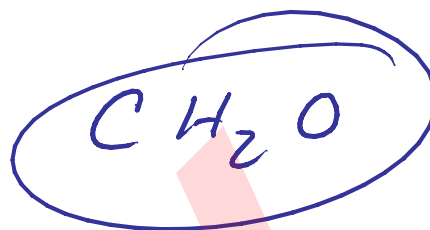
35. If a compound contains 40.00% carbon, 6.713% hydrogen, and 53.28% oxygen:

a. What is the empirical formula of the compound?

$$\frac{40.00\text{g C}}{12.011\text{g}} \div \frac{1\text{mole}}{3.330} = \frac{3.330}{3.330} = 1$$

$$\frac{6.713\text{g H}}{1.0079\text{g}} \div \frac{1\text{mole}}{3.330} = \frac{6.660}{3.330} = 2$$

$$\frac{53.28\text{g O}}{15.999\text{g}} \div \frac{1\text{mole}}{3.330} = \frac{3.330}{3.330} = 1$$



b. If the molar mass of the compound is approximately 180 grams/mole, what's the molecular formula?

$$\text{C } 12.011 \times 1 = 12.011$$

$$\text{H } 1.0079 \times 2 = 2.0158$$

$$\text{O } 15.999 \times 1 = 15.999$$

$$\frac{180}{30.0258} = 5.99 = 6$$



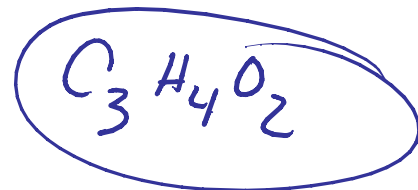
36. If a compound contains 49.99% carbon, 5.61% hydrogen, and 44.4% oxygen:

c. What is the empirical formula of the compound?

$$\frac{49.99\text{g C}}{12.011\text{g}} \div \frac{1\text{mole}}{2.775} = \frac{4.162}{2.775} = 1.4998 = 1.5 \times 2 = 3$$

$$\frac{5.61\text{g H}}{1.0079\text{g}} \div \frac{1\text{mole}}{2.775} = \frac{5.566}{2.775} = 2 \times 2 = 4$$

$$\frac{44.4\text{g O}}{15.999\text{g}} \div \frac{1\text{mole}}{2.775} = \frac{2.775}{2.775} = 1 \times 2 = 2$$



d. If the molar mass of the compound is approximately 72 grams/mole, what's the molecular formula?

$$\text{C } 12.011 \times 3 = 36.033$$

$$\text{H } 1.0079 \times 4 = 4.0316$$

$$\text{O } 15.999 \times 2 = 31.998$$

$$\frac{72}{72.0626} = 0.999 = 1$$

