

TOOTHPICKASE ACTIVITY

INTRODUCTION

This is a lesson in enzyme action, demonstrating the natural increase in reaction rate, the leveling off of the reaction and the subsequent effect on products produced as the substrate is used up. You are to pretend that toothpicks are the substrate to be broken down and your hands are an enzyme, complete with an active site (between your fingers and thumb.) Notice that the enzyme (your hand) is much larger than the substrate (toothpicks.) As you will be performing the activity with your eyes closed, this simulates the random contact made between substrate and enzyme. The object of the activity is to break as many toothpicks in half as possible in two minutes.

During the activity, you will also notice that the substrate will not break unless you find just the right spot (the bonding site) and that you will naturally find a maximum rate of reaction, the top speed at which your hands can find and break an enzyme. This speed may lower during the activity as your hands become tired, the pieces are all too small to break and the substrates get more and more scattered in the solution (your desk top.) that the enzyme (your hands) remains unchanged throughout the reaction.

MATERIALS: Toothpicks (75 per group) Clock, Calculator

PROCEDURE: The Rules:

1. You must break each toothpick one at a time
2. You must break each toothpick with two hands ONLY. Do not use the table or other items.
3. You must break each toothpick completely in half.
4. You cannot begin before the someone calls Go!
5. You must stop precisely when they says STOP!
6. You must keep your eyes closed throughout the entire activity.

The Game

1. Spread the toothpicks on the lab table in a random pile. You can work by yourself or with a partner to help with timing.
2. When your group is ready, start the time for 10 seconds and begin breaking toothpicks. Remember the enzyme (the toothpick breaker's hands) are to have their eyes closed. Enzymes don't have eyes to see where the substrates are. They interact with substrates (toothpicks) randomly.
3. After **10 seconds**, the timer will call STOP!
4. Count and record the number of toothpicks broken in the table on the next page on the row with the @ symbol.
5. Next you will break for 20 Seconds (total of 30 seconds so far). When the timer says GO!, begin breaking toothpicks again. Leave the already broken toothpicks in the pile. This means the enzyme will accidentally try to pick up the broken toothpicks but will not be able to break them as they are already separated. That is ok!

6. At end of **20 more seconds (30 sec. accumulated)**, the timer will say STOP!
7. Count and record the total number of toothpicks broken in the table on the line with the \$ symbol. (This includes the number of toothpicks already broken from the first round).
8. Next you will break for 30 seconds. When the timer says GO!, begin breaking toothpicks again. Again, leave the broken toothpicks in the pile. This means the enzyme will accidentally try to pick up the broken toothpicks but will not be able to break them as they are already separated. That is ok!
9. At **end of 30 more seconds (60 sec. accumulated)**, the timer will say STOP!
10. 10. Count and record the total number of toothpicks broken in the table on the line with the #. (This includes the number of toothpicks already broken from the first and second rounds).
11. When the timer says GO!, begin breaking toothpicks again. Again, all the toothpicks unbroken and broken should be in the pile.
12. Next you will break for 60 seconds. At **end of 60 more seconds (120 sec. accumulated)**, the timer will say STOP!
13. Count and record the total number of toothpicks broken from ALL rounds. Record the total number of toothpicks broken from all the rounds and record it in the table on the row with the ☺ symbol. Remember that you are counting the number of toothpicks and not the number of half-toothpicks. You can count the halves but divide the total by 2 so you know the total number of toothpicks.

COMPILING DATA

1. Record the number of total toothpicks broken at each time by YOUR enzyme below the table below

CALCULATIONS

1. Calculate the reactions rates for each time interval, using the formula:

(N = number of toothpicks metabolized T = time)

