**Redox solutions**

**SECTION A: Multiple-choice questions (1 mark each)**

**Question 1**

*Answer:* D

*Explanation:*

There is a range of oxidation numbers present.

 V2O5 +5 VO2+ +3 VO2+ +4 VCl3  +3 VCl2 +2

**Question 2**

*Answer:* C

*Explanation:*

 Zinc atoms go to zinc ions, this is oxidation making zinc the reductant and silver ions the oxidant

**Question 3**

*Answer:* D

*Explanation:*

The equation shows that each zinc atom reacts with two silver ions.

**Question 4**

*Answer:* B

*Explanation:*

The cell requires a solution of Sn4+ ions and Sn2+ ions. It must not have Sn metal or a different half-equation could occur.

**Question 5**

*Answer:* D

*Explanation:*

 Comparisons need to be in terms of mole, not mass. The mole ratio of Cr to Co is 2:3

**Question 6**

*Answer:* A

*Explanation:*

The half-equations are listed in alphabetical order. Once they are listed in order of voltage, it can be seen that Ce4+ is the strongest oxidant and Ti metal the strongest reductant.

**Question 7**

*Answer:* B

*Explanation:*

Ce4+ is a strong oxidant with a voltage over gold metal. A reaction will occur.

**Question 8**

*Answer:* C

*Explanation:*

Silver ions form silver metal and release OH- ions.

**Question 9**

*Answer:* B

*Explanation:*

 Oxidation occurs at the anode so the reaction needs to oxidation. B is a balanced half-equation

**Question 10**

*Answer:* C

*Explanation:*

 Fuel cells are relatively expensive. One of the reasons for this is the electrodes. They have to be porous and to act as a catalyst.

**SECTION B: Short-answer questions**

**Question 1** (10 marks)

a.  **i**. HClO +1 **ii**. NaClO4 **+7iii**. ClO3-  +5

3 marks

**b**. **i**. H2S(g) 🡪S(s) + 2H+(aq) + 2e- oxidation

 **ii**. NO3-(aq) + 4H+(aq) + 3e- 🡪 NO(g) + 2H2O(l) reduction

 **iii**. see above

4 marks

**c**.  **i**. 2I-(aq) 🡪 I2(g) + 2e- F2(g) + 2e- 🡪 2F-(aq)

 **ii**. Identify the oxidant F2 and the reductant 2-

3 marks

**Question 2** (10 marks)

 e

*  +

 Solution Cd(NO3)2  Solution H2SO4

 cadmium electrode PbO2 on some grid

 Cd(s) 🡪 Cd2+(aq) + 2e- PbO2(s) + 4H+(aq) + 2e- ⇄ Pb2+(aq) + 2H2O(l)

 Overall: PbO2(s) + Cd(s) + 4H+(aq) ⇄ Pb2+(aq) + 2H2O(l) + Cd2+(aq)

 Voltage 1.86 V

 1 mark for each correct feature

**Question 3** (5 marks)

**a. i**. C2H2O4(aq) 🡪 2CO2(g) + 2H+(aq) + 2e-

 **ii**. 2CO2(g) + 2H+(aq) + 2e- 🡪 C2H2O4(aq)

 2 marks

**b**. **i**. I2(l) + 2e- 🡪 2I-(aq)

 **ii**. C2H2O4(aq) + I2(l) 🡪 2CO2(g) + 2H+(aq) + 2I-(aq)

 **iii**. 0.54 - - 0.48 = 1.02 V 1 + 1 + 1 = 3 marks

**Question 4** (8 marks)

**a. i**. negative

 **ii**. the electrode will corrode away as aluminium metal turns to aluminium ions

1 + 1 = 2 marks

**b. i**. O2(g) + 2H2O(l) + 4e- 🡪 4OH-(aq)

 **ii**. 4Al(s) + 3O2(g) + 6H2O(l) 🡪 4Al(OH)3(aq)

1 + 1 = 2 marks

**c**. *n*(Al) =  = 0.05 mol

 *n*(O2) = ¾ × 0.05 = 0.0375 mol

 mass = 0.0375 × 32 = 1.2 g 3 marks

**d**. Oxygen can be obtained from the air so does not need replacing. If the aluminium electrode

 is replaced periodically the cell can run for a long time. 1 mark

**Question 5** (7 marks)

**a**. Anode : O2(g) + 4H+(aq) + 4e- 🡪 2H2O(g)

 Cathode: 2CH3OH(l) + 2H2O(l) 🡪 2CO2(g) + 12H+(aq) + 12e-

 Overall equation: 2CH3OH(l) + 3O2(g) 🡪 2CO2(g) + 4H2O(g) 3 marks

**b**. n(methanol) =  = 0.125 mol

 *E* = 0.125 × 725 = 91 kJ 2 marks

**c**. emissions of CO2 will add to greenhouse issues. Water is also a greenhouse gas and could

 lead to busy roads being permanently wet. A source of methanol that is sustainable needs to

 be found. 2 marks