Topic 4.1 Energy Revision Booklet

AQA GCSE Physics 8463 · Foundation & Higher



Name _____ Class _____ Target grade _____

4.1
Energy

Work through a topic, then come back to it on the dates in your planner. Little and often beats one long cram.

Revise like a scientist

This booklet uses six revision techniques that research shows work best. Every activity is labelled with the technique it uses and the grade it targets.

Retrieval practice

Pulling ideas out of your memory makes them stick far better than re-reading. Brain dumps, quizzes and cover-and-recall tasks.

Spaced practice

Revisit each topic after 2 days, 1 week and 3 weeks. Forgetting a little, then remembering again, strengthens memory.

Interleaving

Mixed-topic questions train you to spot which idea a question needs, just like the real exam.

Dual coding

Words plus diagrams: graphs, ray diagrams and labelled apparatus give your memory two routes in.

Elaboration

Asking 'why?' and 'how?' and linking ideas together turns facts into understanding.

Worked examples

I do → We do → You do: study a full solution, finish a half-done one, then do one alone.

KEY

Grade pathways

GRADE 4

Secure the basics: recall definitions and units, pick the right equation from the equation sheet, and do one-step calculations.

GRADE 5

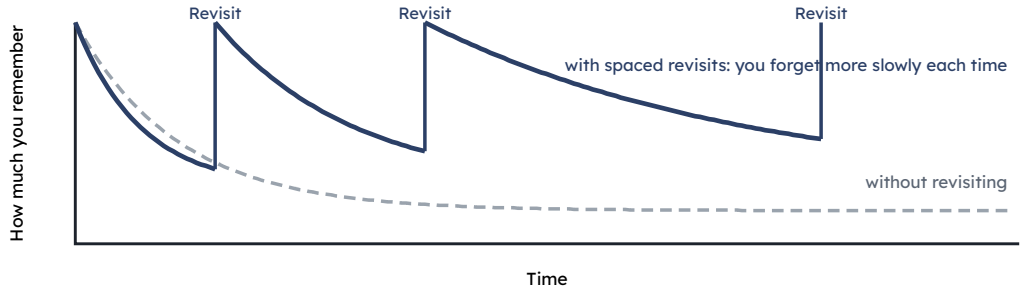
Rearrange equations, convert units, describe practicals and explain in two linked steps.

GRADE 7+

Multi-step calculations, evaluate methods and data, and write logical 6-mark answers.

SPACED PRACTICE DUAL CODING

Why spacing works



SPACED PRACTICE

My spaced revision planner

Write the date you'll do each session. Tick it off when it's done.

Topic	First go	+2 days	+1 week	+3 weeks	Before the mock
4.1 Energy					
Final review					

What's inside

Topic 1 · Energy (4.1)

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Final review

Final review: mixed questions	18

ROUTINE

The routine for every page

1. Try it cold. Answer from memory first, without notes. Struggling a bit is good: it's what makes learning stick.

2. Check and correct. Mark it with the answer booklet in a different colour pen. Fix every mistake.

3. Come back later. Redo anything you got wrong on your next spaced session.

ONLINE

Use it with mrsullyphysics.com

Flashcards for retrieval practice: cards you get wrong come back until you get them right.

Quizzes and Aim higher for extra Grade 5+ and 7+ questions with mark schemes.

Animations to see the physics move (dual coding).

Extra practice

Retrieval · answers in the answer booklet

1 Grade 7+ A 2 kW heater warms 0.5 kg of water from 20 °C to 80 °C in 75 s. Calculate the heater's efficiency. (c = 4200 J/kg °C) [4]

2 Grade 5 A 60 kg student climbs a 3 m high staircase in 4 s. Calculate the gravitational potential energy gained, then the student's power. (g = 9.8 N/kg) [3]

3 Grade 5 A spring with a spring constant of 40 N/m is stretched by 0.10 m. Calculate the energy stored in it. [2]

Brain dump and checklist

RETRIEVAL PRACTICE · GRADE 4 · GRADE 5 · GRADE 7

Brain dump

Set a timer for 5 minutes. Write or draw everything you remember about energy. No notes! Afterwards, add anything you missed in a different colour.

