AQA

AS
Chemistry

7404/1 Inorganic and Physical Chemistry
Mark scheme

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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.

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AS and A-level Chemistry

Mark scheme instructions for examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the examiner make his or her judgement and help to delineate what is acceptable or not worthy of credit or, in discursive answers, to give an overview of the area in which a mark or marks may be awarded.

The extra information in the 'Comments' column is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

You should mark according to the contents of the mark scheme. If you are in any doubt about applying the mark scheme to a particular response, consult with your Team Leader.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent.

The use of M1, M2, M3 etc in the right-hand column refers to the marking points in the order in which they appear in the mark scheme. So, M1 refers to the first marking point, M2 the second marking point etc.

2. Emboldening

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **OR**. Different terms in the mark scheme are shown by a / ; eg allow smooth / free movement.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of error / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (often prefaced by 'Ignore' in the mark scheme) are not penalised.

3.2 Marking procedure for calculations

Full marks should be awarded for a correct numerical answer, without any working shown, unless the question states 'Show your working' or 'justify your answer'.

If an answer to a calculation is incorrect and working is shown, process mark(s) can usually be gained by correct substitution / working and this is shown in the 'Comments' column or by each stage of a longer calculation.

3.3 Extended responses

Where a mark scheme includes linkage words (such as 'therefore', 'so', 'because' etc), these are optional. However, a student's marks for the question may be limited if they do not demonstrate the ability to construct and develop a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. In particular answers in the form of bullet pointed lists may not be awarded full marks if there is no indication of logical flow between each point or if points are in an illogical order.

3.4 Equations

In questions requiring students to write equations, state symbols are generally ignored unless otherwise stated in the 'Comments' column.

Examiners should also credit correct equations using multiples and fractions unless otherwise stated in the 'Comments' column.

3.5 Organic structures

Where students are asked to draw organic structures, these may be given as displayed, structural or skeletal formulas unless a specific type of structure is required in the question and stated in the mark scheme.

3.6 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.7 Errors carried forward, consequential marking and arithmetic errors

Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ECF or consequential in the marking scheme.

An arithmetic error should be penalised for one mark only unless otherwise amplified in the marking scheme. Arithmetic errors may arise from a slip in a calculation or from an incorrect transfer of a numerical value from data given in a question.

3.8 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **unless** there is a possible confusion with another technical term or if the question requires correct IUPAC nomenclature.

3.9 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.10 Ignore / Insufficient / Do not allow

Ignore or insufficient is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

Do **not** allow means that this is a wrong answer which, even if the correct answer is given, will still mean that the mark is not awarded.

3.11 Marking crossed out work

Crossed out work that **has not been** replaced should be marked as if it were not crossed out, if possible. Where crossed out work **has been** replaced, mark the replacement work and not the crossed out work.

Question	Marking Guidance	Mark	Comments
01.1	$1s^2 2s^2 2p^6 3s^2 3p^1$ $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$	1 1	If noble gas core used correctly in both then scores 1 Allow subscripts and capitals Ignore $4s^0$
01.2	Sr^{2+}	1	Ignore name and correct proton/mass number Allow Sr^{+2}
01.3	Ca_3P_2	1	Allow reversed or ionic formula Ignore name

Question	Marking Guidance	Mark	Comments
02.1	$Mg(^{2+})$ or Magnesium	1	Na^+ CE=0
	Because Mg^{2+} has more protons		Allow larger/stronger nuclear charge
	AND With the <u>same</u> shielding/screening/electron arrangement/number of electrons (or isoelectronic)	1	Ignore atomic radius
02.2	$Na(g) \rightarrow Na^+(g) + e^-$	1	1 for correct species and gas phase Allow e without charge Allow $Na(g) - e^- \rightarrow Na^+(g)$ $Na(g) + e^- \rightarrow Na^+(g) + 2e^-$
02.3	Mg between 600-800	1	
	S between 800-1040	1	If S not lower than P on graph then M1 only If no plots on graph must state S below P to access M3 & M4
	e^- paired in (3)p orbital in S (owtte)	1	Allow (3)p subshell/sublevel provided pair mentioned
	Paired e^- repel (so less energy needed to remove)	1	

