

## Analytic Rubric for Conducting an Experiment in the Lab

Attribute	Exemplary (3)	Competent (2)	Needs Work (1)
<b>Materials</b>	All materials needed are present and entered on the lab report;  The materials are appropriate for the procedure; The student is not wasteful of the materials.	All materials are present, but not all are entered on the lab report, or some materials are absent and must be obtained during the procedure;  The materials are appropriate for the procedure.	All materials needed are not present and are not entered on the lab report;  The materials are not all appropriate for the procedure or there are some major omissions.
<b>Procedure</b>	The procedure is well designed and allows control of all variables selected;  All stages of the procedure are entered on the lab report.	The procedure could be more efficiently designed, but it allows control of all variables selected;  Most stages of the procedure are entered on the lab report.	The procedure does not allow control of all variables selected;  Many stages of the procedure are not entered on the lab report.
<b>Courtesy &amp; Safety</b>	While conducting the procedure, the student is tidy, respectful of others, mindful of safety, and leaves the area clean.	While conducting the procedure, the student is mostly tidy, sometimes respectful of others, sometimes mindful of safety, and leaves the area clean only after being reminded.	While conducting the procedure, the student is untidy, not respectful of others, not mindful of safety, and leaves the area messy even after being reminded.
<b>Purpose</b>	Research question and hypothesis are stated clearly and the relationship between the two is clear; The variables are selected.	Research question and hypothesis are stated, but one or both are not as clear as they could be, or the relationship between the two is unclear; The variables are selected.	Research question and hypothesis are not stated clearly, and the relationship between the two is unclear or absent; The variables are not selected.
<b>Data Collection</b>	Raw data, including units, are recorded in a way that is appropriate and clear;  The title of the data table is included.	Raw data, including units, are recorded although not as clearly or appropriately as they could be;  The title of the data table is included.	Raw data, including units, are not recorded in a way that is appropriate or clear;  The title of the data table is not included.
<b>Data Analysis</b>	Data are represented in ways (charts, tables, graphs) that best facilitate understanding and interpretation;  Error analysis is included.	Data are presented in ways (charts, tables, graphs) that can be understood and interpreted, although not as clearly as they could be;  Error analysis is included.	Data are presented in ways (charts, tables, graphs) that are very unclear;  Error analysis is not included.
<b>Evaluation of Experiment</b>	The results are interpreted and compared with literature values; The limitations and weaknesses are discussed and suggestions are made on how to limit or eliminate them.	The results are interpreted and compared with literature values, but not as fully as they could be; The limitations and weaknesses are discussed, but few or no suggestions are made as to how to limit or eliminate them.	The results are not interpreted in a logical way or compared with literature values; The limitations and weaknesses are not discussed, nor are suggestions made as to how to limit or eliminate them.

(Adapted from Stevens, D.D. & Levi, A.J., (2205). *Introduction to Rubrics*. Sterling, VA: Stylus)

## Analytic Rubric for Undergraduate Research Project in the Sciences

Attribute	Exemplary (3)	Acceptable (2)	Unacceptable (1)
<b>Statement of the Problem/ Hypothesis</b>	The student has independently identified and developed a research question/hypothesis that provides a contribution to the scientific literature in the research area.	The student has made independent contributions and development to a general idea or project suggested by faculty advisor.	The question under study is poorly specified and/or is completely specified by the faculty advisor with no development or contribution by the student.
<b>Role of Theory</b>	The experiment is a novel test of one or more current theories, or the experiment tests an important set of novel phenomena;  Relevant theory is clearly and correctly described so that the contribution of the experiment is clear.	The experiment tests one or more current theories or seeks to document and expand understanding of phenomena described in the empirical literature.	The experiment is unrelated or misconstrues current theory and is a poor extension of the empirical literature.
<b>Development of Idea</b>	Logical, testable prediction(s) are identified and tested in the final experiment;  One or more follow on experiments are conducted to expand theoretical conclusions or rule out alternative explanations.	Logical, testable prediction(s) are identified and tested in a single experiment.	The logic underlying the experiment is incorrect, badly explained, or missing entirely.
<b>Experimental Design</b>	The design of the experiment is novel; Independent and dependent variable(s) have been identified and possible confounding factors are controlled.	Appropriate independent and dependent variable(s) are used;  Adequate care has been taken to control possible confounding factors.	Inappropriate independent and/or dependent variable(s) are used;  Limited effort has been taken to control possible confounding factors.
<b>Analysis &amp; Presentation of Data</b>	The data analysis technique is sophisticated and appropriate for data collection, and informative with respect to the question being studied	The data analysis technique is appropriate for the data collected and correctly computed;  Data is appropriately reported and displayed so that relevant findings are obvious.	The data analysis technique is inappropriate and/or incorrectly computed;  Data displays are incorrect, sloppy, or difficult to interpret.
<b>Interpretation of Results</b>	The conclusions drawn are appropriate given the data and analysis conducted;  Alternative interpretations are developed into follow-on experiments to further limit conclusions.	The conclusions drawn are appropriate given the data and analyses conducted;  Alternative interpretations are considered and either convincingly rejected or used as the basis for further research suggestions.	Conclusions are inappropriate given the data; Obvious alternative interpretations are omitted.

