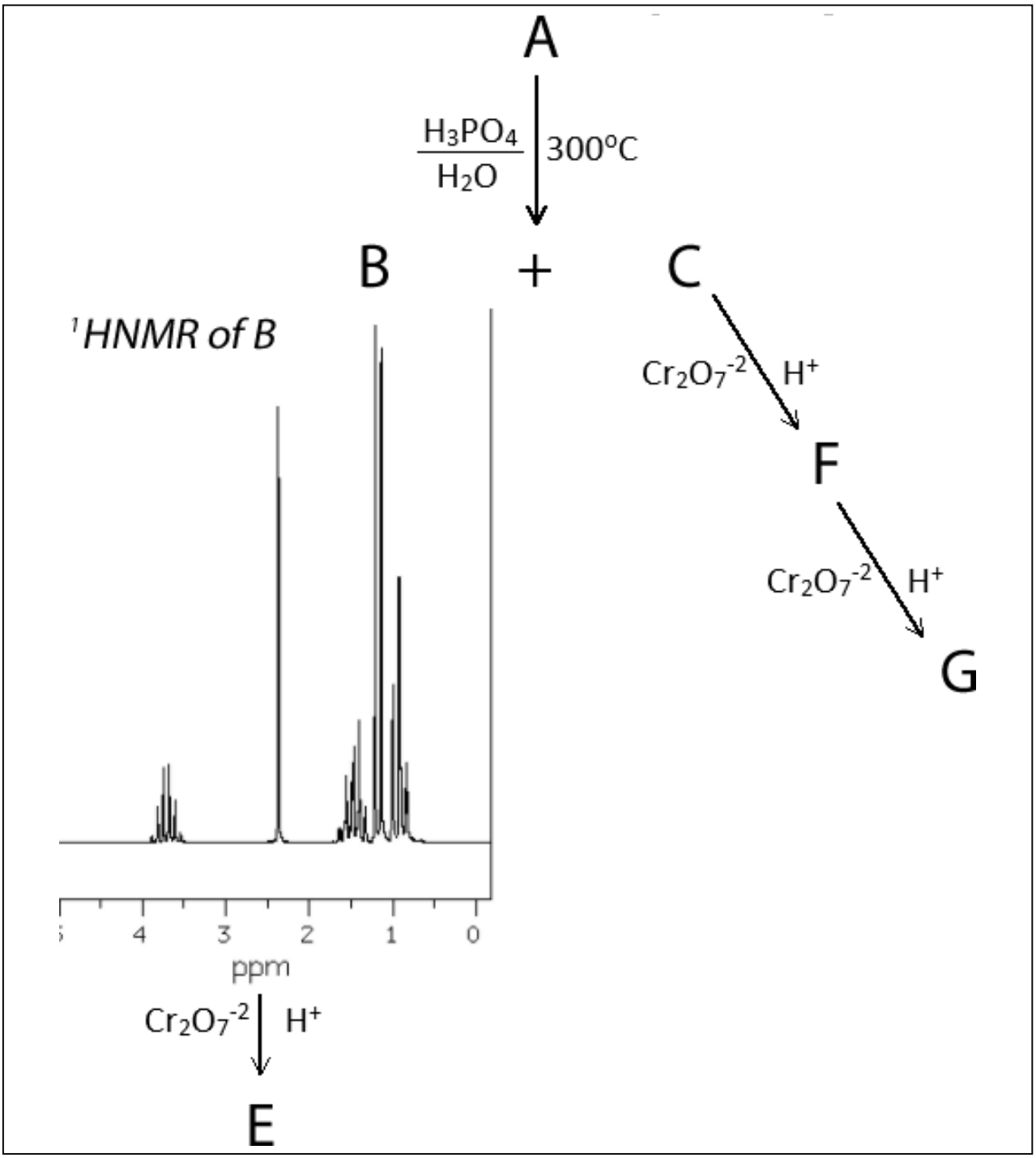
Revision – Unit 3 and 4

1) A ***pure***, mono-unsaturated hydrocarbon, labelled "A" in the diagram below, of mass 5.60 grams reacts with exactly 16.0 grams of Br_2.
   a) Identify the molecular formula of substance "A" and name all the possible compounds formed from this reaction with Br_2.