Question	Marking Guidance	Mark	Comments
03.1	Selects correct titres $\text{mean titre} = \frac{9.75 + 9.65}{2}$ = 9.7(0) cm^3 mol HCL = 0.102 × $^{9.70}/_{1000}$ = 9.89×10^{-4} (allow 9.9x10-4 for M3 but check not via 4 titres in which case only 1 mark)	1 1 1	If 3 or more titres used them MAX 1 for conseq M3 Calculates mean Calculates mol (working or result gains credit) 9.92×10^{-4} scores 1 if all 4 titres used 9.83×10^{-4} scores 1 if titres 1,2,and 3 used
03.2	mol $MHCO_3$ = ANS 3.1 x 10 (= 9.89×10^{-3}) $\text{Mr} = \frac{1464/1000}{M1}$ Mr = 148 (3sf)	1 1 1	Use ecf if wrong mean calculated above Allow ecf following wrong mass conversion
03.3	Suggestion: Use a larger mass of solid OR use a more concentrated solution of $MHCO_3$ OR less concentrated / more dilute solution of HCl OR more $MHCO_3$ Justification: So a larger titre/reading will be needed OR larger volume of HCl	1 1	 Cannot score justification mark unless suggestion correct, but suggestion could be after justification Assume reference to the solution means the $MHCO_3$

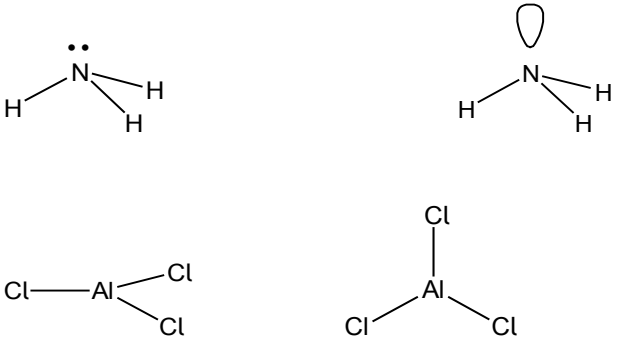
Question	Marking Guidance	Mark	Comments
03.4	This question is marked using levels of response. Level 3 - Must use volumetric flask to access level 3 Answer is communicated coherently and shows a logical progression from stage 1 to stage 2 then stage 3. 6 marks - All stages are covered and the description of each stage is complete 5 marks – all stages are covered but up to 2 omissions/errors from different stages. If 2 omissions/errors from same stage only level 2 possible Level 2 Answer is mainly coherent and shows progression from stage 1 to stage 3 4 marks - All stages are covered but 3 omissions/errors 3 marks – all stages are attempted Level 1 Answer includes isolated statements but these are not presented in a logical order or show confused reasoning. 2 marks – 2 stages attempted 1 mark – 1 stage attempted Level 0 0 marks Insufficient correct chemistry to gain a mark.	6	**Indicative Chemistry content** **Stage 1:** transfers known mass of solid a) Weigh the sample bottle containing the solid on a (2 dp) balance b) Transfer to beaker* and reweigh sample bottle c) Record the difference in mass Or d) Place beaker* on balance and tare e) Transfer solid into beaker f) Record mass Or g) Known mass provided h) Transfers (known) mass into beaker* i) Wash all remaining solid from sample bottle into beaker Allow use of weighing boat *Allow other suitable glassware including volumetric flask **Stage 2:** Dissolves in water a) Add distilled / deionised water b) Stir (with a glass rod) or swirl c) Until all solid has dissolved **Stage 3:** Transfer, washing and agitation a) Transfer to <u>volumetric / graduated</u> flask. Allow if a clear description/diagram given eg long necked flask with $250cm^3$ mark b) With washings c) Make up to $250cm^3$ / mark with water d) Shakes/inverts/mixes

Question	Marking Guidance	Mark	Comments
04.1	Structures **M1** Bromine is (simple) molecular / simple molecules **M2** Magnesium is metallic / consists of (positive) ions in a (sea) of delocalised electrons Strength **M3** Br_2 has weak (van der Waals) forces between the molecules / weak IMFs **M4** so more energy is needed to overcome the Stronger (metallic) bonds or converse. The comparison could be direct or implied. Liquid range **M5** Mg has a much greater liquid range because forces of attraction in liquid / molten metal are strong(er) OR converse argument for Br_2	1 1 1 1 1	Chemical Error penalties If Br_2 (covalent) bonds broken lose M3 and M4 If eg Mg molecules or Mg ionic bonds lose M2 and M4 Must refer to liquid range to score M5

