2.2 Dissipation efficiency and resources

Name: _____ Class: _____ Date: _____ **Total: 25 marks**

KEY WORDS efficiency • renewable

Objective

Build the skills to answer exam questions on **energy transfers, efficiency and energy resources** 、 : energy stores and transfers, dissipation, efficiency, Sankey diagrams and renewable and non-renewable resources.

You must be able to:

- name energy stores and the ways energy is transferred
- explain how wasted energy is dissipated, including in a pendulum
- calculate efficiency from energy or power, and use Sankey diagrams
- compare renewable and non-renewable energy resources

1 Key knowledge and worked examples

■ Energy transfers and efficiency

idea	equation or rule
energy stores	kinetic, gravitational potential, elastic, thermal, chemical, nuclear, magnetic, electrostatic
ways to transfer energy	by a force (mechanical work), by an electric current, by heating, by waves such as light and sound
conservation	the total energy stays the same; wasted energy spreads out (is dissipated), mostly as thermal energy
efficiency	$= \frac{\text{useful output energy}}{\text{total input energy}}$ or $\frac{\text{useful output power}}{\text{total input power}}$; $\times 100$ for a percentage
Sankey diagram	the width of each arrow shows the energy; useful energy goes straight on, wasted energy bends away
non-renewable	coal, oil, gas, nuclear fuel: will run out; fossil fuels release carbon dioxide
renewable	wind, solar, hydroelectric, tides, waves, geothermal, biofuel: will not run out; some depend on the weather

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Worked example 1: efficiency. A lamp takes in 60 J of electrical energy and gives out 9 J of light. Find its efficiency.

1. Known: useful output 9 J, input 60 J.
2. Rule: efficiency $= \frac{\text{useful output}}{\text{input}}$.
3. Numbers: $\frac{9}{60} = 0.15$.
4. Result: 15%.

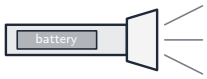
Worked example 2: useful power. A motor has an efficiency of 0.80 and an input power of 500 W. Find the useful and the wasted power.

1. Known: efficiency 0.80, input 500 W.
2. Rule: useful power = efficiency × input power.
3. Numbers: $0.80 \times 500 = 400$ W; $500 - 400 = 100$ W.
4. Result: **useful** 400 **W, wasted** 100 **W**.

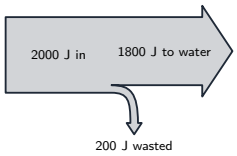
Answer shapes: an efficiency is never more than 1 (or 100%); say where the wasted energy goes.

2 Practice

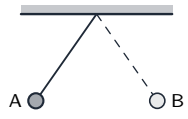
2.1 A torch runs on a battery. Name the energy store in the battery and the useful energy the torch gives out. [2]



2.2 The Sankey diagram is for an electric kettle. Calculate the efficiency of the kettle. [2]



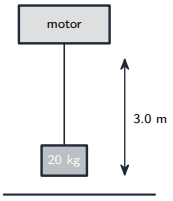
2.3 A pendulum swings from A to B. Which energy store is largest at A? Explain why the pendulum stops after some time. [2]



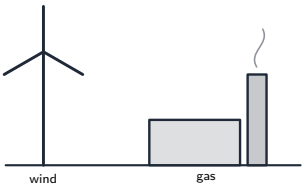
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3 Exam-style questions

3.1 An electric motor lifts a 20 kg load through 3.0 m in 6.0 s. The input power to the motor is 150 W. Calculate the efficiency of the motor. [3]

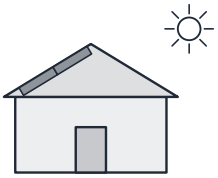


3.2 A country wants to replace some gas power stations with wind turbines. Give one advantage and two disadvantages of wind turbines compared with gas power stations. [3]



3.3 A family puts solar panels on their roof. One panel has an area of 1.5 m^2. In full sunlight, 1000 W of light falls on each m^2, and one panel gives out 270 W of electrical power.

(a) Calculate the efficiency of one panel. [2]



(b) Calculate the electrical energy one panel gives out in 5.0 hours of full sunlight. [2]

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(c) The family uses 24 000 000 J of electrical energy each day. How many panels do they need? Assume 5.0 hours of full sunlight a day. [3]

(d) Evaluate using solar panels instead of electricity from a gas power station for this family. [6]

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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

- chemical energy store
- light

2.2

- $1800 \div 2000$
- $= 0.90$ or **90**%

2.3

- gravitational potential energy store
- air resistance (and friction at the pivot) dissipate energy as thermal energy to the surroundings

3.1

- useful energy $= mgh = 20 \times 9.8 \times 3.0 = 588$ J
- input energy $= 150 \times 6.0 = 900$ J
- efficiency $= 588 \div 900 =$ **0.65** (65%)

3.2

- advantage: renewable, or no carbon dioxide released when generating, or no fuel cost
- disadvantage: no electricity when there is no wind (not reliable)
- disadvantage: many turbines needed for the same power, or noise, or spoil the view

3.3

(a) input $= 1000 \times 1.5 = 1500$ W; $270 \div 1500 = 0.18$ or **18**%

(b) $t = 5.0 \times 3600 = 18\,000$ s; $E = Pt = 270 \times 18\,000 =$ **4 860 000** J

(c) $24\,000\,000 \div 4\,860\,000 = 4.9$; so they need **5** panels

(d) points to include:

- solar energy is renewable and will not run out
- no carbon dioxide is released while generating, unlike burning gas
- no fuel cost after the panels are bought
- no electricity at night and much less on cloudy days or in winter
- the panels cost a lot to buy and fit, and need roof space
- the family still needs the grid or batteries as a backup; a sensible conclusion

Levels: **5–6** a full, logical answer with correct physics and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.

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