GCE

Chemistry A

H432/01: Periodic table, elements and physical chemistry

Advanced GCE

Mark Scheme for Autumn 2021

OCR
Oxford Cambridge and RSA

Tuesday 5 October 2021 –Afternoon

A Level Chemistry A

H432/01   Periodic table, elements and physical chemistry

MARK SCHEME

Duration: 2 hours 15 minutes

MAXIMUM MARK   100

Last updated: 17/10/2021
Post-standardisation

This document consists of 27 pages

1. Annotations

Annotation	Meaning
✔	Correct response
✘	Incorrect response
∧	Omission mark
BOD	Benefit of doubt given
CON	Contradiction
RE	Rounding error
SF	Error in number of significant figures
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
NBOD	Benefit of doubt not given
SEEN	Noted but no credit given
I	Ignore

2. Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

Question	Answer	Marks	AO element	Guidance
1	C	1	AO1.1	
2	B	1	AO1.2	
3	D	1	AO2.6	
4	B	1	AO2.2	
5	D	1	AO2.6	
6	C	1	AO2.6	
7	A	1	AO1.1	
8	B	1	AO2.2	
9	B	1	AO2.2	
10	A	1	AO2.6	
11	A	1	AO1.2	
12	C	1	AO1.2	
13	D	1	AO1.1	Accept 1
14	B	1	AO2.1	
15	C	1	AO2.3	
	Total	**15**		

Question			Answer	Marks	AO element	Guidance
16	(a)		Diagram with regular arrangement of **labelled** '**Mg**$^{2+}$ ions' **OR** '**2+** ions' **AND** attempt to show electrons ✓ **Labelled** electrons between other species **AND** statement anywhere of **delocalised** electrons (can be in text or in diagram) Electrons move ✓	3		Regular arrangement must have at least two rows of correctly charged ions and a minimum of two ions per row **ALLOW** as label: +2 ions **OR** + 2 cations **OR** +2/2+ seen within circle **ALLOW** e$^-$ or 'e' as a **label** for electron **IGNORE** "–" for electron label **ALLOW** mobile/flow for move **IGNORE** 'carry charge'
	(b)	(i)	$Mg^{3+}(g) \rightarrow Mg^{4+}(g) + e^-$ ✓	1	AO1.2	State symbols required (ignore states on electrons) **ALLOW** $Mg^{3+}(g) - e^- \rightarrow Mg^{4+}(g)$ **ALLOW** $Mg^{+3}(g)$ **ALLOW** e for e$^-$
	(b)	(ii)	Big jump/larger difference between 2 and 3 ✓	1	AO1.2	**IGNORE** big jump between 10 and 11 **DO NOT ALLOW** other combinations.
	(b)	(iii)	1st **AND** 3rd **AND** 4th **AND** 5th **AND** 9th **AND** 11th ✓ i.e. 	1	2	3	4	5	6	7	8	9	10	11	12
---	---	---	---	---	---	---	---	---	---	---	---
✓		✓	✓	✓				✓		✓			1	AO2.1	

