

Student Number:



2007

Mid Year Examination

HSC CHEMISTRY

Thursday 22 March, 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
Miss Dreesbeimdieke
Mr Weeding
44 students

Total marks - 65

Section I – 45 marks

Part A (15 marks)

- Attempt Questions 1-15

Part B (30 marks)

- Attempt Questions 16- 22

Section II - 20 marks

- Attempt Question 23

Student Number:

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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,

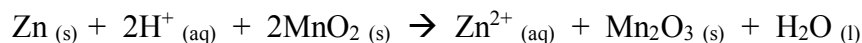
A **B** **C** **D**

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** **D**

Correct ↙

1. Consider the following reaction:



What is the reductant in this reaction?

- (A) $\text{MnO}_2_{(s)}$
 - (B) $\text{Mn}_2\text{O}_3_{(s)}$
 - (C) $\text{Zn}_{(s)}$
 - (D) $\text{H}^+_{(aq)}$
2. Identify the amphoteric species.
- (A) methanol
 - (B) water
 - (C) ammonium sulphate
 - (D) calcium carbonate
3. The pH values of four acids and their concentrations are shown in the table below.

Acid	Concentration (mol/L)	pH
A	0.1	2.0
B	0.1	1.0
C	0.05	1.0
D	0.01	2.0

Which acid is diprotic?

- (A) A
 - (B) B
 - (C) C
 - (D) D
4. Which group of substances below would produce a solution with a pH greater than 7?
- (A) ammonia, sodium hydroxide, potassium carbonate
 - (B) carbon dioxide, sulphur dioxide, hydrogen iodide
 - (C) hydrogen chloride, ethanol, carbon dioxide
 - (D) sodium oxide, nitrous oxide (N_2O), magnesium hydroxide

5. Two drops (0.1mL) of 0.1 mol/L HCl is added to a small beaker of each of the following solutions. In which beaker will the pH of the solution stay approximately constant?

- (A) A solution of ethanol and ethanoic acid.
- (B) A solution of ethanol and ethane.
- (C) A solution of ethanoic acid and sodium ethanoate.
- (D) An equimolar solution of ethanol and sodium ethanoate.

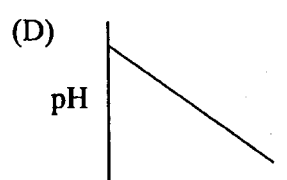
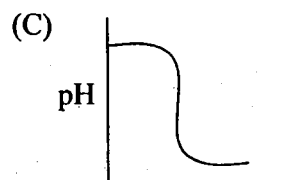
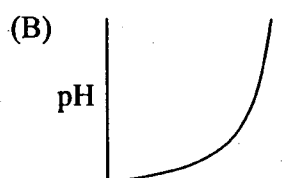
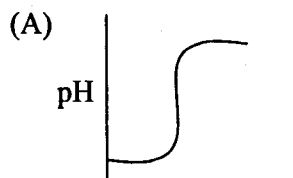
6. An unknown chemical was extracted from a soil sample and sent to a laboratory. The following result was achieved using indicators.

Indicator	Colour
Phenolphthalein	colourless
Methyl orange	red
Bromothymol blue	yellow

It can be assumed that the unknown chemical is:

- (A) strongly acidic
- (B) slightly acidic
- (C) neutral
- (D) slightly alkaline

7. Which curve below would represent the change in pH in a conical flask when a solution of sodium hydroxide (from a burette) is added to a solution of hydrochloric acid (in the conical flask)?

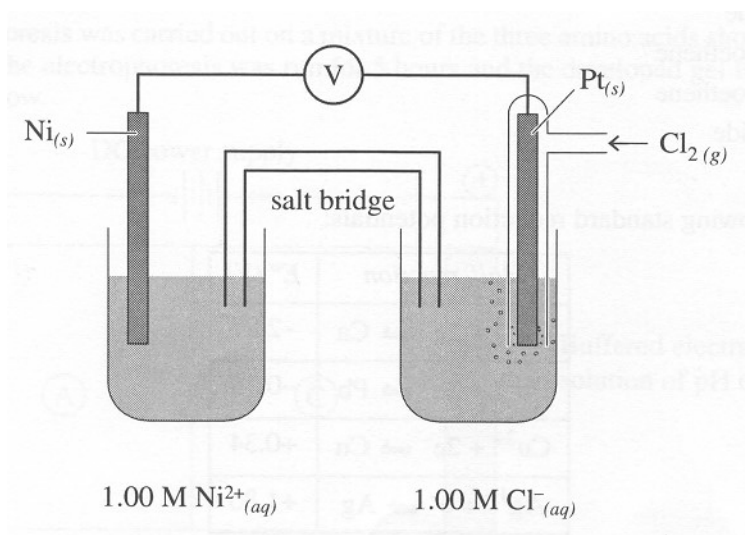


Student Number:

8. Calculate the mass of carbon dioxide formed when 1.67g of ethanol reacts with excess oxygen gas to ensure complete combustion.

