Amount of substance – A2 2022 Chemistry P2
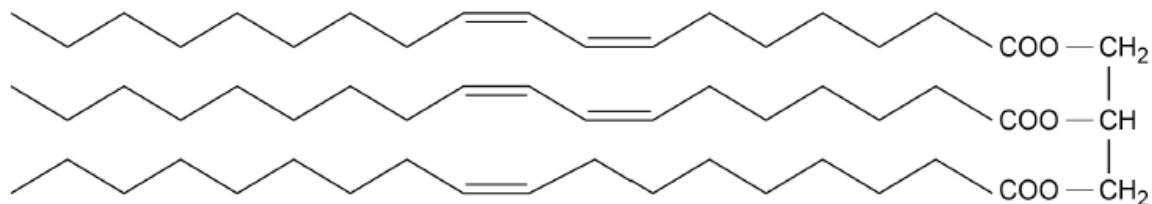
1. June/2022/Paper_7405/2/No.9

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This question is about olive oil.

A sample of olive oil is mainly the unsaturated fat **Y** mixed with a small amount of inert impurity.

The structure of **Y** in the olive oil is shown.
Y has the molecular formula $C_{57}H_{100}O_6$ (M_r = 880).

The amount of **Y** is found by measuring how much bromine water is decolourised by a sample of oil, using this method.

- Transfer a weighed sample of oil to a 250 cm^3 volumetric flask and make up to the mark with an inert organic solvent.
- Titrate 25.0 cm^3 samples of the olive oil solution with 0.025 mol dm^{-3} Br$_2$(aq).

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A suitable target titre for the titration is 30.0 cm^3 of 0.025 mol dm^{-3} Br$_2$(aq).

Justify why a much smaller target titre would **not** be appropriate.

Calculate the amount, in moles, of bromine in the target titre.

[2 marks]

Justification _____

_____

_____

_____

Mass of olive oil _____ g

The olive oil solution can be prepared using this method.

- Place a weighing bottle on a balance and record the mass, in g, to 2 decimal places.
- Add olive oil to the weighing bottle until a suitable mass has been added.
- Record the mass of the weighing bottle and olive oil.
- Pour the olive oil into a 250 cm³ volumetric flask.
- Add organic solvent to the volumetric flask until it is made up to the mark.
- Place a stopper in the flask and invert the flask several times.

0 9 . 3 Suggest an extra step to ensure that the mass of olive oil in the solution is recorded accurately.

Justify your suggestion.

[2 marks]

Extra step _____

_____

_____

Justification _____

_____

0 9 . 4 State the reason for inverting the flask several times.

[1 mark]

_____

_____

_____

0 9 . 5 A sample of the olive oil was dissolved in methanol and placed in a mass spectrometer. The sample was ionised using electrospray ionisation.
Each molecule gained a hydrogen ion (H^+) during ionisation.
The spectrum showed a peak for an ion with $\frac{m}{z}$ = 345 formed from an impurity in the olive oil.
The ion with $\frac{m}{z}$ = 345 was formed from a compound with the empirical formula $C_5H_{10}O$

Deduce the molecular formula of this compound.

[2 marks]

Show your working.

Molecular formula _____

2. June/2022/Paper_7405/3/No.7

Tschermigite is a hydrated, water-soluble mineral, with relative formula mass of 453.2

The formula of tschermigite can be represented as $M.xH_2O$, where M represents all the ions present.

Table 4 shows its composition by mass.

Table 4

Element	% by mass
N	3.09
H	6.18
Al	5.96
S	14.16
O	70.61

In an analysis, it is found that the mineral contains the ions NH_4^+, Al^{3+} and SO_4^{2-}

Calculate the empirical formula of tschermigite and the value of x in $M.xH_2O$

Describe the tests, with their results, including ionic equations, that would confirm the identities of the ions present.

[6 marks]

3. June/2022/Paper_7405/3/No.9

Consider the change that occurs in the shape of the curve for the distribution of molecular energies in a gas when the temperature of the gas is increased.

Which is a correct statement about the gas molecules at a higher temperature?

[1 mark]

A There are more molecules with any given energy.　　　　○

B There are more molecules with the mean energy.　　　　○

C There are more molecules with the most probable energy.　　　　○

D There is an increase in the most probable energy of the molecules.　○