5.4 QUESTIONS PART 1 MS

1. (a) *Feature 1* coloured ions **(1)**

Feature 2 variable oxidation states **(1)**

Feature 3 catalysis
complexes **(1)** max 3

(b)

Prediction for hexane	no **(1)**	
Reason	hexane no lone pairs <u>or</u> not Lewis base **(1)**	
Prediction for ethanol	yes **(1)**	
Reason	lone pairs on O <u>or</u> Lewis base **(1)**	4

[10]

2. $3d^7$ 1

[1]

3. Electrons excited / transition from ground state to excited state **(1)**
Energy absorbed from visible / light (spectrum) **(1)** 2

[2]

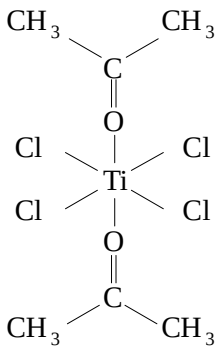
4. (a) (i) Shared or pair of electrons
Come from one atom **(1)**

(ii) TM ions can accept electron pairs **(1)**
H_2O (O) can donate pair **(1)**

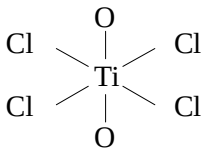
(iii) bidentate **(1)**

$NH_2CH_2CH_2NH_2$ <u>or</u> $C_2O_4^{2-}$ **(1)** 5

(b)



<u>or</u> <u>cis</u> **(2)**



scores **(1)**

irrespective of what
is bonded to O

2

[7]

5. (a) partially filled d shell **(1)** 1

(b) (i) haemoglobin or heme **(1)**

(ii) cis–platin or $Pt(NH_3)_2Cl_2$ **(1)** 2

(c) (i) complexes or catalysis **(1)**

(ii) colourless/white cpds or one common oxid^n state **(1)** 2

[5]

6. (i) multidentate **(1)**
or polydentate
hexadentate
sexadentate

(ii) moles EDTA = $36.2 \times 0.0168 \times 10^{-3}$
$= 6.08 \times 10^{-4}$ **(1)**

moles Co^{2+} = moles EDTA **(1)**

moles Co^{2+} in 1 dm^3
$= \frac{6.08 \times 10^{-4} \times 10^3}{25}$ **(1)**
= 0.0243 **(1)**

(iii)

$AgNO_3$ **(1)** weigh $\smile$ AgCl **(1)** or titrate	Na_2CO_3 **(1)** weigh $\smile$ $CoCO_3$ **(1)**	Evaporate/use oven weigh $\smile$ $CoCl_2$
NaOH **(1)** ignite ppt in air, weigh Co_2O_3.	uv-vis or colorimetry **(2)**	atomic absorption **(2)**

7

[7]

7. (a) $ls^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^1$ **(1)** 1

(b) Copper (I) has a fully filled d sub–shell **(1)**
Copper (II) has a partially filled d sub–shell **(1)** 2

[3]

8. (a) (i) Cu $3d^{10}\ 4s^1$ / $4s^1\ 3d^{10}$) **(1)**
) mark independently
$Cu^{2+}\ 3d^9$) **(1)** 2

[2]

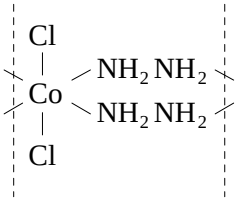
9. (a) Co^{2+} *[AR]* $3d^7$ **(1)** 1

(b) (i) 3 **(1)**

(ii) two donor atoms <u>or</u> 2 lone pairs bond **(1)**

(iii) 6 **(1)**

(iv) 1 Cl^- available <u>or</u> ionic structure **(1)**
2 Cl are covalently bonded **(1)**
<u>or</u> strongly bonded <u>or</u> complex ion stable 5

(c) 