Question			Answer	Marks	AO element	Guidance
(c)	(i)		(enthalpy change for) **1 mole** of a compound/substance/solid/solute **dissolving** ✓	1	AO1.1	**IGNORE** 'energy released' **OR** 'energy required' For dissolving, **ALLOW** forms aqueous/hydrated ions **IGNORE** ionic **OR** covalent **DO NOT ALLOW** dissolving elements **DO NOT ALLOW** response that implies formation of **1 mole** of aqueous ions
(c)	(ii)		$\underline{\text{Mg}^{2+}(aq) + 2F^-(g)}$ ✓ $\underline{\text{Mg}^{2+}(aq) + 2F^-(aq)}$ ✓	2	AO2.2 ×2	**ALLOW** $Mg^{2+}(g) + 2F^-(aq)$ **ALLOW** $MgF_2(aq)$
(c)	(iii)		−6 (kJ mol^{-1}) ✓ $\Delta_{sol}H$ (MgF$_2$) = − (−2926) + (2 × −506) + (−1920)	1	AO2.2	**1 mark ONLY**
(c)	(iv)		**Ionic radius** Halide **ion** gets larger down the group ✓ **Lattice enthalpy** Lattice enthalpy is less exothermic down group **OR** halide ion has less attraction for Mg^{2+} ✓ **Hydration enthalpy** Hydration enthalpy is less exothermic down group **OR** halide ion has less attraction for H$_2$O ✓ **Enthalpy of solution** Difficult to predict whether lattice enthalpy or hydration enthalpy has bigger effect ✓	4	AO1.2 ×3 AO3.2	**ALLOW ORA** throughout **ALLOW** ions closer together in MgF$_2$ **OR** further apart in MgI$_2$ **DO NOT ALLOW** atomic radius **ALLOW** MgI$_2$ is less exothermic than MgF$_2$ for LE and hydration enthalpy -as trend 'down the group'. **ALLOW** less negative/more positive **BUT** **IGNORE** is smaller/less
			Total	14		

Question			Answer	Marks	AO element	Guidance

17	(a)		**_Transition element:_**
			Has an **ion** with an incomplete/partially-filled d **sub-shell/d-orbital** ✓
			
			d-block
			d **sub-shell/d-orbital** is being filled/has highest energy
			OR
			Electron configurations shown for
			    Sc: $1s^22s^22p^63s^23p^63d^14s^2$
			    AND
			     Zn:$1s^22s^22p^63s^23p^63d^{10}4s^2$ ✓
			
			Electron configurations of ions
			Sc^{3+}: $1s^22s^22p^63s^23p^6$
			AND
			d **sub-shell empty / d orbital(s) empty** ✓
			
			Zn^{2+}: $1s^22s^22p^63s^23p^63d^{10}$
			AND
			 d **sub-shell full / d-orbitals full** ✓
				4	AO1.1
					×4
						**FULL ANNOTATIONS MUST BE USED**
						--- 	
						DO NOT ALLOW d shell
						
						IGNORE d block
						
						IGNORE outer electron
						
						electron configurations
						    ALLOW $4s^0$
						    ALLOW $4s^2$ before 3d, i.e....... $4s^23d^1$; $4s^23d^{10}$
						    IGNORE other Sc and Zn ions
						
						ALLOW ECF for short hand notation**.**
						
						For Sc^{3+}, **ALLOW** Sc^{+3} **OR** Sc forms a 3+ ion;
						
						For Zn^{2+}, **ALLOW** Zn^{+2} **OR** Zn forms a 2+ ion;

	(b)	(i)	**Donates two** electron **pairs** (to a metal ion) **AND** forms **two** coordinate **bonds** (to a metal ion) ✓	1	AO1.1 x1	**ALLOW** lone pairs for electron pairs **ALLOW** dative (covalent) bonds for coordinate bonds **TWO** is only needed once if bonds are plural, e.g. **Donates 2** electron **pairs** to form coordinate **bonds** **Donates** electron **pairs** to form **2** coordinate **bonds**

