Student Number	
Mark / 45	

Chemistry

Chemical Earth + Metals

Theory Test • 2005

General Instructions

- Reading time – 5 minutes
- Working time – 70 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 – 45

Part A – 15 marks
- Attempt Questions 1 – 15
- Allow about 20 minutes for this part

Part B – 30 marks
- Attempt Questions 16 – 24
- Allow about 50 minutes for this part

Part A – 15 marks
Attempt Questions 1 – 15
Allow about 20 minutes for this part

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

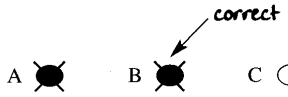
Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

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.



Answer Box for Questions 1 – 15

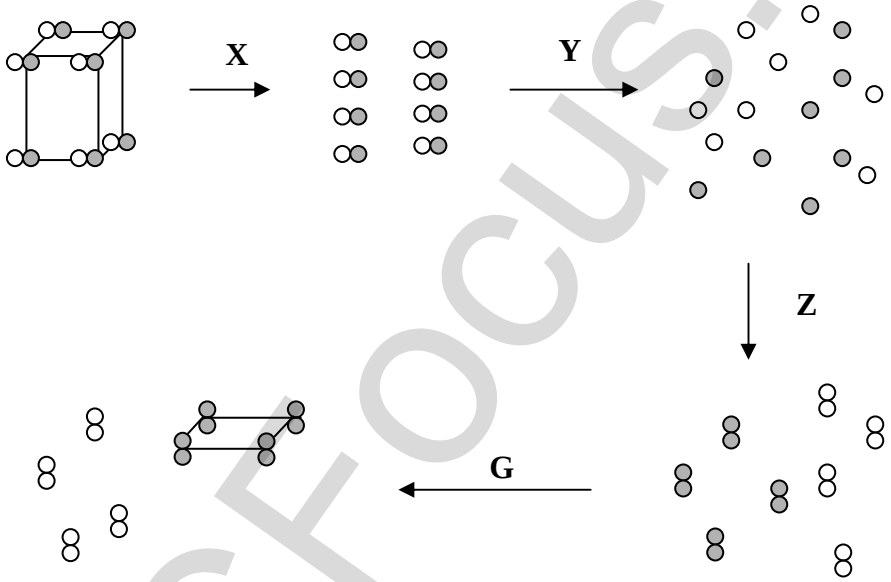
1	**A** ○	**B** ○	**C** ○	**D** ○
2	**A** ○	**B** ○	**C** ○	**D** ○
3	**A** ○	**B** ○	**C** ○	**D** ○
4	**A** ○	**B** ○	**C** ○	**D** ○
5	**A** ○	**B** ○	**C** ○	**D** ○
6	**A** ○	**B** ○	**C** ○	**D** ○
7	**A** ○	**B** ○	**C** ○	**D** ○
8	**A** ○	**B** ○	**C** ○	**D** ○
9	**A** ○	**B** ○	**C** ○	**D**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

► ***Mark your answers for Questions 1 – 15 in the Answer Box on page 2.***

1 Which of the following is a property of all ionic solids?

(A) They are malleable and ductile.
(B) Their solubility in water is high.
(C) They are good conductors of electricity.
(D) Their melting points are above room temperature.

2 Study the following transformations…



Which of the following gives the correct sequence of chemical or physical changes?

	X	*Y*	*Z*	*G*
(A)	physical change	chemical change	chemical change	physical change
(B)	chemical change	chemical change	chemical change	physical change
(C)	physical change	chemical change	chemical change	chemical change
(D)	chemical change	chemical change	physical change	chemical change

3 Which is the number of neutrons in the $^{35}Cl^-$ ion?

(A) 17
(B) 18
(C) 19
(D) 35

4 Which property is related to a metal's reactivity?

(A) electrical conductivity
(B) first ionisation energy
(C) melting point
(D) density

5 Which of the following ions has an electron arrangement which is the same as an inert gas?

(A) O^{2-}
(B) Li^{2+}
(C) Be^{+}
(D) Al^{2+}

6 Which of the following changes of energy is observed in these reactions?

	Reaction	*Energy absorbed*	*Energy released*
(A)	$H_2 + O_2 +$ spark	sound	heat
(B)	AgBr + light	heat	light + heat
(C)	$H_2 + O_2 +$ spark	heat	heat + sound
(D)	AgBr + light	light	heat

7 W, X, Y and Z are elements, each of which has only one possible valency. They form four ionic compounds. The formulae of three of them are… X_2Z, W_2Z_3, and XY.
What is the formula of the fourth compound?

(A) WY
(B) WY_2
(C) WY_3
(D) W_2Y_3

8 Which equation shows the reaction of magnesium metal with oxygen gas*?*

(A) $Mg + ½O_2 \rightarrow MgO$
(B) $2Mg + O_2 \rightarrow Mg_2O_2$
(C) $Mg + O \rightarrow MgO$
(D) $Mg^{2+} + O^{2-} \rightarrow MgO$

9 The number of which two subatomic particles can be the same*?*

(A) protons in an ion and electrons in the ion
(B) protons in an atom and electrons in its ion
(C) electrons in an atom and electrons in its ion
(D) electrons in an atom and the protons in its ion

10 Which substance contains covalent bonds*?*

(A) NH_4Cl
(B) $BaCl_2$
(C) $InCl_3$
(D) CsCl

11 The melting points of some metal chlorides are given in the table…

Metal chloride	*Melting Point (°C)*
chromium(II) chloride	815
copper(II) chloride	498

Which bonding force is the strongest among the four compounds*?*

(A) Cu – Cl (covalent bond)
(B) Cu – Cl (ionic bond)
(C) Cr – Cl (covalent bond)
(D) Cr – Cl (ionic bond)

