Q1. (a) By reference to the forces between molecules, explain why ammonia is very soluble in water.

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(2)

(b) Aqueous solutions of ammonia have a pH greater than 7.

(i) Write an equation for the reaction of ammonia with water.

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(ii) Explain why the pH of a solution containing 1.0 mol dm^{-3} of ammonia is less than
14 at 298 K.

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(3)

(c) An ammonium ion in aqueous solution can behave as a Brønsted–Lowry acid. State what is meant by the term *Brønsted–Lowry acid*.

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(1)

(d) State what is meant by the term *buffer solution*. Identify a reagent which could be added to a solution of ammonia in order to form a buffer solution.

Buffer solution .....

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Reagent .....

(3)

(e) An acidic buffer solution is obtained when sodium ethanoate is dissolved in aqueous ethanoic acid.

(i) Calculate the pH of the buffer solution formed at 298 K when 0.125 mol of sodium ethanoate is dissolved in 250 cm^3 of a 1.00 mol dm^{-3} solution of ethanoic acid.
The acid dissociation constant, K_a, for ethanoic acid is 1.70×10^{-5} mol dm^{-3} at 298 K.

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(ii) Write an ionic equation for the reaction which occurs when a small volume of dilute hydrochloric acid is added to this buffer solution.

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(5)
(Total 14 marks)

Q2. An aqueous solution contains 4.0 g of sodium hydroxide in 250 cm^3 of solution.
($K_w = 1.00 \times 10^{-14}$ mol^2 dm^{-6})

The pH of the solution is

A 13.0

B 13.3

C 13.6

D 13.9

(Total 1 mark)

Q3. (a) At 50°C, the ionic product of water, K_w, has the value 5.48×10^{-14} mol^2 dm^{-6}.

(i) Define the term K_w

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(ii) Define the term *pH*

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(iii) Calculate the pH of pure water at 50 °C. Explain why pure water at 50 °C is still neutral even though its pH is not 7.

Calculation .....

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Explanation .....

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(5)

(b) At 25°C, K_w has the value 1.00×10^{-14} mol^2 dm^{-6}. Calculate the pH at 25 °C of

(i) a 0.150 mol dm^{-3} solution of sodium hydroxide,

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(ii) the solution formed when 35.0 cm^3 of this solution of sodium hydroxide is mixed with 40.0 cm^3 of a 0.120 mol dm^{-3} solution of hydrochloric acid.

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(8)

(c) In a 0.150 mol dm^{-3} solution of a weak acid HX at 25 °C, 1.80% of the acid molecules are dissociated into ions.

(i) Write an expression for K_a for the acid HX.

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(ii) Calculate the value of K_a for the acid HX at this temperature and state its units.

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(5)
(Total 18 marks)