Student Number: ……..

2008

Mid Year Examination

HSC CHEMISTRY

Thursday 3 April, 9 – 11am

General Instructions

- Reading time - 5 minutes
- Working time - 2 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board approved calculators may be used
- A Data Sheet and Periodic Table are provided at the back of this paper
- Write your student number at the top of every page.

Mr Hunter
Mr Lee
Mr Weeding
40 students

Total marks - 65

Section I – 45 marks
Part A (15 marks)
- Attempt Questions 1-15

Part B (30 marks)
- Attempt Questions 16- 20

Section II - 20 marks
- Attempt Question 21

Question 15
Source: Smith, R. (2005). Conquering Chemistry. McGraw-Hill Australia.

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Section 1
45 marks

Part A

Total marks 15
Attempt questions 1-15

Use the Multiple-choice Answer Sheet provided.

Answer the questions by selecting the alternative that best answers the question. Indicate your choice by filling in the appropriate place on the Answer sheet, as shown below, where **A** has been selected as the best alternative,

A ● **B** ○ **C** ○ **D** ○

If you make a mistake, indicate your choice by labelling the correct alternative, as shown below where, the original choice **A** was a mistake, and **C** is now selected as being the correct answer.

A ⊗ **B** ○ **C** ● *Correct* **D** ○

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1 Which of the following statements correctly describes a redox reaction?

(A) The oxidation half-reaction and the reduction half-reaction occur simultaneously.
(B) The oxidation half-reaction occurs before the reduction half-reaction.
(C) The oxidation half-reaction occurs after the reduction half-reaction.
(D) The oxidation half-reaction occurs spontaneously but the reduction half-reaction does not.

2. Consider the following reaction

$$Zn_{(s)} + 2\,H^+ + 2\,MnO_{2\,(s)} \longrightarrow Zn^{2+} + Mn_2O_{3\,(s)} + H_2O_{(l)}$$

What is the oxidant in this reaction?

(A) $MnO_{2\,(s)}$
(B) $Mn_2O_{3\,(s)}$
(C) $Zn_{(s)}$
(D) H^+

3. The hydronium ion concentration (in $molL^{-1}$) of some common substances is given in the Table below

$[H_3O^+]$	**Substance**
10^{-9}	baking soda
10^{-5}	black coffee
10^{-8}	sea water
10^{-11}	laundry detergent
10^{-6}	milk
10^{-13}	chlorine bleach
10^{-4}	soda water

Of the substances listed which of the following are acidic?

(A) Soda water and chlorine bleach
(B) Milk and laundry detergent
(C) Sea water and baking soda
(D) Black coffee and milk

4. In the equilibrium

$$N_2H_5^+(aq) + SCN^-(aq) \rightleftharpoons HSCN(aq) + N_2H_4(aq)$$

(A) $N_2H_5^+$ acts as a acid
(B) SCN^- acts as a acid
(C) HSCN acts as a base
(D) N_2H_4 acts as a acid

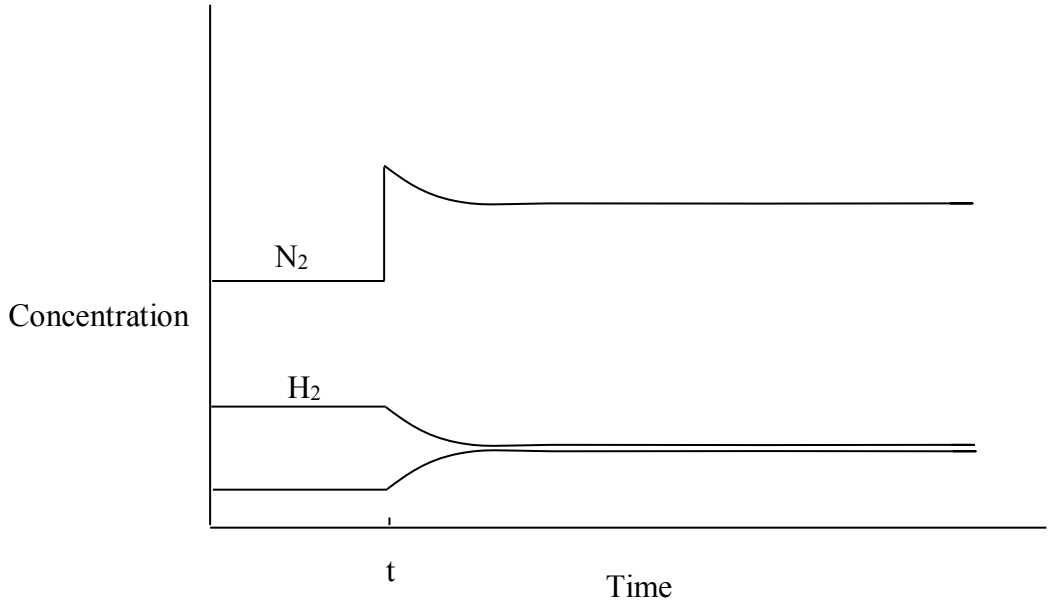
5. Which statement best describes a weak acid solution?

