Sydney Girls High School

Student Number

2023

YEAR 11

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 60 minutes
- Write using black pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- A data sheet and a Periodic Table are provided on pages 13 -15
- Write your student number on the multiple choice answer sheet and the cover page

Total marks – 35

Part A – Pages 2-5
10 marks
- Attempt Questions 1 – 10

Part B – Pages 6-8
13 marks
- Attempt Questions 11 – 12

Part B – Pages 9-11
12 marks
- Attempt Questions 13 – 15

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Attempt Questions 1 – 10

Use the multiple-choice answer sheet for Questions 1–10

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1 Which observation will be made when a clean strip of magnesium is dipped into aqueous copper sulfate:

(A) Hydrogen gas is released.

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(C) The blue colour of the copper nitrate becomes more intense.

(D) The magnesium strip becomes coated with a reddish deposit of copper.

2 Hydrogen and copper (II) oxide react to produce metal in water.

$$\mathbf{CuO_{(s)} + H_{2(g)} \rightarrow Cu_{(s)} + H_2O_{(l)}}$$

Which row correctly describes the oxidising and reducing agent?

	Oxidising agent	**Reducing agent**
(A)	H_2O	Cu
(B)	H_2	CuO
(C)	Cu	H_2O
(D)	CuO	H_2

3 Which combination of the following periodic table trends would result in an increase in a metal's reactivity?

(A) Decrease in atomic radius, decrease in electronegativity.

(B) Increase in ionisation energy, increase in atomic radius.

(C) Increase in ionisation energy, decrease in electronegativity.

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4 Which equation represents a neutralisation reaction?

(A) $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$

(B) $C_6H_{12}O_{6(aq)} + 6O_{2(g)} \rightarrow 6CO_{2(g)} + 6H_2O_{(g)}$

(C) $CuCl_{2(aq)} + 2NaOH_{(aq)} \rightarrow Cu(OH)_{2(s)} + 2NaCl_{(aq)}$

(D) $2HNO_{3(l)} + Ba(OH)_{2aqs)} \rightarrow Ba(NO_3)_{2(aq)} + 2H_2O_{(l)}$

5 Which of the following is a true statement that can be used to predict the entropy change in a system?

(A) As the temperature of a substance increase, the entropy increases.

(B) A substance in its gaseous state has less entropy, than the same amount of the substance in its liquid state.

(C) A substance in its liquid state has less entropy than the same amount of substance in its solid state.

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6 Catalysts such as iron and nickel are commonly used in industrial reactions.

Which statement about a catalyst is NOT correct?

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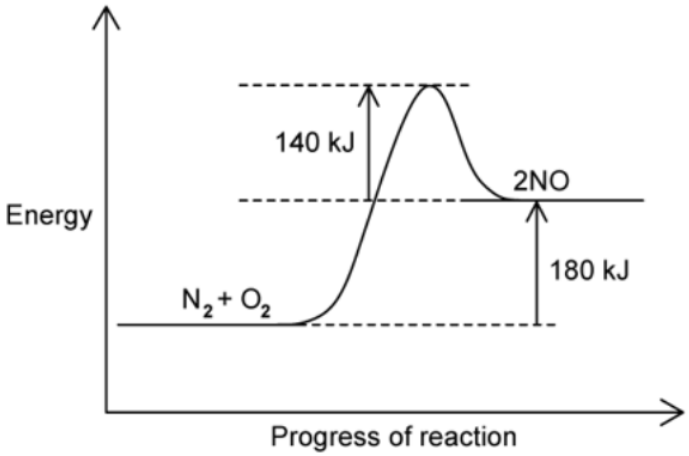

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(B) +180 kJ

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8 Which of the following is a statement describing Hess' Law?

(A) Energy cannot be created nor destroyed, but it can be changed from one form into another.

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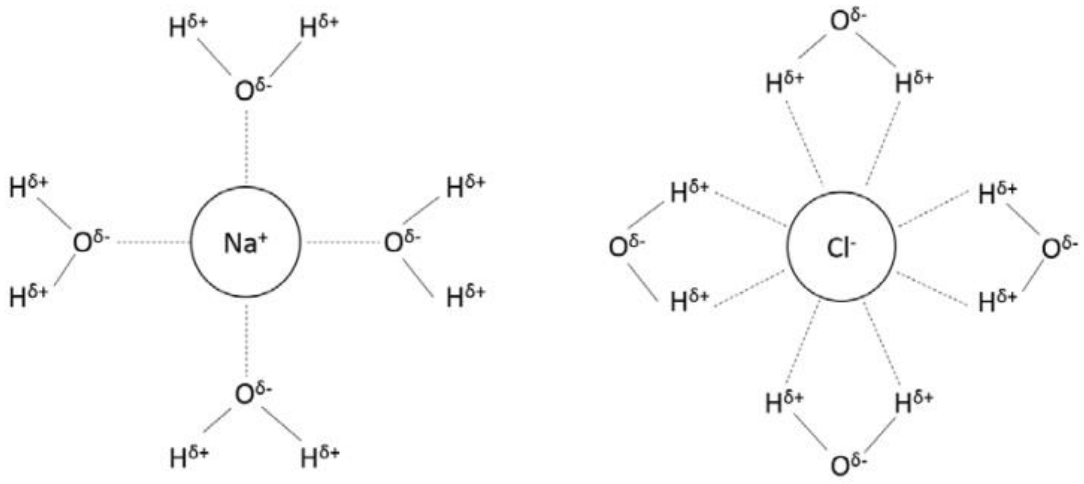

Which chemical process is demonstrated by these diagrams?