Question			Answer	Marks	AO element	Guidance
		(ii)*	*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.*	6		**Indicative scientific points:**
			Level 3 (5–6 marks) Reaches a comprehensive conclusion with most detail and few errors to obtain: the formulae of **A** and **B** **AND** ionic equation for ligand substitution **AND** the 3D structures of **B** stereoisomers *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.*		AO2.2 ×2	**1. Formula of the hydrated salt A** **Formula of A**: $Cr_2H_{24}O_{24}S_3$ *Example of working* $$\begin{array}{ccccccc} Cr & : & H & : & O & : & S \\ \underline{17.10} & : & \underline{3.94} & : & \underline{63.13} & : & \underline{15.83} \\ 52.0 & & 1.0 & & 16.0 & & 32.1 \end{array}$$
			Level 2 (3–4 marks) Reaches a sound conclusion with some detail and some errors for the formula of **A OR B** **AND** ionic equation for ligand substitution **OR** the 3D structures of **B** stereoisomers *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*		AO2.6 ×2 AO3.1 ×2	*There may be other methods* *Detail Hydrated salt = $Cr_2(SO_4)_3 \bullet 12H_2O$* **2. Formula of B and ionic equation** **Formula of B**: $[Cr(H_2O)_2(C_2O_4)_2]^-$ **Ionic equation** $[Cr(H_2O)_6]^{3+} + 2C_2O_4^{2-} \rightarrow [Cr(H_2O)_2(C_2O_4)_2]^- + 4H_2O$
			Level 1 (1–2 marks) Obtains the correct formula of **A OR B OR** 3D structures of **B** stereoisomers which are mostly correct. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** No response or no response worthy of credit.			**ALLOW** ligands in any order, e.g. $[Cr(C_2O_4)_2(H_2O)_2]^-$ *Detail Use of charges and brackets* **3. 3D structures of B stereoisomers**

Question			Answer	Marks	AO element	Guidance
						• Consistent use of 2 'out wedges', 2 'in wedges', 2 lines in plane of paper **OR** 4 lines, 1 'out wedge' and 1 'in wedge' **ALLOW** following orientations *Detail* • Most bonding shown from Cr to O of H_2O and O^- $C_2O_4^{2-}$
			Total	**11**		
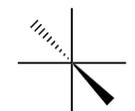
Question			Answer	Marks	AO element	Guidance
18	(a)		Formula: $CuCO_3$ ✓ $CuCO_3 + 2HNO_3 \rightarrow Cu(NO_3)_2 + CO_2 + H_2O$ ✓	2	AO1.2 AO2.6	**IGNORE state symbols** **ALLOW** formula within equation. **ALLOW** other copper(II) compounds which can react with nitric acid to form a gas e.g. CuS, $CuSO_3$ for mark 1, with correct equation for mark 2. e.g. $CuSO_3 + 2HNO_3 \rightarrow Cu(NO_3)_2 + SO_2 + H_2O$
	(b)		$2Cu^{2+}(aq) + 4I^-(aq) \rightarrow 2CuI(s) + I_2(aq)$ ✓	1	AO2.6	**ALLOW** multiples State symbols are required
	(c)		starch (solution) **AND** blue-black to colourless ✓	1	AO1.2	**ALLOW** blue **OR** black **OR** purple for colour of mixture **ALLOW** blue colour disappears (to colourless) **IGNORE** 'clear' **IGNORE** 'colorimetry
	(d)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1.35 award 4 marks** - $n(S_2O_3{}^{2-}) = 0.0200 \times \dfrac{20.00}{1000}$ $= 5.31 \times 10^{-4}$ (mol) ✓ $n(I_2) = 2.655 \times 10^{-4}$ **OR** $n(Cu^{2+}) = 5.31 \times 10^{-4}$ (mol) ✓ $m(Cu/Cu^{2+})$ in ore $= 63.5 \times 5.31 \times 10^{-4}$ $= 0.0337.....$ (g) ✓ percentage $= \dfrac{0.0337....}{2.50} \times 100$ $= 1.35$ (%) ✓ (**3SF** required)	4	AO2.8 ×5	***FULL ANNOTATIONS MUST BE USED*** --- **ALLOW ECF** throughout If 1:2 ratio for I_2:Cu^{2+} not used check ratio in b) and allow **ECF** **IGNORE** rounding errors after 3 SF Calculator: 0.0337185 **ALLOW** 3 SF (0.0337) up to calculator value **ECF** dependent on the use of a calculated mass of Cu/Cu^{2+}