(A) There are no neutral acid molecules present.
(B) Only a fraction of the acid molecules is ionised.
(C) All acid present is ionised to hydrogen ions.
(D) The total concentration of acid molecules present is high.

6. In the process of esterification the reactant alcohol and acid mixture is refluxed. What is the purpose of refluxing the mixture?

(A) Speed up the reaction
(B) Prevent the loss of alcohol as the reactant mixture is heated
(C) Remove the water produced as a product of the reaction
(D) Force the reaction to come to equilibrium

7. An equilibrium mixture between nitrogen, hydrogen and ammonia was subjected to a change at time t. The result of this change is shown in the diagram below.



What was the change made to the equilibrium mixture at time t?

(A) The pressure in the equilibrium mixture of nitrogen and hydrogen was decreased.
(B) The temperature of the reaction mixture was raised.
(C) The concentration of nitrogen gas in the equilibrium mixture was increased.
(D) The volume of the reaction vessel was increased.

8. Which substance can act both as an acid and as a base, in dilute solutions?

(A) Calcium carbonate
(B) Ammonium nitrate
(C) Ethanol
(D) Water

9. The pH values of four acids and their concentrations are shown in the table below.

Acid	Conc. (mol L^{-1})	pH
P	0.01	2.0
Q	0.05	1.0
R	0.1	1.0
S	0.1	2.0

Which acid can donate more than one proton?

(A) P
(B) Q
(C) R
(D) S

10. Which group of substances below result in a lower pH when dissolved in water?

(A) Ammonia, sodium hydroxide, potassium carbonate
(B) Hydrogen chloride, ethanol, carbon monoxide
(C) Sodium oxide, magnesium oxide, calcium hydroxide
(D) Carbon dioxide, sulfur dioxide, hydrogen bromide

11. When making the ester, ethyl propanoate, concentrated sulfuric acid is added to a mixture of ethanol and propanoic acid. One effect of the sulfuric acid is to increase the yield of the ester. Which of the following is the correct explanation for this increased yield?

(A) Sulfuric acid is a dehydrating agent and removes water as a reaction product.
(B) Sulfuric acid provides hydrogen ions which catalyse the reaction.
(C) The mixture becomes hot, which accelerates the reaction.
(D) The boiling point of the mixture increases, allowing a higher reaction temperature.

12. Which of the following 4 carbon atom molecules has the highest boiling point?

(A) Butane
(B) Methyl propanoate
(C) Butanoic acid
(D) 2-butanol

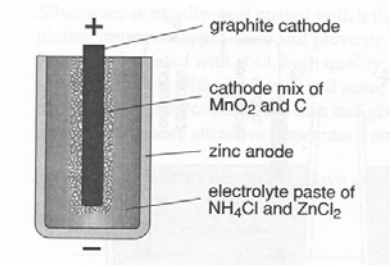
13. A 285.3 g bottle of soda awater was deccarboanted by adding 14.7 g of salt into it. The final mass was 296 g. The volume of gas formed at 25°C and 100kPa was -

(A) 2.22 L
(B) 2.06 L
(C) 2.25 L
(D) 2.04 L

14. When an indicator is used in acid base titration, its colour change -

(A) always identifies the equivalence point.
(B) only occurs at a pH of 7.
(C) needs to correspond to that point when the moles of acid and base present in the mixture are identical.
(D) needs to correspond to that point when the moles of acid and base present in the mixture correspond to the molar ratio of the balanced equation.

