

SECTION A

Answer ALL the questions in this section.

There is useful data on the front cover and a Periodic Table is printed on the back cover of this question paper.

1. (a) When manganese(IV) oxide is added to concentrated hydrochloric acid, chlorine is formed.

When manganese(IV) oxide is added to aqueous hydrogen peroxide, oxygen is formed.

State the role of manganese(IV) oxide

- (i) in the formation of chlorine,

.....

- (ii) in the formation of oxygen.

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(2)

- (b) Give a test to identify

- (i) chlorine,

.....

- (ii) oxygen.

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(2)

- (c) A different oxide of manganese has the following composition by mass:

$$\text{Mn} = 69.6\% \quad \text{O} = 30.4\%$$

Calculate the empirical formula of the oxide of manganese.

(3)



(d) Manganese is a transition metal. Give three chemical characteristics of a typical transition metal that would distinguish it from a non-transition metal.

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(3)

(Total 10 marks)

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Q1

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2. (a) Methane is the first member of the homologous series of alkanes.

(i) Write the general formula for an alkane.

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(1)

(ii) Draw a diagram to show the shape of a methane molecule, using lines to represent covalent bonds. Name the shape that a methane molecule adopts.

Diagram:

Name of shape:
(3)

(iii) State how the chemical properties and a named physical property of members of a homologous series change, if at all, as the molecular mass increases.

Chemical properties:

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Named physical property:

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(2)



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(b) The formula $C_2H_4Cl_2$ can represent two isomers.

(i) Explain what is meant by **isomers**.

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(1)

(ii) Draw the displayed formulae for the two isomers of $C_2H_4Cl_2$

(2)

(iii) Write the empirical formula for $C_2H_4Cl_2$

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(1)

Q2

(Total 10 marks)

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5

Turn over



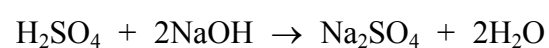
N 3 5 9 2 0 A 0 5 2 4

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3. A student performed a series of titrations using aqueous sulphuric acid of concentration $0.0500 \text{ mol dm}^{-3}$ and a solution of sodium hydroxide of unknown concentration. In each titration, 25.00 cm^3 of sodium hydroxide solution was placed in a conical flask and the volumes of sulphuric acid used are shown in the table.

Titration	1	2	3	4
Volume of sulphuric acid used / cm^3	26.80	25.70	25.60	25.65

The equation for the reaction is



- (a) Name the piece of apparatus that would be used to add the sulphuric acid.

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(1)

- (b) Name a suitable indicator for the titration and state the colour change during the neutralisation process.

Indicator:.....

Colour change:.....

(2)

- (c) State two precautions that should be taken during the addition of sulphuric acid in order to achieve an accurate result.

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(2)



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(d) (i) Suggest a reason why the first titration value is higher than the other values.

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(1)

(ii) Calculate the mean volume of $0.0500 \text{ mol dm}^{-3}$ sulphuric acid used in titrations 2, 3 and 4.

(1)

(iii) Use the mean value to calculate the concentration in mol dm^{-3} of the sodium hydroxide solution.

(3)

Q3

(Total 10 marks)

7

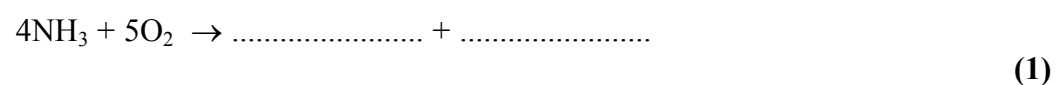
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N 3 5 9 2 0 A 0 7 2 4

4. (a) The first stage in the manufacture of nitric acid is the catalytic oxidation of ammonia to form nitrogen oxide, NO.

(i) Complete the equation for the reaction.



(ii) Identify the catalyst used.

..... (1)

(iii) State the temperature used for the reaction.

..... (1)

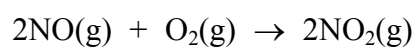
(iv) Explain why no further heating is required once the correct temperature has been reached.

..... (1)

(b) 0.150 g of nitrogen oxide gas, NO, has a volume of 112 cm³ at 0 °C and 1 atmosphere pressure. Calculate the volume of one mole of the gas under these conditions.

(3)

(c) The reaction between nitrogen oxide and oxygen is represented by the equation



If 200 cm³ of nitrogen oxide is reacted with excess oxygen, what volume of nitrogen dioxide will be formed, all measurements being taken at the same temperature and pressure?

..... (1)





<p>(d) (i) State what is meant by the Avogadro constant.</p> <p>.....</p> <p>.....</p> <p style="text-align: right;">(1)</p> <p>(ii) The Avogadro constant is represented as L. Calculate, in terms of L, the number of molecules in 480 cm^3 of nitrogen oxide at room temperature and pressure.</p> <p style="text-align: right;">(1)</p> <p style="text-align: right;">(Total 10 marks)</p>	<p>Leave blank</p> <p>Q4</p> <table border="1"><tr><td style="width: 20px; height: 20px;"></td><td style="width: 20px; height: 20px;"></td></tr></table>		



N 3 5 9 2 0 A 0 9 2 4



5. (a) The following is a description of the preparation of a pure sample of hydrated cobalt(II) chloride crystals, starting from cobalt(II) oxide and dilute hydrochloric acid.

