

Student Number	
Mark / 48	

Chemistry

The Chemical Earth and Metals
Modules Test • 2004

General Instructions

- Reading time – 5 minutes
- Working time – 55 minutes
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- A data sheet and a Periodic Table are provided at the back of this paper and may be removed for convenience
- Write your Student Number at the top of this page

Total Marks – 48

Part A – 12 marks

- Attempt Questions 1 – 12
- Allow about 10 minutes for this part

Part B – 36 marks

- Attempt Questions 13 – 28
- Allow about 45 minutes for this part

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Part A – 12 marks
Attempt Questions 1–12
Allow about 10 minutes for this part

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

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

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

A ☒ B ☒ C ☐ D ☐

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

A ☒ B ☒ C ☐ D ☐
 correct ↗

Answer Box for Questions 1- 12

1	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
2	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
3	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
4	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
5	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
6	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
7	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
8	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
9	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
10	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
11	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
12	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>

1 Which element is found uncombined in the biosphere?

- (A) Carbon
- (B) Hydrogen
- (C) Oxygen
- (D) Neon

2 Which of the following elements has the smallest first ionisation energy?

- (A) Lithium
- (B) Sodium
- (C) Fluorine
- (D) Chlorine

3 The properties of elements X, M, Z and T were investigated and the results tabled...

Element	Malleability	Hardness	Electrical Conductivity (liquid state)
X	malleable	hard	high
M	brittle	soft	nil
Z	brittle	soft	high
T	brittle	hard	low

Choose the correct classification of elements X, M, Z and T based on the data.

	X	M	Z	T
(A)	metal	non-metal	carbon	semi-metal
(B)	non-metal	non-metal	carbon	metal
(C)	semi-metal	metal	carbon	semi-metal
(D)	metal	semi-metal	carbon	metal

4 Which of these substances does not exist as a molecule?

- (A) $C_6H_{12}O_6$
- (B) H_2
- (C) He
- (D) NaCl

- 5 Which of these compounds has the highest melting point?
- (A) LiH
 - (B) SiH₄
 - (C) NH₃
 - (D) HCl
- 6 Which of the following is an application of gravimetric analysis?
- (A) Determining the melting point of a metal alloy.
 - (B) Determining the salinity of the Murray River by testing its electrical conductivity.
 - (C) Testing the flesh of tuna for the presence of mercury.
 - (D) Determining the mass percentage of iron in molasses.
- 7 Which statement is correct for element X located in period 4 and group 7?
- (A) X is a solid that sublimates to a purple vapour.
 - (B) X covalently bonds with sodium to form NaX.
 - (C) X is a liquid at room temperature.
 - (D) X has a higher electronegativity than oxygen.
- 8 Which statement is correct for the recycling process for aluminium?
- (A) The process involves a physical change.
 - (B) The process involves electrolysis.
 - (C) The process involves alloying.
 - (D) The process involves extraction.
- 9 Lithium and sodium have similar physical and chemical properties. This is best explained by which of the following statements?
- (A) They are both metals.
 - (B) They have the same outer shell electronic configuration.
 - (C) They have low relative atomic mass.
 - (D) They are in period 1 of the Periodic Table.

- 10 The melting points of four ionic salts are shown in the table...

Ionic salt	Melting point (°C)
Sodium iodide	660
Silver nitrate	209
Rubidium bromide	692
Potassium sulfate	1072

Which list gives the correct order of the strength of bonds between the indicated ions?

- (A) $\text{Ag}^+ - \text{NO}_3^- > \text{Rb}^+ - \text{Br}^- > \text{Na}^+ - \text{I}^- > \text{K}^+ - \text{SO}_4^{2-}$
 (B) $\text{K}^+ - \text{SO}_4^{2-} > \text{Rb}^+ - \text{Br}^- > \text{Na}^+ - \text{I}^- > \text{Ag}^+ - \text{NO}_3^-$
 (C) $\text{Ag}^+ - \text{NO}_3^- > \text{Na}^+ - \text{I}^- > \text{Rb}^+ - \text{Br}^- > \text{K}^+ - \text{SO}_4^{2-}$
 (D) $\text{K}^+ - \text{SO}_4^{2-} > \text{Na}^+ - \text{I}^- > \text{Rb}^+ - \text{Br}^- > \text{Ag}^+ - \text{NO}_3^-$
- 11 Which of these processes is used in the purification stage of producing pure, 99.96–99.99% copper?
- (A) alloying
 (B) electrolysis
 (C) roasting
 (D) smelting
- 12 The table shows the properties and uses of four metal alloys...