Prompts if you get stuck: energy stores? · Ek? · Ep? · Ee? · specific heat capacity? · power? · efficiency? · dissipation? · thermal conductivity? · renewable vs non-renewable?

METACOGNITION

How confident am I?

Rate each statement now (before) by shading R, A or G. Rate again at the end of the topic (after).

I can...	Before			After		
	R	A	G	R	A	G
Name the energy stores and the ways energy is transferred	○	○	○	○	○	○
Use Ek = ½mv² and Ep = mgh	○	○	○	○	○	○
Use Ee = ½ke² (limit of proportionality not exceeded)	○	○	○	○	○	○
Use ΔE = mcΔθ and describe RP1 (specific heat capacity)	○	○	○	○	○	○
Define power as the rate of energy transfer; use P = E/t and P = W/t	○	○	○	○	○	○
State the principle of conservation of energy	○	○	○	○	○	○
Explain how energy is dissipated and how to reduce it	○	○	○	○	○	○
Describe how thermal conductivity and wall thickness affect the rate of cooling (RP2)	○	○	○	○	○	○
Calculate efficiency as a decimal or a percentage	○	○	○	○	○	○
Compare renewable and non-renewable energy resources	○	○	○	○	○	○
Evaluate the use of different energy resources	○	○	○	○	○	○

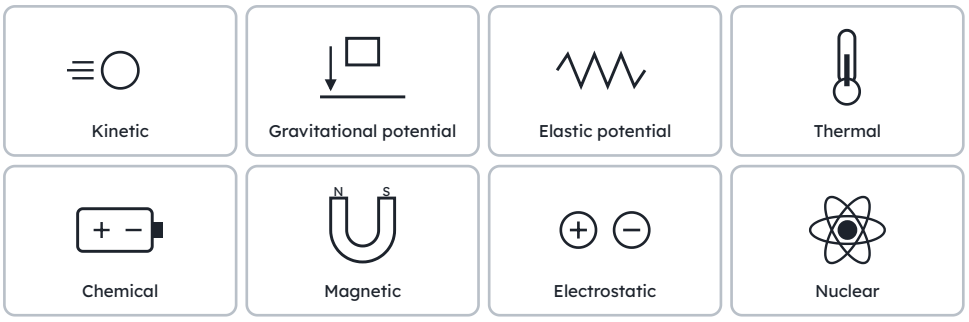
Extra practice

Retrieval · answers in the answer booklet

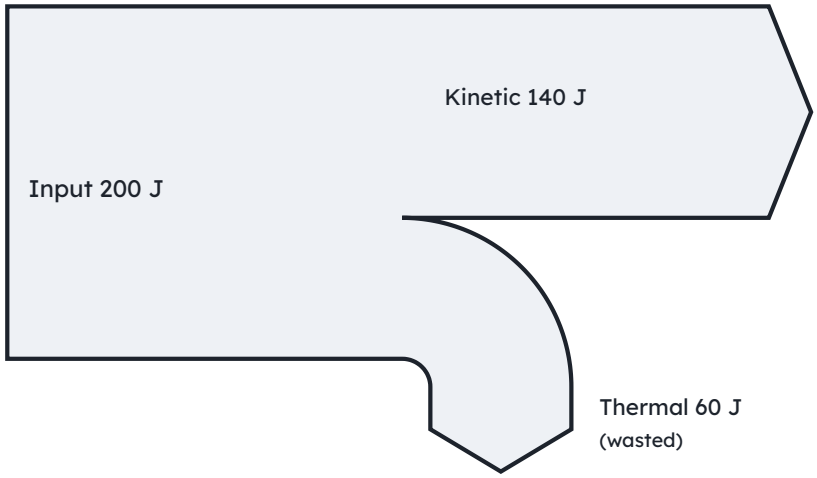
1 True or false? A device with an efficiency of 0.8 wastes 80% of its input energy. Explain. [2]

