GCSE CHEMISTRY

Total Marks: 100
Version 1.0

Practice Paper 4 - Master Mark Scheme (Unofficial)

General Marking Guidance

- **Acceptable Answers:** Mark schemes are prepared by subject specialists. They indicate the points required to gain marks. Alternative wording or symbols that express the same chemical meaning should be accepted.
- **Bolding:** Bold chemical terms are key elements that must be present in the student's answer to score the mark.
- **Error Carried Forward (ECF):** ECF applies to mathematical calculations. If a student makes an early arithmetic error, they lose that specific mark but can score full marks for subsequent steps that apply correct chemical calculations to their incorrect value.
- **Reject Boxes:** These specify incorrect chemical concepts or terminology that negate the mark if included.
- **Ignore:** Refers to details that are irrelevant and neither score nor penalise.

This resource is an independent educational tool created to support student revision. It is completely independent and is not endorsed by, affiliated with, or sponsored by any official examination board. All trademarked terms are used under Nominative Fair Use purely for descriptive compatibility indexing. Licensed for individual personal use only.
Chemistry Made Easy is an independent resource. Not affiliated with or endorsed by AQA, Pearson Edexcel, or the IBO.

GCSE CHEMISTRY MARK SCHEME

Topic 1 Total: 16 Marks

Topic 1: Atomic Structure & The Periodic Table

Question 1 Mark Scheme (Total: 16 Marks)

(a) Electronic configurations [2 Marks]

M1: Sodium atom (atomic number = 11): **2,8,1** [1].

M2: Chlorine atom (atomic number = 17): **2,8,7** [1].

(b) Atomic radius trend across Period 3 [3 Marks]

M1: Across the period, the **number of protons increases / nuclear charge increases** [1].

M2: Electrons are added to the **same outer shell**, so the amount of **shielding remains similar** [1].

M3: This results in a **stronger electrostatic attraction** pulling the outer electrons closer to the nucleus [1].

> **Reject:**
> Any claim that shielding increases significantly across a period or that new shells are added.

(c) Physical properties comparison: Group 1 vs Group 7 [4 Marks]

M1: Group 1 elements are **soft / can be cut with a knife**, whereas Group 7 elements are **brittle** as solids [1].

M2: Group 1 elements have **low densities** (first three float on water), whereas Group 7 elements have **higher densities** (or densities that increase down the group) [1].

M3: Group 1 elements are **electrical and thermal conductors**, whereas Group 7 elements are **insulators** [1].

M4: Group 1 elements are **shiny / metallic** when freshly cut, whereas Group 7 elements are **dull / non-metallic** [1].

> **Reject:**
> Comparing chemical properties instead of physical properties (e.g. reacting with water).

(d) Reactivity trends down Group 1 and Group 7 [7 Marks]

> **Indicative Content:**
>
> - **Common structural trend:** Down both groups, the **number of electron shells increases** / the outer shell is further from the nucleus, and **electron shielding increases**.
> - **Group 1 trend:** Group 1 metals react by **losing their single outer electron**. As you go down the group, the electrostatic attraction between the positive nucleus and the outer electron becomes **weaker** because of the increased distance and shielding. Therefore, the electron is **lost more easily**, making the elements **more reactive**.
> - **Group 7 trend:** Group 7 non-metals react by **gaining one electron** to form a full outer shell. As you go down the group, the attraction between the positive nucleus and incoming electrons becomes **weaker** due to increased distance and shielding. Therefore, it is **harder to attract and gain an electron**, making the elements **less reactive**.

Level 3 (6-7 Marks): Coherent explanation of both groups. Correctly identifies that Group 1 loses an electron and Group 7 gains one. Explains both trends using atomic radius, shielding, strength of electrostatic attraction, and ease of electron transfer.

Level 2 (3-5 Marks): Explains the trend for one group thoroughly, or provides partial explanations for both groups. May lack specific references to both shielding and distance.

