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.

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 Ions get bigger / more (energy) shells Weaker attraction of ion to lost electron	1 1 1	AO1a AO1a AO1a	If answer to 'trend' is not 'decrease', then chemical error = 0/3 Allow atoms instead of ions

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	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	$C(s) + 2F_2(g) \longrightarrow CF_4(g)$	1	AO1a	State symbols essential
03.2	Around carbon there are 4 bonding pairs of electrons (and no lone pairs)	1	AO1a	
	Therefore, these repel equally and spread as far apart as possible	1	AO1a	
03.3	$\Delta H = \Sigma\, \Delta_f H$ products – $\Sigma\, \Delta_f H$ reactants or a correct cycle	1	AO1b	
	Hence = (2 × –680) + (6 × –269) – (x) = –2889	1	AO1b	
	x = 2889 – 1360 – 1614 = –85 (kJ mol^{-1})	1	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	1	AO3 1a	Both required
	–1904 = [4 × 412 + 4(F–F)] – [4 × 484 + 4 × 562]			
	4(F–F) = –1904 – 4 × 412 + [4 × 484 + 4 × 562] = 632	1	AO3 1a	
	F–F = 632 / 4 = 158 (kJ mol^{-1})	1	AO3 1a	
	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 1b	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)	1	AO2h	
	amount of Y = 0.50 – 2 × 0.20 = 0.10 (mol)	1	AO2h	
04.2	Axes labelled with values, units and scales that use over half of each axis	1	AO2h	All three of values, units and scales are required for the mark
	Curve starts at origin	1	AO2h	
	Then flattens at 30 seconds at 0.20 mol	1	AO2h	
04.3	Expression = $K_c = \frac{[Z]}{[X][Y]^2}$	1	AO1a	
	$[Y]^2 = \frac{[Z]}{[X]\,K_c}$	1	AO2b	
	$[Y] = (0.35 / 0.40 \times 2.9)^{0.5}$ = 0.5493 = 0.55 (mol dm^{-3})	1	AO1b	Answer must be to 2 significant figures
04.4	Darkened / went more orange	1	AO2g	
	The equilibrium moved to the right	1	AO2g	
	To oppose the increased concentration of Y	1	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 $2Br^- + 2H_2SO4 \longrightarrow Br_2 + SO_4^{2-} + SO_2 + 2H_2O$
	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	

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 4 AO3 2b	**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
	Level 3 5–6 marks	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.			
	Level 2 3–4 marks	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.			
	Level 1 1–2 marks	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.			
	Level 0 0 marks	Insufficient correct chemistry to warrant a mark.			

05.3	$Cl_2 + 2HO \rightarrow OCl^- + Cl^- + H_2O$	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
	Stage 1: appreciation that the acid must be in excess and calculation of amount of solid that permits this			Maximum of 7 marks for answers which do not show a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.
	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 hydroxide = 5.00 × 10^{-3} – (v × 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} Moles of calcium sulfate = $3.204 \times 10^{-2} \times 83.4/100 = 2.672 \times 10^{-2}$ Mass of calcium sulfate = $2.672 \times 10^{-2} \times 136.2$ = 3.6398 = 3.64 (g)	1 1 1	AO2h AO2h AO2h	 Answer must be to 3 significant figures

Question	Marking guidance	Mark	AO	Comments
07.1				Extended response calculation
	Stage 1			
	M_r for $Mg(NO_3)_2$ = 148.3			
	Moles of $Mg(NO_3)_2$ = $\frac{3.74 \times 10^{-2}}{148.3}$ = 2.522×10^{-4} mol	1	AO2h	
	Stage 2			
	Total moles of gas produced = 5/2 × moles of $Mg(NO_3)_2$			
	= 5/2 × 2.522×10^{-4} = 6.305×10^{-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