**Argumentative Writing in Science**

Using Experimental Data

The data collected in an experiment can be used as the evidence for constructing an argumentative essay. Students can write the conclusion of a lab report in an argumentative format using the CERCC format described below.

**Claim:** The claim is a testable statement that answers the experimental question. This paragraph is concise, 1-2 sentences. It relates directly to the experimental question, and focus only on the most important features of the experiment.

**Evidence:** The evidence is data or observations from the experimentthat supports the claim. the Evidence must be relevant, sufficient and accurate. Relevant means that the data relates to and supports the claim. Sufficient means there must be multiple data points that support the claim. Accurate means correct in all details and free from error or defect, including correct units.

**Reasoning:** The reasoning explains howthe evidence supports the claim by connecting it to scientific background knowledge or a scientific theory. It shows why data counts as evidence. If more than one piece of evidence is provided each piece of evidence has its own reasoning section.

**Counterclaim** (Rebuttal): The counter claim describes an alternative answer to the experimental question. It then provides evidence and reasoning for why the alternative explanation is incorrect and why the original claim is still the most valid explanation of the data. Alternative explanations may include: other scientific theories, physical or chemical properties (variables) not accounted for in the procedure, or experimental errors that were significant enough to affect the data.

**Conclusion**: The conclusion summarizes all the evidence and reasoning to reinforce the claim as the best answer to the experimental question. It also incorporates background knowledge, makes connections to science concepts studied in class, and describes how these concepts relate to real life events.

**Rubric for Argumentative Writing in Science:** Using Experimental Data

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|  | **1** | **2** | **3** | **4** |
| **Claim**   * A testable statement that answers the experimental question. * Concise statement, 1-2 sentences. * Relates directly to the question * Focuses on only the most important features of the experiment | The claim shows that the student does not understand the concept / content of the lab.  The claim does not respond to the purpose of the lab.  The claim is so vague or incomplete that the answer is not clear or reasonable. | The claim shows that the student has a partial understanding of the concept / content of the lab.  The claim relates to the purpose of the lab.  The claim is only partially correct or accurate but incomplete claim. | The claim shows that the student has a thorough understanding of the concept / content of the lab.  The claim correlates to the purpose of the lab presents complete and original thoughts.  The claim is accurate and complete claim. | The claim shows that the student has a deep understanding of the concept / content of the lab.  The claim responds directly to the experimental question or prompt  The claim establishes a perceptive or insightful idea |
| **Evidence**   * Uses data from the experimentthat supports the claim. * Data is:   Relevant: connects to claim  Sufficient: multiple data sources  Accurate: correct in all details, correct units. | Data is not relevant, or is incorrect, random or illogical. | Data is relevant but insufficient or incomplete. Units are missing.  Data shows little or no depth of thought, or is just mentioned / listed. | Data is relevant to the claim. It is specific, logical, related to the claim and focused on the purpose of the lab  Data is sufficient to support claim. Multiple data sources are used and the connection between the data are stated. | Data is relevant to the claim. The data thoroughly proves a relationship between the evidence.  Data shows a deep understanding of the complexity of the topic. Multiple data sources are used and the connection between the data are stated. |
| **Reasoning**   * Shows why data counts as evidence. * Explains howthe evidence supports claim by connecting it to scientific background knowledge or a scientific theory. | Reasoning does not link evidence to the claim. | Reasoning links the claim and evidence.  Repeats the evidence and/or includes some scientific principles, but not sufficient.  Reasoning included more than one piece of evidence. | Provides reasoning that links evidence to claim. Includes appropriate and sufficient scientific principles.  Each piece of evidence has its own reasoning. | Reasoning clearly links evidence to claim and insightfully explains the connection the evidence and claim.  Each piece of evidence has its own reasoning. |
| **Counterclaim**   * Describes an alternative answer to experimental question. * Provides evidence / reasoning why alternative explanation is incorrect and original claim is most valid. | Does not recognize that an alternative explanation exists  Does not provide relevant counter evidence  Poor reasoning in making a rebuttal. | Recognizes alternative explanations  Provides relevant but insufficient counter evidence  Good reasoning in making a rebuttal. | Recognizes alternative explanations  Provides relevant and sufficient counter evidence  Clear reasoning when making rebuttals. | Recognizes alternative explanations  Provides highly effective counter evidence  Compelling reasoning when making rebuttals. |
| **Conclusion**   * Summarizes evidence and reasoning to reinforce claim as the best answer to the experimental question. * Incorporates background knowledge, makes connections to science concepts studied in class, and describes how these concepts relate to real life events. | Conclusion does not adequately explain the connection between the evidence / reasoning and concept / content.  Conclusion is hard to follow because ideas do not connect together, are unreasonable, vague, generic, or unrelated to the experimental question. | Conclusion partially explains connection between the evidence / reasoning and concept / content.  Conclusion is slightly difficult to follow because some ideas are vague or relationship to the experimental question is unclear.  Some evidence is ignored. | Conclusion adequately explains the connection between the evidence / reasoning and concept / content.  Conclusion makes sense and is easy to follow. It connects evidence back to the experimental question and claim.  Each piece of evidence is included.  Clear application to real world. | Conclusion clearly and insightfully explains the connection between the evidence / reasoning and concept / content.  Conclusion smoothly guides the reader from one point to the next. It includes intricate and interesting connections of evidence to the claim.  Thoroughly explains each piece of evidence.  Shows a deep understanding of concept and connections to real world. |

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EXAMPLE:Lab Report Directions

