Chapter 7: Redox reactions

Homework marking scheme

1 a i 0 oxidation state in chlorine [1]
−1 oxidation state in NaCl and +1 in NaOCl [1]
it is oxidised in going to NaOCl and reduced in going to NaCl. [1]

ii $2OH^-(aq) + Cl_2(g) \rightarrow Cl^- + OCl^- + H_2O$ [1]

iii $n(NaOH) = 2 \times n(Cl_2)$ [1]

$= 2 \times \frac{1800}{24000} = 0.15$ mol [1]

$V = \frac{n}{C} = \frac{0.15}{0.1} = 1.5\ dm^3$ [1]

b i $2H^+(aq) + 2e^- \rightarrow H_2(g)$ [1]

ii $2Cl^- \rightarrow Cl_2 + 2e^-$ [1]

iii Oxidation is the conversion of chloride ions into chlorine because the chloride ions lose electrons, or
the oxidation state of the chlorine increases from −1 to 0. [1]

iv $n(H_2) = ½n(NaCl) = ½ \times 6 \times \frac{200}{1000} = 0.6$ mol
the relationship between the number of moles of hydrogen and the number of moles of sodium chloride [1]
the correct number of moles of hydrogen [1]
volume of hydrogen = 0.6 × 24 dm^3 = 14.4 dm^3. [1]

v also 14.4 dm^3 [1]

vi chlorine is soluble in water/in the sodium hydroxide produced [1]

c A $3ClO^- \rightarrow ClO_3^- + 2Cl^-$ [1]

B $4ClO_3^- \rightarrow 3ClO_4^- + Cl^-$ [1]
In reaction **A** the oxidation state of the chlorine increases from +1 to +5 and decreases from +1 to −1 in the same reaction. [1]
In reaction **B** the oxidation state of the chlorine increases from +5 to +7 and decreases from +5 to −1 in the same reaction. [1]

2 a carbon: oxidation state = 0 [1]
carbon dioxide: oxidation state = +4 [1]
carbon monoxide: oxidation state = +2 [1]

b $3CO + Fe_2O_3 \rightarrow 3CO_2 + 2Fe$ [1]

c i +3 [1]

ii +2 [1]

iii +6 [1]

d $FeO_4^{2-} + 8H^+ + 3e^- \rightarrow Fe^{3+} + 4H_2O$
reactants [1]
products [1]

e $2NH_3 \rightarrow N_2 + 6H^+ + 6e^-$
reactants [1]
products [1]

f $2FeO_4^{2-} + 16H^+ + 2NH_3 \rightarrow 2Fe^{3+} + 8H_2O + N_2 + 6H^+$
reactants [1]
products and correct balancing numbers [1]
if the excess H^+ ions on the right-hand side are cancelled out [1]
(so giving the reaction as $2FeO_4^{2-} + 10H^+ + 2NH_3 \rightarrow 2Fe^{3+} + 8H_2O + N_2$).

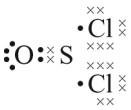
3 **a** **i** −2 [1]
ii 0 [1]
iii +4 [1]
iv +1 [1]
v +6 [1]

b $2H_2S + SO_2 \rightarrow 2H_2O + 3S$
products [1]
balancing [1]
in H_2S the oxidation state −2, which increases to 0 in S, therefore oxidised [1]
in SO_2 the oxidation state is +4, which decreases to 0 in S, therefore reduced. [1]

c **i** magnesium loses two electrons to form the magnesium (Mg^{2+}) ion [1]
oxidation state of the magnesium increases from 0 in Mg to +2 in the Mg^{2+} ion. [1]

ii $n(Mg) = n(H_2SO_4) = 0.1 \times 20 \times 10^{-3} = 2 \times 10^{-3}$
relationship between Mg and sulfuric acid [1]
correct number of moles [1]
mass of magnesium = $2 \times 10^{-3} \times 24.3 = 0.049$ g.
Lose this mark if a result of 0.0486 g is given, because the top-pan balance reads to 3 decimal places only. [1]

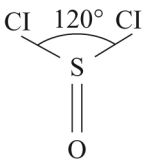
d **i**



double bond with oxygen [1]
two single bonds with two chlorine atoms [1]
correct number of outer electrons in all four atoms. [1]

ii +4 [1]
the molecule is neutral, therefore total oxidation number = 0
oxidation number of S + oxidation number of oxygen (−2)
+ 2 × oxidation number of chlorine (−1) = 0 [1]

iii



correct diagram [1]
correct bond angle. [1]

iv $SOCl_2 + H_2 \rightarrow SO_2 + 2HCl$
correct products [1]
balancing. [1]