Energy

AQA 8463 · Edexcel 1PH0 · OCR J249 / J259

1 Stores & transfers

Part 1 · D1

Store	Example
Kinetic	any moving object
Gravitational potential	object raised above the ground
Elastic potential	stretched / squashed spring, band
Thermal	hot objects (particle energy)
Chemical	food, fuel, batteries
Nuclear	atomic nuclei
Magnetic · Electrostatic	magnets · separated charges

Mechanical — a force moves an object

Electrical — a current flows

Heating — temperature difference

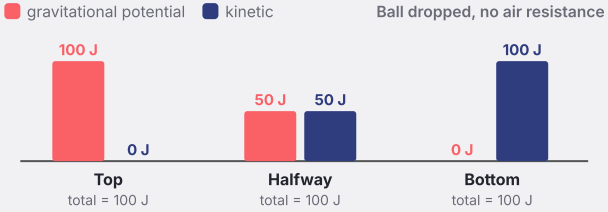
Radiation — waves, e.g. light, sound

System = the object(s) being studied. **Closed system**: no energy enters or leaves, so the total stays the same.

2 Conservation & dissipation

Part 1 · D1, D3

Energy cannot be created or destroyed
only transferred, stored or dissipated



- **Dissipated** = spread out to the surroundings (thermal store), so no longer useful. Say *where* it goes, not just "lost".
- Real pendulum / roller-coaster: friction and air resistance move some energy to the thermal store, so it never regains its starting height.

3 Kinetic & gravitational PE

Part 1 · D2

$E_k = \frac{1}{2} m v^2$
E_k = kinetic energy (J), m = mass (kg), v = speed (m/s)

$E_p = m g h$
E_p = GPE (J), m = mass (kg), g = field strength (N/kg), h = **change** in height (m)

- Double the speed → **4×** the kinetic energy; double the mass → 2×.
- **Square v first**, then × ½ m. Rearranging for speed: $v = \sqrt{(2E_k \div m)}$.
- Use the g in the question (9.8 or 10 N/kg).

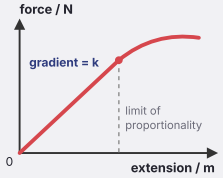
GPE → KE (no air resistance): $m g h = \frac{1}{2} m v^2$, so **$v = \sqrt{(2 g h)}$**; mass cancels.
Dropped 5 m, g = 9.8: $v = \sqrt{(2 \times 9.8 \times 5)}$ = **9.9 m/s**

4 Springs & elastic energy

Part 1 · D3

$F = k e$
F = force (N), k = spring constant (N/m), e = extension (m)

$E_e = \frac{1}{2} k e^2$
E_e = elastic energy stored (J)



- **e** = new length − original length (convert cm → m).
- Straight line through the origin: **gradient = k**; area under it = E_e.
- Past the limit of proportionality, F ∝ e no longer holds.

k = 40 N/m, e = 0.050 m: F = **2.0 N**; $E_e = \frac{1}{2} \times 40 \times 0.050^2$ = **0.050 J**

5 Specific heat capacity

Part 2 · D1

$\Delta E = m c \Delta\theta$
ΔE = energy change (J), m = mass (kg), c = specific heat capacity (J/kg °C), Δθ = temp. change (°C)

- **c** = energy needed to raise 1 kg of a substance by 1 °C. Water: **4200 J/kg °C**.
- High c → slow to heat *and* slow to cool.

0.50 kg water, 20 °C → 60 °C: ΔE = 0.50 × 4200 × 40 = **84 000 J**

Practical: find c of a metal block

- Heater and thermometer in the block, insulated; measure mass.
- Energy supplied: E = V I t (= P t). Record Δθ.
- c = ΔE ÷ (m Δθ). Without lagging some energy escapes, so c comes out **too high**.

6 Power

Part 2 · D1

$P = E \div t$
P = power (W), E = energy transferred (J), t = time (s)

$P = W \div t$
W = work done (J)



- **1 W = 1 J/s**. Higher power = more energy transferred each second (not "stronger").
- Rearrange: E = P t, t = E ÷ P.

1.5 W motor runs for 4.0 s: E = 1.5 × 4.0 = **6.0 J**

Unit traps kW → W (× 1000) · minutes → s (× 60) · kJ → J (× 1000)

7 Efficiency & insulation

Part 2 · D2

efficiency = useful output energy ÷ total input energy
× 100 for a percentage; the same works with power. Never above 1 (100%).



- Reduce unwanted transfers: **lubricate** moving parts (less friction); **insulate** to slow heat loss.
- Lower thermal conductivity or thicker walls → **slower** energy transfer (cavity walls, loft insulation).

Lamp: 80 J in, 20 J as light → 20 ÷ 80 = **0.25 (25%)**

8 Energy resources

Part 2 · D3

Resource	Renewable	Reliable	Key points
Fossil fuels	✗	✓	release CO_2 (climate change); finite; fast to start
Nuclear	✗	✓	no CO_2; radioactive waste; slow to start; high cost
Wind	✓	✗	depends on wind; no fuel or CO_2; noise, visual impact
Solar	✓	✗	depends on daylight and cloud; no CO_2 in use; high set-up cost
Hydroelectric	✓	✓	starts quickly; flooding destroys habitats
Tidal	✓	✓	predictable (not constant); harms estuary wildlife
Geothermal	✓	✓	only in certain places (hot rocks)
Bio-fuel	✓	✓	burning releases CO_2 (offset by regrowth); needs land

Renewable = replaced as fast as it is used. **Evaluate** with: cost · reliability · CO_2 / pollution · start-up time · where it can be built.

9 Exam skills

Parts 1 & 2 · Review

Calculation marks

Equation / substitution → rearrange → answer → **unit**. Show every line: error carried forward (ECF) rewards correct method after a slip.

6-mark questions

Levels-based: name the stores, then link each transfer **in order**, then explain dissipation. Level 3 = complete and linked (5–6).

Data & investigations

Mean excludes the anomaly · uncertainty = ½ range · control variables for fair tests (mass, start temperature, thickness).

AQA multi-step Higher calculations; required practical (specific heat capacity).

Edexcel starred 6-markers and "show that" questions.

OCR about half the marks are 1-mark multiple choice; estimates; answers to 2 s.f.