Revision of organic and digestion.

Some questions may have appeared in previous VCAA exams.

1)The equation on the right is an example of what type of reaction?

$$HCOOH(l) + CH_3OH(l) \xrightarrow{H^+} HCOOCH_3(l) + H_2O(l)$$

A. condensation
B. denaturation
C. hydrolysis
D. addition

2) Pentane, hexane, heptane and octane are non-branched alkanes. Which one of the following statements gives a valid comparison?

A. Octane has a greater viscosity and a higher boiling point than hexane.
B. Pentane has a greater viscosity and a lower boiling point than octane.
C. Heptane has a lower viscosity and a higher boiling point than octane.
D. Heptane has a lower viscosity and a lower boiling point than pentane.

3) The semi-structural formula for an isomer of $C_5H_{13}NO$ is $NH_2CH_2CH_2CH(CH_3)CH_2OH$ The correct systematic name for this molecule is

A. 4-amino-pentan-1-ol
B. 4-amino-2-methyl-butan-1-ol
C. 4-hydroxy-3-methyl-butan-1-amine
D. 1-hydroxy-2-methyl-4-amino-butane

4) A meal containing a mixture of carbohydrates, fats and protein is eaten. The biomolecules in this meal are broken down into smaller molecules in the body before they can be absorbed. Which of the following summarises the chemical reactions that would occur prior to the smaller molecules being absorbed by the body?

	Type of reaction	H_2O is a reactant	Possible product
A.	hydrolysis	yes	glycine
B.	condensation	yes	glycogen
C.	hydrolysis	no	glucose
D.	condensation	no	glycerol

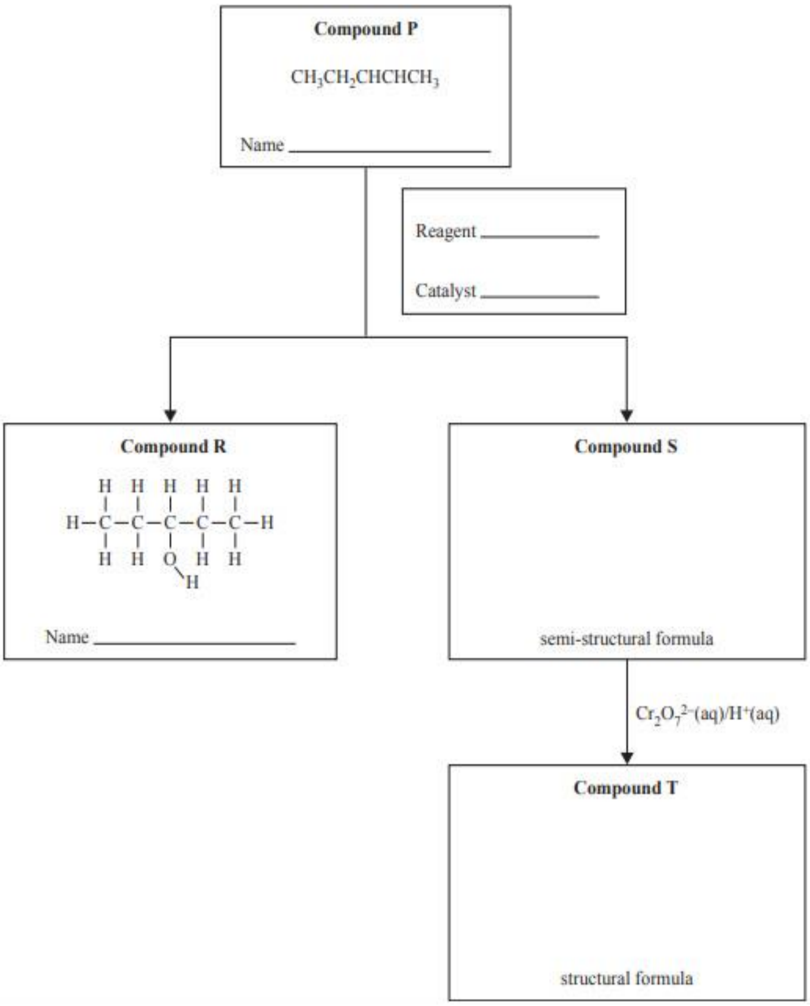
5) Alkenes can be used to manufacture a range of products. The reaction pathway diagram below represents one example of the use of an alkene. In this reaction pathway, Compound P is used to produce Compound R and Compound S. Compound S can then be used to produce Compound T. Complete the following in the appropriate boxes in the reaction pathway diagram provided.

a. Give the IUPAC systematic names for Compound P and Compound R.

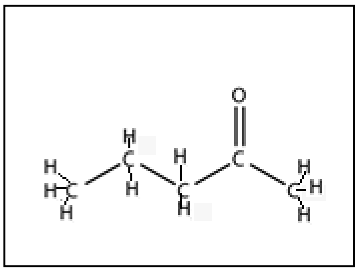
b. Write the formulas of the reagent and the catalyst required to produce Compound R and Compound S from Compound P.