Another sample of substance "A", this time weighing 10.00 grams, is taken through a set of processes shown in the diagram below.



Consider the ^{1}HNMR of substance "B".

b) Name the following compounds and draw their skeletal structures in the box provided:

B _____

C _____

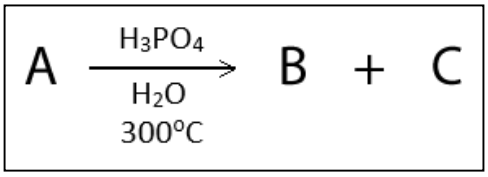
c) Draw the structural formula of substance "E" and "F" in the space provided

E

F

d) Identify one feature that is common to the IR spectra of both compounds "F" and "G".

e) Consider the reaction on the right.



i. Name the type of reaction shown on the right.

ii. Name an isomer of compound "A" that forms only one compound undergoing the reaction in i. above.

iii. Name the type of reaction that forms compound "G"

iv. To what class of compounds does "B" belong to?

v. Consider the possible ^{1}HNMR spectrum of compound "E". What type of signals appear and what is the simplest ratio of the area under each signal? Complete the table below. An example is shown on the right.

Type of signal	Simplest ratio of area

Type of signal	Simplest ratio
Triplet	2
Quintet	1
Sextet	3

f) Compound “G” was collected and dried. A 59.701 gram sample was obtained and placed in a 250 mL volumetric flask and made to the mark with distilled water. Five 20.00 mL aliquots of the solution were taken from the volumetric flask and placed in five separate 100 mL conical flasks. Each flask was then titrated against a 2.500 M NaOH and the 5 titres, listed below were obtained.
23.45 mL, 21.11 mL, 21.19 mL, 21.15 mL and 21.10 mL.

i. Find the average titre.

ii. Give a balanced chemical equation of the reaction taking place in the conical flask. States not required.

iii. Calculate the amount in mol of compound “G” present in the conical flask.

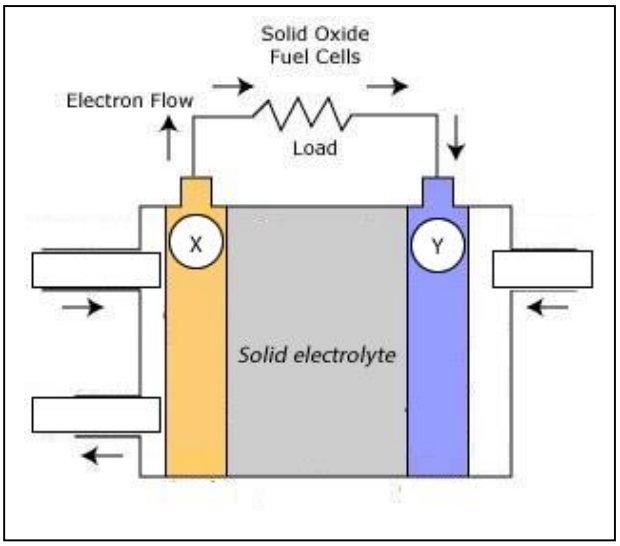
iv. Calculate the amount in grams of compound “G” in the volumetric flask

v. Calculate percent purity of compound “G” in the 4.357 gram of the original sample, to the right number of significant figures.

vi. Each conical flask was washed with distilled water but was not given time to dry. What impact will this have on the percent purity of compound “G? Explain.

vii. The volumetric flask was accidentally rinsed with the standardised sodium hydroxide solution but allowed to dry completely before use. What impact will this have on the percent purity of compound “G“? Explain.

