Student Number: ……..…….…..

2009
TRIAL HIGHER SCHOOL CERTIFICATE

CHEMISTRY 2 UNIT

General Instructions

- **Write your student number at the top of this page and pages 7, 11 and 16.**
- Reading time – 5 minutes
- Working time – 3 hours
- Write using blue or black pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- A data sheet and a Periodic Table are provided with this paper
- Write your student number at the top of this page

Total marks – 100

Section 1
75 marks
This section has two parts, Part A and Part B
Part A – 15 marks
- Attempt Questions 1–15
- Allow about 30 minutes for this part

Part B – 60 marks
- Attempt Questions 16–27
- Allow about 1 hour and 45 minutes for this part

Section II
25 marks
- Attempt Question 28
- Allow about 45 minutes for this section

This task is weighted 35% HSC Chemistry assessment mark

Section I

Part A – 15 marks

Allow about 30 minutes for this section.

Instructions

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

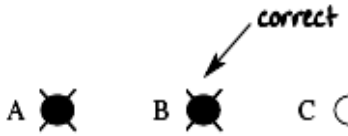
Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9

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 ○

Section I
75 marks

Part A – 15 marks
Attempt Questions 1–15
Allow about 30 minutes for this part

Use the multiple-choice answer sheet for Questions 1–15.

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1 Which conditions would be best for the fermentation of sugars by yeast?

(A) Low oxygen concentration and a temperature between 25°C and 35°C

(B) High oxygen concentration and a temperature between 25°C and 35°C

(C) Low oxygen concentration and a temperature between 35°C and 45°C

(D) High oxygen concentration and a temperature between 35°C and 45°C

2 The monomer ethenylbenzene is more readily identified by its common name, which is

(A) Styrene

(B) Propylene

(C) Acrylonitrile

(D) Vinyl chloride

3 The heat of combustion of butan-1-ol is 2676 kJ mol^{-1}.
What is the value of the heat of combustion in kJ g^{-1}?

(A) 27.79

(B) 30.41

(C) 36.10

(D) 44.60

4 Which of the following sets of elements contains only those with stable nuclei?

(A) $^{238}_{92}U$ $^{16}_{8}O$ $^{24}_{12}Mg$

(B) $^{18}_{8}O$ $^{65}_{30}Zn$ $^{12}_{6}C$

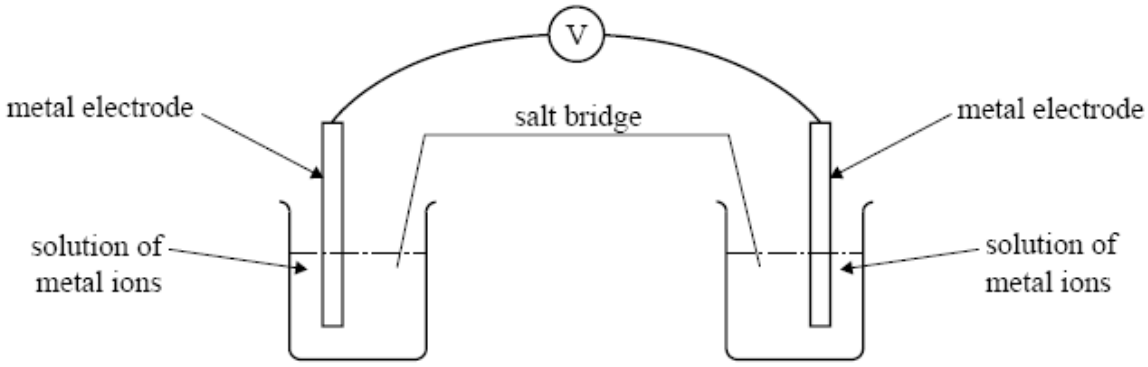
(C) $^{14}_{6}C$ $^{16}_{8}O$ $^{24}_{12}Mg$

(D) $^{16}_{8}O$ $^{39}_{19}K$ $^{12}_{6}C$

5 Four half cells were constructed as follows:

Half cell I: an electrode of metal P in a 1.0 M solution of $P^+(aq)$ ions
Half cell II: an electrode of metal Q in a 1.0 M solution of $Q^+(aq)$ ions
Half cell III: an electrode of metal R in a 1.0 M solution of $R^+(aq)$ ions
Half cell IV: an electrode of Cu(s) metal in a 1.0 M solution of $Cu^{2+}(aq)$ ions

The half-cells were connected in pairs, as shown below, to form a series of galvanic cells



For each cell, the polarity of the electrodes and the voltage generated are recorded.

Half cells used	Positive electrode	Negative electrode	Voltage (V)
I and IV	P	Cu	0.46
II and IV	Cu	Q	0.57
III and IV	Cu	R	1.10
II and III	Q	R	0.53

Which one of the following alternatives lists the metals in order of **increasing** strength as reductants?

(A) R, Q, Cu, P

(B) Cu, P, Q, R

(C) P, Cu, R, Q

(D) P, Cu, Q, R

.

6 Which of the following is a condensation polymer?

(A) polystyrene

(B) polyethylene

(C) poly(chloroethene)

(D) poly(ethylene terephthalate)

7 Which of the following is **NOT** an everyday use of indicators?

(A) Checking swimming pool acidity.

(B) Determining the pH of garden soils.

