SYDNEY GRAMMAR SCHOOL

2014
FORM V
HALF-YEARLY EXAMINATION
1:00pm 14 May 2014

Chemistry

General Instructions

- Working time – 2 hours
- Board-approved calculators may be used
- Write using blue or black pen
- Draw diagrams using pencil
- A Data Sheet and Periodic Table are provided at the back of this paper
- Write your name and Master's initials at the top of the Multiple Choice Answer Sheet and the first page in Parts B to F

Collection

- **Remove central staple** and collect in ONE bundle
- Hand in **all** parts of the paper, including the multiple choice questions

Total marks (88)

This paper has five parts, Parts A to F

Part A
Total marks **(13)**
- Attempt ALL Questions
- Allow about 15 minutes for this Part.

Parts B to F
Total marks **(75)**
- Attempt ALL questions
- Allow about 1 hour and 45 minutes for this Part.

CHECKLIST	
Each boy should have the following:	
1 Question Paper	
1 Multiple Choice Answer Sheet	

5CY201 - AKBB	5CY202 - CF	5CY203 - ASG	
5CY204 - EJS	5CY205 - MRB	5CY206 - TW	5CY207 - ZI

EXAMINERS: TW / AKBB / CF / MRB / ASG

Part A

Total marks (13)
Attempt ALL Questions
Allow about 15 minutes for this Part

Use the multiple-choice Answer Sheet.

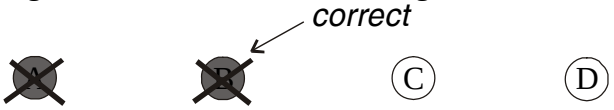
Select the alternative A, B, C or D that best answers the question. Fill the response circle completely.

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.

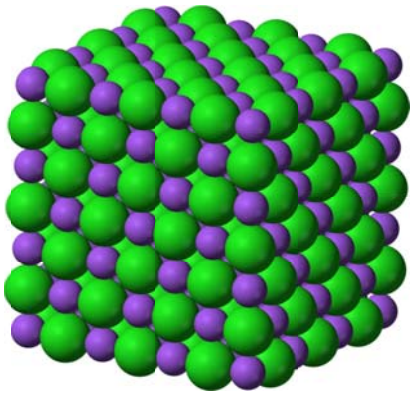
If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows.



1 Which of the following is a characteristic of covalent bonding?

(A) It will never be found in a lattice structure.
(B) It represents an uneven charge distribution resulting in a positive and negative particle.
(C) It results from two atoms sharing a pair of electrons.
(D) It can only be found in pure elements.

2 Which substance does the following model best represent?



(A) solid sodium metal
(B) solid graphite (carbon)
(C) solid iodine trichloride
(D) solid sodium chloride

3 What are the products resulting from the decomposition of a metal carbonate?

(A) Metal oxide + carbon dioxide
(B) Metal + carbon dioxide + water
(C) Metal carbide + oxygen
(D) Metal + carbon dioxide

4 Identify the list which contains only chemicals which have a lattice structure at room temperature.

(A) sodium chloride, silicon dioxide, diamond
(B) methane, silicon dioxide, diamond
(C) sodium chloride, carbon dioxide, ammonium sulfide
(D) sodium chloride, methane, diamond

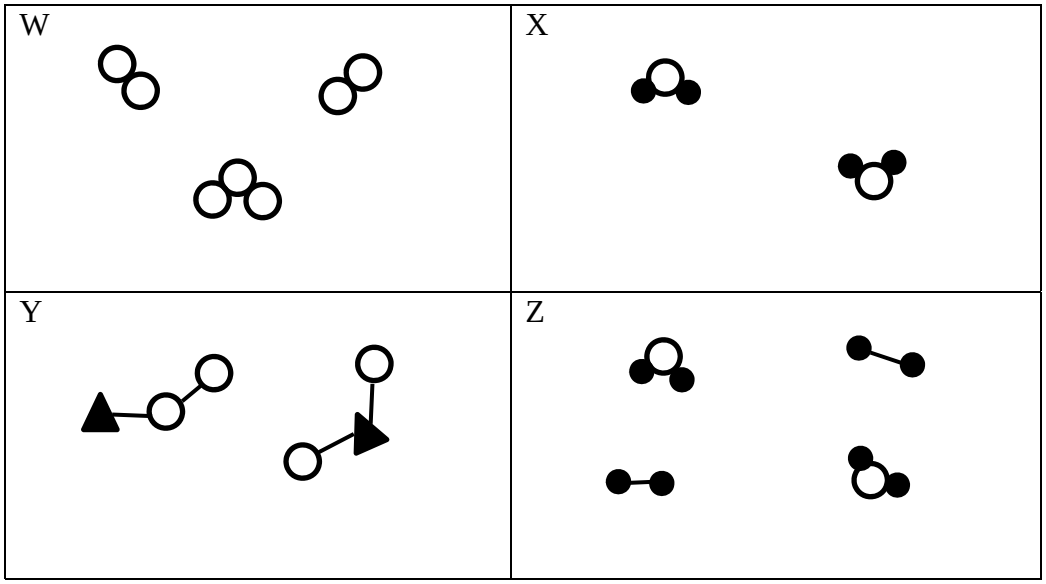
5 What name is given to the separation of naturally occurring mixtures of solids of different sizes?

