Marking Scheme and Outcomes

Chemistry

HSC Course
Production of Materials
Theory Test • 2002

Assessment Weighting – 4%

Total Marks – 24

Working Time – 40 minutes

		OUTCOMES														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
QUESTION	1									•						
	2									•						
	3								•	•						
	4							•						•		
	5							•			•			•		
	6									•						
	7								•	•						
	8									•						
	9								•	•				•		
	10							•	•					•		

Part A – Answer Box for Questions 1 – 4

1	**A** ◎	**B** ○	**C** ○	**D** ○
2	**A** ○	**B** ○	**C** ○	**D** ◎
3	**A** ◎	**B** ○	**C** ○	**D** ○
4	**A** ○	**B** ◎	**C** ○	**D** ○

1 Which of the following lists contains only condensation polymers*?*

(A) cellulose, protein, starch
(B) cellulose, polyvinyl chloride, polyethylene
(C) polystyrene, starch, protein
(D) polyvinyl chloride, polyethylene, polystyrene

2 Which of the following defines the term *cracking* used in the petrochemical industry*?*

(A) addition of hydrogen to a compound
(B) preparation of a polymer from a hydrocarbon monomer
(C) formation of saturated hydrocarbons from alkanes
(D) conversion of long chain hydrocarbons to shorter chain molecules

3 A mixture of ethanol and ethylene is heated with concentrated sulfuric acid in a closed container and a reaction occurs. What is the likely outcome*?*

(A) more ethylene forms
(B) more ethanol forms
(C) CO_2 and H_2O form
(D) butane forms

4 In which of the following equations is the species printed in **bold** type being reduced*?*

(A) $3Zn^{2+} + 2\mathbf{Al}_{(s)} \rightarrow 3Zn_{(s)} + 2Al^{3+}$
(B) $2Br^- + \mathbf{Cl_2}_{(g)} \rightarrow Br_{2\,(l)} + 2Cl^-$
(C) $2H^+ + \mathbf{Mg}_{(s)} \rightarrow Mg^{2+} + H_{2\,(g)}$
(D) $2H_2O_{(l)} + 3I_2 + 2\mathbf{S_2O_3}^{2-} \rightarrow S_4O_8^{2-} + 4H^+ + 6I^-$

Part B – 20 marks

Question 5 (4 marks)

Three groups of students set out to determine the heat of combustion of the three alkanols… methanol, CH_3OH; ethanol, C_2H_5OH; and 1–propanol, C_3H_7OH.

Each group measured out 100 mL of water into a container and heated the water by burning a measured mass of alcohol. Their results are shown below…

Alcohol burned	Mass of H_2O heated (g)	Temperature rise (°C)	Mass of alcohol burned (g)	Heat of Combustion (kJ mol^{-1})
methanol	100	10	0.185	725
ethanol	100	10	0.142	
1–propanol	100	10	0.125	2016

(a) Given that 4.18 J are required to raise the temperature of 1.00 g of water by 1.00 °C, use the above data to determine the following values…

(i) Heat of combustion of ethanol in kJ g^{-1} **(1 mark)**

Heat of combustion (kJ/g) = – m C ΔT / mass ethanol
kJ/g = – (100g x 4.18 J/g/°C x 10°C) / 0.142 = **29.4 kJ/g**