Question			Answer	Marks	AO element	Guidance
	(e)	(i)	Lower **AND** smaller titre ✓	1	AO3.4	**ALLOW** less I_2 produced / less Cu^{2+} reacts
		(ii)	The same **AND** burette measures by difference ✓	1	AO3.4	**ALLOW AW**
	(f)		Any two of the following: Make up a (standard solution) from Step 2 to a stated volume (e.g. 250 cm^3) **OR** Repeat titrations **AND** Take mean of concordant/closest titres/ identify anomalies **OR** lower $[S_2O_3]^{2-}$ to increase titre volume (to reduce the percentage error). **OR** higher $[S_2O_3]^{2-}$ so not to refill the burette. **OR** Use a 3 dec place balance (to reduce the percentage error).	2	AO3.4 x 2	
			Total	12		

Question			Answer	Marks	AO element	Guidance
19	(a)	(i)	**Complete** circuit with voltmeter **AND** labelled salt bridge linking two half-cells ✓ Cr electrode in Cr^{3+} ✓ Pt electrode in MnO_4^- **AND** H^+ **AND** Mn^{2+} ✓	3	AO1.2 ×3	Half cells can be drawn in either order Half cells must show electrodes dipping into solutions **ALLOW** small gaps in circuit **IGNORE** any stated concentrations **IGNORE** state symbols In salt bridge, **ALLOW** any stated ion that may be present, e.g. Cr^{3+}, MnO_4^-, Mn^{2+}, H^+
	(a)	(ii)	$5Cr + 3MnO_4^- + 24H^+ \rightarrow 5Cr^{3+} + 3Mn^{2+} + 12H_2O$ ✓	1	AO2.6	**IGNORE** state symbols **ALLOW** multiples
	(b)	(i)	Mn is oxidised from +6 (in MnO_4^{2-}) to +7 (in MnO_4^-) ✓ Mn is reduced from +6 (in MnO_4^{2-}) to +4 (in MnO_2) ✓	2	AO2.1 ×2	**IGNORE** '6' (signs required) **ALLOW** after number, e.g. 5+ **ALLOW** 1 mark for correct oxidation numbers but not linked to oxidation/reduction. **IGNORE** any reference to electron loss/gain (even if wrong)

Question			Answer	Marks	AO element	Guidance

	(b)	(ii)	*Explanation using E^o values*
			(E^o of) system **3** (MnO_4^-/MnO_4^{2-}) is
			    less positive / more negative than system **5**
			    (MnO_4^{2-}/MnO_2)✓
			
			Equilibrium shift related to E^o values
			    system **3** (MnO_4^-/MnO_4^{2-}) shifts left
			    AND
			    system **5** (MnO_4^{2-}/MnO_2) shifts right ✓
				2	AO3.1
					×2
						IGNORE 'lower/higher'
						ALLOW reverse argument:
						System 5 more positive than system 3, etc
						Must be comparative
						ALLOW response in terms of E_{cell}
						$E = (+)1.14$ V for system 5 – system 3
						
						Shift dependent on systems 3 and 5 correctly identified

	(c)	(i)	$H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$ ✓	1	AO2.6	**ALLOW** multiples **ALLOW** $H_2 + 2OH^- - 2e^- \rightarrow 2H_2O$ **ALLOW** equation with equilibrium sign
	(c)	(ii)	$(0.40 - 1.23 =) -0.83$ (V) ✓	1	AO1.2	
	(c)	(iii)	Fuel reacts with oxygen/oxidant to give **electrical energy/voltage** ✓	1	AO1.1	**ALLOW** named fuel. e.g. hydrogen/H_2; ethanol; methanol, etc **ALLOW** fuel cell requires <u>continuous</u> supply of fuel **AND** oxygen/an oxidant **OR** fuel cell operates <u>continuously</u> as long as a fuel **AND** oxygen/an oxidant are added **IGNORE** 'reactants' 'products' and comments about pollution and efficiency
			Total	11		

