Ongoing revision task 11 – volumetric analysis, food chemistry, percentage atom economy.

1) A glutamic acid, $C_5H_9NO_4$, of molecular mass 147 amu is a dioic acid. It is used as a food additive in preparation of a particular cracker biscuit. The food packaging contained the label "1.82 % m/m saturated fat" . A concentration higher than this is illegal. Investigators tested a sample of this food to measure the concentration of this acid.

   A 34.5 gram sample of the cracker was placed in 250 mL volumetric flask and made up to the mark with a mixture of alcohol and distilled water. A 20.0 mL aliquot was taken from the volumetric flask and placed in a 100 mL conical flask and two drops of an appropriate indicator added. This was titrated against a 0.221M NaOH solution and repeated four times. A table of the results is given below.

titre	1	2	3	4
Start (mL)	0.01	10.02	20.05	31.07
Finish (mL)	10.02	20.05	31.07	41.09
Total (mL)	10.01	10.03	11.02	10.02

   a) Write a balanced chemical equation for the reaction between the acid and the NaOH. States not included
   $C_5H_9NO_4 + 2NaOH \rightarrow 2H_2O + Na_2C_5H_7NO_4$

   b) What is the average titre?
   Only the concordant results are averaged.
   (10.01 + 10.03 + 10.02) / 3 = 10.02 mL

   c) Find the mol of NaOH in the average titre.
   $N_{NaOH} = C \times V = 0.221 \times 0.01002 = 2.21 \times 10^{-3}$

   d) Find the mol of acid present in the 20.0 mL aliquot
   According to the stoichiometry the NaOH reacts with the acid in a 2:1 ratio. So the amount of mols of acid is 1.11×10^{-3}.

   e) Find the mass of the fatty acid present in the 20.0 mL aliquot
   Mass = Fm X n = 147 X 1.11×10^{-3} = 0.163 grams

   f) Find the mass of the fatty acid present in the original sample
   All the mass of glutamic acid came from the volumetric flask which in turn came from the original sample.
   => (250 /20) X 0.163 = 2.04 g

   g) Find the concentration of the acid in the food in %m/m
   => (2.04 / 34.5) X 100 = 5.91%

   h) Circle the option that describes how the answer to g) above might change if :
   - the conical flask was washed with NaOH solution — ***lower, same, higher***
   - burette was washed with distilled NaOH solution — ***lower, same, higher***
   - if one drop of indicator was used rather than two. — ***Lower, same, higher***

2) The three major food groups are proteins, fats and carbohydrates.

a) 10 amino acids have a combined mass of 1506 amu. When they polymerise into a single peptide chain how much lighter than 1506 amu will the chain be?

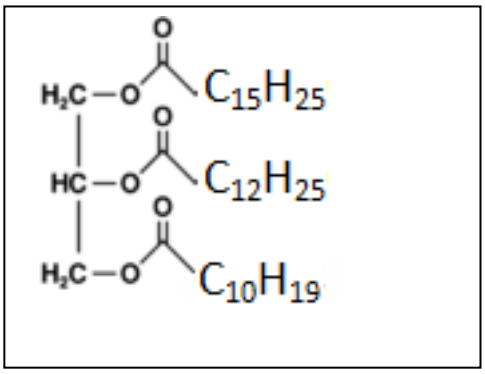
Ten amino acids will form 9 peptide links with the expulsion of 9 water molecules.
=> 1506 – (9 X 18) = 1344 amu

b) What is the percentage atom economy of this polymerisation reaction?

(1344 / 1506) X 100 = 89.2%

c) Draw the structure of a triglyceride composed of the following fatty acids. Use molecular formulae to avoid having to write the entire structure of the fatty acids.

$C_{15}H_{25}COOH$, $C_{12}H_{25}COOH$ and $C_{10}H_{19}COOH$



d) Which of the three fatty acids is most considered to be a :

i. Monounsaturated *$C_{10}H_{19}COOH$*

ii. Polyunsaturated *$C_{15}H_{25}COOH$*

iii. Saturated *$C_{12}H_{25}COOH$*

e) Triglyceride A when hydrolysed produces three fatty acids with the same chemical formula of $C_{12}H_{19}COOH$, while triglyceride B produces three fatty acids with the same molecular formula of $C_{12}H_{25}COOH$. Which triglyceride is found as an oil at room temperature and give an explanation as to why.

Triglyceride A has polyunsaturated fatty acids. Double bonds tend to kink the carbon chain of the fatty acid and hence the molecules are unable to pack tightly together where the dispersion forces can take hold. Triglyceride B has straight chain saturated fatty acids. These molecules pack tightly together where the distance between one fatty acid and the next is small and hence dispersion forces can take hold. So triglyceride B will be a solid fat at room temperature while triglyceride A will be an oil.