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Level: CIE AS and A Level (9701)

Subject: Chemistry

Topic: CIE Chemistry

Type: Topic Question

2002

XVIII

1583

Chemistry CIE AS & A Level
To be used for all exam preparation for 2025+

CHEMISTRY

AS and A

This to be used by all students studying CIE AS and A level Chemistry (9701) But students of other boards may find it useful

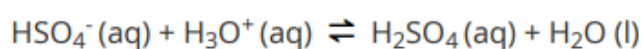


Question 1.

(a) Define a Brønsted-Lowry acid.

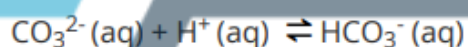
(1 mark)

(b) Which species in the following reaction acts as a Brønsted-Lowry base.



(1 mark)

(c) Which species in the following equation is acting as a Brønsted-Lowry acid.



(1 mark)

(d) Propanoic acid, $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$ is classed as a weak acid.

Write an equation to show the dissociation of propanoic acid.

(1 mark)



Question 2.

(a) A pH curve can be drawn from the data recorded from the following procedure

Step 1 Placing a fixed volume of a HCl (aq) into a beaker

Step 2 Add KOH (aq) in known small portions from a burette and stir

Step 3 Use pH meter to record pH after every addition of alkali

Sketch a curve on the graph in Fig. 6.1 for a strong acid - strong base titration that could be drawn after this procedure is carried out.