(Adapted from Brown University as cited in The University of North Carolina at Chapel Hill's Guide to using Rubrics to Assess Student Learning: <https://oira.unc.edu/wp-content/uploads/sites/297/2017/07/Developing-and-Using-Rubrics.pdf>)

## Science Lab Report Evaluation Rubric

This analytic rubric is used to verify specific tasks performed when producing a lab report. The rubric permits students to self-assess as well as receive feedback from the instructor.

Category	Scoring Criteria	Weight	Student Evaluation	Instructor Evaluation
<b>Lab Introduction 15 points</b>	The question to be answered during the lab is stated.	<b>5</b>		
	Research references used to prepare for the lab are listed.	<b>5</b>		
	The hypothesis clearly shows it is based on research and not just speculation.	<b>5</b>		
<b>Procedures 15 points</b>	Procedures are written as part of pre-lab preparation and clearly state the plan for the experiment. If adjustments are made during the lab, those changes are noted as they occur.	<b>5</b>		
	All procedures are followed in appropriate order.	<b>5</b>		
	Specific formulas for chemicals used or equations for reactions that occur during the lab, when required, are shown on the procedures side of the lab sheet.	<b>5</b>		
<b>Observations 15 points</b>	Results that occur during a procedure are clearly recorded.	<b>5</b>		
	Measurements, when required, are recorded as observations, using proper units.	<b>5</b>		
	Calculations, when required, are clearly shown on the observation side of the lab sheet.	<b>5</b>		
<b>Conclusion 25 points</b>	Reasoning for the lab design is summarized, listing any facts or assumptions on which the lab is based.	<b>5</b>		
	The essential data gathered during the lab is summarized.	<b>5</b>		
	Essential data from the lab is used to answer the lab question.	<b>5</b>		
	Aspects of the lab most likely responsible for measurable experimental error are identified.	<b>10</b>		
<b>Presentation 25 points</b>	The report is neatly printed in ink, with no visible corrections.	<b>10</b>		
	The report is written in such a way that others could accurately duplicate the experiment and compare their data.	<b>5</b>		
	There is a clear diagram of the essential apparatus used in the experiment drawn in the largest available white space on the front of the lab report sheet.	<b>10</b>		
<b>Lab Safety 5 points</b>	No group members were cited for safety violations during the lab period.	<b>5</b>		
<b>Score</b>	<b>Total Points</b>	<b>100</b>		
<b>Self- Evaluation</b>	Students are expected to honestly evaluate their own work. If the difference between the student evaluation and the teacher evaluation is more than 10 points, 5 points will be deducted from the teacher's score when the grade is recorded.			
<b>Deadline</b>	Lab reports are due at the beginning of class the day after the lab. Reports will be accepted at the beginning of class the second day after the lab for 3/4 credit. No credit will be given after this time.			

(Adapted from California State University as cited in The University of North Carolina at Chapel Hill's Guide to using Rubrics to Assess Student Learning: <https://oira.unc.edu/wp-content/uploads/sites/297/2017/07/Developing-and-Using-Rubrics.pdf>)

