IB · HL · Chemistry

60 mins 3 questions

Practice Paper 1B

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Total Marks **/35**

1 (a) A student investigated the enthalpy change of neutralisation by gradually adding aqueous potassium hydroxide (KOH) to a known volume of aqueous ethanoic acid (CH_3COOH) in a polystyrene cup. A temperature probe recorded the temperature after each addition.

The following data were obtained:

Volume of KOH added (±0.1 cm^3)	0.0	5.0	10.0	15.0	20.0	25.0	30.0	35.0
Temperature (±0.1 °C)	22.5	24.7	26.5	27.8	28.6	28.9	28.7	28.4

(i) Describe the overall trend in the temperature as the volume of KOH increases.

[1]

(ii) Suggest a reason for the slight decrease in temperature after 25.0 cm^3 of KOH have been added.

[1]

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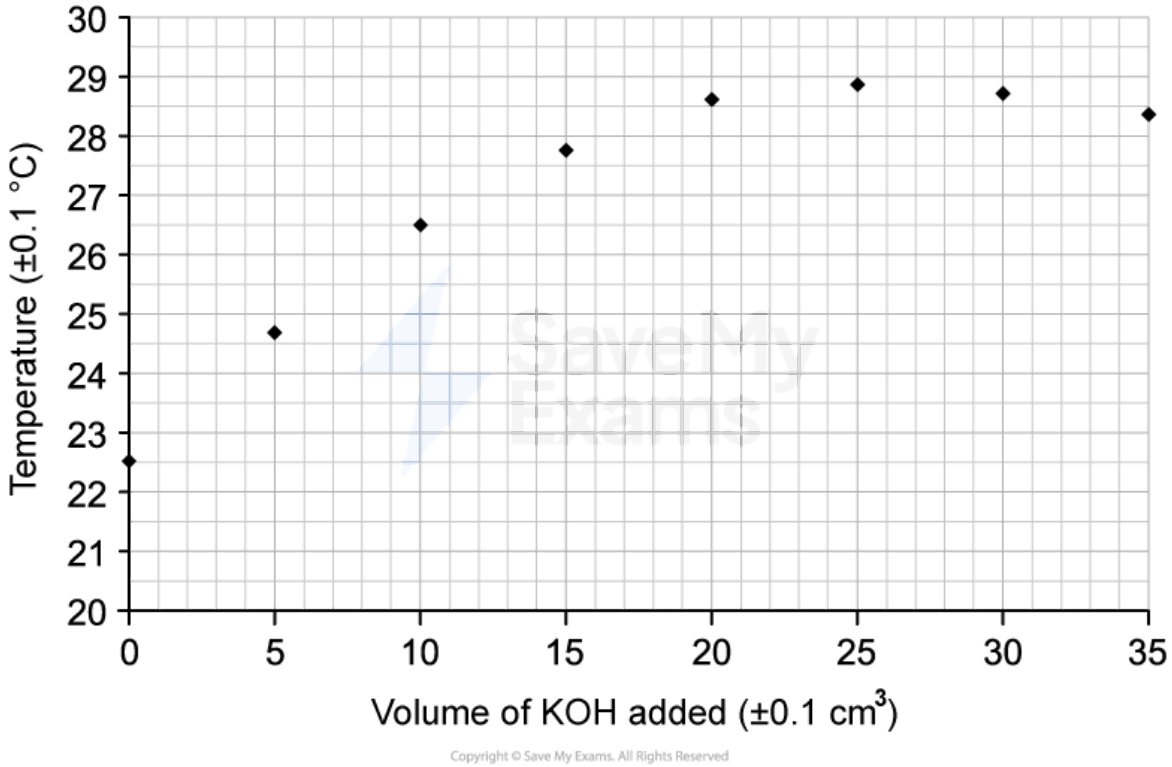
..... **(2 marks)**

(b) A graph of temperature against volume of KOH added was plotted.



Estimate the volume of KOH added at which neutralisation is complete, based on the data.

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(1 mark)

(c) The concentration of the ethanoic acid was 1.00 mol dm^{-3}, and the volume used was 25.0 cm^3.

Determine the number of moles of ethanoic acid in the cup before titration began.

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(1 mark)

(d) The student forgot to record the concentration of the KOH solution.

