

Some PUM Rubrics
Graphical representation

Missing	An attempt	Needs some improvement	Acceptable
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Force diagrams

Missing	An attempt	Needs some improvement	Acceptable
No force diagram is constructed.	Force diagram is constructed but contains major errors: missing or extra forces (not matching with the interacting objects), incorrect directions of arrows or incorrect relative length of force arrows.	Force diagram contains no errors in force arrows but lacks a key feature such as labels of forces with two subscripts or forces are not drawn from single point.	The diagram contains all appropriate force and each force is labeled so that one can clearly understand what each force represents. Relative lengths of force arrows are correct. Axes are shown.

Motion diagrams

Missing	An attempt	Needs some improvement	Acceptable
No motion diagram is constructed.	Diagram does not represent motion properly, either spacing of the dots or the directions and length of v arrows or Δv arrows do not match the motion.	Diagram has no errors but is missing one key feature: dots that represent position or velocity arrows, or Δv arrows.	The diagram contains no errors in dots, v arrows or Δv arrows and it clearly describes the motion of the object.

Energy bar charts

Missing	An attempt	Needs some improvement	Acceptable
No energy bar chart is constructed.	Bar chart is either missing energy bars, values drawn do not show the conservation of energy or bars are drawn in the wrong places not matching the energy of the system.	Bar chart has the energy bars and the work bar drawn correctly, but is missing labels or zero. Energy bars are in the correct spot, but may not be of proper relative size.	Bar chart is properly labeled and has energy bars and work bar at appropriate magnitudes and signs. Zero level is marked.

No graph is present.	A graph is present but the axes are not labeled. There is no scale on the axes	The graph is present and axes are labeled but the axes do not correspond to the independent and dependent variable or the scale is not accurate.	The graph has correctly labeled axes, independent variable is along the horizontal axis and the scale is accurate.
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Ability	Absent	An attempt	Needs some improvement	Acceptable
Is able formulate the question to be investigated	The question to be investigated. Is not mentioned.	The question is posed but it is not clear.	The question is posed but it involves more than one variable.	The question is posed and it involves only one variable.

Rubric for designing an experiment to answer your own question (observational experiment)

Is able to design an experiment to answer the question	The experiment does not answer the question.	The experiment is related to the question but will not help answer it.	The experiment investigates the question but might not produce the data to find a pattern.	The experiment investigates the question and might produce the data to find a pattern.
Is able to decide what is to be measured and identify independent and dependent variables	It is not clear what will be measured.	It is clear what will be measured but independent and dependent variables are not identified.	It is clear what will be measured and independent and dependent variables are identified but the choice is not explained.	It is clear what will be measured and independent and dependent variables are identified and the choice is explained.
Is able to use available equipment to make measurements	At least one of the chosen measurements cannot be made with the available equipment.	All chosen measurements can be made, but no details are given about how it is done.	All chosen measurements can be made, but the details of how it is done are vague or incomplete.	All chosen measurements can be made and all details of how it is done are clearly provided.
Is able to describe what is observed in words, pictures and diagrams.	There is no description of what was observed.	A description is mentioned but it is incomplete. No picture is present.	A description exists, but it is mixed up with explanations or other elements of the experiment. A labeled picture is present.	Clearly describes what happens in the experiments both verbally and by means of a labeled picture.
Is able to construct a mathematical (if applicable) relationship that represents a trend in data	No attempt is made to construct a relationship that represents a trend in the data.	An attempt is made, but the relationship does not represent the trend.	The relationship represents the trend but no analysis of how well it agrees with the data is included (if applicable), or some features of the relationship are missing.	The relationship represents the trend accurately and completely and an analysis of how well it agrees with the data is included (if applicable).

Hypothesis-prediction-testing rubric (used for testing experiments)

Scientific Ability	Missing	An attempt	Needs some improvement	Acceptable
Is able to distinguish between a	No prediction is made. The experiment is not	A prediction is made but it is identical to the hypothesis.	A prediction is made and is distinct from the hypothesis but	A prediction is made, is distinct from the hypothesis,

hypothesis and a prediction	treated as a testing experiment.		does not describe the outcome of the designed experiment.	and describes the outcome of the designed experiment
Is able to make a reasonable prediction based on a hypothesis	No attempt to make a prediction is made.	A prediction is made that is distinct from the hypothesis but is not based on it.	A prediction is made that follows from the hypothesis but does not have if-and-then structure	A prediction is made that is based on the hypothesis and has if-and-then structure.
Is able to make a reasonable judgment about the hypothesis	No judgment is made about the hypothesis.	A judgment is made but is not consistent with the outcome of the experiment.	A judgment is made and is consistent with the outcome of the experiment but assumptions are not taken into account.	A reasonable judgment is made and assumptions are taken into account.

Data analysis rubrics (simplified for middle school)

Ability	Missing	An attempt	Needs some improvement	Acceptable
Is able to record and represent data in a meaningful way	Data are absent.	Data are present but impossible to understand. Units are missing.	Data are present and have units, but one needs to make a serious effort to understand the data.	Data are present, organized, and recorded clearly. A table is made.
Is able to analyze data using a graph	No graph is present.	A graph is present but the axes are not labeled. There is no scale on the axes	The graph is present and axes are labeled but the axes do not correspond to the independent and dependent variable or the scale is not accurate.	The graph has correctly labeled axes, independent variable is along the horizontal axis and the scale is accurate.

Is able to construct a mathematical (if applicable) relationship that represents a trend in data	No attempt is made to construct a relationship that represents a trend in the data.	An attempt is made, but the relationship does not represent the trend.	The relationship represents the trend but no analysis of how well it agrees with the data is included (if applicable), or some features of the relationship are missing.	The relationship represents the trend accurately and completely and an analysis of how well it agrees with the data is included (if applicable).
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<i>Ability to collect and analyze experimental data</i>				
Scientific Ability	Missing	An attempt	Needs some improvement	Acceptable
1 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 but the source of the biggest uncertainty is not specified.	All experimental uncertainties are correctly identified and the source of the biggest uncertainty is specified.
2 Is able to evaluate specifically how identified 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. Or only absolute uncertainties are mentioned. Or the final result does not take the uncertainty into the account.	The final result does take the identified uncertainties into account but is not correctly evaluated.	The experimental uncertainty of the final result is correctly evaluated; the final result is written within the margin of uncertainty.
3 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.
5 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 inappropriate.	The analysis is appropriate but it contains minor errors or omissions (units for example).	The analysis is appropriate, complete, and correct.