- (A) 0.80g
- (B) 1.59g
- (C) 3.19g
- (D) 44.0g

9. Consider the following diagram.



Which of the following describes what happens to the concentrations of nickel ions, chlorine gas and chloride ions and the masses of the nickel and platinum electrodes as this galvanic cell operates under standard conditions.

	<i>Concentration of Ni²⁺</i>	<i>Concentration of Cl₂</i>	<i>Concentration of Cl⁻</i>	<i>Mass of Ni electrode</i>	<i>Mass of Pt electrode</i>
(A)	decrease	no change	no change	increase	no change
(B)	increase	decrease	increase	decrease	no change
(C)	decrease	increase	increase	increase	decrease
(D)	increase	decrease	increase	decrease	increase

10. Which of the following substances would NOT be present in the reaction flask during the preparation of propyl ethanoate

- (A) 1-propanol
- (B) ethanoic acid
- (C) propanoic acid
- (D) concentrated sulphuric acid

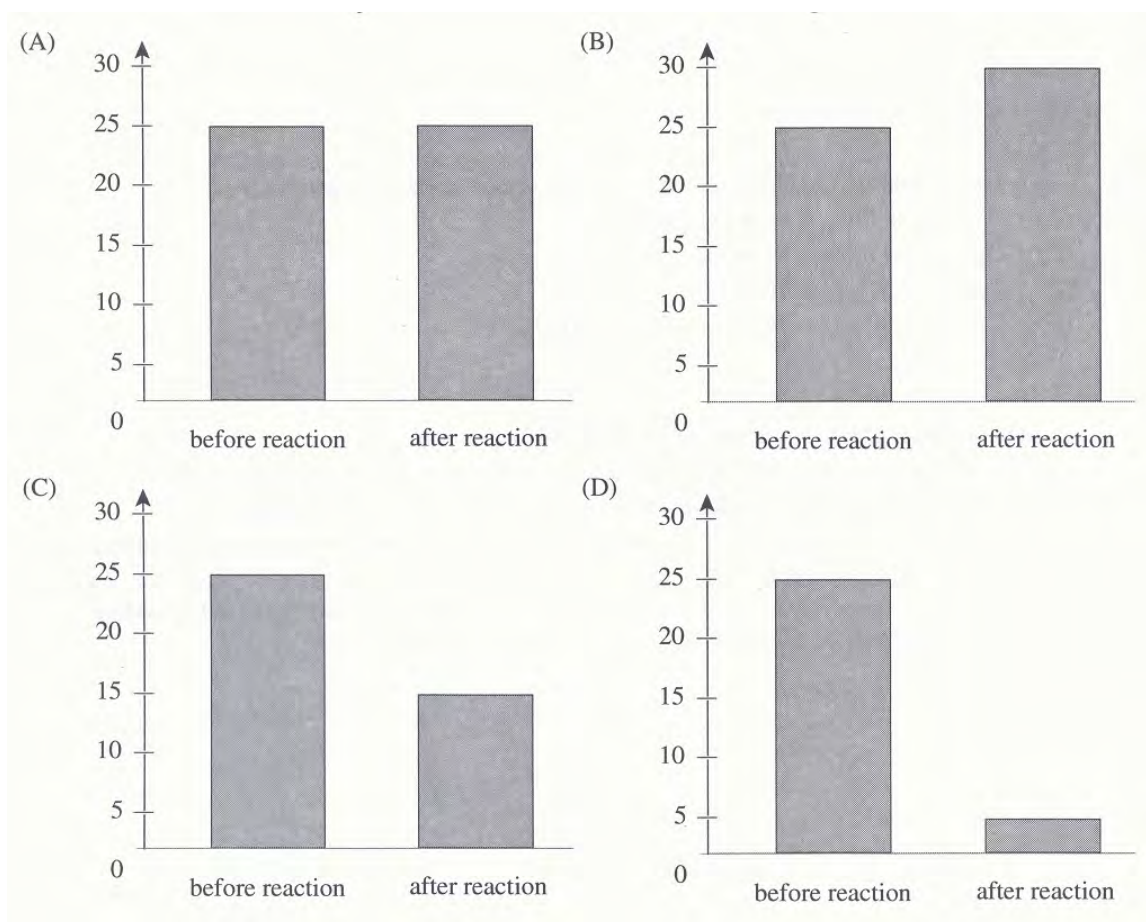
Student Number:

11. A student performs a titration between acetic acid and sodium hydroxide. The acid is delivered from the burette and the sodium hydroxide is in the conical flask.