15. The diagram below shows a dry cell battery.



Which of the following statements is correct for this dry cell battery?

(A) The manganese(IV) oxide is the electrolyte.
(B) The graphite rod is the anode
(C) Graphite is reduced at the cathode
(D) Zinc is oxidised to zinc(II) at the anode.

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Section 1 (continued)

Part B – 30 marks
Attempt Questions 16-20

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Marks

Question 16 (10 marks)

(a) (i) From the Table of Standard Potentials, select TWO metals that will reduce hydrogen ions to hydrogen gas. **1**

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(ii) Using one of the metals in part (i) write oxidation and reduction half reactions for the reaction which occurs. **2**

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(iii) Write a balanced overall cell equation for the redox reaction. **1**

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Question16 continues on page 9.

(b) (i) Sketch and label a diagram showing the structure of ONE of the following cells: **Marks**

- button cell
- fuel cell
- lithium cell
- liquid junction photovoltaic device (eg the Gratzel cell),
- vanadium redox cell

3

(ii) Explain the chemistry of the cell drawn in b(i) **3**

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Student Number: ……..

Marks

Question 17 (9 marks)

(a) (i) Define acids and bases according to the Bronsted-Lowry theory. **1**

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(ii) In the following two reactions, state whether HCO_3^- behaves as an acid or a base. Explain your answer in each case. **2**

1. $H_2CO_3(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + HCO_3^-(aq)$
2. $HCO_3^-(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + CO_3^{2-}(aq)$

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(b) The pH of a 0.001 $molL^{-1}$ solution of hydrochloric acid and the pH of a 0.056 $molL^{-1}$ of acetic (ethanoic, CH_3COOH) acid is 3.

(i) Compare the concentration of each acid. Explain your answer. **2**

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(ii) Compare the strength of each acid. Explain your answer. **2**

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Question17 continues on page 11.

Marks

(iii) Compare the hydrogen ion concentration in the solutions of each acid. Explain your answer.

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Marks

Question 18 (6 marks)

During your practical course you have performed a first hand investigation whereby you made an ester.

(a) Identify the ester produced. **1**

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(b) Write a balanced chemical equation for the production of this ester. **1**

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(c) Justify the procedure used to produce this ester.

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Question 19 (2 marks) **Marks**

Potassium metabisulphite, $K_2S_2O_5$, is added to wine to prevent oxidation. The reaction mechanism is as follows:

$$S_2O_5^{2-}{}_{(aq)} + H_2O_{(l)} \rightarrow 2HSO_3^-{}_{(aq)}$$
$$HSO_3^-{}_{(aq)} + H_3O^+{}_{(aq)} \leftrightarrow SO_2{}_{(aq)} + 2H_2O_{(l)}$$

Use the equations to explain how adding potassium metabisulphite will affect the pH of wine.

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Student Number: ……..

Marks

Question 20 (3 marks)

(a) Use an equation to show the ionisation of acetic (ethanoic) acid in water. **1**

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(b) Use a diagram to model the ionisation of acetic (ethanoic) acid in water. **2**

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Section II

20 marks

Answer Question 21 below.

Answer the question in a writing booklet. Extra writing booklets are available. Show all relevant working in questions involving calculations.

Question 21 – Shipwrecks, Corrosion and Conservation (20 marks) **Marks**

(a) A solution of copper(II) chloride is electrolysed using inert graphite electrodes. At one of the electrodes, bubbles form. Analysis of these bubbles shows that two different gases are being formed, one of which is confirmed to be chlorine.