(C) Measuring the eutrophication of lakes.

(D) Monitoring wastes from photographic processing.

8 When 1 mole of zinc is reacted with 250 mL of 1.0 mol L^{-1} hydrochloric acid solution, the volume of hydrogen gas formed, at 25°C and 100 kPa, is closest to

(A) 1.6 L.

(B) 3.1 L.

(C) 6.2 L.

(D) 12.4 L.

9 Which statement best represents Lavoisier's definition of an acid?

(A) Acids contain oxygen.

(B) Acids are proton donors.

(C) Acids contain replaceable hydrogen.

(D) Acids ionise in solution to form hydrogen ions.

10 Identify which of the following species is amphiprotic.

(A) OH^-

(B) NH_3

(C) SO_4^{2-}

(D) H_3PO_4

11 A car engine burns fuel with insufficient air. Identify the substance that would have an increased concentration in the car's exhaust as a result.

(A) Water

(B) Nitrous oxide

(C) Carbon dioxide

(D) Carbon monoxide

12 The flame test method of analysis can be used to distinguish between

(A) methanol and ethanol.

(B) sulfuric acid and nitric acid.

(C) lithium nitrate and calcium nitrate.

(D) sodium carbonate and sodium chloride.

13 Which of the following pairs of haloalkanes are isomers of each other?

(A) 2-fluoro-3-methylbutane and 1-fluoropentane

(B) dichlorodifluoromethane and dichlorodibromomethane

(C) 1-fluoro-2-pentene and 2,2-difluoro-3-methylpentane

(D) 2-fluoro-3-methylpentane and 1-fluoro-2-methylpentane

14 Why is chlorine used to treat local water supplies?

(A) To make water suitable for swimming.

(B) To kill micro-organisms living in the water.

(C) To promote sedimentation of finely suspended solids.

(D) To precipitate heavy metal ions such as lead and mercury.

15 In a chemical reaction which is held at a constant temperature, the addition of a catalyst

(A) affects the equilibrium position.

(B) lowers the activation energy required.

(C) increases the percentage yield at equilibrium.

(D) increases the kinetic energy of the molecules involved in the reaction.

Section I (continued)

Part B – 60 marks
Attempt Questions 16–27
Allow about 1 hour and 45 minutes for this part

Student Number

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Marks

Question 16 (4 marks)

Ethylene is used as a raw material in the production of many other substances.

(a) Construct a flowchart that identifies the industrial source of ethylene, the process by which it is produced, and two useful chemicals formed from ethylene. **3**

(b) Write a balanced chemical equation to summarise the formation of one of these chemicals. **1**

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Marks

Question 17 (7 marks)

The July 2009 *Scientific American* included an article on "Grassoline", the name given to second-generation biofuels derived from cellulose. The article summarised the advances in technologies to convert cellulose directly into fuel, bypassing the need for the fermentation process needed in first-generation biofuels.

The article stated that "first-generation biofuels are not as environmentally friendly as we would like them to be."

(a) Discuss the above quotation with reference to ethanol derived from sugar cane. **4**

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Question 17 is continued on the next page

Marks

Question 17 (continued)

(b) Explain why cellulose is considered a potential raw material to build petrochemicals. **3**

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Question 18 (4 marks)

You performed a first-hand investigation to identify the conditions under which a galvanic cell is produced.
Justify the conclusion that you made. **4**

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Marks

Question 19 (4 marks)

Teams of Russian and American scientists claimed the discovery of element 113 in February 2004.
Following international conventions, it has initially been given the name ununtrium and the symbol Uut, before a permanent name and symbol are given to it.
Uut undergoes rapid radioactive decay but atoms of Uut have been identified with a mass number of 283 and also with a mass number of 284.

(a) Identify the number of each type of subatomic particle in an uncharged Uut atom of mass number 284. **1**

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(b) Atoms of Uut with a mass number of 283 undergo radioactive decay into two particles, one of which is an α-particle. Write a balanced equation for this nuclear reaction. **1**

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(c) Describe another (other than element 113) recent discovery of an element. **2**

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Student Number

Marks

Question 20 (5 marks)

Red cabbage indicator chart

Colour	red		violet		purple		blue		green		yellow		
pH	1	2	3	4	5	6	7	8	9	10	11	12	13	14

(a) State what colour the red cabbage indicator would be in a 0.05 mol L^{-1} solution of H_2SO_4.
Show your working. **1**

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(b) Using the red cabbage indicator, what colour would the solution be if 10 mL of 0.05 mol L^{-1} H_2SO_4 was diluted to form a 1L solution? **1**

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(c) What volume of 0.005 mol L^{-1} KOH is required to neutralise 15 mL of the diluted solution of H_2SO_4? **3**

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Marks

Question 21 (4 marks)

Sulfur forms gases that contribute significantly to the pollution of the atmosphere. Sulfur dioxide (SO_2) is formed when solid fuels such as coal are burned.

(a) Draw the electron dot formula for sulfur dioxide**.** **1**

(b) Oxides of sulfur in the atmosphere contribute to the formation of acid rain. Name the acid formed in the atmosphere from sulfur dioxide and write a balanced chemical equation to show its formation. **2**

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(c) Identify a problem affecting the natural environment that is caused by acid rain. **1**

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Marks

Question 22 (4 marks)

Acetic acid (ethanoic acid) is the compound responsible for the sour taste and characteristic odour of vinegar. Vinegar can have a number of uses around the home. It can be used to remove the deposits left when tap water is boiled in kettles; it inhibits the growth of bacteria and so is used as a preservative. It is also used as flavouring in cooking and salad dressings.