2) Propanol is used as a fuel in a fuel cell, pictured on the right, to generate electrical energy at 1.89V.



i. Label the :
- anode and give it's polarity.
- cathode and give it's polarity.
- label the direction of negative ion flow through the electrolyte.

ii. Propanol is the fuel while oxygen gas from the atmosphere is the oxidant. Clearly label on the diagram the points of input of both propanol and oxygen gas.

iii. Clearly label the waste product/s

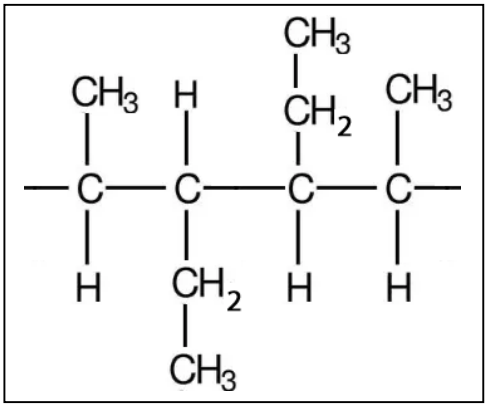
iv. Write the half equation for the reaction occurring at the cathode where oxygen molecules are converted to oxygen ions. States not required.

v. Calculate the electrical energy, in kilojoules, generated per mol of propanol consumed in the fuel cell. The half equation for the reaction of propanol at one of the electrodes can be simplified as shown below.

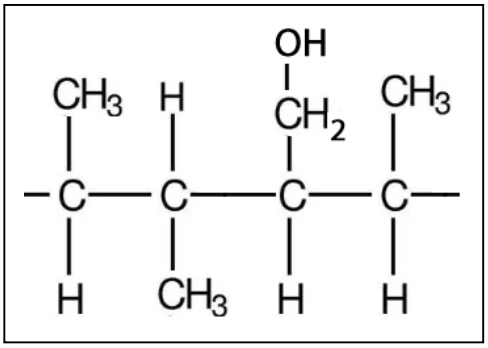
$$C_3H_8O + 9O^{-2} \rightarrow 3CO_2 + 4H_2O + 18e$$

3) Three sections of polymer molecules are shown below.
i. Identify the monomer/s that formed each section by giving their systematic name/s in the space provided.

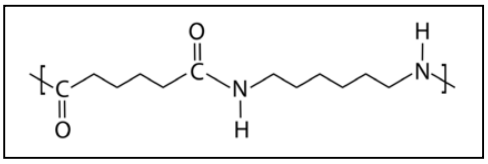
Monomer/s
_____



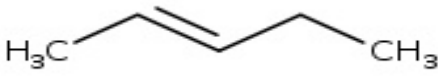
Monomer/s
_____



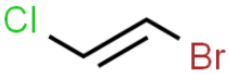
Monomer/s
_____



ii. Two molecules shown below, in skeletal form, are used as monomers for the formation of a long chain polymer. Name the monomers.



Name _____



Name _____

iii. Draw the possible structural formula of the repeating unit of the polymer in the space below.

4) Biodiesel is a mixture of fatty acid methyl esters. A particular triglyceride used in the manufacture of biodiesel was hydrolysed with excess methanol and a potassium hydroxide catalyst. This reaction produced two liquid layers in the reaction vessel as shown on the right. The bottom layer is an aqueous solution.

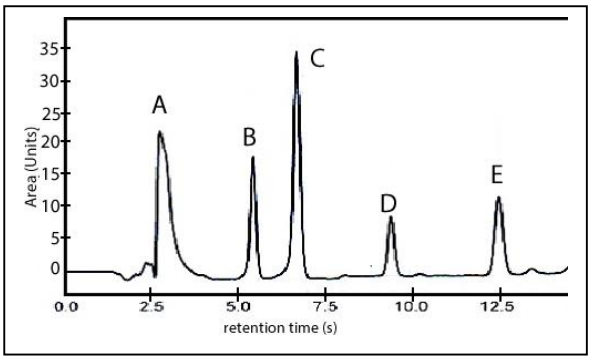
a) Other than water, name three other substances that could possibly be found in the aqueous layer. Justify your answer for each substance.

