

	4	3	2	1	0
Physics Approach	The solver has clearly stated an appropriate and complete physics approach.	The approach is clear but contains minor omissions or errors.	The approach is unclear, or an important physics concept or principle of the approach is missing or inappropriate.	An attempt is made to identify relevant physics concepts or principles, but most of the approach is vague, incomplete, or inappropriate.	The solution does not indicate a basic physics approach, or all of the chosen concepts and principles are inappropriate.
Useful Description*	The solution includes an appropriate and useful problem description.	The description is useful but contains minor omissions or errors.	The description is not useful, or a key feature of the description is missing or incorrect.	An attempt is made, but most of the description is not useful, incomplete, or incorrect.	The solution does not include a description, or all of the description is incorrect.
Specific Application of Physics**	The solution indicates an appropriate and complete application of physics to the specific conditions in this problem.	The specific application of physics to this problem contains minor omissions or errors.	An important specific relationship or condition is missing or applied incorrectly.	An attempt is made, but most of the specific application of physics to this problem is missing or incorrect.	The solution does not indicate a specific application of physics, or all of the application is incorrect.
Mathematical Procedures	Suitable mathematical procedures are used during the solution execution.	Suitable mathematical procedures are used with minor omissions or errors.	An important mathematical procedure is missing or is used with errors.	Attempted mathematical procedures are inappropriate, left unfinished, or contain serious errors	There is no evidence of mathematical procedures in the problem solution or all mathematical procedures are inappropriate.
Logical Organization	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 inconsistent.	The entire solution is unorganized and contains obvious logical breaks.
NA (Problem)	The skill is not necessary for this <u>problem</u> , or constitutes a very small part of the solution.				
NA (Solver)	Explicit statement is not necessary for this <u>solver</u> , as indicated by the overall solution.				

Category Descriptions:

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.

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 variables, defining variables, stating a goal or target, 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.

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 variables, 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 variable(s) 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 Organization 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).