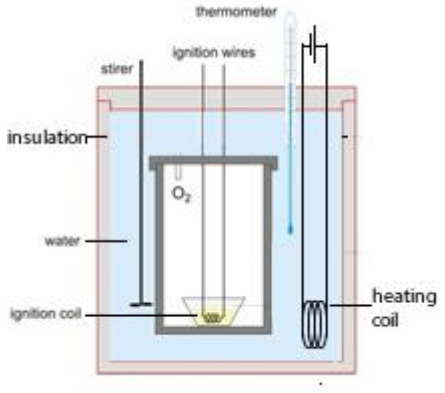
Ongoing revision of unit 3 and 4

1) Write the balanced thermochemical equation, with states, for the ***complete*** combustion of the following two substances :
   a. A fatty acid found in oil with the formula $C_{12}H_{21}COOH$

   b. Liquid lactose $C_{12}H_{22}O_{11}$ (342.3 g/mol)

   c. Calculate the mass, in grams, of Br_2 that will react with one mol of the fatty acid with the formula $C_{12}H_{21}COOH$.

2. An unknown fatty acid "Y" was analysed using a bomb calorimeter to verify its molar heat of combustion.



A typical bomb calorimeter

The following steps were undertaken in order.
step 1 – the calorimeter was filled with 100 mL of water at 25.0 ^{o}C

Step 2 – 0.191 g of pure ethanol was placed in the bomb and ignited.
Step 3 – The temperature of the water was measured and recorded every 30 seconds, on a temperature vs time graph shown in diagram 1 on the right, while the ethanol underwent complete combustion.

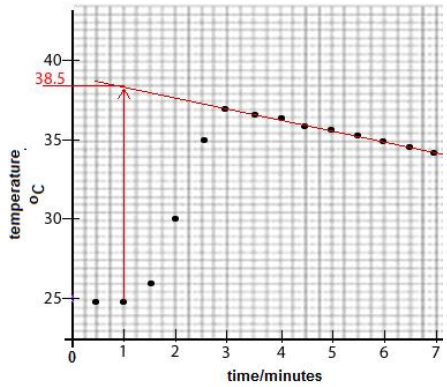


Diagram 1

Step 4 – The water in the calorimeter was allowed to cool back down to 25.0 ^{o}C before a 0.140 gram sample of the fatty acid "Y" was placed in the calorimeter and ignited.
step 5 – The temperature of the water was measured and recorded every 30 seconds as shown in diagram 2.

a. Calculate the calibration factor of the bomb calorimeter. Express the answer to the right number of significant figures.

b. Calculate the amount of energy, in kJ, given out by the 0.140 grams of the fatty acid while undergoing complete combustion.

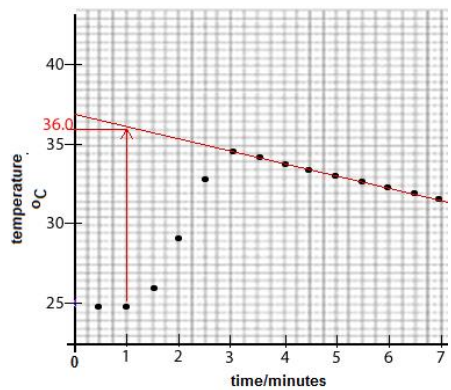


Diagram 2

c. Calculate the heat of combustion (kJ/g).

d. Compare the value obtained in question c. above with the value of the energy content of lipids and fats given in the data book. Give an explanation for any discrepancy.

e. The bomb calorimeter shown above has a heating coil.
   i. What is the purpose of the heating coil?

   ii. Is the heating coil essential? Explain.

   iii. Name one difference and two similarities in the use and operation between a solution calorimeter and a bomb calorimeter?

3. Consider the organic molecule with the molecular formula $C_3H_6Br_2$.
   a. Name all the possible structural isomers with this formula

   b. Identify the structural isomer that has only one signal, with no splitting pattern, in its ^{1}HNMR spectrum and give the number of signals that appear in its ^{12}CNMR spectrum

c. Which structural isomer in question a. above has more than one optical isomer?

d. Suppose that $C_3H_6Br_2$ was formed from a hydrocarbon and an inorganic substance according to the chemical equation shown below.

