Revision - food chemistry and chromatography

1. A bomb calorimeter, diagram 1, containing 100 mL of water was calibrated by passing a current of 2.86 amps at 12.50 volts for 25.0 seconds through the heating coil. The temperature of the water was taken every 25 seconds after the power was turned on.

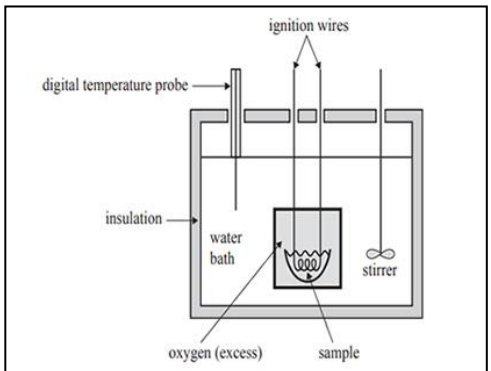
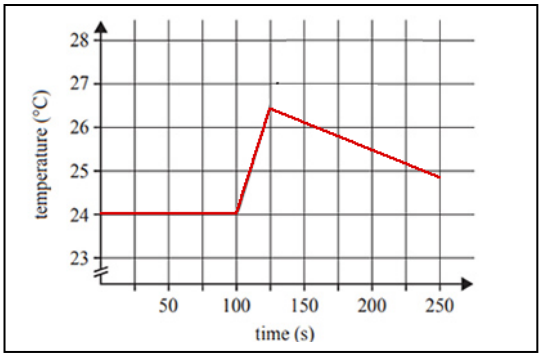


Diagram 1

Results were plotted on the graph shown on the right.



a. Calculate the calibration factor(C_f)

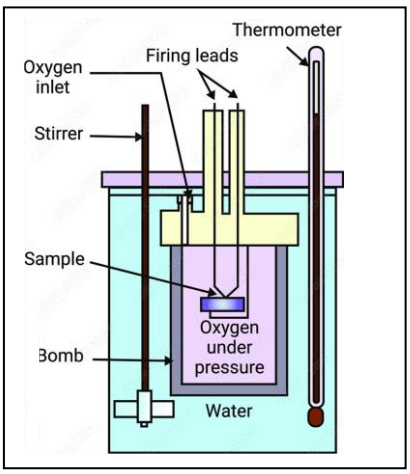
b. A mass of 0.05801 grams of butane gas was burnt in the calorimeter, in excess oxygen, to change the temperature of the water by 9.03 °C.

   i. Write a balanced chemical equation, states included, for the complete combustion of butane gas.

   ii. Calculate the ΔH of the combustion reaction.

c. Is the calorimeter well insulated? Explain

d. Another bomb calorimeter, containing 200 mL of water at 25 ^{O}C was calibrated. A sample of 0.0640 grams of liquid methanol was burnt in excess oxygen to raise the temperature of the water by 10.00 ^{o}C.



i. Calculate the C_f of this calorimeter.

ii. A pure, 0.04600 gram sample of ethanol was burnt in this calorimeter with excess oxygen to raise the temperature of the water by 9.40 ^{o}C.
Calculate the molar heat of combustion in kJ/mol of ethanol. Give the answer to the right number of significant figures and show all working out in the space below.

iii. On the same day another group also calibrated the same calorimeter, following the same procedure, but filled the calorimeter with 100 mL of water instead of 200 mL. Are the results that this group obtained for the molar heat of combustion of ethanol valid? Explain.

2. Diagram 2 shows the chromatogram of a mixture of six compounds, given below, when run through a HPLC column.
   The mixture consists of propane, propan-1-ol, propan-2-ol, propanone, propanoic acid, pentane.

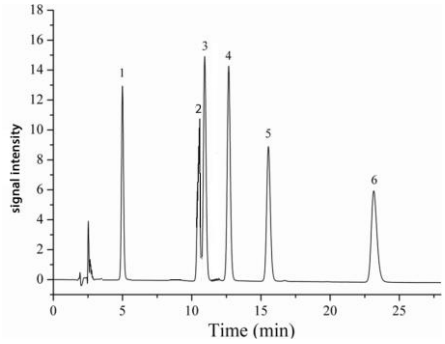


Diagram 2

   a. Peak 6 in the chromatogram is identified as pentane. Is this reverse-phase chromatography? Explain using the terms ***adsorption and desorption.***

   b. Identify each peak.

