Student Number: ……

Teacher:…….....

2006

Trial HSC Examination

CHEMISTRY

Tuesday 29 August 2006, 9am – 12.05pm

General Instructions

- Reading time - 5 minutes
- Working time - 3 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 separately
- Write your student number at the top of every page.

Total marks - 100

Section I – 75 marks
Part A (15 marks)
- Attempt Questions 1-15
- Allow about 30 minutes for this part

Part B (60 marks)
- Attempt Questions 16-28
- Allow about 1 hour and 45 minutes for this part.

Section II - 25 marks
Option
- Attempt Question 29
- Allow about 45 minutes for this section

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57 students

Student Number: ……

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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.

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

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

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

Student Number: ……

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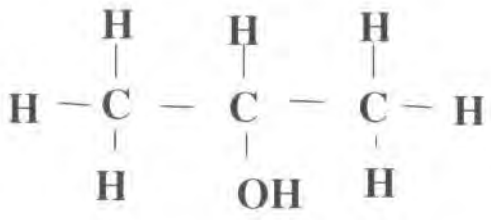
1 Which of the following is the correct IUPAC name for the molecule below.



(A) 1-propanol

(B) 2-hydroxypropane

(C) 2-hydroxypropanol

(D) 2-propanol

2 What is the oxidation state of chromium in potassium dichromate, $K_2Cr_2O_7$.

(A) -2

(B) +3

(C) +6

(D) +8

3 What is the systematic name for the monomer from which polyvinyl chloride is built?

(A) chloroethene

(B) 1,1-dichloroethene

(C) 1,2-dichloroethene

(D) vinyl chloride

4 Which of the following are significant natural sources of sulphur dioxide?

(A) lightning and bacteria

(B) bacterial decomposition and volcanoes

(C) internal combustion engine and air conditioning units

(D) coal burning power stations and metal ore smelting

Student Number: ……

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5 Which of the following is the conjugate base of water?

(A) H_3O^+

(B) OH^-

(C) H_2O_2

(D) Cl^-

6 Which of the following is the common name for 2-hydroxypropane-1,2,3-tricarboxylic acid?

(A) acetic acid

(B) citric acid

(C) ascorbic acid

(D) sulphuric acid

7 Who defined an acid as a substance containing oxygen?

(A) Lavoisier

(B) Davy

(C) Arrhenius

(D) Lowry and Bronsted

8 Which of the following equations describes a buffer?

(A) $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

(B) $HCl(aq) + H_2O(aq) \rightarrow Cl^- + H_3O^+$

(C) $H_2SO_4(aq) + H_2O(l) \leftrightarrows HSO_4^-(aq) + H_3O^+(aq)$

(D) $CH_3COOH(aq) + H_2O(l) \leftrightarrows CH_3COO^-(aq) + H_3O^+(aq)$

9 What is the pH of a $1.5 \times 10^{-4} molL^{-1}$ solution of sulphuric acid assuming complete ionisation?

(A) 4.0

(B) 3.8

(C) 3.5

(D) 1.5

Student Number: ……

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10 Which of the following pairs are isomers?

(A) graphite and diamond

(B) cyclohexane and 1-hexene

(C) cyclohexane and cyclohexene

(D) carbon-12 (^{12}C) and carbon-14 (^{14}C)

11 Consider the following standard reduction potentials:

Half-reaction	*E°(V)*
$Ca^{2+} + 2e^- \leftrightarrows Ca$	-2.87
$Pb^{2+} + 2e^- \leftrightarrows Pb$	-0.13
$Cu^{2+} + 2e^- \leftrightarrows Cu$	+0.34
$Ag^{+} + e^- \leftrightarrows Ag$	+1.80

Using the above table, which of the following metals is the strongest OXIDANT?

