



AS CHEMISTRY (7404/1)

Paper 1: Inorganic and Physical Chemistry

Mark scheme

Specimen paper

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Section A

| Question | Marking guidance | Mark | AO | Comments |
|----------|--|------|------|---|
| 01.1 | $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$ | 1 | AO1a | Allow correct numbers that are not superscripted |
| 01.2 | $\text{Ca(s)} + 2\text{H}_2\text{O(l)} \longrightarrow \text{Ca}^{2+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) + \text{H}_2(\text{g})$ | 1 | AO2d | State symbols essential |
| 01.3 | Oxidising agent | 1 | AO2c | |
| 01.4 | $\text{Ca(g)} \longrightarrow \text{Ca}^{+}(\text{g}) + \text{e}^{-}$ | 1 | AO1a | State symbols essential Allow 'e' without the negative sign |
| 01.5 | Decrease | 1 | AO1a | If answer to 'trend' is not 'decrease', then chemical error = 0/3 |
| | Ions get bigger / more (energy) shells | 1 | AO1a | Allow atoms instead of ions |
| | Weaker attraction of ion to lost electron | 1 | AO1a | |

| Question | Marking guidance | Mark | AO | Comments |
|----------|---|------|------|---|
| 02.1 | Abundance of third isotope = $100 - 91.0 - 1.8 = 7.2\%$ | 1 | AO1b | Answer must be rounded to the nearest integer |
| | $\frac{(32 \times 91) + (33 \times 1.8) + (y \times 7.2)}{100} = 32.16$ | 1 | AO2f | |
| | $7.2y = 32.16 \times 100 - 32 \times 91 - 33 \times 1.8 = 244.6$ | 1 | AO2f | |
| | $y = 244.6 / 7.2 = 33.97$ $y = 34$ | 1 | AO1b | |
| 02.2 | A high voltage is applied to the sample (in polar solvent) | 1 | AO1b | |
| | Molecules lose an electron | 1 | AO1b | |
| 02.3 | Ions, not molecules, will interact with and be accelerated by an electric field | 1 | AO2e | |
| | Only ions will create a current when hitting the detector | 1 | AO2e | |

| Question | Marking guidance | Mark | AO | Comments |
|--|--|--------|---|---|
| 03.1 | $\text{C(s)} + 2\text{F}_2(\text{g}) \longrightarrow \text{CF}_4(\text{g})$ | 1 | AO1a | State symbols essential |
| 03.2 | Around carbon there are 4 bonding pairs of electrons (and no lone pairs) | 1 | AO1a | |
| | Therefore, these repel equally and spread as far apart as possible | 1 | AO1a | |
| 03.3 | $\Delta H = \sum \Delta_f H \text{ products} - \sum \Delta_f H \text{ reactants}$ or a correct cycle | 1 | AO1b | Score 1 mark only for +85 (kJ mol ⁻¹) |
| | Hence = $(2 \times -680) + (6 \times -269) - (x) = -2889$ | 1 | AO1b | |
| | $x = 2889 - 1360 - 1614 = -85 \text{ (kJ mol}^{-1}\text{)}$ | 1 | AO1b | |
| 03.4 | Bonds broken = $4(\text{C-H}) + 4(\text{F-F}) = 4 \times 412 + 4 \times \text{F-F}$ | 1 | AO3 1a | Both required |
| | Bonds formed = $4(\text{C-F}) + 4(\text{H-F}) = 4 \times 484 + 4 \times 562$ | | | |
| | $-1904 = [4 \times 412 + 4(\text{F-F})] - [4 \times 484 + 4 \times 562]$ | | | |
| | $4(\text{F-F}) = -1904 - 4 \times 412 + [4 \times 484 + 4 \times 562] = 632$ | | | |
| $\text{F-F} = 632 / 4 = 158 \text{ (kJ mol}^{-1}\text{)}$ | 1 | AO3 1a | Relevant comment comparing to other bonds (Low activation energy needed to break the F-F bond) | |
| The student is correct because the F-F bond energy is much less than the C-H or other covalent bonds, therefore the F-F bond is weak / easily broken | 1 | AO3 1a | | |
| | | 1 | AO3 1b | |

| Question | Marking guidance | Mark | AO | Comments |
|----------|---|-------------|----------------------|---|
| 04.1 | amount of X = 0.50 – 0.20 = 0.30 (mol) amount of Y = 0.50 – 2 × 0.20 = 0.10 (mol) | 1 1 | AO2h AO2h | |
| 04.2 | Axes labelled with values, units and scales that use over half of each axis Curve starts at origin Then flattens at 30 seconds at 0.20 mol | 1 1 1 | AO2h AO2h AO2h | All three of values, units and scales are required for the mark |
| 04.3 | Expression = $K_c = \frac{[Z]}{[X][Y]^2}$ $[Y]^2 = \frac{[Z]}{[X] K_c}$ $[Y] = (0.35 / 0.40 \times 2.9)^{0.5} = 0.5493 = 0.55 \text{ (mol dm}^{-3}\text{)}$ | 1 1 1 | AO1a AO2b AO1b | Answer must be to 2 significant figures |
| 04.4 | Darkened / went more orange The equilibrium moved to the right To oppose the increased concentration of Y | 1 1 1 | AO2g AO2g AO2g | |
| 04.5 | The orange colour would fade | 1 | AO3 1a | |