$4NH_2$- and Cl around Co **(1)**

NH_2NH_2 bridging 2Co **(1)**

or 1 bridging and 1 chelating NH_2NH_2 2

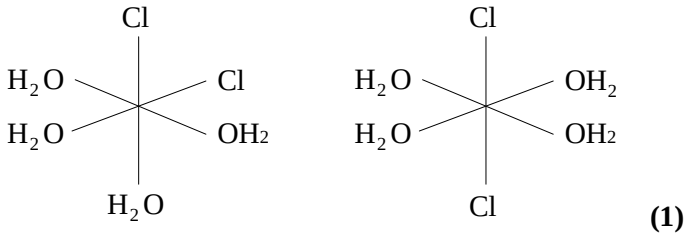
[8]

10. (a) *Feature 1* coloured ions **(1**
Feature 2 complexes **(1)**
Feature 3 catalysts **(1)** variable oxidation states **(1)**
3 × (1) 3

(b) $ZrCl_4$ **(1)** 1

[4]

11. (a) +3 **(1)**
6 **(1)** 2

(b) 

(1)

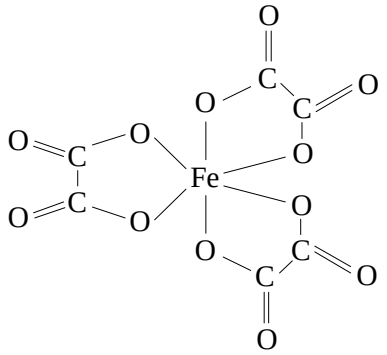
(oct^e cis/trans, ignore charge and way H_2O bonded) 1

[3]

12. (a) (i) Donates lone pairs **(1)** from two atoms **(1)**
<u>or</u> two donor atoms <u>or</u> forms two co-ordinate bonds

(ii) *Formula* $[Fe(C_2O_4)_3]^{3-}$ **(1)**

Structure



6 O linked around Fe **(1)**

$C_2O_4^{2-}$ shown correctly **(1)** 5

(b) (i) haem/haemoglobin/porphyrin **(1)**

(ii) O_2 transport **(1)** 2

[7]

13. (a) electron pair from one atom **(1)**

<u>no</u>. of atoms bonded **(1)**

<u>or</u> no. of co–ordinate bonds

<u>or</u> no. of nearest neighbours

<u>not</u> "no. of ligands" 2

(b) (i) +3 **(1)**

(ii) Cl^- not bonded to Co **(1)**
<u>or</u> ionically bonded

(iii) $[CoCl_4]^{2-}$ or $[CoCl(NH_3)_5]Cl_2$ etc **(1)**

(iv) $[Co(NH_3)_4Cl_2]Cl$ **(1)**
or $[Co(NH_3)_3Cl_3]NH_3$ 4

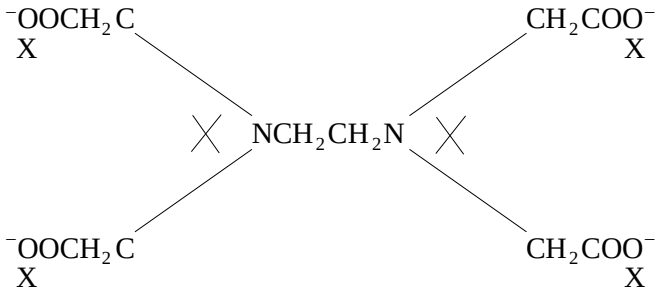
[6]

14. (a) $C_2O_4^{2-}$ or $H_2NCH_2CH_2NH_2$ **(1)** 1

(b) $[AgCl_2]^-$ or $[Ag(CN)_2]^-$ or $[Ag(NH_3)_2]^+$ **(1)** 1

[2]

15. (a)



(1) 1

(b) many atoms **(1)** donate **(1)**

or many lone pairs **(1)** forming co-ordinate bonds **(1)** 2

(c) moles EDTA = $\frac{25 \times \cdot 01}{1000}$ $= 2.5 \times 10^{-4}$ **(1)**

$= \text{moles } Cu^{2+}$ **(1)**

mass of 1 mole = $\frac{0.0624}{2.5 \times 10^{-4}}$ = 249.6 or 250 **(1)**

$CuSO_4$ = 159·5 **(1)** or 160

n H_2O = 249.6 – 159·5 = 90·1 **(1)**

$n = \frac{90 \cdot 1}{18} = 5$ **(1)**

OR moles EDTA **(1)**

$= \text{moles } Cu^{2+}$ **(1)**

$CuSO_4$ = 159.5 **(1)**

mass $CuSO_4$ = 0.0398 g **(1)**

mass H_2O = 0.0226g **(1)**

$\frac{\cdot 0398}{159.5} : \frac{\cdot 0226}{18} = 1:5$ **(1)** 6

[9]