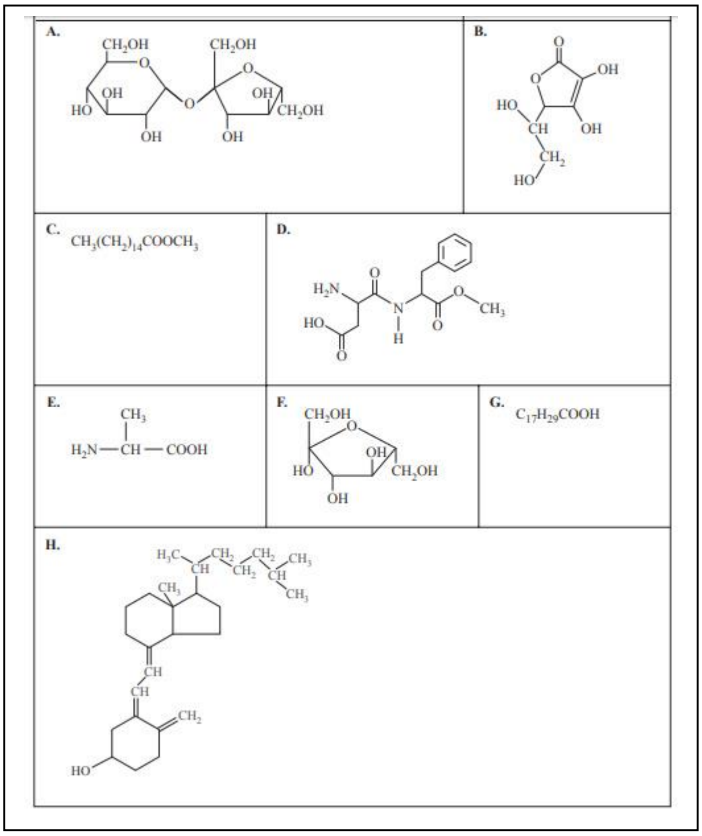
c. Write the semi-structural formula of Compound S.

d. Draw the structural formula of Compound T



$CH_3CH_2CH_2CHOHCH_3$





6) The structures or formulas of a number of important biomolecules are shown on the left. In the table below, for each of the following characteristics of biomolecules, write the letter or letters in the space provided for the corresponding biomolecule or biomolecules shown on the left. Each biomolecule may be used more than once or may not be used at all.

Characteristic	Biomolecule letter(s) (A.–H.)
contains a glycosidic linkage	*A*
is a product of fat digestion in the human digestive system	*G*
is soluble in water (give letters for **two** examples)	*Any two of A, B, D, E, F*
is able to form a zwitterion	*D, E*
contains an ester linkage (give letters for **two** examples)	*C, B, D*
can be a key constituent of biodiesel	*C*
has phenylalanine as a component	*D*
is likley to be stored in fat tissue within the body.	*H*

7) Enzymes are crucial for the reactions involved in the metabolism of food in the human body. Even when conditions vary in the human body, there are enzymes that function to ensure the chemical reactions needed to sustain life take place. In the digestive tract, there is a variation in pH. The stomach can have a pH in the range of 1 to 4, while in the intestines, the pH can vary from 5 to 7. Describe the tertiary structure of enzymes and explain the chemistry that enables enzymes to function in different parts of the digestive tract. Your response should:

• describe the chemical bonding that enables the tertiary structure to be maintained
• comment on the significance of chemical bonding to the correct functioning of the enzyme
• explain how the enzyme chemically interacts with the substrate. Diagrams may be used to support your answer.

The tertiary structure is made by the folding and twisting of the primary and secondary structures into shapes held in place by specific interaction between various Z-group residues. The actual bonding present will depend on the amino acids present in the primary structure. For example:

• covalent bonds can form between Cys and Met, Cys and Cys residues
• ionic bonds can form, depending on pH (between Asp and Asn)
• hydrogen bonds can form (between His and Thr).

This bonding is significant to the tertiary structure which in turn is significant to the function of enzymes by maintaining the shape of the active site.

The shape of the active site, which is where the reaction occurs, is crucial to the function of the enzyme. It is shaped in such a way that the substrate 'fits' into the active site and attaches so that the reaction can occur.

The tertiary structure of the enzyme is crucial for this. Interaction between the substrate and enzyme

• 'Attach' at the active site. The substrate interacts with the active site of the enzyme. The bonds that form are electrostatic in nature and include ion-ion, dipole-dipole, hydrogen bonding or ion-dipole

The active site changes its shape slightly as a result of its interaction with the substrate to better fit the substrate. This is known as the induced fit model.

