

Exercise walk-through

3.1

Energy stores, work and efficiency

International Baccalaureate · IB Diploma · Physics · HL

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

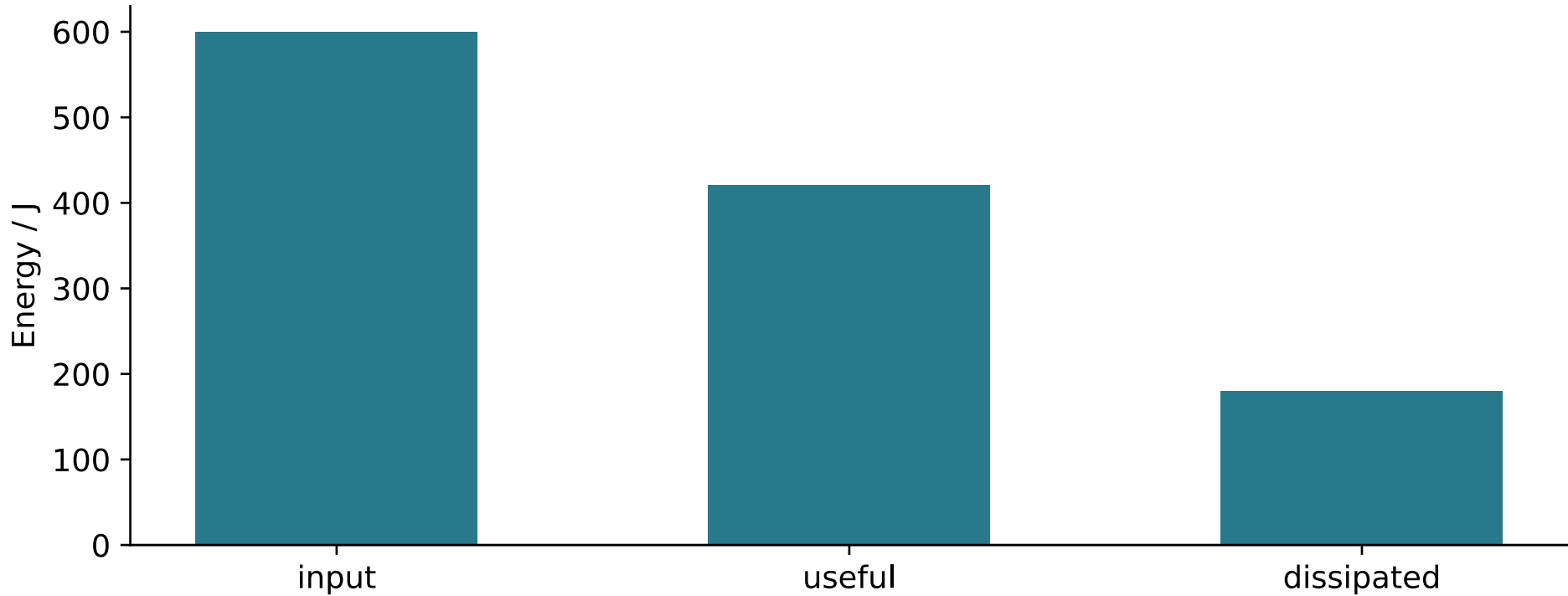
■ What would explain this observation?

- 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 $\rightarrow$ model $\rightarrow$ relation $\rightarrow$ substitution $\rightarrow$ unit and interpretation.

■ Check the conclusion and its limits

- Efficiency cannot exceed 100% for a properly defined energy balance. Energy dissi-

pated 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.

Exercises 2.1·2.3

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]

Exercises 2.1·2.3

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]

2.1 B 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.

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

[2]

2.2 $\text{Efficiency} = 150/250 \times 100 = 60\%$.

2.3 Decide whether this claim is true and justify: Dissipated energy is destroyed. [2]

2.3 False. Efficiency cannot exceed 100% for a properly defined energy balance. Energy dissipated by heating is still conserved.

Exercises 2.4·3.1

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]

Exercises 2.4·3.1

2.4 Energy transferred per unit time: write the technical term. [1]

3 Exam-style questions

2.4 power. power means Energy transferred per unit time.

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]

3.1 Input power 125 W, useful power 75 W, efficiency 60%. The remaining 200 J goes to other transfers or stores. Define the task and system before calling energy useful.