AQA Qualifications

AS

Chemistry

Paper 1 (7404/1): Inorganic and Physical Chemistry
Mark scheme

7404
Specimen paper

Version 0.6

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	$Ca(s) + 2H_2O(l) \longrightarrow Ca^{2+}(aq) + 2OH^-(aq) + H_2(g)$	1	AO2d	State symbols essential
01.3	Oxidising agent	1	AO2c	
01.4	$Ca(g) \longrightarrow Ca^+(g) + e^-$	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	
	$\frac{(32 \times 91) + (33 \times 1.8) + (y \times 7.2)}{100} = 32.16$	1	AO2f	
	7.2y = 32.16 × 100 – 32 × 91 – 33 × 1.8 = 244.6	1	AO2f	
	y = 244.6 / 7.2 = 33.97 y = 34	1	AO1b	Answer must be rounded to the nearest integer
02.2	(for electrospray ionisation)			
	A high voltage is applied to a sample in a polar solvent	1	AO1b	
	the sample molecule, M, gains a proton forming MH^+	1	AO1b	
	OR			
	(for electron impact ionisation)			
	the sample is bombarded by high energy electrons	1	AO1b	
	the sample molecule loses an electron forming M^+	1	AO1b	

02.3	Ions, not molecules, will interact with and be accelerated by an electric field Only ions will create a current when hitting the detector	1 1	AO2e AO2e	

Question	Marking guidance	Mark	AO	Comments
03.1	$C(s) + 2F_2(g) \longrightarrow CF_4(g)$	1	AO1a	State symbols essential
03.2	Around carbon there are 4 bonding pairs of electrons (and no lone pairs) Therefore, these repel equally and spread as far apart as possible	1 1	AO1a AO1a	
03.3	$\Delta H = \Sigma\ \Delta_f H$ products – $\Sigma\ \Delta_f H$ reactants or a correct cycle Hence = (2 × –680) + (6 × –269) – (x) = –2889 x = 2889 – 1360 – 1614 = –85 (kJ mol^{-1})	1 1 1	AO1b AO1b AO1b	Score 1 mark only for +85 (kJ mol^{-1})
03.4	Bonds broken = 4(C–H) + 4(F–F) = 4 × 412 + 4 × F–F Bonds formed = 4(C–F) + 4(H–F) = 4 × 484 + 4 × 562 –1904 = [4 × 412 + 4(F–F)] – [4 × 484 + 4 × 562] 4(F–F) = –1904 – 4 × 412 + [4 × 484 + 4 × 562] = 632 F–F = 632 / 4 = 158 (kJ mol^{-1}) 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 1 1 1	AO3 1a AO3 1a AO3 1a AO3 1b	Both required Relevant comment comparing to other bonds (Low activation energy needed to break the F–F bond)

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 = $K_c = \frac{[Z]}{[X][Y]^2}$ $[Y]^2 = \frac{[Z]}{[X]\ K_c}$ $[Y] = (0.35 / 0.40 \times 2.9)^{0.5} = 0.5493 = 0.55$ (mol dm^{-3})	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	$2NaBr + 2H_2SO_4 \longrightarrow Na_2SO_4 + Br_2 + SO_2 + 2H_2O$	1	AO1a	Allow ionic equation $2Br^- + 2H_2SO_4 \longrightarrow Br_2 + SO_4^{2-} + SO_2 + 2H_2O$
	Br^- ions are bigger than Cl^- ions	1	AO2c	
	Therefore Br^- ions more easily oxidised / lose an electron more easily (than Cl^- ions)	1	AO2c	

<table>
<tr>
<td rowspan="5">05.2</td>
<td colspan="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.</td>
<td rowspan="5">6</td>
<td rowspan="5">2 AO1a

4 AO3 2b</td>
<td rowspan="5">Indicative chemistry content

Stage 1: formation of precipitates
• Add silver nitrate
• to form precipitates of AgCl and AgBr
• $AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$
• $AgNO_3 + NaBr \rightarrow AgBr + NaNO_3$