Some dilute hydrochloric acid was placed in a beaker and heated. Spatula measures of cobalt(II) oxide were added and stirred until there was a small excess of cobalt(II) oxide remaining at the bottom of the beaker. The mixture was filtered and the filtrate was placed in an evaporating basin. The basin was heated until about half the solution had evaporated. The solution was allowed to cool slowly and crystals appeared.

(i) Write the equation for the reaction of cobalt(II) oxide, CoO, and dilute hydrochloric acid.

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(1)

(ii) Why was the mixture warmed?

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(1)

(iii) Why was cobalt(II) oxide added until in excess?

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(1)

(iv) Why was the mixture filtered?

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(1)

(v) Why was the solution evaporated until only half remained?

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(1)

(vi) What was the effect of cooling slowly on the size of the crystals?

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(1)



(vii) What would have happened if the solution had been evaporated until no more water was evolved?

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(1)

(b) The M_r of $\text{CoCl}_2 \cdot x\text{H}_2\text{O}$ is 238. Calculate the value of x .

(3)

(Total 10 marks)

Q5

TOTAL FOR SECTION A: 50 MARKS



N 3 5 9 2 0 A 0 1 1 2 4

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SECTION B

Answer TWO questions in this section.

Where appropriate, equations and diagrams should be given to clarify your answer.

If you answer Question 6, put a cross in this box .

6. (a) The boiling points and melting points for some gases present in the air are given in the table. This information can be used to separate the components of air in industry.

Gases	Melting point / °C	Boiling point / °C
water vapour	0	100
oxygen	-218	-183
nitrogen	-210	-196
neon	-248	-246

Use the values in the table to answer the following questions.

- (i) State what happens to water vapour when the temperature is lowered from room temperature to $-10\text{ }^{\circ}\text{C}$.

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(1)

- (ii) In the industrial process, the gases are passed through a series of pipes until the temperature reaches $-200\text{ }^{\circ}\text{C}$.

Why must water vapour be removed before this takes place?

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(1)



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(iii) State what happens to the remaining gases when the temperature is lowered to $-200\text{ }^{\circ}\text{C}$. Describe how the gases can then be separated so as to obtain a pure sample of each one.

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(5)

(b) You are given two 100 cm^3 gas syringes that can be connected by a piece of glass tubing, some small pieces of copper and a Bunsen burner.

Describe an experiment to find the percentage by volume of oxygen in the air. State and explain what you would see during the experiment and write an equation for the reaction that occurs.

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(c) The carbon dioxide content of the atmosphere is increasing as more fossil fuels are burnt.

(i) State what is meant by the term **fuel**.

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(1)

(ii) Write an equation for the complete combustion of octane, C_8H_{18} , in air. Give the name of another gas that would be produced when the burning takes place in a limited supply of air.

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(3)

(iii) A higher amount of carbon dioxide in the atmosphere results in a decrease in the pH of the oceans. Explain how this can happen and write an equation for any reaction that occurs.

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(3)

(iv) Give one other environmental problem caused by an increase in the carbon dioxide content of the atmosphere.

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(1)

(Total 25 marks)

Q6

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If you answer Question 7, put a cross in this box .

7. (a) Electrolysis is used in industry to obtain many important elements and compounds.

(i) When brine is electrolysed, the products are hydrogen, chlorine and sodium hydroxide. Write equations for the reactions that occur at the electrodes and state why sodium hydroxide is a product of the electrolysis process.

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(3)

(ii) Magnesium is extracted from molten magnesium chloride by electrolysis. Write an equation for the reaction at the cathode and explain why this is a reduction process. Give a reason why magnesium chloride is electrolysed when molten rather than in aqueous solution.

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(3)



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(iii) After extraction from its ore, impure copper requires further refining by electrolysis. Describe how this is carried out and write equations for the reactions that occur. Do **not** draw a diagram.

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(5)

(b) Name the gaseous product, give a condition and write an equation for the reaction of hydrogen with chlorine. State the conditions under which the product has acidic properties; explain your answer.

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(5)



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- (c) (i) Describe how sodium hydroxide is used in the manufacture of soap from a naturally-occurring ester.

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(4)

- (ii) The ester methyl ethanoate has the molecular formula $C_3H_6O_2$. Give the displayed formula of the ester and identify by name the two organic compounds used in the preparation of the ester.

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(3)

- (d) Pure copper is used in electrical cables. Explain how copper conducts electricity.

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(2)

Q7

(Total 25 marks)



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If you answer Question 8, put a cross in this box .