Which of the following shows the best rinsing procedure that the student should follow?

	<i>Pipette</i>	<i>Conical Flask</i>	<i>Burette</i>
(A)	Rinsed with NaOH	Rinsed with distilled H ₂ O	Rinsed with CH ₃ COOH
(B)	Rinsed with distilled H ₂ O	Rinsed with NaOH	Rinsed with distilled H ₂ O
(C)	Rinsed with NaOH	Rinsed with distilled H ₂ O	Rinsed with distilled H ₂ O
(D)	Rinsed with distilled H ₂ O	Rinsed with NaOH	Rinsed with CH ₃ COOH

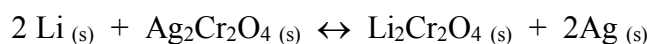
12. A student added 20mL of 1 mol/L HCl (aq) to 20mL of 1 mol/L NaOH (aq) at room temperature. The column graph that correctly compares the temperature of the solutions before they were reacted and once the reaction is complete is -



13. Identify the entry in the table below that correctly identifies a Bronsted-Lowry acid base pair.

	<i>Acid</i>	<i>Base</i>
(A)	H ₂ F ₂	HF
(B)	H ₂ O	OH ⁻
(C)	HCO ₃ ⁻	H ₂ CO ₃
(D)	CH ₃ COOH	CH ₃ OH

14. Heart pacemakers are often powered by lithium-silver chromate button cells. The overall reaction is:



What is the anode this cell?

- (A) Ag
 (B) Li
 (C) Ag⁺
 (D) Cr₂O₄²⁻
15. During a first-hand investigation, a student recorded the following results:

Metal E displaces ions of metal F. Metal F displaces ions of both metals G and H. Both metals G and H displace ions of metal I.

Based on these results, which scenario below is correct if a galvanic cell was to be established?

	<i>Anode</i>	<i>Cathode</i>	<i>Electron movement</i>
(A)	G	H	H → G
(B)	F	G	F → G
(C)	E	I	I → E
(D)	E	G	G → E

Section 1 (continued)

Part B – 30 marks

Attempt Questions 16-22

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Marks

Question 16 (5 marks)

You have performed a first-hand investigation in which you identified the pH of a range of salt solutions.

(a) Outline the procedure you used for your first-hand investigation.

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(b) Predict the acidic, basic or neutral nature of ammonium nitrate and sodium ethanoate. Justify your prediction, including relevant equations in your answer.

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Student Number:

Marks

Question 17 (4 marks)

Although the atmosphere naturally contains acidic oxides of nitrogen and sulphur, the levels of these oxides have been increasing since the industrial revolution.

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Assess the evidence which indicates increases in atmospheric concentration of these oxides.

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Question 18 (5 marks)

Marks

- (a) In the space below, sketch a graph that demonstrates the difference in boiling points between alkanes, alkanolic acids and alkanols.

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- (b) Explain the trends in boiling points shown in the graph.

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Student Number:

Marks

Question 19 (5 marks)

- (a) Many commercial products contain acids and esters. Using specific examples, outline the use of esters and acids found in products that can be purchased in the supermarket.

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- (b) Draw a diagram of the reflux apparatus used in the preparation of an ester in the laboratory.

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Student Number:

Marks

Question 20 (3 marks)

Wayne is a very poor surfer so he would rather collect shells at the beach and determine the percentage composition of calcium carbonate in the shells he finds.

3

He placed a clean dry shell which weighed 1.306g in a small beaker. To this he added 10mL of 5 mol/L hydrochloric acid to dissolve the shell completely. The HCl is in excess. The resulting solution was transferred into a volumetric flask and the volume was made up to 25mL with distilled water. A 10mL sample from this solution required 11.2mL of 1 mol/L NaOH for complete neutralisation.

Calculate the percentage of calcium carbonate in the shell.

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Question 21 (5 marks)

In order to produce a cell with a voltage between 1.1V and 1.2V, a student constructed a Galvanic Cell with copper and silver half cells using a potassium chloride salt bridge. The cell was set up under standard conditions.

(a) Draw a diagram of the Galvanic Cell the student constructed.

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(b) Assess this students' experimental design.