(A) Ionisation.

(B) Carbonation.

(C) Precipitation.

(D) Dissociation.

10. Which row in the table shows how the metal will react?

	Metal	Reacts with dilute acid	Reacts rapidly with cold water	Reacts with steam
(A)	Copper	✓	×	×
(B)	Calcium	×	✓	✓
(C)	Zinc	✓	×	×
(D)	Magnesium	✓	×	✓

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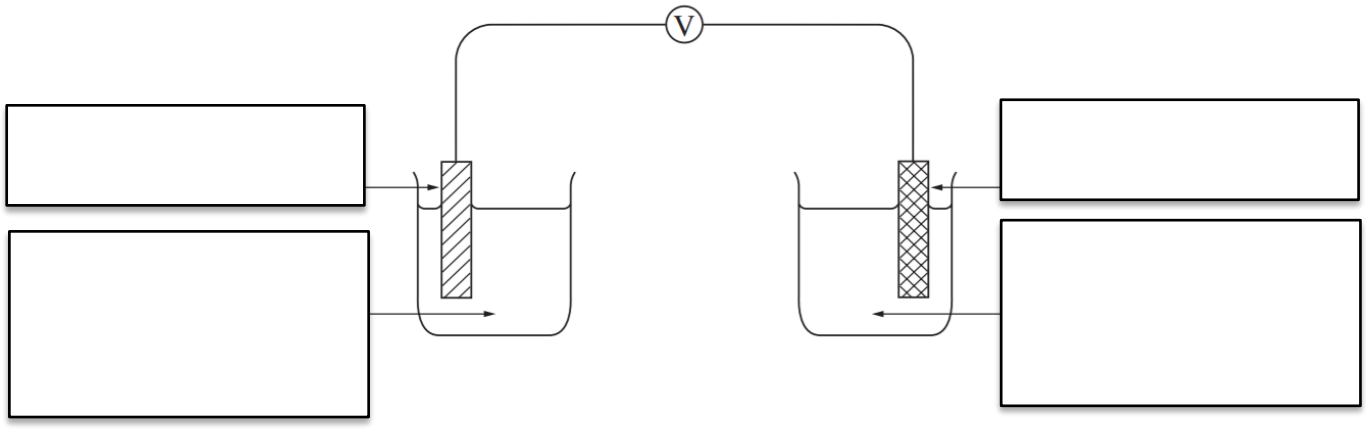
Part B – 25 marks
Attempt Questions 11 - 15

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 11 (5 marks)

The galvanic cell below is made by connecting two half-cells. One half-cell was made by putting an aluminium electrode in an aluminium nitrate solution. The other half-cell was made by putting a lead electrode in a lead nitrate solution. The electrodes were connected to a voltmeter as shown in the diagram.



Add the following labels to the diagram: 3P

- Which metal is the Anode and cathode
- Direction of electron flow
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- A salt-bridge

a) Using the standard potentials tale in the data sheet, calculate the theoretical voltage of this galvanic cell.

2K

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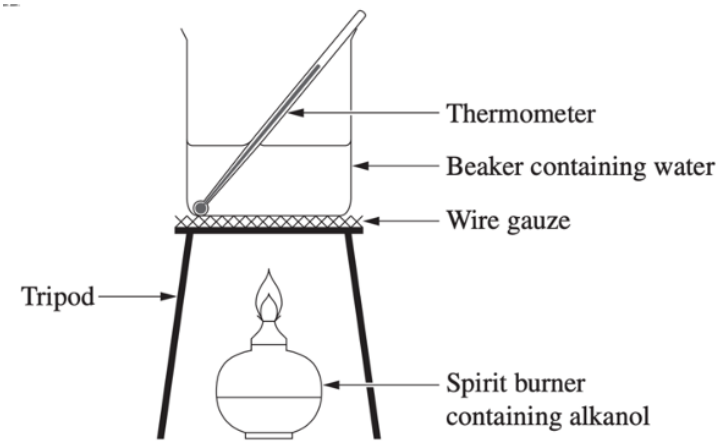
Question 12 (7 marks)

Three groups of students set out to determine the heats of combustion of the following alcohols:

- Methanol, CH_3OH
- Ethanol, C_2H_5OH
- Propan-1-ol, C_3H_7OH

Each group of students measured out 100mL of water into a container and heated the water by burning a measured mass of each of the alcohols.
Their results are shown in the table below:



Fuel (alcohol)	Amount of water heated (g)	Temperature rise (K)	Mass of alcohol burnt (g)	Heat of combustion ($kJ.mol^{-1}$)
Methanol	100	10	0.185	725
Ethanol	100	10	0.142	?
Propan-1-ol	100	10	0.125	2016

a) From the data in the table, calculate the molar heat of combustion of ethanol. 4K

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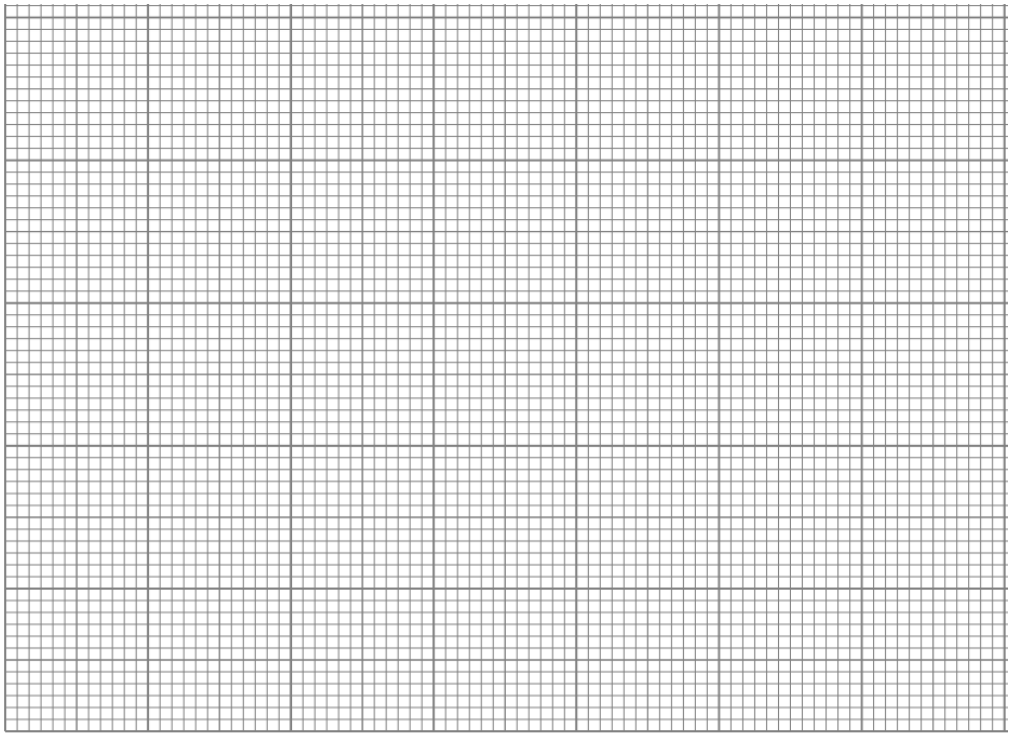
b) On the grid below, draw a graph representing the molar heat of combustion for the three alcohols against the molar mass of the alcohols. 3A



Student Number

Part C – 13 marks
Attempt Questions 13 - 15

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 12 (5 marks)

a) Write a method to describe an experiment you performed in a school laboratory to measure the change in reaction rate with concentration. 3P

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b) Using collision theory, explain why increasing the temperature increases the rate of any chemical reaction. 2K

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Question 14 (4 marks)

The overall equation representing the formation of quinone, $C_6H_4O_2$ is as follows:

$$C_6H_4(OH)_{2(aq)} + H_2O_{2(aq)} \rightarrow C_6H_4O_{2(aq)} + 2H_2O_{(\ell)}$$

Use the following data to calculate the enthalpy change, in kJ mol^{-1}, for the above reaction. 4A

$C_6H_4(OH)_{2(aq)} \rightarrow C_6H_4O_{2(aq)} + H_{2(g)}$ $\Delta H = +177{\cdot}4$ kJ mol^{-1}

$H_{2(g)} + O_{2(g)} \rightarrow H_2O_{2(aq)}$ $\Delta H = -191{\cdot}2$ kJ mol^{-1}

$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(g)}$ $\Delta H = -241{\cdot}8$ kJ mol^{-1}

$H_2O_{(g)} \rightarrow H_2O_{(\ell)}$ $\Delta H = -43{\cdot}8$ kJ mol^{-1}

Question 15 (4 marks)

Use the data in the table to answer this question.