A + B → $C_3H_6Br_2$

i. Identify A and B

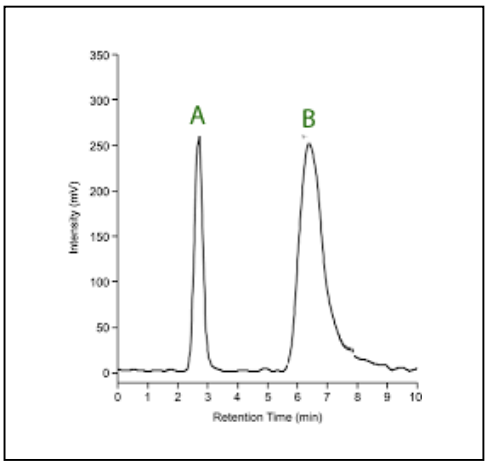
A =

B =

ii. What type of reaction is this?

iii. What is the ***atom economy*** of this reaction?

iv. A mixture of the organic reactant and $C_3H_6Br_2$ was separated into its components using normal-phase liquid chromatography. The chromatogram is shown on the right. Identify substance A and B and indicate which substance has the highest concentration in the mixture. Explain your reasoning.



e. Which isomer/s from the answer given to question a. above, could not have formed from the reaction A + B → $C_3H_6Br_2$?

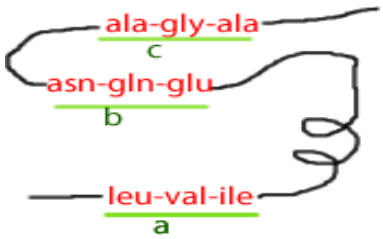
4. Enzymes are proteins and act as biological catalysts. Being proteins, the tertiary structure of the enzyme is critical to its ability to perform its role in living organisms.

   i. Explain how enzymes act as catalysts with reference to the enzyme-substrate complex and make mention of the type of bonds that exist between the enzyme and the substrate.

   ii. Describe the chemical bonding that enables the tertiary structure to be maintained and offer some examples of the amino acids that take part in the strongest of these chemical bonds.

   iii. Suggest how the tertiary structure facilitates the proteins function as an enzyme and its specificity to particular substrates.

   iv. Consider the section of a protein shown on the right.



      i. What structure of the protein is represented by the segments a, b and c?

      ii. Which statement below is true?
      Offer an explanation for your choice.

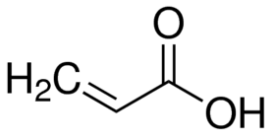
      1 – Segments a and c will attract each other to influence the tertiary structure of the protein.

      2 – Segments a and b will attract each other to influence the secondary structure of the protein.

      3 – Segments c and b will attract each other to influence the tertiary structure of the protein.

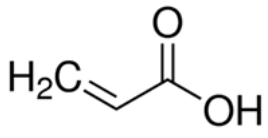
      4– Segments c and b will attract each other to influence the secondary structure of the protein.

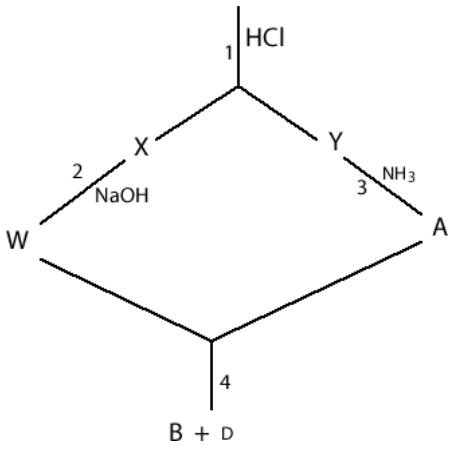
5. An organic compound is shown on the right.



   a. Give the IUPAC name for the compound shown on the right.

   b. Consider the organic pathway shown on the right and the ^{1}HNMR spectrum for compound X.





      i. Name the following compounds:

         X _____

         Y _____

         W _____

         A _____

      ii. Identify the class of reaction that the following belong to.

