FORMULA → MASS PERCENTAGES

H_2O → 11.19% H

88.81% O

MASS PERCENTAGES → ? → FORMULA

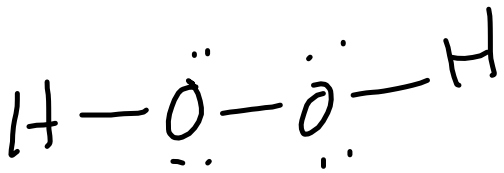
Can we do this?

With certain limitations

Yes.

KINDS OF CHEMICAL FORMULAS

(using hydrogen peroxide as an example)

STRUCTURAL 

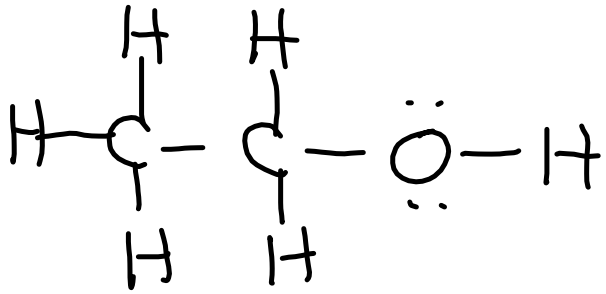
MOLECULAR H_2O_2

EMPIRICAL HO

SUBSTANCE	MOLECULAR	EMPIRICAL
WATER	H_2O	H_2O
GLUCOSE	$C_6H_{12}O_6$	CH_2O
ACETYLENE	C_2H_2	CH
BENZENE	C_6H_6	CH

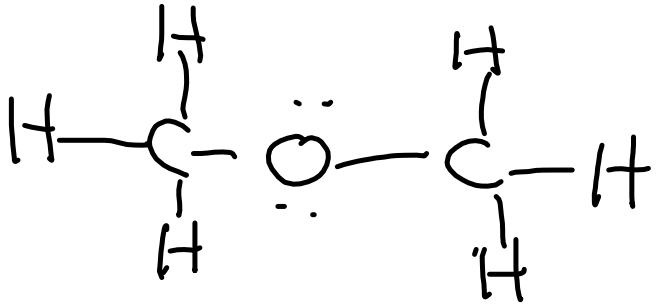
Are molecular formulas unique?

ETHYL ALCOHOL (ETHANOL)



C_2H_6O

DIMETHYL ETHER



C_2H_6O

ETHYL ALCOHOL

C_2H_5OH

CH_3CH_2OH

DIMETHYL ETHER

CH_3OCH_3

$(CH_3)_2O$

A nitrogen-oxygen compound was analyzed and found to contain 63.65% nitrogen by mass. What is the empirical formula of this compound?

100.00 g compound

63.65 g N

36.35 g O

$$63.65\ \text{g N}\left(\frac{1\ \text{mol N}}{14.01\ \text{g N}}\right) = 4.543\ \text{mol N}$$ (like 2)

$$36.35\ \text{g O}\left(\frac{1\ \text{mol O}}{16.00\ \text{g O}}\right) = 2.272\ \text{mol O}$$ (like 1)

$N_{4.543}O_{2.272}$

Empirical Formula: N_2O

$$\frac{4.543}{2.272} : \frac{2.272}{2.272}\ (N:O)$$

$$\downarrow \qquad \downarrow$$

$$2 : 1$$

A 5.000 g sample of an iron-oxygen was found to contain 3.497 g of iron. What is the empirical formula of this compound?

$$\text{PERCENT} = 100\% \left(\frac{\text{PART}}{\text{WHOLE}} \right)$$

$$\%\ Fe = 100\% \left(\frac{3.497\ g}{5.000\ g} \right) = 69.94$$

69.94 % Fe

30.06 % O

$$3.497\ g\ Fe \left(\frac{1\ mol\ Fe}{55.85\ g\ Fe}\right)$$

$$= 0.06261\ mol\ Fe$$

$$1.503\ g\ O \left(\frac{1\ mol\ O}{16.00\ g\ O}\right)$$

$$= 0.09394\ mol\ O$$

$$\frac{0.06261}{0.06261} : \frac{0.09394}{0.06261} \quad (1\ Fe : O)$$

$$\downarrow \qquad \downarrow$$

$$1 : 1.500$$

$$\downarrow \times 2 \qquad \downarrow \times 2$$

$$2 : 3$$

Empirical Formula: Fe_2O_3

$\frac{1}{2} = 0.5$

$\frac{1}{3} = 0.333\ldots$

$\frac{1}{4} = 0.25$