Names _____

Workshop: Buffers

1) Consider the following weak acids and their K_a values:

Acetic acid	$K_a = 1.8 \times 10^{-5}$
Phosphoric acid	$K_{a1} = 7.5 \times 10^{-3}$
Hypochlorous acid	$K_a = 3.5 \times 10^{-8}$

You are to prepare buffers at pH = 2.8, 4.5, and 7.5. In the 2nd column write the chemical fomulas for the respective weak acid–conjugate base buffer system (reactants and products in equilibrium) which is the best choice for each pH from the listed acids? Explain your reasoning in the 3rd column.

2.8		
4.5		
7.5		

2) Consider the 100.0 mL solution containing 0.010 mol acetic acid, $HC_2H_3O_2$, and 0.010 mol sodium acetate, $NaC_2H_3O_2$, which was introduced in the reading. Determine the resulting pH if 0.005 mol NaOH is added to the buffer. Show your calculation on a separate page and attach to the Workshop.

pH =

3) Consider the titration of an acetic acid solution with a sodium hydroxide solution at the following three stages of the titration: (i) before the titration begins, (ii) when the number of moles of sodium hydroxide added is equal to 1/2 the number of moles of acetic acid originally in the beaker, and (iii) at the endpoint. For each of the following questions, select one of the above three stages and be able to explain your reasoning.

(a) At which stage does the reaction solution contain mostly acetate ion? b) When does it contain mostly acetic acid? c) When does it contain significant amounts of both?

a)	b)	c)

(d) At what point during the titration is the reaction solution's pH at its lowest value? e) At what point is it at its highest value? f) When is it between the two extreme values?

d)	e)	f)

4) Student A claims that she can calculate the pH of a buffer system without knowing the actual concentrations of the acid and conjugate base. Student B disagrees, citing the fact that the buffer equation clearly requires concentrations. Who is correct? Briefly explain.

5) The carbonate buffer system is very important in regulating blood pH levels. Carbonic acid is diprotic and therefore has two K_a values:

$$H_2CO_3(aq) \rightleftharpoons H^+(aq) + HCO_3^-(aq) \qquad K_{a_1} = 4.2 \times 10^{-7}$$
$$HCO_3^-(aq) \rightleftharpoons H^+(aq) + CO_3^{2-}(aq) \qquad K_{a_2} = 4.8 \times 10^{-11}$$

Since the second dissociation has a K_a value significantly smaller than that of the first dissociation, it can be assumed to have no effect on the $H_2CO_3(aq)/HCO_3^-(aq)$ equilibrium.

The pH of a patient's blood sample is 7.2. What is the ratio of carbonic acid to bicarbonate ion in the patient's blood?

6) Biochemical experiments frequently utilize a buffer system based on *tris*-(hydroxymethyl)aminomethane, $(HOCH_2)_3CNH_2$, which is also called TRIS or THAM. The pK_a of the conjugate acid of TRIS, $(HOCH_2)_3CNH_3^+$, is 8.075. What the calculated mole ratio of acid-to-base is required to prepare a buffer at the same pH as human blood, pH = 7.4?