Answers and Marking Scheme

Chemistry

HSC Course

Production of Materials

Theory Test • 2005

General Instructions

- Reading time – 5 minutes
- Working time – 50 minutes
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- A Data Sheet and a Periodic Table are provided
- Write your Student Number at the top of this page

Total Marks – 35

Part A – 5 marks
- Attempt Questions 1 – 5
- Allow about 5 minutes for this part

Part B – 31 marks
- Attempt Questions 6 – 10
- Allow about 45 minutes for this part

Part A – 5 marks
Attempt Questions 1 – 5
Allow about 5 minutes for this part

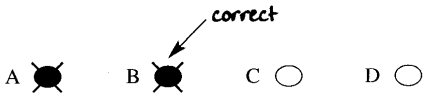
Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

A ○ B ● C ○ D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.



Answer Box for Questions 1 – 5				
1	A ○	B ◎	C ○	D ○
2	A ○	B ○	C ◎	D ○
3	A ○	B ◎	C ○	D ○
4	A ○	B ○	C ○	D ◎
5	A ◎	B ○	C ○	D ○

► ***Mark your answers for Questions 1 – 5 in the Answer Box on page 2.***

1 Which of the following is the most commercially significant addition polymer?

(A) cellulose
(B) polyethylene
(C) vinyl chloride
(D) starch

2 Equal volumes of bromine water were added to individual test tubes of cyclohexane and cyclohexene. Which of the choices in the table would be the likely result after the mixtures were shaken vigorously?

	Cyclohexane		*Cyclohexene*	
	Layer X	*Layer Y*	*Layer P*	*Layer Q*
(A)	colourless water layer	colourless organic layer	orange water layer	colourless organic layer
(B)	colourless water layer	orange organic layer	colourless water layer	colourless organic layer
(C)	darker orange organic layer	lighter orange water layer	colourless organic layer	colourless water layer
(D)	lighter orange organic layer	darker orange water layer	colourless organic layer	colourless water layer

3 What is the oxidation state of chromium in $Na_2Cr_2O_7$?

(A) 2 +
(B) 6 +
(C) 7 +
(D) 12 +

4 The molar heats of combustion of four alkanols are shown in the table…

	ΔH_c ($kJ\ mol^{-1}$)
methanol	726
ethanol	1367
2–propanol	2006
2–butanol	2661

Which alkanol produces the greatest amount of heat in kJ g^{-1} ?