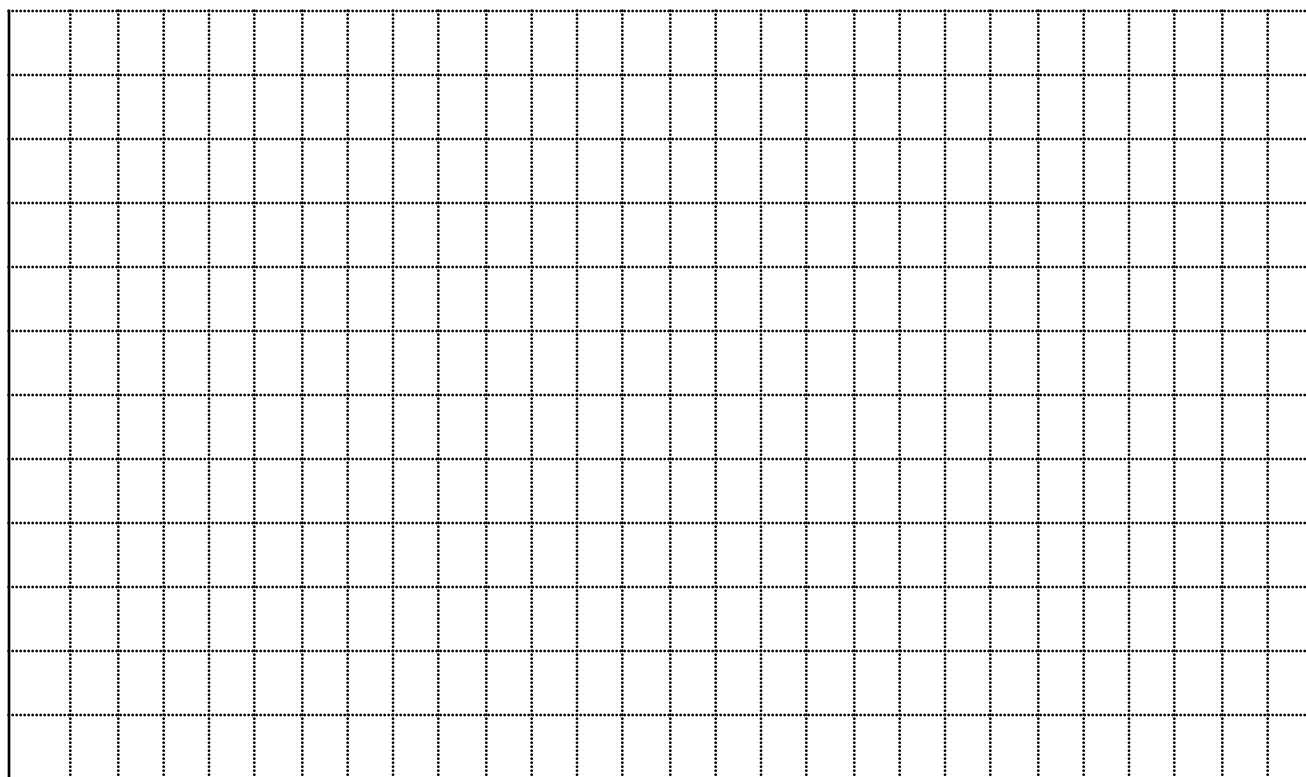
For example: on the @ row, if you broke 5 toothpicks in the 10 seconds, the reaction rate would be 5 toothpicks broken / 10 seconds = $5/10 = .5$ toothpicks broken per second. Thus, the reaction rate would be .5

Table 1. Reaction rate of Toothpickase (5 pts)

Time (T) in seconds	# of Toothpicks broken by your enzyme (N)	Reaction Rate= N/T Toothpicks broken/second
@ 10		
\$ 30		
# 60		
☺ 120		

Total toothpicks broken in 120 seconds: _____

2. Construct a graph (properly labeled and titled) and plot the data. Graph the reaction rate vs time. (10 pts)



ANALYSIS: Answer the following questions in complete sentences for credit.

1. What do you think the reaction rate would be if we used 100 toothpicks/group? Why? (4 pts)

2. What would the reaction rate be if the toothpicks were more spread out on bigger table? (4 pts)

3. What would happen to the reaction rate if two pairs of hands acted as enzymes at table? (2 pts)

4. What would happen to the reaction rate if your hands were very cold? (3 pts)

5. What would happen to the reaction rate if I had added some plastic toothpicks to your desk? (2 pts)