Using the information above and your knowledge of chemistry, answer the following questions.

(a) Acetic acid in the form of vinegar is suitable for human consumption. Explain why the 0.1 mol L^{-1} acetic acid found in vinegar can be consumed, but other acids such as 0.1 mol L^{-1} hydrochloric and 0.05 mol L-1 sulfuric acids should not be consumed. **3**

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(b) The most common deposit left in kettles is calcium carbonate.
Write an equation to illustrate how acetic acid removes the calcium carbonate. **1**

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Marks

Question 23 (4 marks)

The pH of blood is maintained through buffering. The major buffer system present in blood is based on a carbonic acid/hydrogen carbonate ion buffer. When carbon dioxide enters the blood stream, the following reaction occurs:

$$CO_{2(g)} + 2\,H_2O_{(l)} \rightleftharpoons H_2CO_{3(aq)} + H_2O_{(l)} \rightleftharpoons HCO_3^-{}_{(aq)} + H_3O^+_{(aq)}$$

The presence of carbonic acid and hydrogen carbonate ions maintains the pH of blood to about 7.4.

Use Le Chatelier's principle to explain how the presence of carbonic acid and hydrogen carbonate ions in the blood help to maintain the pH of the blood. **4**

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Marks

Question 24 (4 marks)

You performed a first-hand investigation to prepare an ester by reflux.

(a) Identify the products formed when butanoic acid and propanol are refluxed with acid catalyst. **1**

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(b) Identify the acid catalyst used and justify its use in this procedure. **2**

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(c) In the space below, draw a structural formula to represent the ester formed when butanoic acid and propanol react together.

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Examination paper continues on the next page

Student Number

Marks

Question 25 (7 marks)

The Good Weekend magazine supplement of the Sydney Morning Herald published on June 20, 2009, carried an article on Ross Mann, a plant pathologist. The article stated that Mann was working on a natural pesticide to replace

"the ozone-depleting chemical methyl bromide, a fumigant used world wide."

(a) Methyl bromide's systematic name is bromomethane.
Write the formula for methyl bromide: **1**

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(b) Use equations to justify the assertion that methyl bromide is an ozone-depleting chemical. **4**

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(c) Identify the two main groups of haloalkanes that are usually responsible for the destruction of ozone **2**

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Marks

Question 26 (6 marks)

The Sydney Morning Herald published an article on the toxic metal threat to Sydney's water supply on the 18th June. 2009. The article stated that dangerous levels of copper, boron and arsenic were found in the Cox's River, downstream from a coal-fired power station.

(a) Identify another common source of copper contamination in the Sydney catchment. **1**

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(b) Identify an instrumental method of analysis that could be used to determine precisely the amount of copper present in a water sample taken from the Cox's River just downstream from the power station. **1**

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(c) Describe tests that a student could use in the school laboratory to identify that a solution contained copper ions. **3**

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(d) Identify a possible domestic (household) source of copper contamination in drinking water. **1**

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Marks

Question 27 (7 marks)

Explain why monitoring of the reaction vessel used in the Haber process is crucial and discuss the monitoring required. **7**

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End of Section I

Section II

25 marks
Attempt Questions 28
Allow about 45 minutes for this section

Answer the questions in a writing booklet. Extra writing booklets are available.

Show all relevant working in questions involving calculations.

Marks

Question 28 – Industrial Chemistry (25 marks)

(a) On Tuesday 14th April 2009, the Sydney Morning Herald newspaper reported on an acid spill on the Princes Highway, near Berry, on the N.S.W. South Coast.

The following excerpt was part of the news story.

> NSW Fire Brigades has closed a section of the Princes Highway after a truck carrying 20,000 litres of sulfuric acid crashed near Berry today.
>
> Fire Brigade spokesman Craig Brierly said the tanker flipped onto its side and was leaking acid from vents on its roof after crashing about two kilometres north of Berry just after 5 a.m.
>
> The driver managed to get out of the cabin and fire fighters had built makeshift dam walls to stop the acid from leaking off the road, Mr Brierly said.
>
> Three fire engines and two hazardous materials trucks were sent to the incident.

(i) Identify the main hazard associated with sulfuric acid. **1**

(ii) Explain the Fire Brigades' decision to contain the acid spill to the road. **3**

(iii) Identify a suitable chemical to be used to neutralise the acid and justify your choice. **2**

(iv) Assuming the sulfuric acid is 98% pure, calculate the molarity of the concentrated acid. (Hint: the density of sulfuric acid is 1.8g/mL). **2**

(v) Dilute sulfuric acid reacts readily with iron. Explain why steel tankers can be used to transport concentrated sulfuric acid. **3**

