

- M1.** (a) $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ 1
- octahedral
- Only allow if species has 6 ligands
but allow if M1 not given because charge missing* 1
- (b) CoCO_3 1
- Mark independently*
- Purple solid (allow pink)
- Allow pink precipitate* 1
- (c) $[\text{Co}(\text{H}_2\text{O})_6]^{2+} + 6\text{NH}_3 \rightarrow [\text{Co}(\text{NH}_3)_6]^{2+} + 6\text{H}_2\text{O}$
- Allow $[\text{Co}(\text{NH}_3)_5\text{H}_2\text{O}]^{3+}$*
- Formula of product 1
- Balanced equation 1
- (d) $[\text{Co}(\text{NH}_3)_6]^{3+}$ 1
- Allow $[\text{Co}(\text{NH}_3)_5\text{H}_2\text{O}]^{3+}$*
- Oxidising agent 1
- (e) $[\text{Co}(\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2)_3]^{2+}$ 1
- Allow use of en $[\text{Coen}_3]^{2+}$*
- Entropy change for reaction is positive
- Mark independently* 1
- Because 4 mol reactants form 7 mol products
(or increase in number of particles)

Or bidentate replaces unidentate

1



1

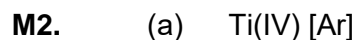
Cl⁻ ligand too big to fit more than 4 round Co²⁺

Allow Cl⁻ is bigger

Allow chlorine and Cl but NOT chlorine molecules.

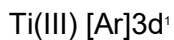
1

[13]



Or $1s^2 2s^2 2p^6 3s^2 3p^6$

1



Or $1s^2 2s^2 2p^6 3s^2 3p^6 3d^1$

1

Ti(III) has a d electron that can be excited to a higher level

Allow idea that d electrons can be excited to another level (or move between levels)

1

Absorbs one colour of light from white light

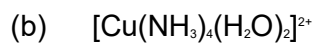
Allow idea that light is absorbed

1

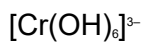
Ti(IV) has no d electron so no electron transition with energy equal to that of visible light

Allow Ti(IV) has no d electrons

1



1



1



1

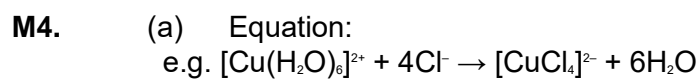
- (c) (i) Rapid determination of concentration
Or easy to get many readings 1
- Does not use up any of the reagent/does not interfere
 with the reaction
Or possible to measure very low concentrations 1
- (ii) Curve starts with small gradient (low rate) 1
- Because negative ions collide so E_a high 1
- Curve gets steeper 1
- Because autocatalyst (Mn^{2+}) formed 1
- Curve levels out approaching time axis
*Can score this mark and next one ONLY with simple curve
 (that is curve with gradually decreasing gradient)* 1
- Because MnO_4^- ions used up
5 max 1

[15]

- M3.** (a) Ligand: -
 atom, ion or molecules which can donate a pair of electrons to a metal ion. 1
- co-ordinate bond:- a covalent bond 1
- in which both electrons are donate by one atom 1

(b) (i)	Two correct complex ions	1
	Balanced equation	1
	Two correct colours	2
(ii)	Complex with a bidentate ligand	1
	Balanced equation	
	<i>NB en not allowed as a ligand unless structure also given</i>	1
	More molecules/ions formed	1
	Increase in entropy	1
	more stable complex formed	1
		Max 2
(c)	ΔE ; energy absorbed by electron, ground to excited state (QoL)	1
	h ; Planck's constant or a constant	1
	Change in	
	Oxidation state	1
	Ligand	1
	Co-ordination number	
	<i>Apply list principle to incorrect additional answers</i>	1

[16]



Species		1
Balance		1
Colours: e.g. $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ blue		1
e.g. $[\text{CuCl}_4]^{2-}$ yellow/green		1
(b) (i) ΔE : The energy absorbed		1
h: Planck's constant		1
(ii) Factor 1 Change of ligand		1
Factor 2 Change in oxidation state		1
Factor 3 Change in co-ordination number		1

[9]