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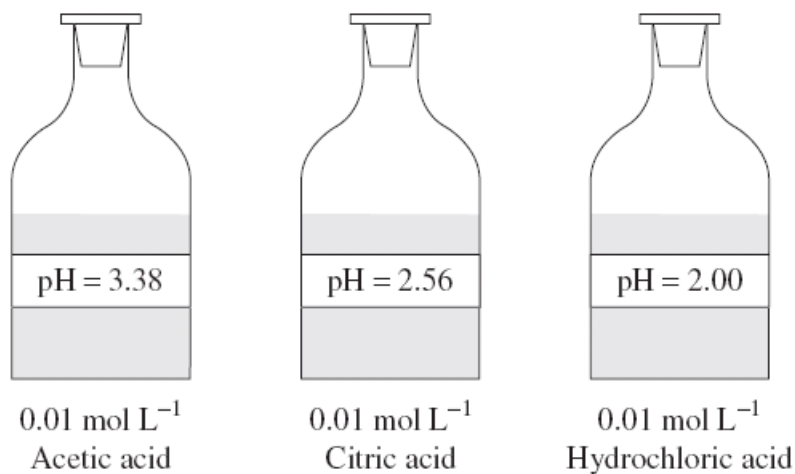
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Question 22 (3 marks)

The diagram below can be used to compare the relative strengths of three different acids.

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Use the information provided in the above diagram to describe the difference between a strong and a weak acid in terms of an equilibrium between the intact molecule and its ions.

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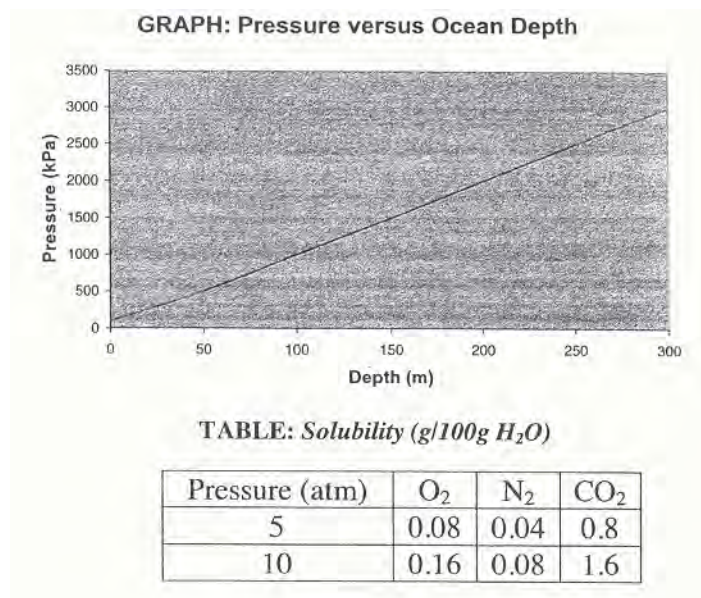
Section II**20 marks****Answer Question 23 below.**

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

Marks**Question 23 – Shipwrecks, Corrosion and Conservation (20 marks)**

- (a) A student was asked to compare and explain the solubility and concentration of selected gases at increasing depths in the oceans.

The student found the following information on the internet.



Evaluate the relevance of this information in relation to the area of investigation.

5

Student Number:

	Marks
(b) Sea water contains a variety of ions including sodium, magnesium, calcium, potassium, chloride, sulphate and hydrogen carbonate. Explain the origins of these ions from minerals in the oceans.	4
(c) In your practical work, you performed a first-hand investigation to identify factors that affect the rate of an electrolysis reaction.	
(i) Outline the method you used to show how ONE factor effects the rate of an electrolysis reaction, making sure that you incorporate a risk assessment.	4
(ii) Provide a conclusion based on the results you achieved in this experiment.	2
(d) (i) Explain what steel is.	1
(ii) Compare the composition, properties and uses of TWO types of steel.	4

END OF EXAM

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DATA SHEET

Avogadro constant, N_A	$6.022 \times 10^{23} \text{ mol}^{-1}$
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	$4.18 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$

Some useful formulae

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

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

PERIODIC TABLE OF THE ELEMENTS

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	
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	
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	
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	
117 Uuh — Ununheptium		118 Uuo — Ununoctium		119 Uuq — Ununquadium		120 Uuq — Ununquadium		121 Uuq — Ununquadium		122 Uuq — Ununquadium		123 Uuq — Ununquadium		124 Uuq — Ununquadium		125 Uuq — Ununquadium		126 Uuq — Ununquadium	

KEY

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

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
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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
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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 ²³⁷Np and ⁹⁹Tc.