Level 1 (1-2 Marks): Simple statements of the trends (reactivity increases down G1, decreases down G7) without detailed reference to electron loss/gain or attraction.

This resource is an independent educational tool created to support student revision. It is completely independent and is not endorsed by, affiliated with, or sponsored by any official examination board. All trademarked terms are used under Nominative Fair Use purely for descriptive compatibility indexing. Licensed for individual personal use only.
Chemistry Made Easy is an independent resource. Not affiliated with or endorsed by AQA, Pearson Edexcel, or the IBO.

DO NOT WRITE OUTSIDE THIS BOX

DO NOT WRITE OUTSIDE THIS BOX

GCSE CHEMISTRY MARK SCHEME

Topic 2 Total: 22 Marks

Topic 2: Bonding, Structure & Properties

Question 2 Mark Scheme (Total: 16 Marks)

(a) Ammonia dot-and-cross diagram [3 Marks]

M1: Three shared pairs of electrons (one dot and one cross in each of the three N-H overlap regions) [1].

M2: One lone pair of electrons on the Nitrogen atom (two dots or crosses not in overlap) [1].

M3: Correct number of outer electrons showing only Hydrogen (1 electron each) and Nitrogen (5 outer electrons) [1].

(b) Ice vs Sodium Chloride structure and bonding [6 Marks]

> **Indicative Content:**
>
> - **Ice (solid water):**
>   - Structure: **Simple molecular** / molecular crystal [1].
>   - Particles: **Molecules** (H2O) made of hydrogen and oxygen atoms held by strong covalent bonds [1].
>   - Forces: Molecules are held together by **weak intermolecular forces** / hydrogen bonds [1].
> - **Sodium chloride:**
>   - Structure: **Giant ionic lattice** [1].
>   - Particles: Oppositely charged **ions** (Na+ and Cl-) [1].
>   - Forces: Ions are held together by **strong electrostatic forces of attraction** [1].

(c) Melting points comparison [3 Marks]

M1: Melting ice involves overcoming the **weak intermolecular forces** between water molecules, which requires **little energy** [1].

M2: Melting sodium chloride involves breaking the **strong electrostatic forces** / ionic bonds between oppositely charged ions [1].

M3: This requires **very high energy**, resulting in a much higher melting point [1].

> **Reject:**
>
> Any claim that covalent bonds in water are broken during melting.

(d) Electrical conductivity comparison [4 Marks]

M1: Water / ice consists of neutral molecules with **no delocalized electrons** or free ions to carry charge [1].

M2: In solid sodium chloride, the **ions are in fixed positions** in the lattice and **cannot move** to carry charge [1].

M3: In molten sodium chloride, the lattice is broken and the **ions are free to move** [1].

M4: Therefore, the mobile ions can carry electrical charge through the liquid [1].

> **Reject:**
>
> Any reference to electrons moving or carrying charge in sodium chloride.

Question 3 Mark Scheme (Total: 6 Marks)

(a) Graphite vs Graphene structure and properties [6 Marks]

M1: In both graphite and graphene, carbon atoms form **three covalent bonds** with other carbon atoms [1].

M2: Graphene is a **single layer** of carbon atoms (one atom thick), meaning all its atoms are locked in a strong, continuous 2D sheet of covalent bonds, making it extremely strong [1].

M3: Graphite consists of **many layers of graphene** held together by **weak intermolecular forces** / Van der Waals forces [1].

M4: These weak forces allow the layers in graphite to **slide over each other** easily, making it soft and slippery [1].

M5: Both have **delocalized electrons** (one per carbon atom) that are free to move throughout the structure [1].

M6: Therefore, both can conduct electricity, but graphene has higher conductivity because electrons move along its single sheet without interlayer scattering [1].

This resource is an independent educational tool created to support student revision. It is completely independent and is not endorsed by, affiliated with, or sponsored by any official examination board. All trademarked terms are used under Nominative Fair Use purely for descriptive compatibility indexing. Licensed for individual personal use only.
Chemistry Made Easy is an independent resource. Not affiliated with or endorsed by AQA, Pearson Edexcel, or the IBO.