DUAL CODING GRADE 4 GRADE 5 GRADE 7

ENERGY STORES



SANKEY DIAGRAM: AN ELECTRIC MOTOR



KEY EQUATIONS: ALL GIVEN ON THE PHYSICS EQUATIONS SHEET IN THE EXAM

Equation	Quantities and units	Watch out
$E_k = \frac{1}{2} m v^2$	kinetic energy (J), mass (kg), speed (m/s)	Square the speed first
$E_p = m g h$	gravitational potential energy (J), mass (kg), g (N/kg), height (m)	g = 9.8 N/kg is given in the question
$E_e = \frac{1}{2} k e^2$	elastic potential energy (J), spring constant (N/m), extension (m)	Extension in metres
$\Delta E = m c \Delta\theta$	change in thermal energy (J), mass (kg), specific heat capacity (J/kg °C), temperature change (°C)	$\Delta\theta$ = final – start temperature
$P = E \div t$	power (W), energy transferred (J), time (s)	kW → W, minutes → s
$P = W \div t$	power (W), work done (J), time (s)	Work done = energy transferred
efficiency = useful output energy transfer ÷ total input energy transfer	no unit (or %); also works with power	Never more than 1 (100%)

CONSERVATION OF ENERGY

Energy can be transferred usefully, stored or dissipated, but cannot be created or destroyed. In a closed system there is no net change to the total energy.

ENERGY RESOURCES

Non-renewable: coal, oil, gas, nuclear fuel (will run out).
Renewable: solar, wind, hydro-electricity, geothermal, tides, waves, bio-fuel (can be replenished as it is used).

TURN OVER

Key words, misconceptions, required practicals and Grade 7+ links are on the next page.

Knowledge organiser: key words, misconceptions, practicals

ELABORATION GRADE 4 GRADE 5 GRADE 7

KEY WORDS: LEARN THESE WORD FOR WORD (SAME AS SIDE 2 OF YOUR KNOWLEDGE ORGANISER)

System: an object or group of objects.
Conservation of energy: energy can be transferred usefully, stored or dissipated, but cannot be created or destroyed.
Dissipated: energy transferred to the surroundings so it is stored in less useful ways; often called 'wasted'.
Specific heat capacity: the amount of energy required to raise the temperature of 1 kg of a substance by 1 °C.
Power: the rate at which energy is transferred, or the rate at which work is done.
Thermal conductivity: the higher it is, the higher the rate of energy transfer by conduction across a material.
Efficiency: useful output energy transfer ÷ total input energy transfer.
Renewable resource: one that is being (or can be) replenished as it is used.

MISCONCEPTIONS: SPOT THE MISTAKE

× Common mistake	✓ What's actually true
× Energy gets used up.	✓ Energy is never used up; it's transferred to other stores, often dissipated.
× Heat and temperature are the same.	✓ Temperature is a measure of hotness; energy is transferred by heating.
× A machine can be 100% efficient.	✓ Some energy is always dissipated, so efficiency is less than 1.

RP1: SPECIFIC HEAT CAPACITY

Aim: Determine the specific heat capacity of one or more materials, such as aluminium and copper blocks, by linking the energy transferred by the heater (work done) to the increase in temperature and thermal energy stored.
Change: Energy transferred (J) · **Measure:** Temperature (°C) · **Control:** Mass of block, insulation, power of heater
Must include: Measure mass with a balance; Insulate the block; Measure energy with a joulemeter or E = VIt; Record temperature at regular intervals.
Common mistake: Forgetting to convert mass to kg or time to seconds.