Substance 1 _____

Substance 2 _____

Substance 3 _____

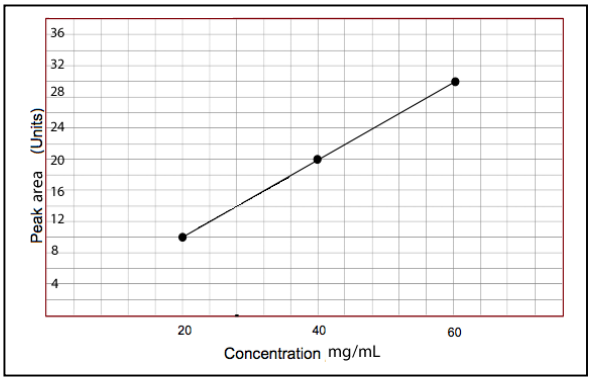
b) A 1.15 mL sample of the mixture in the top layer was analysed by reverse phase HPLC.



i. How many compounds, possibly methyl esters, are present?

ii. Which methyl ester has the highest molar mass? Justify your decision.

iii. Three standard solutions of a methyl ester ("X") suspected of being present in the top layer were made up and put through the column under the exact conditions as the 1.15 mL sample above. A calibration curve was constructed and shown on the right. Methyl ester "X" was eluted from the column in 6.5 seconds.



Is methyl ester "X" present in the original sample? Justify your answer.

iv. Calculate the concentration, in ppb, of methyl ester "X" in the top layer of the reaction vessel.

v. Discuss why the accuracy of this measurement of the concentration of methyl ester "X" is not high and offer one suggestion of how it can be improved.

5) The isoelectric point of an amino acid is the pH at which the amino acid exists a neutral charged molecule (Zwitterion). Aspartic acid has an isoelectric point of 2.77.

In the space provided, draw the skeletal formula of aspartic acid:

i. at a pH of 2.77

(show all charges in the exact location on the molecule)

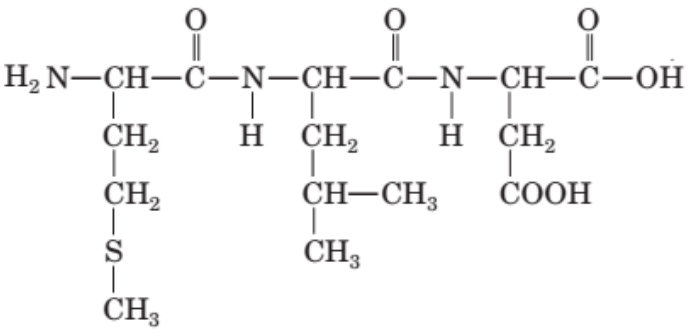
ii. when floating in a solution of pH 10.3

(show all charges in the exact location on the molecule)

iii. in an acid bath of pH of 1.1

(show all charges in the exact location on the molecule)

6) Consider the molecule shown on the right.



a) To what class of food molecules does this belong to?

b) Circle and name three different functional groups that are visible in this structure.

c) Name the products of digestion of this molecule.

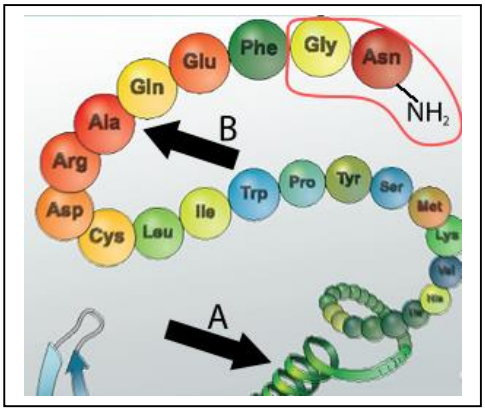
d) What type of chemical reaction does this molecule undergo during digestion?

e) What is the mass difference, in grams, between one mol of the original molecule and the sum of its products after digestion?