DO NOT WRITE OUTSIDE THIS BOX

GCSE CHEMISTRY MARK SCHEME

Topic 3: Quantitative Chemistry

Question 4 Mark Scheme (Total: 25 Marks)

(a) Limiting reactant and theoretical mass of copper [6 Marks]

M1: Calculate Mr of CuO: 63.5 + 16.0 = **79.5** [1].

M2: Calculate moles of CuO: 15.9 / 79.5 = **0.200 mol** [1].

M3: Calculate moles of C: 2.40 / 12.0 = **0.200 mol** [1].

M4: Use reaction ratio (2 CuO : 1 C) to determine limiting reactant:
0.200 mol CuO requires 0.100 mol C. Since 0.200 mol C is present, C is in excess and **copper(II) oxide (CuO) is the limiting reactant** [1].

M5: Calculate moles of Cu produced:
Ratio of CuO to Cu is 2:2 (or 1:1), so moles of Cu = moles of CuO = **0.200 mol** [1].

M6: Calculate mass of Cu:
Mass = 0.200 * 63.5 = **12.7 g** [1].

(b) Percentage yield and reasons [3 Marks]

M1: Calculate percentage yield: (11.2 / 12.7) * 100 = **88.2%** (Accept 88.0% to 88.5% depending on rounding) [1].

M2: Reason 1: The reaction may not have gone to completion (incomplete reaction) / some reactants remained unreacted [1].

M3: Reason 2: Some product may have been lost during transfer / collection / isolation [1]. (Accept: Side reactions occurred).

(c) Percentage atom economy [3 Marks]

M1: Calculate total formula mass of desired product (2 Cu): 2 * 63.5 = **127** [1].

M2: Calculate total formula mass of reactants (2 CuO + C): (2 * 79.5) + 12 = 159 + 12 = **171** [1].

M3: Calculate atom economy: (127 / 171) * 100 = **74.3%** [1].

This resource is an independent educational tool created to support student revision. It is completely independent and is not endorsed by, affiliated with, or sponsored by any official examination board. All trademarked terms are used under Nominative Fair Use purely for descriptive compatibility indexing. Licensed for individual personal use only.
Chemistry Made Easy is an independent resource. Not affiliated with or endorsed by AQA, Pearson Edexcel, or the IBO.

DO NOT WRITE OUTSIDE THIS BOX

(d) Titration calculation [7 Marks]

M1: Calculate moles of NaOH: Moles = Volume * Concentration = (30.0 / 1000) * 0.200 = **0.00600 mol** [1].

M2: Determine moles of H3PO4 using ratio 1 H3PO4 : 3 NaOH:
Moles of H3PO4 = 0.00600 / 3 = **0.00200 mol** [1].

M3: Calculate concentration of H3PO4 in mol/dm3:
Concentration = Moles / Volume = 0.00200 / (25.0 / 1000) = **0.0800 mol/dm3** [2].

M4: Calculate Mr of H3PO4: (3 * 1.0) + 31.0 + (4 * 16.0) = 3.0 + 31.0 + 64.0 = **98.0** [1].

M5: Calculate concentration of H3PO4 in g/dm3:
Concentration in g/dm3 = 0.0800 * 98.0 = **7.84 g/dm3** [2].

(e) Disappearing cross experiment [6 Marks]

(i) Method description [3 Marks]

M1: Place the flask on the **black cross** and measure the time taken for the cross to be completely obscured [1].

M2: Repeat the experiment with different **concentrations** of sodium thiosulfate [1].

M3: Calculate rate of reaction as **1 / time** [1].

(ii) Balanced chemical equation [3 Marks]

M1: Correct formulas for all reactants and products: **Na2S2O3 + HCl → NaCl + S + SO2 + H2O** [1].

M2: Correct balancing: **Na2S2O3 + 2HCl → 2NaCl + S + SO2 + H2O** [1].

