

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

examples **include**

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

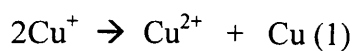
nickel as a catalyst in hydrogenation of oils

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)



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 Ni²⁺(aq) (1)

salt bridge and suitable circuit (1)

platinum electrode (1)

I₂ 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 → Ni²⁺ + 2e⁻ (1)

I₂ + 2e⁻ → 2I⁻ (1) [2]

(iii) Ni + I₂ → Ni²⁺ + 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 $\text{NH}_3 : \text{Ni}^{2+} = \frac{8.58}{1.42} = 6$ (1) allow ecf
formula is $[\text{Ni}(\text{NH}_3)_6]^{2+}$ (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 $\text{KCr}(\text{SO}_4)_2 = 283$ (1)
- $$\text{KCr}(\text{SO}_4)_2 : \text{H}_2\text{O} = \frac{0.98}{283} : \frac{0.75}{18} \text{ (1)}$$
- $$= 0.00346 : 0.0417 = 1 : 12 \text{ (1)}$$
- other valid methods credited [3]
- (b)(i) 3D diagram to show octahedral shape (1)
- bond angle marked as 90° (1) [2]
- (ii) octahedron/ octahedral (1) [1]
- (c)(i) $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]^+$ (1) [1]
- (ii) cis isomer drawn (1)
- trans isomer drawn (1)
- correct labels cis and trans (1) [3]

[Total: 10]