Chapter 4 Review

Understanding Concepts

1. In your own words, explain the law of definite proportions, and relate how this law was applied in the determination of relative atomic mass of the elements.
2. If an atom of an element has a mass double that of a C-12 atom, what would be its relative atomic mass?
3. If the mass of a C-12 atom were reassigned a value of 18 u, what would be the relative mass of a hydrogen atom?
4. In what way was the knowledge of molecular formulas important in the assignment of relative atomic mass?
5. Explain the term "isotopic abundance," and explain why the relative atomic masses of the elements are not whole numbers.
6. The isotopic abundance of a naturally occurring sample of silicon is given in **Table 1**. Calculate the relative atomic mass of silicon.

Table 1

Isotope	Percentage abundance
Si-28	92.21%
Si-29	4.70%
Si-30	3.09%

7. (a) What is the mass, in atomic mass units, of a single C-12 atom?
   (b) What is the mass, in grams, of a mole of C-12 atoms?
   (c) What is Avogadro's constant and how is it related to the term mole?
   (d) Identify the term and the SI symbol used to represent the mass of a single mole of a substance.
8. What is the molar mass of each of the following chemicals?
   (a) calcium carbonate (limestone)
   (b) dinitrogen tetroxide (pollutant)
   (c) sodium carbonate decahydrate (washing soda)
9. Convert the following masses into amounts (in moles):
   (a) 1.000 kg of table salt
   (b) 1.000 kg of dry ice
   (c) 1.000 kg of water
10. Convert the following amounts into masses:
    (a) 1.50 mol of liquid oxygen
    (b) 1.50 mmol of liquid mercury
    (c) 1.50 kmol of liquid bromine
11. How many molecules are there in each of the following masses or amounts?
    (a) 0.42 mol of hydrogen acetate (acetic acid, vinegar)
    (b) 7.6×10^{-4} mol of carbon monoxide (poisonous gas)
    (c) 100 g of carbon tetrachloride (poisonous fluid)
    (d) 100 g of dihydrogen sulfide (rotten egg gas)
12. Aspartame is an artificial sweetener marketed under the brand name NutraSweet. It has the molecular formula $C_{14}H_{18}N_2O_{5(s)}$.
    (a) What is the molar mass of aspartame?
    (b) What is the amount of aspartame in moles contained in one package of NutraSweet (35 mg of aspartame)?
    (c) How many hydrogen atoms are in 35 mg of aspartame?
13. Calculate the percentage by mass of the indicated element in each of the following compounds:
    (a) sodium in sodium azide, $NaN_{3(s)}$, a compound that rapidly decomposes, forming nitrogen gas. This reaction is used in automobile inflatable airbags;
    (b) aluminum in aluminum oxide, $Al_2O_{3(s)}$, the naturally occurring mineral corundum;
    (c) nitrogen in dopamine, $C_8H_{11}O_2N_{(aq)}$, a neurotransmitter in the brain.
14. (a) What is the difference between an empirical formula and a molecular formula?
    (b) Explain why an empirical formula can be determined from percentage composition of a compound, but a molecular formula requires further evidence.
15. Caffeine, a stimulant found in coffee and some soft drinks, consists of 49.5% C, 5.15% H, and 28.9% N by mass; the rest is oxygen.
    (a) Determine the empirical formula of caffeine.
    (b) Given the molar mass of caffeine is 195 g/mol, determine its molecular formula.
16. Many compounds in a family called esters have pleasant odours and are used in the perfume industry. When one of these esters was analyzed, the information in **Table 2** was obtained.

Table 2

mass of sample of ester analyzed	4.479 g
mass of carbon in sample	3.161 g
mass of hydrogen in sample	0.266 g
mass of oxygen in sample	1.052 g

    (a) Calculate the empirical formula of the ester.