(A) methanol
(B) ethanol
(C) 2–propanol
(D) 2–butanol

5 Which of the following metals would reduce manganese(II) ions in aqueous solution?

(A) magnesium
(B) zinc
(C) copper
(D) silver

Part B – 31 marks
Attempt Questions 6 – 10
Allow about 45 minutes for this part

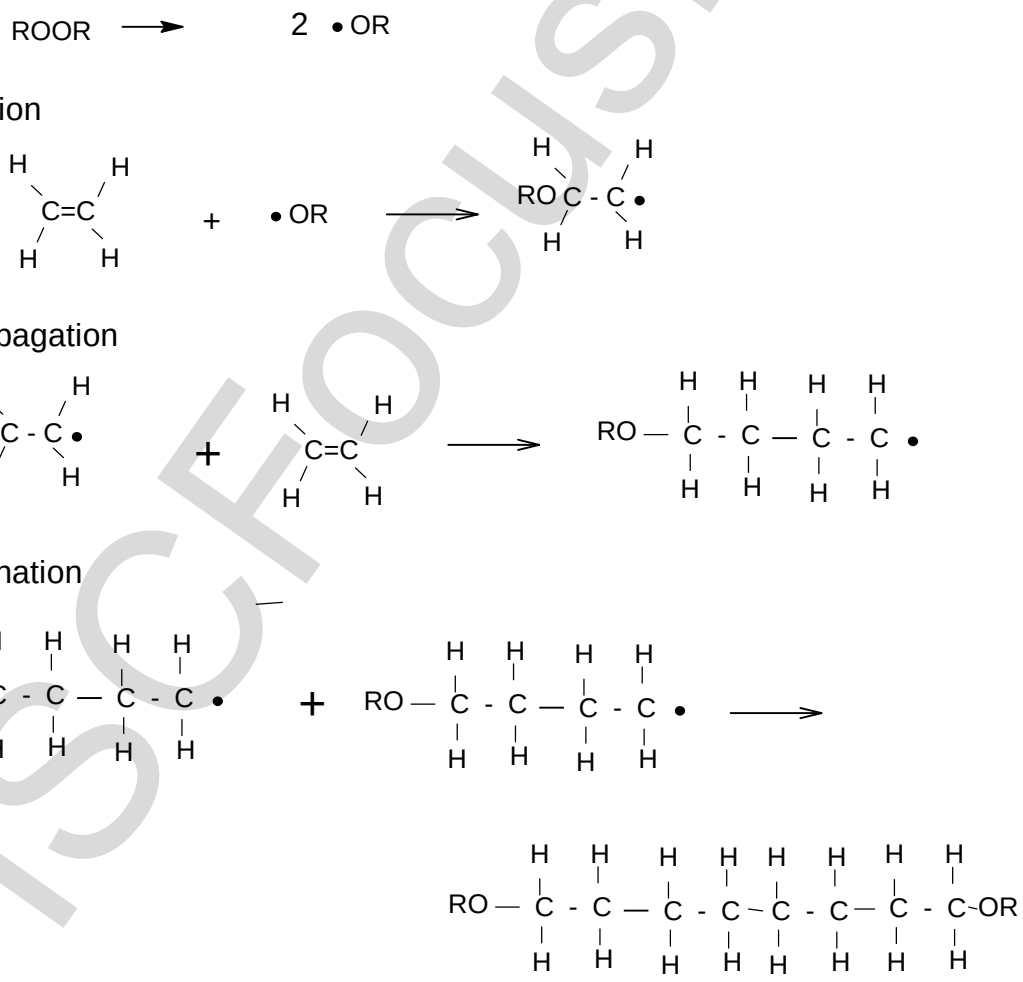
► ***Show all relevant working in questions involving calculations.***

Question 6 (3 marks)

The production of low density polyethylene from ethylene involves three major steps.

Outline the steps using relevant equations and structural formulae.

Possible Answer:



One mark for each step in the sequence.

Question 7 (10 marks)

(a) Traditional sources of petrochemicals are non-renewable and will run-out in the future. Alternative sources have been identified, such as cellulose.

Describe the structure of cellulose. **(2 marks)**

Cellulose is a condensation polymer composed of β-glucose monomers linked via carbons 1 and 4 of the glucose monomer. (1,4–glycosidic linkage) or a diagram of the cellulose polymer with a short description. OR via structural formula.

(b) Biopolymers are being developed for commercial use.

(i) Identify one such biopolymer. **(1 mark)**

e.g. *Poly(3-hydroxy butanoate) or Biopol*

(ii) Name the specific enzyme or organism used to synthesize the identified biopolymer. **(1 mark)**

e.g. *Alcaligenes eutrophus*

(iii) Describe a use for the identified biopolymer and relate it to its properties. **(2 marks)**

Since the polymer is biodegradable, it is suitable for single use applications such as liners for disposable nappies or packaging for hospital or medical supplies.

► *One mark for mentioning the property and one mark for the use.*

(c) Discuss the use of ethanol as a solvent. **(4 marks)**

Ethanol is used as a solvent for a variety of substances, both polar and non-polar. This versatility is due to its structure. Ethanol has a polar (– OH) and non-polar (C_2H_5 –) part. The polar, hydroxy group can interact with polar substances by dipole-dipole interaction or by hydrogen bonding with hydroxylated substances such as water or other alkanols. The non-polar, ethyl group can interact with non-polar substances such as hexane.