(A) sieving
(B) filtering
(C) dissolving
(D) centrifuging

6 Calculate the percentage of hydrogen in calcium hydrogen carbonate.

(A) 24.7%
(B) 1.2%
(C) 1.0%
(D) 0.6%

7 Materials W, X, Y and Z are represented below.



Which of the following correctly classifies W, X, Y and Z?

	W	X	Y	Z
(A)	mixture	compound	compound	mixture
(B)	element	mixture	mixture	compound
(C)	mixture	compound	mixture	mixture
(D)	element	compound	compound	mixture

8 Why was bronze was discovered before brass?

(A) The element bronze is less reactive than the element brass.
(B) Copper is less reactive than zinc.
(C) Tin is less reactive than zinc.
(D) Copper is less reactive than tin.

9 Which one of the following trends occurs consistently from top to bottom down the sixth group (from O to Po)?

(A) An increase in first ionisation energy
(B) An increase in atomic radius
(C) A decrease in atomic number
(D) A decrease in melting point

10 Which set of properties would make a metal ideal for use in electrical wiring?

(A) Lustrous and malleable
(B) Brittle and dull
(C) Low melting point and conductive
(D) Ductile and conductive

11 Which arrangement shows the metals in increasing reactivity order?

(A) K, Mg, Fe, Cu, Au
(B) K, Mg, Cu, Fe, Au
(C) Au, Cu, Fe, Mg, K
(D) Au, Fe, Cu, Mg, K

12 Copper, gold and tin were among the first metals to be used by human societies. The iron age came later, despite the fact that iron is much more abundant in the Earth's crust than copper, gold or tin. What is the reason for the later use of iron by humans?

(A) Iron is harder than copper, gold and tin.
(B) Iron is principally found in the Earth's core and mantle.
(C) Iron rusts rapidly, unlike copper, gold and tin.
(D) Iron is more reactive and so is more difficult to obtain from its ores

13 Identical samples of calcium reacted completely with four different gases. Which of the following gases produced the largest increase in mass?

(A) hydrogen
(B) fluorine
(C) sulfur
(D) nitrogen

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Master's initials

Name

Part B

Total marks (75)
Attempt ALL Questions
Write your name and your Master's initials in the space provided above.

Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Marks

Question 14 (5 marks)

A student wishes to demonstrate the decomposition of silver bromide.

I. Outline a method that could be used to synthesise silver bromide.
II. Outline how this salt can be decomposed.
III. Explain how you could tell that a chemical reaction had taken place.
IV. Write a balanced chemical equation for the decomposition reaction.
V. Identify an application of this process.

5

Question 15 (2 marks) **Marks**

Write the formula for

(a) aluminium sulfide

_____ **1**

(b) diiodine pentaoxide

_____ **1**

Question 16 (5 marks)

Discuss in terms of the type of change which is taking place, the boiling and the electrolysis of water and what this means in terms of bond strength and particle rearrangement.

Include a balanced chemical equation for the electrolysis of water in your answer.

_____ **5**

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Master's initials

Name

Question 17 (2 marks) **Marks**

Compare and contrast the terms molecular and covalent.

2

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Master's initials

Name

Question 18 (3 marks)

Using dinitrogen tetraoxide as an example, explain the difference between a molecular and empirical formula.

3

Question 19 (5 marks) **Marks**

About two thirds of the known elements are metals.

(a) Briefly describe the structure and bonding of a metal.

2

(b) Metals are known to be malleable and good conductors of electricity. Explain **both** of these properties in terms of structure and bonding.

3

Master's initials

Name

Marks

Question 20 (4 marks)

Classify the following elements by their structure/bonding classification (metallic, ionic, covalent molecular, covalent network).

4

	Melting point (^oC)	Electrical conductivity ($MS\ m^{-1}$)	Thermal conductivity ($J\ s^{-1}\ m^{-1}\ K^{-1}$)	Density ($g\ cm^{-3}$)	Structure/bonding classification
A	3550	10^{-17}	1000	3.51	
B	63	14	102	0.86	
C	-112	-	0.006	3.5 (liquid)	
D	1535	10	80	7.9	

Marks

Question 21 (2 marks)

Explain why elemental iron meteorites occur in outer space, but rocks containing elemental iron are not found on the Earth's surface.

