

3. Fireflies emit light when the enzyme luciferase catalyzes a reaction in which its substrate, D-luciferin, reacts to form oxyluciferin and other products (Figure 1). In order to determine the optimal temperature for this enzyme, scientists added ATP to a solution containing D-luciferin, luciferase, and other substances needed for the reaction. They then measured the amount of light emitted during the first three seconds of the reaction when it was carried out at different temperatures.

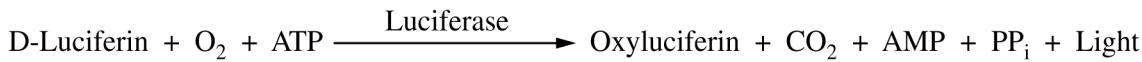


Figure 1. Light is emitted as a result of the reaction catalyzed by luciferase.

- (a) **Describe** a characteristic of the luciferase enzyme that allows it to catalyze the reaction.
- (b) **Identify** the dependent variable in the experiment.
- (c) **State** the null hypothesis for the experiment.
- (d) A student claims that, as temperature increases, there will be an increase in the amount of light given off by the reaction in the first three seconds. **Support** the student’s claim.

Write your responses to this question only on the designated pages in the separate Free Response booklet.

Question 3: Scientific Investigation**4 points**

Fireflies emit light when the enzyme luciferase catalyzes a reaction in which its substrate, D-luciferin, reacts to form oxyluciferin and other products (Figure 1). In order to determine the optimal temperature for this enzyme, scientists added ATP to a solution containing D-luciferin, luciferase, and other substances needed for the reaction. They then measured the amount of light emitted during the first three seconds of the reaction when it was carried out at different temperatures.

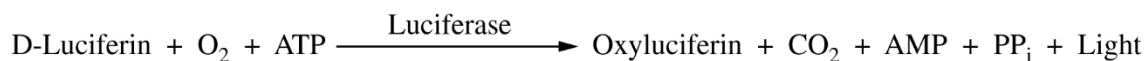


Figure 1. Light is emitted as a result of the reaction catalyzed by luciferase.

- | | | |
|------------|--|----------------|
| (a) | Describe a characteristic of the luciferase enzyme that allows it to catalyze the reaction. | 1 point |
|------------|--|----------------|
- Accept one of the following:
- It has an active site/a shape that can bind with the substrate(s)/brings reactants together.
 - It has a charge that is compatible with the substrate(s).
-
- | | | |
|------------|---|----------------|
| (b) | Identify the dependent variable in the experiment. | 1 point |
|------------|---|----------------|
- The amount of light emitted
-
- | | | |
|------------|--|----------------|
| (c) | State the null hypothesis for the experiment. | 1 point |
|------------|--|----------------|
- Temperature has no effect on the amount of light emitted.
-
- | | | |
|------------|---|----------------|
| (d) | A student claims that, as temperature increases, there will be an increase in the amount of light given off by the reaction in the first three seconds. Support the student’s claim. | 1 point |
|------------|---|----------------|
- Accept one of the following:
- Higher temperature increases the frequency of collisions/interactions between molecules, resulting in an increase in reaction rate.
 - The higher temperature results in a change to the active site that enhances substrate binding.

Total for question 3 4 points