16. (a) A shared electron pair or a covalent bond **(1)**
Both electrons from one atom **(1)**
OR when a Lewis base reacts with a Lewis acid
Mark points separately **2**

(b) Two atoms or two points of attachment **(1)**
Each donating a lone electron pair **(1)**
OR forms 2 (1) co-ordinate bonds (1)
OR donates two (1) pairs of electrons (1)

2

(c) $ClNH_3CH_2CH_2NH_3Cl$ **(1)**
OR $(NH_3CH_2CH_2NH_3)^{2+}$ $2Cl^-$
Allow $C_2H_{10}N_2Cl_2$ and $NH_3ClCH_2CH_2NH_3Cl$

1

[5]

17. (a) (i) have lone pair **(1)**

(ii) +3 **(1)**
6 **(1)**

(iii) different ligands **(1)** 4

(b) Tollen's or diammine silver(I) **(1)**
$[Ag(NH_3)_2]^+$ **(1)** 2

(c) (i) $[NiCl_4]^{2-}$ **(1)**

(ii) $[TiCl_6]^{2-}$ **(1)**

(iii) $[CuCl_2]^-$ **(1)** 3

(d) F^- smaller than Cl^- **(1)** 1

[10]

18. (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 donated by one atom 1

(b) ΔE*;* energy absorbed by electron, ground to excited state (Q o L) 1
h; Planck's constant or a constant 1
Change in

Oxidation state 1
Ligand 1
Co-ordination number 1
Apply list principle to incorrect additional answers

[8]

19. Linear complex e.g. $[Ag(NH_3)_2]^+$ **(1)**

Tetrahedral complex e.g. $[CoCl_4]^{2-}$ **(1)**

Octahedral complex e.g. $[Fe(H_2NCH_2CH_2NH_2)_3]^{3+}$ 4

*Species **(1)***
*Charge **(1)***

[4]

20. (a) octahedral $\angle$ 90° **(1)**

tetrahedral $\angle$ $109\frac{1}{2}$° **(1)**
(109–110)

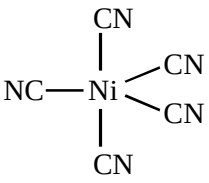
<u>oct</u> $[Ni(H_2O)_6]^{2+}$ or NiL_6^{2+} (L = NH_3 etc)
(1) $[Ni(LL)_3]^{2+}$ (L = en etc)

$[Ni(C_2O_4)_3]^{4-}$, $[Ni(EDTA)]^{2-}$

<u>tet</u> $[NiCl_4]^{2-}$ or NiX_4^{2-} (X = Br, I)
(1) 4

(b) ligand change **(1)**
oxidation state change **(1)**
co-ord^{n} no change **(1)** 3

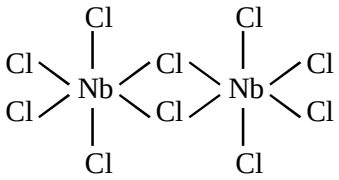
(c) (i)



trig bipy shape **(1)**
or bond angles correct

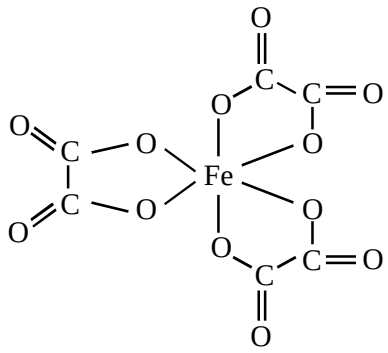
all C bonded **(1)**

(ii)



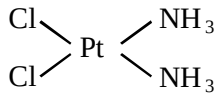
2 Cl bridges **(1)**
6 Cl round each **(1)**

(iii)



FeO_6 **(1)**
C_2O_4 correctly displayed **(1)**

(iv)



square with N bonded NH_3 **(1)**
cis Cls **(1)** 8

[15]