_____ **2**

_____

Question 22 (2 marks)

Account for the use of a named metal of your choice in terms of two of its physical properties.

Metal : _____

Property 1: _____ **1**

Use 1 : _____

Property 2:_____ **1**

Use 2 :_____

Master's initials

Name

Question 23 (2 marks) **Marks**

Identify a possible formula for a compound formed from the reaction of the following elements:

(a) gallium and chlorine

_____ **1**

(b) tin and bromine

_____ **1**

Question 24 (3 marks)

Identify an atom, a cation and an anion that have the electron configuration of 2,8,8.

Atom : _____ **1**

Cation : _____ **1**

Anion : _____ **1**

Marks

Question 25 (3 marks)

Draw the electron dot structures for:

F_2

1

OF_2

1

OCS

1

Master's initials

Name

Question 26 (4 marks) **Marks**

(a) Explain why atoms of an element can have many different mass numbers but only one relative atomic mass.

3

(b) Use the appropriate notation to represent the atom whose nucleus is depicted below.

1

Marks

Question 27 (3 marks)

Often we talk about the properties of metals as if they were uniform for all metals, but there is considerable variation. Complete the following table by giving examples of specific metals.

Property		**Metal**
melting point	low (<100°C)	
reactivity	corrodes easily	
	resistant to corrosion	

3

Master's initials

Name

Marks

Question 28 (5 marks)

Explain how the first ionisation energy of metals correlates to their reactivity. Does this relationship translate to the reactivity of non-metals? Explain with examples from the periodic table.

5

Question 29 (2 marks)

Outline an example of how our use of metals has changed with the development of new technologies.

2

Question 30 (3 marks)

When zinc metal is added to a hydrochloric acid solution the following reaction occurs:

$$Zn_{(s)} + 2\ HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$$

(a) Identify the oxidation and reduction half equations.

Oxidation: **2**

Reduction:

(b) Write a net ionic equation for this reaction.

1

Master's initials

Name

Question 31 (3 marks) **Marks**

(a) Explain what is meant by the term atomic radius.

1

(b) Explain the difference between the atomic radius of a sodium atom and the ionic radius of a sodium ion.

2

Question 32 (5 marks) **Marks**

Pyrolusite (MnO_2) is the main ore of manganese. Manganese was first isolated by heating pyrolusite with carbon, forming carbon dioxide.

(a) Write a balanced chemical equation for this reaction.

_____ **1**

(b) Calculate the volume of carbon dioxide (measured at 25°C and 100 kPa) generated when 1000 g of manganese metal is produced from pyrolusite.

_____ **2**

_____

_____

_____

(c) Calculate the mass of pyrolusite required to produce 1000 g of manganese metal.

