

Student Number	
Mark / 24	

Chemistry

**HSC Course
Production of Materials
Theory Test • 2002**

General Instructions

- Reading time – 5 minutes
- Working time – 40 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 at the back of this paper
- Write your Student Number at the top of this page

Assessment Weighting – 4%

Total Marks – 24

Part A – 4 marks

- Attempt Questions 1 – 4
- Allow about 5 minutes for this part

Part B – 20 marks

- Attempt Questions 5 – 10
- Allow about 35 minutes for this part

Part A – 4 marks
Attempt Questions 1 – 4
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.

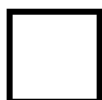
A ☒ B ☒ C ☐ D ☐

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.

A ☒ B ☒ C ☐ D ☐
 correct ↗

Answer Box for Questions 1 – 4

1	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
2	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
3	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
4	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>



Mark your answers for Questions 1 – 4 in the Answer Box on page 1.

- 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) CO₂ and H₂O form
 - (D) butane forms
- 4 In which of the following equations is the species printed in **bold** type being reduced?
- (A) $3\text{Zn}^{2+} + 2\text{Al}_{(\text{s})} \rightarrow 3\text{Zn}_{(\text{s})} + 2\text{Al}^{3+}$
 - (B) $2\text{Br}^{-} + \text{Cl}_{2(\text{g})} \rightarrow \text{Br}_{2(\text{l})} + 2\text{Cl}^{-}$
 - (C) $2\text{H}^{+} + \text{Mg}_{(\text{s})} \rightarrow \text{Mg}^{2+} + \text{H}_{2(\text{g})}$
 - (D) $2\text{H}_2\text{O}_{(\text{l})} + 3\text{I}_2 + 2\text{S}_2\text{O}_3^{2-} \rightarrow \text{S}_4\text{O}_8^{2-} + 4\text{H}^{+} + 6\text{I}^{-}$

Part B – 20 marks**Attempt Questions 5 – 10****Allow about 35 minutes for this part****Show all relevant working in questions involving calculations.**

Question 5 (4 marks)

Three groups of students set out to determine the heat of combustion of the three alkanols...
methanol, CH_3OH ; ethanol, $\text{C}_2\text{H}_5\text{OH}$; and 1-propanol, $\text{C}_3\text{H}_7\text{OH}$.

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...

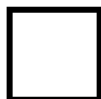
Alcohol burned	Mass of H_2O heated (g)	Temperature rise ($^{\circ}\text{C}$)	Mass of alcohol burned (g)	Heat of Combustion (kJ mol^{-1})
methanol	100	10	0.185	725
ethanol	100	10	0.142	
1-propanol	100	10	0.125	2016

- (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)**

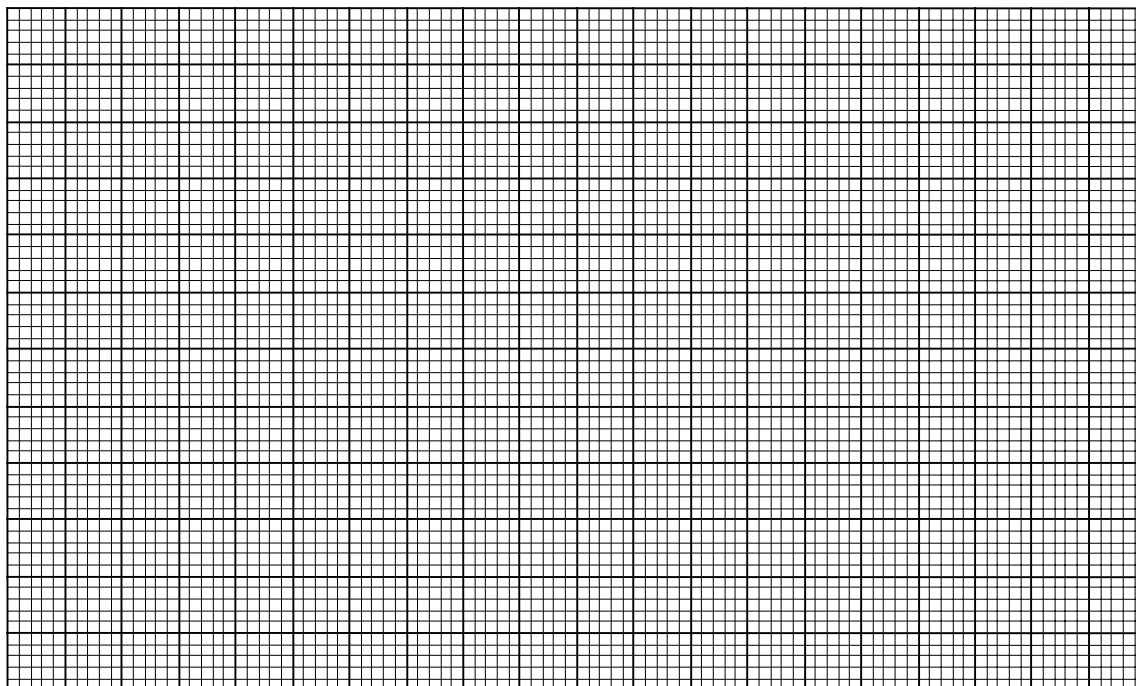
- (ii) Heat of combustion of ethanol in kJ mol^{-1} **(1 mark)**

