2001 HIGHER SCHOOL CERTIFICATE EXAMINATION

Chemistry

Section I – Part B (continued)

Marks

Question 19 (7 marks)

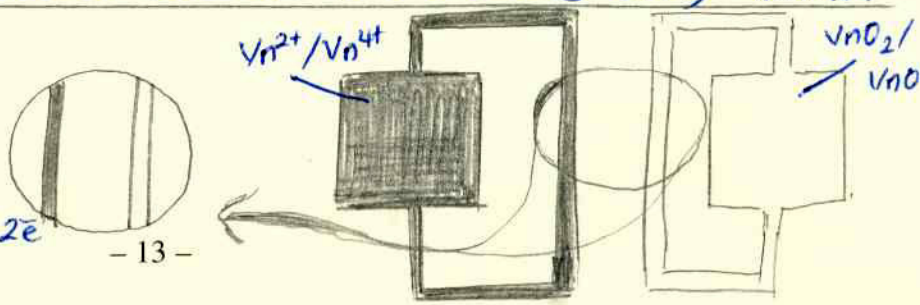
Name ONE type of cell, other than the dry cell or lead–acid cell, you have studied. Evaluate it in comparison with either the dry cell or lead–acid cell, in terms of chemistry and the impact on society. Include relevant chemical equations in your answer. **7**

The dry cell, or Leclanche cell is perhaps one of the oldest and most common batteries used by society. (named after its' inventor Georges Leclanche). It consists of primary cell with a graphite cathode, a zinc anode (also acts as the casing) and an ammonium hydroxide/manganese paste as electrolyte. It is non-rechargeable and best used infrequently as it somewhat polarises. Disposal of these can post some environmental problems, and leakage is also a potential hazard. Comparatively, the vanadium redox cell is a new development - it is still in its early stages. However, it may prove to be revolutionary both in terms of its chemistry and impact of society. The vanadium redox cell consists of vanadium in different oxidation states. Thus, it is infinitely rechargable and highly energy efficient - thus removing the likelihood of it being an environmental hazard. ~~The~~ VRBs are possibly the new alternative to lead-acid batteries, and can also be used in remote areas to store ~~photo~~ energy obtained from photovoltaic devices. It is currently being trialled.

(anodic reaction: $Zn \longrightarrow Zn^{2+} + 2e$)

but results look promising when compared to the Leclanche cell.

~~Eg~~



∴ anodic reaction:

$Vn^{2+} \longrightarrow Vn^{4+} + 2e^-$

Marks

Question 20 (4 marks)

A 0.1 mol L^{-1} solution of hydrochloric acid has a pH of 1.0, whereas a 0.1 mol L^{-1} solution of citric acid has a pH of 1.6.

(a) State ONE way in which pH can be measured. **1**

pH can be measured using colorimetry methods. ie using an indicator such as universal indicator and compare the result to a colour chart according to the indicator.

(b) Explain why the two solutions have different pH values. **3**

While both HCl and citric acid have the same molarity in this case, hydrochloric is a much stronger acid in that it completely dissociates into ions when in solution compared to citric acid which only enters an equilibrium in which not all of its ions dissociate (ie weak acid). Therefore even though they have the same molarity there is a differing concentration of H^+ ions therefore affecting pH, causing citric acid to have a higher pH.

Marks

Question 21 (4 marks)

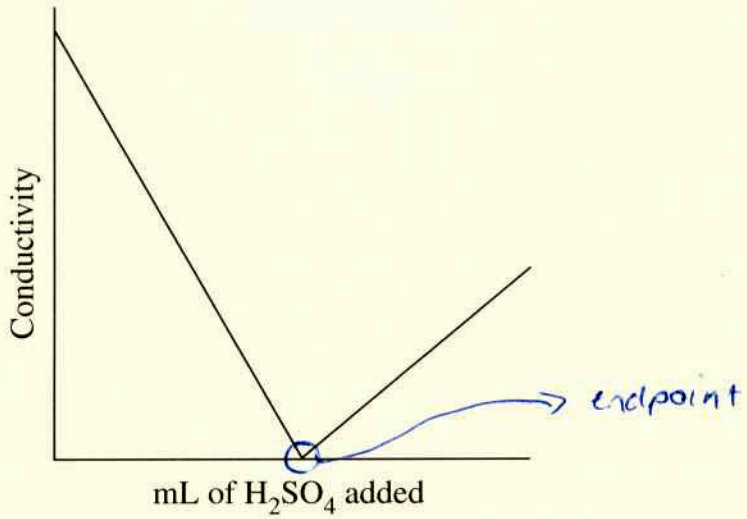
Barium hydroxide and sulfuric acid react according to the following equation:

$$Ba(OH)_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2H_2O(l)$$

(a) Name this type of chemical reaction. **1**

neutralisation

(b) A 20 mL sample of barium hydroxide was titrated with 0.12 mol L^{-1} sulfuric acid. The conductivity of the solution was measured throughout the titration and the results graphed, as shown. **3**



Explain the changes in conductivity shown by the graph.

Barium hydroxide ($Ba(OH)_2$) is a strong base and sulfuric acid (H_2SO_4) is a strong acid. With this in mind: conductivity decreases as H_2SO_4 is added to the $Ba(OH)_2$. This is because neutralisation is occurring, thus removing the mobile ions which allow for conductivity. At the endpoint of the titration, there is complete neutralisation (all products converted into $BaSO_{4(s)}$ and H_2O) therefore 0 conductivity. Then as excess sulfuric acid is added, the ~~so~~ aliquot becomes acidic and there are mobile ions in solution to allow for conductivity once again. Therefore conductivity increases.