_____ **2**

_____

_____

_____

Master's initials

Name

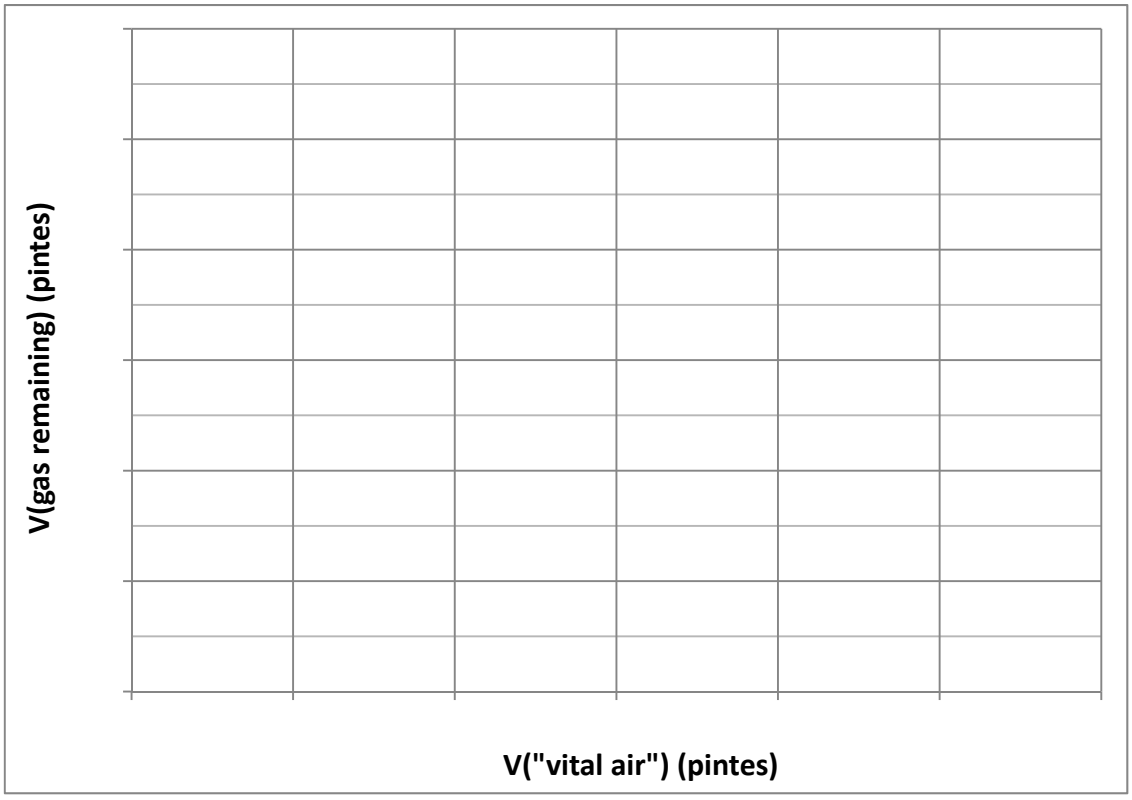
Question 33 (7 marks) **Marks**

Early alchemists discovered that "nitrous gas" reacts immediately with "vital air" to form a gas that is entirely absorbed into water. Neither "nitrous gas" nor "vital air" is soluble in water.

A series of experiments was conducted with various volumes of "nitrous gas" and "vital air". The gas resulting from the reaction was absorbed into water and the volume of residual gas remaining measured. All volumes are given in pintes, an antiquated unit equivalent to 0.953 L and are measured at 20°C and 101.3 kPa.

V("nitrous gas") (pintes)	0	2	4	6	8	10
V("vital air") (pintes)	10	8	6	4	2	0
V(gas remaining) (pintes)	10	7	4	1	4	10

(a) Plot a graph of V(gas remaining) against V("vital air"). **3**



(b) From your graph, or otherwise, estimate the composition of 10 pintes of a mixture of "vital air" and "nitrous gas" that would react to leave no residual gas. **1**

_____

_____

Question 33 continues on the next page.

Question 33 continued.

(c) State Gay-Lussac's Law of Combining volumes, using this data as an example.

2

(d) "Vital air" is now known as oxygen, and the gas produced in the reaction between "nitrous gas" and "vital air" is now known as nitrogen dioxide. State the formula of "nitrous gas".

1

End of question 33.

Master's initials

Name

Question 34 (5 marks) **Marks**

Element X is a silvery gray solid whose compounds have been used for centuries. 9.930 g of element **X** reacts stoichiometrically with 8.67 g of chlorine gas to give 18.600 g of compound **A**. When 5.210 g of compound **A** is heated in excess chlorine gas, 6.829 g of compound **B** is produced. Compound **B** reacts violently with excess water to give a solution of hydrochloric acid and a binary compound **C**, which does not contain chlorine and consists of 75.28% element **X** by mass.

Name or give the formula of element **X** and compounds **A**, **B** and **C**, showing all working and logic.

5

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Master's initials

Name

Chemistry

Data Sheet

Avogadro's constant, N_A ……. 6.022×10^{23} mol^{-1}

Volume of 1 mole ideal gas: at 100 kPa and

at 0 °C (273 K) …… 22.71 L

at 25 °C (298K) …… 24.79 L

Ionisation constant for water at 25°C (298 K), K_w …….. 1.0×10^{-14}

Specific heat capacity of water ……..4.18×10^3 Jkg^{-1}K^{-1}

Some useful formulae

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

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
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_{2(g)} + 2H_2O$	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
$\frac{1}{2} O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O	1.23 V
$\frac{1}{2} Cr_2O_7^{2-} + 7H^+ + 3e^-$	$\rightleftharpoons$	$Cr^{3+} + \frac{7}{2} H_2O$	1.36 V
$\frac{1}{2} Cl_{2(g)} + e^-$	$\rightleftharpoons$	Cl^-	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
Symbol
Standard Atomic Weight
Name

79 Au 197.0 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						

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

Elements with atomic numbers 112 and above have been reported but not fully authenticated.

Standard atomic weights are abridged to four significant figures.

Elements with no reported values in the table have no stable nuclides.

The International Union of Pure and Applied Chemistry Periodic Table of the Elements (February 2010 version) is the principal source of data. Some data may have been modified.