RP2: THERMAL INSULATION (PO)

Aim: Investigate the effectiveness of different materials as thermal insulators, and the factors that may affect the thermal insulation properties of a material (such as its thickness).
Change: Type of material (or number of layers) · **Measure:** Temperature drop over a fixed time · **Control:** Starting temperature, volume of water, beaker size, time, lid
Must include: Investigate a factor such as thickness (number of layers); Control the volume and starting temperature of water; Measure temperature at regular intervals for a fixed time; Use a lid.
Common mistake: Starting the timer at different temperatures.

AIM FOR GRADE 7+

- Combine equations: Ep lost = Ek gained → v = √(2gh).
- Explain why measured specific heat capacity is too high (energy dissipated → smaller Δθ).
- Evaluate energy resources: give both sides and a justified conclusion.

Extra practice

Retrieval · answers in the answer booklet

1 Grade 7+ A 2.0 kW heater warms 3.0 kg of a liquid from 20 °C to 70 °C in 5 minutes. Assuming no energy is wasted, calculate the specific heat capacity of the liquid. [3]

RETRIEVAL PRACTICE | SPACED PRACTICE | GRADE 4 | GRADE 5

Equation sheet skills: which equation, which unit?

Every equation is on the Physics Equations Sheet, but it won't tell you which one a question needs or what unit the answer has. Cover the knowledge organiser and fill in the table. Redo it on another day.

Situation	Which equation?	Unit of the answer	Redo 1 ✓/ ×	Redo 2 ✓/ ×
A sprinter's kinetic energy at top speed				
Energy stored in a stretched bungee cord				
A heater warms a tank of oil				
How quickly a crane does work				
Energy gained by a rock lifted onto a lorry				
What fraction of a TV's energy is useful				

RETRIEVAL PRACTICE | GRADE 4 | GRADE 5

Fill the gaps

Use the AQA key words. No word bank: that's the point.

1. Energy cannot be created or _____, only transferred.
2. Wasted energy is _____ to the surroundings, often by heating.
3. The higher the thermal _____ of a material, the higher the rate of energy transfer through it.
4. Power is the _____ at which energy is transferred.
5. Energy resources that can be replenished as they are used are _____.

ELABORATION | GRADE 5

Odd one out

Circle the odd one out in each row and explain why.

1. kinetic · gravitational potential · elastic potential · friction

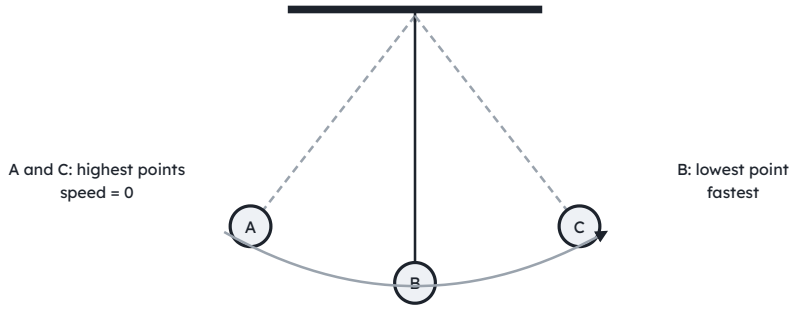
2. wind · solar · coal · tidal

3. joule · watt · kilowatt · newton

DUAL CODING GRADE 4 GRADE 5 GRADE 7

A pendulum swinging

A pendulum bob is pulled to one side and let go.



a At the highest point, which store is largest? [1]

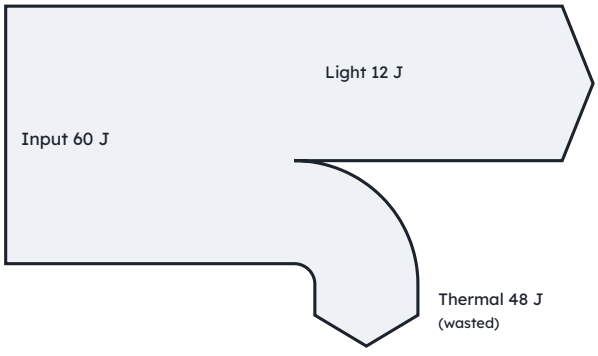
b At the lowest point, which store is largest? [1]

c Explain why each swing gets a little lower. [3]

