

Empirical formula test revision Year 11 Chemistry

Name _____

- 1) Three unidentified compounds are analysed and found to have the empirical formula CH_2O . What is needed to identify each compound?

The molar mass of each compound.

- 2) An organic compound has the empirical formula $\text{C}_2\text{H}_5\text{O}$ and a molar mass of 90g/mol. What is the molecular formula of the compound?

$\text{C}_4\text{H}_{10}\text{O}_2$

- 3) What is the empirical formula of a compound containing 47.37% carbon, 10.59% hydrogen and 42.04% oxygen by mass?

$\text{C}_3\text{H}_8\text{O}_2$

- 4) A compound is found to have the molecular formula $\text{C}_2\text{H}_3\text{O}_2$. Find its percentage composition.

40.6% carbon, 5.1% hydrogen, and 54.2% oxygen.

- 5) During experiments it is important to weigh accurately the given substances. Electronic balances have systematic errors of about ± 0.005 g. A student weighed two samples of the same compound.

Sample A = 0.011 grams

Sample B = 12.501 grams

Which sample is most accurate? Explain

The larger the mass weighed the less the percentage error.

eg and error range of 0.01 is given by the balance. Hence $(0.01 / 0.011)$ is 91% error margin

Whereas $(0.01 / 12.501)$ is 0.08% error margin

- 6) A 200.0 g sample of pure $\text{MgSO}_4 \cdot 5\text{H}_2\text{O}$ (molar mass 310 amu) contains:

a) how many grams of water

percent composition of water in $\text{MgSO}_4 \cdot 5\text{H}_2\text{O}$ is $90/310 = 29.0\%$

$\Rightarrow 0.29 \times 200 = 58.0$ grams

b) how many mol of oxygen atoms

\Rightarrow mol of $\text{MgSO}_4 \cdot 5\text{H}_2\text{O}$ is $200/310 = 0.645$

\Rightarrow mol of O atoms = $9 \times 0.645 = 5.81$ mol of oxygen atoms

c) what mass, in grams, of sulphur

percent composition of sulphur in $\text{MgSO}_4 \cdot 5\text{H}_2\text{O}$ is $32/310 = 10.3\%$

$\Rightarrow 0.103 \times 200 = 20.6$

d) what percent by mass of Mg

$(24.3 / 310) \times 100 = 7.84\%$

- 7) A compound was analysed and found to contain 40% carbon, 7% hydrogen and 53% oxygen by mass. If 3.01×10^{23} molecules of this compound weigh 30.0 g find the molecular formula of this compound. Atomic mass C=12.0, H=1.0, O=16.0

First find the empirical formula

Step 1 convert percentage to mass

=> 40g C : 7g H : 53g O

convert to mol

=> 40/12 : 7/1 : 53/16

=> 3.33 : 7 : 3.33

=> 1 : 2 : 1

=> CH₂O

Find the mol of the compound in 30.0 grams

=> $3.01 \times 10^{23} / 6.02 \times 10^{23}$

=> n = 0.5

Find molar mass

=> M_{mass} = mass/mol = 30/0.5 = 60

Find the integer that should be used to multiply the empirical formula

=> formula mass / empirical mass = 60 / 30 = 2

=> C₂ H₄ O₂

- 8) A 5.80 g sample of a hydrocarbon undergoes complete combustion to produce 17.6 g of CO₂ and 9.00 g of H₂O.

a) Find its empirical formula. Show all working out in the space provided below.

Step 1 find the mol of carbon in 17.6 g of CO₂

=> 17.6 / 44.0 = 0.400

Step 2 find the mol of hydrogen in water

=> mol of water = 9.00 / 18.0 = 0.50

=> mol of hydrogen = 0.5 X 2 = 1.0

Step 3 Simplest ratio

=> 0.4 C : 1 H

=> 0.4/0.4 : 1.0/0.4

=> 1 : 2.5

=> 2 : 5

C₂H₅

b) if 5.80 grams represents 0.10 mol of the substance find its molecular formula.

Find the molar mass

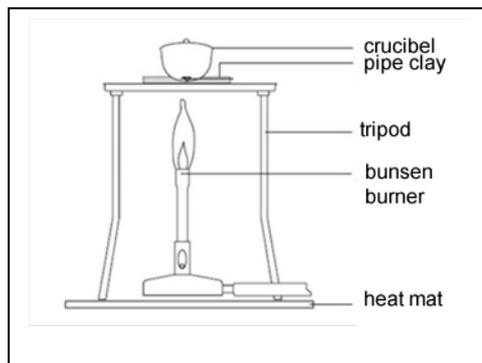
=> 5.80/0.1 = molar mass = 58.0 g/mol

Find the integer to multiply the empirical formula with

=> molecular mass/ empirical mass = 58.0 / 29.0 = 2

C₄H₁₀

- 9) When exposed to the atmosphere, CuSO_4 bonds with water molecules in the air. This behaviour can be shown as $\text{CuSO}_4 \cdot x\text{H}_2\text{O}$ where x is some integer quantity of water molecules. A student used the setup below to find the value of x .



The student strongly heated a 4.00 g sample of $\text{CuSO}_4 \cdot x\text{H}_2\text{O}$ and recorded the mass of the sample every two minutes to constant mass. The final mass recorded was 2.76.

- a) Calculate the mol CuSO_4 present in the sample

$$\text{mol CuSO}_4 = 2.76 / 160 = 0.0172$$

- b) Calculate the mol of water present.

$$\text{mass of water} = 4.00 - 2.76 = 1.24\text{g}$$

mol of water

$$\Rightarrow 1.24 / 18.0 = 0.069$$

- c) Calculate the value of x .

$$0.0172 : 0.069$$

\Rightarrow *simplest ratio*

$$\Rightarrow 0.0172/0.0172 : 0.069 / 0.0172$$

\Rightarrow 1 : 4

