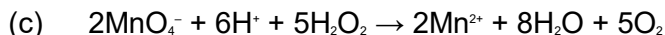


- M1.** (a) (i) Ammonia
If reagent is missing or incorrect cannot score M3 1
- Starts as a pink (solution) 1
- Changes to a yellow/straw (solution)
Allow pale brown
Do not allow reference to a precipitate 1
- (ii) (dark) brown
Do not allow pale/straw/yellow-brown (i.e. these and other shades except for dark brown) 1
- (b) (i) Ruby/red-blue/purple/violet/green
Do not allow red or blue
If ppt mentioned contradiction/CE =0 1
- Green
If ppt mentioned contradiction/CE =0 1
- $[\text{Cr}(\text{H}_2\text{O})_6]^{3+} + 6\text{OH}^- \rightarrow [\text{Cr}(\text{OH})_6]^{3-} + 6\text{H}_2\text{O}$ 1
- Formula of product
Can score this mark in (b) (ii) 1
- (ii) $\text{H}_2\text{O}_2 + 2\text{e}^- \rightarrow 2\text{OH}^-$ 1
- $2[\text{Cr}(\text{OH})_6]^{3+} + 3\text{H}_2\text{O}_2 \rightarrow 2\text{CrO}_4^{2-} + 8\text{H}_2\text{O} + 2\text{OH}^-$
Allow 1 mark out of 2 for a balanced half-equation such as
Cr(III) \rightarrow Cr(VI) + 3e⁻
or Cr³⁺ + 4H₂O \rightarrow CrO₄²⁻ + 8H⁺ + 3e⁻ etc
also for 2Cr(III) + 3H₂O₂ \rightarrow 2CrO₄²⁻ (unbalanced) 2
- Yellow

Do not allow orange

1



if no equation and uses given ratio can score M2, M3, M4 & M5

1

Moles $\text{MnO}_4^- = (24.35/1000) \times 0.0187 = \underline{4.55 \times 10^{-4}}$

Note value must be quoted to at least 3 sig. figs.

M2 is for 4.55×10^{-4}

1

Moles $\text{H}_2\text{O}_2 = (4.55 \times 10^{-4}) \times \underline{5/2} = 1.138 \times 10^{-3}$

M3 is for $\times 5/2$ (or $7/3$)

Mark consequential on molar ratio from candidate's equation

1

Moles H_2O_2 in 5 cm^3 original

M4 is for $\times 10$

1

$= (1.138 \times 10^{-3}) \times \underline{10} = 0.01138$

Original $[\text{H}_2\text{O}_2] = 0.01138 \times \underline{(1000/5)} = 2.28 \text{ mol dm}^{-3}$

(allow 2.25-2.30)

M5 is for consequentially correct answer from (answer to mark 4) $\times (1000/5)$

Note an answer of between 2.25 and 2.30 is worth 4 marks)

If candidate uses given ratio 3/7 max 4 marks:

M1: Moles of $\text{MnO}_4^- = \underline{4.55 \times 10^{-4}}$

M2: Moles $\text{H}_2\text{O}_2 = (4.55 \times 10^{-4}) \times \underline{7/3} = 1.0617 \times 10^{-3}$

M3: Moles H_2O_2 in 5 cm^3 original

$= (1.0617 \times 10^{-3}) \times 10 = 0.01062$

M4: Original $[\text{H}_2\text{O}_2] = 0.01062 \times (1000/5) = 2.12 \text{ mol dm}^{-3}$

(allow 2.10 to 2.15)

1

[17]

