1 A student investigated the reaction between iodine and propanone in acidic conditions.

$$CH_3COCH_3(aq) + I_2(aq) \rightarrow CH_3COCH_2I(aq) + HI(aq)$$

- 50 cm^3 of 0.020 mol dm^{-3} iodine solution was measured into a flask.
- 25 cm^3 of propanone and 25 cm^3 of 1.0 mol dm^{-3} sulfuric acid were measured into a second flask.
- Several 10 cm^3 samples of 0.5 mol dm^{-3} sodium hydrogencarbonate solution were placed in separate conical flasks.
- The mixture of propanone and sulfuric acid was added to the iodine, and a clock started.
- At two minute intervals, 10 cm^3 of the reaction mixture was removed and added to one of the flasks containing sodium hydrogencarbonate solution.
- The contents of this flask were then titrated with 0.01 mol dm^{-3} sodium thiosulfate.

(a) Explain the purpose of adding the reaction mixture to the sodium hydrogencarbonate.

(2)

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(b) What indicator should be used in the titration?

(1)

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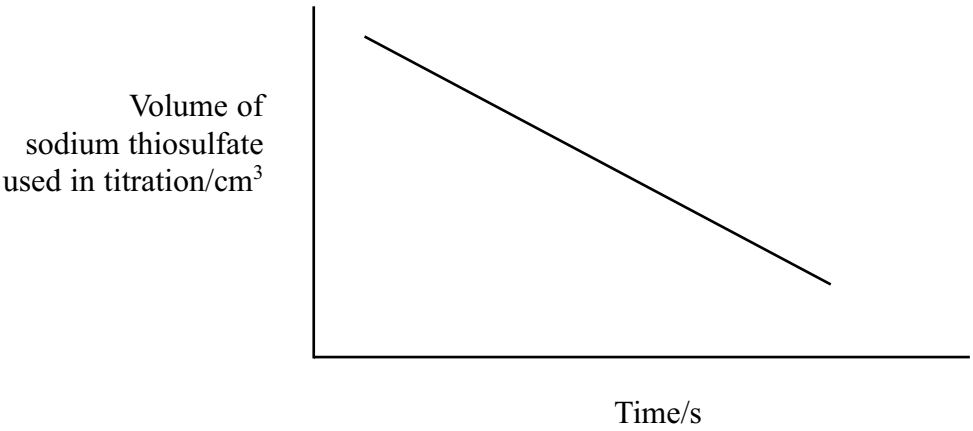
*(c) In this experiment the concentration of the iodine was 0.020 mol dm^{-3} and the concentrations of propanone and sulfuric acid were both 1.00 mol dm^{-3}. Why was the iodine solution used much less concentrated than the propanone and sulfuric acid?

(2)

(d) The shape of the graph obtained from the results of the experiment is shown below.



Use the graph to deduce the order of reaction with respect to iodine, explaining your reasoning.

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(e) The solutions used in this experiment could be measured using either measuring cylinders or pipettes.

Give **one** advantage of using a measuring cylinder and **one** advantage of using a pipette.

(2)

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(f) In a further investigation, different volumes of sulfuric acid, propanone, iodine and water were mixed. The time taken for the mixture to go colourless was measured.

The experiments were repeated and the results below show average values for the rate of the reaction.

Expt	2 mol dm ^{3} H_2SO_4 /cm^3	2 mol dm ^{3} propanone /cm^3	Water /cm^3	0.01 mol dm ^{3} iodine /cm^3	Rate /mol dm ^{3} s ^{1}
1	20.0	8.0	0	4.0	8×10^{5}
2	10.0	8.0	10.0	4.0	4×10^{5}
3	20.0	4.0	4.0	4.0	4×10^{5}

(i) Explain why water is added in experiments 2 and 3.

(1)

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(ii) Show how you would use the data in the table to deduce the order of reaction with respect to propanone and hydrogen ions. Write the rate equation for the reaction.

(3)

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(Total for Question 13 marks)

2 ***(a)** Ethanol can be oxidized successively to ethanal and to ethanoic acid.

The boiling temperatures of these substances are:
ethanol 78 °C, ethanal 21 °C, ethanoic acid 118 °C.

Explain in terms of the intermolecular forces in the liquids why the order of the boiling temperature is

ethanal < ethanol < ethanoic acid

(3)

(b) State what tests you would perform in each case, and the result you would expect, to show that

(i) ethanal contains a carbonyl group.

(2)

(ii) ethanal is an aldehyde.

(2)

(c) Ethanal reacts with HCN, in the presence of a catalyst of cyanide ions from KCN, to give a cyanohydrin, $CH_3CH(OH)CN$.

(i) Give the mechanism for this reacti

(3)

(ii) Explain why it is necessary to use HCN and KCN in this reaction, rather than HCN on its own.

(1)

*(iii) Explain why the product mixture from this reaction is **not** optically active.

(2)

(Total for Question = 13 marks)