Question 25 is continued over the page

Marks

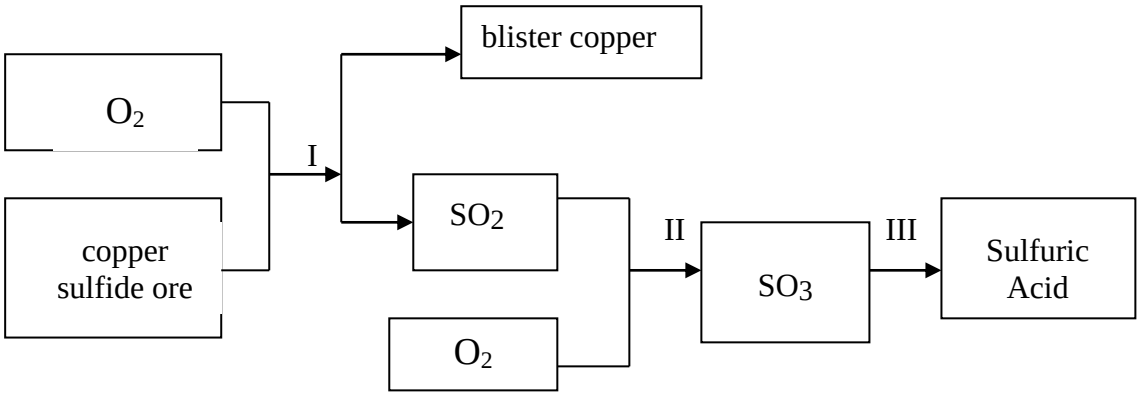
Question 25 (continued)

(b) You performed a first-hand investigation in the school laboratory to observe the reactions of sulfuric acid.

(i) Justify **TWO** additional safe work practices that are required when handling concentrated sulfuric acid, (as opposed to handling dilute sulfuric acid), in the school laboratory. **3**

(ii) Use balanced equations to explain the results that you observed for concentrated sulfuric acid acting as an oxidising agent and as a dehydrating agent. **4**

(c) The diagram below represents one way by which sulfuric acid can be prepared industrially.



(i) Identify another commonly used source of sulfur dioxide. **1**

(ii) Compare the environmental issues associated with the two methods of obtaining sulfur dioxide. **2**

(iii) Justify the conditions you would use to maximise the rate and yield of step II in the above process. **4**

End of Examination

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Student Number

Section I – Multiple choice

Answer sheet

	A	B	C	D
1				
2				
3				
4				
5				
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7				
8				
9				
10				
11				
12				
13				
14				
15				

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DATA SHEET

Avogadro constant, N_A ..... 6.022×10^{23} mol^{-1}

Volume of 1 mole ideal gas: at 100 kPa and

at 0°C (273.15 K) ..... 22.71 L

at 25°C (298.15 K) ..... 24.79 L

Ionisation constant for water at 25°C (298.15 K), K_w ..... 1.0×10^{-14}

Specific heat capacity of water ..... 4.18×10^3 J kg^{-1} K^{-1}

Some useful formulae

$$pH = -\log_{10}[H^+] \qquad \Delta H = -mC\Delta T$$

Some standard potentials

$K^+ + e^-$	$\rightleftharpoons$	$K(s)$	–2.94 V
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	$Ba(s)$	–2.91 V
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	$Ca(s)$	–2.87 V
$Na^+ + e^-$	$\rightleftharpoons$	$Na(s)$	–2.71 V
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	$Mg(s)$	–2.36 V
$Al^{3+} + 3e^-$	$\rightleftharpoons$	$Al(s)$	–1.68 V
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	$Mn(s)$	–1.18 V
$H_2O + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g) + OH^-$	–0.83 V
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	$Zn(s)$	–0.76 V
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	$Fe(s)$	–0.44 V
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	$Ni(s)$	–0.24 V
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	$Sn(s)$	–0.14 V
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	$Pb(s)$	–0.13 V
$H^+ + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g)$	0.00 V
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(aq) + 2H_2O$	0.16 V
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	$Cu(s)$	0.34 V
$\frac{1}{2}O_2(g) + H_2O + 2e^-$	$\rightleftharpoons$	$2OH^-$	0.40 V
$Cu^+ + e^-$	$\rightleftharpoons$	$Cu(s)$	0.52 V
$\frac{1}{2}I_2(s) + e^-$	$\rightleftharpoons$	I^-	0.54 V
$\frac{1}{2}I_2(aq) + e^-$	$\rightleftharpoons$	I^-	0.62 V
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	0.77 V
$Ag^+ + e^-$	$\rightleftharpoons$	$Ag(s)$	0.80 V
$\frac{1}{2}Br_2(l) + e^-$	$\rightleftharpoons$	Br^-	1.08 V
$\frac{1}{2}Br_2(aq) + e^-$	$\rightleftharpoons$	Br^-	1.10 V
$\frac{1}{2}O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O	1.23 V
$\frac{1}{2}Cl_2(g) + e^-$	$\rightleftharpoons$	Cl^-	1.36 V
$\frac{1}{2}Cr_2O_7^{2-} + 7H^+ + 3e^-$	$\rightleftharpoons$	$Cr^{3+} + \frac{7}{2}H_2O$	1.36 V
$\frac{1}{2}Cl_2(aq) + e^-$	$\rightleftharpoons$	Cl^-	1.40 V
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	1.51 V
$\frac{1}{2}F_2(g) + e^-$	$\rightleftharpoons$	F^-	2.89 V

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number	Symbol of element	Name of element
79	Au	Gold
Atomic Weight	197.0	

