M1. (a) $Pt(NH_3)_2Cl_2 + H_2O \rightarrow [Pt(NH_3)_2Cl(H_2O)]^+ + Cl^-$

Correct product

1

Balanced equation

1

(b) (i) Hydrogen bond

1

Oxygen (or nitrogen)

Only score this mark if type of bond is correct

1

(ii) Co-ordinate

1

Nitrogen (or oxygen)

Bond type must be correct to score this mark but allow M2 if bond is covalent

1

(c) Killing them or causing damage (medical side effects)

Allow any correct side effect (e.g. hair loss)
Allow kills healthy (or normal) cells

1

May attach to DNA in normal cells

1

[8]

M2. (a) A shared <u>electron</u> pair or a <u>covalent</u> bond **(1)**
Both electrons from one atom **(1)**

OR when a Lewis base reacts with a Lewis acid
Mark points separately

2

(b) *Brønsted-Lowry acid*: A proton or H^+ donor **(1)**

Not H_3O^+

Lewis acid: A lone or electron pair acceptor **(1)**

2

(c) 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

(d) *Change in co-ordination number*: 6 to 4 **(1)**

Reason for change: chloride ligands are larger than water ligands **(1)**

2

OR greater repulsion between chloride ligands
DO NOT allow chlorine or Cl

(e) Same number **(1)**, and same type of bonds **(1)**, broken and made

2

(f) $ClNH_3CH_2CH_2NH_3Cl$ **(1)**

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

1

[11]

M3. (a) (i) $Fe + 2HCl \rightarrow FeCl_2 + H_2$

(allow ionic formulae)

or $Fe + 2H^+ \rightarrow Fe^{2+} + H_2$

1

(ii) PV = nRT n = PV/RT

(allow either formula but penalise contradiction)

1

$n = \frac{110000 \times 102 \times 10^{-6}}{8.31 \times 298}$

1

$= 4.53 \times 10^{-3}$ (mol)

(answer must have at least 3 sig. figs. Ignore units)

1

(iii) Moles of iron = $4.5(3) \times 10^{-3}$ mol

(allow conseq on (a)(ii))

(or = $4.2(5) \times 10^{-3}$ if candidate uses given moles of hydrogen)

1

Mass of iron = $4.53 \times 10^{-3} \times 55.8 = 0.253$ g
(mark is for method mass = moles × A_r)
(Mass of iron can be 56)

1

(iv) $0.253 \times 100/0.263 = 96.1$ % (mark is for answer to 2 sig. figs.)

(allow conseq on mass of iron. E.g. = 90% from $4.2(5) \times 10^{-3}$ moles of H_2 and Fe)

(Do not allow answers greater than or equal to 100%)

1

(b) (i) $Fe^{2+} \rightarrow Fe^{3+} + e^-$

(ignore state symbols)

1

$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

1

$Cr_2O_7^{2-} + 14H^+ + 6Fe^{2+} \rightarrow 2Cr^{3+} + 7H_2O + 6Fe^{3+}$

1

(ii) Moles of dichromate = moles $Fe^{2+}/6$
$= 4.53 \times 10^{-3}/6 = 7.55 \times 10^{-4}$

(Allow conseq, mark is for method (a)(iii)/6)

1

Volume of dichromate = moles/concentration
$(= (7.55 \times 10^{-4} \times 1000)/0.0200)$

(mark is for this method)

1

V = 37.75 (cm^3)

(allow 37.7 to 37.8, allow no units but penalise wrong units)

(allow conseq on moles of dichromate)

(if value of 3.63×10^{-3} used answer is 30.2 to 30.3, otherwise ans = moles Fe^{2+}/0.00012)

(if mole ratio wrong and candidate does not divide by 6, max score is ONE for volume method)

1

(iii) ($KMnO_4$) will also oxidise (or react with) Cl^- (or chloride or HCl)

1

[14]

M4. (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

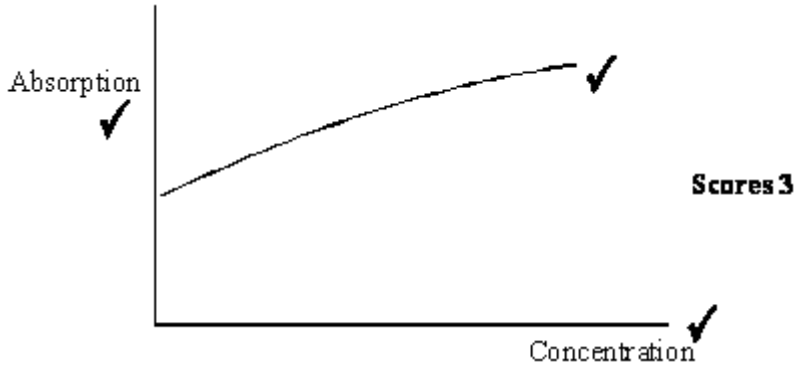
3

(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



5

[10]

M5. (a) (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 or ion in which co-ordination number exceeds oxidation state

1

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

1

(b) (i) *Allow the reverse of each substitution*

$[Co(H_2O)_6]^{2+} + 6NH_3 \rightarrow [Co(NH_3)_6]^{2+} + 6H_2O$

Complex ions

1

Balanced

1

Allow partial substitution

(ii) $[Co(H_2O)_6]^{2+} + 4Cl^- \rightarrow CoCl_4^{2-} + 6H_2O$

Complex ions

1

Balanced

or H_2O or NH_3 or $C_2O_4^{2-}$ by Cl^-

1

eg. (iii) $[Co(H_2O)_6]^{2+} + 3C_2O_4^{2-} \rightarrow [Co(C_2O_4)_3]^{4-} + 6H_2O$

Complex ions

1

Balanced

1

Allow all substitution except
(i) NH_3 by H_2O
(ii) more than $2Cl^-$ substituted for NH_3 or H_2O

eg. (iv) $[Co(H_2O)_6]^{2+} + EDTA^{4-} \rightarrow [Co(EDTA)]^{2-} + 6H_2O$

Complex ions

1

Balanced

or H_2O or NH_3 by $C_2O_4^{2-}$ and NH_3 or Cl^- by $EDTA^{4-}$

1

(c) (i) $[Fe(H_2O)_6]^{2+}$

1

(ii) $Fe(OH)_2$ or $Fe(OH)_2(H_2O)_x$ where x = 0 to 4

1

(iii) Fe^{2+} is oxidised to Fe^{3+} or $Fe(OH)_3$

1

By oxygen in the air

1

[15]

M6.B

[1]