



**Assessment Rubric for the Design of an Application Experiment (1/2)**

Scientific Ability		0	1	2	3
		Missing	Inadequate	Needs Improvement	Adequate
1	Is able to identify the problem to be solved and define the objectives of the experiment	No mention is made of the problem to be solved.	An attempt is made to identify the problem to be solved but it is described in a confusing manner, objectives are not relevant, objectives contain technical/conceptual errors or objectives are not	The problem to be solved is described but there are minor omissions or vague details. Objectives are conceptually correct and measurable but may be incomplete in scope or have linguistic errors	The problem to be solved is clearly stated. Objectives are complete, specific, concise, and measurable. They are written using correct technical terminology and are free from linguistic errors.
2	Is able to find relevant theory and previously published theoretical and experimental data and to use them to explain the expected outcomes of the experiment	No theory or previously published data is included	Theory and previously published data are irrelevant or contain conceptual or mathematical errors	Theory and previously published data are relevant and well written with equations and some discussions but are not used to explain the expected outcomes of the	Theory is well written with equations and discussion relevant to the experiment. Published data are included and correctly used to explain the expected outcomes of the
3	Is able to identify variables to be measured	Dependent and independent variables are not correctly identified	Dependent and independent variables are identified as well as the range of some of them	dependent and independent variables are identified as well as the range for both of them	dependent and independent variables are identified as well as the range for both and the appropriate increments for measurements.
4	Is able to identify appropriate available sensors, instrumentation and/or software tools to measure physical quantities	Failure to identify appropriate tools and instrumentation or some of the chosen measurements cannot be made with the available equipment.	The list of appropriate tools and instrumentation is incomplete, the selection is not justified, or no details are given about how they will be used (range and appropriate number of data points to capture the phenomenon)	A complete list of appropriate tools and instrumentation is present with incomplete justification or with vague or incomplete details about how they will be used (range and appropriate number of data points to capture the phenomenon).	A complete list of appropriate tools and instrumentation is present with complete justification. All details about how tools and instruments will be used are provided and clear (range and number of data points are optimized to capture full response of system)
5	Is able to design a reliable experiment that solves the problem	The experiment does not solve the problem.	The experiment attempts to solve the problem but due to the nature of the design the data will not lead to a reliable solution.	The experiment attempts to solve the problem but due to the nature of the design there is a moderate chance the data will not lead to a reliable solution.	The experiment solves the problem and has a high likelihood of producing data that will lead to a reliable solution.
6	Is able to deal responsibly with safety and environmental issues related to experimentation as a technological process.	No mention is made to safety or environmental issues related to the designed experiment	Measures to deal with safety and environmental hazards are vague, incomplete, or insufficient	Measures to deal responsibly either with safety issues or with environmental hazards are presented	Measures to deal responsibly with both safety issues and environmental hazards are presented
	Is able to identify sources of experimental uncertainty	No attempt is made to identify experimental uncertainties.	An attempt is made to identify experimental uncertainties, but most are missing, described vaguely, or incorrect.	Most experimental uncertainties are correctly identified.	All experimental uncertainties are correctly identified.
7	Is able to evaluate specifically how experimental uncertainties may affect the data	No attempt is made to evaluate experimental uncertainties.	An attempt is made to evaluate experimental uncertainties, but most are missing, described vaguely, or incorrect.	Most experimental uncertainties are evaluated correctly, though a few contain minor errors, inconsistencies, or omissions.	All experimental uncertainties are correctly evaluated.
8	Is able to minimize experimental uncertainty	No attempt is made to minimize experimental uncertainty.	An attempt is made to minimize experimental uncertainty, but most major sources of uncertainty are not addressed or are addressed inappropriately.	Effective steps are taken to minimize most major sources of uncertainty, but one major source is not addressed.	Effective steps are taken to minimize all major sources of experimental uncertainty.
9	Is able to record and represent data in a meaningful way	Data are either absent or incomprehensible.	Some important data are absent or incomprehensible.	All important data are present, but recorded in a way that requires some effort to comprehend.	All important data are present, organized, and recorded clearly.



