ALL SAINTS' COLLEGE

Science Department

Year 12 Chemistry ATAR

Organic Synthesis 2018

Name: Answers

Instructions to Students:

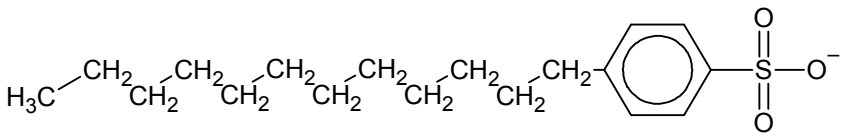
1. 50 minutes permitted
2. Attempt all questions
3. Write in the spaces provided
4. Show all working when required
5. All answers to be in blue or black pen, diagrams in pencil.

Multiple Choice	Short Answer	TOTAL
/10	/50	/60

Final Percentage

Multiple choice

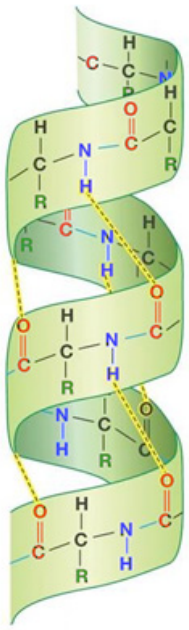
1. The molecule below is a common detergent - the production of which is specifically named in your year 12 syllabus.



The correct name is:

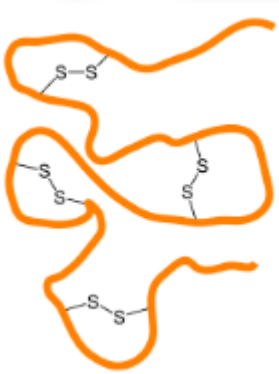
a. Sodium stearate
b. Benzene sulfonate ion
c. Dodecylbenzene sulfonate
d. Dodecylbenzene stearate

2. The diagram below depicts:



a. An alpha helix, tertiary structure
b. An alpha helix, secondary structure
c. A beta pleated sheet, secondary structure
d. A beta pleated sheer, tertiary structure

3. The diagram shown depicts



a. Covalent sulfur links
b. Elastomer linkages
c. A silk fibre
d. Disulphide bridges

4. Which of the following is NOT a principle of green chemistry

a. Real-time analysis for pollution prevention

b. Land rights

c. Less hazardous chemical syntheses

d. Catalysis

5. Which of the following substances could not be used to produce a viable amount of soap from a vegetable oil?

a. Sodium hydroxide

b. Potassium hydroxide

c. Lead Hydroxide

d. Barium Hydroxide

6. Biodiesel can be produced from a triglyceride using either a base catalysed or lipase-catalysed process. An advantage of using the lipase method is:

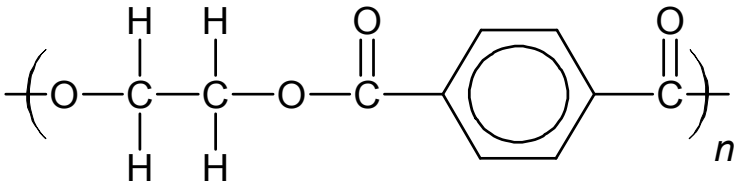
a. It is a batch process

b. Fresh catalyst must be regularly supplied

c. It operates at ambient temperatures

d. It has a high operating cost.

7. The polymer shown below is known as:



a. High Density Polyethene (HDPE)

b. Poly-paraphenylene terephthalamide (Kevlar)

c. Polyethylebenzoic acid

d. Polyethylene terephthalate (PET)

8. A polymer that can be melted and recast into a new shape is known as a:

a. Thermoplasic

b. Polymorphic plastic

c. Thermoset

d. Elastomer

9. A characteristic property of polytetrafluoroethene (PTFE) is:

a. It has the lowest coefficient of friction known
b. It has the greatest ability to stretch
c. It has an incredibly high heat resistance
d. It is incredibly resistant to wear and abrasion

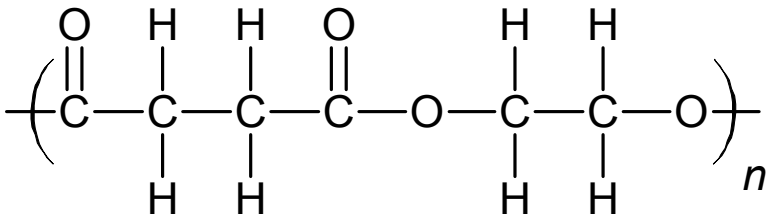
10. In the micelle that is created when soap dissolves in water:

a. The hydrophobic heads repel each other to form a sphere.
b. The hydrophobic portions of the molecule bond with dipole-dipole forces.
c. The hydrophilic parts of the molecule are attracted to each other.
d. The charged ionic portions of the molecule interact with water.