DUAL CODING GRADE 4 GRADE 5

Read the Sankey diagram

A light bulb has a total input of 60 J each second.



a How much energy is usefully transferred by light each second? [1]

b Calculate the efficiency of the bulb. [2]

c An LED gives the same light from 15 J each second. Calculate its efficiency. [2]

Picture it (continued)

ELABORATION GRADE 4 GRADE 5 GRADE 7

Keeping a house warm

a Give two ways to reduce the rate of energy transfer out of a house. [2]

b Two houses have walls of the same material. House A's walls are twice as thick. Explain which cools more slowly. [3]

c Why are building materials with a low thermal conductivity chosen for walls? [2]

Extra practice

Retrieval · answers in the answer booklet

1 Grade 7+ A 3 kW kettle heats 1.2 kg of water from 15 °C to 100 °C. Assuming no energy is wasted, calculate how long this takes. (c = 4200 J/kg °C) [4]

2 Grade 7+ In reality, the 0.2 kg ball dropped from 1.8 m hits the ground at 5.0 m/s. Calculate the percentage of its gravitational potential energy that was dissipated, and explain where it went. [4]

3 Grade 5 A motor is supplied with 500 J of energy and transfers 350 J usefully. Calculate its efficiency and state what happens to the rest of the energy. [3]

WORKED EXAMPLES GRADE 4 GRADE 5

Kinetic energy

I do (worked example)

A 1200 kg car travels at 15 m/s. Calculate Ek.

1. Ek = ½ m v^2
2. Ek = 0.5 × 1200 × 15^2
3. = 0.5 × 1200 × 225
4. **Ek = 135 000 J**

We do (finish it)

A 70 kg cyclist at 6 m/s.

1. Ek = 0.5 × 70 × ___^{2}
2. = 0.5 × 70 × ___
3. Ek = ___ J

You do

A 0.06 kg tennis ball at 50 m/s.

WORKED EXAMPLES GRADE 4 GRADE 5

Gravitational potential energy

I do (worked example)

A 50 kg climber climbs 12 m. (g = 9.8 N/kg)

1. Ep = m g h
2. Ep = 50 × 9.8 × 12
3. **Ep = 5880 J**

Height in metres

We do (finish it)

A 2 kg book lifted 1.5 m.

1. Ep = 2 × 9.8 × ___
2. Ep = ___ J

You do

A 600 kg lift rises 25 m.

WORKED EXAMPLES GRADE 7

Energy transfer: two steps (Grade 7+)

Use conservation of energy to link the two stores.

1 A 0.5 kg ball is dropped from 3.2 m. Ignoring air resistance, calculate its speed just before it hits the ground. (g = 9.8 N/kg) [4]

Extra practice

Retrieval · answers in the answer booklet

1 Grade 5 A 2000 W kettle is switched on for 150 s. Calculate the energy transferred. [2]

WORKED EXAMPLES GRADE 5 GRADE 7

Elastic potential energy

I do (worked example)

A spring (k = 40 N/m) stretches 0.15 m. Calculate Ee.

1. $E_e = \frac{1}{2} k e^2$
2. $E_e = 0.5 \times 40 \times 0.15^2$
3. $= 0.5 \times 40 \times 0.0225$
4. **$E_e = 0.45$ J**

We do (finish it)

k = 200 N/m, e = 0.1 m.

1. $E_e = 0.5 \times 200 \times$ ___^{2}
2. $E_e =$ ___ J

You do

k = 80 N/m, e = 5 cm.

