Answers to 3.3 Paper 1

Question One

a Mg A

b LHE is Mg and solution is $Mg^{2+}(aq)$, RHE is Cu and solution is $Cu^{2+}(aq)$, salt bridge.
A = minor error, M = correct labels

c To complete the circuit and allow ions to flow through it.
A = one point, M = both points

d $Mg(s) + Cu^{2+}(aq) \rightarrow Mg^{2+}(aq) + Cu(s)$
A = correct equation

e $E^{\circ}_{Cell} = E_{RHE} - E_{LHE}$
$= 0.34\ V - (-2.37\ V)$
$= 2.71\ V$
A = correct formula, but minor error eg. no units, M = correct voltage

f Copper with nitric acid: $E^{\circ}_{Cell} = 0.96\ V - 0.34\ V = 0.62\ V / > 0$: spontaneous
Copper with sulfuric acid: $E^{\circ}_{Cell} = 0.00\ V - 0.34\ V = -0.34\ V / < 0$: not spontaneous
Magnesium with sulfuric acid: $E^{\circ}_{Cell} = 0.00\ V - (-2.37\ V) = 2.37\ V / > 0$: spontaneous
M = some mention of oxidising nature of dilute nitric acid, E = correct answer backed by reasoning using emfs

g $3Cu(s) + 8H^{+}(aq) + 2NO_3^{-}(aq) \rightarrow 2NO(g) + 4H_2O(l) + 3Cu^{2+}(aq)$
A = writes a balanced ionic equation for a reaction between Cu^{2+} and NO_3^-, M = writes correct equation

h The pink/brown solid would slowly disappear, fizzing/bubbling would be seen (a colourless gas given off), a brown gas would form, a blue liquid would be left.
A = 2 correct observations, M = 3 correct observations, E = 5 correct observations

Question Two

a An orange/brown colour appears (an orange-brown vapour may be seen). ***A***

b Br^- loses electrons while Cl_2 gains electrons.
A = electron transfer mentioned, M = full answer given

c $Cl_2(g) + H_2O(l) \rightarrow 2H^{+}(aq) + ClO^{-}(aq) + Cl^{-}(aq)$
or $HCl(aq) + HOCl(aq)$
or $H^{+}(aq) + Cl^{-}(aq) + HOCl(aq)$
A = correct equation

d Chlorine is in the zero oxidation state as elemental chlorine. When it reacts with water it is both oxidised to OCl^- where its oxidation state is +1, and reduced to Cl^- where its oxidation state is −1. Hence, it is acting as both an oxidising agent and a reducing agent.
A = some mention of change in oxidation states/numbers, M = correct changes in the oxidation states/numbers, E = full discussion, mentioning acting as both oxidant and reductant

Question Three

1 **a** $H_2C_2O_4 \rightarrow 2CO_2 + 2H^{+} + 2\ e^{-}$
or $C_2O_4^{2-} \rightarrow 2CO_2 + 2\ e^{-}$ A

b a reductant
Oxidation number of carbon changes from +3 to +4
A = correct answer, M = correct reasoning

2 **a** 10
Each manganese goes from +7 to +2, 2 moles of MnO_4^- gains $2 \times 5 = 10$ electrons.
A = correct answer, M = correct reasoning

3 **a** Colourless A

b Pink/purple A

2

c The catalyst Mn^{2+} is formed in the reaction and is therefore now present. M

Judgement Statement

Achievement: **9 questions answered correctly**
A minimum of 9 × A

Merit: **13 questions answered correctly, 7 at Merit level**
A minimum of 6 × A + 7 × M

Excellence: **13 questions answered correctly, 8 at Merit level and 2 at Excellence level**
A minimum of 3 × A + 8 × M + 2 × E