CRIB

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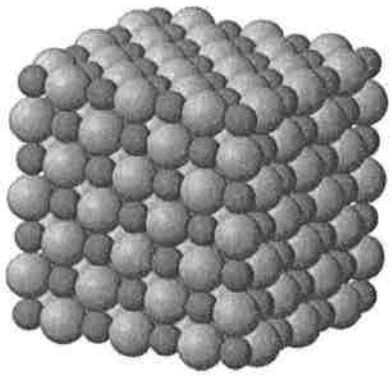

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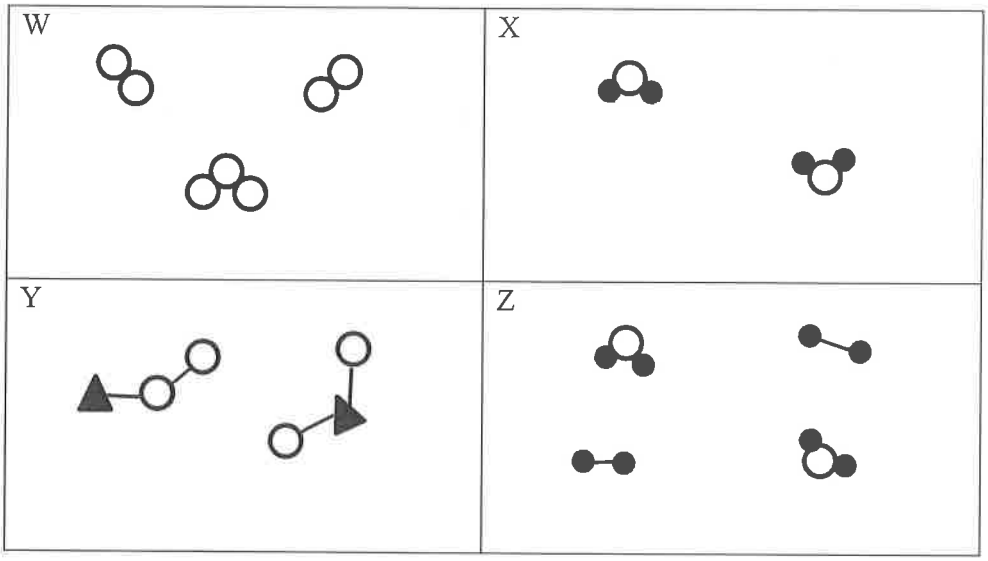

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(B)	element	mixture	mixture	compound.
(C)	mixture	compound	mixture	mixture.
(D)	element	compound	compound	mixture.

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(C) Au, Cu, Fe, Mg, K
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(B) fluorine
(C) sulfur
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Master's initials

Name

Part B

Total marks (75)
Attempt ALL Questions
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Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.

Marks

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I. Outline a method that could be used to synthesise silver bromide.
II. Outline how this salt can be decomposed.
III. Explain how you could tell that a chemical reaction had taken place.
IV. Write a balanced chemical equation for the decomposition reaction.
V. Identify an application of this process.

I. Precipitation of a soluble silver salt & a soluble bromide salt. 5
II. (U.V.) light
III. Change in colour
IV. $2AgBr \rightarrow 2Ag + Br_2$
V. Black & White film photography etc.

AUBB.

Question 15 (2 marks) **Marks**

Write the formula for

(a) aluminium sulfide

Al_2S_3 **1**

(b) diiodine pentaoxide

I_2O_5 **1**

Question 16 (5 marks)

Discuss in terms of the type of change which is taking place, the boiling and the electrolysis of water and what this means in terms of bond strength and particle rearrangement.

Include a balanced chemical equation for the electrolysis of water in your answer.

Physical - chemical
Bond Strengths comparison
Bond Types x2 named
Energy requirement comparison
Particle Rearrangement
Reversibility comparison

5 ANY 4 1 MARK EACH

$2H_2O \rightarrow 2H_2 + O_2$ 1 MARK

Some what holistically marked.

Master's initials

Name

Question 17 (2 marks) **Marks**

Compare and contrast the terms molecular and covalent.

Molecular - independent units/ finite structure
Covalent - shared (pair) of electrons

2

Master's initials

Name

Question 18 (3 marks)

Using dinitrogen tetraoxide as an example, explain the difference between a molecular and empirical formula.

3

- Molecular Formula - the number of each type of atom in a molecule (1 mark) (not ratio)
- Empirical Formula - the simplest ratio of atoms in a compound. (not just ratio) (1 mark)

1 Correctly Identifies the molecular and empirical formula of dinitrogen tetroxide as N_2O_4 and NO_2 respectively.

Question 19 (5 marks) **Marks**

About two thirds of the known elements are metals.

