

1. (a)(i) voltage/PD (1)
- of a cell when the electrode is **connected** to a reference electrode/  
hydrogen electrode (1)
- under standard conditions/one of standard conditions specified (1) [3]
- (ii) argument based on iron being the more negative system/  
based on iron releasing electrons/ argument based on dichromate(VI)  
being more positive/ based on dichromate(VI) accepting electrons [1]
- (iii)  $14\text{H}^+ + 6\text{Fe}^{2+} + \text{Cr}_2\text{O}_7^{2-} \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O} + 6\text{Fe}^{3+}$
- species on correct sides (1)
- balancing (1) [2]
- (b) green/yellow (1)
- red and blue absorbed (1) [2]
- (c) orbitals split 2 and 3 (1)
- 2 above 3 (1) [2]

[Total: 10]

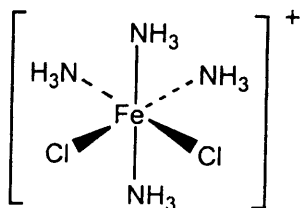
2. (a) zinc (1) [1]
- (b)(i)  $4.46 \times 10^{-3}$  (mol) [1]
- (ii)  $2.23 \times 10^{-3}$  (mol) [1]
- (iii)  $4.46 \times 10^{-3}$  (mol) [1]
- (iv) 0.283 g (1) [2]
- 56.6% (1)
- (c)(i) from brown/yellow (1) [2]
- to colourless/white (1)
- (ii) change blue to colourless more distinct [1]
- (d) any eg bronze/cupronickel (1) [2]
- relevant use eg statues/coins/medals (1)

[Total: 11]

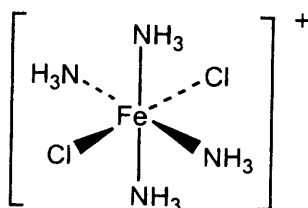
3. (a)(i)  $[\text{Fe}(\text{NH}_3)_4\text{Cl}_2]^+$  [1]

(ii) octahedral shape – clearly 3D(1)

cis and trans forms drawn (1)



cis with  $2\text{Cl}^-$  at  $90^\circ$



trans with  $2\text{Cl}^-$  at  $180^\circ$

labelling (1)

[3]

(iii) 6

[1]

(b) anti cancer drug (1)

destroys cell DNA (1)

[2]

[Total: 7]

4. (a) +5 [1]
- (b) yellow (to green) to blue to mauve/purple all correct (2)/ 3 correct (1)  
reaction is reduction (1)  
oxidation states are +5 to +4 to +3 to +2 (1)  
explanation based on use of SEPs (1)  
not reduced to vanadium 0 (1)  
effervescence (1)  
any correct redox equation (1) [7 max]
- (c) catalyst (1)  
acts by changing oxidation state (1) [2]

[Total: 10]

5. most common oxidation states are +2 and +3 (1)

+2 is more stable than +3 (1)

stable aqueous ion is  $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$  (1)

this complex is pink (1)

$[\text{CoCl}_4]^{2-}$  (1)

this complex is blue (1)

+3 oxidation stabilised by complexing with ammonia (1)

$[\text{Co}(\text{NH}_3)_6]^{3+}$  (1)

QWC [1]

[8] Max [6]

plus QWC [1]

[Total: [7]