

Equilibria

Question Paper 1

Level	International A Level
Subject	Chemistry
Exam Board	Edexcel
Topic	Rates, Equilibria & Further Organic Chemistry
Sub Topic	Equilibria
Booklet	Question Paper 1

Time Allowed: 52 minutes

Score: /43

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 The pH of three solutions with concentration 1.0 mol dm^{-3} was measured.

Solution 1 NH_3

Solution 2 CH_3COONa

Solution 3 NH_4Cl

Which of the following shows the three solutions in order of **increasing** pH?

- A 1, 2, 3
- B 3, 2, 1
- C 3, 1, 2
- D 2, 1, 3

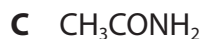
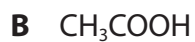
(Total for Question 1 = 1 mark)

2 Calculate the pH of an aqueous solution of hydrochloric acid, HCl, of concentration 0.40 mol dm^{-3} .

- A 0.40
- B -0.40
- C -0.92
- D 0.92

(Total for Question 2 = 1 mark)

3 Consider the four compounds shown below.



Which of these compounds

(a) forms the **most** acidic solution when equimolar amounts of each compound are separately dissolved in 10 cm^3 of water?

(1)

A

B

C

D

(b) has a peak at 3348 cm^{-1} in its infrared spectrum? Use your Data Booklet.

(1)

A

B

C

D

(c) is most likely to be used as a fruit-flavoured food additive?

(1)

A

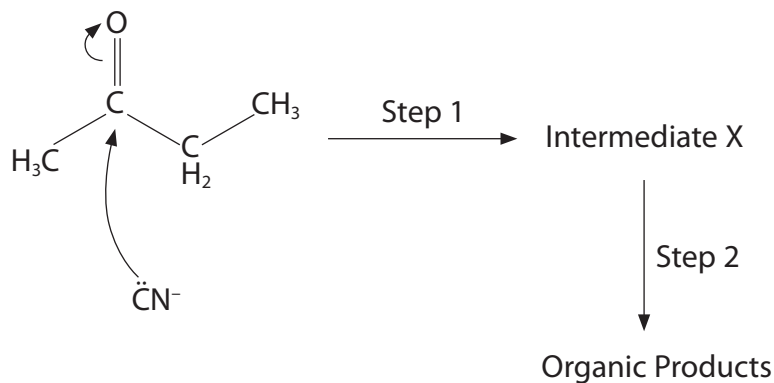
B

C

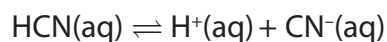
D

(Total for Question 3 = 3 marks)

- 4 This question is about the nucleophilic addition of hydrogen cyanide to butanone. The diagram below shows part of the mechanism for this reaction.



- (a) Consider the dissociation of the weak acid HCN.



Which of the following reagents would lower the concentration of the nucleophile, CN^- , by the greatest extent?

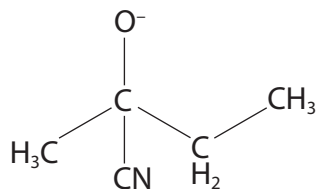
(1)

- A CH_3COOH
- B HCl
- C NH_3
- D KOH

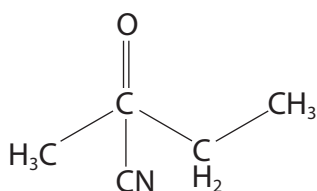
(b) The intermediate X is

(1)

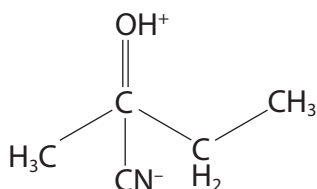
A



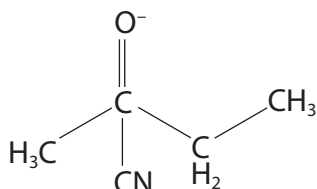
B



C



D



(c) Which statement about the mixture of organic products formed is **not** correct?
The mixture

(1)

- A contains products with one more carbon atom than the ketone.
- B rotates the plane of plane-polarized light.
- C contains products with the nitrile functional group.
- D contains products with chiral molecules.

