Oxidation and Reduction

(c) IDENTIFY: X = **Ba** //
Z = **56** (2 × 3)

(d) WRITE: (i) **2 / +2** //
(ii) **4 /+4** (2 × 3)

(e) STATE: **equal (same) volumes of gases contain equal (same) numbers of molecules (particles, moles)** //
at the same (constant) temperature and pressure (2 × 3)
['*Amounts*' unacceptable instead of '*volumes*'; '*all temperatures and pressures*' and '*at s.t.p.*' unacceptable instead of '*at the same (constant) temperature and pressure*'.]

(b) DEFINE: (i) **gain of (increase in)** electrons (3)

(ii) **reduction (decrease)** in oxidation number (3)

ASSIGN: $\underset{+1}{ClO^-} + \underset{+2}{S_2O_3^{2-}} + OH^- \rightarrow \underset{-1}{Cl^-} + \underset{+6}{SO_4^{2-}} + H^+$ (3)

IDENTIFY: (iii) Reducing agent: **$S_2O_3^{2-}$ / S^{2+} / S(+2) /S(2) / S(II) / sulfur (S) in +2 oxidation state / sulfur (S) in $S_2O_3^{2-}$** (3)

(iv) Oxidising reagent: **ClO^- / Cl^+ / Cl(+1) / Cl(1) / Cl(I) / chlorine (Cl) in +1 oxidation state / chlorine (Cl) in ClO^-** (3)

BALANCE: $4ClO^- + S_2O_3^{2-} + OH^- \rightarrow 4Cl^- + 2SO_4^{2-} + H^+$ **(10)**
[Charges essential throughout.]

Where 10 marks not awarded for the balanced equation
$4ClO^- + S_2O_3^{2-} + OH^- \rightarrow 4Cl^- + 2SO_4^{2-} + H^+$
award 3 marks for sulfur balanced and 3 marks for chlorine balanced.
[Charges essential throughout.]

or

$ClO_3^- + 6Br^- + 6H^+ \rightarrow Cl^- + 3Br_2 + 3H_2O$ **(10)**
[Charges essential throughout.]

Where10 marks not awarded for the balanced equation
$ClO_3^- + 6Br^- + 6H^+ \rightarrow Cl^- + 3Br_2 + 3H_2O$
award 3 marks for bromine balanced and 3 marks chlorine balanced.
[Charges essential throughout.]

Award marks for one equation only.

(c) DEFINE: (i) **loss** of electrons //

(ii) **increase** in oxidation number (2 × 3)

USE: (iii) oxidising agent: **NO_3^-** // **+5 (5)** → **+2 (2)** (2 × 3)

[N or nitrogen not acceptable.]

(iv) reducing agent: **Cd** // **0** → **+2 (2)** (2 × 3)

BALANCE: $3Cd + 8H^+ + 2NO_3^- \rightarrow 3Cd^{2+} + 2NO + 4H_2O$ (7)

[Charges essential.]

[$3Cd + 2NO_3^- \rightarrow 3Cd^{2+} + 2NO$ ….allow 4 marks even if H^+ and H_2O not balanced.]

[Charges essential.]

(b) DEFINE: **loss of electrons** (4)

(i) **platinum / carbon (graphite)** (3)

(ii) *anode*: $I^- \rightarrow {}^1/_2I_2 + e^-$ / $2I^- \rightarrow I_2 + 2e^-$ FORMULAS: (3) BALANCING: (3)

[Electrons may be shown subtracted on the left. Neg. charge on e *need not be shown.]*

cathode: $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ / $H_2O + e^- \rightarrow {}^1/_2H_2 + OH^-$

FORMULAE: (3) BALANCING: (3)

[Electrons may be shown subtracted on the right. Neg. charge on e *need not be shown.]*

(iii) colour of the **iodine** produced (6)

[Allow 3 for "correct colour : red, orange, yellow, brown or combinations of them" if iodine not stated]