Peak	Compound
1	
2	
3	
4	
5	

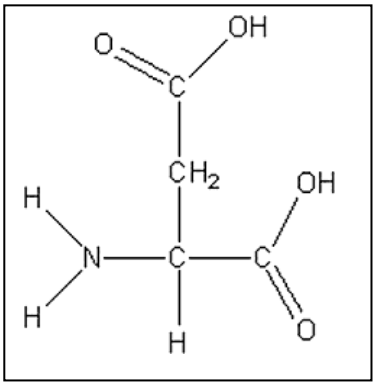
   c. Peaks 2 and 3 overlap. Which of the following will increase the resolution of the chromatogram and separate the peaks? Explain why or why not for each.
      i. Increase the temperature that the column runs at.

      ii. Increase the concentration of the mixture

      iii. Decrease the pressure at which the column runs at.

      iv. Increase the length of the column.

3. Consider the structural formula of aspartic acid (M=133 g/mol) shown below.
   a. Draw the zwitterion of aspartic acid in the box provided.



   b. A dipeptide formed from aspartic acid (M=133g/mol) and glutamic acid (M=147g/mol) is known as aspartylglutamic acid.
      i. How many possible isomers exist of aspartylglutamic acid? _____

      ii. Draw each isomer in the space provided below.

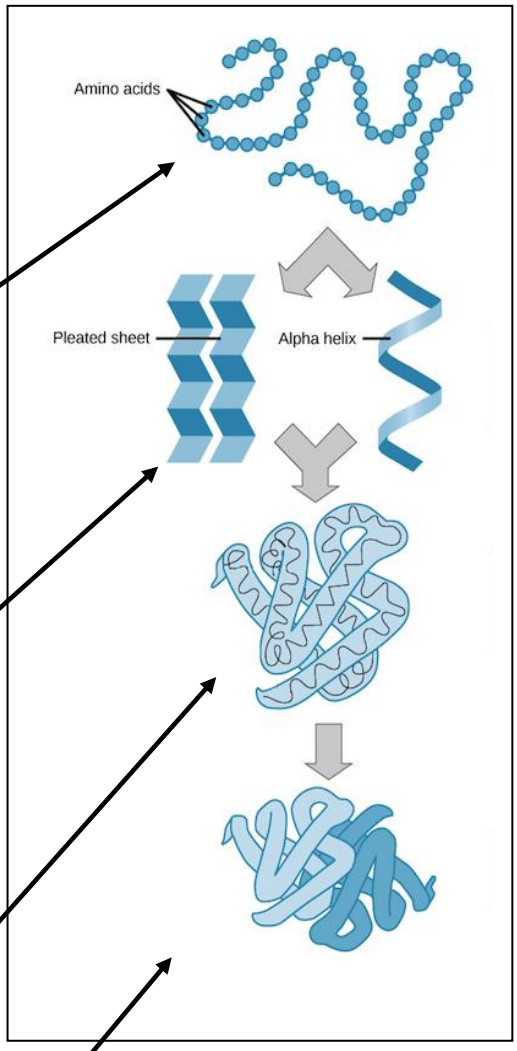
      iii. Give the molar mass of aspartylglutamic acid? _____

      iv. Give structural formula of the zwitterionic state of the dipeptide at the pH specified in the boxes below.

At the isoelectric point	At pH 12.5

4. The number of carbon-to-carbon double bonds (C=C) in a molecule can be identified by reacting the molecule with bromine (Br_2) solution. Four unknown acids are to be identified. A 10.0 g sample of one of the fatty acids listed below was dissolved in an appropriate solvent and titrated with 3.100 M Br_2. An average titre of 42.50 mL was obtained. Identify the acid. Show all calculations.
   i. oleic acid (M = 282 g mol^{-1}).
   ii. linolenic acid (M = 278 g mol^{-1}).
   iii. arachidic acid (M = 312 g mol^{-1})
   iv. arachidonic acid (M = 304 g mol^{-1}).

5. Consider the following structures shown on the right.
   a. To what group of foods do these structures belong to? _____
   b. Complete the box relating to each structure.