1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.39 Zinc	31 Ga 69.72 Gallium	32 Ge 72.61 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc [98.91] Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanides	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.8 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po [210.0] Polonium	85 At [210.0] Astatine	86 Rn [222.0] Radon
87 Fr [223.0] Francium	88 Ra [226.0] Radium	89–103 Actinides	104 Rf [261.1] Rutherfordium	105 Db [262.1] Dubnium	106 Sg [263.1] Seaborgium	107 Bh [264.1] Bohrium	108 Hs [265.1] Hassium	109 Mt [268] Meitnerium	110 Uun — Ununnilium	111 Uuu — Unununium	112 Uub — Ununbium	113	114 Uuq — Ununquadium	115	116 Uuh — Ununhexium	117	118 Uuo — Ununoctium

Lanthanides

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

Actinides

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

Where the atomic weight is not known, the relative atomic mass of the most common radioactive isotope is shown in brackets.
The atomic weights of Np and Tc are given for the isotopes ^{237}Np and ^{99}Tc.

Marking guidelines

Section I – Part A

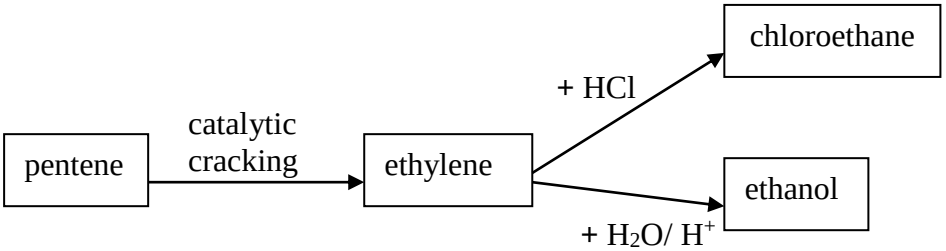
1	A	**8**	B
2	A	**9**	A
3	C	**10**	B
4	D	**11**	D
5	D	**12**	C
6	D	**13**	A
7	C	**14**	B
		15	B

Section I – Part B

Question 16(a)

Criteria	Marks
• Constructs a flowchart that identifies the industrial source of ethylene, the process by which it is produced, and two useful chemicals formed from ethylene	3
• Constructs a flowchart that identifies the industrial source of ethylene and the process by which it is produced **OR** • Identifies two useful chemicals formed from ethylene **OR** • Constructs a flowchart that identifies the industrial source of ethylene and identifies a useful chemical formed from ethylene	2
• Constructs a flowchart **OR** • Identifies the industrial source of ethylene **OR** • Identifies the process by which ethylene is produced **OR** • Identifies a useful chemical formed from ethylene	1

Suggested answer:



Question 16(b)

Criteria	Marks
• Writes correct equation	1

Suggested answer:

$$C_2H_4(g) + HCl(aq) \longrightarrow C_2H_5Cl(l)$$

Question 17(a)

Criteria	Marks
• Discusses the quotation using at least **TWO** environmentally friendly examples and at least **TWO** environmentally damaging examples for the process of deriving ethanol from sugar cane	4
• Correctly identifies at least **TWO** environmental issues associated with deriving ethanol from sugar cane **AND/OR** • Identifies both environmental benefits and problems associated with deriving ethanol from sugar cane	2-3
• Correctly identifies an environmental issue associated with deriving ethanol from sugar cane	1

Suggested answer:

When ethanol is made from fermented sugar cane, claims are often made that it is an environmentally friendly process as the sugar cane is a renewable source and the process can also be viewed as being greenhouse neutral. However, claims that it is greenhouse neutral ignore the greenhouse emissions associated with the cultivation and fertilising of the sugar cane and the distillation of the fermentation product. Degradation of the land used to grow the sugar cane and the disposal of the waste fermentation liquor are both environmental problems associated with the fermentation of sugar cane.

Question 17(b)

Criteria	Marks
• Explains why cellulose is considered a potential raw material to build petrochemicals	3
• Correctly identifies that both petrochemicals and cellulose contains carbon chains	2
• Correctly identifies cellulose contains carbon atoms **OR** • Identifies that petrochemicals contain carbon chains	1

Suggested answer:

Many of the chemicals derived from petroleum contain a carbon-carbon chain as their backbone. Cellulose has a long carbon chain structure and is both renewable and plentiful. Research is being conducted into producing the starting material for petrochemicals (ethanol and ethylene) from cellulose, as well as the Grassoline mentioned in the article.

Question 18

Criteria	Marks
• Correctly states appropriate conclusion(s) and justifies the conclusion with correct results	4
• Correctly states appropriate conclusion(s) **AND/OR** • Correctly identifies appropriate observations	2-3
• Correctly identifies an observation that could be made as the cell is tested **OR** • Correctly states an appropriate conclusion	1

Suggested answer:

For a cell to produce a potential difference, it requires two different half-cells, a salt bridge and external wires to connect the two half-cells and complete the circuit. When the two half-cells are identical, or the salt bridge or external wires are missing, no voltage was recorded for the cell.

