LIVE: PAPER 2 QUESTIONS

Lesson Description

In this lesson we:

- Work through selected examination questions adapted from 2014 Exemplar Paper covering:
  - Acids and Bases
  - Electrochemistry
  - Chemical Systems

Challenge Question

A solution of sodium carbonate is prepared by dissolving 5,13 g of the salt in 250cm^3 of water. 25 cm^3 of this solution is used to neutralise 36 cm^3 of a sulphuric acid solution. Calculate the concentration of the sulphuric acid.

Improve your Skills

Question 1

(Adapted from DBE 2014 Exemplar P2, Question 7)

A Grade 12 class wants to determine the percentage of ethanoic acid in a certain bottle of vinegar. They titrate a sample taken from the bottle of vinegar with a standard solution of sodium hydroxide. The equation for the reaction is:

$$CH_3COOH(aq) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_3O$$

1.1. Define an acid in terms of Arrhenius theory. (2)

1.2. Give a reason why ethanoic acid is classified as a weak acid (1)

1.3. Explain the meaning of standard solution (1)

1.4. Write down the names of TWO items of apparatus needed to measure accurate volumes of the acid and the base in this titration. (2)

1.5. It is found that 40 ml of a 0,5 mol.dm^{-3} sodium hydroxide solution is needed to neutralise 20 ml of the vinegar.

Calculate the

1.5.1. pH of the sodium hydroxide solution (4)

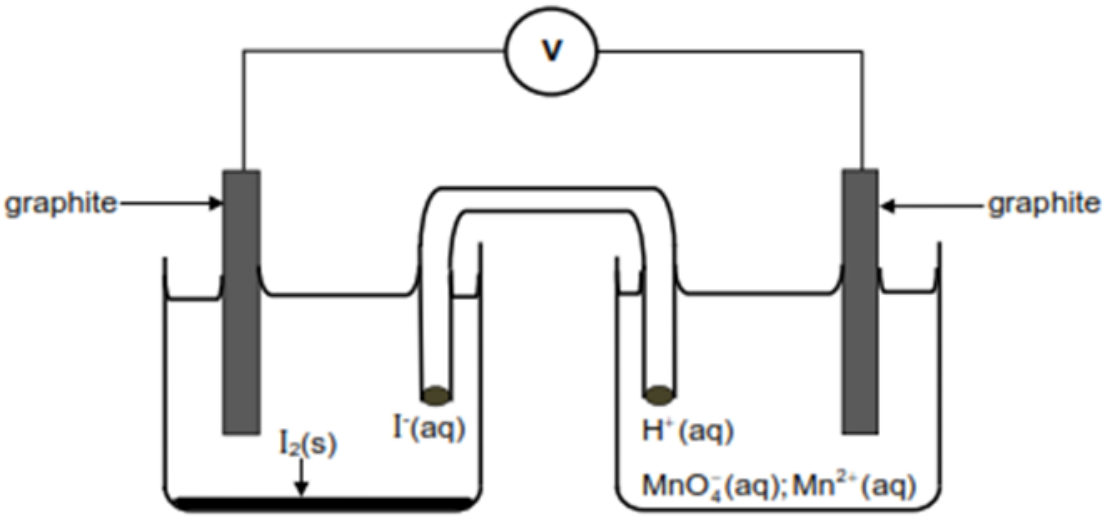
1.5.2. percentage of ethanoic acid by mass present in the vinegar (Assume that 1 ml of vinegar has a mass of 1 g) (7)

1.6. The sodium ethanoate (CH_3COONa) formed during the above neutralisation reaction undergoes hydrolysis to form an alkaline solution. Write down an equation for this hydrolysis reaction. (3)

Question 2

(Adapted from DBE 2014 Exemplar P2, Question 8)

The voltaic cell represented below functions at standard conditions



2.1. Write down the concentration of $H^+(aq)$ in the one half-cell (1)

2.2. Solids present in the half-cells are usually used as electrodes. Give a reason why $I_2(s)$ is not suitable to be used as an electrode. (1)

2.3. Write down TWO properties of graphite, other than being a solid that makes it suitable for use as electrodes in the above voltaic cell. (2)

