**Instructions [Course Parameters and Assignment Guidelines]**

Use the following rubric to assist in the evaluation of skill performance related to ***Learning Outcomes 1 and 2***. Different courses will aspire to either the novice or apprentice level depending on the population and aims of the course. Students can successfully demonstrate novice-level abilities through adequate performance on scripted or “canned” lab assignments, whereas apprentice or proficient levels require open-ended or “exploratory” labs.

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| **Learning Outcome** | **Subcategory** | **Performance** | | | |
| **Proficient** | **Apprentice** | **Novice** | **Deficient** |
| **Application of the Scientific Method** | **Rationale** | **The purpose of the lab or the question to be answered during the lab is clearly identified and stated. Many reputable background sources were used and cited correctly. Material is translated into student's own words.** | **The purpose of the lab or the question to be answered during the lab is identified, but is stated in a somewhat unclear manner. Several reputable background sources are used and cited correctly. Material is translated into student's own words.** | **The purpose of the lab or the question to be answered during the lab is partially identified, and is stated in a somewhat unclear manner. One or more background sources are used and cited correctly, but some are not reputable sources. Material is translated into student’s own words.** | **The purpose of the lab or the question to be answered during the lab is erroneous or irrelevant. Material is directly copied rather than put into student’s own words and/or background sources are cited incorrectly.** |
| **Hypotheses** | **Hypothesized relationship between the variables and the predicted results is clear and reasonable based on previous findings.** | **Hypothesized relationship between the variables and the predicted results is reasonable based on general knowledge, observations, and previous findings.** | **Hypothesized relationship between the variables and the predicted results is clearly stated and appropriate.** | **No hypothesized relationship has been stated, or demonstration of substantial inaccuracies in logic.** |
| **Experimental Design** | **An appropriate experimental design with controls is reported and thoroughly explained. Alternative designs or modifications are discussed and explained.** | **An appropriate experimental design including controls is reported and thoroughly explained.** | **The experimental design including controls is reported and minimally explained.** | **The experimental design is not defined and/or lacks appropriate structure or controls.** |
| **Conclusions** | **Conclusion includes whether the findings supported the hypothesis, possible sources of error, and what was learned from the experiment. The relationship between the variables is discussed and trends/patterns logically analyzed. Predictions are made about what might happen if part of the lab were changed or how the experimental design could be changed. Results are thoroughly compared to previous findings.** | **Conclusion includes whether the findings supported the hypothesis and what was learned from the experiment. The relationship between the variables is discussed and trends/patterns logically analyzed. Some relation to previous findings mentioned.** | **Conclusion includes what was learned from the experiment. The relationship between the variables is discussed but no patterns, trends or predictions are made based on the data. Minimal relation to previous findings.** | **No conclusion was included in the report OR shows little effort and reflection. The relationship between the variables is minimally discussed. Little or no relation to previous findings noted.** |
| **Learning Outcome** | **Subcategory** | **Performance** | | | |
| **Proficient** | **Apprentice** | **Novice** | **Deficient** |
| **Collection, Analysis, and Interpretation of Quantitative Data** | **Materials** | **All materials and setup used in the experiment are clearly and accurately described.** | **Almost all materials and the setup used in the experiment are clearly and accurately described.** | **Most of the materials and the setup used in the experiment are accurately described.** | **Many materials are described inaccurately or are not described at all.** |
| **Procedures** | **Procedures are listed in clear steps. Each step is numbered and described in a complete sentence. Procedures appear to be replicable. Steps are outlined sequentially and are adequately detailed.** | **Procedures are listed in a logical order, but steps are not numbered and/or are not in complete sentences. Procedures appear to be replicable. Steps are outlined and are adequately detailed.** | **Procedures are listed but are not in a logical order or are difficult to follow. All steps are outlined, but there is not enough detail to replicate procedures.** | **Procedures do not accurately list the steps of the experiment. Several steps are not outlined and there is not enough detail to replicate procedures.** |
| **Statistical Analysis** | **Appropriate descriptive and inferential statistical analyses are reported and thoroughly explained. Experimental errors and outliers, their possible effects, and ways to reduce them are discussed.** | **Both descriptive and inferential statistical analyses are reported and explained. Experimental errors and outliers and their possible effects are discussed.** | **Both descriptive and inferential statistical analyses are reported but minimally explained. Experimental errors and outliers are mentioned.** | **Statistical analyses are not reported or are erroneous.**  **There is no discussion of errors or outliers.** |
| **Ethical**  **Considerations** | **Thorough identification and discussion of applicable ethical considerations related to data collection, human subjects and organism, health and safety, use of others work, and/or bias.** | **Thorough identification of applicable ethical considerations related to data collection, human subjects and organism, health and safety, use of others work, and/or bias.** | **Identifies key ethical considerations related to data collection, human subjects and organisms, health and safety, use of others work, and/or bias.** | **Inadequately identifies key applicable ethical considerations related to data collection, human subjects and organisms, health and safety, use of others work and/or bias.** |
| **Limitations** | **Clearly articulates a firm understanding of assumptions and provides a thorough analysis of the limitations.** | **Articulates an understanding of the assumptions and specifies several limitations.** | **Identifies either assumptions or limitations.** | **Does not articulate an understanding of assumptions or limitations.** |
| **Safety** | **Lab is carried out with full attention to relevant safety procedures. The set-up, experiment, and tear-down posed no safety threat to any individual.** | **Lab is generally carried out with attention to relevant safety procedures. The set-up, experiment, and tear-down posed no safety threat to any individual, but one safety procedure needs to be reviewed.** | **Lab is carried out with some attention to relevant safety procedures. The set-up, experiment, and tear-down posed no safety threat to any individual, but several safety procedures need to be reviewed.** | **Safety procedures were ignored and/or some aspect of the experiment posed a threat to the safety of the student or others.** |
| **Outcome** | **Subcategory** | **Performance** | | | |
| **Proficient** | **Apprentice** | **Novice** | **Deficient** |
| **Communication of Findings** | **Data** | **Professional-looking and accurate representation of the data in tables and/or graphs. Graphs and tables are labeled and titled.** | **Accurate representation of the data in tables and/or graphs. Graphs and tables are labeled and titled.** | **Accurate representation of the data in written form, but no graphs or tables are presented.** | **Data are not reported or are inaccurate.** |
| **Appearance/ Organization** | **Written or oral report is complete, superbly organized, and appears professional in all respects.** | **Written or oral report is complete, well-organized, and largely professional in appearance.** | **Written or oral report contains all necessary sections and information, but some organizational problems remain.** | **Written or oral report is incomplete and poorly organized.** |
| **Format** | **Superbly utilizes an appropriate professional communication format suitable to the discipline and nature of the experiment.** | **Utilizes an appropriate professional communication format suitable to the discipline and nature of the experiment.** | **Utilizes appropriate communication format suitable to the discipline and nature of the experiment, but lacks a professional polish.** | **Does not utilize communication format suitable to the discipline.** |

