

3 • Molecules and Compounds

STUDY QUESTIONS and PROBLEMS

- The structural formula for acetic acid is $\text{CH}_3\text{CO}_2\text{H}$. What is its empirical formula; what is its molecular formula?
 - The molecular formula of acrylonitrile is $\text{C}_3\text{H}_3\text{N}$. Look up in the text, and draw, its structural formula.
 - The molecular formula of aspartame (nutrasweet) is $\text{C}_{14}\text{H}_{18}\text{O}_5\text{N}_2$. Look up in the text, and draw, its structural formula.
- The formulas for ethanol and ammonium nitrate are $\text{C}_2\text{H}_5\text{OH}$ and NH_4NO_3 . In what respects are these formulas and compounds different?
- The molecular formula for both butanol and diethylether is $\text{C}_4\text{H}_{10}\text{O}$. Write structural formulas for both and show how they are different. Are any other structures possible?
- Name the polyatomic ions:

CH_3CO_2^-	HCO_3^-
H_2PO_4^-	$\text{Cr}_2\text{O}_7^{2-}$
SO_3^{2-}	ClO_4^-
- What are the formulas of the polyatomic ions:

phosphate	nitrite
sulfate	cyanide
bisulfite	chlorite
- Write the ions present in the following salts and predict their formulas:
 - potassium bromide
 - calcium carbonate
 - magnesium iodide
 - lithium oxide
 - aluminum sulfate
 - ammonium chlorate
 - beryllium phosphate
- Name the following ionic salts:

$(\text{NH}_4)_2\text{SO}_4$	$\text{Co}_2(\text{SO}_4)_3$
KHCO_3	NiSO_4
$\text{Ca}(\text{NO}_3)_2$	AlPO_4
- Name the following binary compounds of the nonmetals:

CS_2	SiCl_4
SF_6	GeH_4
IF_5	P_4O_{10}
N_2H_4	S_4N_4
PCl_5	OF_2
Cl_2O_7	IF_7

9. What are the formulas for the following binary compounds?
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|----------------------|-----------------------|
| silicon dioxide | phosphine |
| boron trifluoride | silicon carbide |
| xenon tetroxide | phosphorus tribromide |
| dinitrogen pentoxide | disulfur dichloride |
| bromine trifluoride | hydrogen selenide |
| carbon tetrachloride | |
10. a. How many moles are present in 128 grams of sulfur dioxide?
 b. What is the mass of 3 moles of oxygen molecules?
 c. If 5 moles of a metallic element have a mass of 200 grams, which element is it?
 d. What is the molar mass of methane CH_4 ?
 e. What is the mass of 9 moles of fluorine molecules?
 f. 102 grams of a gas contains 6 moles. What is its molar mass?
 g. How many grams are there in one mole of benzene C_6H_6 ?
 h. How many moles of nitrogen atoms are there in 6 moles of TNT (trinitrotoluene $\text{CH}_3\text{C}_6\text{H}_2(\text{NO}_2)_3$)?
 i. What is the molar mass of TNT?
11. What is the percent by mass of nitrogen in ammonium nitrate?
12. The hydrocarbons ethylene (molar mass 28 g/mol), cyclobutane (molar mass 56 g/mol), pentene (molar mass 70 g/mol), and cyclohexane (molar mass 84 g/mol), all have the same empirical formula. What is it? Write the molecular formulas for these four compounds.
13. A compound was analyzed and found to contain 76.57% carbon, 6.43% hydrogen, and 17.00% oxygen by mass. Calculate the empirical formula of the compound. If the molar mass of the compound is 94.11 g/mol, what is the molecular formula of the compound?
14. A compound was analyzed and found to contain 53.30% carbon, 11.19% hydrogen, and 35.51% oxygen by mass. Calculate the empirical formula of the compound. If the molar mass of the compound is 90.12 g/mol, what is the molecular formula of the compound?
15. A 15.67 g sample of a hydrate of magnesium carbonate was carefully heated, without decomposing the carbonate, to drive off the water. The mass was reduced to 7.58 g. What is the formula of the hydrate?
16. Anhydrous lithium perchlorate (4.78 g) was dissolved in water and re-crystallized. Care was taken to isolate all the lithium perchlorate as its hydrate. The mass of the hydrated salt obtained was 7.21 g. What hydrate is it?