Type of structure _____

Type of bonding forming this structure and functional groups involved.

_____
_____
_____

Type of structure _____

Type of bonding forming this structure and functional groups involved.

_____
_____
_____

Type of structure _____

Type of bonding forming this structure and functional groups involved.

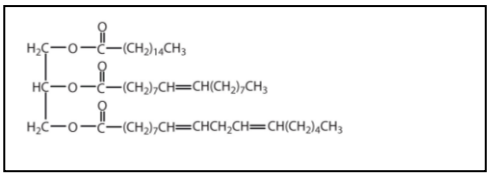
_____
_____
_____

Type of structure _____

Type of bonding forming this structure and functional groups involved.

_____
_____
_____

6. Consider the molecule shown on the right.



   a. To what class of organic compounds does this molecule belong to.

      _____

   b. Excluding the C=C, circle and name another functional group shown in the structural formula. _____

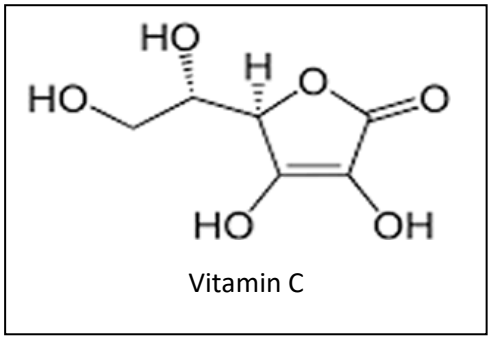
   c. Name the products expected from the complete hydrolysis of this molecule.

   d. Name the essential fatty acid that is formed from the hydrolysis of organic molecule.

   e. To what class of fatty acid does the essential fatty acid given in question d. belong to?

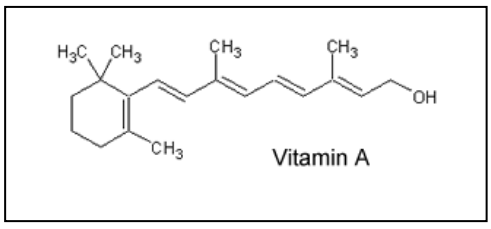
   f. Which one of the products given in c. is most likely to undergo rancidity? Explain.

   g. Vitamin C is said to be an anti-oxidant, capable of slowing down the process of rancidity. Explain how vitamin c slows down the process of rancidity.



Vitamin C

   h. Consider the structure of vitamins A and C.

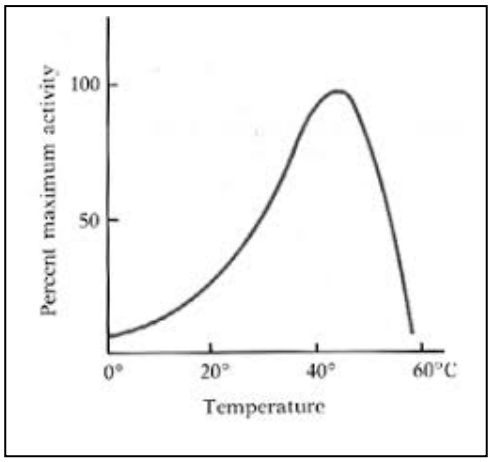


Vitamin A

      i. Which vitamin is most likely to be stored in the lipid tissue of animals? Explain

      ii. Which vitamin is most likely required to be ingested daily? Explain.

7. The activity of an enzyme is shown by the graph on the right.



   a. What is the optimum temperature at which this enzyme functions. _____

   b. Explain why the activity of the enzyme is very low at temperatures around 20°C.

   c. When asked why the activity of the enzyme falls away at temperatures above 40°C a student wrote " The enzyme denatures though hydrolysis at temperatures above 40°C"
      i. Is the student correct? _____
      ii. Explain the difference between "***hydrolysis"*** and ***"denaturing"***

_____
_____
_____
_____

   d. With reference to the "***active site***" explain how enzymes act as organic catalysts for <u>specific</u> chemical reactions.

