| | |
|---|---|
| **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.

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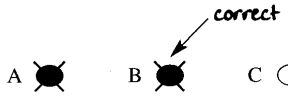



## Answer Box for Questions 1 – 15

| | | | | |
|---|---|---|---|---|
| **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** ○ |

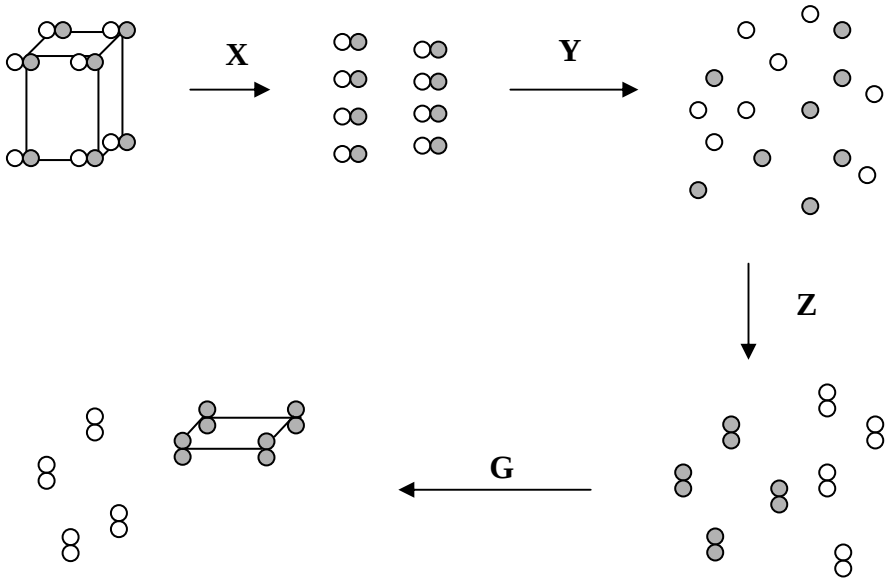
► ***Mark your answers for Questions 1 – 15 in the Answer Box on page 2.***

---

**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)

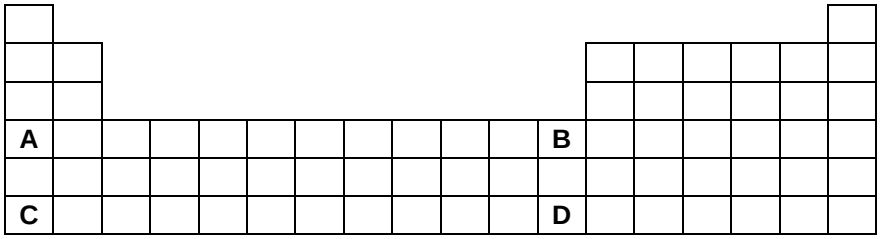
**12** The extraction of aluminium from alumina ($Al_2O_3$) requires 50 megajoules per kg of Al produced. What is the explanation for this extremely high energy value*?*

(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…

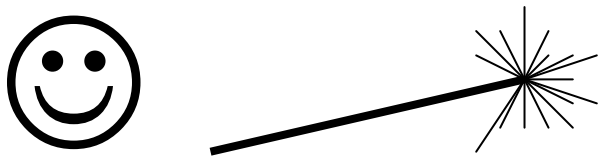
| *Element* | Li | Be | B | C | N | O | F | Ne |
|---|---|---|---|---|---|---|---|---|
| *Atomic radius (nm)* | 0.152 | 0.112 | 0.085 | 0.077 | 0.075 | 0.073 | 0.072 | 0.071 |

(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, $N_A$ ..... $6.022 \times 10^{23}$ 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), $K_w$ ..... $1.0 \times 10^{-14}$

Specific heat capacity of water ..... $4.18 \times 10^3$ 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
Atomic Weight
79 Au 197.0 Gold
Symbol of element
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.

**Answers and Marking Scheme**

# Chemistry

**Chemical Earth + Metals**

**Theory Test • 2005**

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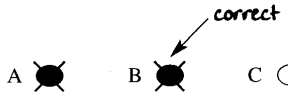


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| 13 | A ○ | B ✪ | C ○ | D ○ |
| 14 | A ○ | B ○ | C ✪ | D ○ |
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(C) They are good conductors of electricity.
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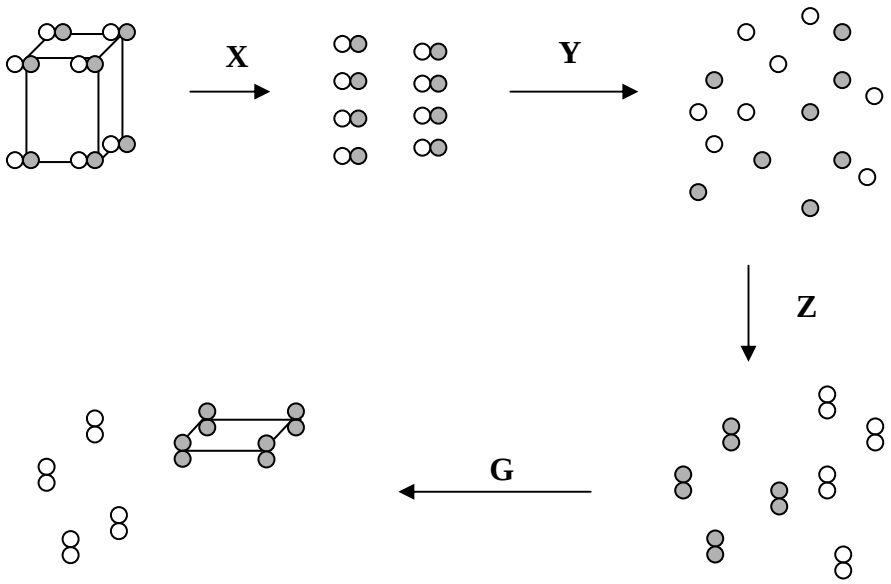


