

Energy

OxfordAQA · International GCSE · Physics

Energy: the accountant of physics

Nothing destroys energy – it is only moved between stores and partly dissipated into less useful forms. OxfordAQA's second topic builds the accounting: work and power, the three energy-store equations, conservation with Sankey diagrams, and the choices behind national energy resources.

OxfordAQA International GCSE Physics 9203, topic 3.2 (Version 5.1). Statements marked (P) are Paper-2-only.

Forces and energy

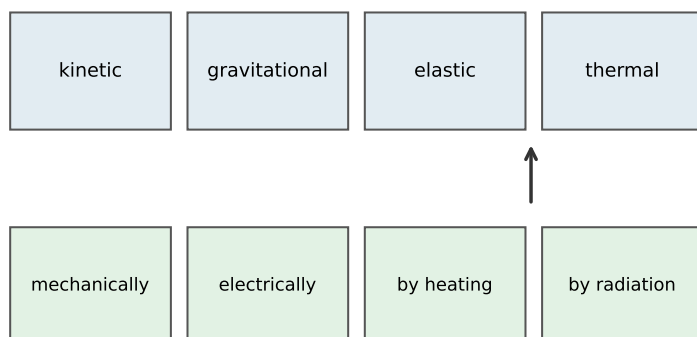
$$W = F \times d \quad E_e = \frac{1}{2}ke^2 \quad E_p = mgh \quad E_k = \frac{1}{2}mv^2 \quad P = \frac{E}{t}$$

Work is done when a force moves its point of application through a distance; work against friction transfers energy by heating (shuttle re-entry, meteorites, brakes). A stretched spring stores **elastic potential energy** $\frac{1}{2}ke^2$; a raised mass stores **gravitational potential energy** mgh ; a moving mass carries **kinetic energy** $\frac{1}{2}mv^2$ – doubling mass doubles it, doubling speed **quadruples** it (the road-safety link). **Power** is the rate of energy transfer.

Worked check. A 1500 kg car at 20 m/s brakes to rest: KE removed = $\frac{1}{2} \times 1500 \times 400 = 300\,000$ J – all transferred to heating the brakes. Lifting it 2 m at $g = 10$ N/kg stores $1500 \times 10 \times 2 = 30\,000$ J.

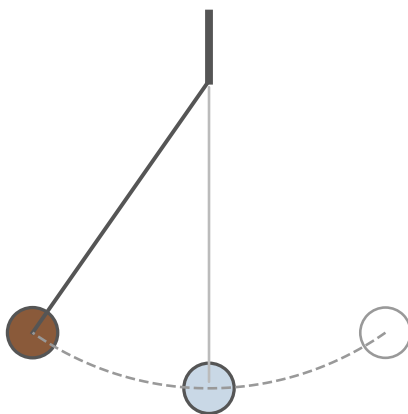
Energy transfers and dissipation

energy STORES (left) are moved by TRANSFER PATHWAYS (right)



a system change moves energy between stores along the pathways

When a system changes, energy is transferred – usefully, stored, or **dissipated** (“wasted”) into less useful stores; it is never created or destroyed. Friction and air resistance dissipate energy by heating. (P) A **pendulum** swaps kinetic and gravitational potential energy each swing.



highest points: all GPE

lowest point: all KE

$$\text{efficiency} = \frac{\text{useful energy out}}{\text{total energy in}} \times 100\% \left(= \frac{\text{useful power out}}{\text{total power in}} \right)$$

Sankey diagrams show the redistribution: arrows split in proportion to the energy flows (draw them to scale – width $\propto$ energy).

Worked check. A 60 W lamp gives 6 W of light: **efficiency** $= 6/60 \times 100 = 10\%$.

Energy resources

Fuels are chosen for ease of storage, energy content and safety; some transfer more of their energy usefully than others. National generation trades **renewability** against cost, reliability and the environmental cost of extraction, use and disposal.

solar	+ renewable; no fuel cost	- night and cloud dependent
wind	+ renewable; no emissions	- unreliable; visual impact
geothermal	+ steady output	- few suitable sites
wave/tidal	+ predictable tides	- harsh marine environment

Check yourself

1. Calculate the work done by a 50 N force moving 4 m.
2. Calculate the elastic energy in a spring ($k = 200 \text{ N/m}$) stretched 0.15 m.
3. A 2 kg book is lifted 3 m at $g = 10 \text{ N/kg}$. Calculate the GPE gained.
4. What happens to the kinetic energy of a car when it brakes?
5. A motor transfers 800 J in 20 s. Calculate its power.
6. State the efficiency equation in energy and power forms.
7. A lamp gives out 12 J of light for every 100 J in. Calculate the efficiency.
8. What does a Sankey diagram's arrow width show?
9. Give one advantage and one drawback of wind power.
10. What does "dissipated" mean?

Answers: 1 $W = 50 \times 4 = 200 \text{ J}$; 2 $E_e = \frac{1}{2} \times 200 \times 0.0225 = 2.25 \text{ J}$; 3 $E_p = 2 \times 10 \times 3 = 60 \text{ J}$; 4 it is transferred to thermal energy of the brakes and surroundings by the friction force (the brakes heat up); 5 $P = 800/20 = 40 \text{ W}$; 6 useful energy out $\div$ total energy in ($\times 100 \%$); equally useful power out $\div$ total power in; 7 $12/100 \times 100 = 12\%$; 8 the energy flowing in that direction – width is proportional to energy; 9 renewable with no fuel or emissions; unreliable output with visual impact; 10 transferred to less useful stores (often waste heat), so it cannot readily do what we want.