Describe how the temperature data and the enthalpy change of neutralisation (ΔH_{neut} = –57.0 kJ mol^{-1}) can be used to determine the concentration of the KOH solution.

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(3 marks)

(e) Identify one assumption made in the method described in (d), and explain how it could affect the final value obtained.

(2 marks)

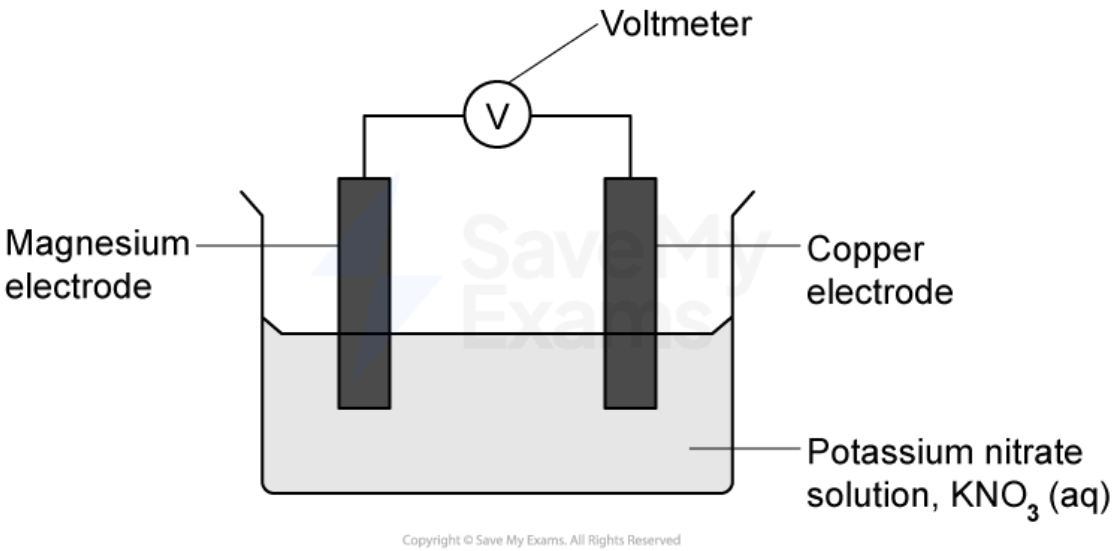
(f) Suggest two improvements to the experimental method to reduce heat loss to the surroundings.

(2 marks)

2 (a) A student investigated how the distance between two electrodes affects the current in a voltaic cell. She used a magnesium electrode and a copper electrode, connected by wires to a voltmeter. Both electrodes were immersed in aqueous potassium nitrate (KNO_3) solution.

The experiment was repeated with two different concentrations of KNO_3: 0.50 mol dm^{-3} and 1.00 mol dm^{-3}. For each trial, the student increased the distance between the electrodes from 2.0 cm to 10.0 cm and recorded the current.

A diagram of the setup is shown below.



Identify the direction of electron flow in the external circuit and explain your answer.

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..... **(2 marks)**

(b) (i) Write the half-equation for the reaction occurring at the magnesium electrode.

[1]

(ii) Explain whether the magnesium electrode acts as the anode or cathode.

[1]

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..... **(2 marks)**

(c) Explain why the current is higher in the 1.00 mol dm^{-3} KNO_3 solution than in the 0.50 mol dm^{-3} solution.