Question	Marking Guidance	Mark	Comments
05.1	n = PV/RT	1	If PV=nRT rearranged incorrectly then M3 only
	$\frac{102\,000 \times (1.00 \times 10^{-3})}{8.31 \times 300} = n$ = ($4.091456077 \times 10^{-2}$)	1	
	Mass = M2 x 17 = 0.696 (g) (3 sig figs only)	1	Allow 0.695 or 0.697
05.2	If pV = nRT $\text{Total volume} = \frac{nRT}{P}$ $= \frac{n \times 8.31 \times 295}{75\,000}$ = 1.34×10^{-3} m^3	1	Incorrect unit conversion loses M1 only; can get M2/M3 if possible volume obtained Inserts correct numbers (inc pressure in Pa)
	Volume of Q in m^3 = 1.00×10^{-3} Volume of bulb P = $1.34 \times 10^{-3} - 1.00 \times 10^{-3}$ Volume of bulb P = 3.42×10^{-4} m^3	1	No subtraction M1 only
	= 342 cm^3 (Allow 310-342 cm^3)	1	Alternative method also worth full credit (note if mol in M2 of 05.1 rounded to 0.04 this could lead to a final answer of $3.1 \times 10^{-4} m^3$ so allow range 310-342cm^3

Question	Marking Guidance	Mark	Comments
06.1	(Ions accelerated by) attraction to negatively charged plate / electric field Ions detected by gaining electrons Abundance determined by (size) of current flowing (or amount of electrons gained) in the detector	1 1 1	Mark independently Allow the transfer of electrons Allow current is proportional to abundance
06.2	Mass = $^{52}/_{\frac{1000}{6.022\text{x}10^{23}}}$ Mass = $8.6(4)\text{x}10^{-26}$	1	
06.3	$V^2 = (2\text{x}1.269\text{x}10^{-13})/8.64\text{x}10^{-26}$ $V = 1.71\text{x}10^{6}\text{ms}^{-1}$	1 1	Allow correct rearrangement for V or V^2 Allow ecf from 6.2 (note if $8.6\text{x}10^{-23}$ in 6.2 leads to approx. $5.4\text{x}10^{4}\text{ ms}^{-1}$)
06.4	Sketch with peaks at 158,160,162 In ratio 25%:50%:25%	1 1	Mark independently Allow approx. ratio 1:2:1

Question	Marking Guidance	Mark	Comments
06.5	% abundance ^{m}Xe = 20(%)	1	Working must be shown
	131.31=(0.28*129)+(0.25*131)+(0.27*132)+(0.20*m)	1	
	131.31-104.51=0.2m	1	
	Mass number = 134	1	Answer must be an integer

Question	Marking Guidance	Mark	Comments
07.1	Correct diagram of NH_3 including LP on N Correct diagram of $AlCl_3$ bond angles in range 106-108° and bond angle of 120° 	1 1 1	Ignore shape names
07.2	Dative (covalent) /co-ordinate bond Shared pair of / both electrons come from the N(H_3)	1 1	Wrong bond CE=0 but mark on if covalent quoted
07.3	Aluminium is now surrounded by 4 electron pairs/bonds or is tetrahedral Therefore Cl-Al-Cl bond angle decreases / changes (from 120° in $AlCl_3$) to allow range 107-111° in H_3NAlCl_3	1 1	Independent

Question	Marking Guidance	Mark	Comments ClO^-
08.1	$2Cl^- \rightarrow Cl_2 + 2e^{(-)}$	1	Allow $2Cl^- - 2e^{(-)} \rightarrow Cl_2$ Alow correct equation forming ClO^- but not Cl^+
08.2	$2ClO^- + 4H^+ + 2e^- \rightarrow Cl_2 + 2H_2O$	1	Allow HClO in correctly balanced equation
08.3	$ClO^- + Cl^- + 2H^+ \rightarrow Cl_2 + H_2O$	1	allow $HClO + HCl + \rightarrow Cl_2 + H_2O$
08.4	Goes brown (or shades of brown) Due to iodine or I_3^- Because I^- oxidised	1 1 1	Allow black ppt/solid but NOT black solution or purple Correct ½ equation scores M2 and M3

Question	Marking Guidance	Mark	Comments
09.1	Identifies precipitate as being $BaSO_4$ Moles of Barium sulfate = mass/Mr (= 0.764 / 233.4) = 0.003273 moles Mass of Barium chloride = 208.3 x 0.003273 = 0.6818 g $\text{Percentage of Magnesium chloride} = \frac{1.056 - 0.6818}{1.056} \times 100$ = 35.4 %	1 1 1 1	 Allow conseq if Mr $BaSO_4$ or $BaCl_2$ incorrect Do NOT penalise incorrect precision here Allow range 33.7-35.5% (rounding errors penalised elsewhere in paper)

Question	Marking Guidance	Mark	Comments
10.0	C	1	
11.0	C	1	
12.0	B	1	
13.0	D	1	
14.0	C	1	
15.0	A	1	
16.0	C	1	
17.0	B	1	
18.0	B	1	
19.0	A	1	
20.0	A	1	
21.0	C	1	
22.0	C	1	
23.0	D	1	
24.0	B	1	