(i) In your answer booklet, draw a fully labelled diagram of the equipment used for this electrolysis. **2**

(ii) With the use of a half equation, identify the other gas produced. **1**

(iii) Calculate the applied voltage required for this electrolysis reaction to proceed. **2**

(iv) As the reaction proceeds, other observable changes occur. Describe two of these changes and explain why they occur. **2**

(b) (i) Identify the trend in oxygen concentration with increasing depth in the ocean. **1**

(ii) Explain why the oxygen concentration changes with increasing depth. **2**

(c) The work of Galvani, Volta, Davy and Faraday has helped in increasing an understanding of electron transfer reactions. Describe the impact of this work on society. **4**

(d) You performed a first-hand investigation to compare and describe the rate of corrosion of metals in different acidic and neutral solutions.

(i) Outline the procedure used and the results you obtained. **2**

(ii) Identify a risk associated with this procedure. **1**

(iii) Use your results to explain why metal corrosion is accelerated in an acidic environment. **3**

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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

$$\text{pH} = -\log_{10}[\text{H}^+] \qquad \Delta H = -m\,C\,\Delta T$$

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 / Atomic Weight / Name of element

Example: 79 Au 197.0 Gold

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.

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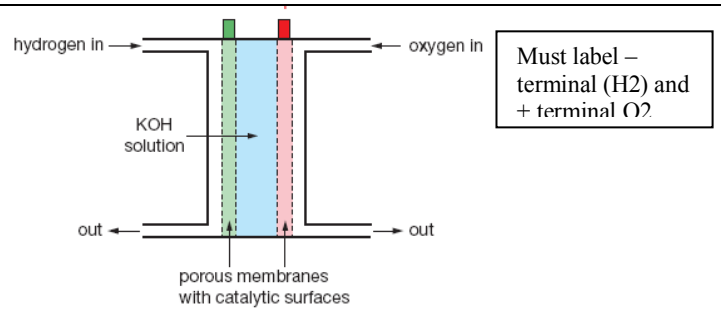
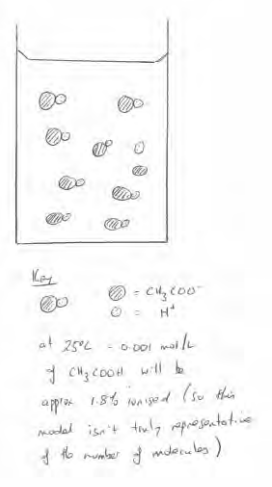
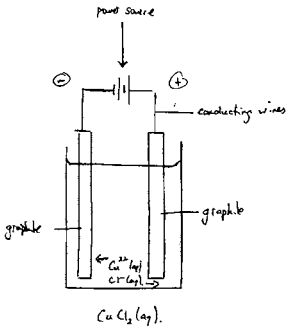
2008 HSC Half Year
Marking Guidelines

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

Quest	Sample Answer	Marking Scheme
16 (a) (i)	any TWO of Mg, Al, Zn, Fe, Ni, Sn or Pb	Must have 2 for 1 mark
16 (a) (ii)	Oxidation half reaction $Mg(s) \leftrightarrow Mg^{2+}(aq) + 2e$ Reduction half reaction $2H^{+(aq)} + 2e \leftrightarrow H_{2(g)}$	1 for each correct oxidation and reduction equation
16 (a) (iii)	Redox cell reaction $Mg + 2H^+ \leftrightarrow Mg^{2+} + H_2$	Correct combination of half cell reactions to overall redox cell reaction (depending on metal chosen) with states.
16(b) (i)		Correct sketch that represents accurate diagram of cell, correct labelling of electrodes, electrolytes, and terminals (-1 each error) NB Identify, by name of the cell chosen
16(b) (ii)	Cause: $H_2 + 2OH^- \rightarrow 2H_2O + 4e^-$ Effect: The oxidation reaction involving hydrogen gas and the hydroxide ion provides the electrons for the reaction. Cause: $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$ Effect: The reduction reaction results due to the electrons provided at the anode to produce hydroxide ions. These reactions above produce water. $2H_2 + O_2 \rightarrow 2H_2O$ • Description to include at least an understanding of electrodes (porous carbon with a catalyst surface)and the fact they don't undergo change with electrode reactions • the cell can work indefinitely as long as fuel is supplied • electrolyte, gets diluted and must be replenished	3 Marks Correct half equations and correct net equation (1 mark) and description of the reactions (2 marks)
17 (a) (i)	An acid is a substance, that in solution, tends to **donate protons**, and a base is a substance that tends to **accept protons.**	1 all correct
17 (a) (ii)	**Cause:** the hydrogen carbonate ion is amphiprotic. **Effect:** In the first reaction, HCO_3^- is acting as a base as it accepts H^+ to form H_2CO_3; in the second reaction, HCO_3^- is acting as an acid as it donated a proton to form CO_3^{2-}.	1 mark each reaction

