AS
CHEMISTRY
7404/1

Paper 1 Inorganic and Physical Chemistry

Mark scheme

June 2019

Version: 1.0 Final

I96A7404I/MS

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

Level of response marking instructions

Level of response mark schemes are broken down into levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1 Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 content.

Step 2 Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the Indicative content to reach the highest level of the mark scheme.

An answer which contains nothing of relevance to the question must be awarded no marks.

<table>
<tr><th>Question</th><th>Marking guidance</th><th>Additional Comments/Guidelines</th><th>Mark</th></tr>
<tr><td>01.1</td><td>Fluoride <u>ion</u> has (two) fewer protons/lower nuclear charge

Weaker attraction between nucleus and (outer) electrons</td><td>Do not allow fluorine, but allow fluorine <u>ion</u>
Any reference to different numbers of electrons in the ions loses M1

Allow answers in terms of sodium <u>ion</u> but must be explicit.
Ignore references to atomic radius</td><td>1

1</td></tr>
<tr><td>01.2</td><td>(Electrostatic) forces of <u>attraction</u> between oppositely charged ions/Na^+ and F^-

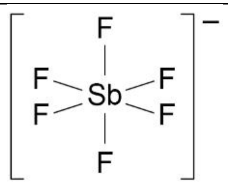
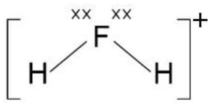
Lots of energy needed to overcome/break forces</td><td>Mention of IMF, covalent, macromolecular, metallic, electronegativity of ions loses both marks

Allow strong ionic bonding
Allow strong forces/bonds of attraction (need to be broken)</td><td>1

1</td></tr>
<tr><td>01.3</td><td>Type of Bond: Coordinate bond / dative (covalent) bond

Explanation: A (lone) pair of electrons is donated <u>from F</u></td><td>If just covalent, then do not award M1 but mark on

Allow both electrons (in the shared pair) come from F</td><td>1

1</td></tr>
<tr><td>01.4</td><td><table><tr><td>Shape</td><td></td><td></td></tr><tr><td>Name of shape</td><td>Octahedral</td><td>Bent / V-shaped / angular</td></tr></table></td><td>Lone pairs on H_2F^+ are essential (can be shown in lobes)
Ignore missing charges

Mark independently</td><td>1

1

1

1</td></tr>
</table>

01.5	$\Delta H = \sum\Delta H$(Bonds broken) - $\sum\Delta H$(Bonds Formed) -179 = 2(412) + 837 + 2(562) – [348 + 4(412) + 2(C—F)] -179 = 2785 – (1996 +2(C—F)) 2(C—F) = 968 C—F = 484	Allow M1 if 2785 <u>and</u> 1996 seen (or allow M1 if 1961 <u>and</u> 1172 seen) M3 consequential on any M2 if it is clear that M2 is for 2(C-F) -484 scores 2	1 1 1

Question	Marking guidance	Additional Comments/Guidelines	Mark
02.1	(Sample is) dissolved (in a volatile solvent) (Injected through) needle/nozzle/capillary at high voltage/positively charged Each molecule/particle gains a proton/H^+	Allow named solvent (eg water/methanol) Ignore pressure Allow M3 from a suitable equation (ignore state symbols) Do not allow atoms gain a proton for M3 Ignore references to electron gun ionisation Mark each point independently	1 1 1
02.2	$C_3H_6O_2N^+$ / $C_3H_5O_2NH^+$	Must be charged	1
02.3	$Ge(g) + e^- \rightarrow Ge^+(g) + 2e^-$ OR $Ge(g) \rightarrow Ge^+(g) + e^-$	State symbols essential	1

02.4	M1 v = length/t = 0.96 / 4.654 x 10^{-6} v = 206274 m s^{-1} m = 2*KE*/v^2 M2 mass of one ion = 1.146 x 10^{-25} kg M3 mass of 1 mole ions = 1.146 x 10^{-25} x 6.022 x 10^{23} = (0.06901 kg) M4 = 69(.01) g M5 mass number = 69	Notes: M1 = working (or answer) M2 = answer conseq on M1 M3 = M2 x 6.022 x 10^{23} M4 = M3 x 1000 M3/M4 could be in either order M5 must have whole number for mass no	1 1 1 1 1