(A) Ca^{2+}

(B) Pb^{2+}

(C) Cu^{2+}

(D) Ag^{+}

12 To which area had Atomic Absorption Spectroscopy contributed the most?

(A) The analysis of organic water pollutants

(B) The analysis of pollutant gas levels in the atmosphere

(C) The identification and effects of trace elements

(D) The identification of metal ions in water

Student Number: ……

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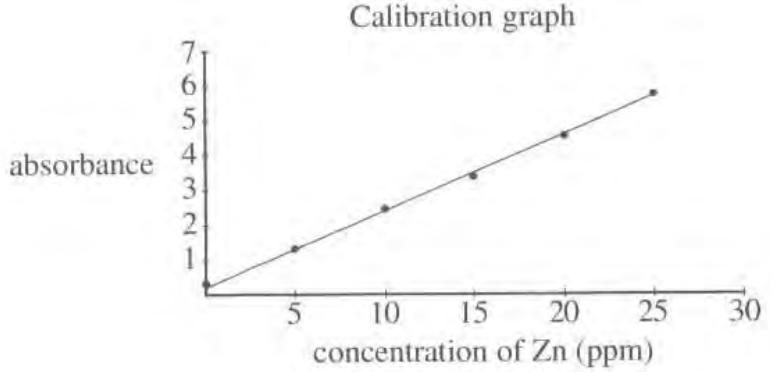
13 A sample of water was collected downstream from a factory producing batteries.
The sample was analysed for zinc content using the following method.

- Standard solutions of zinc were used to prepare a calibration curve.
- One litre of river water was collected.
- A 100 mL sample of this water was diluted to 1 L using distilled deionised water.
- A 50 mL sample of the dilute solution was used to aspirate into an atomic absorption spectrometer.

The following graph was obtained using standard solutions of zinc nitrate.



The absorbance reading of the 50 mL sample of the diluted river water was 1. Which of the following is closest to the concentration of zinc in the original river water sample?

(A) 10 ppm

(B) 40 ppm

(C) 50 ppm

(D) 100 ppm

14 The table below gives the results of some tests performed on water from four different sites.

Test	**Site Q**	**Site R**	**Site S**	**Site T**
Total dissolved solids (ppm)	350	120	50	635
Phosphate (ppm)	2.2	0.02	0.01	1.1
Dissolved oxygen (ppm)	2.5	5.0	7.0	3.5
Micro-organisms (CFU/100mL)	190	220	1	2

Which site is most likely to be down stream from a farm?

(A) Site Q

(B) Site R

(C) Site S

(D) Site T

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15 A student performed an investigation to measure the sulphate content of ammonium sulphate lawn fertiliser by precipitating the sulphate as barium sulphate ($BaSO_4$) and weighing the precipitate. His results are tabulated below.

What was weighed	**Mass (g)**
Ammonium sulphate fertiliser sample	2.00
Clean filter paper	1.05
Filter paper + dry barium sulphate precipitate	1.88

What is the percentage of sulphate, by mass, in the measured ammonium sulphate fertiliser?

(A) 17.1 %

(B) 24.4 %

(C) 41.5 %

(D) 72.7 %

Student Number: ……

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Section I (continued)

Part B – 60 marks
Attempt Questions 16-28
Allow about 1 hour and 45 minutes for this part.

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 16 (6 marks) **Marks**

Ethanol can be produced by *the addition of water to ethylene* OR by *fermentation of sugars*.

(a) Give the equation for the production of ethanol by the addition of water to ethylene. **1**

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(b) Justify the steps for the production of ethanol by fermentation in the school laboratory. **2**

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Question 16 continues over the page

Student Number: ……

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Marks

(c) Discuss the potential wide-scale use of ethanol as an alternative fuel to petrol in cars. **3**

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Student Number: ……

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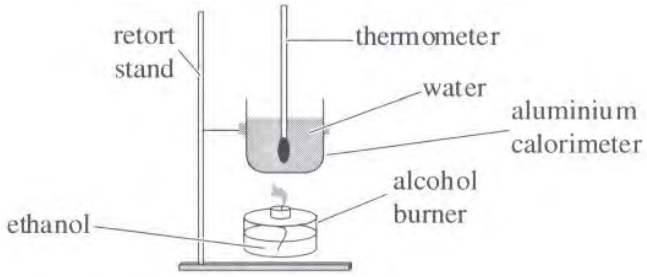
Question 17 (8 marks) **Marks**

A student assembled the following equipment in order to determine the Molar Heat of Combustion of ethanol.