(ii) Heat of combustion of ethanol in kJ mol^{-1} **(1 mark)**

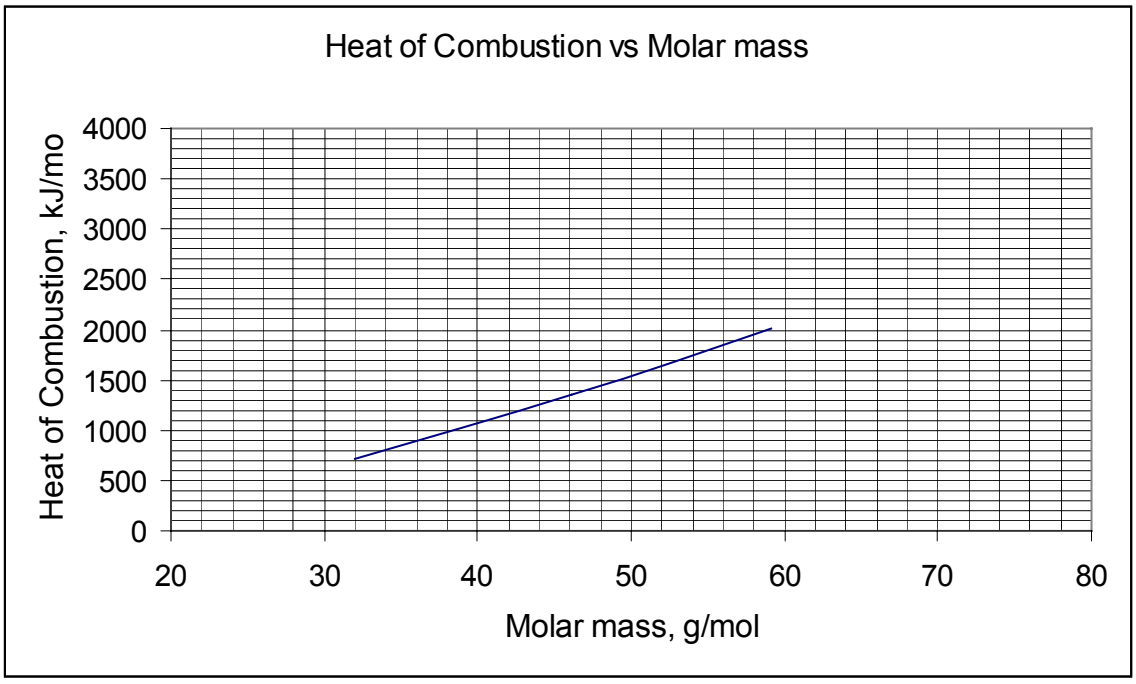
Heat of combustion = – m C ΔT / n
n = # moles of ethanol = (0.142g / 46.068 g/mol) = 3.08 x 10^{-3} mol
kJ/mol = – (100g x 4.18 J/g/°C x 10°C) / 3.08 x 10^{-3} mol = **1360 kJ/mol**

☞ *Heat of combustion is defined as the heat evolved, ∴ in this linguistic context a negative sign is not required, but will be accepted.*

Question 5 continues on page 4

Question 5 (continued)

(b) Plot the heat of combustion (kJ mol $^{-1}$) against molar mass for all three alkanols. Clearly label the axes. **(1 mark)**



(c) Use the graph to predict the heat of combustion of 1–butanol, C_4H_9OH in kJ mol $^{-1}$

Extrapolated value is about **2600 kJ/mol**

Criteria	Marks
Correct calculation of heat of combustion for the units specified	**2**
Graph drawn with the proper values on y - axis	**1**
Correct extrapolated value	**1**

Question 6 (5 marks)

(a) Give a balanced equation for the conversion of ethylene to ethanol including reaction conditions. **(1 mark)**

$$C_2H_4 + H_2O \rightarrow C_2H_5OH$$

Criterion	Mark
Correct equation including heating with catalyst of conc. H_2SO_4 or H_3PO_4	**1**

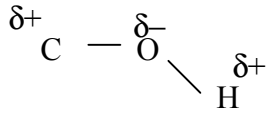
Question 6 continues on page 5

Question 6 (continued)

(b) Account for ethanol's extensive use as a solvent for polar and non-polar substances. Use a diagram to explain your answer. **(2 marks)**

Criterion	Marks
The answer should include a depiction of the molecular structure of ethanol and as a cause of the resulting charge polarization within the molecule to explain its ability to dissolve various types of substances.	**2**

Ethanol has both polar (the – OH) and non-polar,(the C_2H_5 –) parts. The polarity of the hydroxy group is due to the much greater electronegativity of oxygen compared with carbon and hydrogen. The non-polar ethyl group enables ethanol to dissolve non-polar substances such as hexane. Hence, ethanol is able to dissolve both polar and non-polar substances. The partial charges on the polar part of the molecule are…



Question 7

An electrochemical cell was constructed using two half-cells. One half-cell consisted of tin metal and a tin(II) chloride solution and the other half-cell consisted of zinc metal and zinc chloride solution**.**

- Draw a diagram of the galvanic cell.
- Label the anode and the cathode.
- Indicate the direction of electron flow.

Criterion	Marks
Correctly drawn diagram with labels	**2**
Correct direction of electron flow	**1**

Question 8

(a) Explain the term *biopolymer* **(1 mark)** and identify an example **(1 mark)**.

