Onion Chemistry Exam Answer Key & CER Leveled Responses

Multiple Choice Answer Key (1 point each)

1. B. Chemical change
2. C. Alliinase
3. B. syn-Propanethial-S-oxide
4. B. Thermal decomposition
5. C. The onion released new smells and turned brown
6. C. It denatures and stops working
7. C. A chemical breakdown caused by heat
8. D. Cutting the onion into pieces
9. B. Covalent bond
10. B. Endothermic

Multi-Select Answer Key (2 points each)

11.
- ☐ Change in odor
- ☐ Color change (browning)
- ☐ Formation of a gas

12.
- ☐ Sulfur compound conversion
- ☐ Production of syn-Propanethial-S-oxide

13.
- ☐ It is a product of a chemical reaction
- ☐ It is responsible for eye irritation
- ☐ It results from an enzymatic reaction

14.
- ☐ Formation of new substances
- ☐ Energy absorption or release
- ☐ Production of gases or precipitates

15.

- ☐ New odor compounds form
- ☐ Color change due to new molecules
- ☐ It results from heat-driven decomposition

CER Response Scoring Guidelines (5 points each)
Use rubric:
- 1 pt – Claim: Clearly answers the question
- 2 pts – Evidence: Includes at least two accurate pieces of scientific evidence
- 2 pts – Reasoning: Connects evidence to claim using relevant vocabulary and concepts

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Question 16 – Chopped vs. Cooked Onion

On-Level Sample Response: - Claim: Chopping and cooking the onion caused different chemical changes. - Evidence: Chopping released an enzyme that created a gas that made the student cry. Cooking changed the smell and color of the onion. - Reasoning: The enzyme alliinase in raw onions causes the formation of syn-Propanethial-S-oxide, which irritates eyes. When onions are cooked, heat breaks down different sulfur compounds and causes thermal decomposition, forming new substances.

Honors Sample Response: - Claim: The reactions from chopping vs. cooking onions are both chemical, but caused by different mechanisms. - Evidence: Cutting activates alliinase, which reacts with sulfur compounds to form syn-Propanethial-S-oxide. Cooking causes browning and a new aroma due to heat breaking covalent bonds. - Reasoning: Enzymatic reactions occur at room temperature and produce volatile tear-inducing compounds. Thermal decomposition requires higher temperatures and leads to molecular restructuring and new aromatic compounds.

Question 17 – Onion vs. Garlic

On-Level Sample Response: - Claim: Only onions cause eye irritation because of the production of syn-Propanethial-S-oxide. - Evidence: Garlic and onions both release sulfur compounds, but only onions make people cry. - Reasoning: Onions contain the enzyme LF synthase, which converts sulfenic acid into syn-Propanethial-S-oxide. Garlic lacks this enzyme, so it doesn’t produce the tear-inducing chemical.

Honors Sample Response: - Claim: Onions cause eye irritation due to a specific enzymatic pathway not present in garlic. - Evidence: While both contain sulfur compounds and alliinase, only onions use LF synthase to produce syn-Propanethial-S-oxide. - Reasoning: The presence of LF synthase in onions catalyzes the conversion of intermediates into syn-Propanethial-S-oxide. Garlic's pathway produces different sulfur-containing products like allicin, which do not trigger a lachrymatory response.

Question 18 – Browning as a Chemical Change

On-Level Sample Response: - Claim: Browning of onions is a chemical change caused by heat. - Evidence: The onions changed color and smell at high temperatures. - Reasoning: Heat causes a breakdown of molecules (thermal decomposition), creating new substances with different colors and smells. These changes show a chemical reaction occurred.

Honors Sample Response: - Claim: The browning of onions is a result of endothermic chemical reactions caused by heat. - Evidence: At ~150°C, sulfur compounds in the onion begin to decompose, leading to brown pigmentation and a sweeter aroma. - Reasoning: The energy provided by heat breaks covalent bonds, enabling new molecules to form through thermal decomposition and Maillard-type reactions. This structural change and evidence of new substances confirm a chemical change.

Total: 15 points possible

Exam Total: 35/35 points (+5 optional for participation or extra credit completion)