5.4 TEST MS

1. (i) An atom, ion or molecule which can donate a lone electron pair 1

(ii) A central metal ion/species surrounded by co-ordinately bonded ligands 1
or ion in which co-ordination number exceeds oxidation state

(iii) The number of co-ordinate bonds formed to a central metal ion 1
or number of electron pairs donated or donor atoms

[3]

2. (a) Electron transitions/electrons excitedin d shell **(1) o**r d-d transition
Do NOT allow charge transfer

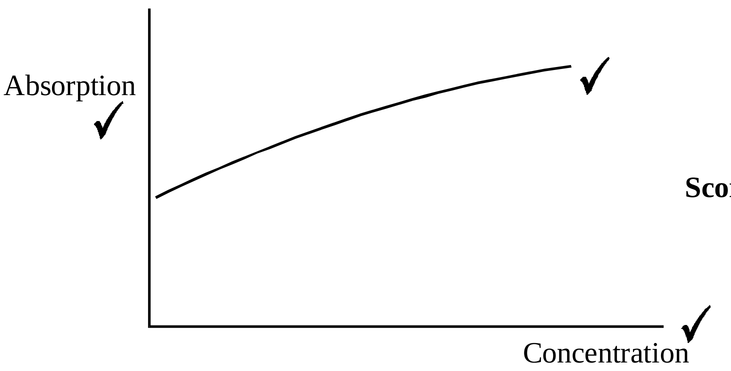
(Energy in) visible range **(1)**
(NOT emits in visible region)

2

(b) *Change 1*: (Different) oxidation states **(1)**
Change 2 : (Different) ligands **(1)**
Change 3: (Different) co-ordination number **(1)**
Do not allow shape as an answer

3

(c) Add an appropriate (or a given correct) ligand to <u>intensify colour</u> **(1)**
e.g. thiocyanate $(CNS)^{-}$ or bipyridyl
Make up solutions of known concentration **(1)**
Measure absorption or transmission **(1)**
Plot graph of results or calibration curve **(1)**
Measure absorption of unknown and **(1)**
compare
N.B.: Allow concentration statement if included in graph statement
Allow adsorption but circle the d
Also



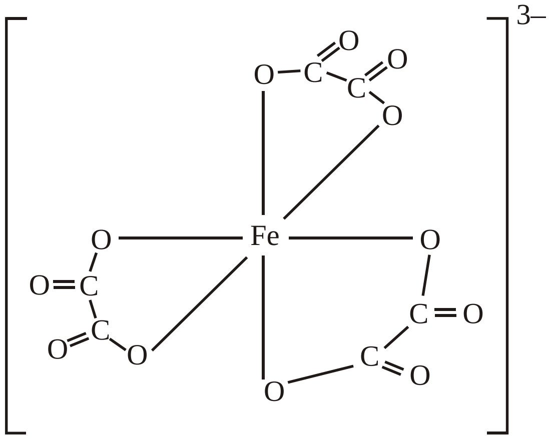
Scores 3

5

[10]

3. (a) (i) Two **(1)** lone pair donor / electron pair donor **(1)** atoms
Allow:– forms two co-ordinate bonds **(1)**
NOT atom with two lone pairs

(ii) 5



Correct ligand structure ***(1)*** ($\overset{O}{\underset{C}{\|}}$ not essential)

penalise any error

Six correct O–Fe bonds ***(1)***

Correct charge ***(1)***

N.B. Penalise the second mark if arrow from Fe shown

N.B. Ignore charges on atoms

(b) (i) $[AgCl_2]^-$ or $AgCl_2^-$ **(1)**

(ii) Chloride or Cl^- big or large or repel **(1)** 2
NOT Cl_2 or Cl^+ or Cl
Allow 'chlorine ion'

[7]

4. (a) (i) <u>H_2O_2</u> **(1)** plus NaOH **(1)**
only allow if H_2O_2 given
Alkaline H_2O_2 scores (1)
Na_2O_2 scores (2)

(ii) <u>Zn</u> **(1)** plus HCl/H_2SO_4 **(1)**
only allow if Zn given
Ignore conc
Not HNO_3

(iii) A <u>named</u> aldehyde or a correct formula clearly with an aldehyde gropup **(1)** 5
or Cu $\rightarrow$ Mg

(b) (i) *Half-equation for the oxidation of* H_2O_2

$H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-$ (or multiple) **(1)**

Half-equation for the reduction of manganate(VII) ions

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ (or multiple) **(1)**

Overall equation

$2MnO_4^- + 5H_2O_2 + 6H^+ \rightarrow 2Mn^{2+} + 5O_2 + 8H_2O$ **(1)**

only allow this or multiple

(ii) Moles MnO_4^- = mv/1000 = (2.82 to 2.83) × 10^{-4} **(1)**

Moles H_2O_2 = 2.826 × 10^{-4} × 5/2 **(1)** = (7.06 to 7.08) × 10^{-4}

mark conseq to equation in b(i)

$[H_2O_2]$ = 7.065 × 10^{-4} × 1000/20 **(1)** = (3.53 to 3.54) × 10^{-2}

Mass = moles × M_r = 3.53 × 10^{-2} × 34

= 1.2(0) **(1)** 7

Ignore units

Max 3 if ratio 2/5 used. (Final answers 0.19)

N.B. Using 3:5 ratio

Moles MnO_4^- *= (2.82 to 2.83) ×* 10^{-4} ***(1)***

Moles $[H_2O_2]$ *= 2.826 ×* 10^{-4} *× 5/3* ***(1)*** *= (470 to 472) ×* 10^{-4}

$[H_2O_2]$ *= 4.71 ×* 10^{-4} *× 1000/20* ***(1)*** *= (2.35 to 2.36) ×* 10^{-2}

Mass = 0.8(0) ***(1)*** *(i.e. 2 sig fig required)*

[12]

5. (i) (Both) ions are negative or ions repel or High E_a **(1)**

(ii) *Meaning of the term autocatalytic:* A product of the reaction acts as a catalyst **(1)**

NOT a self catalysing reaction (0)

Catalyst: Mn^{2+} or Mn^{3+} **(1)**

(iii) Mn^{2+} converted into Mn^{n+} or Mn^{2+} oxidised **(1)**

Mn^{n+}/oxidised species then <u>oxidises/reacts with $C_2O_4^{2-}$</u> **(1)** 5

[5]

6. (a) V_2O_5 or NH_4VO_3 or name **(1)**
xs **(1)** Zn **(1)** HCl or dil H_2SO_4 **(1)**
abscence of air **(1)** colours seen **(1)**
V(IV), V(III), V(II) seen **(1)** max 6

(b) speeds rate **(1)** unchanged at end **(1)**
different route/intermediate mechm **(1)**
lower AE **(1)** different phase **(1)**

contact process/SO_3 or H_2SO_4 manufacture **(1)**
$V_2O_5 + SO_2 \rightarrow V_2O_4\ (2VO_2) + SO_3$ **(1)**
$V_2O_4\ (2VO_2) + \frac{1}{2}O_2 \rightarrow SO_3$ **(1)**
$SO_2 + \frac{1}{2}\ O_2 \rightarrow SO_3$ **(1)**
change of oxidation state of
vanadium stated **(1)** max 9

[15]