

## INSTRUCTIONS TO STUDENTS

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page with your details if required.
- Answer all questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.
- A [Periodic Table](#) is provided as a separate insert if required.
- Calculators may be used.

## Information for Candidates

This practice paper is designed to support student revision for the GCSE Chemistry examinations. It contains questions covering atomic structure, bonding, quantitative chemistry, chemical changes, and energy changes. The marks for individual questions and parts of questions are shown in round brackets.

Turn over →

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# GCSE CHEMISTRY

## Topic 1: Atomic Structure & The Periodic Table

Practice Paper 4 - Higher Tier

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The periodic table is structured based on atomic number and electronic configurations. Elements in the same group exhibit similar chemical properties.

(a) Write the electronic configuration of: (2)

1. A sodium atom (atomic number = 11)
2. A chlorine atom (atomic number = 17)

(b) Across Period 3 (from sodium to argon), the atomic radius of the elements decreases. Explain (3) why the atomic radius decreases across a period.

(c) Sodium is a Group 1 alkali metal, and chlorine is a Group 7 halogen. Compare the physical (4) properties of Group 1 metals with Group 7 non-metals.

(d) Explain, in terms of electronic configurations and atomic structures, why reactivity increases (7) down Group 1 but decreases down Group 7.

## Question 2

[16 Marks]

Ammonia (NH<sub>3</sub>) is a gas at room temperature, having a simple molecular structure with covalent bonds.

(a) Draw a dot-and-cross diagram to show the bonding in a molecule of ammonia (NH<sub>3</sub>). Show only the outer shell electrons. (3)

(b) Compare the structures and bonding of ice (solid water) and sodium chloride. In your answer, you should specify the type of structure, the types of particles involved, and the forces holding the structures together for both substances. (6)

(c) Ice melts at 0 degrees Celsius, whereas sodium chloride melts at 801 degrees Celsius. Explain (3) this difference in melting points by referring to the structures and bonding of both substances.

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(d) Pure water does not conduct electricity, and solid sodium chloride does not conduct electricity. (4) However, molten sodium chloride conducts electricity. Explain these observations in terms of particles and movement.

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**Question 3**

**[6 Marks]**

**Graphite and graphene are both allotropes of carbon with giant covalent structures.**

(a) Explain, in terms of structure and bonding, why graphite is soft and can conduct electricity, (6) whereas graphene is extremely strong and has high electrical conductivity.

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## Question 4

[25 Marks]

Copper metal can be extracted by heating black copper(II) oxide with carbon powder. The chemical equation for the reaction is:



(a) A student heats 15.9 g of copper(II) oxide (CuO) with 2.40 g of carbon powder (C). Show by calculation which reactant is the limiting reactant, and calculate the maximum theoretical mass of copper metal that can be produced. (6)

Relative atomic masses (Ar): C = 12.0; O = 16.0; Cu = 63.5

(b) Upon completing the reaction, the student obtains 11.2 g of copper metal. Calculate the percentage yield of copper and suggest two reasons why the yield is less than the theoretical maximum. (3)

(c) Calculate the percentage atom economy for the production of copper metal in this reaction. (3)

Equation:  $2\text{CuO(s)} + \text{C(s)} \rightarrow 2\text{Cu(s)} + \text{CO}_2\text{(g)}$

Relative atomic masses (Ar): C = 12.0; O = 16.0; Cu = 63.5

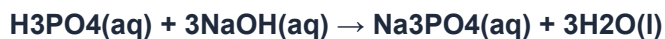
# GCSE CHEMISTRY

## Topic 3: Quantitative Chemistry

### Practice Paper 4 - Higher Tier

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(d) A student performs a titration to standardise a phosphoric acid (H<sub>3</sub>PO<sub>4</sub>) solution. The balanced equation for the neutralisation reaction is: (7)



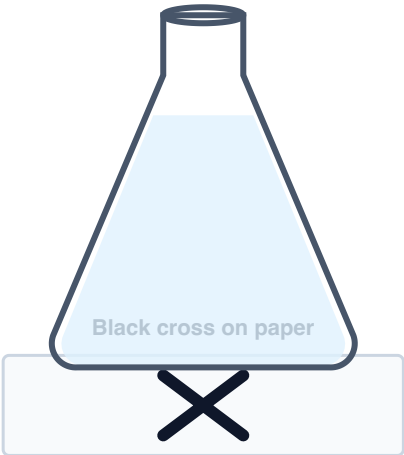
The student titrates 25.0 cm<sup>3</sup> of the phosphoric acid solution against 30.0 cm<sup>3</sup> of a 0.200 mol/dm<sup>3</sup> sodium hydroxide (NaOH) solution. Calculate the concentration of the phosphoric acid solution in:

