Revision food, calorimetry and volumetric analysis

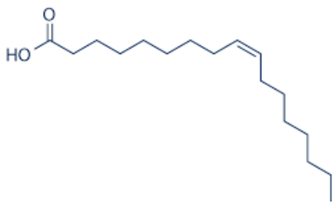
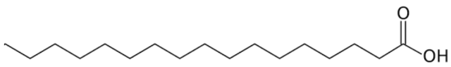
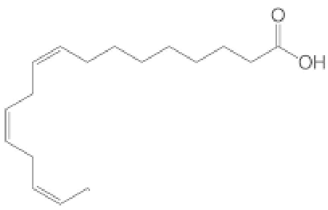
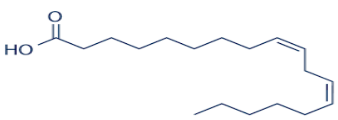
1. Below is a table with data pertaining to arachidic and arachidonic acids.

Fatty acid	Formula	Melting point (C°)	Boiling point(C°) (at 1 atm)
Arachidic	$C_{19}H_{39}COOH$	76	328
Arachidonic	$C_{19}H_{31}COOH$	-50	407

   a. Explain the trend in melting temperature between the two molecules.

   b. Explain the trend in boiling temperature between the two molecules.

2. Below are the structural formulae of 4 fatty acids, all of which have a carbon chain length comprising of 18 carbon atoms.

Fatty acid		Boiling temperature (°C)	Melting temperature (°C)
A			
B			
C		443	-11
D			

The boiling and melting temperatures, in °C and at 760 mmHg, of the acids are listed in no particular order.

- Boiling temperature, 443, 430, 360, 359.
- Melting temperatures, -11, -5, 13, 69.

Allocate the MP and BP to the appropriate molecule. C is done for you.

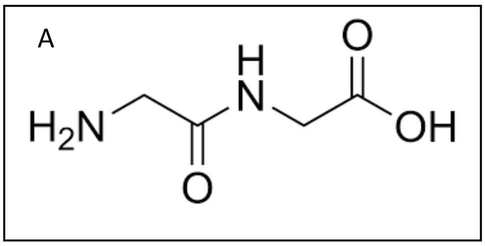
3. A bottle is labelled “ 1.00 M Linoleic fatty acid”. A spelling error was suspected and so a titration was conducted to analyse the fatty acid. A 30.00 mL aliquot of this solution was placed into a 100 mL conical flask and titrated against a 2.800 M I_2 solution. A titre of 32.20 mL was required to reach the end point.
   a. Calculate the amount of acid, in mol, present in the 30.00 mL aliquot of the original solution.

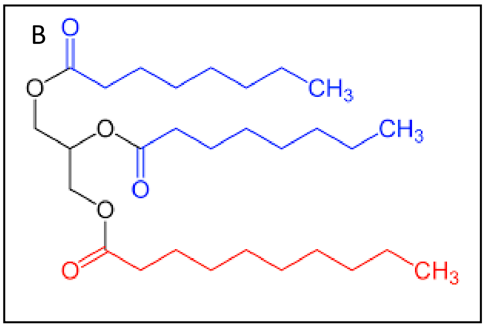
   b. Calculate the mol of I_2 required to completely react with the acid in the conical flask.

   c. Is this fatty acid linolenic or linoleic? Justify your choice.

   d. This time, a 0.300 mL aliquot of the original solution was taken and the solvent was evaporated so that the pure fatty acid remained. This was then burnt in a bomb calorimeter which contained 100 mL of distilled water. If the temperature of the water was originally at 30.0 °C, calculate the final temperature of the water, to the right number of significant figures assuming all the energy released was absorbed by the water.

4. Consider molecule “ A” shown on the right.





   a. What are the products when molecule “ A” is digested?

   b. What is the general name for this type of compound?

   c. What type of reaction is involved in the breakdown of molecule “ A” ?