	$CaCO_{3(s)}$	**$CaO_{(s)}$**	**$CO_{2(g)}$**
S (J mol^{-1} K^{-1})	**90**	**40**	**214**

Calcium carbonate decomposes according to the following equation at 25°C.

$$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)} \qquad \Delta H = +178 \text{ kJ mol}^{-1}$$

Calculate ΔG for this reaction. 4K

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Chemistry

FORMULAE SHEET

$$n = \frac{m}{MM} \qquad c = \frac{n}{V} \qquad PV = nRT$$

$$q = mc\Delta T \qquad \Delta G^\circ = \Delta H^\circ - T\Delta S^\circ \qquad \text{pH} = -\log_{10}[\text{H}^+]$$

$$pK_a = -\log_{10}[K_a] \qquad A = \varepsilon lc = \log_{10}\frac{I_o}{I}$$

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

Gas constant ..... 8.314 J mol^{-1} K^{-1}

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}

DATA SHEET

Solubility constants at 25°C

Compound	K_{sp}
Barium carbonate	2.58×10^{-9}
Barium hydroxide	2.55×10^{-4}
Barium phosphate	1.3×10^{-29}
Barium sulfate	1.08×10^{-10}
Calcium carbonate	3.36×10^{-9}
Calcium hydroxide	5.02×10^{-6}
Calcium phosphate	2.07×10^{-29}
Calcium sulfate	4.93×10^{-5}
Copper(II) carbonate	1.4×10^{-10}
Copper(II) hydroxide	2.2×10^{-20}
Copper(II) phosphate	1.40×10^{-37}
Iron(II) carbonate	3.13×10^{-11}
Iron(II) hydroxide	4.87×10^{-17}
Iron(III) hydroxide	2.79×10^{-39}
Iron(III) phosphate	9.91×10^{-16}

Compound	K_{sp}
Lead(II) bromide	6.60×10^{-6}
Lead(II) chloride	1.70×10^{-5}
Lead(II) iodide	9.8×10^{-9}
Lead(II) carbonate	7.40×10^{-14}
Lead(II) hydroxide	1.43×10^{-15}
Lead(II) phosphate	8.0×10^{-43}
Lead(II) sulfate	2.53×10^{-8}
Magnesium carbonate	6.82×10^{-6}
Magnesium hydroxide	5.61×10^{-12}
Magnesium phosphate	1.04×10^{-24}
Silver bromide	5.35×10^{-13}
Silver chloride	1.77×10^{-10}
Silver carbonate	8.46×10^{-12}
Silver hydroxide	2.0×10^{-8}
Silver iodide	8.52×10^{-17}
Silver phosphate	8.89×10^{-17}
Silver sulfate	1.20×10^{-5}

Aylward and Findlay, *SI Chemical Data* (5th Edition) is the principal source of data for this examination paper. Some data may have been modified for examination purposes.

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	Au
Standard Atomic Weight	197.0
Name	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 65.38 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 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 87.61 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.96 Molybdenum	43 Tc 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 Lanthanoids	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.9 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 Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89–103 Actinoids	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	113 Nh Nihonium	114 Fl Flerovium	115 Mc Moscovium	116 Lv Livermorium	117 Ts Tennessine	118 Og Oganesson

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm 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 173.1 Ytterbium	71 Lu 175.0 Lutetium

Actinoids

89 Ac Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

Standard atomic weights are abridged to four significant figures.
Elements with no reported values in the table have no stable nuclides.
Information on elements with atomic numbers 113 and above is sourced from the International Union of Pure and Applied Chemistry Periodic Table of the Elements (November 2016 version).
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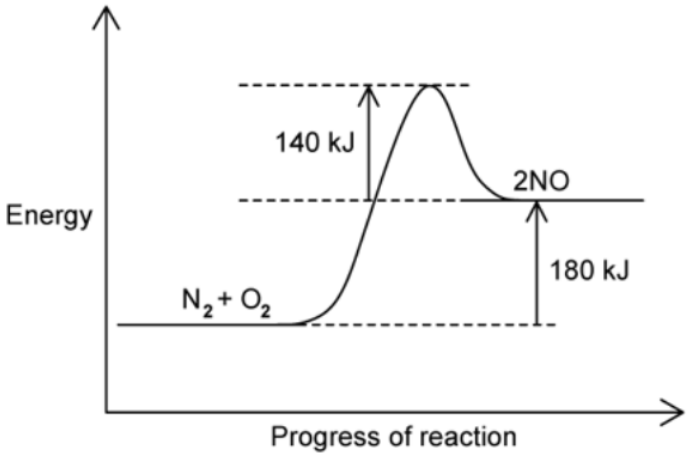