► General characteristic as a solvent. – 1 mark

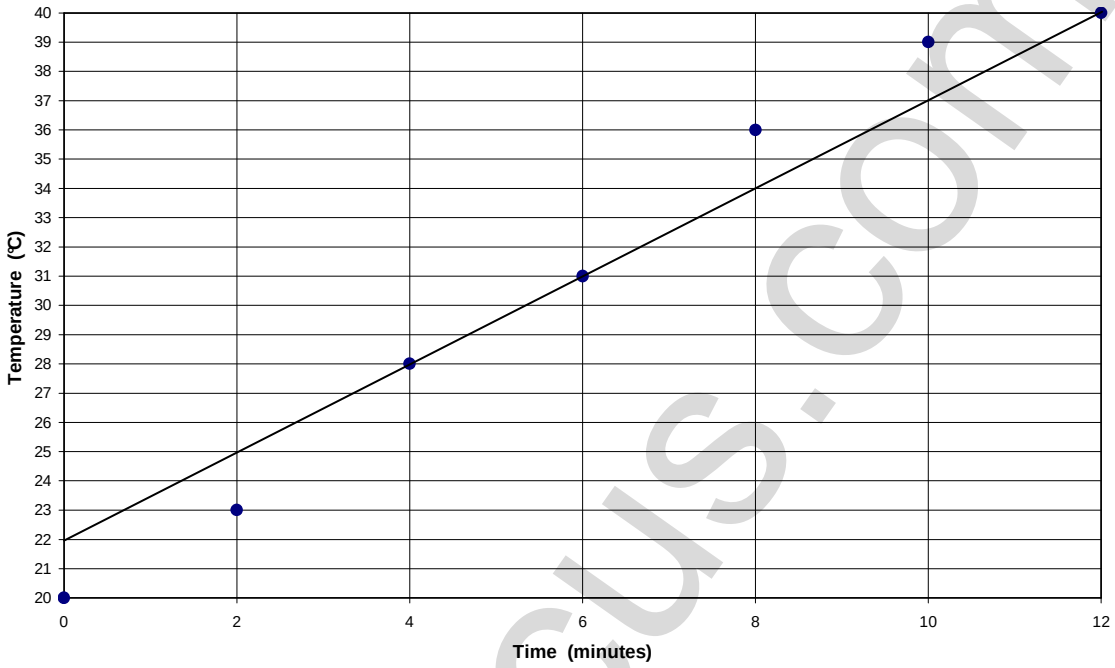
► Structure of ethanol and characteristics as a solvent. – 1 mark

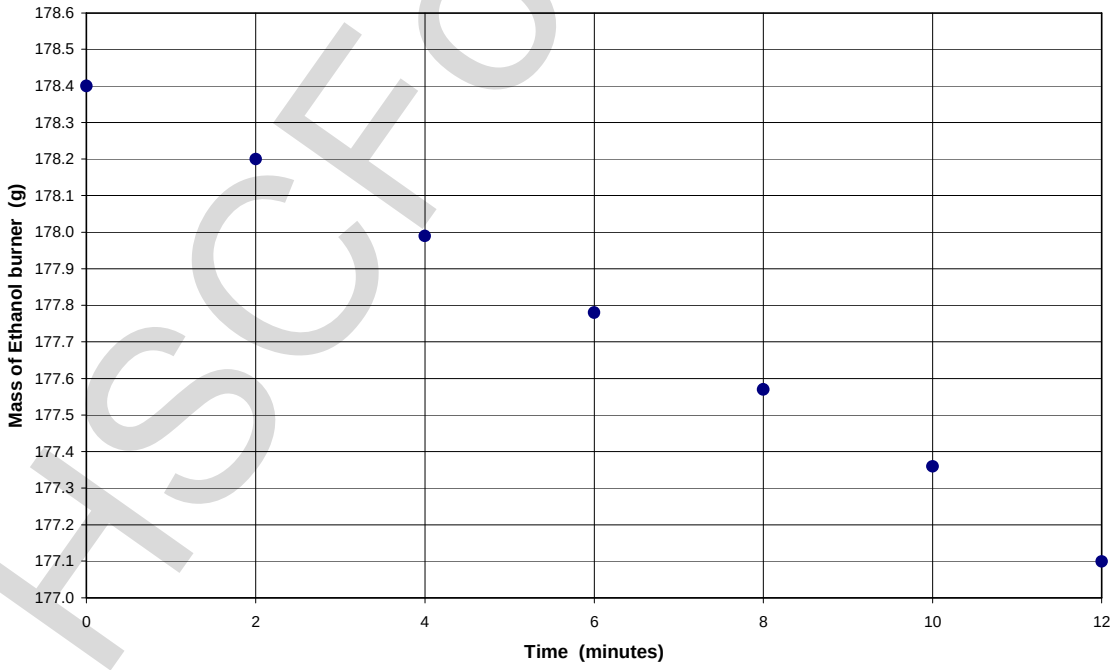
► How the polar part aids in dissolving polar substances. – 1 mark