WORKED EXAMPLES GRADE 5 GRADE 7

Power and efficiency

I do (worked example)

A motor does 4500 J of useful work in 30 s. Input 6000 J.

1. $P = W \div t = 4500 \div 30 = 150$ W
2. efficiency = 4500 ÷ 6000
3. **= 0.75 (75%)**

We do (finish it)

A kettle transfers 180 000 J in 90 s.

1. $P = E \div t$
2. $P = 180\,000 \div$ ___
3. $P =$ ___ W

You do

Useful output 300 J, efficiency 0.6. Calculate the input.

ELABORATION GRADE 5

Spot the mistake

Each student has made one mistake. Find it and correct it.

1 Gus: "$E_k = \frac{1}{2} \times 4 \times 3 = 6$ J for a 4 kg object at 3 m/s." [2]

2 Hana: "The motor's efficiency is 120%." [1]

3 Ivan: "$E_e = \frac{1}{2} \times 50 \times 20^2$ for a 20 cm extension." [2]

Extra practice

Retrieval · answers in the answer booklet

1 Which equation calculates elastic potential energy? [1]

A $E_e = \frac{1}{2}ke^2$ **B** $E_e = ke$ **C** $E_e = mgh$ **D** $E_e = \frac{1}{2}mv^2$

ELABORATION GRADE 4 GRADE 5 GRADE 7

Build an explanation

Answer each question in two steps. Use the starter, then push yourself with the Grade 7+ extension.

1 Explain why a rollercoaster car can never rise higher than the point it started from.

Grade 4–5 starter: "At the start, the car's energy is in its gravitational potential store…"

Grade 7+ extension: "Link to dissipation:…"

2 Explain why lubricating a bicycle chain makes cycling easier.

Grade 4–5 starter: "Oil reduces the friction between…"

Grade 7+ extension: "Link to wasted energy and the useful work done:…"

3 Explain why a country might keep some fossil-fuel power stations even though they add to global warming.

Grade 4–5 starter: "Fossil fuels are reliable because…"

Grade 7+ extension: "Compare with renewables:…"

ELABORATION GRADE 5

True or false? Justify it.

Saying why is worth more marks than saying true or false.

4 "An efficient device wastes no energy at all." [2]

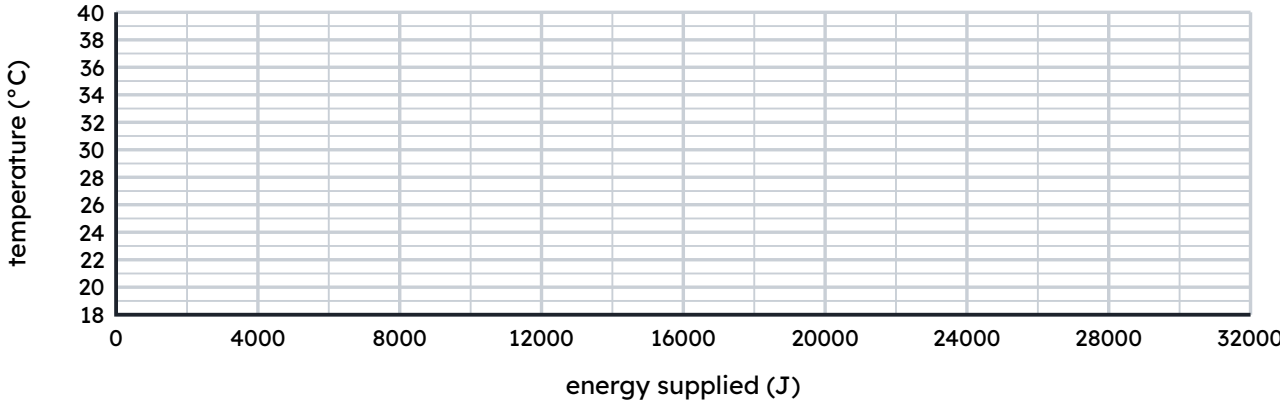
5 "Nuclear power is renewable because it produces no carbon dioxide." [1]

DUAL CODING | WORKED EXAMPLES | GRADE 5 | GRADE 7

RP1: specific heat capacity of oil

A student heats 0.8 kg of oil with a 50 W heater for 10 minutes and records the temperature every minute.

