NCEA past exam questions on buffer solutions

**2018**

5.11 g of sodium methanoate, HCOONa, was added to 125 mL of 0.105 mol L–1 methanoic acid, HCOOH,

to make a buffer solution. Assume there is no change in the total volume.

p*K*a(HCOOH) = 3.74 *K*a(HCOOH) = 1.82 × 10–4

(i) Give the pH range over which the resulting solution will function as a buffer.

(ii) Show, by calculation, that the pH of this buffer solution is 4.50.

*M*(HCOONa) = 68.0 g mol–1

(iii) Evaluate whether this buffer solution will be more effective at neutralising small volumes of strong acid

or strong base.

**2017**

Ammonia, NH3, is a weak base.

p*K*a(NH4+) = 9.24 *K*a(NH4+) = 5.75 × 10–10

(i) Calculate the pH of a 0.105 mol L–1 NH3 solution.

(ii) Dilute hydrochloric acid, HCl, is added to the NH3 solution until the ratio of NH3 to NH4+ in the solution is 5:1.

Determine the pH of this solution, and evaluate its ability to resist a change in pH when small volumes of strong acid or base are added.

**2015**

20.0 mL of 0.258 mol L–1 hydrofluoric acid, HF, solution is titrated with a sodium hydroxide, NaOH, solution.

The equation for the reaction is:

HF + NaOH → NaF + H2O

p*K*a(HF) = 3.17

After a certain volume of NaOH solution has been added, the concentration of HF in the solution will be

twice that of the F–. Calculate the pH of this solution, and evaluate its ability to function as a buffer.

**2014**

An aqueous solution containing a mixture of HF and sodium fluoride, NaF, can act as a buffer solution.

Calculate the mass of NaF that must be added to 150 mL of 0.0500 mol L–1 HF to give a buffer solution

with a pH of 4.02. Assume there is no change in volume. *M*(NaF) = 42.0 g mol–1 p*K*a(HF) = 3.17

**2013**

The following two solutions are mixed to form a buffer solution:

20.0 mL of 1 mol L–1 CH3NH3Cl and 30.0mL of 1 mol L–1 CH3NH2

(i) Calculate the pH of the resultant buffer solution. p*K*a (CH3NH3+) = 10.64

(ii) Explain the effect on the solution formed when a small amount of acid is added.

**2012**

(a) A mixture of aqueous solutions of NH3 and ammonium chloride, NH4Cl, can act as a buffer solution. Calculate the mass of NH4Cl required, when added to 250 mL of a 0.150 mol L–1 NH3 solution, to give a buffer solution with a pH of 8.60. Assume there is no change in volume.

*M* (NH4Cl) = 53.5 g mol–1 p*K*a (NH4+) = 9.24

(b) Discuss the ability of the NH3 / NH4Cl solution to act as a buffer at a pH of 8.60. In you answer you should:

• describe the function of a buffer solution

• evaluate its effectiveness when small amounts of acid or base are added

• include any relevant equations.

**2011**

Sodium glycolate, the sodium salt of the acid, is also used in skin care. Sodium glycolate can be represented

as **NaG**.

Calculate the amount (in moles) of sodium glycolate that must be added to 200 mL of 1.00 mol L–1 glycolic

acid solution to produce a buffer solution that has a pH of 4.00.

*Assume there is no change in volume.*

**2010**

A buffer solution is made by adding solid sodium methanoate, HCOONa, to an aqueous solution of methanoic acid, HCOOH. p*K*a(HCOOH) = 3.74

(a) Describe the function of a buffer solution.

(b) Explain why the solution made with methanoic acid, HCOOH, and sodium methanoate, HCOONa, has

the ability to act as a buffer. *Your answer should include relevant equations.*

**2009**

25.0 mL of 0.0500 mol L–1 benzoic acid solution (C6H5COOH) is titrated with 0.0500 mol L–1 sodium hydroxide solution.

The equation for the reaction is:

C6H5COOH(*aq*) + NaOH(*aq*) → C6H5COONa(*aq*) + H2O(*ℓ*)

Explain why the solution in the titration flask has buffering properties after 9.80 mL of the NaOH solution has been added, but not when 25.0 mL has been added.

**2008**

Two solutions, A and B, were made as described below.

**Solution A**: 50 mL of aqueous 1.00 mol L–1 ammonium chloride was added to 50 mL of aqueous 1.00 mol L–1 ammonia.

**Solution B**: 25 mL of aqueous 0.010 mol L–1 hydrochloric acid was added to 50 mL of aqueous 0.010 mol L–1 ammonia.

The pH of each of the solutions is 9.24.

Discuss the abilities of solutions A and B to act as buffers.

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