M3: Correct state symbols: **Na2S2O3(aq) + 2HCl(aq) → 2NaCl(aq) + S(s) + SO2(g) + H2O(l)** [1].

This resource is an independent educational tool created to support student revision. It is completely independent and is not endorsed by, affiliated with, or sponsored by any official examination board. All trademarked terms are used under Nominative Fair Use purely for descriptive compatibility indexing. Licensed for individual personal use only.
Chemistry Made Easy is an independent resource. Not affiliated with or endorsed by AQA, Pearson Edexcel, or the IBO.

DO NOT WRITE OUTSIDE THIS BOX

GCSE CHEMISTRY MARK SCHEME

Topic 4 Total: 23 Marks

Topic 4: Chemical Changes

Question 5 Mark Scheme (Total: 23 Marks)

(a) Molten zinc chloride electrolysis description [6 Marks]

> **Indicative Content:**
>
> - **Setup:** Zinc chloride solid is placed in a crucible and heated with a Bunsen burner until it is completely molten. Two inert carbon (graphite) electrodes are inserted into the molten electrolyte and connected to a DC power supply.
> - **Ionic dissociation:** Melting zinc chloride breaks the giant lattice, allowing the ions (**Zn2+ and Cl-**) to become free to move and carry charge.
> - **Cathode process:** Positive zinc ions (Zn2+) are attracted to the negative electrode (cathode), where they gain electrons (reduction) to form zinc metal, which deposits as a shiny layer.
> - **Anode process:** Negative chloride ions (Cl-) are attracted to the positive electrode (anode), where they lose electrons (oxidation) to form chlorine gas, observed as effervescence / bubbles of pale green gas.

Level 3 (5-6 Marks): Clear description of the heating setup, state of ions, movement of specific ions to correct electrodes, and correct description of products formed at both electrodes. Uses correct electrochemical terms (attract, cathode, anode, gain/lose electrons).

Level 2 (3-4 Marks): Partial description of the setup and products. Identifies that zinc is formed at one electrode and chlorine at the other, but may confuse anode/cathode polarities or electron gain/loss details.

Level 1 (1-2 Marks): Mentions that electricity is passed through molten zinc chloride to form zinc and chlorine. Lacks structural detail or electrochemistry explanation.

(b) Half-equations [4 Marks]

(i) Cathode half-equation [2 Marks]

M1: Correct reactant and product: **Zn2+ → Zn** [1].

M2: Correct balancing of electrons: **Zn2+ + 2e- → Zn** [1].

(ii) Anode half-equation [2 Marks]

M1: Correct reactant and product: **2Cl- → Cl2** [1].

M2: Correct balancing of electrons: **2Cl- → Cl2 + 2e-** (Accept 2Cl- - 2e- → Cl2) [1].

This resource is an independent educational tool created to support student revision. It is completely independent and is not endorsed by, affiliated with, or sponsored by any official examination board. All trademarked terms are used under Nominative Fair Use purely for descriptive compatibility indexing. Licensed for individual personal use only.
Chemistry Made Easy is an independent resource. Not affiliated with or endorsed by AQA, Pearson Edexcel, or the IBO.

DO NOT WRITE OUTSIDE THIS BOX

GCSE CHEMISTRY MARK SCHEME

Topic 4: Chemical Changes

(c) Conductivity of solid vs molten zinc chloride [3 Marks]

M1: Solid zinc chloride has a giant ionic lattice where the **ions are locked in fixed positions** and **cannot move** to carry charge [1].

M2: When molten, the electrostatic forces are overcome, and the **ions are free to move** [1].

M3: These mobile ions can then flow and transfer electrical charge through the liquid [1].

> **Reject:**
> Any mention of delocalized electrons carrying charge in zinc chloride.

(d) Strong vs weak acids [10 Marks]

(i) Ionisation difference [2 Marks]

M1: A strong acid is **fully ionised / completely dissociated** in aqueous solution [1].

M2: A weak acid is only **partially ionised / incompletely dissociated** in aqueous solution [1].