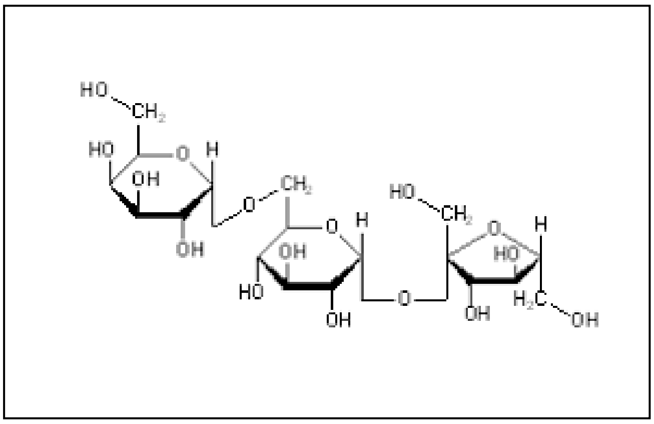
   d. Using chemical formulae write a balanced chemical equation for the formation of compound “ B” .

   e. What category of food contains molecule “ B”?

   f. Name the functional group present in this compound.

5. Carbohydrates are the primary energy source for animals.
   a. Give an example of a high GI food and explain why it is Labelled as "High GI"

   b. Consider the trisaccharide, raffinose, shown on the right.

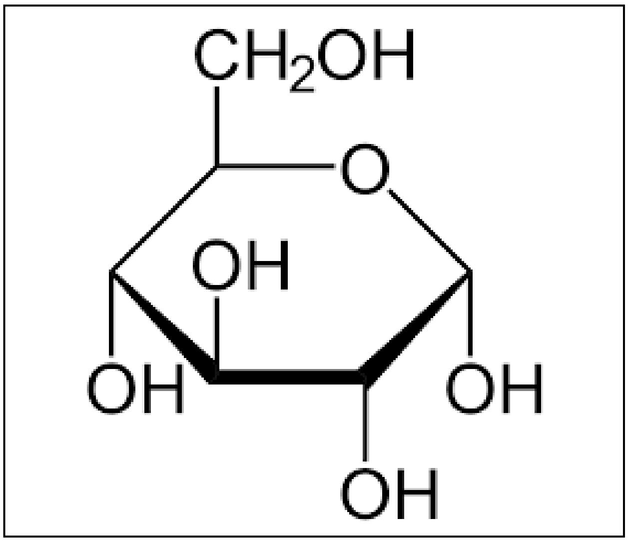


      i. What type of reaction formed raffinose?

      ii. Complete digestion of raffinose yields three monosaccharides, one of which is galactose. Name the other two monosaccharides.

      iii. What type of bonds link the saccharide monomers of raffinose?

      iv. Name the saccharide shown on the right.



      v. Circle and name two different functional groups present.

   c. Two snack foods are sold commercially.
   "Superbo Energy", contains starch, 10% of which is amylose and 90% is amylopectin.
   "Fit-n-healthy Energy" on the other hand contains starch made up of 80% amylose and 20% amylopectin. Which snack food can be given to a diabetic suffering from hypoglycaemia (low blood sugar) to speed their recovery? Explain.

6. A bomb calorimeter was calibrated by passing a current of 1.50 amps for 5.00 minutes at 2.50 V through the heating element. A mass 50.00 grams of water was heated and recorded a temperature change 5.00 °C.
   a. Calculate the calibration factor of the calorimeter.

   b. A mass of 0.50 grams of sucrose (formula mass 342 g/mol) was burnt in the same calorimeter and the temperature change of the water measured at 39.72 °C. Calculate the ΔH of the reaction below, in kJ per mol, to the right number of significant figures.
   $C_{12}H_{22}O_{11}(s) + 12O_2(g) \rightarrow 12CO_2(g) + 11H_2O(l)$ ΔH =

   c. Suggest a reason as to why a calibration factor is used rather than the heat capacity of water (4.18 J/g/°C).

   d. Fat (palmitate fatty acid), when burnt in a bomb calorimeter, produces approximately 37 kJ of heat energy per gram. During cellular respiration fat yields its energy via the formation of high energy chemical bonds in the form of ATP. Both cellular respiration and combustion reactions are shown below.
   cellular respiration – $C_{16}H_{32}O_2 + 6O_2 + 129ADP + 129P \rightarrow 6CO_2 + 6H_2O + 129ATP$
   combustion – $C_{16}H_{32}O_2 + 23O_2 \rightarrow 16CO_2 + 16H_2O$
   How does the heat energy produced by a known mass of palmitate compare with the energy produced, by the exact same mass of palmitate, during cellular respiration?