

Energy Flow in Technological Systems: Marking Rubric

Task

Students present a labelled model or report on energy flow in technological systems. The model or report identifies forms of energy. It describes transformations between forms. It explains how energy is transferred or converted. It analyzes efficiency or energy loss in the system.

Curriculum Alignment

This rubric assesses student work against the following outcomes:

- Analyze and illustrate how technologies based on thermodynamic principles were developed ([Outcome](#))
- Explain and apply concepts used in theoretical and practical measures of energy in mechanical systems ([Outcome](#))
- Apply the principles of energy conservation and thermodynamics to investigate, describe and predict efficiency of energy transformation in technological systems ([Outcome](#))

Rubric

Criterion	Beginning	Developing	Proficient	Exemplary
Identification of Energy Forms	Names one or two energy forms present in the system; labels are missing or unclear.	Names most energy forms in the system; some labels are incomplete or partially incorrect.	Correctly identifies and labels all major energy forms (mechanical, chemical, thermal, etc.) present in the system.	Identifies all energy forms, distinguishes between kinetic and potential energy, and explains the source or condition of each form.
Description of Energy Transformations	Describes energy change in vague terms; no clear pathway shown between forms.	Describes some energy transformations with minor gaps; pathway is partially visible but incomplete.	Describes the sequence of energy transformations clearly; shows how energy changes from one form to another at each stage.	Describes transformations with precision; explains why each transformation occurs and relates it to the design or function of the technology.
Application of Energy Conservation and Efficiency	Does not address energy loss or efficiency; assumes all energy is "useful."	Acknowledges that some energy is lost as heat; does not quantify or explain why.	Explains that not all energy becomes "useful" work; describes where energy is lost and why (friction, heat, etc.).	Quantifies or estimates efficiency; applies first or second law of thermodynamics to explain why the system cannot be 100% efficient.

Clarity and Organization of Model or Report	Model or report is disorganized; labels are missing or difficult to follow; information is incomplete.	Model or report is mostly organized; most labels are present but some connections or explanations are unclear.	Model or report is well-organized with clear labels and logical flow; all major components and energy pathways are easy to follow.	Model or report is exceptionally clear and detailed; labels are precise; visual or written explanations guide the reader through the entire energy flow.
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Scoring

Assign each criterion a level: Beginning (1), Developing (2), Proficient (3), or Exemplary (4).

Sum the four criterion scores. Students are assessed on their ability to identify energy forms, describe energy transformations, apply energy conservation and efficiency concepts, and organize their model or report clearly.

- **4 to 6:** Beginning. Student has not yet demonstrated the ability to identify energy forms in the system or describe how energy changes from one form to another. Student requires additional practice with labelling energy forms and addressing efficiency or energy loss.
- **7 to 9:** Approaching expectations. Student demonstrates partial understanding of energy forms and transformations but does not consistently address efficiency or energy loss.
- **10 to 12:** Meets expectations. Student demonstrates understanding of energy forms, transformations, and efficiency, with a clearly organized model or report.
- **13 to 16:** Exceeds expectations. Student demonstrates comprehensive understanding, clearly explaining energy forms, transformations, and efficiency, applying thermodynamic principles with a well-organized and detailed model or report.

Notes for the Teacher

- **Consistency on energy forms:** Accept any system from the curriculum (automobile engine, hydroelectric dam, thermal power plant, bicycle braking, fuel cell, solar heating panel). Ensure students identify at least three distinct forms of energy in their chosen system. If a student chooses a simple system (e.g., a falling object), require explicit identification of gravitational potential energy and kinetic energy.
- **Efficiency language:** Students at the Proficient level should recognize that "useful" energy is a practical concept tied to the technology's purpose. At the Exemplary level, expect reference to heat loss, friction, or the second law of thermodynamics. Do not require quantitative calculation ($E_k = 1/2 mv^2$ or efficiency percentage) unless the student chooses to include it; qualitative explanation satisfies the outcome.
- **Model versus report:** Accept either format. A labelled diagram with annotations counts as a model; a written explanation with sketches counts as a report. Ensure the format chosen allows the student to show energy pathways clearly. A model must include labels for energy forms and arrows or descriptions showing transformations.
- **Differentiation:** For students struggling with abstract energy concepts, provide a template with energy forms pre-listed and ask them to match transformations to each stage. For advanced students, ask them to compare the efficiency of two similar technologies (e.g., two engine designs) or to propose a design change that would improve efficiency.