         Reaction 1

         _____

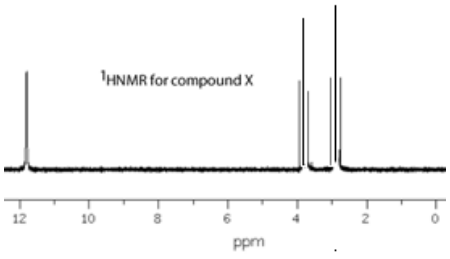
         Reaction 2

         _____

         Reaction 3

         _____

         Reaction 4



      iii. Draw the structural formula of compound B, in the space provided on the right.

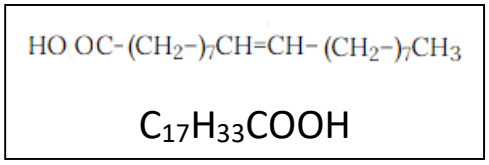
      iv. Circle and label the functional group/s present in compound B

      v. Identify substance D

      vi. A student classified compound A as a beta-amino acid.
      Do you agree? Justify your response and draw the structural formula of compound A.

      vii. What wave numbers on the IR spectrum of compound B would you expect to show strong absorption that could identify important bonds within the molecule?

6. Elaidic acid and oleic acid share the same molecular formula and semi-structural formula as shown on the right.



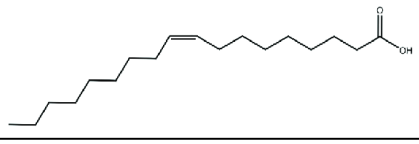
   a. The table of the physical properties of both fatty acids is shown below.

Acid	Elaidic	Oleic
Melting temperature (°C)	43	13.5
Boiling temperature (°C)	288	360
Flash point (°C)	110	189

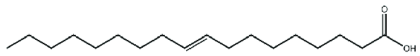
   i. Oleic acid can be classified as what type of omega fatty acid.

   ii. Using the information in the table above draw skeletal structures of the two geometric isomers in the space provided on the right.

Oleic acid



Elaidic acid



   iii. Explain the difference between the melting points and boiling points of the two geometric isomers. You may draw a labelled diagram to assist in your explanation.

   .

   iv. Explain the trend in the flash point between the two geometric isomers.

v. Using the data given in the table above suggest, with reasons, which of the two acids is the more viscous.

b. Biofuels are formed by a reaction with methanol in the presence of a catalyst (KOH) to form methyl esters.

i. Complete the equation for the formation of the methyl ester shown below (states not required)

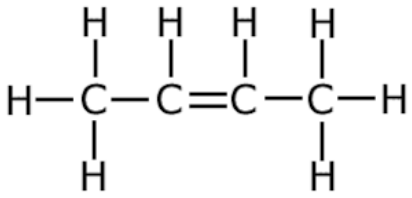
$C_{17}H_{33}COOH + CH_3OH \rightarrow$

ii. Identify this type of reaction

iii. Oleic acid can be used to produce biodiesel for use in vehicles in cold environments. Discuss one advantage and one disadvantage of using oleic acid over elaidic acid based on the data given in the table above.

7. Below are to columns. On the left are the monomers and on the right are the polymers formed by the monomers. Complete each square with the name and structural formula of each monomer and the structural formula of the repeating unit in the polymer.

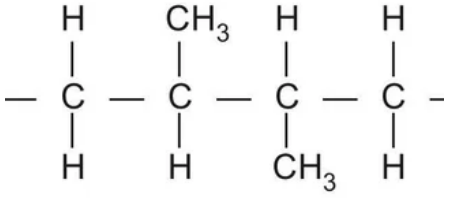
a.



Name _____

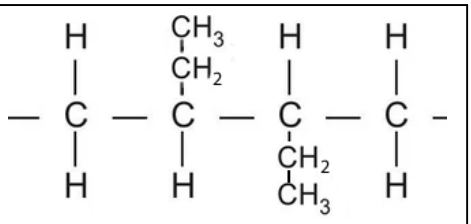
b.

Name _____



c.

Name _____

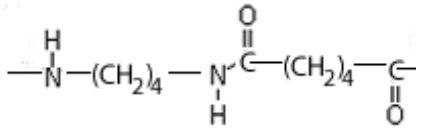


d.

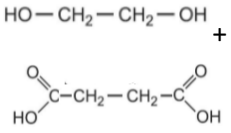
Name Pent-2-ene

e.

Name _____
Name _____



f.



Name _____
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