Alloy	Properties	Uses
W	malleable	car bodies, pipes, nuts and bolts, roofing
X	hard and shock resistant	security safes, files, ball bearings
Y	resists corrosion, easily cast	ships' propellers, casting statues
Z	low melting point, adheres firmly to other metals when molten	joining metals together, applications in plumbing and electronics

Which alloy best describes the properties and uses of solder?

- (A) W
 (B) X
 (C) Y
 (D) Z

Part B – 36 marks

Attempt Questions 13 – 28

Allow about 45 minutes for this part

► *Show all relevant working in questions involving calculations.*

Question 13 (3 marks)

- (a) Complete the table showing the existence of compounds on the Earth... **(2 marks)**

	Example of a compound found in the 'sphere
atmosphere	
biosphere	
hydrosphere	
lithosphere	

- (b) Explain why uncombined elements are rare. **(1 mark)**

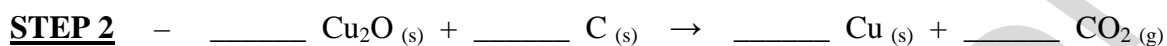
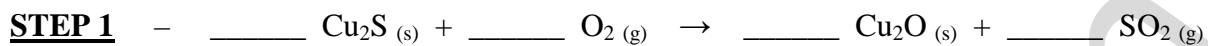
Question 14 (2 marks)

Name these compounds...

Fe_2S_3	
$\text{Fe}(\text{OH})_2$	
NO_2	
N_2O_4	

Question 15 (2 marks)

Chalcocite, a copper sulfide ore is converted into crude copper by a two-step process...



Balance each of the chemical equations. **(2 marks)**

Question 16 (4 marks)

Calcium reacts vigorously with sulfur producing calcium sulfide via an electron transfer reaction.

Complete the table detailing the process...

	Calcium atom	+	Sulfur atom	→	Calcium ion	+	Sulfide ion
Electronic configuration	2-8-8-2	+		→		+	
Lewis electron dot structure		+		→		+	

Question 17 (2 marks)

To separate the components of a mixture, differences in physical properties are used as the basis of the separation. Complete the table to illustrate this principle...

Separation Process	Physical property which enables the separation to occur
distillation	
evaporation	
filtration	
sieving	

Question 18 (2 marks)

For a Prac test, a student is given the task of separating a sample of water collected at Bondi Beach into its three components (water, salt and sand) and determining the mass percentage of each.

A student records this data after filtration and evaporation...

Mass of original sample	226.73 g
Mass of filter paper	1.33 g
Mass of filter paper + dry sand	28.08 g
Mass of salt recovered after evaporation	9.66 g

Calculate the percentage mass of water in the original sample.

Question 19 (3 marks)

Active metal, M, forms M^{2+} when it reacts.

Write balanced formulae equations for the reactions of metal, M, with...

- (i) oxygen
- (ii) water
- (iii) hydrochloric acid

(i) _____

(ii) _____

(iii) _____

Question 20 (2 marks)

Explain why the formula for an ionic compound is an empirical formula.

Question 21 (2 marks)

The reactions of metals with acids requires the transfer of electrons.

Write two half-equations to show the reaction between aluminium and sulfuric acid.

Question 22 (1 mark)

Identify one common element that exists as a covalent molecular structure and one common element that exists as a covalent network structure.

covalent molecule _____

covalent network _____

Question 23 (2 marks)

Identify and explain the trend in the atomic radius from left to right across the Periodic Table.

Question 24 (3 marks)

The table shows the melting points of the chlorides of seven consecutive elements A – F in a period of the Periodic Table...

