



RECOGNISING ACHIEVEMENT

TRANSITION ELEMENTS

Mark Scheme 2815/06

June 2003



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- 1 (a) Diagram to show  
 Cu in  $\text{Cu}^{2+}$  (1)  
 1 mol  $\text{dm}^{-3}$  solution for  $\text{Cu}^{2+}$  (1)  
 298K (1)  
 salt bridge (1)  
 named reference electrode, if hydrogen used, must show  $\text{H}^+$  and  $\text{H}_2$  (1)  
 measure voltage, diagram must show complete circuit including voltmeter (1)  
 comment on how SEP relates to voltage measured/ SEP of hydrogen is 0 (1)  
[6max]
- (b)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$  /  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$  (1)  
 $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$  (1)  
 $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$  (1) [3]
- (c)  $\text{Cu}^{2+}$  coloured because  
 has vacant d-orbital (1)  
 (colour due to) electron promotion/ excitation (1)  
 energy is absorbed (1)  
 in visible part of spectrum (1) (1)  
 colour seen is complementary or described (1)  
 $\text{Cu}^+$  not coloured because has a full d-subshell (1) [5max]  
 QWC: correct use of two of the terms electron promotion/excitation, d-orbital,  
 complementary colour(1) [1]

[Total: 15]

- 2 (a)(i) (+)3/ 3+/III (1) [1]
- (ii) 3D sketch to show  
tetrahedral (1)  
square planar (1) [2]
- (iii) purple (1)  
green absorbed/ blue and red reflected (1) [2]
- (b)(i) has a lone/unbonded pair (1)  
that it donates to a metal (ion)/ that it donates to a central ion/ that it uses to  
form a dative covalent bond with a metal (1) [2]
- (ii) ligand that can donate two lone pairs/ that can form two bonds (1) [1]
- (c)(i) mirror image drawn (1) [1]
- (ii) optical (1)  
non-superimposable mirror images/ cannot be superimposed (1) [2]

[Total: 11]

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- 3 (a) SEP used to explain feasibility eg more negative releases electrons/  
use of SEP to explain which equation is reversed and then added/ cell  
potential is + 0.37(V) (1) [1]
- (b) involves both oxidation and reduction (1)  
of the same species/ use of  $\text{Cu}^+$  or named example (1) [2]
- (c) making into solids/ insoluble compounds/ forming complexes NOT named  
compound (1) [1]
- (d)(i) formula  $\text{CuI}$ /  $\text{Cu}_2\text{I}_2$  (1)  
equation complete and balanced (1) [2]
- (ii) blue (solution) at start (1)  
white solid is  $\text{CuI}$ / copper iodide (1)  
iodine is brown (1) [3]
- (e) any sensible use of copper as metal and a valid reason for its use in this case  
examples include: electrical wiring because it conducts electricity/is  
ductile  
pans because it conducts heat  
water pipes because it does not corrode/is not  
poisonous/ can be bent NOT conducts heat  
decorative purposes because it does not corrode/  
because it corrodes to attractive colour (1) [1]

[Total: 10]

- 4 (a)(i)  $2 \times 10^{-3}$  (1) [1]  
(ii)  $6 \times 10^{-3}$  (1) [1]  
(iii) 3 ecf possible from (i) and (ii) [1]  
(iv)  $1 \times 3 \times 2 = 3 \times$  change in oxidation state of manganese/ evidence of calculation (1)

final oxidation state of manganese = +4 (1) ecf possible

answer alone = 1 [2]

- (b) not oxidation/reduction/redox/ statement is not valid BUT must have attempt at explanation (1)

yellow is  $\text{CrO}_4^{2-}$ / chromate (1)

equilibrium is  $\text{Cr}_2\text{O}_7^{2-} + \text{H}_2\text{O} \rightleftharpoons 2\text{CrO}_4^{2-} + 2\text{H}^+$  / other correctly balanced equations(1)

chromate is in oxidation state 6 (1)

comment on movement of equilibrium with change in pH (1) [4max]

[Total: 9]