EXAMPLE: A gas has the empirical formula POF_3. If 0.350 L of the gas at STP has a mass of 1.62 g, what is the molecular formula of the compound?

empirical mass of POF_3 = 104.0 g

$$\text{density of gas} = \frac{1.62\,g}{0.350\,L} = 4.63\,\frac{g}{L}$$

$$\text{mass of 1 mol gas} = 4.63\,\frac{g}{L} \times \frac{22.4\,L}{1\,mol} = 104\,\frac{g}{mol}$$

$$N = \frac{\text{molar mass}}{\text{empirical mass}} = \frac{104.0\,g}{104\,g} = 1$$

So that: molecular formula = 1 x (empirical formula) = POF_3

EXAMPLE: The empirical formula of a compound is SiH_3. If 0.0275 mol of compound has a mass of 1.71 g, what is the compound's molecular formula?

empirical mass = 31.1 g

$$\text{molar mass} = \frac{1.71\,g}{0.0275\,mol} = 62.2\,\frac{g}{mol}$$

$$N = \frac{62.2\,g}{31.1\,g} = 2$$

and: molecular formula = 2 x (empirical formula) = 2 x (SiH_3) = Si_2H_6

EXERCISES:

47. A gas has the empirical formula CH_2. If 0.850 L of the gas at STP has a mass of 1.59 g, what is the molecular formula?

48. A gas has the percentage composition: 30.4% N and 69.6% O. If the density of the gas is 4.11 g/L at STP, what is the molecular formula of the gas?

49. A compound has an empirical formula C_5H_{11}. If 0.0275 mol of the compound has a mass of 3.91 g, what is the molecular formula of the compound?

50. A gas has an empirical formula CH. If 450 mL of the gas at STP has a mass of 0.522 g, what is the molecular formula?

51. When a sample of nickel carbonyl is heated, 0.0600 mol of a gas containing carbon and oxygen is formed. The gas has a mass of 1.68 g and is 42.9% C. What is the molecular formula of the gas?

52. A gas sample is analyzed and found to contain 33.0% Si and 67.0% F. If the gas density is 7.60 g/L at STP, what is the molecular formula of the gas?

53. A gas has the percentage composition: 78.3% B and 21.7% H. A sample bulb is filled with the unknown gas and weighed. The mass of unknown gas is found to be 0.986 times the mass of a sample of nitrogen gas, $N_2(g)$, in the same bulb under the same conditions of temperature and pressure. What is the molecular formula of the unknown gas?

54. A gas has an empirical formula CH_2. If 0.500 L of the gas at STP has a mass of 0.938 g, what is the molecular formula of the compound?

55. A sample of gas has an empirical formula of O and has a molar mass which is 3 times that of CH_4. What is the molecular formula of the gas?