(a) Briefly describe the structure and bonding of a metal.

(Three dimensional) lattice of metal cations (not nuclei) surrounded by a sea of electrons **2**

(b) Metals are known to be malleable and good conductors of electricity. Explain **both** of these properties in terms of structure and bonding.

Malleable – the mobile delocalised sea of electrons move as lattice of cations move so bonding remains intact as the ~~object~~ metal's shape changes **3**

2 marks (note bonds do not break + reform)

Electrical Conductivity

– The sea of electrons are mobile and the moving electrons create an electrical current in the metal when a voltage is applied across the metal.

1 mark.

Master's initials

Name

Marks

Question 20 (4 marks)

Classify the following elements by their structure/bonding classification (metallic, ionic, covalent molecular, covalent network).

4

	Melting point (°C)	Electrical conductivity (MS m^{-1})	Thermal conductivity (J s^{-1} m^{-1} K^{-1})	Density (g cm^{-3})	Structure/bonding classification
A	3550	10^{-17}	1000	3.51	covalent network
B	63	14	102	0.86	metallic
C	-112	-	0.006	3.5 (liquid)	covalent molecular
D	1535	10	80	7.9	metallic

Marks

Question 21 (2 marks)

Explain why elemental iron meteorites occur in outer space, but rocks containing elemental iron are not found on the Earth's surface.

Iron is a reactive metal and reacts with oxygen in atmosphere, hence no metallic iron on Earths surface. There is no oxygen in ~~space~~ outer space so elemental iron remains elemental. 1

Question 22 (2 marks)

Account for the use of a named metal of your choice in terms of two of its physical properties.

Metal : Metal not alloy.

Property 1: _____ 1

Use 1 : _____

Property 2: _____ 1

Use 2 : _____

Any 2 physical properties with associated use.

ASG
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CR13
Name

Question 23 (2 marks) **Marks**

Identify a possible formula for a compound formed from the reaction of the following elements:

(a) gallium and chlorine

$GaCl_3$ 1

(b) tin and bromine

$SnBr_4$ or $SnBr_2$ 1

Question 24 (3 marks)

Identify an atom, a cation and an anion that have the electron configuration of 2,8,8.

Atom : Argon 1

Cation : K^+ or Ca^{2+} 1

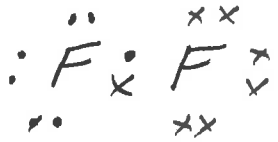
Anion : Cl^- or S^{2-} 1

Marks

Question 25 (3 marks)

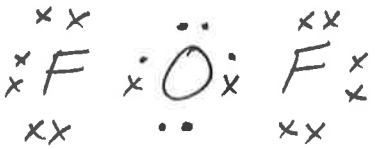
Draw the electron dot structures for:

F_2



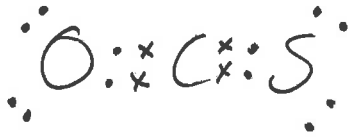
1

OF_2



1

OCS



1

Electrons in pairs

Bonding electrons between symbols.

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CRIB

Name

Question 26 (4 marks) **Marks**

(a) Explain why atoms of an element can have many different mass numbers but only one relative atomic mass.

(1) mass number is the number of protons + neutrons

(1) Mass number varies for different isotopes of that element due to varying numbers of neutrons

(1) R.A.M is the weighted average atomic mass of the different isotopes found in a natural sample of that element

3

(b) Use the appropriate notation to represent the atom whose nucleus is depicted below.

9P
10N

$^{19}_{9}F$ – numbers on L.H.S.

$-{}^{19}_{9}F$ not ${}^{19}_{9}X$....

1

Marks

Question 27 (3 marks)

Often we talk about the properties of metals as if they were uniform for all metals, but there is considerable variation. Complete the following table by giving examples of specific metals.

Property		Metal
melting point	low (<100°C)	Na, K, Rb, Cs, Hg, Ga
reactivity	corrodes easily	Pb and above on reactivity series, Mn.
	resistant to corrosion	Cu and below on activity series

3

Aluminium – both

CF
Master's initials

Name

Marks

Question 28 (5 marks)

Explain how the first ionisation energy of metals correlates to their reactivity. Does this relationship translate to the reactivity of non-metals? Explain with examples from the periodic table.

5

- I, decreases ↓ down group. Reactivity increases ↓ down group.
- ~~less energy ∴ needed~~
- Ionisation energy is the energy needed to remove an electron.
- less energy easier it is to remove an electron.
- Easier it is to remove an electron, more reactive.
  - ↳ Examples = Anything reasonable - Any Group I
  - e.g. Fluorine most common.
- Doesn't correlate to non-metals
  - ↳ fluorine highest ionisation energy but most reactive non-metal.
  - And noble gasses high ionisation energy and not reactive

- Overall holistically marked needed some variant of the 5 statements above.