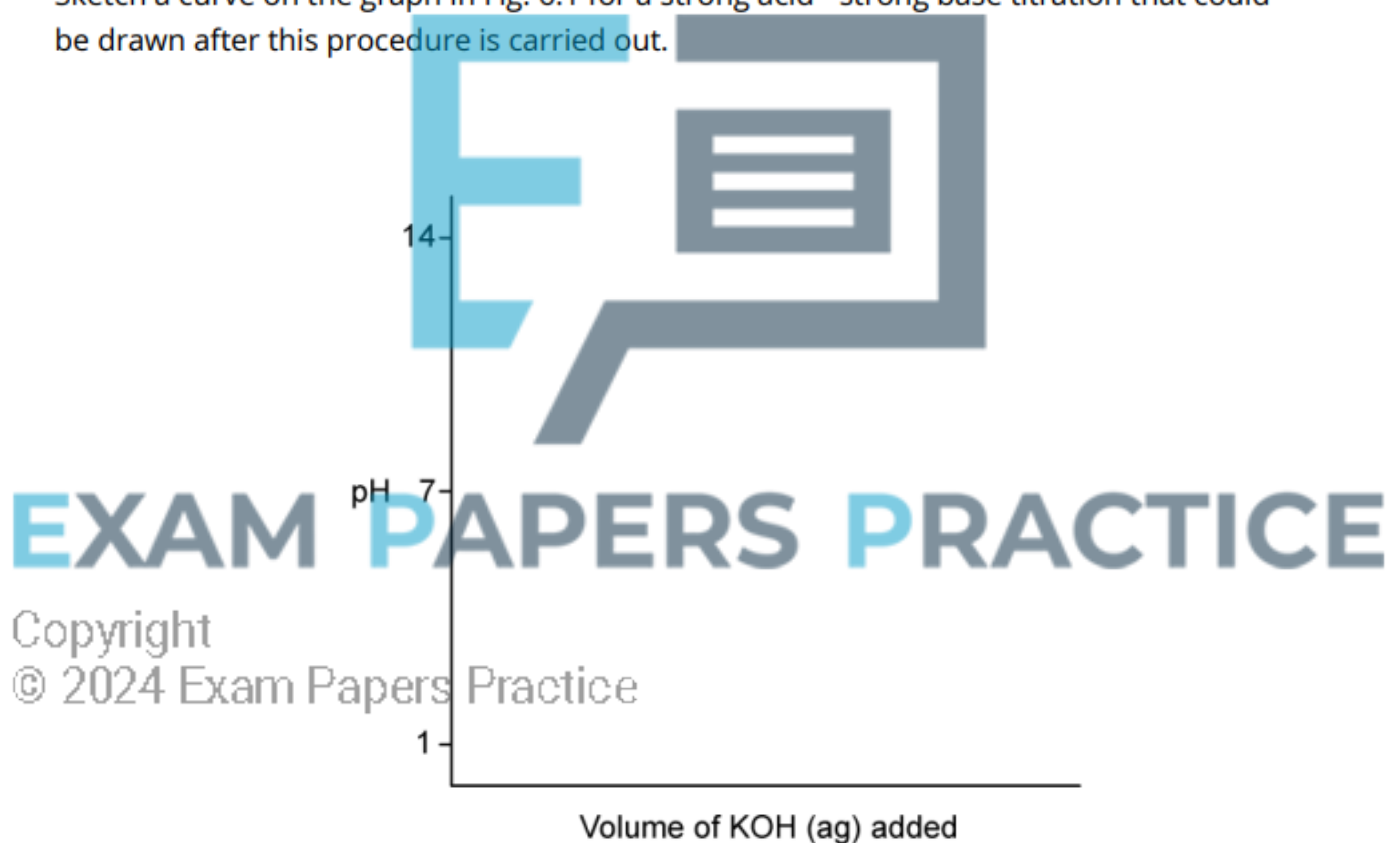


Fig. 6.1

(3 marks)



- (b) A titration was performed between ethanoic acid, $\text{CH}_3\text{CO}_2\text{H}$ (aq) and sodium hydroxide, NaOH (aq). Using the information in Table 6.1, suggest which indicator would be suitable for this titration.

Table 6.1

Indicator	pH range
Pentamethoxy red	1.2 - 3.2
Naphthyl red	3.7 - 5.0
4-nitrophenol	5.6 - 7.0
Cresol purple	7.6 - 9.2

- i) Write an equation for the reaction between ethanoic acid and sodium hydroxide [1]
- ii) Using the information in Table 6.1, suggest which indicator would be suitable for this titration [1]

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- (c) Apart from using an indicator or pH probe, describe **one** test that could be used to show that hydrochloric acid is a stronger acid than ethanoic acid of the same concentration.

(2 marks)



Question 3.

(a) This question is about Brønsted-Lowry acids and bases.

i) Give the meaning of the term Brønsted-Lowry base.

[1]

ii) Explain the term weak acid.

[2]



(3 marks)

(b) A student titrated 0.10 mol dm^{-3} acid into a conical flask containing 25.0 cm^3 of 0.1 mol dm^{-3} of a base, recording the pH with each addition of acid.

The student repeated the procedure using different combinations of acids and bases.

