

Exercise walk-through

3.1

Energy stores, work and efficiency

International Baccalaureate · IB Diploma · Physics · SL

3.1 Energy stores, work and efficiency

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS power • efficiency

Objective

Energy stores, work and efficiency. Original classroom practice for IB SL; not an official IB paper.

1 Key knowledge and worked examples

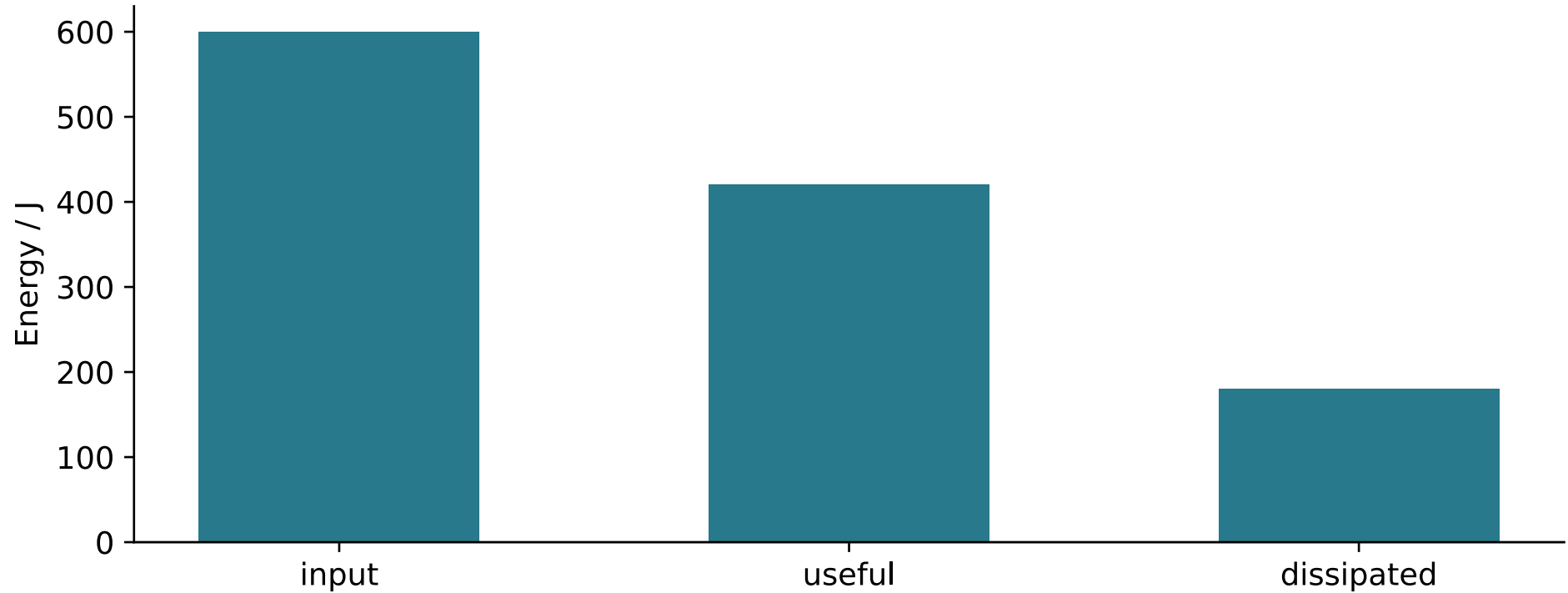
■ What would explain this observation?

- A motor can transfer some input energy to lifting and the rest to heating. Useful output is part of the total energy transfer.

■ 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.

In the lab: 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

- 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.

Your turn: A device receives 250 J and gives 150 J useful output. Find efficiency as a percentage.

■ Check the conclusion and its limits

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

Not true: Dissipated energy is destroyed. Energy is always conserved. “Dissipated” means spread into the surroundings as heating, where it becomes hard to use again - not destroyed.

Key:

- Work done by a constant force parallel to displacement is force multiplied by distance.
- Define the system and useful output before calculating efficiency.
- Watch for: efficiency cannot exceed 100% for a properly defined energy balance.

■ Write from an efficiency of 40 percent

- A device receives 300 J and gives 120 J of useful output.

- Find the efficiency. The other energy is dissipated, not destroyed.



Exercises 2.1·2.2

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

- **A** It quadruples
- **B** It doubles
- **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]

Exercises 2.1·2.2

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

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

[1]

2.1 A Kinetic energy depends on v squared: $KE = 1/2 m v^2$. Doubling v squares the factor 2, giving four times the energy at the same mass - which is why braking distances grow so quickly with speed.

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 Efficiency = $150/250 \times 100 = 60\%$.

Exercises 2.3-3.1

2.3 Decide whether this claim is true and justify: Energy is always conserved. “Dissipated” means spread into the surroundings as heating, where it becomes hard to use again - not destroyed. [2]

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

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 2.3-3.1

2.3 Decide whether this claim is true and justify: Energy is always conserved. “Dissipated” means spread into the surroundings as heating, where it becomes hard to use again - not destroyed. [2]

2.3 True. True. Energy is always conserved. “Dissipated” means spread into the surroundings as heating, where it becomes hard to use again - not destroyed.

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

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.