1. mol/dm<sup>3</sup> (Give your answer to 3 significant figures)
2. g/dm<sup>3</sup> (Give your answer to 3 significant figures)

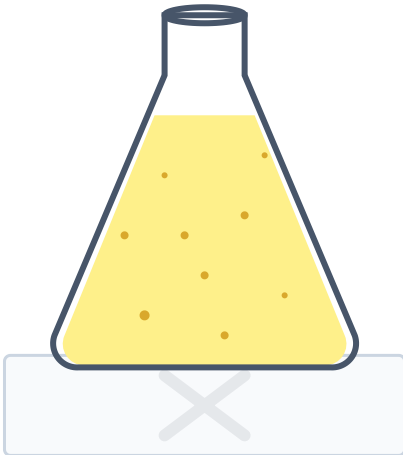
Relative atomic masses (Ar): H = 1.0; O = 16.0; Na = 23.0; P = 31.0

(e) Sodium thiosulfate ( $\text{Na}_2\text{S}_2\text{O}_3$ ) reacts with dilute hydrochloric acid to form a cloudy yellow precipitate of sulfur. A student uses the disappearing cross experiment to investigate how concentration affects reaction rate.

**Disappearing Cross Experiment (RP5)**



**Start: Clear Solution**  
Cross is clearly visible



**End: Cloudy Precipitate**  
Cross is completely obscured

(i) Describe a method the student should use to investigate how the concentration of sodium thiosulfate affects the rate of this reaction. Refer to the diagrams and state how rate is calculated. (3)

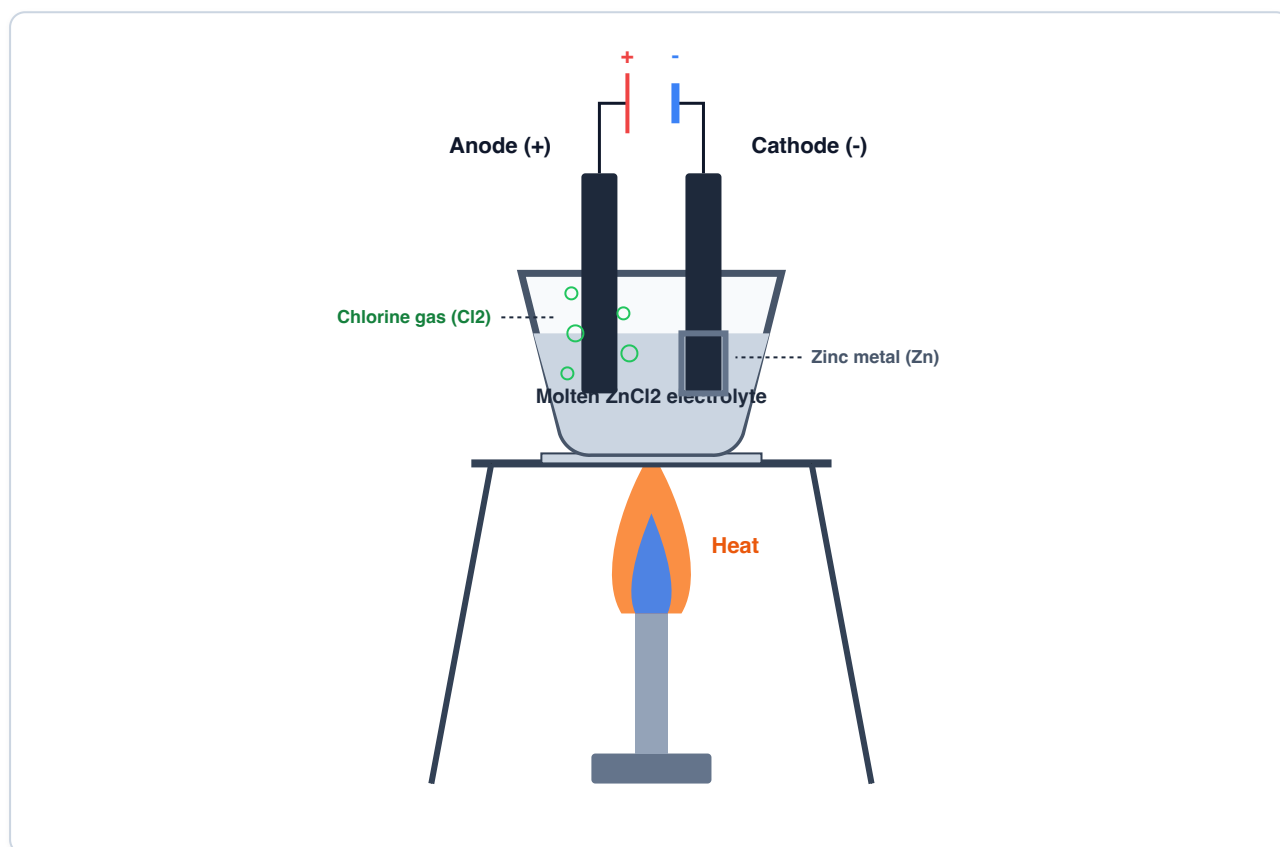
(ii) Write the balanced chemical equation for the reaction between sodium thiosulfate ( $\text{Na}_2\text{S}_2\text{O}_3$ ) and hydrochloric acid ( $\text{HCl}$ ) to produce sodium chloride, sulfur, sulfur dioxide, and water. Include state symbols. (3)