2007 HSC Half Year
Marking Guidelines

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

Quest	Sample Answer	Marking Scheme
16 (a)	<ul style="list-style-type: none"> Risk assessment performed. All risks were identified, assessed and controlled. 20mL of acidic salt (NH₄⁺), neutral salt (NaCl) and basic salt (Na₂CO₃) were put in a beaker. Calibrated pH meter was placed in each and the reading taken 	<ul style="list-style-type: none"> Risk assessment (1 mark) Specific mention of a range of salts by name (1 mark) Specific mention of how the pH is taken (universal indicator OK but volume and colours must be mentioned)
16 (b)	<p>NH₄⁺ + H₂O ↔ NH₃ + H₃O⁺ therefore acidic due to hydronium ions as a result of the hydrolysis reaction. Nitrate neutral. (1 mark)</p> <p>CH₃COO⁻ + H₂O ↔ CH₃COOH + OH⁻ therefore basic due to hydroxide ion as a result of hydrolysis reaction. Sodium neutral. (1 mark)</p>	As shown
17	<p><u>A brief overview outlining the oxides of nitrogen and sulphur</u></p> <p>Oxides of sulphur can enter the atmosphere naturally, such as from volcanic eruptions or industrially such as through the extraction of iron from its ore as outlined in the following equation:</p> $4\text{FeS}_2(\text{s}) + 11\text{O}_2(\text{g}) \rightarrow 2\text{Fe}_2\text{O}_3(\text{s}) + 8\text{SO}_2(\text{g})$ <p>Oxides of nitrogen can enter the atmosphere naturally through lightning strikes breaking down nitrogen and oxygen molecules or industrially as a result of air passing through an internal combustion engine as outlined in the equation below.</p> $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \leftrightarrow 2\text{NO}(\text{g})$ $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \leftrightarrow 2\text{NO}_2(\text{g})$ <p>The oxides can then react with the water in the atmosphere.</p> $\text{SO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \leftrightarrow \text{H}_2\text{SO}_3(\text{aq})$ $\text{SO}_3(\text{g}) + \text{H}_2\text{O}(\text{l}) \leftrightarrow \text{H}_2\text{SO}_4(\text{aq})$ $2\text{NO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \leftrightarrow \text{HNO}_3(\text{aq}) + \text{HNO}_2(\text{aq})$ <p><u>Evidence which shows increasing concentrations of SO₂</u></p> <ul style="list-style-type: none"> ➤ Post industrial revolution (1800's), there has been an increase in SO₂ emissions in industrial areas – expand and explain why. ➤ Acid rain (equations above) levels increased, especially since 1940, proven through precipitation record, ice cores and tree borings. This increase is associated with high manufacturing activity. For example, in the 1930's during the Depression acid rain levels low, but rose substantially in the lead up to WWII. ➤ This has been proven through processes such as deforestation such as in Eastern Europe where 50% of forests have been affected in recent years. <p><u>Evidence which shows concentrations of SO₂ is not increasing</u></p> <ul style="list-style-type: none"> ➤ Regulations in 50's and 60's have resulted in most industrial countries having concentrations lower than expected. ➤ WHO goal is 23ppb, Sydney normally 10ppb as fossil fuels have a low S content. Areas such as Illawarra and Hunter have raised levels due to increased industrial activity. ➤ Washed out by rain ➤ Primary sources of SO₂ emissions filter the air they release. Flue Gas Desulphurisation (FGD) is achieved through scrubbers containing lime (CaO) which turns SO₂ into calcium sulphite which is then oxidized to form CaSO₄ (then used as plasterboard). $\text{SO}_2(\text{g}) + \text{CaO}(\text{s}) \rightarrow \text{CaSO}_3(\text{s})$ $2\text{CaSO}_3(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{CaSO}_4(\text{s})$ <ul style="list-style-type: none"> ➤ Coal with low sulphur content used. 	<p><u>4 marks</u></p> <ul style="list-style-type: none"> Shows oxides and how they enter the atmosphere with the use of equations Evidence for increasing levels Limitations to the evidence Overall assessment <p><u>3 marks</u></p> <ul style="list-style-type: none"> Shows oxides and how they enter the atmosphere with the use of equations Evidence for increasing levels Overall assessment <p><u>1-2 Marks</u></p> <p>Limited understanding using the above as a guideline.</p>