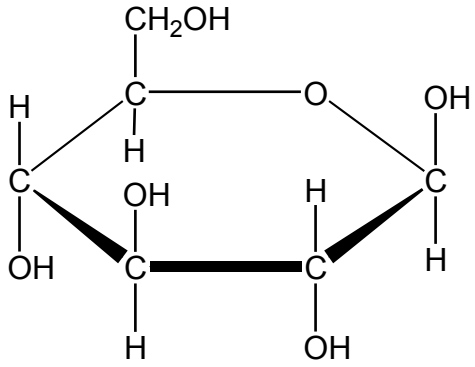
"Biopolymers are polymers that are made totally or in large part by living things." (Smith)
"Naturally occurring polymer generated using renewable resources like microorganisms or plants." (OTEN)
"A natural polymer." (Thickett)
"These are naturally occurring polymers such as cellulose, starch, and gluten..." (Syllabus Notes)

Examples… **cellulose, starch, protein, rubber, carboxymethyl cellulose (CMC), PLA, PHA or PHB (poly ß–hydroxyalkanoate), etc.**

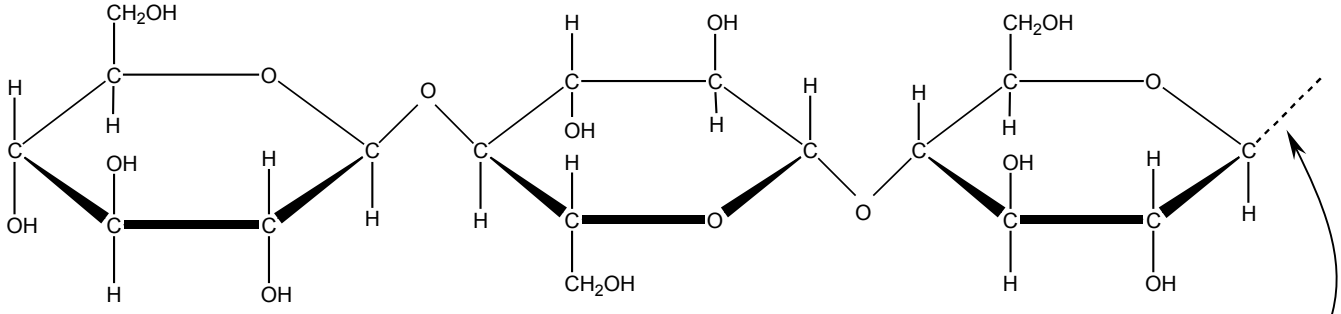
Question 8 continues on page 6

Question 8 (continued)

(b) Cellulose is a polymer of β–glucose. A β–glucose molecule is shown below….



Draw a segment of a cellulose molecule by joining three glucose molecules together. **(3 marks)**



One mark for showing three glucoses joined via the – O – linkage with suitable termination, e.g.

One mark for showing one – O – linkage up and one down.

One mark for showing the three – CH_2OH groups alternately up, down, up.

Question 9 (2 marks)

A student was asked to perform a first-hand investigation to compare the reactivities of hexane and hexene by observing their reactions with bromine water.

(a) Describe the reaction(s) observed by the student when the procedures were carried out in a darkened laboratory. **(1 mark)**

The hexene immediately decolourised the bromine water.

(b) Write an equation to show any addition reaction(s) that occurred. **(1 mark)**

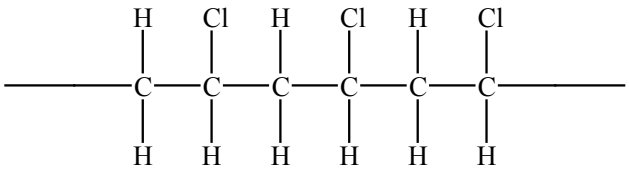
$CH_3CH_2CH_2CH_2CH = CH_2 \quad + \quad Br_{2\ (aq)} \quad \rightarrow CH_3CH_2CH_2CH_2CHBrCH_2Br$

☞ Production of bromohydroxyhexane is also acceptable.

Question 10 (3 marks)

Alkenes and their derivatives are important substances in the production of polymers.
Polyvinyl chloride (PVC) is one such polymer.

(a) Draw the structure of polyvinyl chloride showing three linked monomer units. **(1 mark)**



(b) Describe **one** use of polyvinyl chloride and a property which makes it useful for this purpose. **(2 marks)**

e.g. PVC can be used to make electrical conduit because it is an electrical insulator.
The presence of Cl atoms in the polymer make it flame resistant.

e.g. PVC is used for credit cards because it is a tough, rigid polymer.

Must relate property to usage for **two marks**.
Usage without related property gains **one mark**.
Property without specific use gains **one mark**.