

## BUFFER SOLUTIONS - INTRODUCTION AND USES

### Definition

“Solutions which **resist** changes in pH when **small quantities** of acid or alkali are added.”

### Types

**Acidic Buffer (pH < 7)**

**weak acid + its sodium or potassium salt**  
*ethanoic acid sodium ethanoate*

**Alkaline Buffer (pH > 7)**

**weak base + its chloride**  
*ammonia ammonium chloride*

### Biological

#### Uses

In biological systems (saliva, stomach, and blood) it is essential that the pH stays 'constant' in order for any processes to work properly. Most enzymes work best at particular pH values.

#### Blood

- the pH of blood is normally about 7.4
- If the pH varies by 0.5 it can lead to unconsciousness and coma
- carbon dioxide produced by respiration can increase the acidity of blood by forming H<sup>+</sup> ions in aqueous solution



- the presence of hydrogencarbonate ions in blood removes excess H<sup>+</sup>



### Other

#### Uses

Many household and cosmetic products need to control their pH values.

*Shampoo* Counteract the alkalinity of the soap and prevent irritation

*Baby lotion* Maintain a pH of about 6 to prevent bacteria multiplying

*Others* Washing powder

Eye drops

Fizzy lemonade



### CALCULATING THE pH OF AN ACIDIC BUFFER SOLUTION

**Example 1** Calculate the pH of a buffer solution whose  $[HA]$  is  $0.1 \text{ mol dm}^{-3}$  and  $[A^-]$  of  $0.1 \text{ mol dm}^{-3}$ . Assume the  $K_a$  of the weak acid  $HA$  is  $2 \times 10^{-4} \text{ mol dm}^{-3}$ .

$$K_a = \frac{[H^+_{(aq)}][A^-_{(aq)}]}{[HA_{(aq)}]}$$

$$\text{re-arranging} \quad [H^+_{(aq)}] = \frac{[HA_{(aq)}] K_a}{[A^-_{(aq)}]} = \frac{0.1 \times 2 \times 10^{-4}}{0.1} = 2 \times 10^{-4} \text{ mol dm}^{-3}$$

$$\therefore \text{pH} = -\log_{10} [H^+_{(aq)}] = 3.699 \quad (3.7)$$

**Example 2** Calculate the pH when  $500\text{cm}^3$  of  $0.10 \text{ mol dm}^{-3}$  of weak acid  $HX$  is mixed with  $500\text{cm}^3$  of a  $0.20 \text{ mol dm}^{-3}$  solution of its salt  $NaX$ .  $K_a = 4.0 \times 10^{-5} \text{ mol dm}^{-3}$ .

$$K_a = \frac{[H^+_{(aq)}][X^-_{(aq)}]}{[HX_{(aq)}]}$$

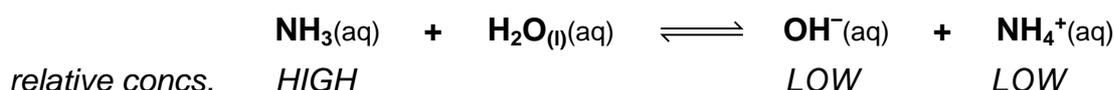
$$\text{re-arranging} \quad [H^+_{(aq)}] = \frac{[HX_{(aq)}] K_a}{[X^-_{(aq)}]}$$

**The solutions have been mixed;** volume is now  $1 \text{ dm}^3$   $[HX] = 0.05 \text{ mol dm}^{-3}$   
 $[X^-] = 0.10 \text{ mol dm}^{-3}$

$$\therefore [H^+_{(aq)}] = \frac{0.05 \times 4.0 \times 10^{-5}}{0.1} = 2.0 \times 10^{-5} \text{ mol dm}^{-3}$$

$$\therefore \text{pH} = -\log_{10} [H^+_{(aq)}] = 4.699 \quad (4.7)$$

**Alkaline buffer** Similar but is based on the equilibrium surrounding a weak base.



but one needs ; **a large conc. of  $\text{OH}^-(\text{aq})$**  to react with any  $\text{H}^+(\text{aq})$  added  
**a large conc of  $\text{NH}_4^+(\text{aq})$**  to react with any  $\text{OH}^-(\text{aq})$  added

There is enough  $\text{NH}_3$  to act as a source of  $\text{OH}^-$  but one needs to increase the concentration of ammonium ions by adding an ammonium salt.

**Use** AMMONIA (a weak base) + AMMONIUM CHLORIDE (one of its salts)