17 (b) (i)	**Cause:** The concentration of an acid refers to the amount of solute in a volume of solution **Effect:** Thus hydrochloric acid is less concentrated as 0.001 is lower in conc than 0.56	1 mark qualitative 2 marks quantitative
17 (b) (ii)	**Cause:** The strength of an acid refers to the degree of ionisation or dissociation in solution. **Effect:** Ethanoic is less ionised in solution and thus is the weaker acid. Using this information, it is only 1.8% ie (0.001÷0.056)x100 ionised while HCl is 100% ionised.	2 marks must be quantitative with working
17 (b) (iii)	**Cause:** Since the pH, which is a measure of hydrogen ion concentration, **Effect:** Each acid is the same, the hydrogen ion concentration in solution must be the same. $[H^+] = 10^{-pH}$ $= 10^{-3}$ $= 0.001$ mol/L	2 marks must be quantitative with working with the correct explanation
18 (a)	(a) Ethyl ethanoate	1 mark – identifies the ester made.
18 (b)	$CH_3COOH + CH_3CH_2OH \overset{*}{\leftrightarrow} CH_3COOCH_2CH_3 + H_2O$ * concentrated sulphuric acid + heat under reflux.	1 marks – balanced equation
18 (c)	Add together 5mL of ethanol, 6mL of ethanoic acid and 8 drops of sulphuric acid in a quick fit reaction flask that can be connected to a water cooled condensor. **Justification:** The concentrated sulphuric acid acts as a catalyst and speeds up the rate of reaction. It also absorbs water therefore drives the above equilibrium to the right and increases the yield of ester. Add a couple of glass boiling chips. **Justification:** Dispersal of heat to ensure even heating and prevents bumping. Heat in a hot water bath under reflux for 20 minutes. **Justification:** The hot water bath provides a constant heating temperature of 100°C around the flask which also ensures even heating. This increases the rate of reaction and results in a higher yield.. A Bunsen flame used directly would be too hot and as the reactants are flammable and volatile they maybe ignited by the flame. Reflux ensures that as reactants evaporate, they then get condensed and return to the reaction flask. After refuxing for 20 minutes distill and collect the fraction that evaporates at 75-85°C. **Justification:** In the reaction flask is a mixture of ethyl ethanoate, ethanol, ethanoic acid and sulphuric acid. Distillation helps separate the ester as this is the temperature it evaporates. Pour distillate into a separating funnel and add sodium carbonate until gas stops evolving. **Justification:** The sodium carbonate reacts with left over ethanoic acid and sulphuric acid that escaped into the distillate. The sodium carbonate reacts to produce salt,	3-4 marks • detailed description of necessary equipment and the refluxing process or suitable diagram. • Justification given for all equipment, chemicals (including catalyst, must say conc sulphuric acid) and refluxing. 2 marks • Describes equipment and refluxing process or draws a diagram. • Identifies some chemicals and gives at least one reason for a piece of equipment. 1 mark Outlines some chemicals or equipment