2.4. For the above voltaic cell, write down the:

2.4.1. Name of the oxidising agent (1)

2.4.2. Net cell reaction (3)

2.4.3. Cell notation (3)

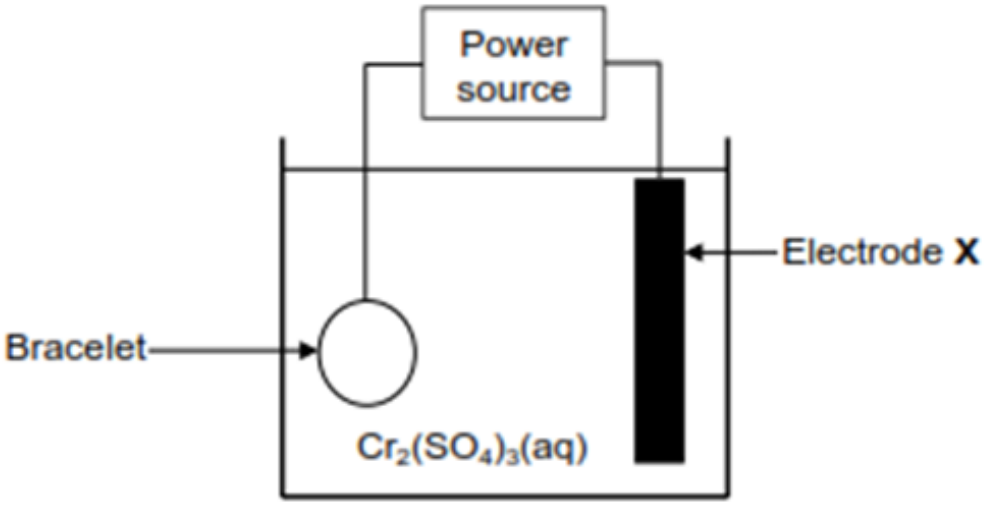
2.5. Calculate the cell potential of the above cell (4)

2.6. How will the reading on the voltmeter be affected if the concentration of $MnO_4^-(aq)$ decreases? Only write down increases, decreases or no effect. (1)

Question 3

(Adapted from DBE 2014 Exemplar P2, Question 9)

A technician is plating a bracelet with chromium in an electrolytic cell containing $Cr_2(SO_4)_3(aq)$. A simplified diagram of the electrolytic cell is shown below.



3.1. Define the term electrolyte. (2)

3.2. Which electrode, the Bracelet or X, is the cathode? (1)

3.3. Write down the:

3.3.1. Metal of which electrode X is made (1)

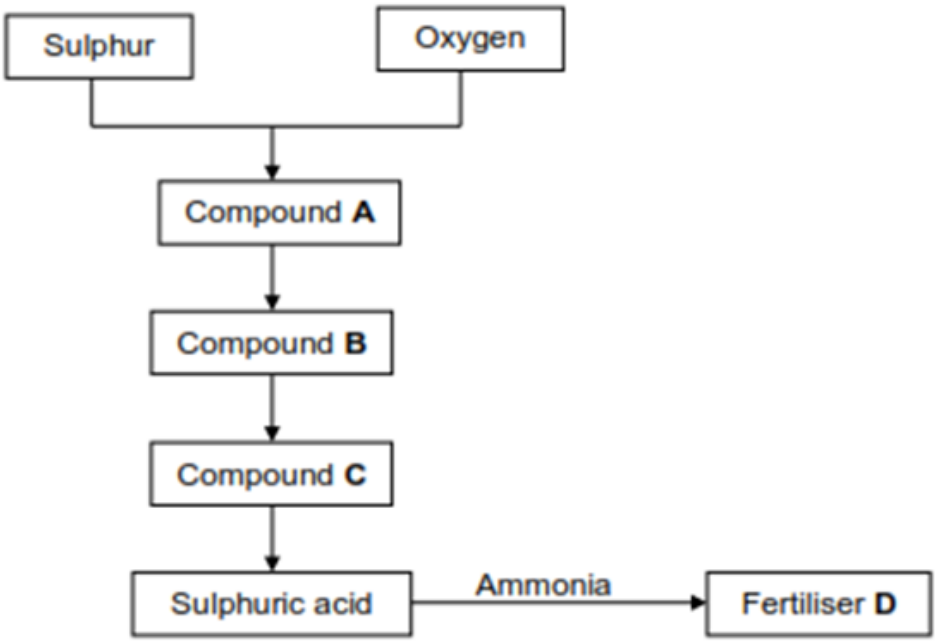
3.3.2. Reduction half reaction (2)

3.4. During the process, the bracelet is plated with 0,86 g of chromium. Calculate the number of electrons transferred during the process. (6)

Question 4

(Adapted from DBE 2014 Exemplar P2, Question 10)

Sulphuric acid is used, amongst others, in the manufacturing of fertilisers. The flow diagram below shows how fertiliser D can be prepared using sulphuric acid as one of the reagents.



