8.2 More About Acids

Question Paper

Course	DP IB Chemistry
Section	8. Acids & Bases
Topic	8.2 More About Acids
Difficulty	Medium

Time allowed: 60

Score: /43

Percentage: /100

Question 1a

a) The equilibrium constant for the first dissociation of formic acid is 1.8×10^{-4} mol dm^{-3}. State, with a reason, the strength of formic acid.

[2 marks]

Question 1b

b) Outline **one** laboratory method used to distinguish between equimolar solutions of formic acid and hydrochloric acid, giving the expected observations.

[1 mark]

Question 1c

c) Formic acid has the chemical formula HCOOH. Identify the conjugate base of formic acid and state whether it is a weak or strong conjugate base.

[2 marks]

Question 1d

d) Draw the structure of formic acid and give its systematic IUPAC name.

[2 marks]

Question 2a

a) The pH of an aqueous solution of salicylic acid at 298 K is 3.85. Determine the concentration of hydroxide ions in the solution, using Section 2 of the Data booklet.

[2 marks]

Question 2b

b) **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.

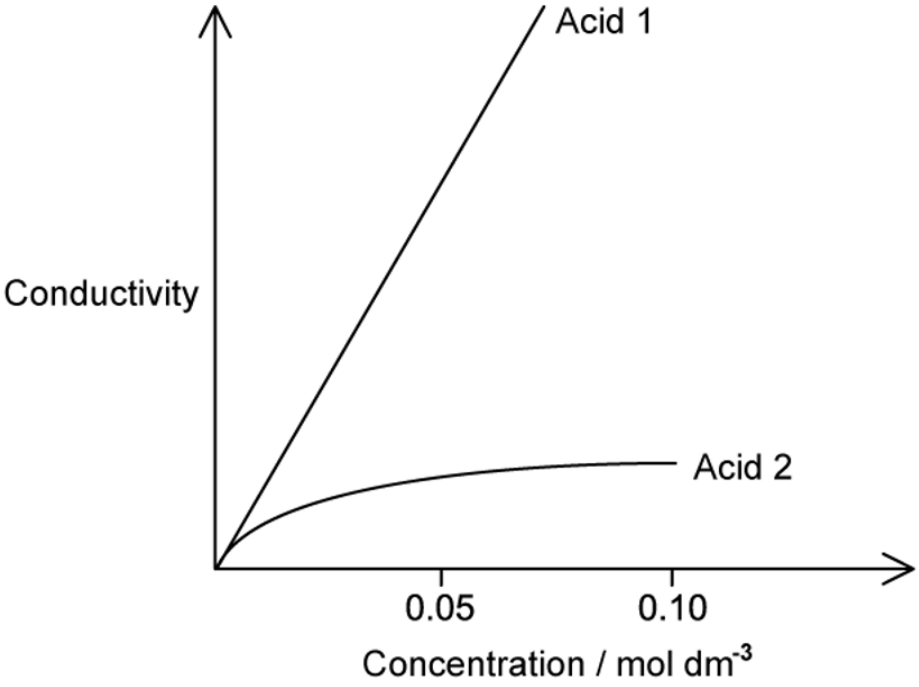
ii) Calculate the ratio of the hydrogen ion concentrations in both **A** and **B**.

[3 marks]

Question 2c

c) The variation of conductivity and concentration of a strong and weak monoprotic acid are shown in **Figure 1**.

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



[3 marks]

Question 2d

d) For acid 1 and acid 2 in part (c) compare the volume of 0.2 mol dm^{-3} NaOH required to neutralise 20 cm^3 of 0.1 mol dm^{-3} solutions of the acids

[1 mark]

Question 3a

a) The concentrations of solutions of weak acids can be determined by titration against standard solutions of alkalis, such as sodium hydroxide.

i) Explain what is meant by the term *standard solution*.

ii) State the name of the indicator which should be used for this titration and what would be observed at the equivalence point of the reaction if the sodium hydroxide is placed in the burette.

[3 marks]

Question 3b

b) A solution of 25.0 cm^3 ethanoic acid was titrated against 0.150 mol dm^{-3} NaOH (aq) and it was found that 22.35 cm^3 of the NaOH was needed for complete neutralisation.

Write an equation for the reaction and determine the concentration of the ethanoic acid.

[3 marks]

Question 3c

c) A solution of 0.1 mol dm^{-3} ammonia has a pH of approximately 11. Predict how the pH value of 0.1 mol dm^{-3} sodium hydroxide solution would compare and calculate its value.

[2 marks]

Question 3d

d) Write an equation for the reaction between ammonia and water and use it to classify each product as a Brønsted–Lowry acid or base.

[2 marks]

Question 4a

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]

Question 4b

b) Another acid that is sometimes used to descale kettles is sulfamic acid, NH_2SO_3H. Sulfamic is classed as a *strong monoprotic* acid.

i) Explain the meaning of the term *strong monoprotic acid*.

ii) Calculate the pH of a 0.136 mol dm^{-3} solution of sulfamic acid and determine the concentration of hydroxide ions in the solution at 298 K.

[3 marks]

Question 4c

c) 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]

Question 4d

d) 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.

[4 marks]

Question 5a

a) Four solutions of acids with identical concentrations are prepared. The equilibrium constants of these acids are given in **Table 1**.

Table 1

Acid	K_c mol dm^{-3} at 298 K
HCN	4.9×10^{-10}
HF	6.8×10^{-4}
CH_3COOH	1.7×10^{-5}
HCl	1.3×10^{6}

Write down the acid dissociation equation for HCN.

[1 mark]

Question 5b

b) Use the information in part (a) to complete this question.

i) Write down the list of acids in part (a) in order of **decreasing** pH.

ii) Write down the list of acids in order of **increasing** concentration of molecules of the acid present in the solution.

[2 marks]

Question 5c

c) State the name and formula of all the chemical species present in the solution of CH_3COOH.

[2 marks]

Question 5d

d) Write the name and formula of the conjugate base of HF.

[1 mark]