Experimental results found that the temperature of 100 mL of water increased from 18°C to 58°C on burning 0.76g of ethanol.

(a) Define the term *molar heat of combustion*.

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(b) Write a balanced chemical equation to show the complete combustion of ethanol. **1**

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(c) Calculate the Molar Heat of Combustion of ethanol based on the experimental results. **2**

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Student Number: ……

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Marks

(d) Explain how this calculated value would compare to the theoretical value.

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(e) Identify a potential hazard in this experiment and outline how you addressed this hazard

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Student Number: ……

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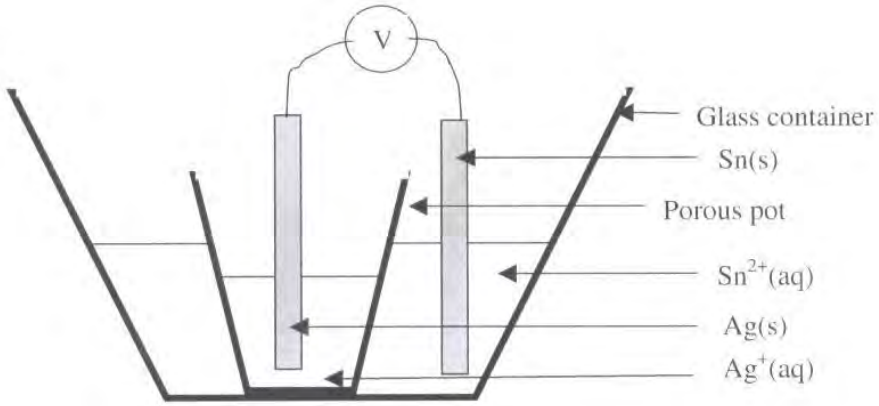
Question 18 (4 marks) **Marks**

A Galvanic cell may be constructed by placing one half-cell in a porous pot inside another half-cell as shown below.



(a) Identify the cathode. **1**

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(b) Calculate the theoretical voltage of this cell. **1**

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(c) Explain the function of the *porous pot*.

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Student Number: ……

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Question 19 (3 marks) **Marks**

You performed a first-hand investigation to identify the pH of salt solutions. If solutions of ammonium chloride and sodium chloride were used, predict the acidic, basic or neutral nature of those salts. **3**

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Question 20 (4 marks) **Marks**

During this course you studied the use of catalysts in a number of different reactions and processes.

(a) Identify one chemical reaction that uses a catalyst. **1**

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(b) Name the catalyst used. **1**

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(c) Explain why the catalyst is used. **2**

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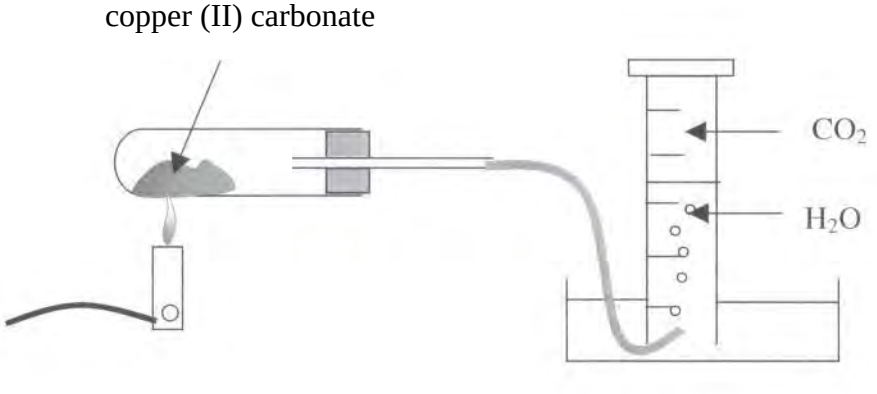
Question 21 (7 marks) **Marks**

Copper carbonate is decomposed to carbon dioxide and copper (II) oxide when heated.

