

- 1 (a) Diagram to show
 Cu in Cu^{2+} (1)
 1 mol dm^{-3} solution for Cu^{2+} (1)
 298K (1)
 salt bridge (1)
 named reference electrode, if hydrogen used, must show H^+ and 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) 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)
 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]

- 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 Cu^+ or named example (1) [2]
- (c) making into solids/ insoluble compounds/ forming complexes NOT named
compound (1) [1]
- (d)(i) formula CuI / Cu_2I_2 (1)
equation complete and balanced (1) [2]
- (ii) blue (solution) at start (1)
white solid is 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) 2×10^{-3} (1) [1]
- (ii) 6×10^{-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 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]