St Paul's School

FOUNDED 1509

16+ Entry Examination

SAMPLE PAPER

Chemistry

45 Minutes

Instructions to Candidates

- Answer all of the questions.
- Write your answers in the spaces provided on the question paper.

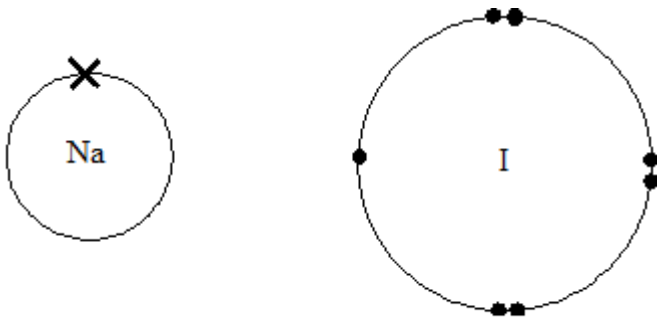
Information for Candidates

- The number of marks available is shown in brackets [ ] at the end of each question or part question. The total mark for the paper is 45.
- The marks allocated and the spaces provided for your answers are a good indication of the length of answer required.
- A Periodic Table is provided on page 8.
- You may use a calculator.

1. **This is about structure and bonding.**

(a) Sodium reacts with iodine to form a substance called sodium iodide.

(i) The diagram below shows the **outer** electrons only in an atom of sodium and an atom of iodine.



Draw the way the **outer** electrons are arranged in sodium iodide
Show on your diagram the charges on the particles formed.
(i.e. a dot/cross bonding diagram for sodium iodide)

[2]

(ii) What type of bonding is present in sodium iodide?

[1]

(iii) Explain in terms of the bonding involved why sodium chloride has a higher melting point than sodium iodide.

[2]

(b) When excess nitrogen gas, N_2 , reacts with magnesium metal a compound **X** is formed.

(i) Draw dot/cross bonding diagram to show how the **outer** electrons are arranged in Nitrogen, N_2.

[2]

(ii) A student finds that 10.1 g of magnesium reacts completely in excess nitrogen to form 14.0g of compound **X**. Calculate the empirical formula of **X**.

[3]

(c) Study the table of data below for five substances, **A** to **E**, and then answer the questions that follow.

Substance	**Melting point /°C**	**Boiling point /°C**	**Electrical conductivity**		**Solubility in water**
			as a solid	**as a liquid**	
A	1610	2230	poor	poor	insoluble
B	– 182	– 161	poor	poor	insoluble
C	1083	2582	good	good	insoluble
D	801	1465	poor	good	soluble
E	– 95	69	poor	poor	immiscible

(i) Which substance is liquid at 1500 °C ? _____[1]

(ii) Which substances have giant structures ? _____[1]

(iii) Which substances have simple molecular structures ? _____[1]

(iv) Which substance has a simple molecular structure with the strongest intermolecular (between molecule) bonds ? _____[1]

(v) Fill in the missing words in the sentence that follows. Substance **C** has a giant structure of _____ held together by strong _____ bonds. [2]

(vi) Which substance would be the most useful as insulator material on a circuit board ? _____[1]

2. **This is about acids.**

(a) Write a balanced symbol equation, without state symbols, for the reaction between magnesium carbonate and nitric acid.

[2]

(b) (i) Balance the equation shown below (all the formulae are correct).

……. $CuO(s)$ + ……. $H_3PO_4(aq)$ → …….. $Cu_3(PO_4)_2(aq)$ + …….. $H_2O(aq)$

[1]

(ii) Use your answer to part (b) (i) to write the ionic equation, with state symbols for the reaction.

[2]

(iii) What sort of chemical change happens to copper(II) oxide when it reacts with phosphoric acid?

[1]

(c) Describe the key experimental steps needed to make sodium sulfate crystals from sodium hydroxide solution and dilute sulfuric acid.

[4]

3. **This is about redox.**

(a) The Thermite reaction is used to produce molten iron for welding in the construction industry.

$$2Al(s) + Fe_2O_3(s) \rightarrow Al_2O_3(s) + 2Fe(l)$$

(i) From this reaction what can you deduce about the relative reactivity of iron and aluminium

[1]

(ii) Use the equation to explain what is meant by the term *oxidising agent*.

[2]

(iii) Calculate the mass of iron oxide needed to release 2.00 kg of molten iron metal.

[3]

(b) Hydrogen sulfide reacts with iron(III) salts as shown in the ionic equation below:

$$H_2S(aq) + 2Fe^{3+}(aq) \rightarrow 2H^+(aq) + S(s) + 2Fe^{2+}(aq)$$

(i) Write an ion/electron equation for the conversion of Fe^{3+} to Fe^{2+} .

[1]

(ii) Use your answer to (b) (i) to **explain** whether the conversion of Fe^{3+} to Fe^{2+} is either oxidation or reduction.

[1]

4. **This is about Group 2**

(a) Complete the missing boxes in the table below.

Element	Species	No of protons	No of electrons	No of neutrons
Magnesium	$^{24}Mg^{2+}$	12	10	12
		12	12	14
Calcium	^{40}Ca	20	20	20
Calcium	$^{46}Ca^{2+}$			

[5]

(b) What term describes atoms of the same element that have different mass numbers?

[1]

(c) A student added an excess of magnesium powder to 25.0 cm^3 of hydrochloric acid of concentration 0.100 mol dm^{-3} (at room temperature and pressure)

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

(i) Deduce the amount, in moles, of hydrochloric acid present.

[2]

(ii) Calculate the total volume of hydrogen gas evolved in this experiment given that one mole of hydrogen occupies 24 dm^3 at room temperature and pressure.

[2]

END OF QUESTIONS

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.