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)**

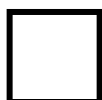


- (c) Use the graph to predict the heat of combustion of 1-butanol, $\text{C}_4\text{H}_9\text{OH}$ in kJ mol^{-1}

Question 6 (3 marks)

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

Question 6 continues on page 5



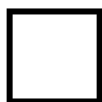
Question 6 (continued)

- (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)**

Question 7 (3 marks)

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.

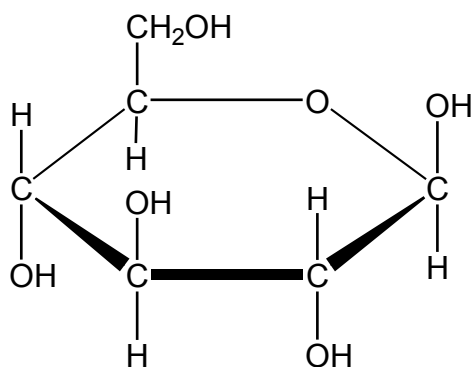
- Draw a diagram of the galvanic cell.
- Label the anode and the cathode.
- Indicate the direction of electron flow.



Question 8 (5 marks)

- (a) Explain the term *biopolymer* and identify an example. **(2 marks)**

- (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)**



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)**

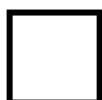
- (b) Write an equation to show any addition reaction(s) that occurred. **(1 mark)**

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)**



Chemistry

DATA SHEET

Avogadro's constant, N_A	$6.022 \times 10^{23} \text{ mol}^{-1}$
Volume of 1 mole ideal gas: at 101.3 kPa (1.00 atm) and	
at 273 K (0°C)	22.41 L
at 298 K (25°C)	24.47 L
Ionisation constant for water at 298 K (25°C), K_w	1.0×10^{-14}
Specific heat capacity of water	$4.18 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$