- M2.** (a) $\text{CaF}_2(\text{s}) \rightarrow \text{Ca}^{2+}(\text{g}) + 2\text{F}^-(\text{g})$ 1
- (b) (i) Enthalpy change for formation of 1 mol of substance
Allow heat energy change, NOT energy 1
- From its elements 1
- Reactants and products/all substances in their standard states
Or normal states at 298 K, 1 bar (100 kPa) 1
- (ii) $\text{Ca}(\text{s}) + \text{F}_2(\text{g}) \rightarrow \text{CaF}_2(\text{s})$ 1
- (iii) $\Delta H_f(\text{CaF}_2) = \Delta H_a(\text{Ca}) + 1\text{st IE}(\text{Ca}) + 2^{\text{nd}} \text{IE}(\text{Ca}) + \text{BE}(\text{F}_2) + 2 \times \text{EA}(\text{F}) - \Delta H_L(\text{CaF}_2)$
Or labelled diagram 1
- $= 193 + 590 + 1150 + 158 + (2 \times -348) - 2602$ 1
- $= -1207 \text{ kJ mol}^{-1}$
- Correct answer scores 3
-842 scores 2 (transfer error)
-859 scores 1 only (using one E.A.)
Units not required, wrong units lose 1 mark* 1
- (c) Electrostatic attraction stronger/ionic bonding stronger/attraction
between ions stronger/more energy to separate ions
Molecular attraction/atoms/intermolecular forces CE=0 1
- Because fluoride (ion) smaller than chloride
Do not allow F or fluorine 1
- (d) (i) $\Delta H = \Delta H_L + \Sigma \Delta H_{\text{hyd}} = 2237 - 1650 + (2 \times -364)$
Can be on cycle/diagram 1
- $= -141 \text{ kJ mol}^{-1}$
*Correct answer scores 2
Units not required, wrong units lose 1 mark* 1

(ii) Decreases
If ans to (d)(i) positive allow increases

1

Reaction exothermic/ ΔH $-ve$
If (d)(i) +ve allow endothermic/ ΔH + ve

1

(Equilibrium) shifts to left/backwards
(as temperature rises)/equilibrium
opposes the change
*If (d) (i) +ve allow shifts to right/forwards/equilibrium opposes
the change*
If no answer to (d) (i) assume $-ve \Delta H$ used
*If effect deduced incorrectly from any ΔH CE = 0 for these 3
marks*

1

(e) u.v. absorbed: electrons/they move to higher energy
(levels)/electrons excited

1

visible light given out: electrons/they fall back down/move to
lower energy (levels)
*Must refer to absorbing u.v. NOT visible light or this must be
implied.*

1

[17]

M3. (a) Partially filled/incomplete d sub-shell/orbital/shell
Ignore reference to f orbitals
*Do **not** allow d block*
*Do **not** allow half-filled d orbitals*

1

(b) Has ligand(s)
Allow molecules/ions with lone pairs

1

- linked by co-ordinate bonds
Allow dative/donation of lone pair 1
- (c) (Blue) light is absorbed (from incident white light) 1
- Due to electrons moving to higher levels/electrons excited
Allow $d \rightarrow d$ transitions 1
- Red light (that) remains (is transmitted)/light that remains
 (transmitted light) is the colour observed
Allow red light reflected 1
- (d) (i) Circle round any O^-
List principle 1
- Circle round either N 1
- (ii) $EDTA^{4-} + [Co(H_2O)_6]^{2+} \rightarrow [CoEDTA]^{2-} + 6H_2O$
Allow missing square brackets
Ignore state symbols 1
- (iii) Increase in entropy/ ΔS positive
Or increase in disorder 1
- Because 2 mol (of particles/molecules/species/entities) form 7 mol
Allow 'increase in number' as stated in words or as shown by
any numbers deduced correctly from an incorrect equation
Do not allow increase in ions/atoms 1
- (e) (i) Co-ordinate/dative/dative covalent bond
Allow pair of electrons donated by nitrogen/ligand
Do not allow pair of electrons donated from Iron/Fe 1

Covalent bond
Shared electron pair

1

(ii) Transport of oxygen/O₂

Allow any statement that implies oxygen carried (around the body)

Do not allow transport of carbon dioxide (CO₂). This also contradicts the mark (list principle)

1

(iii) Because it bonds to the iron/haemoglobin

Allow blocks site

/CO has greater affinity for haemoglobin

/carboxyhaemoglobin more stable than oxyhaemoglobin

1

Displaces oxygen

Or prevents transport of oxygen

QoL

1

[16]