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| | *X* | *Y* | *Z* | *G* |
|---|---|---|---|---|
| **(A)** | **physical change** | **chemical change** | **chemical change** | **physical change** |
| (B) | chemical change | chemical change | chemical change | physical change |
| (C) | physical change | 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
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(C) 19
(D) 35

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

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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)**

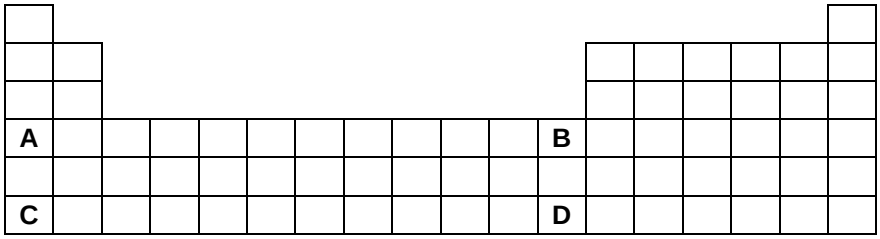
**12** The extraction of aluminium from alumina ($Al_2O_3$) requires 50 megajoules per kg of Al produced. What is the explanation for this extremely high energy value?

(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.***

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**Question 16 (3 marks)**

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

**potassium + water → potassium hydroxide + hydrogen**

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

$$2K_{(s)} + 2H_2O_{(l)} \rightarrow 2KOH_{(aq)} + H_{2(g)}$$

► ***One mark for balanced equation + one mark for correct states.***

**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)**

**HF does not conduct electricity as it does not have mobile ions, it is molecular.**
**When HF dissolves in water free ions are produced to carry a charge.**

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

**KF is an ionic lattice structure, and the formula shows the simplest ratio of ions, 1:1.**

**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.

**Mass of sand = 30.25 – 0.75g = 29.50g**

**Mass of salt = 110.62 – 105.47g = 5.15g**

**Mass of water = 286.47 – 200.00 – 29.5 – 5.15g = 51.82g**

**% Mass of sand = 29.5 ÷ 86.47 × 100 = 34.12%**

**% Mass of salt = 5.15 ÷ 86.47 × 100 = 5.96%**

**% Mass of water = 51.82 ÷ 86.47 × 100 = 59.93%**

**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)**

**Ionic**

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

**Covalent molecular or covalent molecular lattice**

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

**There are no mobile charged species in MX. The ions in the solid phase are rigidly held in place in the crystal lattice. (1 mark)**

**In the liquid phase, the ions are free to move, hence, is able to conduct electricity. (1 mark)**

**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.

**Metals consist of a lattice of cations surrounded by a "sea of delocalised electrons". (1 mark)**

**This model, however, is not able to account for differences in the melting and boiling point of metals. For example, why does Hg have such a low melting point? (1 mark)**

**Question 21 (4 marks)**

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

$$CuCO_{3\,(s)} \rightarrow CuO_{(s)} + CO_{2\,(g)}$$

(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)**

**Observations to support that water is a compound…**

**► Two different substances (oxygen gas & hydrogen gas) were tested to be present during electrolysis. This shows that water is made up of more than one type of atom. (1 mark)**

**► The two substances obtained were in definite ratio of 2:1 as shown by the 2:1 ratio of the gas volumes. (1 mark)**

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

**A chemical change has occurred as shown by the difference in the properties of reactant (water) and the products (oxygen and hydrogen, both gases) or any suitable answer. (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.*

**The predicted atomic radius of sodium would be greater than lithium's value of 0.152 nm (1 mark)**

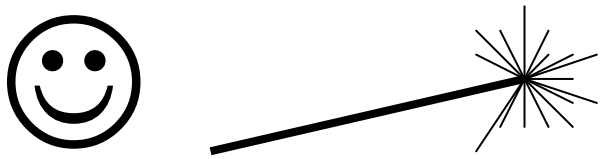
**Since sodium has three electron shells it would be larger than lithium with two electron shells. (1 mark)**

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

**Neon (1 mark) has the highest first ionisation energy value because its outer electrons would be held firmly due to its small size. (1 mark)**

**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)**

$4Fe_{(s)} + 3O_{2\,(g)} \rightarrow 2Fe_2O_{3\,(s)}$

► ***The formation of FeO also acceptable.***

(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)**

$2Al_{(s)} + 6HCl_{(aq)} \rightarrow 2AlCl_{3\,(aq)} + 3H_{2\,(g)}$

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

$Al_{(s)} \rightarrow Al^{3+}_{(aq)} + 3e^-$ **(1 mark)**

$2H^+ + 2e^- \rightarrow H_{2\,(g)}$ **(1 mark)**

**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 | **Steel tools, fasteners, fencing wire (1 mark on any)** | High tensile strength |
| Solder | Joining electrical wires and connections in electronic circuits | **Low melting point Adhesiveness to copper (1 mark for any)** |

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