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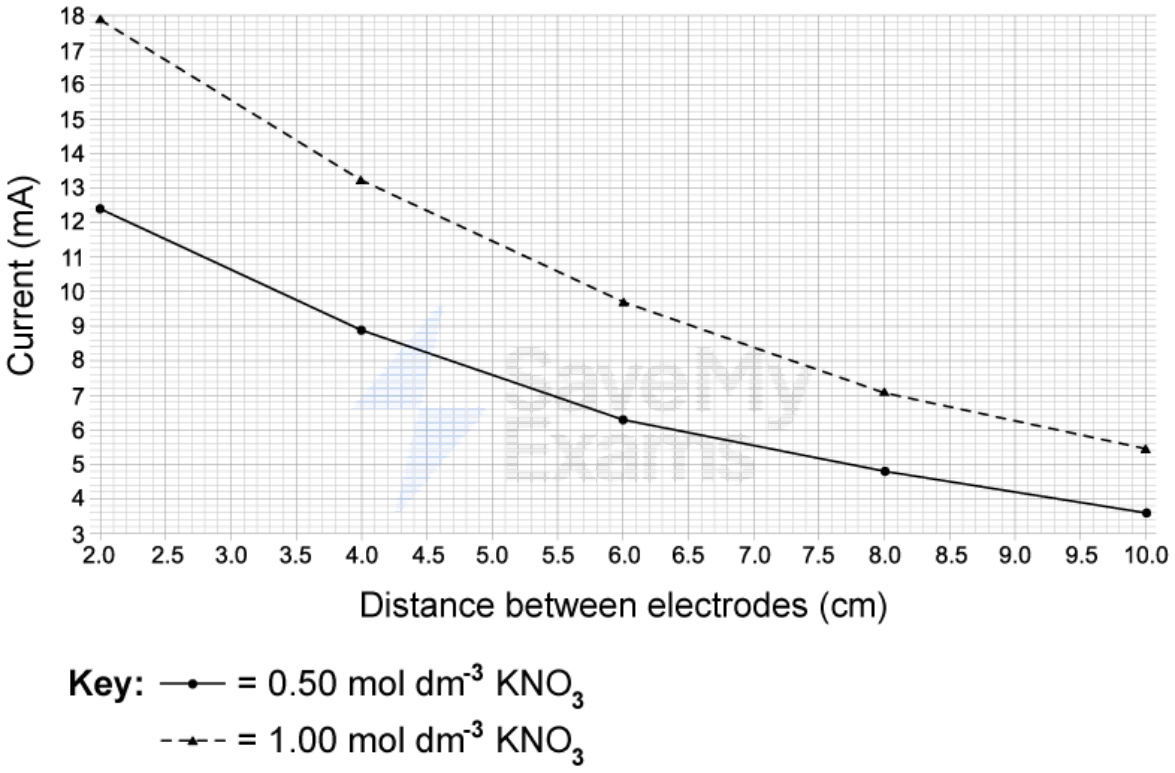
(2 marks)

(d) The student's results are shown in the graph below.



(i) Use the graph to estimate the current for the 1.00 mol dm^{-3} solution when the electrodes are 6.0 cm apart.

[1]

(ii) Calculate the percentage increase in current at 4.0 cm when using the 1.00 mol dm^{-3} solution instead of the 0.50 mol dm^{-3} solution.

[2]

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(3 marks)

(e) Explain the shape of the graph using ideas about ion movement and solution resistance.

(2 marks)

(f) The student considered replacing the Mg and Cu electrodes with platinum.

(i) Explain whether this change would improve the reliability of the results.

[2]

(ii) Suggest one controlled variable (other than distance, electrode material, and concentration) that should remain the same in each trial.

[1]

(3 marks)

3 (a) A student investigates the buffering effect of different concentrations of a weak acid and its conjugate base. The acid used is ethanoic acid (CH_3COOH), and the conjugate base is sodium ethanoate (CH_3COONa).

The student prepares three buffer solutions, each with a total concentration of 0.200 mol dm^{-3}, but with varying ratios of acid to conjugate base. The pK_a of ethanoic acid is 4.76.

Buffer	[CH_3COOH] / mol dm^{-3}	[CH_3COO^-] / mol dm^{-3}
A	0.150	0.050
B	0.100	0.100
C	0.050	0.150

Calculate the pH of buffer A using appropriate principles of buffer chemistry.

(pK_a of CH_3COOH = 4.76)

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..... **(2 marks)**

(b) Explain why all three buffer solutions have the same total concentration but different pH values.

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..... **(2 marks)**

(c) The student tests the ability of each buffer to resist changes in pH.
A small volume of 1.00 mol dm^{-3} HCl is added to each buffer, and the new pH is recorded:

Buffer	pH before	pH after HCl added
A	4.48	4.33
B	4.76	4.59
C	5.04	4.91

Use the data to identify which buffer had the greatest buffering capacity against added acid, and explain your reasoning.

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(2 marks)

(d) Buffer B is tested by adding a small amount of sodium hydroxide. The pH increases from 4.76 to 4.94.

Explain why the pH of this buffer changes only slightly.

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(2 marks)

(e) The student prepares a fourth buffer using 0.200 mol dm^{-3} of CH_3COONa only, with no CH_3COOH.

Predict whether this solution can act as a buffer and justify your answer.

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(2 marks)