## Analytic Rubric for Mathematical Proofs

Attribute	Exemplary (4)	Proficient (3)	Acceptable (2)	Unacceptable (1)
<b>Use of Mathematical Notation</b>	<p>The proof uses accurate and appropriate mathematical notation and terminology;</p> <p>Symbolic notation is used where it clearly simplifies the discourse and avoided when English will better serve the reader.</p>	<p>Notation and terminology are correctly used;</p> <p>There may be instances where the discourse would benefit from either more or less use of symbols versus English.</p>	<p>Most, but not all, the notation and terminology are used accurately;</p> <p>Errors are identifiable and correctable by a reader of experience similar to the author.</p>	<p>Notation and/or terminology is frequently misused;</p> <p>The writer may use personal rather than standard notation.</p>
<b>Use of Definitions</b>	<p>Relevant definitions appear where needed to guide the logical flow.</p>	<p>The proof accurately invokes all needed definitions, though they may appear other than precisely where needed.</p>	<p>Some relevant definitions are missing or misstated, but the proof is otherwise understandable.</p>	<p>Several relevant definitions are missing or incorrectly stated, compromising the argument beyond repair.</p>
<b>Concise Writing</b>	<p>The proof is well-organized and clear, without inclusion or irrelevant definitions or theorems.</p>	<p>The author generally avoids digressions but may repeat some ideas in an unnecessary way.</p>	<p>The proof is well-organized but includes extraneous steps, definitions, theorems, or unnecessary repetition.</p>	<p>The proof contains several extraneous steps which lead to a confused organization.</p>
<b>Reference to Earlier Theorems</b>	<p>The proof accurately references necessary prior theorems, with explicit statements or names.</p>	<p>Reference to necessary prior theorems is complete but may be vague.</p>	<p>Some theorems necessary to the deductions are used correctly, but others are missing, misused, or stated inaccurately.</p>	<p>Reference to prior theorems is generally lacking, or the theorems in question are stated inaccurately.</p>
<b>Logical Flow</b>	<p>A clear, complete, and properly ordered chain of deductive steps leads from hypothesis to the conclusion;</p> <p>The proof moves seamlessly between symbolic notation and standard English.</p>	<p>The chain of deductive steps is complete and ordered correctly.</p>	<p>One or more intermediate deductive steps are missing or unclear, but the correctness of the proof is not compromised.</p>	<p>The hypothesis or conclusion is missing or incorrectly stated;</p> <p>The stated chain of deductions does not lead to the stated conclusion.</p>

(Adapted from Dartmouth College as cited in The University of North Carolina at Chapel Hill's Guide to using Rubrics to Assess Student Learning: <https://oira.unc.edu/wp-content/uploads/sites/297/2017/07/Developing-and-Using-Rubrics.pdf>)

## Engineering Design Project Analytic Rubric

Topic (Weight)	Unacceptable (0)	Marginal (1)	Acceptable (2)	Exceptional (3)	Points
<b>Design Problem &amp; Boundaries</b> (1)	Little or no grasp of problem; Incapable of producing a successful solution.	Some understanding of the problem and constraints; Major deficiencies that will impact the quality of solution.	Overall sound understanding of the problem and constraints; Does not significantly impair solution.	Clear and complete understanding of design goal and constraints.	
<b>Alternative Designs</b> (2)	Only one design presented or clearly infeasible alternative given.	Serious deficiencies in exploring and identifying alternative designs.	Alternative approaches identified to some degree.	Final design achieved after review of reasonable alternatives.	
<b>Use of Computer-Aided Tools</b> (2)	Serious deficiencies in understanding the correct selection and/or use of tools.	Minimal application and use of appropriate tools.	Computer-aided tools used with moderate effectiveness to develop designs.	Computer-aided tools are used effectively to develop and analyze designs.	
<b>Application of Engineering Principles</b> (2)	No or erroneous application of engineering principles yielding unreasonable solution.	Serious deficiencies in proper selection and use of engineering principles.	Effective application of engineering principles resulting in reasonable solution.	Critical selection and application of engineering principles ensuring reasonable results.	
<b>Final Design</b> (3)	Not capable of achieving desired objectives; No implementation of resources conservation and recycle strategies.	Barely capable of achieving desired objectives; Minimal utilization of resource conservation and recycle potentials.	Design meets desired objectives; Moderately effective utilization of resource conservation and recycle potentials.	Design meets or exceeds desired objectives; Effective implementation or resource conservation and recycle strategies.	
<b>Process Economics</b> (1)	No or totally erroneous cost estimates presented.	Reasonable cost estimates presented, but no profitability analysis included.	Reasonable profitability analysis presented, but no interpretation of the results.	Effective use of profitability analysis leading to improvement recommendations.	
<b>Interpretation of Results</b> (2)	No or erroneous conclusions based on achieved results.	Serious deficiencies in support for stated conclusions.	Sound conclusions reached based on achieved results.	Insightful, supported conclusions and recommendations.	
<b>OVERALL PERFORMANCE</b>	<b>Unacceptable</b>	<b>Marginal</b>	<b>Acceptable</b>	<b>Exceptional</b>	<b>TOTAL</b>
<b>POINTS REQUIRED</b>	<b>0 – 9</b>	<b>10 – 19</b>	<b>20 – 29</b>	<b>30 – 39</b>	

(Adapted from University of Wisconsin-Milwaukee as cited in The University of North Carolina at Chapel Hill's Guide to using Rubrics to Assess Student Learning: <https://oira.unc.edu/wp-content/uploads/sites/297/2017/07/Developing-and-Using-Rubrics.pdf>)