Question 19(a)

Criteria	Marks
• Correctly identifies the number of all 3 sub-atomic particles	1

Suggested answer:

• protons: 113
• electrons: 113
• neutrons: 171

Question 19(b)

Criteria	Marks
• Writes a correctly balanced nuclear equation	1

Suggested answer:

$^{283}_{113}\text{Uut} \rightarrow {}^{4}_{2}\text{He} + {}^{279}_{111}\text{Rg}$

Question 19(c)

Criteria	Marks
• Correctly describes the discovery of another recently discovered element	2
• Correctly identifies another recently discovered element	1

Suggested answer:

In 1999 a research team in Dubna in Russia announced the discovery of element 114. It was made by colliding a calcium-48 ion into a plutonium-244 target using a heavy ion accelerator.

Question 20(a)

Criteria	Marks
• Identifies the colour of the indicator with working shown	1

Suggested answer:

pH = $-\log_{10}$ [0.05 x2] = 1, hence the indicator would turn red in the solution.

Question 20(b)

Criteria	Marks
• Correctly calculates the pH of the diluted H_2SO_4 solution and relates to the cabbage indicator colour	1

Suggested answer:

$c_1v_1 = c_2v_2$

$c_2 = \frac{c_1v_1}{v_2}$

$= \frac{0.05 \times 0.010}{1.000}$

$= \underline{0.0005}$

pH = $-\log_{10}$ [0.0005 x2] = $\underline{3}$

Hence the indicator would turn violet in the solution.

Question 20(c)

Criteria	Marks
• Correctly calculates the volume of KOH showing working	3
• Correctly calculates the number of moles of KOH	2
• Correctly calculates the number of moles of H_2SO_4 via either method **OR** • Writes balanced equation **OR** • Identifies 2:1 mole ratio of base to acid **OR** • Makes 2 errors but applies basic titration calculation	1

Suggested answer:

$2KOH_{(aq)} + H_2SO_{4(aq)} \rightarrow K_2SO_{4\,(aq)} + 2H_2O_{(l)}$

moles of sulfuric acid in 15mLdiluted solution = $\frac{15 \times 0.0005}{1,000}$

$= \underline{7.5 \times 10^{-6} \text{ moles}}$

moles KOH required for neutralisation $= 2 \times 7.5 \times 10^{-6}$

$= \underline{1.5 \times 10^{-5} \text{ moles}}$

volume of 0.005 mol L^{-1} KOH required $= \frac{n}{c}$

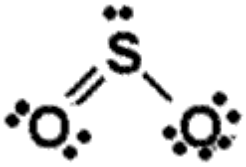
$= \frac{1.5 \times 10^{-5}}{0.005}$

$= 0.003L = \underline{3mL}$

Question 21(a)

Criteria	Marks
• Correctly draws the electron dot formula for sulfur dioxide	1

Suggested answer:



Question 21(b)

Criteria	Marks
Names sulfurous acid and writes a correctly balanced chemical equation	2
• Writes a correctly balanced chemical equation **OR** • Names sulfurous acid	1

Suggested answer:
Sulfurous acid.

$H_2O_{(l)} + SO_{2(g)} \rightarrow H_2SO_{3\,(aq)}$

Question 21(c)

Criteria	Marks
Correctly iidentifies a problem affecting the natural environment that is caused by acid rain	1

Suggested answer:
Trees in Black Forest in Germany have been stripped of foliage.

Question 22(a)

Criteria	Marks
• Explains why the acetic acid found in vinegar can be consumed but other acids such as 0.1 mol L^{-1} hydrochloric and 0.05 mol L-1 sulfuric acids should not be consumed	3
• Identifies that acetic acid is a weak acid **AND** • Identifies that hydrochloric acid and sulfuric acids are strong acids	2
• Identifies that the acids have different strengths **OR** • Identifies that acetic acid is a weak acid **OR** Identifies that hydrochloric acid and sulfuric acids are strong acids	1

Suggested answer

The concentration of acids and their relative strength both impact on the acid's pH. Acetic acid is a weak acid and is only about 1% ionised, therefore 0.1 mol L^{-1} acetic acid has a pH of approximately 3.Whereas, 0.1 mol L^{-1} hydrochloric and 0.05 mol L-1 sulfuric acids are fully ionized and both have a pH of 1. The lower pH value of these acids reflects their greater acidity, and this increased acidity level means that it is dangerous to consume them.

Question 22(b)

Criteria	Marks
• Writes a correctly balanced chemical equation	1

Suggested answer:

$$2CH_3COOH_{(aq)} + CaCO_{3(s)} \rightarrow (CH_3COO)_2\,Ca_{(aq)} + H_2O_{(l)} + CO_{2(g)}$$

Question 23

Criteria	Marks
• Correctly explains, with reference to Le Chatelier's principle, how the reactions of the carbonic acid/hydrogen carbonate ion buffer system helps to maintain the pH of the blood **AND** • Includes correctly balanced equation(s) for reactions	4
• Correctly describes how the reactions of the carbonic acid/hydrogen carbonate ion buffer system helps to maintain the pH of the blood **AND** • Presents a correctly balanced equation for ***at least one*** of the equilibrium shifts	2-3
• Correctly identifies a direction shift for the equilibrium system	1

Specimen Answer:
When the acidity of the blood increases, according to Le Chatelier's principle, the equlibrium will shift to the left to produce carbonic acid.

$$H_2CO_{3(aq)} + H_2O_{(l)} \rightleftharpoons HCO_3^-{}_{(aq)} + H_3O^+{}_{(aq)}$$

