4

- Calculate the pH of a solution that is 0.010 M in benzoic acid, C_6H_5COOH, and 0.010 M in $C_6H_5CO_2Na$. The K_a of benzoic acid is 6.4×10^{-5} M.

This solution contains an acid and its conjugate base so the Henderson-Hasselbalch equation can be used:

$$\mathbf{pH = pK_a + \log_{10}\left(\frac{[base]}{[acid]}\right)}$$

As [acetic acid] = [sodium acetate], $\mathbf{\log_{10}\left(\frac{0.010}{0.010}\right) = \log_{10}(1) = 0}$ **and so**

$$\mathbf{pH = pK_a = -\log(6.4 \times 10^{-5}) = 4.19}$$

Answer: **4.19**

Would this solution make a good buffer system? Give reasons for your answer?

Because the concentrations of weak acid and conjugate base are equal, this solution is a good buffer system. (Good buffers require this ratio to be between 0.1 and 10.)

As the concentrations are only 0.010 M, the buffer does not have a very great capacity. It will buffer effectively for small amounts of added H^+ or OH^-, but large amounts will quickly cause the weak acid/conjugate base ratio to move outside the 0.1-10 range.

2

- The gases NO_2 and N_2O_4 are in equilibrium according to the following equation.

$$N_2O_4(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H = +57 \text{ kJ mol}^{-1}$$

In which direction will the reaction move when the following changes are made?

The pressure is increased by decreasing the volume.

The reaction involves 1 mol → 2 mol so the system will react to an increase in pressure by shifting to lower to the left to reduce it: shift to reactants.

The temperature is increased.

The reaction is endothermic so the system will react to an increase in temperature by shifting to the right to reduce it: shift to products.