	carbon dioxide and water. Example: $CH_3COOH + Na_2CO_3 \leftrightarrow CH_3COO^- Na^+ + CO_2 + H_2O$ Separate by opening the tap of the funnel and release the aqueous layer. **Justification:** The oily layer is on top and is the ester. After releasing the aqueous layer, all that is left in the separating funnel is the ester.	
19	The addition of metabisulphite ($S_2O_5^{2-}$) increases the concentration of of HSO_3^- as shown in the first equation. The second equation shows an equilibrium reaction. The system adjusts to overcome this increase in the concentration of HSO_3^- by favouring the forward reaction. This causes the concentration of H_3O^+ to decrease and the pH to increase.	**3-4 marks** Clearly demonstrates a quantitative understanding of pH as it relates to $[H_3O^+]$AND explains the effect of a decrease in $[H_3O^+]$ concentration with reference to the second equation. **2 marks** Demonstrates an understanding of pH as it relates to $[H_3O^+]$ AND explains the effect of a decrease in $[H3O+]$concentration with reference to the second equation. **1 mark** Identifies the pH change as becoming more basic or less acidic
20 (a)	$CH_3COOH (aq) \leftrightarrow CH_3COO^- (aq) + H^+ (aq)$	Must have states and equil arrow.
20 (b)		Must be quantitative
21	(i) 	2 Marks - Must have electrodes labelled, solutions labelled, electron flow, polarity of electrodes. Subtract 1 for each omission. 1 Mark - Correct identification of gas.

	(ii) $2H_2O(l) \rightarrow O_2(g) = 4H^+(aq) + 4e^-$ Gas produced is oxygen gas (iii) $Cu^{2+} + 2e^- \rightarrow Cu$ +0.34V $Cl^- \rightarrow Cl_2 + 2e^-$ -1.36V $Cu^{2+} + 2Cl^- \rightarrow Cu + Cl_2$ -1.02V So a voltage **<u>greater than 1.02V</u>** must be applied. (iv) The negative electrode (cathode) increases in mass due to the deposition of copper because of the reduction of copper ions. The blue colour of the solution diminishes due to the reduction of the blue copper ions.	2 Marks - Greater than 1.02V with working 1 Mark - Correct answer with equations but no reference to greater than OR greater than 1.02V but no working OF incorrect answer but correct use of equations. 2 Marks - 2 valid observations with explanations. 1 Mark - 1 valid observation with explanation OR 2 valid observations with no explanation.
	(b) (i) Oxygen concentration decreases (then increases in some areas) NB Cause: Effect (ii) Cause: Lot of oxygen at surface At the surface there is a lot of photosynthetic organisms producing oxygen and high partial pressure of oxygen above water results in oxygen dissolving. [1 mark] : As depth increases, less photosynthetic organisms but many organisms respiring and using oxygen causing it to decrease.[1 mark] (At great depths water from Arctic and Anatatric regions feeds in. This water is high on oxygen hence concentration increases slowly.)	1 Mark – Identifies the trend correctly 2 Marks - Full working and correct answer
	<u>Work of Early Scientists</u> <u>Galvani</u> Galvani discovered effect of static charge and electric currents on muscles and nerves in frogs. Frog muscles contracted when the spinal cord was connected to iron with a copper hook. Twitching occurred when the nerve was touched with different metals. Conclusion was the tissues contain an electric fluid called ***"animal electricity"*** as no external source of electricity was involved. Believed the brain created the fluid and nerves conducted the fluid to muscles which were stimulated by it. <u>Volta</u> Repeated and extended his experiments with frogs legs based on extending the idea of whether the electricity was in the muscle or arose from the metals connected by moist salty flesh of frogs leg. He tested different metals and the twitching got stronger as the similarity between the metals decreased. Described Galvani's "animal electricity" as "metal electricity". So concluded that "life, tissue or a vital force" not responsible but it was the metals. The	**3-4 Marks** Outlines the work of Galvani, Volta, Davy and faraday in inceasing our understanding of electron transfer reactions AND provides features and characteristics of the impact of this work on society. **2 marks** States the work of at least two of Galvani, Volta, Davy and faraday increasing our understanding of electron transfer reactions OR provides features and characteristics of the impact of this work on society. **1 mark** States the work of at least one of Galvani, Volta, Davy and faraday increasing our understanding of electron transfer reactions

salty environment from the frogs led connected the metals. Metal ***contact theory*** important lead into electrochemistry.

