Steps for Design of Experiment

1. Define the goals and objectives of the experiment.
    a. Goals: may be general
    b. Objectives: must be specific and measurable, directly or indirectly.
2. Research
    a. Relevant theory
    b. Previously published data from similar experiments.
    c. Computer simulations if appropriate software is available.
3. Select dependent and independent variable(s) to be measured.

4a. Select appropriate methods for measuring these variables.

4b. Select appropriate equipment and instrumentation.

5. Select proper range of the independent variable(s).
6. Determine appropriate number of data points needed for each type of measurement.

1. Define Goals and Objectives of the Experiment

NOT PASS	0	No objectives identified
	1	Objective identified but • Not relevant to experiment OR • Contains technical or conceptual errors OR • Not measurable
PASS	2	Objective is conceptually correct and uses correct technical terminology but may be incomplete in scope or have grammatical errors.
	3	Objective is complete, conceptually correct, concise, and uses correct technical terminology but may have grammatical errors.
	4	Objective is complete, conceptually correct, concise, specific and clear, and uses correct technical terminology and grammar

2. Research any relevant theory and previously published data from similar experiments.

NOT PASS	0	No theory. Previously published data not included. No computer simulations.
	1	Theory section, published experimental data, and computer simulations included but not relevant to the experiment.
PASS	2	Theory section includes some of the relevant equations and some discussion relevant to the experiment. Published experimental data or computer simulations relevant to the experiment are included but not used to predict experimental results.
	3	Theory section is well written, with equations and some discussion relevant to the experiment. Published experimental data and / or computer simulations relevant to the experiment are included but not used to predict experimental results.
	4	Theory section is well written, with equations and discussion relevant to the experiment. Published experimental data are included as well as computer simulations relevant to the experiment. Theory, published data, and simulations are used to predict experimental results.

3. Select dependent and independent variables to be measured (or controlled)

NOT PASS	0	Did not identify variables
	1	Identified variables but did not distinguish dependent and independent
PASS	2	Identified dependent and independent variables and relationship between them Identified range for one variable
	3	Identified dependent and independent variables and relationship between them Identified ranges for both
	4	Identified dependent and independent variables and relationship between them Identified ranges for both Identified appropriate increments for measurements

4a. Select appropriate methods for measuring/controlling variables

NOT PASS	0	Did not identified methods for measuring/controlling variables
	1	Identified inappropriate method(s)
PASS	2	Method(s) listed with no description or incomplete description OR Complete description of method(s) presented, but list is not comprehensive
	3	Comprehensive list of possible methods of measurement and instrumentation with complete descriptions but no discussion of limitations and dynamic range
	4	Comprehensive list of possible methods of measurement and testing instrumentation and equipment based on available resources with complete descriptions including a discussion of limitations and dynamic range

4b. Select appropriate equipment and instrumentation

NOT PASS	0	Did not identify instrumentation and equipment for measuring/controlling variables
	1	Identified inappropriate instrumentation and equipment
PASS	2	Selected appropriate instrumentation and equipment with no justification OR Incomplete list of instrumentation
	3	Selected appropriate instrumentation and equipment with incomplete justification
	4	Selected appropriate instrumentation and equipment with complete justification(for example based on accuracy, sensitivity, reliability, and available resources)

5. Select proper range of independent variables

NOT PASS	0	Ranges not identified
	1	Ranges grossly unreasonable*** OR Ranges provided with no justification
PASS	2	Range is reasonable* but not adequately justified OR Range is unreasonable but based on correct theory with mathematical errors
	3	Reasonable* range for all independent variables that are justified based on appropriate but possibly incomplete use of literature, correct theoretical calculations, and equipment/instrumentation limitations.
	4	Optimal** range for all independent variables that are justified based on appropriate use of literature, theoretical calculations, and equipment/instrumentation limitations.

* reasonable – pushing the limits of equipment, instrumentation or specimens, or captures some aspects of system behavior but is inadequate for complete analysis

** optimal – range will capture full response of system, is within limitations of equipment, instrumentation, and specimens, and will provide sufficient data for a statistically valid and complete analysis

*** unreasonable – theoretically impossible, or significantly outside the limits of the equipment, instrumentation, or specimens

6. Determine an appropriate number of data points needed for each type of measurement.

NOT PASS	0	Number of data points not identified
	1	Number of points grossly unreasonable OR Number of points provided with no justification
PASS	2	Number of points is sufficient to capture mathematical properties in an ideal world, but insufficient in the presence of experimental error or other confounding factors
	3	Reasonable* number of points for measurements, justified based on some but not all of the following: theory, equipment limitations, and potential error
	4	Reasonable* number of points for all measurements, justified based on consideration of theory, equipment limitations, and potential error

* reasonable – a sufficient number of points to capture the mathematical properties of the relationship (e.g. linear versus logarithmic).and account for possible measurement error.
*** unreasonable – insufficient number of points to capture the mathematical properties of the relationship