Exam workout

energy calculations

1 The equations

$E_k = \frac{1}{2} m v^2$ — kinetic energy

$E_p = m g h$ — gravitational potential energy

$P = E / t$ — power · energy over time

$P = W / t$ — power · work done over time

$\text{efficiency} = \frac{\text{useful energy out}}{\text{total energy in}}$ — efficiency (energy)

$\text{efficiency} = \frac{\text{useful power out}}{\text{total power in}}$ — efficiency (power)

2 to find on the sheet

$E_e = \frac{1}{2} k e^2$ — elastic potential energy

$\Delta E = m c \Delta\theta$ — specific heat capacity

- Know by heart: **E = ½ m v²**, E = m g h, P = E / t, P = W / t and the two efficiency equations.
- Find on the sheet: E = ½ k e² (elastic) and ΔE = m c Δθ (specific heat capacity).

2 The five-step method

- ☐ 1 Know: values + units
- ☐ 2 Convert to base units — kg · m · J · W · s
- ☐ 3 Choose the equation
- ☐ 4 Substitute, rearrange
- ☐ 5 Answer + unit

- 1 Know: values and units. 2 Convert to kg, m, J, W and s.
- 3 Choose the equation. 4 Substitute and rearrange. 5 Answer with a unit.

3 Five exam questions

Every question: convert first

Q1 ✓	Q2 ✓	Q3 ✓
800 g → 0.8 kg	150 cm → 1.5 m	12.6 kJ → 12 600 J

Q4 ✓	Q5 ✓
1.5 kW → 1500 W	54 kJ → 54 000 J 1½ min → 90 s

that's where marks are lost

- **Convert first**: g ÷ 1000 = kg, cm ÷ 100 = m, kJ × 1000 = J, kW × 1000 = W, minutes × 60 = s.
- Example: 12.6 kJ warms 0.3 kg of water. Δθ = 12 600 ÷ (0.3 × 4200) = **10 °C**.

4 A stretch question

A spring (k = 50 N/m) is stretched by 20 cm. It launches a ball of mass 50 g. Calculate (a) the energy stored, (b) the top speed. All the energy goes to the kinetic store.

(a) E_e = 1 J (elastic store) → (b) E_k = 1 J (kinetic store)

$E_k = \frac{1}{2} m v^2$: ½ × 0.05 × v² = 1

v² = 1 ÷ 0.025 = 40

v = √40 ≈ 6.3 m/s

- ☑ 1 Know + units
- ☑ 2 Convert
- ☑ 3 Equation
- ☑ 4 Substitute
- ☑ 5 Answer + unit

- Square before you multiply: $0.2^2 = 0.04$, so E = ½ × 50 × 0.04 = 1 J.
- That 1 J goes to the kinetic store: ½ × 0.05 × v^2 = 1, so v^2 = 40 and v ≈ 6.3 m/s.

P = E / t

power = energy transferred ÷ time

P	power	watt (W)
E	energy transferred (or W, work done)	joule (J)
t	time	second (s)

Convert kJ to J and minutes to seconds first.

Exam tip

Convert first, square before you multiply, and use the temperature change Δθ, not a temperature.

Check yourself

1. A 2 kW kettle runs for 3 minutes. It is 80% efficient. How much energy is transferred usefully?

Answers: 1. E = 2000 × 180 = 360 000 J · useful = 0.8 × 360 000 = 288 000 J