(Total for Question 4 = 3 marks)

- 5 A buffer solution is 0.1 mol dm^{-3} with respect to ethanoic acid and 0.05 mol dm^{-3} with respect to sodium ethanoate.

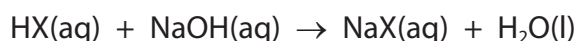
$$K_a \text{ for ethanoic acid} = 1.7 \times 10^{-5} \text{ mol dm}^{-3}$$

The pH of this buffer solution is

- A 2.88
- B 4.47
- C 4.77
- D 5.07

(Total for Question 5 = 1 mark)

- 6 The equation for the reaction between a weak acid, HX, and sodium hydroxide is



The pH of the solution of the salt NaX is most likely to be

- A 5.5
- B 7.0
- C 8.5
- D 13.0

(Total for Question 6 = 1 mark)

- 7 In acid solution, methyl orange is red. When an alkali is added, the solution turns yellow because the indicator

- A gains OH^- ions to form cations.
- B loses H^+ ions to form cations.
- C gains OH^- ions to form anions.
- D loses H^+ ions to form anions.

(Total for Question 7 = 1 mark)

8 Propanoic acid is a weak Brønsted-Lowry acid.

(a) Define the term Brønsted-Lowry acid.

(1)

(b) What is the pH of a $0.100 \text{ mol dm}^{-3}$ solution of hydrochloric acid?
How would the pH of any weak acid of the same concentration differ from the pH of hydrochloric acid?

(1)

(c) Methanoic acid was mixed with propanoic acid.

(i) Use your Data Booklet to decide which acid is stronger.
Justify your answer.

(1)

(ii) Hence complete the following equation.

(1)



(d) Calculate the pH of a solution of $0.050 \text{ mol dm}^{-3}$ sodium hydroxide.

$$[K_w = 1.0 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}]$$

(2)

(e) A buffer was made by mixing 20 cm³ of 0.050 mol dm⁻³ sodium hydroxide and 20 cm³ of 0.25 mol dm⁻³ propanoic acid.

(i) Write the equation for the reaction between sodium hydroxide and propanoic acid. State symbols are not required.

(1)

(ii) Calculate the pH of this buffer solution. Show your working. Refer to your Data Booklet where needed.

(5)

(iii) Explain how this solution acts as a buffer when a small amount of **alkali** is added. Include any relevant equations in your explanation.

(3)

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(Total for Question 8 = 15 marks)

9 Ethanoic acid, CH_3COOH , is a weak acid found in vinegar. Successive replacement of the methyl hydrogen atoms by chlorine atoms gives

chloroethanoic acid, CH_2ClCOOH

dichloroethanoic acid, CHCl_2COOH

trichloroethanoic acid, CCl_3COOH

(a) (i) Explain the term **weak acid**.

(2)

Weak

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Acid

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(ii) Write the expression for the acid dissociation constant, K_a , of dichloroethanoic acid, CHCl_2COOH .

(1)

(iii) Use the K_a data from page 18 in the Data Booklet to place the four acids, named in the introduction to the question, in order of increasing strength. State how the order that you have given can be deduced from the K_a data.

(2)

weakest acid

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strongest acid

Reason

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(b) (i) Calculate the pH of a solution of 0.10 mol dm^{-3} ethanoic acid.

State clearly any assumptions you have made.

(4)