Stage 2: selective dissolving of AgCl
• Add excess of dilute ammonia to the mixture of precipitates
• the silver chloride precipitate dissolves
• $AgCl + 2NH_3 \rightarrow Ag(NH_3)_2^+ + Cl^-$

Stage 3: separation and purification of AgBr
• Filter off the remaining silver bromide precipitate
• Wash to remove soluble compounds
• Dry to remove water</td>
</tr>
<tr>
<td>Level 3
5–6
marks</td>
<td>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.

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.</td>
</tr>
<tr>
<td>Level 2
3–4
marks</td>
<td>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 is mainly coherent and shows a progression through the stages. Some steps in each stage may be out of order and incomplete.</td>
</tr>
<tr>
<td>Level 1
1–2
marks</td>
<td>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 some isolated statements, but these are not presented in a logical order or show confused reasoning.</td>
</tr>
<tr>
<td>Level 0
0 marks</td>
<td>Insufficient correct chemistry to warrant a mark.</td>
</tr>
</table>

05.3	$Cl_2 + 2HO^- \longrightarrow OCl^- + Cl^- + H_2O$	1	AO1a	
	OCl^- is +1 Cl^- is –1	1	AO2b	Both required for the mark

Question	Marking guidance	Mark	AO	Comments
06.1				Extended response Maximum of 7 marks for answers which do not show a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.
	Stage 1: appreciation that the acid must be in excess and calculation of amount of solid that permits this.			
	Statement that there must be an excess of acid	1	AO2d	
	Moles of acid = 50.0 × 0.200/1000 = 1.00 × 10^{-2} mol	1	AO3 2a	
	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 × 1.00 × 10^{-2} = 5.00 × 10^{-3} mol	1	AO3 2b	
	Mass of solid must be < 5.00 × 10^{-3} × 74.1 = < 0.371 g	1	AO3 2a	
	Stage 2: Experimental method.			
	Measure out 50 cm^3 of acid using a pipette and add the weighed amount of solid in a conical flask	1	AO3 2b	
	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	1	AO3 2b	
	Stage 3: How to calculate M_r from the experimental data.			
	Moles of calcium hydroxide = 5.00 × 10^{-3} – (v/2 × conc NaOH)/1000 = z mol	1	AO3 2a	
	M_r = mass of solid / z	1	AO3 2a	

06.2	Moles of calcium chloride = 3.56 / 111.1 = 3.204×10^{-2}	1	AO2h	
	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	Answer must be to 3 significant figures

Question	Marking guidance	Mark	AO	Comments
07.1	Stage 1 M_r for $Mg(NO_3)_2$ = 148.3 Moles of $Mg(NO_3)_2 = \frac{3.74 \times 10^{-2}}{148.3} = 2.522 \times 10^{-4}$ mol	1	AO2h	Extended response calculation
	Stage 2 Total moles of gas produced = 5/2 × moles of $Mg(NO_3)_2$ $= 5/2 \times 2.522 \times 10^{-4} = 6.305 \times 10^{-4}$	1	AO2h	
	Stage 3			If ratio in stage 2 is incorrect, maximum marks for stage 3 is 2
	PV=nRT so volume of gas $V = nRT/P$	1	AO2h	
	$V = \frac{nRT}{P} = \frac{6.305 \times 10^{-4} \times 8.31 \times 333}{1.00 \times 10^{5}} = 1.745 \times 10^{-5}\ m^3$	1	AO2h	
	$V = 1.745 \times 10^{-5} \times 1 \times 10^{6} = 17.45\ cm^3 = 17.5\ (cm^3)$	1	AO1b	Answer must be to 3 significant figures (answer could be 17.4 cm^3 dependent on intermediate values)
07.2	Some of the solid is lost in weighing product / solid is blown away with the gas	1	AO3 1b	

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