	<p><u>Evidence which shows increasing concentrations of NO_x</u></p> <ul style="list-style-type: none"> ➤ Electricity generation and use of cars in the 20th Century have resulted in increased levels of NO_x. ➤ 1960's photochemical smog bad in big cities which led to tight controls on car emissions and from power stations. However, with a continual increase in car numbers will always come increasing levels of NO_x emissions. ➤ Acid rain (equations above) levels increased, especially since 1940, proven through precipitation record, ice cores and tree borings. This increase is associated with high manufacturing activity. For example, in the 1930's during the Depression acid rain levels low, but rose sunstantially in the lead up to WWII. ➤ Ice cores. Nitrous oxides levels (in ppb) supports the above information as in last 50 years gas bubbles show and increase from 285 to 315 ppb of NO_x. <p><u>Evidence which shows concentrations of NO_x is not increasing</u></p> <ul style="list-style-type: none"> ➤ Washed out by rain (use equation) ➤ Emission controls on cars like catalytic converters. ➤ In 15 year period, the EPA in Sydney have shown, on average, no clear trend with respect to increases. ➤ Note Sydney (peak range 93 – 320 ppb) is favourable to London (peak range 130 – 460 ppb) and LA (peak range 240 – 470 ppb). <p><u>Accuracy of Information.</u></p> <ul style="list-style-type: none"> ➤ Ice cores show a good picture of years gone by, but they are not necessarily representative of all parts of the world. ➤ Data from pollution control agencies is now starting to build over a lengthy period of time to give solid trends. Data before 1950 is not too reliable. <p><u>Overall Assessment (value judgment)</u></p> <p>It would appear that the amount of SO₂ and NO_x emitted is always increasing due to an increase in industrialization and populations; however, measures to control concentrations in the atmosphere are working and levels are not rising significantly. The removal of these gases by water also helps. This though leads to problems of decreasing pH of rain water and the problems associated with this such as deforestation. The lower the emissions (and sustained lowering) the better it is for the environment.</p>																					
18(a)	<table border="1"> <caption>Approximate data points from the graph</caption> <thead> <tr> <th>Molecular weight</th> <th>Alkanes (°C)</th> <th>Alkanols (°C)</th> <th>Alkanoic acids (°C)</th> </tr> </thead> <tbody> <tr> <td>60</td> <td>0</td> <td>100</td> <td>120</td> </tr> <tr> <td>75</td> <td>40</td> <td>120</td> <td>140</td> </tr> <tr> <td>90</td> <td>70</td> <td>140</td> <td>170</td> </tr> <tr> <td>100</td> <td>100</td> <td>160</td> <td>190</td> </tr> </tbody> </table>	Molecular weight	Alkanes (°C)	Alkanols (°C)	Alkanoic acids (°C)	60	0	100	120	75	40	120	140	90	70	140	170	100	100	160	190	Must have axis correct, labelled, and shape correct
Molecular weight	Alkanes (°C)	Alkanols (°C)	Alkanoic acids (°C)																			
60	0	100	120																			
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18(b)	<p>There are two clear trends observed in the graph; the boiling point between molecules and the boiling point within molecules.</p> <p><u>Between Molecules</u></p> <p>The boiling point of alkanolic acids is greater than alkanols which is greater than alkanes. Alkanes have the lowest BP of the three when comparing molecules of similar molecular weight. Alkanes are non-polar molecules so have only weak dispersion forces between molecules that need to be broken for boiling to occur. Alkanols also have these dispersion forces to overcome, however, as the molecule is polar with an hydroxyl functional group it also has hydrogen bonding to overcome to boil. Alkanoic acids have the highest BP's of the three. They have dispersion forces and a hydroxyl end and therefore hydrogen bonding. However, they are more polar due to the C=O carbonyl group. This results in extra polarity and greater dipole-dipole interactions and therefore more energy to overcome than alkanols of similar molecular weight.</p>	<p><u>3 Marks</u></p> <p>Must show trend between molecules with a reason and trend within molecules with a reason</p>																				

Within Molecules

As the molecular weight increases in each group the BP increases. The functional group(s) remain the same and does not account for the increase. The number of C atoms does increase and as the chain increases there is a greater number of electrons and therefore a greater number of dispersion forces. More dispersion forces between molecules results in a higher BP.

19 (a)

Ester:

banana	pentyl ethanoate
orange	octyl ethanoate
pear	pentyl ethanoate

Acids:

Acetic acid, citric acid, tartaric acid, malic acid, fumaric acid, lactic acid – preservative in pickles and other processed foods.

Phosphoric acid – preservative in cola drinks

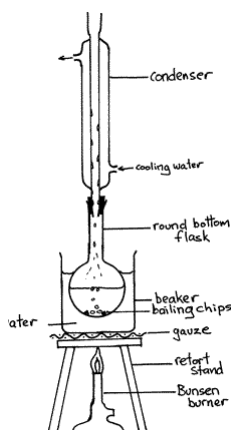
Sulphur dioxide – preservative in dried foods and wine

Ascorbic acid – antioxidant to protect soft drinks, jams, condensed milk, sausages.

Propanoic acid – in bread

2 marks – at least two examples of an ester and two examples of an acid. Each example must show where the acid and ester is used.

19 (b)



3 marks
Completely correct

2 marks
Correct diagram with no more than one error

1 mark
Reflux diagram with 2 or more errors.

