Ticketase

Focus questions	How do enzymes act upon complex sugars like starch? What is the rate of enzyme activity for Ticketase and Glucoticketase? Does enzyme or substrate concentration affect the rate of enzymatic activity?
Vocabulary	Activation energy, reaction rate, active site, enzyme concentration, substrate concentration, products, reactants

Materials

- 4 strings of 50 connected tickets
- Timer
- Blindfold (optional)

Procedure

Part A

1. Organize yourself in groups of 5.
2. Choose one of the following parts:
   - Ticketase (person who will tear the 2 or 3 ticket groups)
   - Glucoticketase (person who will tear the single tickets)
   - Timer (will tell Ticketase and/or Glucoticketase when to start/stop)
   - Counter (counts the # of individual tickets)
   - Data Recorder (record all #s in the data tables)
3. Place a string of 50 tickets in front of Ticketase.
4. When told to do so by the Timer, Ticketase will begin by picking up the string of tickets and folding/tearing off a group of either 2 or 3 tickets at a time while *not looking at the desk and pile of tickets at a constant pace* (it is not a race). Ticketase must then drop both the group of tickets and string of tickets into the pile before being allowed to pick up the string of tickets to tear off another group.
5. As Ticketase tears off the tickets, the Counter will count the number of ticket groups and make sure that the group of tickets is put back in the pile with the chain of tickets (because products and reactants mix during the reaction).
6. Put 10 seconds on the stopwatch. Count the number of ticket groups torn off in 10 seconds. Record the data in Table 1.
7. Then, keeping the same pile of ticket groups and the remaining string of tickets, count the number of ticket groups in 20 seconds. Record the data in Table 1.
8. Repeat step 6, but for 30 seconds. Record the data in Table 1. *(If you run out of tickets, record the amount of time it took Ticketase to do so.)*

Part B

Repeat everything in Part A, but only use Glucoticketase instead of Ticketase. *Remember that Glucoticketase can only tear a single ticket from a group of tickets each time.*

Part C

Repeat everything in Part A, but now have 2 sets of 50 ticket strings (double substrate concentration) and both Ticketase and Glucoticketase tear off either groups of tickets (2 or 3) or single tickets accordingly (double enzyme concentration). Record all data in Table 3.

Table 1: Part A (Ticketase, 2 or 3 sugar groups)

Interval time (sec)	Cumulative time (sec)	Number of ticket groups	Number of single tickets	Total ticket groups	Total single tickets
10	10				
20	30				
30	60				

Table 2: Part B (Glucoticketase, single tickets)

Interval time (sec)	Cumulative time (sec)	Number of single tickets	Total single tickets
10	10		
20	30		
30	60		

Table 3: Part C (Double enzyme concentration)

Interval time (sec)	Cumulative time (sec)	Number of ticket groups	Number of single tickets	Total ticket groups	Total single tickets
10	10				
20	30				
30	60				

Graph the number of single tickets (total) over time (cumulative). Put all 3 sets of data on the same graph and include a key to distinguish them.

Reflection

Create an explanation for the current use of enzymes in commercial ethanol production in the United States. Reflect on the following questions while creating your explanation.

1. What happened to the first polysaccharide as Ticketase was introduced? What happened to the second polysaccharide when Glucoticketase was introduced? How are they similar and different?

2. What happened to the reaction rate when the enzyme concentration and substrate concentration increased? Why did this happen?

3. Why does industry use a combination of enzymes such as Ticketase and Glucoticketase for the fermentation process?

4. Construct an explanation and design future solutions for the current use of enzymes in commercial ethanol production in the United States. How can enzyme use make ethanol production more efficient in the future?

Rubric for self-assessment

Skill	Yes	No	Unsure
I can explain the function of Ticketase.			
I can explain the function of Glucoticketase			
I used reasoning to connect the evidence of enzyme function on starch to construct an explanation for the use of enzymes in commercial ethanol production.			