CHEM1612 Worksheet 12 – Answers to Critical Thinking Questions

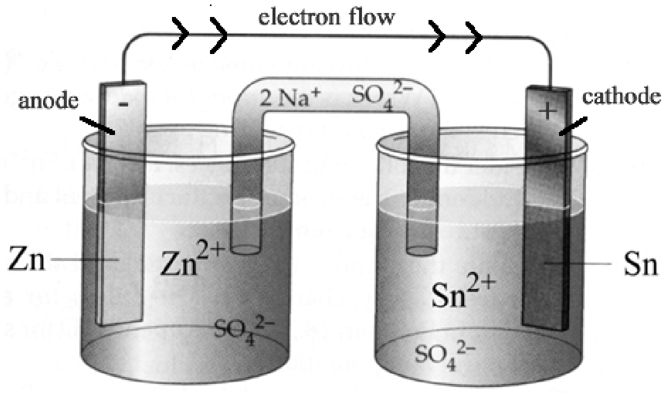
The worksheets are available in the tutorials and form an integral part of the learning outcomes and experience for this unit.

Model 1: Galvanic Cells

1. The zinc electrode will *lose* mass and the tin electrode will *gain* mass.

2. $Sn^{2+}(aq) + Zn(s) \rightarrow Sn(s) + Zn^{2+}(aq)$

3. Zn is being oxidised and Sn^{2+} is being reduced. The Zn electrode is the anode. The Sn electrode is the cathode.



4. Electrons flow through the wire, from the zinc electrode towards the tin electrode.

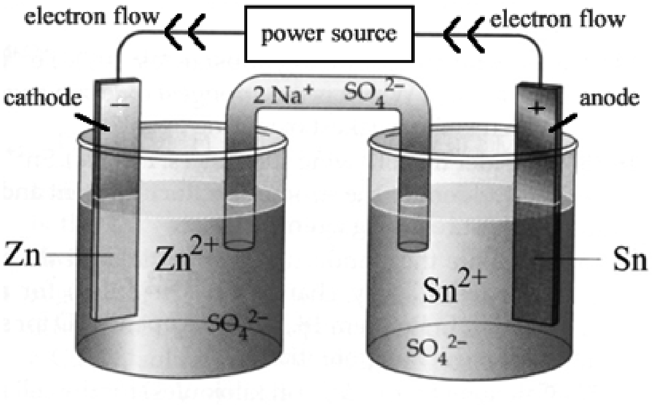
5. The anode is negative and the cathode is positive.

6. $SO_4^{2-}(aq)$ moves into the zinc half cell (as cations are being made in the oxidation reaction in this cell). $Na^+(aq)$ moves into the tin half cell (as cations are being lost in this cell).

Model 2: Electrolytic Cells

1. The zinc electrode will *gain* mass and the tin electrode will *lose* mass.

2. $Sn(s) + Zn^{2+}(aq) \rightarrow Sn^{2+}(aq) + Zn(s)$



3. Zn is being reduced and Sn^{2+} is being oxidised. The Zn electrode is the cathode. The Sn electrode is the anode.

4. Electrons flow through the wire, from the tin electrode towards the zinc electrode.

5. The anode is positive and the cathode is negative.

6. $SO_4^{2-}(aq)$ moves into the tin half cell (as cations are being made in the oxidation reaction in this cell). $Na^+(aq)$ moves into the zinc half cell (as cations are being lost in this cell).

Model 3: Electrolysis of Water

1. $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$.

2. $F = (1.602 \times 10^{-19}\ C) \times (6.022 \times 10^{23}) = 96485\ C\ mol^{-1}$.

3. Number of moles of electrons = $I \times t / F = (10.0\ A) \times (2.00 \times 60 \times 60\ s) / (96485\ C\ mol^{-1}) = 0.746$ mol

4. From the half cell equation for the reduction of H_2O, $2e^-$ are required for each H_2. Therefore, 0.746 mol will produce ½ × 0.746 mol = 0.373 mol of H_2.

5. From Q1, half as much O_2 will be produced: 0.187 mol.

Alternatively, from the half cell equation for the oxidation of H_2O, $4e^-$ are produced for each O_2. Therefore, 0.746 mol will have been produced by ¼ × 0.746 mol = 0.187 mol of O_2.