Some useful formulae

$$\text{pH} = -\log_{10} [\text{H}^+]$$

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

Some standard potentials

$\text{K}^+ + \text{e}^-$	\rightleftharpoons	K(s)	-2.94 V
$\text{Ba}^{2+} + 2\text{e}^-$	\rightleftharpoons	Ba(s)	-2.91 V
$\text{Ca}^{2+} + 2\text{e}^-$	\rightleftharpoons	Ca(s)	-2.87 V
$\text{Na}^+ + \text{e}^-$	\rightleftharpoons	Na(s)	-2.71 V
$\text{Mg}^{2+} + 2\text{e}^-$	\rightleftharpoons	Mg(s)	-2.36 V
$\text{Al}^{3+} + 3\text{e}^-$	\rightleftharpoons	Al(s)	-1.68 V
$\text{Mn}^{2+} + 2\text{e}^-$	\rightleftharpoons	Mn(s)	-1.18 V
$\text{H}_2\text{O} + \text{e}^-$	\rightleftharpoons	$\frac{1}{2}\text{H}_2(\text{g}) + \text{OH}^-$	-0.83 V
$\text{Zn}^{2+} + 2\text{e}^-$	\rightleftharpoons	Zn(s)	-0.76 V
$\text{Fe}^{2+} + 2\text{e}^-$	\rightleftharpoons	Fe(s)	-0.44 V
$\text{Ni}^{2+} + 2\text{e}^-$	\rightleftharpoons	Ni(s)	-0.24 V
$\text{Sn}^{2+} + 2\text{e}^-$	\rightleftharpoons	Sn(s)	-0.14 V
$\text{Pb}^{2+} + 2\text{e}^-$	\rightleftharpoons	Pb(s)	-0.13 V
$\text{H}^+ + \text{e}^-$	\rightleftharpoons	$\frac{1}{2}\text{H}_2(\text{g})$	0.00 V
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^-$	\rightleftharpoons	$\text{SO}_2(\text{aq}) + 2\text{H}_2\text{O}$	0.16 V
$\text{Cu}^{2+} + 2\text{e}^-$	\rightleftharpoons	Cu(s)	0.34 V
$\frac{1}{2}\text{O}_2(\text{g}) + \text{H}_2\text{O} + 2\text{e}^-$	\rightleftharpoons	2OH^-	0.40 V
$\text{Cu}^+ + \text{e}^-$	\rightleftharpoons	Cu(s)	0.52 V
$\frac{1}{2}\text{I}_2(\text{s}) + \text{e}^-$	\rightleftharpoons	I^-	0.54 V
$\frac{1}{2}\text{I}_2(\text{aq}) + \text{e}^-$	\rightleftharpoons	I^-	0.62 V
$\text{Fe}^{3+} + \text{e}^-$	\rightleftharpoons	Fe^{2+}	0.77 V
$\text{Ag}^+ + \text{e}^-$	\rightleftharpoons	Ag(s)	0.80 V
$\frac{1}{2}\text{Br}_2(\text{l}) + \text{e}^-$	\rightleftharpoons	Br^-	1.08 V
$\frac{1}{2}\text{Br}_2(\text{aq}) + \text{e}^-$	\rightleftharpoons	Br^-	1.10 V
$\frac{1}{2}\text{O}_2(\text{g}) + 2\text{H}^+ + 2\text{e}^-$	\rightleftharpoons	H_2O	1.23 V
$\frac{1}{2}\text{Cl}_2(\text{g}) + \text{e}^-$	\rightleftharpoons	Cl^-	1.36 V
$\frac{1}{2}\text{Cr}_2\text{O}_7^{2-} + 7\text{H}^+ + 3\text{e}^-$	\rightleftharpoons	$\text{Cr}^{3+} + \frac{7}{2}\text{H}_2\text{O}$	1.36 V
$\frac{1}{2}\text{Cl}_2(\text{aq}) + \text{e}^-$	\rightleftharpoons	Cl^-	1.40 V
$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^-$	\rightleftharpoons	$\text{Mn}^{2+} + 4\text{H}_2\text{O}$	1.51 V
$\frac{1}{2}\text{F}_2(\text{g}) + \text{e}^-$	\rightleftharpoons	F^-	2.89 V

Aylward and Findlay, *SI Chemical Data* (4th Edition) is the principal source of data for this examination paper. Some data may have been modified for examination purposes.

1	H	1.008							2	He	4.003						
Hydrogen																	
3	Li	6.941	4	Be	9.012												
Lithium			Beryllium														
KEY																	
Atomic Number		79		Au		Symbol of element											
Atomic Weight		197.0		Gold		Name of element											
5	B	10.81	6	C	12.01	7	N	14.01	8	O	16.00	9	F	19.00	10	Ne	20.18
Boron		Carbon		Nitrogen		Oxygen		Fluorine		Neon							

57 La	58 Ce	59 Pr	60 Nd	61 Pm [146.9]	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
138.9	140.1	140.9	144.2		150.4	152.0	157.3	158.9	162.5	164.9	167.3	168.9	173.0	175.0
Lanthanum	Cerium	Praseodymium	Neodymium	Promethium	Samarium	Europium	Gadolinium	Terbium	Dysprosium	Holmium	Erbium	Thulium	Ytterbium	Lutetium

Actinium	Thorium	Protactinium	Uranium	Neptunium	Plutonium	Americium	Curium	Berkelium	Californium	Einsteinium	Fermium	Mendelevium	Nobelium	Lawrencium
89 Ac [227.0]	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np [237.0]	94 Pu [239.1]	95 Am [241.1]	96 Cm [244.1]	97 Bk [249.1]	98 Cf [252.1]	99 Es [252.1]	100 Fm [257.1]	101 Md [258.1]	102 No [259.1]	103 Lr [262.1]

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