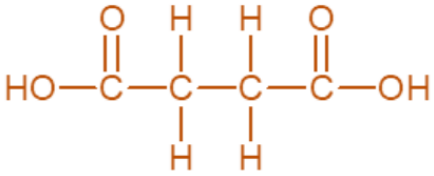
Short Answer

1. Give the structure of the monomers used to form the following polymers. You must also list any **by-products** formed in the reaction and you must state the **type of polymerization**. Finally, provide a possible **use** of the polymer.

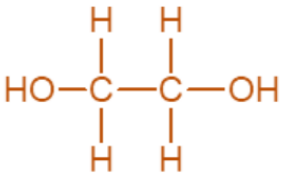
a)



Monomers



butanedioic acid



ethane-1,2-diol

By-product (if any)

Water

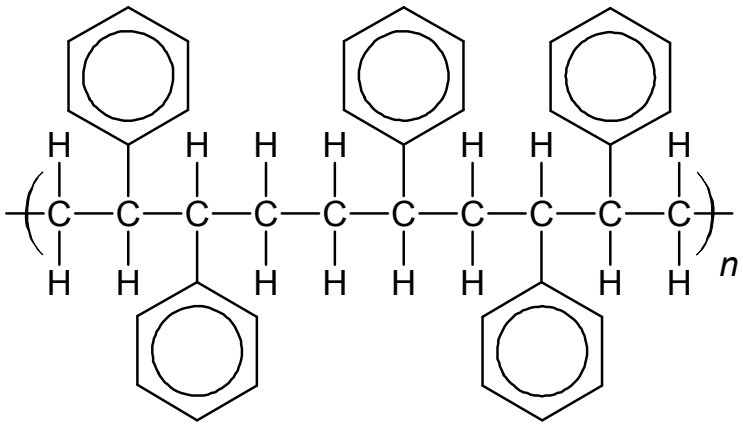
Polymerisation type

Condensation

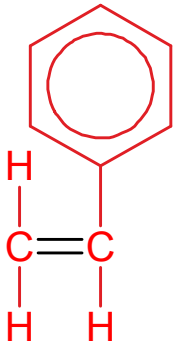
Use

Fibres for clothing, ropes, yarns

b)



Monomers



By-product (if any)

None

Polymerisation type

Addition

Use

A few of the most familiar **uses** of styrene include: Solid and film **polystyrene**, used in rigid foodservice containers, CD cases, appliance housings, envelope windows and many other products. **Polystyrene**foam, used in food service products and building insulation.

[9 marks]

2. Green chemistry is the utilisation of a set of principles that reduces or eliminates the use or generation of hazardous substances in the design, manufacture and application of chemical products. There are 12 main principles, for the three specified below provide an explanation as to how the principle provides a benefit.

(a) **Atom Economy**

Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product. Everything that goes in, comes out as the desired product – less wastage and harmful chemicals released into the environment.

(b) Reduce Derivatives

Unnecessary derivatisation should be minimized or avoided if possible, because such steps require additional reagents and can generate waste (i.e. keep the overall process as simple as possible). Less harmful chemicals used or released into the environment.

(c) Design for Degradation

Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.

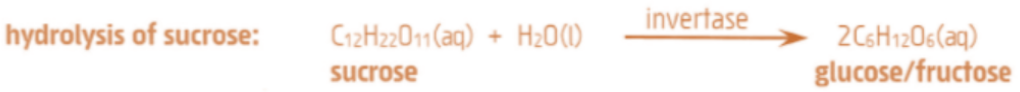
[6 marks]

3. Biofuels like bioethanol and biodiesel are produced from biomass and are considered fossil fuel alternatives. Although their current contribution to total global fuel requirements is small their production is predicted to double by 2025 from 2012 levels.

