Question	Marking Guidance	Mark	Comments
8(a)	Cobalt has variable oxidation states	1	Allow exists as Co(II) and Co(III)
	(It can act as an intermediate that) lowers the activation energy	1	Allow (alternative route with) lower E_a
	$CH_3CHO + 2Co^{3+} + H_2O \rightarrow CH_3COOH + 2Co^{2+} + 2H^+$	1	Allow multiples; allow molecular formulae Allow equations with H_3O^+
	$\frac{1}{2}O_2 + 2Co^{2+} + 2H^+ \rightarrow 2Co^{3+} + H_2O$	1	
8(b)(i)	$[Co(H_2O)_6]^{2+} + 3H_2NCH_2CH_2NH_2 \rightarrow [Co(H_2NCH_2CH_2NH_2)_3]^{2+} + 6H_2O$	1	Do not allow en in equation, allow $C_2H_8N_2$
	The number of particles increases / changes from 4 to 7	1	Can score M2 and M3 even if equation incorrect or missing provided number of particles increases.
	So the entropy change is positive / disorder increases / entropy increases	1	
8(b)(ii)	Minimum for **M1** is 3 bidentate ligands bonded to Co Ligands need not have any atoms shown but diagram must show 6 bonds from ligands to Co, 2 from each ligand	1	Ignore all charges for M1 and M3 but penalise charges on any ligand in M2
	Minimum for **M2** is one ligand identified as H_2N-----NH_2	1	Allow linkage as -C-C- or just a line.
	Minimum for **M3** is one bidentate ligand showing two arrows from separate nitrogens to cobalt	1	

8(c)	Moles of cobalt = (50 × 0.203)/1000 = <u>0.01015</u> mol	1	Allow 0.0101 to 0.0102
	Moles of AgCl = 4.22/143.4 = 0.0294	1	Allow 0.029 If not AgCl (eg $AgCl_2$ or $AgNO_3$), lose this mark and can only score **M1**, **M4** and **M5**
	Ratio = Cl^- to Co = 2.9 : 1	1	Do not allow 3 : 1 if this is the only answer but if 2.9:1 seen somewhere in answer credit this as **M3**
	$[Co(NH_3)_6]Cl_3$ (square brackets not essential)	1	
	Difference due to incomplete oxidation in the preparation	1	Allow incomplete reaction. Allow formation $[Co(NH_3)_5Cl]Cl_2$ etc. Some chloride ions act as ligands / replace NH_3 in complex. Do not allow 'impure sample' or reference to practical deficiencies.