Question			Answer	Marks	AO element	Guidance
20	(a)		rate of forwards reaction = rate of backwards reaction OR concentrations/pressure/temperature are constant /do not change ✓	1	AO1.1	DO NOT ALLOW "are the same"
	(b)	(i)	$\Delta G = \Delta H - T\Delta S = -114 - (298 \times -0.147)$ ✓ $= -70.194$ (kJ mol^{-1}) AND statement of $\Delta G < 0$ OR ΔG is –ve OR $\Delta H < T\Delta S$ ✓	2	AO2.2 ×2	ALLOW $-114000 - (298 \times -147)$ ALLOW -70 up to calculator value of -70.194 correctly rounded, i.e. -70 OR -70.2 OR -70.19 ALLOW -70000 up to -70194 (J mol^{-1}) ALLOW ECF for an incorrectly calculated negative value of ΔG linked to feasibility statement IGNORE rounding after 3 SF ORA for comment about – sign required for feasibility
	(b)	(ii)	776 (K) ✓ i.e. Maximum temperature $= \dfrac{\Delta H}{\Delta S} = \dfrac{-114}{-0.147} = 776$ (K) 3 SF required (appropriate from supplied data)	1	AO2.2	

Question			Answer	Marks	AO element	Guidance

	(c)	(i)	**FIRST, CHECK FOR VALUE OF K_p.**
			IF answer = 20.7 (MPa^{-1}), award **4 marks**
			--- 	
			Equilibrium amounts
			    $n(NO) = 0.4$ (mol)
			    AND $n(O_2) = 0.9$ (mol)
			    AND $n(NO_2) = 1.2$ (mol) ✓
			
			Total moles at equilibrium
			    $n_{tot} = 2.5$(mol) ✓
			
			Partial pressures
			    $p(NO) = \dfrac{0.4}{2.5} \times 1.21 = 0.1936$ (MPa)
			    AND $p(O_2) = \dfrac{0.9}{2.5} \times 1.21 = 0.4356$ (MPa)
			    AND $p(NO_2) = \dfrac{1.2}{2.5} \times 1.21 = 0.5808$ (MPa) ✓
			
			K_p *value*
			    $K_p = \dfrac{0.5808^2}{0.1936^2 \times 0.4356} = $ 20.7 **to 3 SF** (MPa^{-1}) ✓
				4	AO2.4 ×4	***FULL ANNOTATIONS MUST BE USED***
						--- 	
						ALLOW ECF throughout
						
						ALLOW 20.6 from 3 SF partial pressures, 0.194, 0.436 and 0.581
						
						IF there is an alternative answer, check to see if there is any **ECF** credit possible using working below
						--- 	
						
						Look for values to 3 SF here:
						0.194, 0.436 and 0.581
						
						ALLOW
						25.0 as ECF (from omission of partial pressures for **3 marks)**

Question			Answer				Marks	AO element	Guidance
(c)	(ii)						3	AO1.2 ×3	Mark by **COLUMN**

Change	K_p	Equilibrium amount of NO$_2$	Initial rate
Temperature increased	smaller	smaller	greater
Pressure increase	same	greater	greater
Catalyst added	same	same	greater
	✓	✓	✓

Guidance for (c)(ii): **ALLOW** obvious alternatives for greater/smaller/same, e.g. increases/decreases/ more/less

| | | | Total | | | | 11 | | |

Question			Answer	Marks	AO element	Guidance

21	(a)	(i)	*(Expt 1 and 2)*
			  $[S_2O_3^{2-}]$ halves, ($[H^+]$ constant),
			  AND rate halves
			  AND first order (with respect to $[S_2O_3^{2-}]$)✓
			
			(Expt 2 and 3)
			  $[S_2O_3^{2-}]$ quarter **AND** $[H^+]$ halves,
			  AND rate quarters
			  AND zero order (with respect to $[H^+]$)✓
				2	AO3.1
					×2
						ALLOW ORA i.e.
						(Expt 2 and 1)
						  $[S_2O_3^{2-}]$ doubles, ($[H^+]$ constant),
						  AND rate doubles
						AND first order with respect to $[S_2O_3^{2-}]$
						