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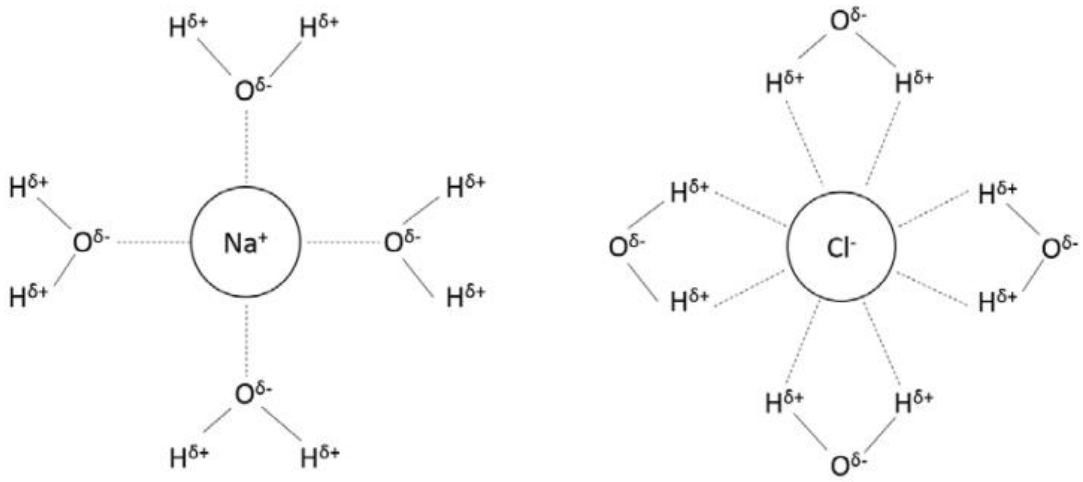

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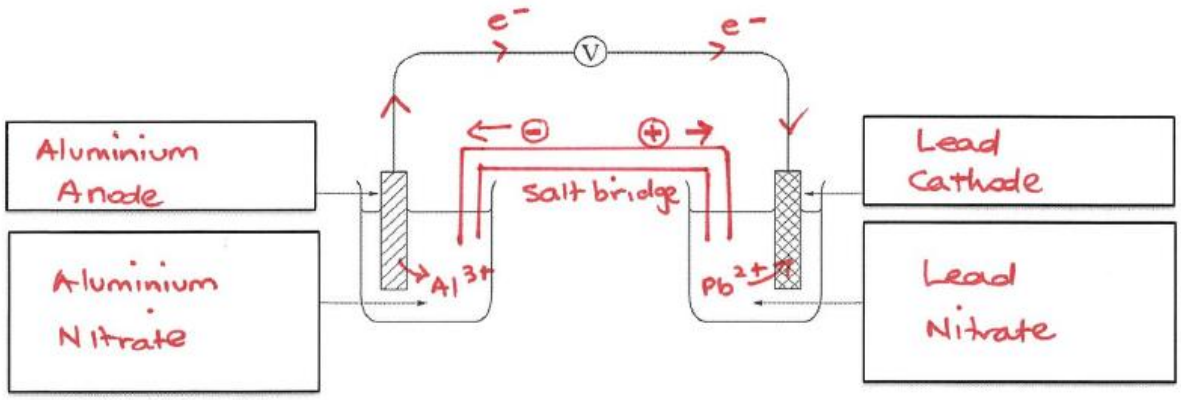
Correct labels	**3**
Substantially correct labels	**2**
Some relevant labels	**1**



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- A salt-bridge

a) Using the standard potentials tale in the data sheet, calculate the theoretical voltage of this galvanic cell. 2K

Correct Calculation	**2**
One relevant step in calculation	**1**

2K

$Al_{(s)} \rightarrow Al^{3+} + 3e^-$ +1.68 V

$Pb^{2+}_{(aq)} + 2e^- \rightarrow Pb_{(s)}$ −0.13 V

+1.55 V

* No need to balance e⁻ etc as only asking for Voltage.

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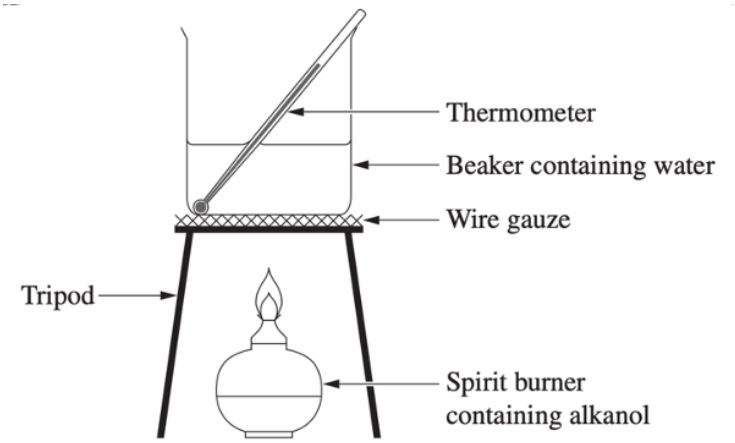
Each group of students measured out 100mL of water into a container and heated the water by burning a measured mass of each of the alcohols.
Their results are shown in the table below:



Fuel (alcohol)	Amount of water heated (g)	Temperature rise (K)	Mass of alcohol burnt (g)	Heat of combustion ($kJ.mol^{-1}$)
Methanol	100	10	0.185	725
Ethanol	100	10	0.142	?
Propan-1-ol	100	10	0.125	2016

a) From the data in the table, calculate the molar heat of combustion of ethanol. 4K

Any two parts of calculation performed eg • **Calculation of heat supplied (eg q)** • **Correct calculation molar mass** • **Calculation of moles of ethanol** • **Calculation of ΔH from q (including – ve sign for exo rxn)**	**4**
Most steps correct	**3**
Some relevant calculations	**2**
One relevant calculation	**1**

$q = mc\Delta T$

$= (100)(4.18)(10)$

$\therefore q = 4180\ J$ or

$= 4.180\ kJ$

$n = m/M$

$= 0.142/46.068$

$\therefore n = 0.0031\ mol$

$\Delta H = -q/n$

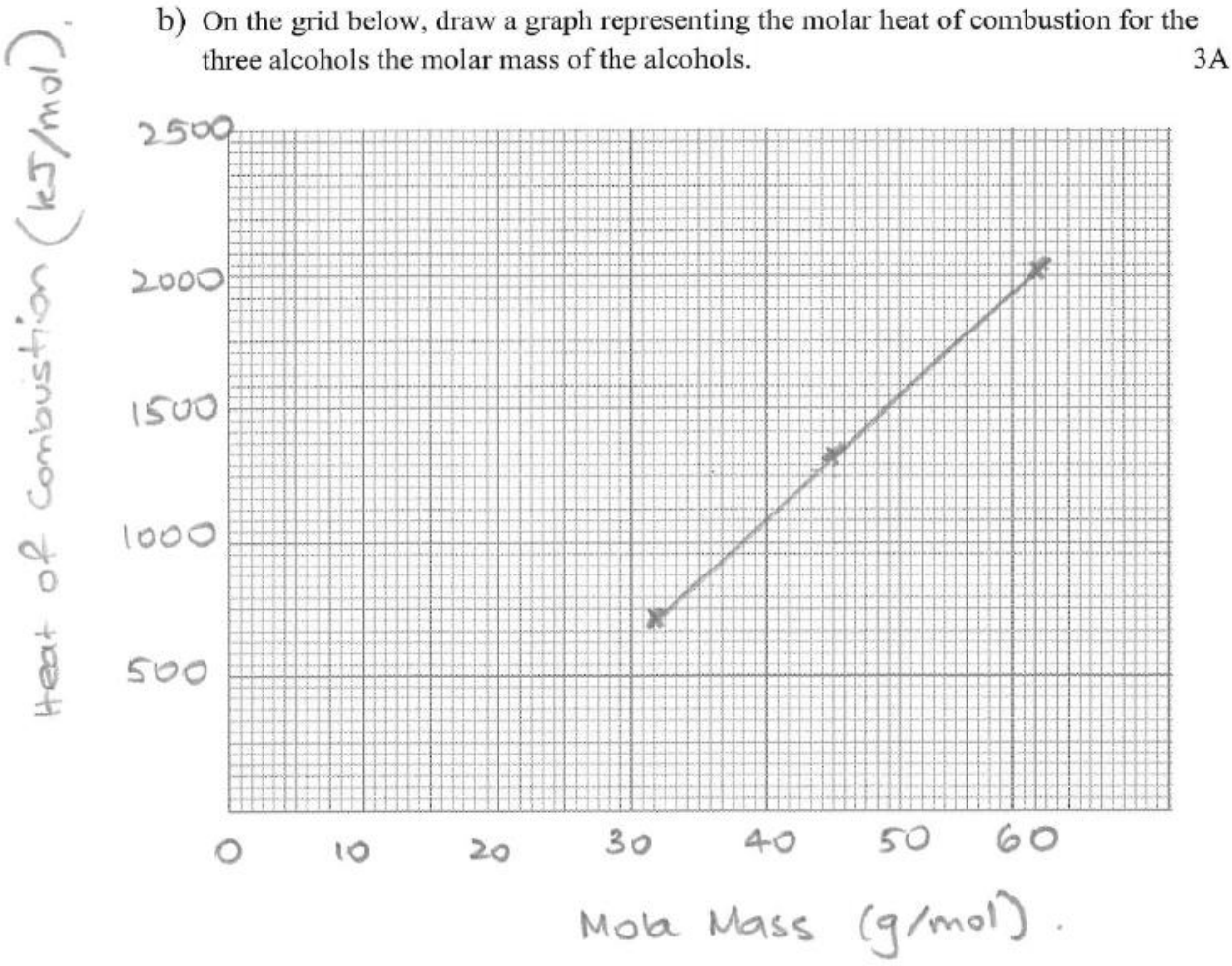
$= -4.180/0.0031$

$\therefore \Delta H = -1348\ kJ/mol$

Graphed correctly including:	**3**

• **Labels of both axes with correct units** • **Using > 50% of grid (appropriate linear scale used)** • **Correct plotting of points** • **Curve straight line**	
As above but with 1 omission/error	**2**
As above but with 2 omissions/errors	**1**

b) On the grid below, draw a graph representing the molar heat of combustion for the three alcohols the molar mass of the alcohols. 3A