4.1. Write down the name of the industrial process for the preparation of sulphuric acid. (1)

4.2. Compound A is formed when sulphur burns in oxygen. Write down the name or formula of compound A. (1)

4.3. Compound B is formed when compound A reacts with oxygen in the presence of a catalyst. Write down the:

4.3.1. Name or formula of the catalyst (1)

4.3.2. Balanced equation for the reaction which takes place. (3)

4.4. Compound B is dissolved in concentrated sulphuric acid to form compound C. Write down the

4.4.1. name or formula of compound C (1)

4.4.2. reason why compound B is not dissolved in water to form sulphuric acid. (1)

4.5. Write down the name or formula of fertiliser D (1)

4.6. Inorganic fertilisers are soluble in water. This can result in eutrophication if they are washed off into rivers during heavy rain. Write down one negative impact of eutrophication on the economy of a country. (2)

SOLUTIONS TO PAPER 2 QUESTIONS (LIVE)

Question 1

1.1. An acid forms hydronium ions / H_3O^+ ions when it dissolved in water✓✓ (2)

1.2. Incompletely / partially ionised ✓ (1)

1.3. Solution of known concentration ✓ (1)

1.4. Burette ✓

Pipette ✓ (2)

1.5.1. $K_w = [H_3O^+][OH^-]$

$1 \times 10^{-14} = [H_3O^+](0,5)$ ✓

$[H_3O^+] = 2 \times 10^{-14}$ mol.dm^{-3}

$pH = - \log [H_3O^+]$ ✓

$= - \log (2 \times 10^{-14})$ ✓

$= 13,7$ ✓ (4)

1.5.2. $n(NaOH) = cV$ ✓

$= (0,5)(0,04)$ ✓

$= 0,02$ mol

$n(CH_3COOH) = n(NaOH) = 0,02$ mol ✓

$m(CH_3COOH) = nM$ ✓

$= (0,02)(6)$ ✓

$= 1,2$ g

$\%\ mass\ of\ CH_3COOH = \frac{12}{20} \times 100$ ✓ $= 6\%$ ✓ (7)

1.6. $CH_3COO^-(aq) + H_2O(l)$ ✓→ $CH_3COOH(aq) + OH^-(aq)$ ✓ ✓ balancing (3)

Question 2

2.1. 1 mol.dm^{-3} ✓ (1)

2.2. Iodine is not a conductor ✓ (1)

2.3. Graphite is a conductor ✓

Graphite is inert ✓ (2)

2.4.1. Permanganate ion ✓ (1)

2.4.2. $2MnO_4^-(aq) + 16H^+(aq) + 10I^-(aq)$ ✓ $\longrightarrow 2Mn^{2+}(aq) + 5I_2(s) + 8H_2O(\ell)$ ✓ ✓ *balancing* (3)

2.4.3. $C(s)|I^-(aq)\ |I_2(s)\ ||H^+(aq), MnO_4^-(aq), Mn^{2+}(aq)|C(s)$ ✓✓✓ (3)

2.5. $E^o_{cell} = E^o_{cathode} - E^o_{anode}$ ✓

$= 1{,}51$ ✓ $- 0{,}54$ ✓

$= 0{,}97\ V$ ✓ (4)

2.6. Decreases ✓ (1)

Question 3

3.1. A solution that conducts electricity through the movement of ions ✓✓ (2)

3.2. Bracelet ✓ (1)

3.3.1 Chromium ✓ (1)

3.3.2. $Cr^{2+}(aq) + 3e^- \rightarrow Cr(s)$ ✓✓ (2)

3.4. $n(Cr) = \frac{m}{M}$ ✓

$= \frac{0{,}86}{52}$ ✓

$= 0{,}0165\ mol$

$n(electrons) = 3n(Cr)$ ✓ $= 4{,}96 \times 10^{-2} mol$

$n = \frac{N}{N_A}$ ✓

$4{,}96 \times 10^{-2} = \frac{N}{6{,}02 \times 10^{23}}$ ✓

$N = 2{,}99 \times 10^{22}$ ✓ (6)

Question 4

4.1. Contact process ✓ (1)

4.2. Sulphur dioxide / SO_2 ✓ (1)

4.3.1. Vanadium pentoxide / V_2O_5 ✓ (1)

4.3.2. $2SO_2(g) + O_2(g)$ ✓ $\rightleftharpoons 2SO_3(g)$ ✓ ✓ $balancing$ (3)

4.4.1. Oleum / pyrosulphuric acid / $H_2S_2O_7$ ✓ (1)

4.4.2. Reaction is highly exothermic and forms a mist ✓ (1)

4.5. Ammonium sulphate / $(NH_4)_2SO_4$ ✓ (1)

4.6. Eutrophication leads to the destruction of aquatic life / dead zones ✓

This results in less income to selling of food / recreation areas ✓ (2)