The volume of carbon dioxide produced can be measured by displacing water.



The results of an investigation into the decomposition of copper (II) carbonate are tabulated below.

Time (s)	Gas Volume at 25°C and 100 kPa (mL)
10	20
30	66
50	84
70	90
100	92
130	92

(a) Write the equation for the decomposition of copper (II) carbonate. **1**

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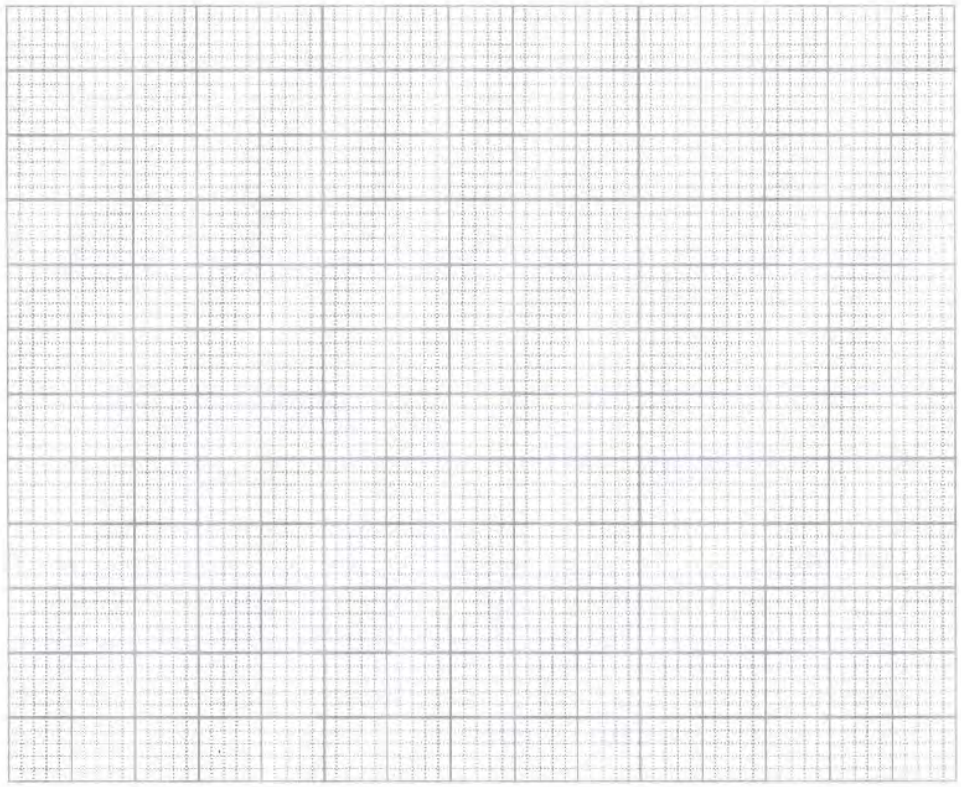
Marks

(b) Graph the results from this experiment.



3

(c) Calculate the mass of copper (II) oxide produced.

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(d) Analyse the accuracy of the procedure for collecting the gas.

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Student Number: ……

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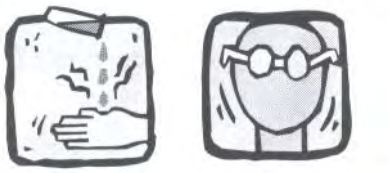
Question 22 (4 marks) **Marks**



Safety glasses should always be worn during practical experiments involving acids since spills and splashes can occur. The corrosive nature of acids can damage workbenches or pose a risk to people working in the laboratory.

A handbook for risk assessment states:

"To minimise risk, large acid spills should be neutralised with limestone before mopping up."

Assess this recommended method. **4**

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Question 23 (3 marks) **Marks**

Special techniques are used to ensure accuracy when preparing a standard solution and conducting a titration.

Describe ONE such technique for the preparation of the standard solution AND ONE such technique for conducting the titration.