						ALLOW comparison of Expt 1 and 3:
						  $[S_2O_3^{2-}] \times 1/8$ **AND** $[H^+]$ halves,
						  AND rate $\times$ 1/8
						  AND zero order with respect to $[H^+]$

	(a)	(ii)	$S_2O_3^{2-}$ as only reactant species in step 1 ✓ Rest of mechanism correct ✓	2	AO3.2 ×2	Step 1: $S_2O_3^{2-} \rightarrow S + SO_3^{2-}$ Step 2 $SO_3^{2-} + 2H^+ \rightarrow SO_2 + H_2O$ **OR** Step 1 $S_2O_3^{2-} \rightarrow SO_2 + SO^{2-}$ Step 2 $SO^{2-} + 2H^+ \rightarrow S + H_2O$ **Check with Team Leader for other equations**

	(b)	(i)	**Gradient**
			  gradient in range of -5700 to -6100✓
			
			***E*ₐ calculation**
			  $E_a = (-)$ gradient $\times$ 8.314
			  e.g. from -5900, $E_a = (+)$ 49052.6 (J mol⁻¹) ✓
			
			  E_a to **3SF** and in kJ mol⁻¹ ✓
			  e.g. 49.1 (kJ mol⁻¹)
				3	AO2.8
					×3
						FULL ANNOTATIONS MUST BE USED
						--- 	
						Marks are for intermediate calculations
						
						ALLOW ECF from an incorrect gradient
						
						ALLOW ECF on missing $\times\ 10^{-3}$,
						e.g. **ALLOW** 2 marks for:
						  gradient $= -5.9$,
						  leading to $E_a = 49.0526$ (J mol⁻¹)
						  AND 0.0491 (kJ mol⁻¹)
						
						DO NOT ALLOW a negative E_a

Question			Answer	Marks	AO element	Guidance
	(b)	(ii)	ln A is intercept at 0 when $1/T$ **OR** x axis is 0 ✓	1	AO3.2	
		(iii)	*ln k* $\quad$ ln $k = -2.59$ ✓ *Temperature* $\quad 1/T = 3.10 \times 10^{-3}$ (s^{-1}) $\quad T = 49.6\ ^oC$ ✓	2	AO3.1 AO3.2	Correct T scores 2 marks **ALLOW ECF** for 1/T from incorrect lnK **shown on the graph** **ALLOW in the range** $1/T = 3.09 - 3.11$ ($\times 10^{-3}$ s^{-1}) T = 48.5 to 50.6 ^oC **ALLOW** $T = 50\ ^oC$
			Total	10		

Question			Answer	Marks	AO element	Guidance
22	(a)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 13.15 award 2 marks** --- $[H+] = \dfrac{1.00 \times 10^{-14}}{0.140} = 7.14..... \times 10^{-14}$ (mol) ✓ $pH = -\log(7.14..... \times 10^{-14}) = 13.15$ ✓ **2 DP** required	2	AO2.2 ×2	**ALLOW ECF** providing pH>7 Calculator: $7.142857143 \times 10^{-14}$ **ALLOW** pOH method $pOH = -\log(0.14) = 0.85.........$ ✓ $pH = 14.00 - (0.85......) = 13.15$ ✓
	(b)	(i)	$n(H_2SO_4) = 1.60 \times \dfrac{25.0}{1000} = 0.04(00)$ (mol) **AND** $n(NaOH) = 1.50 \times \dfrac{55.0}{1000} = 0.0825$ (mol) ✓ 0.04(00) mol H_2SO_4 reacts with 0.08(00) mol NaOH **OR** 1 mol H_2SO_4 reacts with 2 mol NaOH ✓	2	AO2.2 ×2	**ALLOW** 0.0825>0.08