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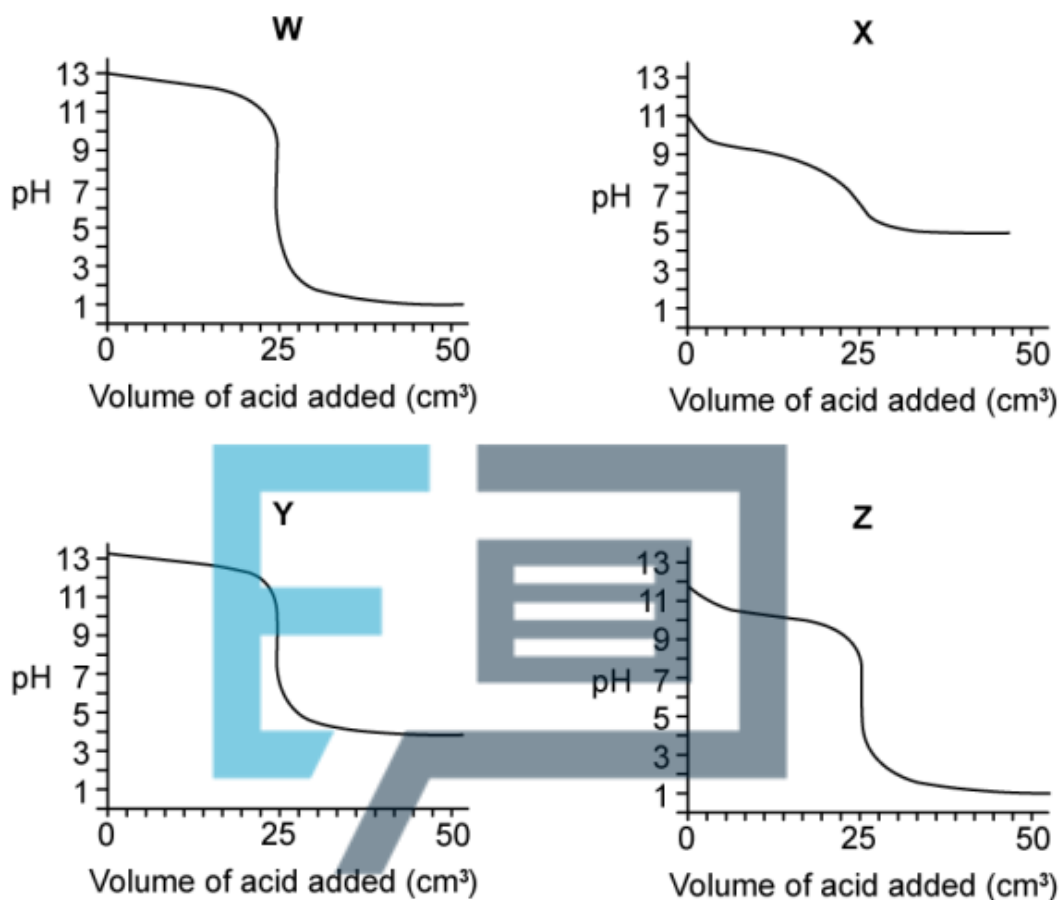


Fig. 5.1

Identify which curve shown above in Fig. 5.1, is the acid-base combination for the following:

i) Ammonia and ethanoic acid.

[1]

ii) Ammonia and nitric acid.

[1]



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iii) Sodium hydroxide and propanoic acid.

[1]

(3 marks)



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(c) Identify which indicator given in Table 5.2 would be most suitable for curve Z. Justify your answer.

Table 5.2

Indicator	pH range
Methyl orange	3.1 - 4.4
Phenolphthalein	8.3 - 10.0
Bromothymol blue	6.0 - 7.6

(3 marks)

(d) Water is amphoteric and will react with nitric acid and ammonia.

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i) Write an equation to show how water reacts with ammonia

[1]

ii) Explain the term amphoteric.

[1]

(2 marks)



Question 5.

(a) **A** and **B** are two solutions of the same concentrations that have pH values of 3 and 6 respectively.

i) Identify which is the stronger acid and calculate the concentration of hydrogen ions in each solution.

[2]

ii) Calculate the ratio of the hydrogen ion concentrations in both **A** and **B**.

[1]

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(3 marks)



- (b) The variation of conductivity and concentration of a strong and weak monoprotic acid are shown in Fig. 2.1.

Identify the strong and weak acid from the information given and justify your choices.