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| **Conservation of Mass Lab Report** Format  * **Title Page** with title, student names, period and date. * Entire report is **typed**, including data table and graph. * Font is Ariel or Times New Roman, 10 or 12 point. Not all caps, bold or italic. Aligned on the left. * Each section should have a heading in bold. * All parts of the report use **complete sentences** and **proper spelling and grammar.**   **Introduction**  Write the introduction in the Informational format.   * Define the law of conservation of mass and explain what the law of conservation of mass tells you about what happens during a chemical reaction * Write the balanced chemical equation of this reaction, and explain how you can tell it is balanced. * Explain how this experiment should prove the law of conservation of mass. * Explain how the law of conservation of mass relates to our planet; think of air, water, food or trash.   **Experiment**   * **Materials**: List all the materials used in the experiment. List the quantity of materials used. * **Method**:   + Describe in detail how you did the experiment. How did you create a closed system? How did you mix the chemicals in the closed system? How and when did you measure the mass? * State the number of **trials**. * **Safety**: Write at least three safety rules related to the procedure.   **Results**   * **Data Table**: present all the data measured in the experiment. Title clearly states what the table shows, Columns and Rows have headings, Measurements have units   **Analysis**   * State the trends in the data and support this statement using multiple data points. * State experimental errors, these may be problems with the experimental design (only one trial) or errors that occurred during the experiment (accidentally unplugged the hot plate for 5 minutes). * Discuss the effect that these errors had on the data (a minor error would have little effect, a major error could make the data so unreliable that the experiment should be repeated before any conclusions can be made.) * Discuss changes that could be made to remove this error.   **Conclusion** (CERCC format)   * Make a testable statement that answers the Experimental Question, is related directly to the experimental question, and focused only on the most important features of the experiment. ***(Claim)*** * Describe data or observations from the experimentthat supports the claim. It must be relevant, sufficient and accurate. ***(Evidence)*** * Explain howthe evidence supports the claim by connecting it to scientific background knowledge or a scientific theory. If more than one piece of evidence is provided each piece of evidence has its own reasoning section. ***(Reasoning)*** * Describe an alternative answer to the Experimental Question. Then provide evidence and reasoning for why the alternative explanation is incorrect and why the original claim is still the most valid explanation of the data. Alternative explanations may include other scientific theories, unaccounted for physical or chemical properties or significant experimental errors. ***(Counterclaim)*** * Summarize all the evidence and reasoning to reinforce the claim as the best answer to the experimental question. Incorporate background knowledge, make connections to science concepts studied in class, and describe how these concepts relate to real life events. ***(Conclusion)*** |

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EXAMPLE:Student Lab Report

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| **Results**   |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | Observation | Mass of Reactants | Mass of Products | Difference | | Trial 1 | Reactants mixed before bag was sealed | 12 g | 10 g | 2 g | | Trial 2 | Reactants bubbled when mixed | 13 g | 13 g | 0 g | | Trial 3 | Reactants bubbled when mixed | 14 g | 14.1 g | - 0.1 g | | Average |  | 13 g | 12.4 g | 0.6 g |   **Analysis**  Two of the trials show that the difference between the Mass of Reactants and Mass of Products was almost 0. In Trial 2 Mass of Reactants and the Mass of Products were both13g. In Trial 3 Mass of Reactants was 14g and Mass of Products 14.1g giving a difference of 0.1 g  There were two errors noticed during the experiment. In trial 1 the reactants were mixed before the bag was sealed so some product might have escaped. This may be why the Mass of the Products was 2 grams less than the mass of the Reactants. This trial should not be considered when analyzing the data because of this possible error. This error could have been eliminated by making sure the bag was sealed before the reactants were mixed.  The other errors that was noticed was that in the third trial there was 0.1 g more product than reactant. Because of the small difference, this is likely a measurement error due to human error or the calibration of the scales. This error is small enough that it is unlikely to affect the reliability of the data and trial 3 does not need to be excluded from consideration when analyzing the data.  **Conclusion**  This experiment addresses the experimental question: Does this reaction demonstrate the law of conservation of mass? The law of conservation of mass states that matter is not created or destroyed in a chemical reaction and therefore, the mass before and after the reaction will be the same. The data from this experiment shows that in this reaction mass was conserved so it does demonstrate the law of conservation of mass. ***(Claim)***  The data from Trial 2 shows that mass is conserved because the mass of the reactants was 12 g and the mass of the products was 12 g. This data shows that mass did not change during the reaction therefore no matter was created or destroyed. ***(Evidence and Reasoning)***  Some of the data appears to contradict the law of conservation of mass. In trial 1 the mass of the products was 12 g and the mass of the reactants was 10 g. It appears that the mass of the products decreased however, it was observed that the reactants were mixed before the bag was sealed. Therefore, the decrease in mass is due to product escaping from the sealed container not that mater was destroyed. In trial 3 the mass of the products was 0.1 g greater than the mass of the products. However this is within the measurement error of the mass balance that was used so it does not indicate that matter was created in the reaction. *(****Counterclaim****)*  This experiment did demonstrate that matter is conserved in a reaction because two trials showed that the mass of the reactants and mass of the products was the same, within the margin of error f or our mass balance. This agrees with other scientists’ studies which have proven that matter is not created or destroyed in a chemical reaction. Conservation of mass is important because in nature nothing is created or destroyed. This can be seen in the water cycle when one molecule of water passes through many stages; evaporation, condensation, precipitation, but no molecules are created or destroyed. ***(Conclusion)*** |