Element	A	B	C	D	E	F
Melting point of the element's chloride (°C)	801	712	193	– 68	– 91	– 80

- (a) Identify an element (A – F) which could be a metal. _____
- (b) Identify the type of bonding which exists in the chlorides of elements A and B. _____
- (c) Compare the electrical conductivity of the chlorides, A – F in the liquid state.

Question 25 (2 marks)

Mendeleev's model of the Periodic Table in 1869 was a landmark in the history of Chemistry.

- (a) Describe how Mendeleev used the properties of the known elements to develop his model for the Periodic Table. **(1 mark)**

- (b) Identify one chemical property of iodine which confirms that it is a halogen and should be placed in group 7. **(1 mark)**

Question 26 (2 marks)

In the lab this semester, you decomposed copper(II) carbonate by strongly heating it.
Write a (a) word equation and (b) a balanced formulae equation for the decomposition reaction.

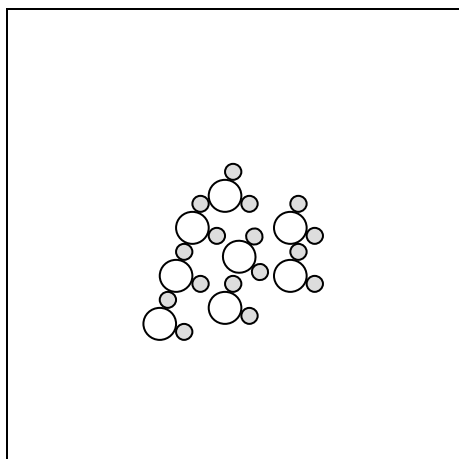
► Assume the reactant is pure copper(II) carbonate.

(a)

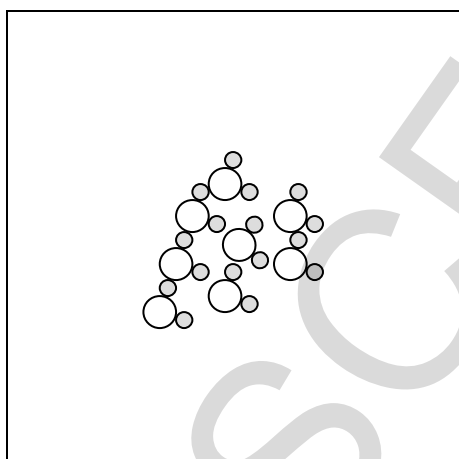
(b)

Question 27 (2 marks)

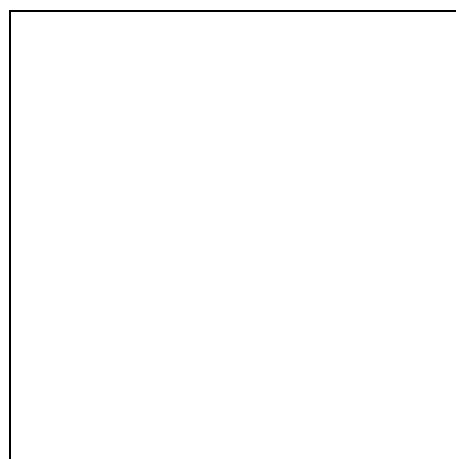
The diagrams on the left show eight water molecules in the liquid state. Complete the diagram boxes on the right, showing the arrangement of particles after all the water molecules have undergone the processes of boiling and electrolysis.



BOILING



ELECTROLYSIS



Question 28 (2 marks)

- (a) Identify one metal and one non-metal. **(1 mark)**

metal _____ non-metal _____

- (b) Account for the use of *either* the metal *or* the non-metal you identified in terms of its *physical properties*. **(1 mark)**

HIGHER SCHOOL CERTIFICATE EXAMINATION
Chemistry

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

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.

PERIODIC TABLE OF THE ELEMENTS			
KEY			
Atomic Number	79	Symbol of element	
Atomic Weight	Au	Name of element	
	197.0		
	Gold		

$^{79}_{19}\text{Au}$ 197.0 Gold	Symbol of element Name of element
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Lanthanides

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

Actinides

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

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 .