The carbonic acid will then decompose to form carbon dioxide (second equilibrium shifts to the left), which will be removed from the blood when it travels through the lungs, resulting in a minimisation of the original pH decrease.

$$CO_{2(g)} + 2\ H_2O_{(l)} \rightleftharpoons H_2CO_{3(aq)} + H_2O_{(l)}$$

If the pH of the blood increases, the equilibrium system will shift to the right in accordance with Le Chatelier's principle, producing more hydronium ions, and lowering pH as a result.

$$CO_{2(g)} + 2\ H_2O_{(l)} \rightleftharpoons H_2CO_{3(aq)} + H_2O_{(l)} \rightleftharpoons HCO_3^-{}_{(aq)} + H_3O^+{}_{(aq)}$$

Question 24(a)

Criteria	Marks
Correctly identifies both products	1

Suggested answer:
propyl butanoate and water

Question 24(b)

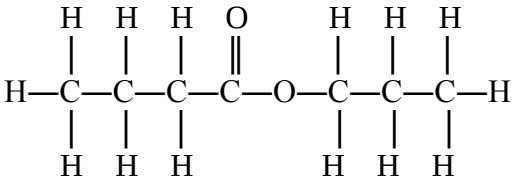
Criteria	Marks
• Correctly identifies the catalyst used **AND** • Correctly justifies its use in terms of rate and yield	2
• Correctly identifies the catalyst used **OR** • Correctly identifies a reason for using the acid	1

Suggested answer:
Concentrated sulfuric acid is used. Acids catalyse esterification reactions and the use of concentrated sulfuric acid helps improve yield, since water is also a product.

Question 24(c)

Criteria	Marks
• Correctly draws the structural formula for propyl butanoate	1

Suggested answer:



Question 25(a)

Criteria	Marks
• Correctly writes the formula for methyl bromide	1

Suggested answer:
CH_3Br

Question 25(b)

Criteria	Marks
• Correctly describes the process by which ozone is destroyed by methyl bromide **AND** • Includes **THREE** correctly balanced equations for reactions	4
• Correctly describes the process by which ozone is destroyed by methyl bromide **AND** • Includes **at least ONE** correctly balanced equations for reactions	2-3
• Presents a correctly balanced equation for one of the ozone destroying reactions **OR** • Correctly identifies an aspect of the ozone destruction	1

Suggested answer:
The methyl bromide will be broken down by u.v. light to form a bromine free radical.

$$CH_3Br(g) \xrightarrow{UV\ light} CH_3\bullet(g) + Br\bullet(g)$$

The bromine atom then reacts with ozone:

$$Br\bullet(g) + O_3(g) \rightarrow BrO\bullet(g) + O_2(g)$$

And the BrO free radical that is formed reacts with an oxygen atom to form oxygen gas, reforming the bromine free radical.

$$BrO\bullet(g) + O\bullet(g) \rightarrow O_2(g) + Br\bullet(g)$$

The last two steps are repeated thousands of times, allowing one molecule of methyl bromide to destroy thousands of ozone molecules.

Question 25(c)

Criteria	Marks
• Correctly identifies the two main groups of chemicals that destroy ozone	2
• Correctly identifies one of the two main groups of chemicals that destroy ozone	1

Suggested answer:
CFCs and halons

Question 26(a)

Criteria	Marks
• Identifies another common source of copper contamination in the Sydney catchment.	1

Suggested answer:
Industrial effluent. (Or run-off from copper mines).

Question 26(b)

Criteria	Marks
• Correctly identifies the instrumental method of analysis	1

Suggested answer:
Atomic absorption spectroscopy

Question 26(c)

Criteria	Marks
• Correctly describes **at least TWO** tests (either steps or results) that a student could use in a school laboratory to identify copper ions in solution	3
• Correctly identifies tests (either steps or results) that a student could use in a school laboratory to identify copper ions in solution	2
• Correctly identifies a test for copper ions	1

Suggested answer:
When NaOH solution is added to the water sample a blue precipitate forms. When ammonia solution is added to the mixture the precipitate dissolves to form a deep blue solution.
The solution produces a blue-green coloured flame when a flame test is conducted.

Question 26(d)

Criteria	Marks
• Correctly identifies a domestic source of copper ions	1

Suggested answer:
Copper pipes used to carry hot water.

Question 27

Criteria	Marks
• Demonstrates an extensive knowledge of the Haber process including the factors that are monitored and managed • Provides a comprehensive explanation of why the reaction conditions used need to be monitored or managed and relates them to the nature of the reaction and safety concerns • Includes a balanced chemical equation	6-7
• Demonstrates a thorough knowledge of the Haber process • Explains why some reaction conditions are monitored or managed	4-5
• Demonstrates a sound knowledge of the Haber process **OR** • Demonstrates a limited knowledge of the Haber process and identifies (a) reaction condition(s) that is (2 marks)/are(3 marks) monitored or managed	2-3
• Identifies the reactants and products of the Haber process **OR** • Gives one correct statement about the Haber process **OR** • Identifies one reaction condition that is monitored	1

Section II
Question 28(a)(i)

Criteria	Marks
Correctly identifies a hazard associated with sulfuric acid	1

Suggested answer:
Sulfuric acid is corrosive.