(ii) pH dilution proof [5 Marks]

M1: State the logarithmic relationship: if pH increases by 1 unit, the hydrogen ion concentration decreases [1].

M2: Mathematical proof: Let initial pH = A. [H+] = 10^-A.
If pH increases by 1 unit to A + 1, new [H+] = 10^-(A+1) = 10^-A * 10^-1 = **0.1 * 10^-A** [1].

M3: Thus, the concentration is multiplied by 0.1, which corresponds to a **tenfold (10 times) decrease** [1].

M4: For a pH change from 2.00 to 5.00, the difference in pH is 5 - 2 = **3 units** [1].

M5: Since each unit corresponds to a factor of 10, a change of 3 units means the concentration decreases by a factor of 10^3 = **1,000 times** [1].

(iii) pH comparison at equal concentration [3 Marks]

M1: Ethanoic acid is a weak acid and only partially ionises, whereas hydrochloric acid is a strong acid and fully ionises [1].

M2: Therefore, at the same concentration, ethanoic acid has a **lower concentration of hydrogen ions / [H+]** than hydrochloric acid [1].

M3: A lower [H+] concentration corresponds to a **higher pH value** on the pH scale [1].

Turn over →

This resource is an independent educational tool created to support student revision. It is completely independent and is not endorsed by, affiliated with, or sponsored by any official examination board. All trademarked terms are used under Nominative Fair Use purely for descriptive compatibility indexing. Licensed for individual personal use only.
Chemistry Made Easy is an independent resource. Not affiliated with or endorsed by AQA, Pearson Edexcel, or the IBO.

DO NOT WRITE OUTSIDE THIS BOX

GCSE CHEMISTRY MARK SCHEME

Topic 5: Energy Changes

Question 6 Mark Scheme (Total: 14 Marks)

(a) Reactivity series metal-acid temperature changes [8 Marks]

(i) Method description [6 Marks]

M1: Measure a fixed volume (e.g. 25 cm3) of dilute hydrochloric acid into an **insulated polystyrene cup** [1].

M2: Place the cup inside a beaker for stability, and measure the **initial temperature** of the acid using a thermometer [1].

M3: Add a known mass (or moles) of the first metal powder (e.g. magnesium) to the cup, and stir the mixture [1].

M4: Record the **maximum temperature reached** during the reaction [1].

M5: Calculate the **temperature rise** (maximum temperature minus initial temperature) [1].

M6: Repeat the entire procedure with the other metals (zinc, iron, copper), and arrange them in order: the metal with the **greatest temperature rise is the most reactive**, and the one with the smallest/no rise is the least reactive [1].

(ii) Control variables [2 Marks]

M1: **Volume of hydrochloric acid** / **concentration of hydrochloric acid** [1].

M2: **Mass of metal powder** / **surface area of metal** (particle size) [1]. (Accept: starting temperature of acid).

(b) Citric acid and sodium hydrogencarbonate endothermic reaction [6 Marks]

M1: The reaction is endothermic because the temperature **decreases / drops** during the reaction, showing that heat energy is **absorbed from the surroundings** [1].

M2: More energy is **absorbed during bond breaking** of the reactants than is **released during bond forming** of the products [1].

M3: Therefore, the overall energy change is positive [1].

M4: In a reaction profile diagram for this process, the **products are at a higher energy level** than the reactants [1].

M5: The curve rises from the reactants to a peak representing the **activation energy** before falling to the product level [1].

M6: The difference between the reactant and product levels represents the **overall energy change (enthalpy change, delta H)**, which is positive [1].

This resource is an independent educational tool created to support student revision. It is completely independent and is not endorsed by, affiliated with, or sponsored by any official examination board. All trademarked terms are used under Nominative Fair Use purely for descriptive compatibility indexing. Licensed for individual personal use only.
Chemistry Made Easy is an independent resource. Not affiliated with or endorsed by AQA, Pearson Edexcel, or the IBO.

DO NOT WRITE OUTSIDE THIS BOX