► How the non-polar part aids in dissolving non-polar substances. – 1 mark

Question 8 (6 marks)

Heidi performs a determination of the heat of combustion for ethanol using a simple calorimeter containing 300 mL of water. She takes water temperature and fuel mass readings every two minutes using a data logger. The graphs show her complete logged data set (14 readings)…





Question 8 continues on page 8

Question 8 (continued)

(a) (i) Draw a line of best fit on the time/temperature graph. **(1 mark)**

► *A line of best fit represents the average line through a field of points. The line drawn is perfectly 'balanced' for all the seven data points.*
► *If a data trend is not linear, a smooth average curve is drawn!*

(ii) Calculate the molar heat of combustion of ethanol using the graphic data. **(3 marks)**

$\Delta H = -m\,C\,\Delta T$

$\Delta H = -300\ g \times 4.18\ J\ g^{-1}\ °C^{-1} \times (40°C - 20°C) = -25080\ J$ *(1 mark)*

$\Delta H = -25080\ J \div 1000 \div (178.4 - 177.1\ g) = -19.29\ kJ\ g^{-1}$ *(1 mark)*

$\Delta H = -19.29\ kJ\ g^{-1} \times 46.068\ g\ mol^{-1} = -888.758 = -890\ kJ\ mol^{-1}$ *(1 mark)*

(b) Derek Dunceford sets up a heat of combustion apparatus pictured on the right. His chemistry teacher, Mr. Chemiski spots several errors that Derek has made and suggests several improvements.

(i) Identify an error in the way the equipment was set-up. **(1 mark)**

✓ *The distance between the flame and the calorimeter is too great. OR The thermometer should not be clamped.*

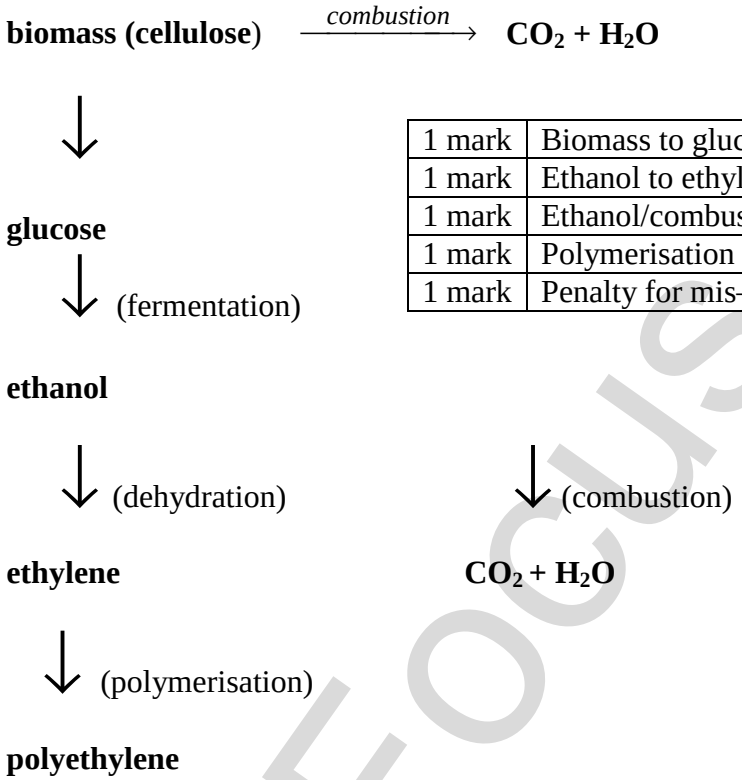
(ii) Identify an improvement to the experimental design which would produce a better result. **(1 mark)**

✓ *Use an aluminium can instead of a beaker.*
OR
Use a draught shield around the burner.
OR
Calibrate the calorimeter.