Replacing petroleum fuels with biofuels is consistent with the principles of green chemistry and a sustainable chemical industry for a number of reasons.

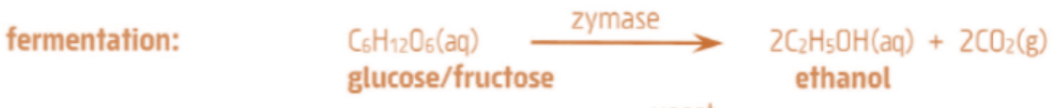
Bioethanol is produced from biomass such as sucrose ($C_{12}H_{22}O_{11}$)

(a) Show a balanced reaction of the hydrolysis of sucrose to glucose ($C_6H_{12}O_6$).



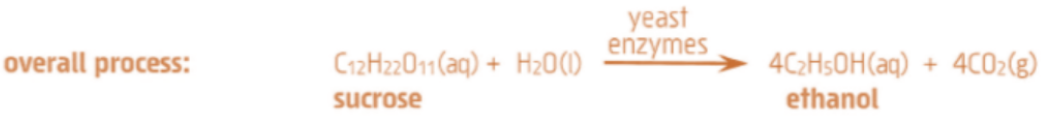
[2 marks]

(b) Show the fermentation of glucose to ethanol



[2 marks]

(c) Show the overall equation for the conversion of sucrose to ethanol.



[2 marks]

(d) What are two advantages in using bioethanol as a fuel to ethanol produced via another method that you have studied?

i. It is carbon neutral – carbon consumed in the production of the biomass is expelled when the fuel is burned.

ii. Burns cleaner, with less particulate emissions

[2 marks]

(e) Show the equation for the production of ethanol from ethene.

$$CH_2CH_2(g) + H_2O(g) \rightleftharpoons CH_3CH_2OH(g)$$

[2 marks]

(f) Why is this process not considered a “green” source of ethanol?

The ethene required comes from **crude oil** which is a non-renewable source.

[1 mark]

(g) What are the advantages of this method?

It is faster or produces more as it is not a batch process.

[1 mark]

4. (a) Suggest a reason why soaps are more effective in suburban Perth than they are on a cattle station in the Pilbara where household water is obtained from a bore.

Bore water is high in dissolved calcium or magnesium salts.

[1 mark]

(b) When 1 mL of a soap solution was added to each litre of hard water, the water would not lather and it had poor detergent qualities. When 10 mL of the soap solution was added to each litre, the resultant solution cleaned clothes effectively. Explain these observations.

When 1mL of soap is added, the calcium and magnesium and magnesium salts form a precipitate with the soap rendering is unable to function as a surfactant.

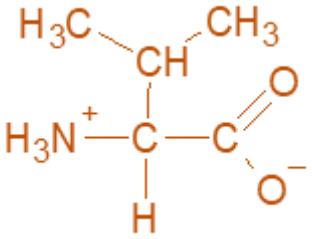
A larger volume of soap means that the calcium and magnesium ions are removed from the solution as a precipitate, meaning that additional soap particles can function as intended.

[2 marks]

4. Valine is an alpha amino acid that can exist as a Zwitterion under different pH conditions.

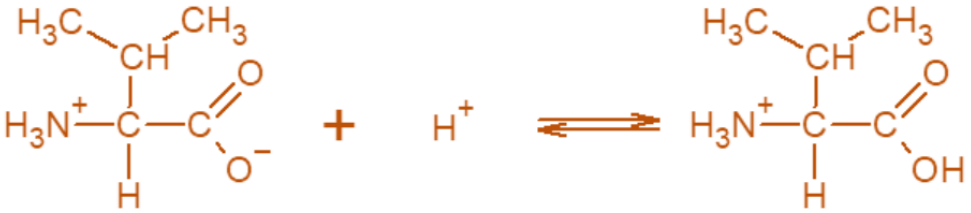
(a) Using your data sheet, draw a full structural diagram of the zwitterion form of valine.

[1 mark]



(b) Show the ionic equation of valine reacting with hydrochloric acid.

