18.2 Calculations Involving Acids & Bases

Question Paper

Course	DP IB Chemistry
Section	18. Acids & Bases (HL only)
Topic	18.2 Calculations Involving Acids & Bases
Difficulty	Hard

Time allowed: 40

Score: /32

Percentage: /100

Question 1a

a)

Determine the K_a of benzoic acid using section 21 of the Data booklet.

[1]

[1 mark]

Question 1b

b)

Using the K_a value for benzoic acid, state and explain its acidic character.

[1]

[1 mark]

Question 1c

c)

Benzoic acid has a solubility of 0.344 g / 100 g water at 293 K. Determine the hydrogen ion concentration and pH of saturated benzoic acid solution at this temperature.

[5]

[5 marks]

Question 1d

d)

What assumption is made in the calculation in part c)?

[1]

[1 mark]

Question 2a

a)

Nitric acid, HNO_3, and hydrocyanic acid, HCN, can be made from ammonia. Hydrocyanic acid has a pK_a of 9.21.
Formulate equations for the dissociation of each acid and distinguish between the terms strong and weak in this context.

[3]

[3 marks]

Question 2b

b)

Write an expression for the acid dissociation constant, K_a, of hydrocyanic acid and calculate the K_a at 298 K.

[2]

[2 marks]

Question 2c

c)

Determine the hydrogen ion concentration and pH of 0.15 mol dm^{-3} hydrocyanic acid.

[2]

[2 marks]

Question 2d

d)
Write an expression to show the ionisation of the conjugate base of hydrocyanic acid and calculate it K_b value.

[2]

[2 marks]

Question 3a

a)
Calculate the pH of a solution made by mixing 50.0 cm^3 of $0.200 \text{ mol dm}^{-3}$ HCl (aq) with 50.0 cm^3 of $0.100 \text{ mol dm}^{-3}$ NH$_3$ (aq)

[3]

[3 marks]

Question 3b

b)
A $0.100 \text{ mol dm}^{-3}$ solution of NH$_3$ (aq) contains $1.28 \times 10^{-3} \text{ mol dm}^{-3}$ in hydroxide ion.

i)
Determine the pH of the solution.

[3]

ii)
Comment on the relative base strength of $0.100 \text{ mol dm}^{-3}$ NaOH (aq) compared to $0.100 \text{ mol dm}^{-3}$ NH$_3$ (aq)

[2]

[5 marks]

Question 3c

c)
Determine the base dissociation constant, K_b for ammonia using the information in part b).

[3]

[3 marks]

Question 3d

d)
The pH of pure water is 6.92 at 328 K and K_b for NH_3 (aq) at this temperature is 1.80×10^{-5}.
Determine the pK_a of [NH_4^+] at this temperature.

[4]

[4 marks]