Question	Marking guidance	Additional Comments/Guidelines	Mark
03.1	$(1s^2) 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$ Or $(1s^2) 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$	Ignore commas Do not penalise capitals and subscripts	1
03.2	$^{57}_{26}Fe$	Allow mass number and atomic number on RHS of Fe	1
03.3	% of 4th isotope = 3.6 M2: $\frac{(52 \times 82.8) + (53 \times 10.9) + (54 \times 2.7) + (3.6x)}{100} = 52.09$ M3: $x = 49.97$ OR $179.9 = 3.6\,x$ and $x = 50$ (evidence of working)	Allow alternative methods M2 (52 x 82.8) + (53 x 10.9) + (54 x 2.7) + (50 x 3.6) =5209 M3 A_r = 5209/100 = 52.09 Or M2 $\frac{(52 \times 82.8) + (53 \times 10.9) + (54 \times 2.7) + (50x)}{100} = 52.09$ M3 awarded for $50x = 179.9$ and then $x = 3.6$ (evidence of working)	1 1 1
03.4	+6 / VI / six / 6+		1
03.5	$2I^- \rightarrow I_2 + 2e^-$	Allow multiples / ignore ss	1
03.6	$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$	Allow multiples / ignore ss	1
03.7	$Cr_2O_7^{2-} + 14H^+ + 6I^- \rightarrow 2Cr^{3+} + 7H_2O + 3I_2$	Allow multiples / ignore ss Allow $Cr_2O_7^{2-} + 14H^+ + 8I^- \rightarrow 2Cr^{2+} + 7H_2O + 4I_2$ as ecf to 03.6	1

<table>
<tr><th>Question</th><th>Marking guidance</th><th>Mark</th><th>Comments</th></tr>
<tr><td>04</td><td colspan="2">This question is marked using levels of response.</td><td rowspan="5">Indicative Chemistry Content

Stage 1: General Trend (Li → Ne)
1a.1st IE increases
1b.More protons/increased nuclear charge
1c.Electrons in same energy level / shell
1d.No extra/similar shielding
1e.Stronger attraction between nucleus and <u>outer</u> e OR <u>outer</u> e closer to nucleus (ignore radius decreases)

Stage 2: Deviation Be → B
2a.B lower than Be
2b.Outer electron in (2)p
2c.higher in energy than (2)s

If Al vs Mg then do not award 2a or 2b

Stage 3: Deviation N → O
3a.O lower than N
3b.2 electrons in (2)p need to pair
3c.pairing causes repulsion (do not award if it is clear reference to repulsion is in s orbital)

If S vs P then do not award 3a or 3b</td></tr>
<tr><td></td><td>Level 3: ALL Stages with matching justifications
All stages are covered and the explanation of each stage is generally correct and virtually complete.

Answer is well structured with no repetition or irrelevant points. Accurate and clear expression of ideas with no errors in use of technical terms.</td><td>5-6</td></tr>
<tr><td></td><td>Level 2: TWO Stages with matching justifications OR THREE Stages with incomplete justifications.
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.

Answer shows some attempt at structure
Ideas are expressed with reasonable clarity with, perhaps, some repetition or some irrelevant points.

Some minor errors in use of technical terms.</td><td>3-4</td></tr>
<tr><td></td><td>Level 1: ONE Stage with matching justification OR TWO Stages with incomplete justifications
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.

Answer includes isolated statements but these are not presented in a logical order or show confused reasoning.

Answer may contain valid points which are not clearly linked to an argument structure. Errors in the use of technical terms.</td><td>1-2</td></tr>
<tr><td></td><td>Level 0

Insufficient correct chemistry to gain a mark.</td><td>0</td></tr>
</table>

Question	Marking guidance	Additional Comments/Guidelines	Mark
05.1	Amount of Nitrogen monoxide = 1.15 mol Amount of Chlorine = 0.825 mol	Answers to min 2sf	1 1
05.2	$K_c = \frac{[NOCl]^2}{[NO]^2[Cl_2]}$		1
05.3	$1.32 \times 10^{-2} = \frac{[NOCl]^2}{\left[{}^{0.85}/_{0.800}\right]^2\left[{}^{0.458}/_{0.800}\right]}$ $[NOCl]^2 = 8.53 \times 10^{-3}$ mol^2dm^{-6} $[NOCl] = 0.0924$ mol dm^{-3} n(NOCl) = 0.0924 x 0.800 = 0.0739 mol (answer to 2sf or more)	M1 = divides mole quantities by 0.800 M2 = evaluates $[NOCl]^2$ M3 = √M2 M4 = M3 x 0.800 (allow ecf on an incorrect volume used in M1) If no division in M1 then max 3 M2 = 4.37×10^{-3} M3 = 0.0661 mol dm^{-3} M4 = 0.0529 mol If Kc upside down then can still score 4 M1 = divides mole quantities by 0.800 M2 = 48.96 M3 = 7.00 mol dm^{-3} M4 = 0.600 mol Incorrect rearrangement loses M2	1 1 1 1