## Question 5

[23 Marks]

Electrolysis is the decomposition of an electrolyte using an electric current. Molten zinc chloride ( $\text{ZnCl}_2$ ) is electrolysed using inert carbon electrodes.

(a) Describe the experimental setup and the chemical changes that occur during the electrolysis of molten zinc chloride. Explain how the products are formed and where they are discharged. (6)



# GCSE CHEMISTRY

## Topic 4: Chemical Changes

Practice Paper 4 - Higher Tier

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**(b)** Write half-equations for the reactions occurring at each electrode during the electrolysis of molten zinc chloride:

**(i)** At the negative electrode (cathode) **(2)**

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**(ii)** At the positive electrode (anode) **(2)**

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**(c)** Explain why zinc chloride can conduct electricity when molten but cannot conduct electricity when in the solid state. **(3)**

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**Dilute hydrochloric acid is a strong acid, and dilute ethanoic acid is a weak acid.**

**(d) (i)** Explain the difference between a strong acid and a weak acid in terms of their ionisation in aqueous solution. **(2)**

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**(ii)** The pH scale is logarithmic. The relationship between pH and hydrogen ion concentration  $[H^+]$  is given by the formula  $pH = -\log_{10}[H^+]$ . Using this relationship, prove mathematically that when a solution of hydrochloric acid is diluted to increase its pH by exactly 1 unit, the hydrogen ion concentration decreases by a factor of 10. Show also how the hydrogen ion concentration changes when pH increases from 2.00 to 5.00. **(5)**

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**(iii)** Explain why a 0.100 mol/dm<sup>3</sup> solution of ethanoic acid has a higher pH than a 0.100 mol/dm<sup>3</sup> solution of hydrochloric acid. **(3)**

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## Question 6

[14 Marks]

A student investigates the reactivity series of metals by measuring the temperature rise when different metals react with dilute hydrochloric acid.

(a) (i) Describe a method the student could use to compare the reactivity of magnesium, zinc, iron, (6) and copper by measuring temperature changes. Your description should include the apparatus used and how the results can be used to arrange the metals in order of reactivity.

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(ii) State two variables that must be controlled in this investigation to ensure a fair comparison. (2)

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**A student investigates the temperature change when citric acid reacts with sodium hydrogencarbonate (RP4). They record a temperature drop during the reaction.**

**(b)** Explain why the reaction between citric acid and sodium hydrogencarbonate is described as endothermic. In your answer, refer to the temperature change, the bond breaking/forming energy changes, and describe the features of a reaction profile diagram for this process. **(6)**