_____
_____
_____
_____
_____
_____
_____

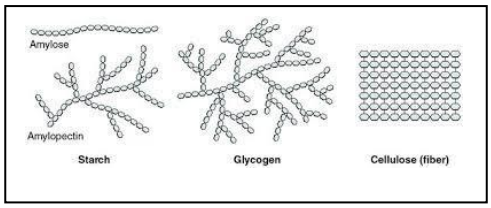
   e. Explain with reference to the "***secondary***" and "***tertiary"*** structures of a protein, why enzymes have a very narrow pH range in which they perform at an optimum level. Refer to the type of bonds involved and how they are impacted by pH.

_____
_____
_____
_____
_____
_____
_____

   f. State three differences between an enzyme and a co-enzyme.

_____
_____
_____
_____

8. Consider the four polysaccharides shown on the right.



   a. How are glycogen and amylose similar?

   _____
   _____
   _____

   b. Name one similarity between cellulose and amylose.

   _____
   _____
   _____
   _____

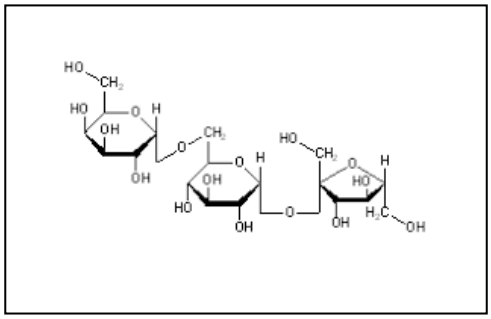
   c. Name one difference between amylose and cellulose.

   _____
   _____
   _____

   d. Explain, with reference to the chemical structure of the polymer, why a plant food high in amylopectin is considered to be "high GI" where as a plant food high in amylose content is considered "low GI.

   _____
   _____
   _____

   e. Raffinose is an oligosaccharide formed from three monosaccharides.



      i. If one of the monosaccharides is galactose, name the other two.

      _____
      _____

      ii. Circle and name the functional group linking each monosaccharide to the molecule. _____

      iii. Explain the difference between the hydrolysis of raffinose and the metabolism of raffinose with reference to the:
      - products formed
      - type of bonds involved.

      _____
      _____
      _____
      _____
      _____
      _____
      _____

9. Consider the following statements.
   i. Formation of a dipeptide
   ii. Formation of a triglyceride
   iii. Water is a reaction product.
   iv. Glucose is formed from glycogen.

   State if the comments below are true of false. Give a reason.

   a. Statement i. is an hydrolysis reaction with the expulsion of a water molecule.

   _____
   _____
   _____
   _____

   b. Statement ii. is an esterfication reaction with the expulsion of a water molecule.

   _____
   _____
   _____
   _____

   c. Statement iv. is an hydrolysis reaction where water is a reactant.

   _____
   _____
   _____
   _____

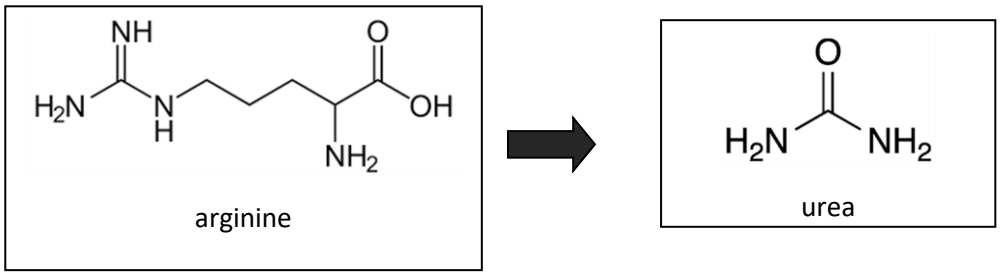
   d. Statement iii. is relevant to the formation of cellulose from beta-glucose.

   _____
   _____
   _____
   _____

   e. Statement iv. involves a polymerisation reaction

   _____
   _____
   _____
   _____

10. Gluconeogenesis is a metabolic pathway that converts amino acids into glucose in times of stress where the body needs glucose to maintain blood sugar levels or energy demands. This process occurs predominantly in the liver. Excess nitrogen , from the breakdown of amino acids, is removed from the body in the form of urea, which is less toxic than ammonia.



arginine urea

a. What mass, in grams, of urea (60.1 g/mol) is produced from 0.123 grams of arginine (174.2 g/mol)

b. How many chiral carbons does arginine have?