30th March 2018

Buffers

1) Explain why a mixture of ammonium chloride and ammonia can act as a buffer, but a mixture of hydrochloric acid and sodium chloride solution cannot.

2) If a buffer solution is composed of a weak acid and its conjugate base in a 1:1 mole ratio, why does mixing 500 mL of 1.0 mol L_1 acetic acid with 250 mL of 1.0 mol L_1 sodium hydroxide produce a buffer solution?

3) Write equations to show what happens to a buffer solution containing equimolar amounts of $H2PO_{4}$_ and HPO42_ when we add a small amount of:
a) OH_(aq)
b) H3O_(aq)

4) Why would it be unwise to use tap water to calibrate a pH meter?

5) In January 2008 researchers in the USA developed a buffer system that resists pH changes when the temperature changes. In their investigations with biologically active molecules that are very sensitive to pH they discovered that in some buffer systems the pH decreased when the temperature dropped while in other buffer systems the pH increased when the temperature dropped.
a) Why does the pH of water change when the temperature is changed?

b) What can you conclude about the buffer systems that caused a decrease in pH when the temperature dropped?

b) What can you conclude about the buffer systems that caused a decrease in pH when the temperature dropped?

c) What can you conclude about the buffer systems that caused an increase in pH when the temperature dropped? (And the answer to the problem of pH varying with temperature faced by the researchers was to simply mix two of the different types of buffer solution until there was no signifi cant change in pH during the cooling process.)

6) a) A 0.1 mol L_1 solution of acetic acid has a pH of 2.93. This changes to a pH of 4.74 when 0.1 mol of sodium acetate is added. Explain why the pH changes in this way.

b) The mixture of acetic acid and sodium acetate solutions produced in part a has 0.5 mL of 0.1 mol L_1 HCl added to it. Explain why the pH of the solution does not change significantly.

7) a) i) Using only ammonium chloride and ammonia solution, describe how you could produce a buffer solution.

ii) Explain how this buffer solution would 'work'.

b) If you wanted to decrease the pH of the buffer solution produced in part a and you only have access to ammonium chloride and ammonia solution, what would you do? Explain your answer.

c) If you wanted to produce a solution with a greater buffer capacity than that produced in part a describe the changes you would make to the production of the buffer.

8) How does ocean acidification decrease the amount of carbonate ions in seawater?

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9) Write ionic equations that illustrate how each pair of compounds can serve as a buffer pair.

(a) H_2CO_3 and $NaHCO_3$ (the "carbonate" buffer in blood)

(b) NaH_2PO_4 and Na_2HPO_4 (the "phosphate" buffer inside body cells)

(c) NH_4Cl and NH_3

MCQ

1.Which of the following would not make a good buffering system?

(A) SO42- and H2SO4
(B) HCO3- and H2CO3
(C) NH3 and NH4+
(D) CH3COO- and CH3COOH

2. Which answer most accurately defines a buffer system in chemistry?

(a). A system that is acidic and has a low pH
(b)A system that is capable of drastic pH changes when a base is added to it
(c) A system that resists changes in pH when an acid or base is added
(d) A naturally occurring solution that is neutral no matter how much acid or base is added to it

3. Which two types of chemicals are necessary buffer ingredients?

(a) A strong acid and a strong base
(b) A weak acid or weak base and the salt of the weak acid or weak base
(c) A weak acid and wea
(d) Water and a salt

4. What forms first when carbon dioxide (CO2) dissolves in water (H2O)?

a. Carbonic acid (H2CO3
b. Bicarbonate (HCO3-)
c. Protons (H+)
d. Nothing, but the temperature of the solution increases

5. A buffer solution is prepared by mixing equal moles of sodium dihydrogenphosphate and sodium hydrogenphosphate in water. Which one of the following statements applies to the buffer solution?

(a) Addition of a few drops of concentrated hydrochloric acid solution will produce more dihydrogenphosphate ions.
(b) Addition of a few drops of concentrated sodium chloride solution will produce more dihydrogenphosphate ions and hydrogenphosphate ions.
(c) Most of the hydrogen ions will be supplied by water.
(d) Addition of water to the buffer will reduce its buffering capacity.

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6. Which of the following would not make a good buffering system?
(A) SO_4^{2-} and H_2SO_4
(B) HCO_3^- and H_2CO_3
(C) NH_3 and NH_4^+
(D) CH_3COO^- and CH_3COOH

7. Which solution would show the least change in pH upon addition of 3.0 mL of 1.0 M KOH? (Assume equal volumes of each solution are used. Ka for $HC_2H_3O_2 = 1.8 \times 10^{-5}$)
(A) A solution that is 0.50 M acetic acid and 0.50 M sodium acetate.
(B) A solution that is 0.10 M acetic acid and 0.10 M sodium acetate.
(C) A solution that is 1.0 M acetic acid.
(D) A solution that is 0.50 M sodium acetate.