

Glucose can decompose in the presence of microorganisms to form a range of products. One of these is a carboxylic acid ($M_r = 88$) containing 40.9% carbon and 4.5% hydrogen by mass.

a) Deduce the empirical formula of this carboxylic acid.

① Calculate the % mass of oxygen:

$$\Rightarrow 100 - (40.9 + 4.5) = 54.6\%$$

② Set up a table:

	Carbon	Hydrogen	Oxygen
% mass	40.9	4.50	54.6
A_r	12.0	1.00	16.0
moles	3.408	4.50	3.413

input the given information and calculate the mole quantities.

③ Calculate the molar ratio:

$$\text{moles} = \frac{\text{mass}}{M_r}$$

$$\text{Oxygen} \Rightarrow \frac{3.413}{3.408} = 1.001... \approx 1$$

$$\text{Hydrogen} \Rightarrow \frac{4.50}{3.408} = 1.320... \approx 1.3$$

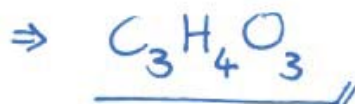
$$\Rightarrow \text{C} : \text{H} : \text{O} \\ 1 : 1.3 : 1$$

divide values by the smallest value to find the ratio.

④ Multiply up to get a whole number ratio:

\Rightarrow multiply by 3

$$\text{C} : \text{H} : \text{O} \\ 3 : 4 : 3$$



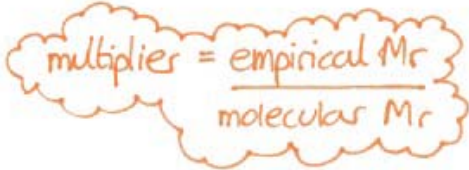
b) Hence, determine the molecular formula of this carboxylic acid.

① Calculate the empirical Mr:

$$\Rightarrow (3 \times 12.0) + (4 \times 1.0) + (3 \times 16.0) \\ = 88.0$$

② Find the value of the multipliers:

$$\Rightarrow \frac{88.0}{88.0} = 1.00$$


$$\text{multiplier} = \frac{\text{empirical Mr}}{\text{molecular Mr}}$$

③ Scale up the empirical formula by the multiplier value:

$$C \Rightarrow 3 \times 1 = 3$$

$$H \Rightarrow 4 \times 1 = 4$$

$$O \Rightarrow 3 \times 1 = 3$$

← in this question, the empirical and molecular formulas are the same.