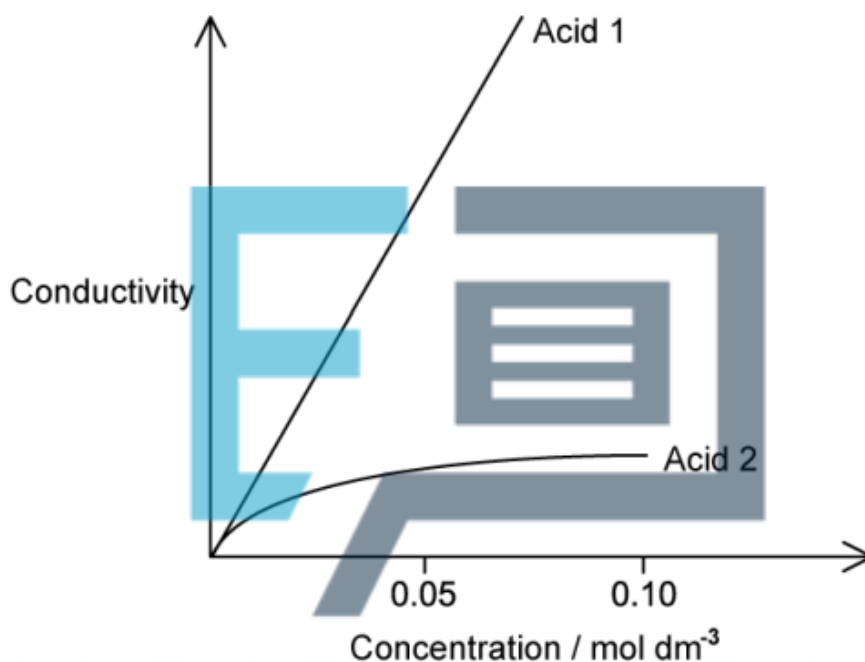


Fig. 2.1

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(3 marks)

- (c) For acid 1 and acid 2 in Fig. 2.1 in part (b) compare the volume of 0.2 mol dm⁻³ NaOH required to neutralise 20 cm³ of 0.1 mol dm⁻³ solutions of the acids.

(1 mark)



Question 5.

- (a) Glycolic acid, $C_2H_4O_3$, is an organic acid sometimes used to remove limescale, $CaCO_3$, from electric kettles and coffee machines.

Predict, with a reason, a difference in the reaction between the same concentration of sulfuric acid and glycolic acid with samples of calcium carbonate.

----- (2 marks)

- (b) A solution of hydrochloric acid has a pH of 1 and a solution of carbonic acid has a pH of 5. Determine the ratio of hydrogen ion concentrations of hydrochloric acid to carbonic acid.

----- (2 marks)

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- (c) Outline two ways, apart from using pH, which could allow you to distinguish between two solutions of carbonic acid and hydrochloric acid that have the same concentration.

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----- (4 marks)



Question 6.

(a) A student carried out some acid-base titrations using different reactants.

The indicators and their pH range are given in Table 1.1.

Table 1.1

Indicator	pH range
methyl red	4.2 - 6.3
bromothymol blue	6.0 - 7.6
bromocresol green	3.8 - 5.4
phenolphthalein	8.2 - 10.0

In the first titration, they titrated 10.0 cm^3 of $0.200 \text{ mol dm}^{-3}$ HCl against $0.200 \text{ mol dm}^{-3}$ aqueous ammonia.

Sketch the pH curve that would be obtained from this titration.

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(3 marks)

(b) Using Table 1.1, explain why methyl red is a suitable indicator for the first titration but phenolphthalein is not.

(2 marks)

(c) In a second titration, the student titrated 25.0 cm^3 of $0.200 \text{ mol dm}^{-3}$ sodium hydroxide against $0.100 \text{ mol dm}^{-3}$ ethanoic acid solution.

Sketch the graph that would be obtained for this titration.



(3 marks)

- (d) Using Table 1.1, explain why phenolphthalein is a suitable indicator for the second titration but methyl orange is not.

(2 marks)

- (e) Explain whether the other two indicators in Table 1.1 are suitable for use in either titration.

(4 marks)

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Question 7.

- (a) Malonic acid is a weak dibasic carboxylic acid with the formula $C_3H_4O_4$. Draw the displayed structure of malonic acid.

(1 mark)

- (b) Suggest, with a reason, whether ethanoic acid or malonic acid has a higher pH.

(2 marks)

- (c) Apart from testing the pH, suggest how equimolar solutions of malonic acid and ethanoic acid may be distinguished.

