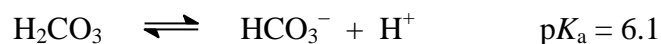


- The primary buffering system in blood plasma is represented by the following equation:



What is the ratio  $\text{HCO}_3^- : \text{H}_2\text{CO}_3$  at the normal plasma pH of 7.4?

**Marks**  
**5**

**The Henderson-Hasselbalch equation with [acid] =  $[\text{H}_2\text{CO}_3]$  and [base] =  $[\text{HCO}_3^-]$  can be used for this buffer system,**

$$\begin{aligned} \text{pH} &= \text{p}K_a + \log_{10} \left( \frac{[\text{base}]}{[\text{acid}]} \right) \\ &= 6.1 + \log_{10} \left( \frac{[\text{base}]}{[\text{acid}]} \right) = 7.4 \end{aligned}$$

$$\frac{[\text{base}]}{[\text{acid}]} = 10^{(7.4-6.1)} = 10^{1.3} = 20$$

Answer: **[base] : [acid] = 20 : 1**

A typical person has 2 L of blood plasma. If such a person were to drink 1 L of soft drink with a pH of 2.5, what would the plasma pH be if it were not buffered? (Assume all of the  $\text{H}^+$  from the soft drink is absorbed by the plasma, but the volume of plasma does not increase.)

**As  $\text{pH} = -\log_{10}[\text{H}^+]$ , the  $[\text{H}^+]$  in the soft drink is,**

$$[\text{H}^+]_{\text{soft drink}} = 10^{-2.5} \text{ M}$$

**1 L of soft drink therefore contains**

$$\text{number of moles} = \text{concentration} \times \text{volume} = (10^{-2.5} \text{ mol L}^{-1} \times 1 \text{ L}) = 10^{-2.5} \text{ mol}$$

**If this amount is present in 2 L of plasma,**

$$[\text{H}^+]_{\text{plasma}} = \frac{\text{number of moles}}{\text{volume}} = \frac{10^{-2.5}}{2} \text{ M}$$

**Hence the pH of the unbuffered plasma is**

$$\text{pH} = -\log_{10}[\text{H}^+] = -\log_{10} \left( \frac{10^{-2.5}}{2} \right) = 2.8$$

Answer: **2.8**

**ANSWER CONTINUES ON THE NEXT PAGE**

What is the pH in this typical person with a normal  $\text{HCO}_3^-$  concentration of 0.020 M? Ignore any other contributions to the buffering.

**Before the addition of the soft drink,  $[\text{HCO}_3^-] = 0.020 \text{ M}$  and, at pH 7.4,  $[\text{H}_2\text{CO}_3] = [\text{HCO}_3^-] / 20 = 0.0010 \text{ M}$ .**

**As the soft drink has  $10^{-2.5}$  mol of  $\text{H}^+$ , its concentration when added to the plasma will again be  $[\text{H}^+] = \frac{10^{-2.5}}{2} \text{ M}$  before buffering. Adding it will decrease the base concentration and increase the acid concentration so that,**

$$[\text{HCO}_3^-] = (0.020 - \frac{10^{-2.5}}{2}) \text{ M} = 0.018 \text{ M}$$

$$[\text{H}_2\text{CO}_3] = (0.0010 + \frac{10^{-2.5}}{2}) \text{ M} = 0.0026 \text{ M}$$

**Hence,**

$$\text{pH} = (6.1) + \log_{10} \left( \frac{0.018}{0.0026} \right) = 7.0$$

**Answer: 7.0**