[2 marks]

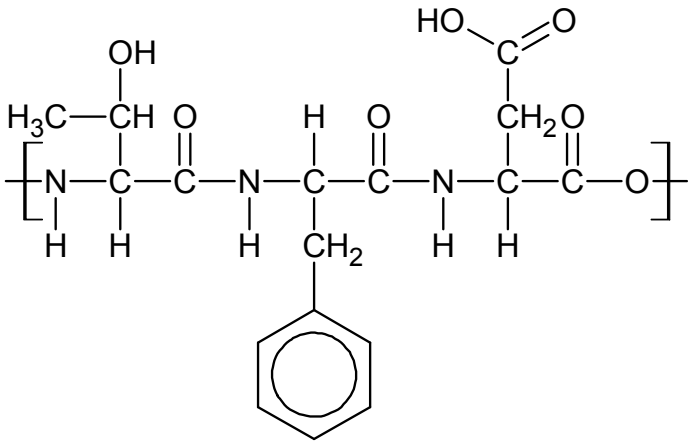


(c) Show the ionic equation of valine reacting with sodium hydroxide.

[2 marks]

5. Proteins are formed when amino acids are combined.

(a) The structure below represents a portion of a protein molecule



Using your data sheet, give the **names** of the amino acids involved in creating this portion of the protein.

One: Theronine

Two: phenylalanine

Three: aspartic acid (Abbreviations not accepted – names asked for)

[3 marks]

(b) The most important level of organisation in a protein is the **tertiary structure** – the 3D shape. The overall tertiary shape may be long and narrow (fibrous proteins) or a roughly globular shape (such as enzymes). There are five types of **interactions** in determining the tertiary structure.

Using the three amino acids shown in the picture above, name and describe **three (3)** of the interactions that will determine the tertiary structure of a protein.

(d) Hydrogen bonding

The Theronine has an -OH group. The difference in electronegativity between O and H creates a hydrogen bounding donor site. This causes H-D interactions between chains of the protein.

(e) Dispersion forces

The phenylalanine has a large benzene ring. The large number of elections in this structure will mean high dispersion forces are present, which can cause significant chain interaction between similar structures in the protein.

(f) Ionic interactions

The aspartic acid can ionize to form a carboxylate ion. This charged part of the molecule can then interact via ionic, or ion-dipole interactions with parts of the protein chain, contributing to tertiary structure.

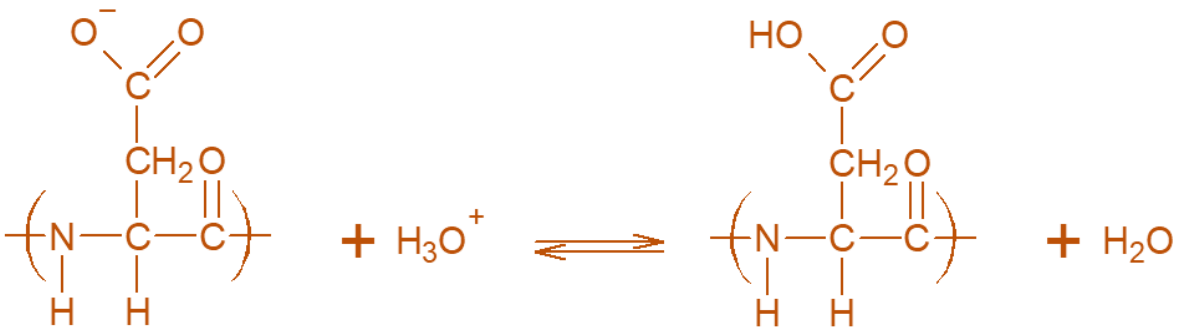
[9 marks]

(c) The portion of the protein given in the diagram will denature in environments where the pH is low. Using your knowledge of chemistry and the interactions that happen at the tertiary level of protein structure, explain this observation. (a diagram may aid your explanation).

The carboxylic acid on the aspartic acid would interact at the tertiary level with ionic (or ion dipole) interactions.

In an acidic environment, the conjugate base portion of the molecule ($-COO^-$) would accept a proton reforming the weak acid. This would disrupt the tertiary structure and cause the protein to denature.

[3 marks]



End of Test