| Grades | | Grader/s |
| --- | --- | --- |
| Pre-lab (100 pts) | | |

# PRE-LAB EXERCISES (E2)

Name: Xiao Luyan Section: 11

*Please finish the following exercises before conducting the experiment and turn in the answers on **CANVAS**. These exercises consist of 6 questions and are worth a total of 100 points, counted as **2%** of the course grade. These pre-lab exercises cover contents of Experiment E2. Please study the corresponding lab manual carefully before doing these exercises. Please turn in the electronic copy either typed or hand-written at the start of your scheduled lab session on **CANVAS**. No late submission will be accepted.*

***Question 1 (20 points)***

Define the term "common–ion effect" used in the BACKGROUND section. How do buffers work by taking advantage of the common-ion effect?

The solubility of a sparingly soluble salt is reduced by the addition of another soluble salt that has an ion in common with the salt.

In the buffer solution, the conjugate acid of the weak acid (basically a strong electrolyte) will completely ionize the corresponding acid ions in water, a large number of acid ions will produce the same ionic effect on the weak acid, inhibit the ionization of the weak acid, so $H^+$ is stored in the weak acid and the change of pH is buffered.

***Question 2 (10 points)***

Give an example of a salt that could be used to make a buffer with $NH_3$.

$NH_4Cl$

***Question 3 (20 points)***

If solution A has pH of 3.23 and solution B has pH of 4.23, what is their relationship in terms of $[H^+]$? Analyze mathematically.

for solution A, $[H^+]_A = 10^{-3.23}$

for solution B, $[H^+]_B = 10^{-4.23}$

$$\frac{[H^+]_A}{[H^+]_B} = 10$$

***Question 4 (20 points)***

Explain the meaning of 'buffer capacity'. What is the relation between the concentration of buffer components and the buffer capacity? Explain.

Buffer capacity is the maximum amount of acid or base that can be added before the buffer loses its ability to resist large changes in pH.

The closer the concentration of the weak acid and the weak base in the buffer, the stronger the buffer's capacity. The buffer is effective when the amount of weak base (acid) is at least 10% of weak acid (base). Otherwise, the weak base (acid) is used quickly when a strong acid (base) is added.

***Question 5 (10 points)***

What is the Henderson–Hasselbalch equation? For a buffer having a [base]/[acid] ratio of 1:1, what is the relationship between pH and pKa?

Henderson - Hasselbalch equation:

$$pH = pK_a + \log \frac{[base]}{[acid]}$$

when $\frac{[base]}{[acid]} = 1$, $pH = pK_a$

***Question 6 (20 points)***

Using Equations 1 and 2 in the lab manual as models, write the acid dissociation reaction and Ka value for acetic and calculate its pKa value (also record these expressions in your laboratory notebook so you will have them available during the experiment).

$$C_2H_5COOH_{(aq)} \leftrightarrow H^+_{(aq)} + C_2H_5COO^-_{(aq)}$$

$$K_a = \frac{[H^+][C_2H_5COO^-]}{[C_2H_5COOH]}$$

$$pK_a = -\log K_a = -\log \frac{[H^+][C_2H_5COO^-]}{[C_2H_5COOH]}$$