

TOPIC 13 ANSWERS TO EXERCISES

Topic 13 Exercise 1

1. a) +7 b) -1 c) +6 d) +6 e) +5 f) +4
2. a) $\text{MnO}_4^- + 8\text{H}^+ + 5\text{e} \rightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O}$
 b) $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e} \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$
 c) $\text{Zn}^{2+} + 2\text{e} \rightarrow \text{Zn}$
 d) $\text{Fe}^{3+} + \text{e} \rightarrow \text{Fe}^{2+}$
 e) $\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e} \rightarrow 2\text{H}_2\text{O}$
3. a) $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}$
 b) $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + \text{e}$
 c) $\text{H}_2\text{O}_2 \rightarrow 2\text{H}^+ + \text{O}_2 + 2\text{e}$
 d) $\text{SO}_3^{2-} + \text{H}_2\text{O} \rightarrow \text{SO}_4^{2-} + 2\text{H}^+ + 2\text{e}$
4. a) $\text{MnO}_4^- + 8\text{H}^+ + 5\text{Fe}^{2+} \rightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O} + 5\text{Fe}^{3+}$
 b) $\text{Cr}_2\text{O}_7^{2-} + 8\text{H}^+ + 3\text{H}_2\text{O}_2 \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O} + 3\text{O}_2$
 c) $2\text{VO}_2^+ + 3\text{Zn} + 8\text{H}^+ \rightarrow 2\text{V}^{2+} + 4\text{H}_2\text{O} + 3\text{Zn}^{2+}$
 d) $2\text{VO}_2^+ + \text{SO}_3^{2-} + 2\text{H}^+ \rightarrow 2\text{VO}^{2+} + \text{H}_2\text{O} + \text{SO}_4^{2-}$
5. a) $\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e} \rightarrow 2\text{OH}^-$ reduction
 b) $\text{Cr}^{3+} + 8\text{OH}^- \rightarrow \text{CrO}_4^{2-} + 4\text{H}_2\text{O} + 3\text{e}$ oxidation
 c) $\text{H}_2\text{O}_2 + 2\text{e} \rightarrow 2\text{OH}^-$ reduction
 d) $\text{MnO}_4^- + 2\text{H}_2\text{O} + 3\text{e} \rightarrow \text{MnO}_2 + 4\text{OH}^-$ reduction

Topic 13 Exercise 2

1. a) Fe Fe²⁺ Cu²⁺ Cu Cu is +ve, Fe is -ve
 b) Pt I, I₂ Fe³⁺, Fe²⁺ Pt Pt in Fe³⁺/Fe²⁺ is +ve, Pt in I/I₂ is -ve
 c) Zn Zn²⁺ H⁺, H₂ Pt Pt is +ve, Zn is -ve
 d) Pt H₂, H⁺ [O₂ + 4H⁺] Pt Pt in O₂/H⁺ is +ve, Pt in H⁺/H₂ is -ve
2. a) $\text{Zn} + 2\text{Fe}^{3+} \rightarrow \text{Zn}^{2+} + 2\text{Fe}^{2+}$
 b) $\text{Fe} + 2\text{Fe}^{3+} \rightarrow 3\text{Fe}^{2+}$
 c) $2\text{Ag} + \text{Cl}_2 \rightarrow 2\text{Ag}^+ + 2\text{Cl}^-$

Topic 13 Exercise 3

1. a) yes b) yes c) no d) no e) yes
2. a) $\text{Pb} + 2\text{H}^+ \rightarrow \text{Pb}^{2+} + \text{H}_2$
b) no reaction
c) $\text{Cu} + 2\text{NO}_3^- + 4\text{H}^+ \rightarrow \text{Cu}^{2+} + 2\text{NO}_2 + 2\text{H}_2\text{O}$
d) no reaction
e) $2\text{Fe}^{3+} + 2\text{I}^- \rightarrow 2\text{Fe}^{2+} + \text{I}_2$
f) no reaction
g) $2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$

Topic 13 Exercise 4

1. An electrochemical cell contains a finite quantity of reactants and will proceed until the reactants are used up. A fuel cell uses a continuous external supply of fuel and oxygen and so can run indefinitely provided that both reactants continue to be supplied
2. a) (+) $\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^-$, (-) $2\text{H}_2 + 2\text{OH}^- \rightarrow 2\text{H}_2\text{O} + 2\text{e}^-$
b) (+) $\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^-$, (-) $\text{CH}_4 + 8\text{OH}^- \rightarrow \text{CO}_2 + 6\text{H}_2\text{O} + 8\text{e}^-$
c) (+) $\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightarrow 4\text{OH}^-$, (-) $\text{C}_8\text{H}_{18} + 50\text{OH}^- \rightarrow 8\text{CO}_2 + 34\text{H}_2\text{O} + 50\text{e}^-$
3. They are more efficient; they don't produce pollutants
4. Adsorbed onto a solid surface, as a liquid under high pressure, absorbed into a solid
5. Limited lifetime; toxic chemicals involved in production; reaction can be slow
6. Lack of an infrastructure to support hydrogen transport; lack of public acceptance; cost and performance of hydrogen cars.