Question			Answer	Marks	AO element	Guidance
(b)	(ii)		$q = mc\Delta T = 80.0 \times 4.18 \times 13.0$ $= 4347.2$ (J) **OR** 4.3472 (kJ) ✓ $\Delta H_1 = (-)\dfrac{\overline{}}{0.0400} = (-)108.68$ kJ mol^{-1} ✓ $\Delta_{neut}H = (-)\dfrac{108.68}{2} = (-)54.34$ kJ mol^{-1} ✓ **– sign** for ΔH value(s) ✓	4	AO2.4 ×4	**FULL ANNOTATIONS MUST BE USED** -- **ALLOW** 3 SF up to calculated answer throughout **ALLOW ECF** from q **DO NOT ALLOW** division by n(NaOH) **ALLOW** $\Delta_{neut}H$ from ΔH_1/2 **ALLOW** alternative methods
(b)	(iii)		The same **OR** 13°C ✓ (Double the moles so) **double** the energy is spread over **double** the volume	2	AO3.1 ×2	**ALLOW** explanation that uses a calculation based on moles, volumes **ALLOW** mass for volume

Question			Answer	Marks	AO element	Guidance

(c)*			*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.*
			Level 3 (5–6 marks)
			Reaches a comprehensive conclusion with most detail and few errors for the formation of the buffer
			AND Calculation of the correct buffer pH
			AND Correct mass of N_2O_3.
			There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.
			
			Level 2 (3–4 marks)
			Reaches a sound conclusion with some detail and some errors for
			Formation of buffer **AND** Calculation of the buffer pH
			  OR
			Formation of buffer **AND** Mass of N_2O_3.
			  OR
			Calculation of the buffer pH **AND** Mass of N_2O_3.
			  OR
			Partial explanations of formation of the buffer
			AND buffer pH **AND** Mass of N_2O_3.
			There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.
			
			Level 1 (1–2 marks)
			Attempts, with some success, to:
			Describe formation of buffer **OR** Calculate buffer pH
			OR Obtain mass of N_2O_3.
			There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.
			
			0 marks No response or no response worthy of credit.
				6	AO1.2
					×2
					
					AO2.6
					×2
					
					AO3.1
					×2
						Indicative scientific points may include:
						1. Formation of buffer
						• Acid / HNO_2 is in excess
						• $HNO_2 + NaOH \rightarrow NaNO_2 + H_2O$
						• Partial neutralisation of HNO_2
						  $\rightarrow$ formation of NO_2^- / $NaNO_2$
						• Buffer contains HNO_2 **AND** NO_2^-/$NaNO_2$
						
						2. Calculation of buffer pH
						• $n(HNO_2)$ added = 0.0500 (mol)
						• $n(NaOH)$ added = 0.0150 (mol)
						• $n(NO_2^-)$ formed = 0.0150 (mol)
						• $n(HNO_2)$ remaining = 0.0500 – 0.0150 = 0.0350 (mol)
						• $K_a = 10^{-3.34} = 4.57\ldots \times 10^{-4}$ (mol dm^{-3})
						• Concentrations = mol (volume 1 dm^3)
						• $[H^+] = \dfrac{4.57\ldots \times 10^{-4} \times 0.0350}{0.0150}$
						  $= 1.0665\ldots \times 10^{-3}$ (mol dm^{-3})
						• pH = 2.97
						• pH to 2 dec places
						
						3. Calculation of mass of N_2O_3
						• 1 mol $N_2O_3 \rightarrow$ 2 mol HNO_2
						  OR $N_2O_3 + H_2O \rightarrow 2HNO_2$
						• $n(HNO_2)$ = 0.0500 (mol)
						• $n(N_2O_3)$ = 0.0500/2 = 0.0250 (mol)
						• $m(N_2O_3)$ = 0.0250 × 76 = 1.9(0) g

			Total	16		

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