Student Number

Part C – 13 marks
Attempt Questions 13 - 15

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 12 (5 marks)

a) Write a method to describe an experiment you performed in a school laboratory to measure the change in reaction rate with concentration. 3P

Correct description of the method	**3**
Substantially correct description of the method	**2**
Some relevant steps	**1**

1. Measure + Place 50mL of $Na_2S_2O_3$ into a 250mL conical flask
2. Place the flask over a cross marked on white paper
3. Measure 5mL ... L of 1M HCl, add to the $Na_2S_2O_3$ in the conical flask, start the stop watch
4. Stop the watch and record the time taken for the cross to become invisible when viewed from above
5. Record your results in a data table.
6. Repeat procedure using 40mL, 30mL, 20mL, 10mL of the $Na_2S_2O_3$ solution made up to a total volume of 50mL with distilled water.

b) Using collision theory, explain why increasing the temperature increases the rate of any chemical reaction. 2K

Correct explanation	**2**
Partially correct explanation	**1**

In collision theory, temp affects the rate of collision as well as the energy of the molecules. Higher temps ↑ the KE of the molecules so more molecules have the minimum KE (or > than E_a). This increases the rate of the reaction.

Question 14 (4 marks)

The overall equation representing the formation of quinone, $C_6H_4O_2$ is as follows:

$$C_6H_4(OH)_{2(aq)} + H_2O_{2(aq)} \rightarrow C_6H_4O_{2(aq)} + 2H_2O_{(\ell)}$$

Use the following data to calculate the enthalpy change, in kJ mol^{-1}, for the above reaction. 4A

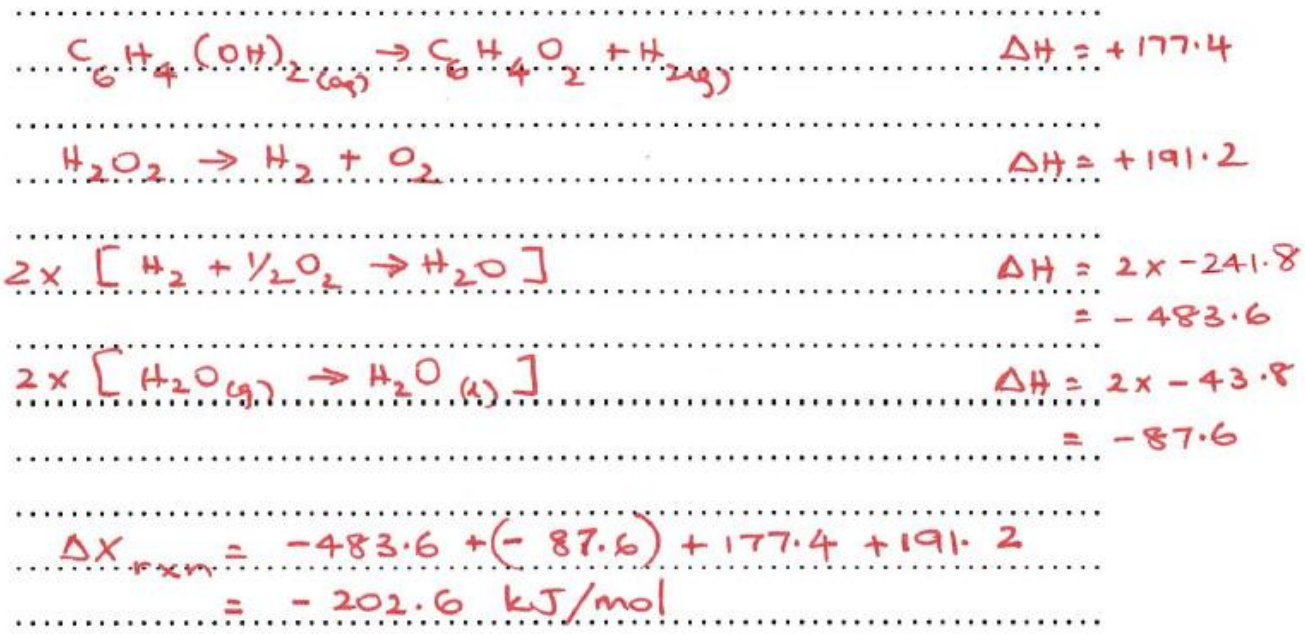
$C_6H_4(OH)_{2(aq)} \rightarrow C_6H_4O_{2(aq)} + H_{2(g)}$ $\Delta H = +177{\cdot}4$ kJ mol^{-1}

$H_{2(g)} + O_{2(g)} \rightarrow H_2O_{2(aq)}$ $\Delta H = -191{\cdot}2$ kJ mol^{-1}

$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(g)}$ $\Delta H = -241{\cdot}8$ kJ mol^{-1}

$H_2O_{(g)} \rightarrow H_2O_{(\ell)}$ $\Delta H = -43{\cdot}8$ kJ mol^{-1}

All correct calculations, including significant figures	**4**
All steps correct	**3**
Several relevant calculations	**2**
Some relevant information	**1**



Question 15 (4 marks)

Use the data in the table to answer this question.