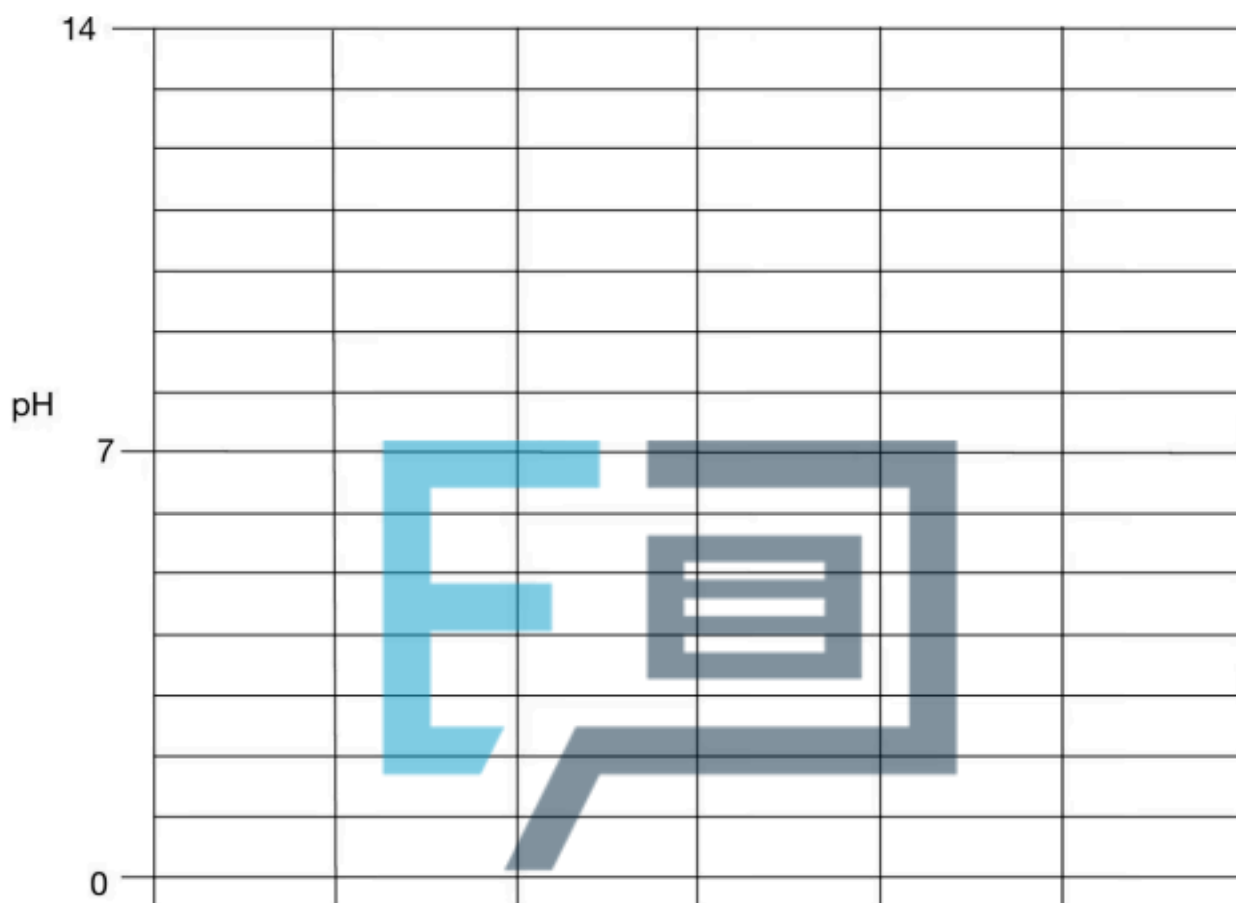
(1 mark)

- (d) 30.0 of $0.075 \text{ mol dm}^{-3}$ CH_3COOH with a pH of 2.93 was slowly added to a sample of 10.0 cm^3 $0.150 \text{ mol dm}^{-3}$ KOH with a pH of 13.1. The pH was measured throughout the addition.

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On the following axes, sketch how the pH will change during the addition of a total of 30.0 of 0.075 CH_3COOH .



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Volume of CH_3COOH added / cm^3

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(3 marks)