QUESTION 1

(a) EXPLAIN: reaction with **potassium iodide (KI)** / reaction with **iodide (I^-)** / **$I_2 + I^-$ (KI)** / forms **soluble (dissolves as) potassium triiodide (KI_3)** / forms **soluble (dissolves as) triiodide (I_3^-)** / **⇌ I_3^- (KI_3)** (6)

(b) DESCRIBE: pour some **iodine (solution) into a clean, dry beaker** //
use **pipette** //
previously **rinsed with deionised (distilled) water** //
rinsed with iodine (solution) //
fill using pipette filler **until bottom of meniscus is on mark** //
read at eye-level / allow drainage time / last drop to remain (not to be shaken out, blown out) / drain under gravity / touch (tip, tap) pipette **against** wall of conical **flask**

ANY THREE: (6 + 3 + 3)

(c) NAME: **starch** (3)

AT WHAT: when colour in conical flask **is light (pale) yellow (straw yellow, straw coloured) / close to** the **end point** / when **nearly all iodine used up** (3)

STATE: **blue-(black, navy) to colourless** (3)

(d) CALCULATE: (i) **0.00125 (1.25×10^{-3})** moles (6)

$M = \frac{6.35 \times 2}{254^*} = 0.05 = \mathbf{0.05}$ M (3)

$\frac{25 \times 0.05}{1000} = \mathbf{0.00125}$ moles (3)

/

$\frac{6.35}{20} = \mathbf{0.3175}$ g in 25 cm^3 (3)

$\frac{0.3175}{254^*} = \mathbf{0.00125}$ moles (3)

/

$\frac{6.35}{254^*} = \mathbf{0.025}$ moles (3)

$\frac{0.025}{20} = \mathbf{0.00125}$ moles (3)

[**Addition must be shown for error to be treated as slip.*]

(*ii*) **0.0025** (**2.5 × 10^{-3}**) moles (3)

0.00125 × 2 = 0.00250 = **0.0025** moles (3)

(*iii*) **0.14** M (6)

$\frac{0.0025}{17.85}$ = 0.000140 = **0.00014**0 moles / cm^3 (3)

0.000140 × 1000 = 0.140 = **0.14**0 M (3)

/

$\frac{17.85 \times M}{2} = \frac{25 \times 0.05}{1}$ (3)

M = 0.140 = **0.14**0 M (3)

(*iv*) **35** g / L [**34.7** – **35** g / L] (3)

0.140 × 248** = 34.72 = **35** g / L [**34.7** – **35** g / L]

[***Addition must be shown for error to be treated as slip*]
[*1 mark to be deducted for incorrect rounding off resulting in candidate's final numerical answer lying outside given values or given range but deduction to be made once only.*]

(*e*) EXPLAIN: **deionised water could contain non-ionic substances** that could be oxidised or reduced / **deionised water could contain chlorine** oxidising reagent / **deionised water** has had **only ions removed** **(5)**
[(5) allowed for '*distilled water is pure (purer, contains less impurities, contains no dissolved substances)*' or '*deionised water is less pure (contains more impurities, contains dissolved substances)*'.][*'Deionised water contains no ions'* is not acceptable.]

(c) (i) HOW: **it decreases** (4)

(ii) ASSIGN: *1st equation*: oxidation number of Br in Br_2 = **0** (3)

oxidation number of Br in Br^- = **– 1** (3)

2nd equation: oxidation number of Cl in Cl_2 = **0** (3)

oxidation number of Cl in Cl^- = **– 1** (3)

[The oxidation numbers may be written under the appropriate formulas]

BALANCE: $Cl_2 + SO_3^{2-} + H_2O \rightarrow \mathbf{2}Cl^- + SO_4^{2-} + \mathbf{2}H^+$ (6)
[Do not insist on correct formulas (they are given). (6) or (0) for balancing numbers.
Accept only the *smallest* correct integral balancing numbers (2 & 2) – not multiples.]

(iii) WHY: **increasing atomic radius (size) / increase in number of shells / atoms get bigger / increase in shielding (screening) / decrease in electronegativity (attraction for electrons)** (3)