	$CaCO_{3(s)}$	**$CaO_{(s)}$**	**$CO_{2(g)}$**

S (J mol^{-1} K $^{-1}$)	**90**	**40**	**214**

Calcium carbonate decomposes according to the following equation at 25^{o}C.

$$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)} \qquad \Delta H = +178 \text{ kJ mol}^{-1}$$

Calculate ΔG for this reaction. 4K

All correct calculations	**4**
Most steps correct	**3**
Some relevant calculations	**2**
One relevant calculation	**1**

ΔS = products − reactants

= (40 + 214) − 90

$\therefore \Delta S$ = +164 J mol^{-1} K^{-1}

= +0.164 kJ mol^{-1} K^{-1}

ΔH = +178 kJ mol^{-1}

T = 298.15 K

ΔG = +178 − (298.15 × 0.164)

= +129.103 kJ

$\therefore \Delta S$ = +129 kJ (2 sig figs)

Chemistry

FORMULAE SHEET

$$n = \frac{m}{MM} \qquad c = \frac{n}{V} \qquad PV = nRT$$

$$q = mc\Delta T \qquad \Delta G^\circ = \Delta H^\circ - T\Delta S^\circ \qquad \text{pH} = -\log_{10}[\text{H}^+]$$

$$pK_a = -\log_{10}[K_a] \qquad A = \varepsilon lc = \log_{10}\frac{I_o}{I}$$

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

Gas constant ..... 8.314 J mol^{-1} K^{-1}

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}

DATA SHEET

Solubility constants at 25°C

Compound	K_{sp}
Barium carbonate	2.58×10^{-9}
Barium hydroxide	2.55×10^{-4}
Barium phosphate	1.3×10^{-29}
Barium sulfate	1.08×10^{-10}
Calcium carbonate	3.36×10^{-9}
Calcium hydroxide	5.02×10^{-6}
Calcium phosphate	2.07×10^{-29}
Calcium sulfate	4.93×10^{-5}
Copper(II) carbonate	1.4×10^{-10}
Copper(II) hydroxide	2.2×10^{-20}
Copper(II) phosphate	1.40×10^{-37}
Iron(II) carbonate	3.13×10^{-11}
Iron(II) hydroxide	4.87×10^{-17}
Iron(III) hydroxide	2.79×10^{-39}
Iron(III) phosphate	9.91×10^{-16}

Compound	K_{sp}
Lead(II) bromide	6.60×10^{-6}
Lead(II) chloride	1.70×10^{-5}
Lead(II) iodide	9.8×10^{-9}
Lead(II) carbonate	7.40×10^{-14}
Lead(II) hydroxide	1.43×10^{-15}
Lead(II) phosphate	8.0×10^{-43}
Lead(II) sulfate	2.53×10^{-8}
Magnesium carbonate	6.82×10^{-6}
Magnesium hydroxide	5.61×10^{-12}
Magnesium phosphate	1.04×10^{-24}
Silver bromide	5.35×10^{-13}
Silver chloride	1.77×10^{-10}
Silver carbonate	8.46×10^{-12}
Silver hydroxide	2.0×10^{-8}
Silver iodide	8.52×10^{-17}
Silver phosphate	8.89×10^{-17}
Silver sulfate	1.20×10^{-5}

Aylward and Findlay, *SI Chemical Data* (5th Edition) is the principal source of data for this examination paper. Some data may have been modified for examination purposes.

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	Au
Standard Atomic Weight	197.0
Name	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 65.38 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 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 87.61 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.96 Molybdenum	43 Tc 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 Lanthanoids	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.9 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 Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89–103 Actinoids	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	113 Nh Nihonium	114 Fl Flerovium	115 Mc Moscovium	116 Lv Livermorium	117 Ts Tennessine	118 Og Oganesson

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm 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 173.1 Ytterbium	71 Lu 175.0 Lutetium

Actinoids

89 Ac Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

Standard atomic weights are abridged to four significant figures.
Elements with no reported values in the table have no stable nuclides.
Information on elements with atomic numbers 113 and above is sourced from the International Union of Pure and Applied Chemistry Periodic Table of the Elements (November 2016 version).
The International Union of Pure and Applied Chemistry Periodic Table of the Elements (February 2010 version) is the principal source of all other data. Some data may have been modified.