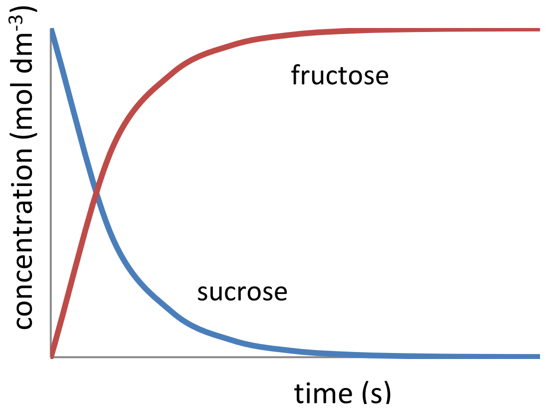
6. The reduction potential of water is -0.82 V so a cation with a *more* negative reduction potential should be used: Cr^{3+}, Al^{3+}, Mg^{2+}, Na^+, Ca^{2+} or Li^+,

   The oxidation potential of water is -1.23 V so an anion with a *more* negative oxidation potential should be used: Cl^- or SO_4^{2-}.

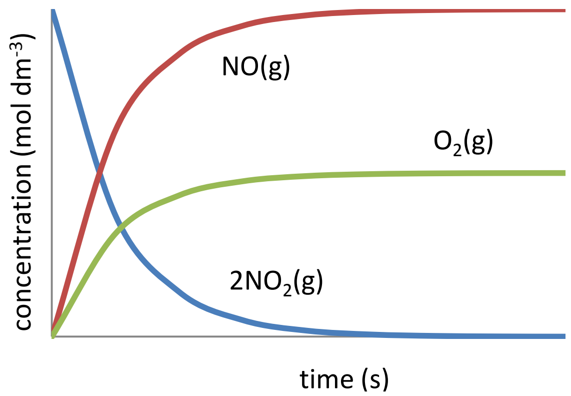
   Na_2SO_4 or K_2SO_4 are commonly used.

Model 4: Rate of Reaction

1. Rate is defined as the change in concentration with time: M s^{-1}.
2. As [sucrose] decreases, [fructose] *increases* at the same rate.



3. Sucrose and H_3O^+ are both reactants and so their concentrations decrease with time, Fructose and glucose are both products and so their concentrations increase with time.
4. From the chemical equation, [NO(g)] will increase at exactly the same rate as [NO_2(g)] decreases but [O_2(g)] is produced at half the rate.



Model 5: The Rate Law

1. (a) The rate increases by a factor of 4 (i.e. it quadruples).
   (b) The rate increases by a factor of 2 (i.e. it doubles)
   (c) The rate is unchanged.
2. (a) The rate doubles.
   (b) The rate doubles.
   (c) The rate quadruples (i.e. it increases by a factor of 4).
3. (a) [lactose]$_0$ is doubled and [H_3O^+] is unchanged. The rate doubles.
   (b) [lactose]$_0$ is unchanged and [H_3O^+] is increased by a factor of 4. The rate increases by a factor of 4.
   (c) The reaction is first order with respect to both lactose and H_3O^+: $x = 1$ and $y = 1$.

   rate = $k[\text{lactose}]^1[H_3O^+]^1 = k[\text{lactose}][H_3O^+]$

   (d) [lactose]$_0$ is decreased by a factor of 2. On its own, this change would half the rate. [H_3O^+] is increased by a factor of 4. On its own, this change would increase the rate by 4.

   When both changes are made together, the rate therefore doubles.

(e) Using experiment (1),

$$\text{rate} = k \times (0.01\ \text{M}) \times (0.001\ \text{M}) = 0.00116\ \text{M s}^{-1}$$

$$k = 116\ \text{M}^{-1}\ \text{s}^{-1}$$

Using experiment (2),

$$\text{rate} = k \times (0.02\ \text{M}) \times (0.001\ \text{M}) = 0.00232\ \text{M s}^{-1}$$

$$k = 116\ \text{M}^{-1}\ \text{s}^{-1}$$

Using experiment (3),

$$\text{rate} = k \times (0.01\ \text{M}) \times (0.004\ \text{M}) = 0.00464\ \text{M s}^{-1}$$

$$k = 116\ \text{M}^{-1}\ \text{s}^{-1}$$