Question	Marking guidance	Additional Comments/Guidelines	Mark
06.1	Average titre = 26.45 cm^3 n(NaOH) = (25 x 0.112 / 1000) = 2.80 x 10^{-3} mol n(acid in titre) = 2.80 x 10^{-3} / 2 = 1.40 x 10^{-3} mol n(acid in 250 cm^3) = 1.40 x 10^{-3} x 250/26.45 = 0.0132 mol M_r = mass / moles = 1.300/0.0132 = 98.2-98.5	M1 = average of concordant titres M2 – this value only M3 = M2/2 M4 = M3 x 250/M1 M5 = (1.300/M4) = answer *Mr* must be given to at least 1dp Alternatives: 98.6 – scores 4 92.9 – scores 4 87.8 – scores 3 49.3 – scores 3 49.1 – scores 4	1 1 1 1 1
06.2	% uncertainty = 0.06/25.0 x 100 = 0.24 %		1
06.3	Some solution/acid replaces air bubble / Solution/acid fills below the tap / Air bubble takes up volume that would be filled by solution/acid	Score for the idea that: Acid/solution replaces air/bubble/fills jet space Allow acid/solution fills the bubble/gap 'The final reading is higher than the volume added' is not enough.	1

06.4	Does not react (with the alkali) / does not change the number of moles (of alkali)	Allow water is a product / water is not a reagent	1

Question	Marking guidance	Additional Comments/Guidelines	Mark
07.1	Equation: $2Mg + TiCl_4 \rightarrow Ti + 2MgCl_2$ Role: Reducing agent	Allow multiples / ignore ss Allow electron donor (not electron pair donor)	1 1
07.2	M1 moles of water in 210 mg = mass / mr = 0.210 / 18 = 0.0117 mol ONLY Equal to moles of magnesium hydroxide produced in stage one M2: mass of $Mg(OH)_2$ = 0.0117 x 58.3 = 0.680 g M3: mass of MgO = 3.2 – 0.68 = 2.52 g M4: % of MgO = 2.52/3.2 x 100 = 78.7%	M1 = moles of water M2 = mass of $Mg(OH)_2$ = M1 x 58.3 M3 = subtraction = 3.2 – M2 M4 = answer to M3 x 100/3.2 Alternative correct alternative methods such as M1 = moles of water M2 = mass of $Mg(OH)_2$ = M1 x 58.3 M3 = M2 x 100/3.2 M4 = 100 – M3 M4: Allow 78.7 – 78.8 or 79 %	4

Question	Marking guidance	Additional Comments/Guidelines	Mark
08.1	Reagent: H_2SO_4 / Na_2SO_4 / any soluble sulfate Observation with NaCl: no (visible) change Observation with $BaCl_2$: white ppt / white solid formed	If reagent incorrect then cannot score observations (ignore conc for H_2SO_4) If reagent incomplete (e.g. SO_4^{2-}), then lose M1 but mark on Allow “no reaction”,”nvc”,”no change”; Do not allow “nothing”,”no observation” and observations by omission (e.g. no ppt)	3

08.2	Reagent: H_2SO_4 / HCl / HNO_3 Observation with NaCl: no (visible) change Observation with Na_2CO_3: effervescence/bubbles/fizzing OR Reagent: <u>acidified</u> $AgNO_3$ Observation with NaCl: white ppt / white solid formed Observation with Na_2CO_3: effervescence/bubbles/fizzing	If reagent incorrect then CE=0 If reagent incomplete (e.g. H^+), then lose M1 but mark on. If reagent is acid and limewater, lose M1, but mark on. Allow “no reaction”; Do not allow “nothing” Allow (CO_2) gas produced Allow “no reaction”,”nvc”,”no change”; Do not allow “nothing”,”no observation” and observations by omission (e.g. no fizzing) If reagent = $AgNO_3$ (not acidified) – do not allow reagent mark, but allow white ppt for observation with NaCl and white ppt for observation with Na_2CO_3 (do not allow nvc for Na_2CO_3) If acid given as HCl with $AgNO_3$, then do not allow reagent mark, but mark on. Ignore references to ppt for observation with Na_2CO_3 Allow (CO_2) gas produced Allow “no reaction”,”nvc”,”no change”; Do not allow “nothing”,”no observation” and observations by omission (e.g. no ppt / no fizzing) Allow alternative reagents (e.g. $BaCl_2$) that would distinguish in a single reaction.	3

Question	Marking Guidance	Mark	Comments
9	**A**	1	
10	**C**	1	
11	**A**	1	
12	**D**	1	
13	**C**	1	
14	**C**	1	
15	**D**	1	
16	**C**	1	
17	**C**	1	
18	**A**	1	
19	**A**	1	
20	**A**	1	
21	**C**	1	
22	**C**	1	
23	**A**	1	