**Problem Solving Rubric for Scientific Reasoning in the Natural Sciences**

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|  | ***Proficient*** | ***Apprentice*** | ***Novice*** | ***Deficient*** |
| **Strategic Approach** | Determines appropriate and complete strategies to solve problems independently. | Determines appropriate and complete strategies to solve problems based upon examples. | Chooses the correct strategy to solve a problem from a limited set of options. | Unable to choose the correct strategy to solve a problem. |
| **Implementation** | Employs scientific principles correctly and independently. | Employs scientific principles correctly to solve problems similar to examples. | Employs scientific principles correctly to solve problems identical to examples. | Unable to employ scientific principles correctly. |
| **Calculations**  **(if appropriate)** | Correctly performs complex mathematical manipulation of algebraic equations when required. | Correctly performs simple mathematical manipulation of algebraic equations when required. | Correctly converts units, plugs numbers into equations and calculates quantities. | Unable to perform calculations correctly. |
| **Evaluation of the Solution** | Provides broad interpretations of results independently and can perform advanced checks properly. | Can broaden interpretations of results with some direction and perform checks properly. | Provides narrow but correct interpretations of results and performs basic checks properly. | Unable to interpret solutions or perform basic checks. |
| **Communication of the Solution** | Consistently communicates solutions in an effective format with high quality. | Consistently communicates solutions in an effective format with average quality. | Generally communicates solutions in an effective format with average quality. | Unable to communicate solutions effectively. |