1(a) name of metal or compound and its use (3)

examples **include**

vanadium(V) oxide as a catalyst in the contact process

nickel as a catalyst in hydrogenation of oils

iron as a catalyst in the Haber process

cobalt in stainless steel/ for hardening steel

copper in brass/bronze/coinage metals/electrical wiring [3]

(b) statement that the ion involved is copper(I) (1)

$2Cu^{+} \rightarrow Cu^{2+} + Cu$ (1)

in disproportionation the same species is both oxidised and reduced (1)

copper in oxidation state +1 goes to copper in oxidation state +2 and oxidation state 0 (1) [4]

[Total:7]

2(a) labels on diagram to show

Ni(s) and $Ni^{2+}(aq)$ (1)

salt bridge and suitable circuit (1)

platinum electrode (1)

I_2 and I^- (1)

concentration of 1 mol dm^{-3} for at least one solution/ 298K (1) [5]

(b)(i) 0.79V (1) [1]

(ii) $Ni \rightarrow Ni^{2+} + 2e^-$ (1)

$I_2 + 2e^- \rightarrow 2I^-$ (1) [2]

(iii) $Ni + I_2 \rightarrow Ni^{2+} + 2I^-$ (1) [1]

(iv) from nickel towards iodine since nickel half-cell standard electrode potential is more negative (1) [1]

[Total: 10]

3(a) prepare mixtures by mixing stated volumes (1)

place mixture in colorimeter (1)

read absorbance/transmittance (1) [3]

(b) straight lines drawn and extrapolated to cross (1)

volume Ni^{2+} for maximum absorbance = 1.42 cm^3 (1)

in complex ratio NH_3: $Ni^{2+} = \frac{8.58}{1.42} = 6$ (1) allow ecf

formula is $[Ni(NH_3)_6]^{2+}$ (1) [4]

(c) blue/ blue-green (1)

red end of spectrum absorbed (1) [2]

[Total: 9]

4 (a) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$ / $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$ (1)

$1s^2 2s^2 2p^6 3s^2 3p^6$ (1) [2]

(b) colour due to energy being absorbed (1)

when electrons are promoted (1)

energy lies within visible part of spectrum/ complementary colour seen (1)

E = hf (1)

transition metal ions have incomplete d shells (1)

d sub-shell split into 2 energy levels (1)

titanium(IV) has no d electrons (1) [6 max]

QWC for use of scientific language

account to include at least 2 of
electron excitation
energy absorption
complementary colour
d shell/ d sub-shell (1) [1]

[Total:9]

5(a) Mr of $KCr(SO_4)_2 = 283$ (1)

$KCr(SO_4)_2 : H_2O = \frac{0.98}{283} : \frac{0.75}{18}$ (1)

$= 0.00346 : 0.0417 = 1 : 12$ (1)

other valid methods credited [3]

(b)(i) 3D diagram to show octahedral shape (1)

bond angle marked as 90^o (1) [2]

(ii) octahedron/ octahedral (1) [1]

(c)(i) $[Cr(H_2O)_4Cl_2]^+$ (1) [1]

(ii) cis isomer drawn (1)

trans isomer drawn (1)

correct labels cis and trans (1) [3]

[Total: 10]