

3.1 Energy stores, work and efficiency

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS power • efficiency

Objective

Energy stores, work and efficiency. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

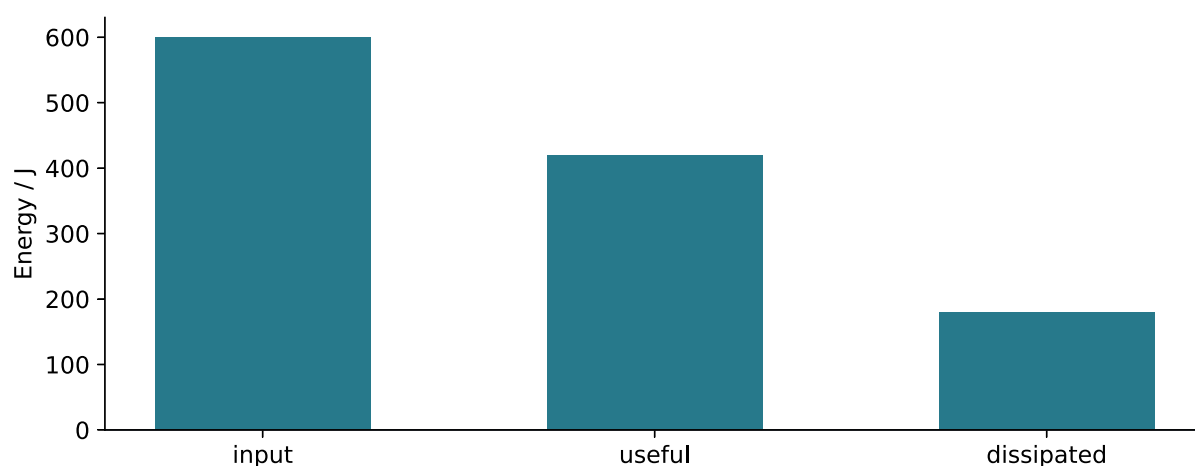
1 Key knowledge and worked examples

■ What would explain this observation?

- A motor can transfer some input energy to lifting and the rest to heating. Useful output is part of the total energy transfer.
- Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.

■ Build the model

- Work done by a constant force parallel to displacement is force multiplied by distance. Kinetic energy depends on speed squared. Energy is conserved when all transfers and stores are included.
- **power** : Energy transferred per unit time; **efficiency** : Useful output divided by total input.



■ Choose evidence that can test it

- Define the system and useful output before calculating efficiency. Doubling speed quadruples kinetic energy at constant mass. Power describes transfer per time, not total energy.
- Measure a lifting height and load, time the lift, and record electrical input with suitable instruments. Repeat trials and account for heating or friction as transfers, not missing energy.

■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: a device receives 600 J and transfers 420 J usefully. Efficiency = useful output / total input. Efficiency = $420/600 = 0.70 = 70\%$. Over 3 s, useful power = useful energy/time = $420/3 = 140$ W.

Example:

A device receives 250 J and gives 150 J useful output. Find efficiency as a percentage. Use the same sequence: known quantities → model → relation → substitution → unit and interpretation.

■ Check the conclusion and its limits

- Efficiency cannot exceed 100% for a properly defined energy balance. Energy dissipated by heating is still conserved.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

Dissipated energy is destroyed. This claim is false: Efficiency cannot exceed 100% for a properly defined energy balance. Energy dissipated by heating is still conserved.

Key:

Energy stores, work and efficiency: Define the system and useful output before calculating efficiency. Doubling speed quadruples kinetic energy at constant mass. Power describes transfer per time, not total energy.

2 Practice

2.1 What happens to kinetic energy when speed doubles at fixed mass? Choose one answer.

- **A** It doubles
- **B** It quadruples
- **C** It stays constant

[1]

2.2 A device receives 250 J and gives 150 J useful output. Find efficiency as a percentage. Show the relation, substitution and units.

[2]

2.3 Decide whether this claim is true and justify: Dissipated energy is destroyed.

[2]

2.4 Energy transferred per unit time: write the technical term.

[1]

3 Exam-style questions

3.1 A fictional device receives 500 J in 4 s and delivers 300 J usefully. Find input power, useful power and efficiency; account for the remainder. [4]