Davy

Developed the voltaic pile to create a bigger battery and electrolysed water. Electrolysed molten KOH and NaOH to produce K and Na. after realizing aqueous solutions only produced hydrogen and oxygen gas. Went on to isolate Sr, Ca, Mg, Ba Electric current through molten salts, resulting in ***reduction reactions*** to produce metals. Electrolyte used regulates the ***substance formed*** at each electrode. Compounds contained charges particles which ***conduct electricity*** by moving to the opposite charged electrode. An electric force holds compounds together

Faraday

Electrolytic reactions leading to the development of the Faraday's Laws of Electrolysis. Amount of an element produced (***quantitative analysis***) by electrolysis dependent on quantity of electricity passed through the circuit, the atomic mass, the element and the valency. Quantitative laws supported the concept at the time ***that electricity was a particle (electron)***. Electrolyte theory that salts break up and the resulting charged particles move to the opposite electrodes. Terms such as anode, cathode, anion, cation, electrode and electrolysis which helped his descriptions of the experiments he carried out.

Impact on society

The above shows the work done by each scientist in assisting in an understanding of electron transfer reactions. With this knowledge came significant impacts on society such as:

- Portable forms of electricity enabling operation of devices such as torches.
- Isolation of metals through electrolysis eg copper to be used in electrical wiring
- Transport is electricity dependent, as is heating lighting, enetertainment

(d)

(i) Set up test tubes according to the following table

Test tube #	Metal	Vol of Soln	Soln
1	0.5cm^2 Mg	5mL	0.1 mol/L HCl
2	0.5cm^2 Fe	5mL	0.1 mol/L HCl
3	0.5cm^2 Mg	5mL	1.0 mol/L HCl
4	0.5cm^2 Fe	5mL	1.0 mol/L HCl
5	0.5cm^2 Mg	5mL	0.1 mol/L CH_3COOH
6	0.5cm^2 Fe	5mL	0.1 mol/L CH_3COOH
7	0.5cm^2 Mg	5mL	1.0 mol/L CH_3COOH
8	0.5cm^2 Fe	5mL	1.0 mol/L CH_3COOH
9	0.5cm^2 Mg	5mL	0.1 mol/L NaCl
10	0.5cm^2 Fe	5mL	0.1 mol/L NaCl
11	0.5cm^2 Mg		1.0 mol/L NaCl

2 marks

Sketches in general terms the relevant procedure identifying all conditions [1] AND shows results [1]

12	0.5cm^2 Fe		1.0 mol/L NaCl
13	0.5cm^2 Mg		Distilled water
14	0.5cm^2 Fe		Distilled water

Results

Test Tube	Results
1	4
2	3
3	5
4	4
5	3
6	2
7	4
8	3
9	2
10	2
11	3
12	3
13	2
14	2

Scale of 0-5 of corrosion, measured by recording appearance and size of metal after all metals being submersed for exactly 24 hours.
0 = no reaction
1 = very small amount corrosion
2 = small amount of corrosion
3 = moderate corrosion
4 = significant corrosion
5 = high corrosion

(ii)
Identify: Acidic solutions
Assess: Acidic solutions are corrosive to the skin.
Control: Use a dropper to carefully transfer the acid to t5he test tube to minimise splashing upon transfer. Wear gloves as a final protection measure.

Full RA [1]

(iii)

In the experiment metal corrosion was significantly accelerated in the acidic environment as compared to the neutral environments. The higher the acid concentration, the greater the rate of corrosion the metal. The more reactive Mg corroded faster than the Fe.

Relates results of experiment [1]
Provides correct equations [1]
Correct explanation [1]

Iron corrosion can be used to explain why this is the case.

Iron oxidises according the following equation:

$Fe_{(s)} \leftrightarrow Fe^{2+}_{(aq)} + 2e^-$

The reduction reaction possibilities are as follows:
$O_{2\,(g)} + 2H_2O_{(l)} + 4e^- \leftrightarrow 4OH^-_{(aq)}$ E^o (red) = +0.40V ……1
$O_{2\,(g)} + 4H^+_{(aq)} + 4e^- \leftrightarrow 2H_2O_{(l)}$ E^o (red) = +1.23V ……2

The acidic environment (eg presence of $SO_{2\,(g)}$ due to human activity) provides a more spontaneous reaction. Also, the H^+ ions from reaction 2 react with the OH^- ions from reaction 1. This drives the first reaction to the right, therefore increasing the E^o of equation 1.