**Assessment Rubric for the Design of an Application Experiment (2/2)**

Scientific Ability		0	1	2	3
		Missing	Inadequate	Needs Improvement	Adequate
10	Is able to analyze data appropriately	No attempt is made to analyze the data.	An attempt is made to analyze the data, but it is either seriously flawed or	The analysis is appropriate but it contains minor errors or omissions.	The analysis is appropriate, complete, and correct.
11	Is able to make a judgment about the results of the experiment	No discussion is presented about the results of the experiment	A judgment is made about the results, but it is not reasonable or coherent.	An acceptable judgment is made about the result, but the reasoning is flawed or incomplete.	An acceptable judgment is made about the result, with clear reasoning. The effects of assumptions and experimental uncertainties
12	Is able to evaluate the results by means of an independent method	No attempt is made to evaluate the consistency of the result using an independent method.	A second independent method is used to evaluate the results. However there is little or no discussion about the differences in the results due to the two methods.	A second independent method is used to evaluate the results. Some discussion about the differences in the results is present, but there is little or no discussion of the possible reasons for the differences.	A second independent method is used to evaluate the results. The discrepancy between the results of the two methods, and possible reasons are discussed. A percentage difference is calculated in quantitative
13	Is able to identify the shortcomings in an experimental design and suggest specific improvements	No attempt is made to identify any shortcomings of the experimental design.	An attempt is made to identify shortcomings, but they are described vaguely and no specific suggestions for	Some shortcomings are identified and some improvements are suggested, but not all aspects of the design are considered.	All major shortcomings of the experiment are identified and specific suggestions for improvement are made.
14	Is able to choose a productive mathematical procedure for solving the experimental problem	Mathematical procedure is either missing, or the equations written down are irrelevant to the design.	A mathematical procedure is described, but it is incomplete, due to which the final answer cannot be calculated.	Correct and complete mathematical procedure is described but an error is made in the calculations.	Mathematical procedure is fully consistent with the design. All quantities are calculated correctly. Final answer is meaningful.
15	Is able to identify the assumptions made in using the mathematical procedure	No attempt is made to identify any assumptions.	An attempt is made to identify assumptions, but most are missing,	Most assumptions are correctly identified.	All assumptions are correctly identified.
16	Is able to determine specifically the way in which assumptions might affect the results	No attempt is made to determine the effects of assumptions.	An attempt is made to determine the effects of some assumptions, but most are missing, described vaguely, or incorrect.	The effects of most assumptions are determined correctly, though a few contain errors, inconsistencies, or omissions.	The effects of all assumptions are correctly determined.
17	Is able to communicate the details of an experimental procedure clearly and completely	Diagrams are missing and/or experimental procedure is missing or extremely vague.	Diagrams are present but unclear and/or experimental procedure is present but important details are missing.	Diagrams and/or experimental procedure are present but with minor omissions or vague details.	Diagrams and/or experimental procedure are clear and complete.
18	Is able to behave with highest ethical standards	No references are mentioned and the role of each team member is not explicitly stated	The list of references is incomplete or does not appear in a standard professional format but the role of each team member is explicitly stated.	A standard professional list of references is used to credit work from other sources but the role of each team member is not explicitly stated.	A standard professional list of references is used to credit work from other sources and the role of each team member is explicitly stated.
19	Is able to work effectively in teams	No team meeting minutes or team peer-to-peer assessment is attached	Team peer-to-peer assessment is presented. Team meeting minutes is missing or does not show assignments of roles, tasks, and responsibilities	Team peer-to-peer assessment is not presented. Team meeting minutes is presented and shows assignments of roles, tasks, and responsibilities	Team peer-to-peer assessment is presented. Team meeting minutes is presented and shows assignments of roles, tasks, and responsibilities
20	Is able to make and justify a reasonable conclusion	No attempt is made to state or justify a conclusion	A conclusion is stated, but its justification is either absent, missing major steps, or containing major mistakes	A conclusion is stated and justified, but it is inconsistent with the results of the student's analysis, or it is incomplete	A conclusion is stated and justified, and is consistent with the results of the student's analysis
21	Is able to communicate his work in concise way	No attempt is made to state or write an executive summary	An executive summary is stated, but it is either very long or very short.	The executive summary has a reasonable length and format but some elements are missing (background, problem definition, relevant theory, experimental approach, results, and conclusions)	The executive summary has a reasonable length and format and contains all of the following: background, problem definition, relevant theory, experimental approach, results, and conclusions)

**Definition:** An experiment that typically involves solving a practical problem or determining an unknown quantity by performing experiments. Students need to solve these experimental problems using at least two different methods and then compare the results. Often they need to perform additional experiments or make informed estimates to determine some physical quantities.

**Example:** Design at least two independent experiments to determine the coefficient of static friction between your shoe and the sample of carpet provided.