Question 28(a)(ii)

Criteria	Marks
Correctly explains the dangers posed by the acid spill to the environment by linking them to a change in pH.	3
Correctly describes the dangers posed by the acid spill to the environment.	2
Correctly identifies a danger posed by the acid.	1

Suggested answer:
The Fire Brigades would want to stop the acid from entering the waterways via drains, as this would change the pH of the water body and could endanger aquatic organisms. They would also want to avoid it contaminating roadside soil, as a change in its pH would impact on plant life and other organisms; and could also result in the acid leaching into the waterways via run-off.

Question 28(a)(iii)

Criteria	Marks
Correctly identifies a suitable chemical to be used to neutralise the acid and justifies choice	2
Correctly identifies a suitable chemical to be used to neutralise the acid	1

Suggested answer:
Sodium carbonate / sodium hydrogen carbonate as it is a stable solid that is safe to handle, store and transport; cheap and limits environmental damage if excess is used.

Question 28(a)(iv)

Criteria	Marks
Correctly calculates the concentration of sulfuric acid	2
Correctly calculates the mass of sulfuric acid per litre	1

Suggested answer:
The mass of sulfuric acid per litre = %mass x density
$= 0.98 \times 1\ 8 \times 10^3$
$= 1\ 76 \times 10^3\ gL^{-1}$

Concentration of sulfuric acid = $\frac{1\ 76 \times 10^3}{98.076}$
$= 18\ mol\ L^{-1}$

Question 28(a)(v)

Criteria	Marks
Correctly explains why steel tankers can be used to transport concentrated sulfuric acid, including a balanced chemical equation.	3
Correctly describes the reaction between sulfuric acid and iron, including a balanced chemical equation. OR Correctly identifies the absence of hydronium ions in concentrated sulfuric acid and states that they are needed for a reaction with iron to occur	2
Correctly identifies the absence of hydronium ions in concentrated sulfuric acid OR Includes a relevant balanced chemical equation.	1

Suggested answer:

When dilute sulfuric acid reacts with iron, the iron is oxidised through its reaction with the hydronium (hydrogen) ions present in the acid.

$$2H_3O^+_{(aq)} + Fe \rightarrow Fe^{2+}_{(aq)} + H_{2(g)} + 2H_2O_{(l)}$$

As concentrated sulfuric acid is mainly molecular and contains very few hydronium ions, the above reaction doesn't occur to any extent between the concentrated acid and the iron in the tanker. Thus steel tanker can be used to transport the tanker safely.

(Can also include the precipitation reaction between the iron and sulfate ions to form the passivating iron sulfate layer inside the tanker, but not required

Question 28(b)(i)

Criteria	Marks
Justifies two correctly identified safe work practices	3
Justifies a correctly identified safe work practice OR Correctly identifies two safe work practices	2
Correctly identifies a safe work practice	1

Question 28(b)(ii)

Criteria	Marks
Correctly uses balanced equations to explain the results for concentrated sulfuric acid acting as an oxidising agent and as a dehydrating agent	4
Describes the results for concentrated sulfuric acid acting as an oxidising agent and as a dehydrating agent AND/OR Writes correctly balanced chemical equation(s) for reactions	2 -3
Identifies a correct observation for one of the reactions OR Writes a correctly balanced chemical equation for one of the reactions	1

Suggested answer:
When concentrated sulfuric acid is added to potassium bromide crystals, a brown vapour and liquid formed. This was bromine, formed when bromide ions were oxidised.

$$2KBr_{(s)} + 3H_2SO_{4(l)} \rightarrow 2KHSO_{4(s)} + SO_{2(g)} + 2H_2O_{(l)} + Br_{2(l)}$$

When concentrated sulfuric acid is added to copper sulfate crystals, the blue colour is bleached form the crystals as the water of crystallisation is removed from them.

$$CuSO_4.5H_2O_{(s)} \rightarrow CuSO_{4.(s)} + 5H_2O_{(l)}$$

Question 28(c)(i)

Criteria	Marks
Correctly identifies another commonly used source of sulfur dioxide	1

Suggested answer:
Sulfur dioxide is formed by combusting sulfur (that was extracted by the Frasch process).

Question 28(c)(ii)

Criteria	Marks
Correctly identifies similar/different environmental issues between the two processes	2
Correctly identifies an environmental issue associated with one of the processes	1

Suggested answer:
The above process uses a polluting by-product from copper production and as such has a positive impact on the environment. There are environmental concerns surrounding the mining of sulfur using the Frasch process including the potential formation of noxious gases and land subsidence.

Question 28(c)(iii)

Criteria	Marks
• Uses Le Chatelier's principle to justify one set of reaction conditions that will maximise the yield of SO3 • Writes a balanced chemical equation • Justifies the need to use an intermediate reaction temperature to maximise yield because of the exothermic nature of the reaction • Identifies that a catalyst should be used to maximise reaction rate	3 - 4
• Uses Le Chatelier's principle to justify ONE set of reaction conditions that will maximise the yield of SO_3 **OR** • Identifies that the reaction is exothermic and explains the effect of a change in temperature on reaction yield **OR** • Any TWO of the statements from 1 mark guidelines below	2
• Identifies that the reaction is exothermic **OR** • Writes a balanced chemical equation for the second step in the Contact process **OR** • States Le Chatelier's principle **OR** • Identifies that adding a catalyst will maximise reaction rate **OR** • Identifies that an increase in concentration of either reactant will increase the yield	1