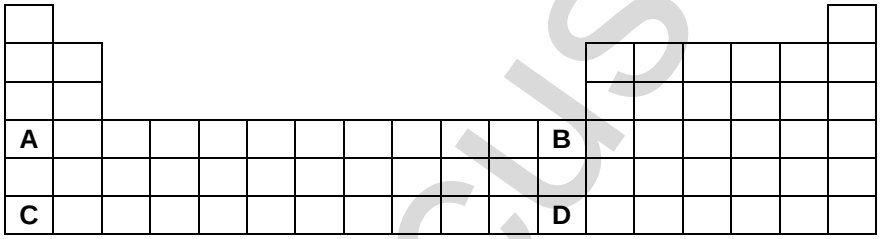
12 The extraction of aluminium from alumina (Al_2O_3) requires 50 megajoules per kg of Al produced. What is the explanation for this extremely high energy value?

(A) The aluminium ion's 3+ charge.
(B) The hardness of the Al_2O_3 crystal lattice.
(C) Aluminium is very inactive.
(D) The strong bond between the aluminium and oxygen.

13 What is the structure of the given elements?

	Molecules	*Covalent lattice (network)*
(A)	carbon, nitrogen, hydrogen, chlorine	carbon, boron, lithium
(B)	hydrogen, nitrogen, chlorine	boron, carbon, silicon
(C)	sulfur, phosphorus, oxygen	nitrogen, chlorine, carbon
(D)	sulfur, chlorine, carbon	nitrogen, oxygen, helium

14 The diagram shows a portion of the Periodic Table…



Which metal is the most active?

(A) A
(B) B
(C) C
(D) D

15 The table shows the chronology of metal use through the ages…

Metal	Gold	Copper	Iron	Aluminium
Date of introduction for common use	10000 BC	3000 BC	1000 BC	1930 AD

What is the best explanation for this chronology?

(A) metallic activity
(B) abundance of metal ore in lithosphere
(C) malleability
(D) expensiveness

Part B – 30 marks
Attempt Questions 16 – 24
Allow about 50 minutes for this part

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

Question 16 (3 marks)

(a) Write the word equation for potassium reacting with water forming an aqueous solution. **(1 mark)**

(b) Write the balanced formulae equation for (a) including states/phases. **(2 marks)**

Question 17 (4 marks)

(a) Draw the Lewis electron dot structure for the compound, hydrogen fluoride, HF. **(1 mark)**

(b) Hydrogen fluoride reacts with water according to the following equation…

$$HF_{(l)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + F^-_{(aq)}$$

At room temperature pure hydrogen fluoride exists as a liquid. Explain why pure hydrogen fluoride does not conduct electricity, but it becomes a conductor when dissolved in water. **(2 marks)**

(c) Explain why the formula of potassium fluoride (KF) is an empirical formula. **(1 mark)**

Question 18 (3 marks)

A student performed a gravimetric analysis of a mixture of sand, salt and water. A beaker that had previously been weighed contained the mixture. The student performed filtration and evaporation in order to separate the mixture. Her results are shown below…

Mass of beaker	200.00g
Mass of filter paper	0.75g
Mass of evaporating dish	105.47g
Mass of beaker and mixture	286.47g
Mass of dried filter paper and dried sand	30.25g
Mass of evaporating dish and salt	110.62g

Determine the percentage by mass of each component in the mixture. Show all working.

Question 19 (4 marks)

MX is a white solid that melts at 730°C. MX does not conduct electricity in the solid state but conducts when molten. YZ melts at – 230°C and boils at 76°C. YZ does not conduct electricity in either the solid or liquid state.

(a) Identify the type of bonding present in MX. **(1 mark)**

_____

(b) Identify the type of structure of YZ. **(1 mark)**

_____

(c) Account for the electrical non–conductivity of MX in the solid phase and its conductivity in the liquid phase. **(2 marks)**

_____

_____

_____

_____

_____

Question 20 (2 marks)

Describe a model for the structure of metals. Discuss one limitation of the use of models with respect to metallic lattices.

Question 21 (4 marks)

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

(b) In class, you observed the electrolysis of water.

(i) List two observations which allowed you to conclude that water is a compound. **(2 marks)**

(ii) State another observation that shows that electrolysis is a chemical change. **(1 mark)**

Question 22 (4 marks)

The table shows the atomic radii of Period 2 elements…

Element	Li	Be	B	C	N	O	F	Ne
Atomic radius (nm)	0.152	0.112	0.085	0.077	0.075	0.073	0.072	0.071

(a) Predict the **relative** size for sodium's atomic radius and give a reason for your prediction. **(2 marks)**
► *A numerical value is not required.*

(b) Which Period 2 element has the highest first ionisation energy?
Give a reason for your choice. **(2 marks)**

Question 23 (4 marks)

(a) A party sparkler produces bright sparks when fine iron powder reacts with oxygen…

Write the balanced formulae equation for this reaction. **(1 mark)**

(b) Aluminium reacts slowly with dilute hydrochloric acid and a transfer of electrons occurs.

(i) Write a balanced formulae equation for this reaction. **(1 mark)**

(i) Write two ionic half–equations which show this electron transfer process. **(2 marks)**

Question 24 (2 marks)

The table outlines the uses of common alloys related to their properties…

Alloy	*Common Use*	*Property related to use*
Brass	Keys	Excellent machinability
Steel		High tensile strength
Solder	Joining electrical wires and connections in electronic circuits	

Complete the blank cells in the table giving an appropriate use and/or property for steel and solder.

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

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

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

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
	Au	
Atomic Weight	197.0	
	Gold	Name of element

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.