| Question | Marking guidance | Mark | AO | Comments |
|----------|---|---------------------|------------------------------|--|
| 05.1 | $2\text{NaBr} + 2\text{H}_2\text{SO}_4 \longrightarrow \text{Na}_2\text{SO}_4 + \text{Br}_2 + \text{SO}_2 + 2\text{H}_2\text{O}$ <p>Br⁻ ions are bigger than Cl⁻ ions</p> <p>Therefore Br⁻ ions more easily oxidised / lose an electron more easily (than Cl⁻ ions)</p> | 1 1 1 | AO1a AO2c AO2c | Allow ionic equation $2\text{Br}^- + 2\text{H}_2\text{SO}_4 \longrightarrow \text{Br}_2 + \text{SO}_4^{2-} + \text{SO}_2 + 2\text{H}_2\text{O}$ |

| | | | | | |
|------|--|--|---|----------|---|
| 05.2 | This question is marked using levels of response. Refer to the Mark Scheme Instructions for Examiners for guidance on how to mark this question. | | 6 | 2 AO1a | Indicative chemistry content Stage 1: formation of precipitates <ul style="list-style-type: none"> • Add silver nitrate • to form precipitates of AgCl and AgBr • $\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3$ • $\text{AgNO}_3 + \text{NaBr} \rightarrow \text{AgBr} + \text{NaNO}_3$ Stage 2: selective dissolving of AgCl <ul style="list-style-type: none"> • Add excess of dilute ammonia to the mixture of precipitates • the silver chloride precipitate dissolves • $\text{AgCl} + 2\text{NH}_3 \rightarrow \text{Ag}(\text{NH}_3)_2^+ + \text{Cl}^-$ Stage 3: separation and purification of AgBr <ul style="list-style-type: none"> • Filter off the remaining silver bromide precipitate • Wash to remove soluble compounds • Dry to remove water |
| | Level 3 5–6 marks | <p>All stages are covered and the explanation of each stage is generally correct and virtually complete. Stages 1 and 2 are supported by correct equations.</p> <p>Answer communicates the whole process coherently and shows a logical progression from stage 1 to stage 2 and then stage 3. The steps in stage 3 are in a logical order.</p> | | 4 AO3 2b | |
| | Level 2 3–4 marks | <p>All stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies OR two stages are covered and the explanations are generally correct and virtually complete.</p> <p>Answer is mainly coherent and shows a progression through the stages. Some steps in each stage may be out of order and incomplete.</p> | | | |
| | Level 1 1–2 marks | <p>Two stages are covered but the explanation of each stage may be incomplete or may contain inaccuracies, OR only one stage is covered but the explanation is generally correct and virtually complete.</p> <p>Answer includes some isolated statements, but these are not presented in a logical order or show confused reasoning.</p> | | | |
| | Level 0 0 marks | Insufficient correct chemistry to warrant a mark. | | | |

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|------|---|---|------|----------------------------|
| 05.3 | $\text{Cl}_2 + 2\text{HO} \longrightarrow \text{OCl}^- + \text{Cl}^- + \text{H}_2\text{O}$ OCl ⁻ is +1 Cl ⁻ is -1 | 1 | AO1a | Both required for the mark |
| | | 1 | AO2b | |

| Question | Marking guidance | Mark | AO | Comments |
|----------|--|--|---|---|
| 06.1 | <p>Stage 1: appreciation that the acid must be in excess and calculation of amount of solid that permits this</p> <p>Statement that there must be an excess of acid</p> <p>Moles of acid = $50.0 \times 0.200/1000 = 1.00 \times 10^{-2}$ mol</p> <p>2 mol of acid react with 1 mol of calcium hydroxide therefore moles of solid weighed out must be less than half the moles of acid = $0.5 \times 1.00 \times 10^{-2} = 5.00 \times 10^{-3}$ mol</p> <p>Mass of solid must be $< 5.00 \times 10^{-3} \times 74.1 = < 0.371$ g</p> <p>Stage 2: Experimental method</p> <p>Measure out 50 cm³ of acid using a pipette and add the weighed amount of solid in a conical flask</p> <p>Titrate against 0.100 (or 0.200) mol dm⁻³ NaOH added from a burette and record the volume (v) when an added indicator changes colour</p> <p>Stage 3: How to calculate M_r from the experimental data</p> <p>Moles of hydroxide = $5.00 \times 10^{-3} - (v \times \text{conc NaOH})/1000 = z$ mol</p> <p>$M_r = \text{mass of solid} / z$</p> | <p></p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p></p> <p>1</p> <p></p> <p>1</p> <p>1</p> | <p></p> <p>AO2d</p> <p>AO3 2a</p> <p>AO3 2b</p> <p>AO3 2a</p> <p></p> <p>AO3 2b</p> <p>AO3 2b</p> <p></p> <p>AO3 2a</p> <p>AO3 2a</p> | <p>Extended response</p> <p>Maximum of 7 marks for answers which do not show a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.</p> |

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|------|--|---|------|---|
| 06.2 | Moles of calcium chloride = $3.56 / 111.1 = 3.204 \times 10^{-2}$ | 1 | AO2h | Answer must be to 3 significant figures |
| | Moles of calcium sulfate = $3.204 \times 10^{-2} \times 83.4/100 = 2.672 \times 10^{-2}$ | 1 | AO2h | |
| | Mass of calcium sulfate = $2.672 \times 10^{-2} \times 136.2 = 3.6398 = 3.64$ (g) | 1 | AO2h | |

Section B

In this section, each correct answer is awarded 1 mark.

| Question | Key | AO |
|-----------------|------------|-----------|
| 8 | D | AO1a |
| 9 | D | AO1b |
| 10 | A | AO3 1b |
| 11 | B | AO3 2a |
| 12 | B | AO2a |
| 13 | A | AO2a |
| 14 | C | AO1a |
| 15 | C | AO1a |
| 16 | D | AO2b |
| 17 | D | AO2a |
| 18 | B | AO1a |
| 19 | A | AO2a |
| 20 | C | AO2b |
| 21 | B | AO1b |
| 22 | B | AO2b |