Explain how each assists in obtaining a valid result. **3**

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Student Number: ……

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Question 24 (4 marks) **Marks**

Explain the importance of monitoring the reaction vessel used in the Haber Process. **4**

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Student Number: ……

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Question 25 (4 marks) **Marks**

Ions produced by industry and farming van move into the environment where they can cause problems.

Describe and explain evidence for the need to monitor levels of ONE named ion used by society. **4**

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Student Number: ……

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Question 26 (3 marks) **Marks**

(a) Define a *coordinate covalent bond*. **1**

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(b) Draw a Lewis electron dot structure to model the formation of the *coordinate covalent bond.* **2**

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Question 27 (6 marks) **Marks**

Ozone is being gradually removed from the stratosphere by our use of chlorofluorocarbons (CFC).

(a) Identify ONE CFC molecule that has caused problems and its source. **1**

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(b) Give equations to demonstrate the removal of ozone from the stratosphere by this CFC. **2**

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(c) Evaluate the effectiveness of replacement chemicals for CFC's. **3**

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Question 28 (4 marks) **Marks**

Assess the effectiveness of methods used to purify and sanitise mass water supplies. **4**

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Student Number: ……

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Question 29 – Shipwrecks, Conversation and Corrosion (25 marks)

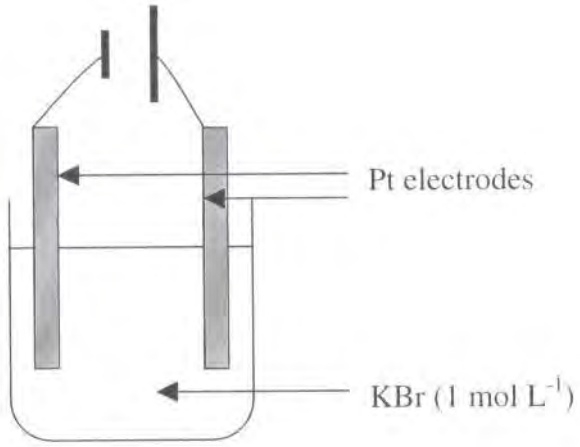
Marks

(a) In 1780 Luigi Galvani generated an electric current by taking two wires made of different metals, at one end joining them together and at the other end placing them on a dissected frog's leg muscle.

The muscle contracted, prompting Galvani to coin the term *animal electricity*.

Outline how a more recent chemist, Alessandro Volta, interpreted Galvani's results and describe how he built on Galvani's work. **3**

(b) The experiment below was set up to investigate the factors that affect the rate of electrolysis.



(i) Give the half-equation for the reaction occurring at the cathode. **1**

(ii) Calculate the voltage required for the reaction to proceed. **1**

(iii) In some investigations, reaction rate can be measured by recording the change in temperature. **1**

Describe what the investigator could have recorded as a measure of reaction rate in this investigation.

(iv) Identify one other factor that the investigator may have varied and give the likely result of varying this factor on reaction rate. **2**

(c) Describe how the process of *cathodic protection* minimises rusting of iron in marine environments. **4**

Question 29 continues

Student Number: ……

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(d) In the year 1770 Captain Cook tossed 10 cannons overboard when his ship, the Endeavour, hit a coral reef. **Marks**

These were discovered 200 years later but they were in poor condition. They were covered in coral ($CaCO_3$) and extensively pitted and corroded.

They were recovered and firstly kept in a basic sodium hydroxide solution.

(i) Explain why the cannons would be kept in a basic solution before work began on them. **1**

(ii) Describe how the coral may have been removed. **1**

(iii) Describe and explain how the corrosion may have been halted and reversed. **3**

(iv) Describe and explain how the cannons may be treated to protect them from further corrosion as they are displayed. **2**

(d) Identify and discuss factors that influence the rate of corrosion of a steel shipwreck in deep ocean waters. **6**

END OF PAPER

Student Number: ……

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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 — 79 — Symbol of element
Atomic Weight — 197.0 — Name of element
Au — 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.

Student Number: .....

Teacher: .....