8. Elements can be broadly classified as 'metals' and 'non-metals'.

(a) (i) Give **two** typical **physical** properties of zinc and **two** typical **physical** properties of sulphur to illustrate the difference between a metal and a non-metal.

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(4)

(ii) Describe the reaction, if any, of zinc and of sulphur with aqueous hydrochloric acid. Write an equation for any reaction that occurs.

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(3)

(b) (i) Magnesium has an electron configuration of 2,8,2 and oxygen has an electron configuration of 2,6. Explain in terms of electron transfer how magnesium oxide is formed.

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(7)



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(ii) Explain how two atoms of oxygen can combine to form a molecule. Draw a diagram to show the electron arrangement in the outer shell of the molecule.

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(5)

(iii) Explain why two metals do not combine to form a compound.

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(1)

(c) Explain why the reactivity of metals increases as a group is descended.

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(3)

(d) State which group of non-metals in the Periodic Table is unreactive and explain why this is so.

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(2)

(Total 25 marks)

Q8

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If you answer Question 9, put a cross in this box .

9. (a) (i) Describe how you would test for the presence of iron(II) ions and sulphate ions in a solution suspected to contain iron(II) sulphate. Write **ionic** equations for the reactions.

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(6)

- (ii) Describe how you would test for the presence of ammonium ions and carbonate ions in a solution suspected to contain ammonium carbonate. Write **ionic** equations for the reactions.

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(8)



- (b) (i) Compound **P** gave a brick-red colour in a Bunsen flame. Addition of dilute nitric acid followed by aqueous silver nitrate to a solution of **P** gave a yellow precipitate. Give the formulae of the ions present in **P**.

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 (2)

- (ii) Compound **R** gave a lilac colour in a Bunsen flame. Addition of dilute hydrochloric acid to **R** gave a gas which turned acidified potassium dichromate(VI) from orange to green. Give the formulae of the ions present in **R**.

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 (2)

- (iii) Compound **T** reacted with magnesium to form a gas which exploded when ignited. Addition of dilute nitric acid followed by aqueous silver nitrate to **T** gave a white precipitate. Give the formulae of the ions present in **T** and write an equation for the reaction between **T** and magnesium.

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 (3)



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(c) An alkane **X** containing eight carbon atoms was cracked at high temperature to form a compound **Y** containing three carbon atoms and one other compound **Z**.

Compound **Y** decolourised bromine water. Identify **X**, **Y** and **Z** and write an equation for the reaction between **Y** and bromine water.

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(4)

Q9

(Total 25 marks)

TOTAL FOR SECTION B: 50 MARKS

TOTAL FOR PAPER: 100 MARKS

END



THE PERIODIC TABLE

Period 1 2 3 4 5 6 7 0

Group

1																	2	
																	He Helium 4	
2	3	4											5	6	7	8	9	10
	Li Lithium 7	Be Beryllium 9											B Boron 11	C Carbon 12	N Nitrogen 14	O Oxygen 16	F Fluorine 19	Ne Neon 20
3	11	12											13	14	15	16	17	18
	Na Sodium 23	Mg Magnesium 24											Al Aluminium 27	Si Silicon 28	P Phosphorus 31	S Sulphur 32	Cl Chlorine 35.5	Ar Argon 40
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
	K Potassium 39	Ca Calcium 40	Sc Scandium 45	Ti Titanium 48	V Vanadium 51	Cr Chromium 52	Mn Manganese 55	Fe Iron 56	Co Cobalt 59	Ni Nickel 59	Cu Copper 63.5	Zn Zinc 65	Ga Gallium 70	Ge Germanium 73	As Arsenic 75	Se Selenium 79	Br Bromine 80	Kr Krypton 84
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
	Rb Rubidium 86	Sr Strontium 88	Y Yttrium 89	Zr Zirconium 91	Nb Niobium 93	Mo Molybdenum 96	Tc Technetium 99	Ru Ruthenium 101	Rh Rhodium 103	Pd Palladium 106	Ag Silver 108	Cd Cadmium 112	In Indium 115	Sn Tin 119	Sb Antimony 122	Te Tellurium 128	I Iodine 127	Xe Xenon 131
6	55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
	Cs Caesium 133	Ba Barium 137	La Lanthanum 139	Hf Hafnium 179	Ta Tantalum 181	W Tungsten 184	Re Rhenium 186	Os Osmium 190	Ir Iridium 192	Pt Platinum 195	Au Gold 197	Hg Mercury 201	Tl Thallium 204	Pb Lead 207	Bi Bismuth 209	Po Polonium 210	At Astatine 210	Rn Radon 222
7	87	88	89											89	90	91	92	
	Fr Francium 223	Ra Radium 226	Ac Actinium 227											Th Thorium 232	Pa Protactinium 231	U Uranium 238	Np Neptunium 237	Pu Plutonium 244

1	H Hydrogen 1
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2	He Helium 4
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Key

Atomic number
Symbol
Name
Relative atomic mass