Most boys have trouble linking cause & effect. low ionisation ⇒ energy require to remove ~~cation~~ electron THUS forming a cation, not the other way around.

Question 29 (2 marks)

Outline an example of how our use of metals has changed with the development of new technologies.

(1) Stating type of technological advancement for obtaining metals
(1) for metal example

2

Note: only one mark given if discussing use of metal has change eg. copper was used for weapons now for wiring.

Question 30 (3 marks)

When zinc metal is added to a hydrochloric acid solution the following reaction occurs:

$$Zn_{(s)} + 2\ HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$$

(a) Identify the oxidation and reduction half equations.

Oxidation: $Zn_{(s)} \longrightarrow Zn^{2+}_{(aq)} + 2e^-$

Reduction: $2H^+_{(aq)} + 2e^- \longrightarrow H_{2(g)}$

2

(b) Write a net ionic equation for this reaction.

$Zn_{(s)} + 2H^+_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + H_{2(g)}$

1

• States required! for one mark.

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Name

Question 31 (3 marks) **Marks**

(a) Explain what is meant by the term atomic radius.

Average distance from centre of nucleus to outer most electron

1

(b) Explain the difference between the atomic radius of a sodium atom and the ionic radius of a sodium ion.

(1) sodium atom bigger than ion

(1) ion has one less electron shell ∴ smaller distance to nucleus ∴ smaller.

2

Question 32 (5 marks) **Marks**

Pyrolusite (MnO_2) is the main ore of manganese. Manganese was first isolated by heating pyrolusite with carbon, forming carbon dioxide.

(a) Write a balanced chemical equation for this reaction.

$MnO_{2(s)} + C_{(s)} \longrightarrow Mn_{(s)} + CO_{2(g)}$ **1**

(b) Calculate the volume of carbon dioxide (measured at 25°C and 100 kPa) generated when 1000 g of manganese metal is produced from pyrolusite.

$1000\,g \div n_{Mn} = \frac{1000}{54.94}$ **2**

$= 18.207$ moles. (1)

∴ as 1:1 ratio

$n_{Mn} = n_{CO_2}$ ∴ $V_{CO_2} = 24.79 \times 18.207$ mols

$= 451.2\,L$

(c) Calculate the mass of pyrolusite required to produce 1000 g of manganese metal.

$n_{Mn} = n_{MnO_2}$ **2**

$\therefore m = n_{MnO_2} \times fw$

$= 18.207 \times (54.94 + 2 \times 16)$ (1) mark for answer

$= 1582.45358\,g$ (1) (1) mark for 4 sig. fig.

$= 1582\,g$ (1) 4 sig fig.