7) Consider a small section of a protein molecule found in Human blood.

a) Two structures "A" and "B" of the molecule are shown with an arrow pointing to them. When this molecule is placed in ethanol it becomes denatured.

i. Which structure/s is/are most likely to be impacted by the ethanol and or a pH change? Explain your answer.



ii. When the molecule is heated to 50 ^{o}C which structure/s remain unchanged? Explain your answer.

iii. Explain the bonding that holds structure "B" in shape.

vi. In the space provided on the left draw the section with the last two amino acids enclosed by a red line.

v. Answer true or False to the following statements and justify your answer.

- during denaturing of a protein molecule both the primary and secondary structures are impacted.

- At 60 ^{o}C most proteins are denatured when all forms of bonding in the tertiary structure are broken.

- Changes in pH disrupt only the hydrogen bonding between neighbouring amide groups in the protein chain.

8) A student was set the task of finding the change in enthalpy of the reaction shown below.
$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(l) + CO_2(g)$ $\Delta H = ?$
The student was provided with 1.100M HCl and 40 grams of $NaHCO_3$. When asked for assistance on how to tackle this problem the student was told to find the ΔH of each of the two reactions shown below whether by experimental means or by looking up the literature. Then apply their chemical knowledge of thermochemistry to solve the problem.

i. $HCl(aq) + NaHCO_3(s) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$

ii. $2HCl(aq) + Na_2CO_3(s) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$

The student's experimental procedure to find the ΔH of equation i. is listed below.

Step 1 – weigh accurately about 10 grams of $NaHCO_3$ using an electronic balance and record the mass.
Step 2 – Using the calorimeter, shown on the right, place the $NaHCO_3$ from step 1 into the calorimeter with 100 mL of HCl solution measured with a 100mL measuring cylinder.
Step 3 – Quickly seal the calorimeter by tightly fitting the cup with the thermometer inserted and record the temperature reading of the contents.
Step 4- When the fizzing has stopped record the final temperature of the contents.

The student's results are shown on the right.

Mass of container	3.867 g
Mass of container + $NaHCO_3$	13.547g
Mass of $NaHCO_3$	9.68 g
Initial temperature of solution	23.2 °C
Final temperature of solution	19.8 °C
Change in temperature	3.4 °C

For reaction ii. above, the student researched the literature and came up with the following equation. $2HCl(aq) + Na_2CO_3(s) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$ $\Delta H = -27$ kJ mol^{-}

i. Calculate the ΔH of reaction i. above from the student's results. Assume density of water is 1.00g/mL

ii. Using the information presented derive the ΔH for the reaction

$2NaHCO_3(s) \rightarrow Na_2CO_3(s) + H_2O(l) + CO_2(g)$

iii. Suggest two improvements to the experimental procedure and outline why this is an improvement in obtaining valid and reliable data.

iv. It was suggested that the investigation be repeated several times as the design of the calorimeter was fairly poor which allowed heat to escape. Will this help to determine the energy loss more accurately?

v. It was suggested that the investigation be repeated several times in order to make up for the poor insulation of the calorimeter and improve the validity of the data collection. Is this true? Explain your answer.

vi. Repeating the investigation several times will increase the reliability and therefore accuracy by removing systematic errors. Is this statement true? Explain your answer.

vii. The calorimeter is held by the student in their right hand the same way during three separate trials. The student records the following results in the drop in temperature.

2.3^oC, 2.4^oC and 2.3^oC

They note that their hand always feels cold. Discuss if the results are valid and reliable.