Find the EMPIRICAL (simples whole-number ratio of elements) FORMULA from the given mass data:

28.17% Mn

30.80% C

100% − 28.17% − 30.80% = 41.03% O

Convert this mass data to a MOLAR ratio:

To reduce this molar ratio to a ratio of WHOLE NUMBERS, divide each term by the SMALLEST - in this case, 0.512...

Assume 100 g

$28.17\,g\,Mn \times \frac{mol\ Mn}{54.94\,g\,Mn} = 0.5127411722\,mol\ Mn \rightarrow 1\,mol\ Mn$

$30.80\,g\,C \times \frac{mol\ C}{12.01\,g\,C} = 2.564529559\,mol\ C \rightarrow 5.002 = 5\,mol\ C$

$41.03\,g\,O \times \frac{mol\ O}{16.00\,g\,O} = 2.564375\,mol\ O \rightarrow 5.001 = 5\,mol\ O$

So the EMPIRICAL FORMULA is: MnC_5O_5

Mn : 1 × 54.94

C : 5 × 12.01

O : 5 × 16.00

194.99 g/mol ; Compare to 366 g/mol

2 × 194.44 = 390, closest multiple to 366 g/mol

It looks like the molecular formula is twice the empirical formula: $Mn_2C_{10}O_{10}$

12.91, p 520

56 grams of a sample contain 0.51 mole fraction propane and the remainder butane. What are the masses of propane and butane in the sample?

Know: $X_{C_3H_8} = 0.51$

$X_{C_4H_{10}} = 1 - 0.51 = 0.49$

Want: mass C_3H_8

mass C_4H_{10}

How do we get from MOLE FRACTION to the mass of each component in the sample?

$$X_{C_3H_8} = \frac{\text{mol } C_3H_8}{\text{total moles}}$$

Let's assume ... FOR NOW ... that we have a mole of the sample solution.

$\text{mol } C_3H_8 = 0.51 \times 1 = 0.51 \text{ mol } C_3H_8$

$\text{mol } C_4H_{10} = 0.49 \times 1 = 0.49 \text{ mol } C_4H_{10}$

Now, we can convert these numbers of moles to masses using the molecular weights of propane and butane!

C_3H_8: 44.094 g/mol C_4H_{10}: 58.12 g/mol : Formula weights

$$0.51 \text{ mol } C_3H_8 \times \frac{44.094 \text{ g } C_3H_8}{\text{mol } C_3H_8} = 22.48794 \text{ g } C_3H_8$$

$$0.49 \text{ mol } C_4H_{10} \times \frac{58.12 \text{ g } C_4H_{10}}{\text{mol } C_4H_{10}} = 28.4788 \text{ g } C_4H_{10}$$

50.96674 g total

Use the ratio of mass butane:total mass and mass propane:total mass to find the masses in the actual sample

$$g\ C_3H_8: 0.51\ mol\ C_3H_8 \times \frac{44.094\ g\ C_3H_8}{mol\ C_3H_8} = 22.48794\ g\ C_3H_8$$

$$g\ C_4H_{10}: 0.49\ mol\ C_4H_{10} \times \frac{58.12\ g\ C_4H_{10}}{mol\ C_4H_{10}} = \frac{28.4788\ g\ C_4H_{10}}{50.96674\ g\ total}$$

For a total mass of solution of 56g ...

$$56\ g \times \frac{22.48794\ g\ C_3H_8}{50.96674\ g\ total} = 24.7 = 25\ g\ C_3H_8$$

$$56\ g \times \frac{28.4788\ g\ C_4H_{10}}{50.96674\ g\ total} = 31.3 = 31\ g\ C_4H_{10}$$

So, the composition of the 56g sample is 25 g propane, 31 g butane

12.103, p 521

Commercial sulfuric acid (98% by mass) is 18 M. What is the density of the solution, and what is the molality?

want: density = $\frac{\text{mass solution}}{\text{Volume solution}}$

know: $18\,M = \frac{\text{mol } H_2SO_4}{\text{L solution}}$

$98\% = \frac{g\ H_2SO_4}{100g \text{ solution}}$

Assume we have 1L solution for our calculations:

$\frac{18 \text{ mol } H_2SO_4}{L} \times 1\,L = 18 \text{ mol } H_2SO_4$

We need to find the MASS of the solution. Since we know MOLES of sulfuric acid, we can convert to mass.

H_2SO_4: 98.086 g/mol

$18 \text{ mol } H_2SO_4 \times \frac{98.086\,g\ H_2SO_4}{\text{mol } H_2SO_4} = 1765.548\,g\ H_2SO_4$

Now find the mass of solution:

$1765.548\,g\ H_2SO_4 = 0.98 \times \text{mass solution}$

$1801.579592\,g = \text{mass solution}$

Find density:

density = $\frac{\text{mass solution}}{\text{Volume solution}} = \frac{1801.579592\,g}{1000\,mL} = 1.8\,g/mL$

$$\text{molality} = \frac{\text{mol } H_2SO_4}{\text{kg } H_2O}$$

We've already assumed 1L of solution to solve the previous problem. If we keep that assumption, the we already know:
moles sulfuric acid, mass sulfuric acid, and total mass of solution.

Find mass of water by subtraction:

$$1801.579592 \text{ g solution} - 1765.548 \text{ g } H_2SO_4 = 36.031592 \text{ g } H_2O$$

or, $0.036031592 \text{ kg } H_2O$

Find molality:

$$\text{molality} = \frac{\text{mol } H_2SO_4}{\text{kg } H_2O} = \frac{18 \text{ mol } H_2SO_4}{0.036031592 \text{ kg } H_2O} = 5\bar{0}0 \text{ m } H_2SO_4$$