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Name

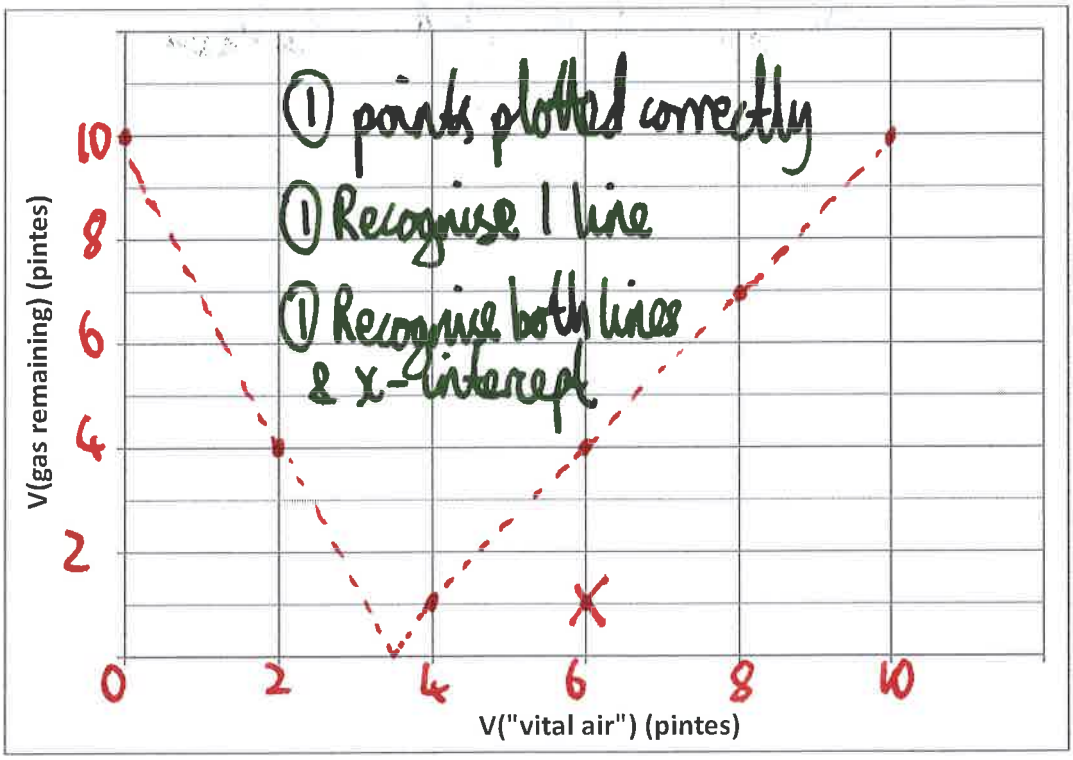
Question 33 (7 marks) **Marks**

Early alchemists discovered that "nitrous gas" reacts immediately with "vital air" to form a gas that is entirely absorbed into water. Neither "nitrous gas" nor "vital air" is soluble in water.

A series of experiments was conducted with various volumes of "nitrous gas" and "vital air". The gas resulting from the reaction was absorbed into water and the volume of residual gas remaining measured. All volumes are given in pintes, an antiquated unit equivalent to 0.953 L and are measured at 20°C and 101.3 kPa.

V("nitrous gas") (pintes)	0	2	4	6	8	10
V("vital air") (pintes)	10	8	6	4	2	0
V(gas remaining) (pintes)	10	7	4	1	4	10

(a) Plot a graph of V(gas remaining) against V("vital air"). **3**



(b) From your graph, or otherwise, estimate the composition of 10 pintes of a mixture of "vital air" and "nitrous gas" that would react to leave no residual gas.

3·3 pintes "vital air", 6·7 pintes "nitrous gas" 1

3-4

Question 33 continues on the next page.

Question 33 continued.

(c) State Gay-Lussac's Law of Combining volumes, using this data as an example.

The ratios of the volumes of gases involved in a reaction, when measured at the same temperature & pressure, are expressed as small whole numbers. e.g. this data suggests that "nitrous gas" and "vital air" combine in the ratio 2:1 (or as stated in (b)). **2**

(d) "Vital air" is now known as oxygen, and the gas produced in the reaction between "nitrous gas" and "vital air" is now known as nitrogen dioxide. State the formula of "nitrous gas".

$NO(g)$; also accepted N_xO_{2x-1}. **1**

End of question 33.

Master's initials

Name

Question 34 (5 marks) **Marks**

Element X is a silvery gray solid whose compounds have been used for centuries. 9.930 g of element **X** reacts stoichiometrically with 8.67 g of chlorine gas to give 18.600 g of compound **A**. When 5.210 g of compound **A** is heated in excess chlorine gas, 6.829 g of compound **B** is produced. Compound **B** reacts violently with excess water to give a solution of hydrochloric acid and a binary compound **C**, which does not contain chlorine and consists of 75.28% element **X** by mass.

Name or give the formula of element **X** and compounds **A**, **B** and **C**, showing all working and logic.

5

$n(Cl)$ in $A = \frac{8.67\,g}{35.45\,g\,mol^{-1}} = 0.2446\,mol$

extra $m(Cl)$ in $B = 6.829 - 5.210 = 1.619\,g$

extra $n(Cl)$ in $B = \frac{1.619\,g}{35.45\,g\,mol^{-1}} = 0.04567\,mol$

Scaling this to $m(A)$: $0.04567\,mol \times \frac{18.600}{5.210} = 0.1630\,mol$.

Then either: 1. $n(Cl)$ in $B = 0.1630 + 0.2446$

$= 0.4076\,mol$

$n(Cl)$ in $A : n(Cl)$ in $B = 1 : 1.67$ or $3:5$

or 2. $n(Cl)$ in A : extra $n(Cl)$ in $B = 1.5:1$ or $3:2$.

Both 1. and 2. strongly suggest that A is XCl_3 & B is XCl_5.

If XCl_3, R.A.M. $(X) = \frac{9.930 \times 3}{0.2446} = 121.8\,g\,mol^{-1}$

$\Rightarrow$ X is Sb,

A is $SbCl_3$, B is $SbCl_5$.

C must contain Sb and O (no Cl, H too light).

$n(Sb) = \frac{75.28\,g}{121.8\,g\,mol^{-1}} = 0.6181\,mol$; $n(O) = \frac{24.72}{16.00} = 1.545\,mol$

$\therefore$ E.F. is Sb_2O_5 (s).

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