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Format: Rubric
Duration: N/A minutes
Focus: Problem-solving (Useful problem description, physics approach, specific application of physics, mathematical procedures, logical progression)
Level: Intro college, High school

How to give the test

- The MAPS is not a test that is given to students. It is a rubric used to assess physics problem solutions.
- Read the "Problem Solving Rubric Category Descriptions" (on page 2 of problem-solving rubric) and familiarize yourself with the rubric descriptions.
- Determine the score (0 to 5 points or NA (problem) or NA (solver)) for each individual category using the rubric descriptions, for each problem you are assessing. Use NA (problem) when a given rubric category is not applicable to a given problem. Use NA (solver) when a given rubric category is not applicable for that specific solver (student).
- More training materials, including sample student solutions and a description of scores using the rubric are available here.

How to score the test

- The developers of the MAPS do not combine the individual scores into a single score, but instead looking at the frequency of rubric scores for each rubric category across all of your students to get a sense of their strengths and weaknesses around problem solving.
- If you want an overall score, you could combine the scores for each category into an overall score by determining the appropriate weighting based on the categories you consider most important for a particular problem. There is no consensus on how to weight the categories to create an overall score. For example, in one study, the developers weighted the total score as: Description (10%), Approach (30%), Application (30%), Math (10%), Logic (20%). For a different problem where the description was more important, the developers weighted the total score as: Description (20%), Approach (20%), Application (30%), Math (10%), Logic (20%).
- Once someone is familiar with the categories of the rubric, it takes approximately the same amount of time to score a written solution as it would take to use standard grading procedures.

	5	4	3	2	1	0	NA(Problem)	NA(Solver)
USEFUL DESCRIPTION	**The description is useful, appropriate, and complete.**	**The description is useful but contains minor omissions or errors.**	**Parts of the description are not useful, missing, and/or contain errors.**	**Most of the description is not useful, missing, and/or contains errors.**	**The entire description is not useful and/or contains errors.**	**The solution does not include a description and it is necessary for this problem /solver.**	**A description is not necessary for this problem. (i.e., it is given in the problem statement)**	**A description is not necessary for this solver.**
PHYSICS APPROACH	**The physics approach is appropriate and complete.**	**The physics approach contains minor omissions or errors.**	**Some concepts and principles of the physics approach are missing and/or inappropriate.**	**Most of the physics approach is missing and/or inappropriate.**	**All of the chosen concepts and principles are inappropriate.**	**The solution does not indicate an approach, and it is necessary for this problem/ solver.**	**An explicit physics approach is not necessary for this problem. (i.e., it is given in the problem)**	**An explicit physics approach is not necessary for this solver.**
SPECIFIC APPLICATION OF PHYSICS	**The specific application of physics is appropriate and complete.**	**The specific application of physics contains minor omissions or errors.**	**Parts of the specific application of physics are missing and/or contain errors.**	**Most of the specific application of physics is missing and/or contains errors.**	**The entire specific application is inappropriate and/or contains errors.**	**The solution does not indicate an application of physics and it is necessary.**	**Specific application of physics is not necessary for this problem.**	**Specific application of physics is not necessary for this solver.**
MATHE-MATICAL PROCEDURES	**The mathematical procedures are appropriate and complete.**	**Appropriate mathematical procedures are used with minor omissions or errors.**	**Parts of the mathematical procedures are missing and/or contain errors.**	**Most of the mathematical procedures are missing and/or contain errors.**	**All mathematical procedures are inappropriate and/or contain errors.**	**There is no evidence of mathematical procedures, and they are necessary.**	**Mathematical procedures are not necessary for this problem or are very simple.**	**Mathematical procedures are not necessary for this solver.**
LOGICAL PROGRESSION	**The entire problem solution is clear, focused, and logically connected.**	**The solution is clear and focused with minor inconsistencies**	**Parts of the solution are unclear, unfocused, and/or inconsistent.**	**Most of the solution parts are unclear, unfocused, and/or inconsistent.**	**The entire solution is unclear, unfocused, and/or inconsistent.**	**There is no evidence of logical progression, and it is necessary.**	**Logical progression is not necessary for this problem. (i.e., one-step)**	**Logical progression is not necessary for this solver.**

Category Descriptions:

Useful Description assesses a solver's skill at organizing information from the problem statement into an appropriate and useful representation that summarizes essential information symbolically and visually. The description is considered "useful" if it guides further steps in the solution process. A *problem description* could include restating known and unknown information, assigning appropriate symbols for quantities, stating a goal or target quantity, a visualization (sketch or picture), stating qualitative expectations, an abstracted physics diagram (force, energy, motion, momentum, ray, etc.), drawing a graph, stating a coordinate system, and choosing a system.

Physics Approach assesses a solver's skill at selecting appropriate physics concepts and principle(s) to use in solving the problem. Here the term *concept* is defined to be a general physics idea, such as the basic concept of "vector" or specific concepts of "momentum" and "average velocity". The term *principle* is defined to be a fundamental physics rule or law used to describe objects and their interactions, such as the law of conservation of energy, Newton's second law, or Ohm's law.

Specific Application of Physics assesses a solver's skill at applying the physics concepts and principles from their selected approach to the specific conditions in the problem. If necessary, the solver has set up specific equations for the problem that are consistent with the chosen approach. A *specific application of physics* could include a statement of definitions, relationships between the defined quantities, initial conditions, and assumptions or constraints in the problem (i.e., friction negligible, massless spring, massless pulley, inextensible string, etc.)

Mathematical Procedures assesses a solver's skill at following appropriate and correct mathematical rules and procedures during the solution execution. The term *mathematical procedures* refers to techniques that are employed to solve for target quantities from specific equations of physics, such as isolate and reduce strategies from algebra, substitution, use of the quadratic formula, or matrix operations. The term *mathematical rules* refers to conventions from mathematics, such as appropriate use of parentheses, square roots, and trigonometric identities. If the course instructor or researcher using the rubric expects a symbolic answer prior to numerical calculations, this could be considered an appropriate mathematical procedure.

Logical Progression assesses the solver's skills at communicating reasoning, staying focused toward a goal, and evaluating the solution for consistency (implicitly or explicitly). It checks whether the entire problem solution is clear, focused, and organized logically. The term *logical* means that the solution is coherent (the solution order and solver's reasoning can be understood from what is written), internally consistent (parts do not contradict), and externally consistent (agrees with physics expectations).