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# GCSE CHEMISTRY

Periodic Table

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END OF QUESTION PAPER

1 H Hydrogen	7 Li Lithium	23 Na Sodium	39 K Potassium	55 Cs Cesium	87 Fr Francium
1 H Hydrogen	9 Be Beryllium	24 Mg Magnesium	40 Ca Calcium	137 Ba Barium	226 Ra Radium
3 Li Lithium	4 Be Beryllium	12 Mg Magnesium	20 Ca Calcium	56 Ba Barium	88 Ra Radium
11 Na Sodium	19 K Potassium	37 Rb Rubidium	85 Cs Cesium	133 Fr Francium	223 Fr Francium
11 Na Sodium	21 Sc Scandium	38 Sr Strontium	86 Rb Rubidium	135 La* Lanthanum	225 Ac** Actinides
11 Na Sodium	21 Sc Scandium	39 Y Yttrium	87 Sr Strontium	138 Ce* Cerium	227 Th* Thorium
11 Na Sodium	21 Sc Scandium	40 Zr Zirconium	88 Sr Strontium	140 Pr* Praseodymium	232 U* Uranium
11 Na Sodium	21 Sc Scandium	41 Nb Niobium	89 Sr Strontium	142 Nd* Neodymium	238 Pu* Plutonium
11 Na Sodium	21 Sc Scandium	42 Mo Molybdenum	90 Sr Strontium	144 Pm* Promethium	242 Am* Americium
11 Na Sodium	21 Sc Scandium	43 Tc Technetium	91 Sr Strontium	146 Sm* Samarium	244 Cm* Curium
11 Na Sodium	21 Sc Scandium	44 Ru Ruthenium	92 Sr Strontium	148 Eu* Europium	248 Bk* Berkelium
11 Na Sodium	21 Sc Scandium	45 Rh Rhodium	93 Sr Strontium	150 Gd* Gadolinium	251 Cf* Californium
11 Na Sodium	21 Sc Scandium	46 Pd Palladium	94 Sr Strontium	152 Tb* Terbium	253 Es* Einsteinium
11 Na Sodium	21 Sc Scandium	47 Ag Silver	95 Sr Strontium	154 Dy* Dysprosium	257 Fm* Fermium
11 Na Sodium	21 Sc Scandium	48 Cd Cadmium	96 Sr Strontium	156 Ho* Holmium	261 Md* Mendelevium
11 Na Sodium	21 Sc Scandium	49 In Indium	97 Sr Strontium	158 Er* Erbium	265 No* Nobelium
11 Na Sodium	21 Sc Scandium	50 Sn Tin	98 Sr Strontium	160 Tm* Thulium	269 Lr* Lawrencium
11 Na Sodium	21 Sc Scandium	51 Sb Antimony	99 Sr Strontium	162 Yb* Ytterbium	
11 Na Sodium	21 Sc Scandium	52 Te Tellurium	100 Sr Strontium	164 Lu* Lutetium	
11 Na Sodium	21 Sc Scandium	53 I Iodine	101 Sr Strontium	167 Hf* Hafnium	
11 Na Sodium	21 Sc Scandium	54 Xe Xenon	102 Sr Strontium	169 Ta* Tantalum	
11 Na Sodium	21 Sc Scandium	55 Ba Barium	103 Sr Strontium	171 W* Tungsten	
11 Na Sodium	21 Sc Scandium	56 La* Lanthanum	104 Sr Strontium	173 Re* Rhenium	
11 Na Sodium	21 Sc Scandium	57 Ce* Cerium	105 Sr Strontium	175 Os* Osmium	
11 Na Sodium	21 Sc Scandium	58 Pr* Praseodymium	106 Sr Strontium	177 Ir* Iridium	
11 Na Sodium	21 Sc Scandium	59 Nd* Neodymium	107 Sr Strontium	179 Pt* Platinum	
11 Na Sodium	21 Sc Scandium	60 Pm* Promethium	108 Sr Strontium	181 Au* Gold	
11 Na Sodium	21 Sc Scandium	61 Sm* Samarium	109 Sr Strontium	183 Hg* Mercury	
11 Na Sodium	21 Sc Scandium	62 Eu* Europium	110 Sr Strontium	186 Tl* Thallium	
11 Na Sodium	21 Sc Scandium	63 Gd* Gadolinium	111 Sr Strontium	188 Pb* Lead	
11 Na Sodium	21 Sc Scandium	64 Tb* Terbium	112 Sr Strontium	190 Bi* Bismuth	
11 Na Sodium	21 Sc Scandium	65 Dy* Dysprosium	113 Sr Strontium	192 Po* Polonium	
11 Na Sodium	21 Sc Scandium	66 Ho* Holmium	114 Sr Strontium	194 At* Astatine	
11 Na Sodium	21 Sc Scandium	67 Er* Erbium	115 Sr Strontium	196 Rn* Radon	
11 Na Sodium	21 Sc Scandium	68 Tm* Thulium	116 Sr Strontium		
11 Na Sodium	21 Sc Scandium	69 Yb* Ytterbium	117 Sr Strontium		
11 Na Sodium	21 Sc Scandium	70 Lu* Lutetium	118 Sr Strontium		

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\*\* Actinides

\* Lanthanides

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