20



$$\begin{aligned} 1000\text{mL has } 1 \text{ mol NaOH, so } 11.2 \text{ mL has } n(\text{NaOH}) &= \\ (11.2/1000) \times 1 & \\ &= 1.12 \times 10^{-2} \text{ mol} \\ n(\text{HCl}) &= 1 \times 1.12 \times 10^{-2} \end{aligned}$$

So, amount of HCl in beaker after reaction with shell and before dilution

$$\begin{aligned} n(\text{HCl}) &= 25 / 10 \times 1.12 \times 10^{-2} \\ &= 2.8 \times 10^{-2} \text{ mol} \end{aligned}$$

The original HCl reacted was 10mL of 5mol/L, is $(10 / 1000)\text{L} \times 5\text{mol/L} = 0.05 \text{ mol}$

3 Marks – all correct with units
2 Marks – 1 error in calculation
1 Mark – a correct equation or at least one correct calculation

	<p>so</p> <p>The amount HCl reacted with shell = $0.05 - 0.028$ $= 2.2 \times 10^{-2} \text{ mol}$</p> <p>$n(\text{CaCO}_3) = \frac{1}{2} \times 2.2 \times 10^{-2}$ $= 0.011 \text{ mol}$</p> <p>$m(\text{CaCO}_3) = 0.011 \text{ mol} \times 100 \text{ g/mol}$ $= 1.10 \text{ g}$</p> <p>$\% \text{ comp CaCO}_3 = 1.10 \text{ g} / 1.306 \text{ g} \times 100$ $= 84.2\%$</p>	
21 (a)	Diagram	2 Marks – diagram all correct 1 Mark – no more than 2 mistakes
21 (b)	<p>$\text{Cu} \leftrightarrow \text{Cu}^{2+} + 2\text{e}^-$</p> <p>$\text{Ag}^+ + \text{e}^- \leftrightarrow \text{Ag}$</p> <p>$\text{Cu(s)} + 2\text{Ag}^+ \leftrightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{Ag(s)}$</p> <p>$-0.34\text{V} + 0.80\text{V} = 0.46\text{V}$</p> <p>Positive: Student is on the right track in terms of producing electrical energy from chemical energy; Negative: however, the voltage produced of 0.46V is insufficient for the 1.1V required. Also, AgCl will ppt on the salt bridge.</p>	<p><u>3 marks</u> Equations, correct voltage and an advantage and disadvantage.</p> <p><u>2 marks</u> Equations all correct. Lacking an advantage or disadvantage.</p> <p><u>1 mark</u> Any one thing correct.</p>
22	<p>(a) All three acids are at the same concentration, that is 0.01 mol/L. However, the pH is different in each solution.</p> <p>HCl = pH 2.00 Acetic Acid = pH 3.38 Citric Acid = pH 2.56</p> <p>From this we can calculate the $[\text{H}^+]$ using $[\text{H}^+] = 10^{-\text{pH}}$</p> <p>So HCl $[\text{H}^+] = 10^{-\text{pH}}$ $= 10^{-2.00}$ $= 0.01 \text{ mol/L}$</p> <p>Acetic $[\text{H}^+] = 10^{-\text{pH}}$ $= 10^{-3.38}$ $= 4.17 \times 10^{-4} \text{ mol/L}$</p> <p>Citric $[\text{H}^+] = 10^{-\text{pH}}$ $= 10^{-2.56}$ $= 2.75 \times 10^{-3} \text{ mol/L}$</p> <p>From these calculations it can be seen that the ionisation of HCl molecules is greatest (100% ionisation) because HCl is the strongest of the 3 acids. $\text{HCl(aq)} \rightarrow \text{H}^+(\text{aq}) + \text{Cl}^-(\text{aq})$ The acetic acid is the weakest acid of the 3 meaning the</p>	<p><u>3 Marks</u> Equations, calculations and a correct statement for each acid about ionisation.</p>

