SL HL Paper 3 Section A Experimental work (7) with worked answers

An experiment was performed to find the concentration of a solution of sodium hydroxide.

1.203 g of hydrated oxalic acid crystals, $(COOH)_2.2H_2O$, were dissolved in distilled water and the total volume made up to 100 cm^3. This solution was used to fill a burette.

10.0 cm^3 of sodium hydroxide solution of unknown concentration were added to a conical flask and titrated with the oxalic acid solution. Phenolphthalein was used as the indicator.

The titration was repeated two more times to determine the average volume of the oxalic acid solution required to reach the end point.

(a) A student calculated the concentration of the oxalic acid solution to be 0.134 mol dm^{-3}. He arrived at this answer by multiplying the mass taken by ten to give the mass in 1.00 dm^3 of solution and then dividing by the molar mass of oxalic acid.

(10 x 1.203) ÷ ((2 x 12.01) + (4 x 16.00) + (2 x 1.01)) = 0.134 mol dm^{-3}.

Outline the major error in the student's calculation and determine the correct value for the concentration. ***[2]***

The student has not included the water of crystallisation in the sum for the molar mass. The correct molar mass should be 126.05 g mol^{-1}. ***[1]***

The correct concentration = 12.03 ÷ 126.05 = 0.0954 mol dm^{-3}. ***[1]***

(b) Identify the piece of glassware that should be used to ensure the total volume of 100 cm^3 is as accurate as possible when preparing a standard solution. ***[1]***

A volumetric flask. (The flask is filled until the bottom of the meniscus lies on the graduated mark.) ***[1]***

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c) Before placing the oxalic acid solution in the burette the student washed out the burette with distilled water but then omitted to dry it before adding the oxalic acid solution. Explain how this would affect the final result for the concentration of the sodium hydroxide solution. ***[1]***

It will make the oxalic acid slightly weaker so more of the acid will be required to neutralise the sodium hydroxide. This means that the concentration of the sodium hydroxide will be determined to be slightly higher than the true value. ***[1]***

(d) The student also washed out the conical flask with distilled water and omitted to dry it before adding the 10.0 cm^3 of the sodium hydroxide solution and then performing the titration with the oxalic acid solution. Explain the effect this would have on the final result for the concentration of the sodium hydroxide solution. ***[1]***

It will have no effect. It does not alter the amount of sodium hydroxide present so the same amount of oxalic acid solution will be required to neutralise it. ***[1]***

(e) Oxalic acid is a diprotic acid. Assuming the sodium hydroxide solution has a very similar concentration to the solution of oxalic that was prepared, predict how the electrical conductivities of the two solutions will compare. ***[1]***

The sodium hydroxide solution will have a much higher conductivity as it is a strong base so is completely ionized in solution. Oxalic acid is a weak acid. As it is only slightly dissociated, the concentration of ions in solution will be much lower, which will make the conductivity much less. ***[1]***