8) The carbohydrate in a cereal is mainly cellulose with a small amount of starch.

i. Name the monosaccharide unit that makes up both cellulose and starch molecules in the cereal.

Glucose

ii. A small section of the label on the cereal pack is shown on the right. It clearly mentions the mass of the carbohydrates per 100 g of cereal.

What is the total amount of energy available to the person who consumes 250 grams of the cereal?

Total Carbohydrate 22g	
Dietary Fiber 13g	
Sugar 4.4g	

Cellulose is a polysaccharide that is not available as an energy source to humans. It usually forms the indigestible fibre present in our diet.

Hence for every 100 g of cereal we have 22 - 13 = 9.0 grams of usable carbohydrates.

For 250 grams of cereal we have 2.5 X 9.0 = 22.5 g of useable carbohydrate.

From the data book we see that carbohydrates contain 16 kJ of energy per gram.

Total energy available from carbohydrates = 16 X 22.5 = 3.6×10^2 *kJ.*

iii. Explain the difference between dietary fibre and sugar?

Sugar or sucrose is a disaccharide of glucose and fructose that can be hydrolysed by enzymes in the body. Cellulose is a polysaccharide formed by beta glucose that cannot be digested by the human body. Cellulose is a structural polymer whereas sugar is used as an energy store by plants.

iv. Why is dietary fibre and sugar placed under the heading "Total Carbohydrates"?
Both sugar and cellulose are formed from smaller monosaccharides via the formation of glycosidic links. They both are classified as carbohydrates.

9) Tristearin(molar mass 891.48 g/mol), a triglyceride, is the primary fat found in beef and it contains stearic acid as the only fatty acid. 5.00 g of a pure sample of tristearin is completely broken down into its component molecules

a) Name the type of reaction that occurs during the digestion of tristearin and the products of this reaction.
Hydrolysis

b) The enzyme breakdown of tristearin involves a small molecule. What mass of this small molecule needs to be supplied to break down 5.00 grams of tristearin?
Since tristearin is a triglyceride it is formed by glycerol being bonded to three fatty acid molecules of stearic acid via three ester bonds.
A water molecule is required to break each ester bond in the triglyceride. Hence the word equation is such
tristearin + 3water → 3stearic acid + glycerol.
=> Mol of tristearin = 5.00 / 891.48 = 5.61×10^{-3}.
=> mol of water required is therefore 3 X $5.61 \times 10^{-3} = 1.68 \times 10^{-2}$
=> mass of water = 18.0 X 1.68×10^{-2} = 0.303 grams

10) A 20.00 mL sample of an unlabelled solution of glutamic acid ($C_5H_9NO_4$) was pipetted into a 200 mL volumetric flask and filled to the mark with distilled water. Five 20.00 mL samples of the solution in the volumetric flask were placed in 5 separate conical flasks and titrated against a 0.100 M NaOH solution. The average titre obtained was 14.56 mL .

a) Write a balanced chemical equation for the reaction between glutamic acid and NaOH?

   Since glutamic acid has two carboxyl groups (COOH) then it is a diprotic acid and as such two NaOHs will react to form water and a salt (sodium glutamate)

   $C_5H_9NO_4(aq) + 2NaOH \rightarrow Na_2O_4NH_7C_5\ (aq) + 2H_2O(l)$

b) Calculate the mol of glutamic acid in the conical flask.
   => mol of NaOH delivered in an average titre = 0.100 X 0.01456 = 1.456×10^{-3}
   => mol of glutamic acid = ½ X $1.456 \times 10^{-3} = 7.28 \times 10^{-4}$

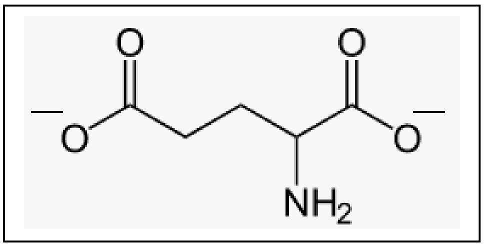
c) Calculate the mol of glutamic acid in the volumetric flask.
   => 200/20 X $7.28 \times 10^{-4} = 7.28 \times 10^{-3}$

d) Calculate the concentration, in %w/v, of glutamic acid (molar mass 147.13 g/mol) that should be placed on the bottle of the original sample of glutamic iced.

e) *Mass of glutamic acid in the 20.00mL original sample*
=> $7.28 \times 10^{-3} \times 147.13 = 1.07$ g
=> (1.07g / 20.00 mL) X 100 = 5.35%

f) Is the equivalence point for the completion of the titration between glutamic acid and NaOH, above pH 7 , below pH 7 or pH 7? Justify your answer.

When the reactants are mixed in the correct stoichiometric ratio what is left in solution is the doubly negative charged molecule shown on the right and of course water.



This molecule will react with water to produce OH^-

and create an alkaline solution.