# CLASS SET – PLEASE DO NOT WRITE ON THIS!

## Toothpickase: An Introduction to Enzyme Kinetics

I. **Purpose**. To determine the rate of enzyme activity for the enzyme "toothpickase" and observe the effects of different substrate concentration on that rate.

II. **Background**. Enzymes work to speed up biological reactions by lowering their activation energy. There are certain conditions that must be met for an enzyme to work efficiently. One of these conditions is substrate concentration. You will observe the affects of different substrate and enzyme concentrations on "toothpickase." You will also be determining the rate of enzyme activity of toothpickase. The toothpicks represent the **substrate**. Your thumb and index finger represent the **active site** of the enzyme toothpickase. To catalyze the reaction (breaking the toothpick completely in half), you may only use ONE hand. Toothpicks not broken completely in half do not count as products.

III. **Materials**. (per group)

150 Toothpicks | Stopwatch | Small paper plate

**IV. Procedure.**

**Part A**

1. Assign the following parts:
   a. Toothpickase (person who will break toothpicks)
   b. Timer (will tell toothpickase when to start and stop)
   c. Counter (counts the # of toothpicks broken)
   d. Data Recorder (record all #s in the tables)
2. Place 50 toothpicks on the small paper plate in front of Toothpickase.
3. When told to do so by the Timer, Toothpickase will begin picking up and breaking toothpicks in half while **NOT LOOKING** at the plate and only using **ONE HAND** and at a constant pace (it is not a race).
4. As Toothpickase breaks toothpicks, the Counter will count the number of broken toothpicks and make sure that the broken toothpicks are put back in the pile with the whole toothpicks (because products and reactants mix during the reaction).
5. Put 10 seconds on the stopwatch. Count the number of toothpicks broken in 10 seconds. Record the number in **Table 1**.
6. Then, keeping the same pile of broken and whole toothpicks, count the number of toothpicks broken in 20 seconds. Record the number in **Table 1**.
7. Repeat #6, but for 30 seconds. Record the number in **Table 1**.
8. Repeat #6, but for 60 seconds. Record the number in **Table 1**. **If you run out of toothpicks, record the amount of time it took to do so.

**Part B**

1. Repeat everything in PART A, but now spread out the toothpicks so that Toothpickase has to reach for them (*toothpick concentration decreases*). Record all data in **Table 2**.

**Part C**

1. Repeat everything in PART A, but now have 2 students break the toothpicks (*double enzyme concentration*). Record all data in **Table 3**. (Again, if you run out of toothpicks before time is up, stop the clock and record how long it took to do so.)

Name ______________________________________________________ Date _____________________ Per ____________
preAP Biology

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**Table 1. Toothpickase Activity Part A**

| Interval Time (sec) | Cumulative time (sec) | # TPs Broken | Total Broken |
|---|---|---|---|
| 10 | 10 | | |
| 20 | 30 | | |
| 30 | 60 | | |
| 60 | 120 | | |

**Table 2. Toothpickase Activity Part B (Decreased Toothpick Concentration)**

| Interval Time (sec) | Cumulative time (sec) | # TPs Broken | Total Broken |
|---|---|---|---|
| 10 | 10 | | |
| 20 | 30 | | |
| 30 | 60 | | |
| 60 | 120 | | |

**Table 3. Toothpickase Activity Part C (Increased Enzyme Concentration)**

| Interval Time (sec) | Cumulative time (sec) | # TPs Broken | Total Broken |
|---|---|---|---|
| 10 | 10 | | |
| 20 | 30 | | |
| 30 | 60 | | |
| 60 | 120 | | |

Graph the number of toothpicks broken (total) over time (cumulative). **Use the shaded data.** Put all 3 sets of data on the same graph and include a key to distinguish them.

# Answer with complete sentences.

1. What happened to the reaction rate as the supply of the unbroken toothpicks diminishes?  Why did this happen?

2. What do you think would happen to the reaction rate if there were 2,000 toothpicks to begin with?  (think about the rate of the toothpickase:  does it have a limited rate or can it keep getting faster and faster)

3. What happened to the reaction rate when there were 2 toothpickase enzymes working?  Why did this happen?

4. What happened to the reaction rate when the toothpicks were all spread out?  Why did this happen?

5. What do you think would happen to the reaction rate if the enzymes could separate the products and reactants?  Why?

6. What do you think would happen to the reaction rate if plastic toothpicks were mixed in with the wooden toothpicks?  Why?

7. What do you think would happen to the reaction rate if toothpickase was put in ice before interacting with the toothpicks?  Why?