Question 9 (6 marks)

(a) Construct a flow chart to present information clearly and succinctly and show relationships in the production of fuel and plastic from biomass. You should use all ten terms in the list below… (► *They are not in any particular order.*) **(4 marks)**

ethylene	dehydration	glucose	polyethylene	ethanol
fermentation	$CO_2 + H_2O$		combustion	polymerisation



1 mark	Biomass to glucose step above must be first
1 mark	Ethanol to ethylene step
1 mark	Ethanol/combustion step
1 mark	Polymerisation step
1 mark	Penalty for mis–sequence

(b) (i) Construct a balanced equation for the fermentation of glucose to ethanol. **(1 mark)**

$C_6H_{12}O_{6(aq)} \rightarrow 2C_2H_5OH_{(aq)} + 2CO_{2(g)}$ ► *Must include yeast/zymase.*

(ii) Calculate the mass of ethanol produced if there was complete conversion of a 300 mL, 10% (w/v) glucose solution to ethanol. **(1 mark)**

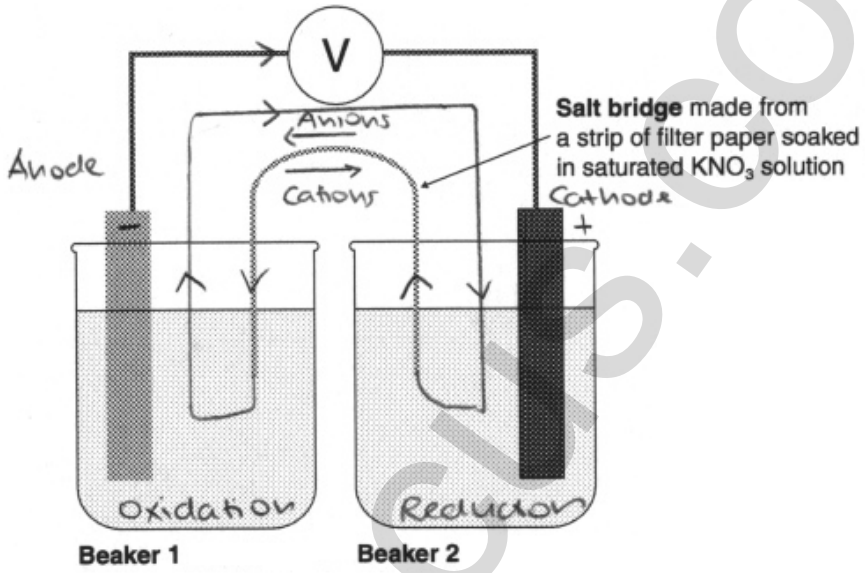
*300 mL = 30g ethanol = 30/180mol glucose = 30/180 × 2 mol ethanol = 30/180 × 2 × 46 g ethanol = **15.3 g***

Question 10 (6 marks)

A student constructed a galvanic cell using silver, silver nitrate, nickel and nickel(II) nitrate.

(a) Draw a diagram of this galvanic cell and label… **(3 marks)**

- composition and location of anode and cathode
- direction and location of electron flow
- direction and location of anion and cation flow



1 mark	Anode (Ni) and cathode (Ag) shown in diagram
1 mark	Direction and location of electron flow
1 mark	Salt bridge labelled and direction of anions and cations

(b) Construct half–equations and the net ionic equation for the cell above. Calculate the cell potential. **(3 marks)**

$Ni_{(s)} \rightarrow Ni^{2+}_{(aq)} + 2e$ +0.24V

$2Ag^{+}_{(aq)} + 2e \rightarrow 2Ag_{(s)}$ +0.80V

$Ni_{(s)} + 2Ag^{+}_{(aq)} \rightarrow Ni^{2+}_{(aq)} + 2Ag_{(aq)}$ +1.04V

1 mark	Oxidation half equation
1 mark	Reduction half equation
1 mark	Net ionic equation and correct E° value