	<p>ionisation of the CH_3COOH molecules (4.17%) is the least producing the lowest concentration of H^+.</p> $\text{CH}_3\text{COOH} \leftrightarrow \text{H}^+_{(\text{aq})} + \text{CH}_3\text{COO}^-_{(\text{aq})}$ <p>The ionisation of the citric acid $\text{C}_3\text{H}_5\text{O}_7\text{H}_3$ molecules (27.5% ionisation) is in the middle meaning it is a stronger acid compared to acetic acid, however a weaker acid compared to HCl.</p> $\text{C}_3\text{H}_5\text{O}_7\text{H}_3 \leftrightarrow \text{C}_3\text{H}_5\text{O}_7^{3-} + 3\text{H}^+$	
23 (a)	<p>Graph shows that as depth increases so too does pressure. The table that shows as pressure increases so too does the solubility of gases. The student therefore may have used both sources to conclude that gas solubility and therefore concentration will increase with depth. Theoretically this is correct. An increase in pressure causes a closer interaction of non-polar gas molecules with water and facilitates the formation of dispersion forces. So an increase in pressure causes an increase in solubility of gas molecules which causes an increase in the concentration of the gas in water.</p> <p>However, In the sea, gas concentration is affected by other variables. O_2 concentration decreases as aerobic organisms consume the surface O_2 so doesn't make its way down to deeper parts. Also, photosynthesis doesn't occur at depths due to no sunlight penetration. Some areas of the ocean may, however, be affected by oxygen rich water from polar regions as a result of deep currents which will cause a concentration of about 2ppm at depths >1000m CO_2 concentration increases due to the respiration of aerobic organisms N_2 concentration does not change much from its surface value of 15-20ppm as there is no significant production or removal.</p> <p>Judgement The data doesn't consider any of the factors in the ocean that regulate gas concentration. This stimulus material is theoretical only and is not relevant for this area of the investigation.</p>	<p>5 marks</p> <p>Shows an understanding of the graph and table to compare conc and solubility [1] Explains the conc and solubility [1] Demonstrates an understanding of the variables that affect CO_2, O_2 and N_2 solubility [2] Evaluates the information to show that these two sources alone are not enough [1]</p>
23 (b)	<p>Leaching of the salts from soil and rocks on land by water eg rain and ground water that runs into the oceans Hydrothermal vents – at mid-ocean ridges the water in the percolates and is super-heated. It therefore dissolves ionic substances from the rocks</p>	<p>For each example, identifies the process [1] and explains [1]</p>
23 (c)(i)	<ul style="list-style-type: none"> • Copper toxic metal so avoid all contact with the skin. • A 100 mL beaker had 50 mL 0.5 mol/L solution of copper(II) sulphate placed in it. • Into the beaker and solution was placed two graphite electrodes. One electrode was connected to the positive terminal, the other to the negative terminal of a power pack and using DC current, a voltage of 4V was applied. • The reaction was allowed to proceed to 5 minutes. • At the anode (positive terminal) oxygen gas evolved. The intensity of the bubbling was 	<p>Risk assessment [1] with a full method identifying variables and the rate will be determined. [3]</p>

	<p>ranked on a scale of 1-5.</p> <ul style="list-style-type: none"> The same procedure was repeated using different concentrations of copper(II) sulphate solution (1mol/L and 2 mol/L) keeping the variables mentioned above constant including volume of solution, same electrodes and same voltage and same time. This ensures accuracy is being achieved. Each experiment could be repeated to ensure reliability. 																									
(c) (ii)	Increasing the concentration of solution causes the rate of the electrolysis reaction to be increased.	2 marks – specific conclusion 1 mark – general conclusion																								
23 (d)(i)	Steel is an alloy of iron and carbon																									
23 (d)(ii)	<table border="1"> <thead> <tr> <th colspan="4">SUBSTANCE COMPOSITION PROPERTIES USES</th> </tr> </thead> <tbody> <tr> <td>Pure iron</td> <td>100% Fe</td> <td>Soft and malleable, corrodes slowly</td> <td>Limited</td> </tr> <tr> <td>Pig iron (cast iron)</td> <td>3-4% C, 1% Mn, 1% Si, rest Fe</td> <td>Hard and brittle, corrodes fairly rapidly</td> <td>Casting engine blocks, fire hydrants</td> </tr> <tr> <td>Mild steel</td> <td><0.2% C, rest Fe</td> <td>Soft and malleable, corrodes fairly rapidly</td> <td>Car bodies, pipes, nuts and bolts, shipbuilding</td> </tr> <tr> <td>Structural steel</td> <td>0.2-0.5% C, rest Fe</td> <td>Hard and malleable, high tensile strength, corrodes fairly rapidly</td> <td>Beams and girders, railways, shipbuilding</td> </tr> <tr> <td>Stainless steel</td> <td>10-20% Cr, 5-20% Ni, rest Fe</td> <td>Hard, takes a high polish, very resistant to corrosion</td> <td>Kitchen sinks, surgical and dental instruments</td> </tr> </tbody> </table>	SUBSTANCE COMPOSITION PROPERTIES USES				Pure iron	100% Fe	Soft and malleable, corrodes slowly	Limited	Pig iron (cast iron)	3-4% C, 1% Mn, 1% Si, rest Fe	Hard and brittle, corrodes fairly rapidly	Casting engine blocks, fire hydrants	Mild steel	<0.2% C, rest Fe	Soft and malleable, corrodes fairly rapidly	Car bodies, pipes, nuts and bolts, shipbuilding	Structural steel	0.2-0.5% C, rest Fe	Hard and malleable, high tensile strength, corrodes fairly rapidly	Beams and girders, railways, shipbuilding	Stainless steel	10-20% Cr, 5-20% Ni, rest Fe	Hard, takes a high polish, very resistant to corrosion	Kitchen sinks, surgical and dental instruments	<p>Composition of both types of steel [1] Properties of both types of both types of steels [1] Uses of both types of steel [1] Comparison is clear in each example [1]</p>
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