Assumptions

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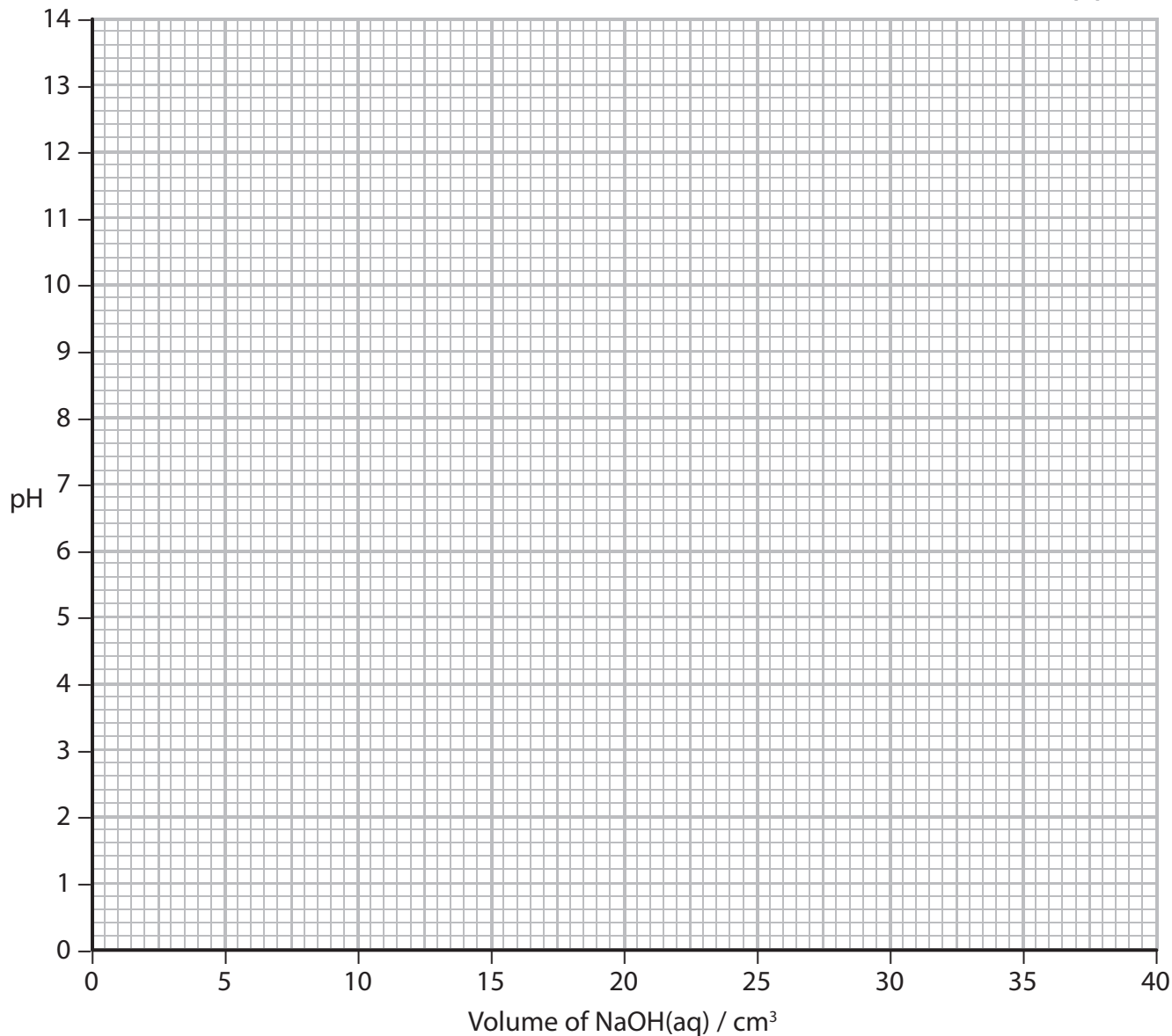
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- (ii) Draw the titration curve, showing the change in pH when 0.10 mol dm^{-3} sodium hydroxide solution is added to 25 cm^3 of 0.10 mol dm^{-3} ethanoic acid, until 40 cm^3 of sodium hydroxide has been added.

(4)



- *(iii) Select a suitable indicator for this titration.

Justify your selection.

(2)

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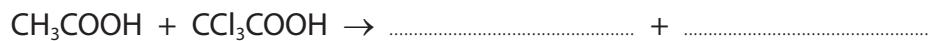
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(c) Ethanoic acid and trichloroethanoic acid react together in an acid-base reaction.

Complete the equation by writing the formulae of the acid and base produced in this reaction.

Identify the conjugate acid-base pairs in the spaces under the formulae.

(2)



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(Total for Question 9 = 17 marks)