Time (min)	0	2	4	6	8	10
Temperature (°C)	20.0	23.6	27.4	31.2	35.1	38.8
Energy supplied (J)						



a Complete the energy row (E = P t) and plot temperature against energy. [3]

b Use the whole run to calculate the specific heat capacity of the oil. [3]

c The accepted value is 1670 J/kg °C. Explain why the student's value is too high. [2]

d Give one improvement. [1]

Extra practice

Retrieval · answers in the answer booklet

1 Grade 7+ A spring stores 0.9 J of elastic potential energy when stretched by 0.15 m. Calculate the spring constant, then the force needed to produce this extension. [4]

RP2: thermal insulation

RETRIEVAL PRACTICE | ELABORATION | GRADE 4 | GRADE 5 | GRADE 7

RP2: comparing insulating materials

Four identical beakers of hot water are each wrapped in a different material. The temperature is recorded after 20 minutes.

Material	Start temperature (°C)	Temperature after 20 min (°C)	Temperature drop (°C)
No material (control)	80	52	
Cotton wool	80	68	
Bubble wrap	80	65	
Newspaper (2 layers)	80	61	

a Complete the table. [2]

b Which material is the best insulator? Explain using the data. [2]

c Name the independent and dependent variables. [2]

d Give two control variables. [2]

e Why is a beaker with no material included? [1]

f Suggest how to change the experiment to investigate the thickness of the material. [2]

Extra practice

Retrieval · answers in the answer booklet

1 Grade 7+ A 0.8 kg ball is dropped from 5 m. Ignoring air resistance, calculate its speed just before it hits the ground. (g = 9.8 N/kg) [4]

GRADE RADE 4

Secure the basics

1 Name the energy store of a moving car. [1]

2 Give the unit of power. [1]

3 Name two renewable energy resources. [2]

4 A device transfers 400 J usefully from 500 J input. Calculate its efficiency. [2]

5 State what happens to wasted energy. [1]

GRADE RADE 5

Apply and rearrange

6 A 3 kW heater runs for 5 minutes. Calculate the energy transferred. [3]

7 Calculate the energy needed to raise the temperature of 4 kg of water by 25 °C. (c = 4200 J/kg °C) [2]

8 Give one advantage and one disadvantage of using wind turbines. [2]

Extra practice

Retrieval · answers in the answer booklet

1 Grade 5 A spring with a spring constant of 80 N/m is stretched by 0.1 m. Calculate the elastic potential energy stored. [2]

GRADE RADE 7+

Stretch

9 A 0.2 kg toy is fired upwards by a spring (k = 500 N/m) compressed by 0.08 m. Calculate the maximum height. Assume no energy is dissipated. (g = 9.8 N/kg) [4]

10 A town is choosing between a gas-fired power station and a solar farm. Evaluate the two options. [6]

Total: _____ / 24

RETRIEVAL PRACTICE SPACED PRACTICE GRADE 4

Quick-fire retrieval: Energy

Cover everything. Answer in under 3 minutes. Redo it on your next spaced session.

1 Unit of energy?

2 Ep equation?

3 Kinetic store depends on?

4 Rate of energy transfer?

5 Fuel that is renewable and burned?

6 Lower thermal conductivity → ?

Extra practice

Retrieval · answers in the answer booklet

1 Grade 5 A 0.5 kg ball moves at 4 m/s. Calculate its kinetic energy. [2]

METACOGNITION

Re-rate yourself

Go back to the checklist at the start of this topic and fill in the 'After' column.

METACOGNITION GRADE 4 GRADE 5 GRADE 7

Exam wrapper: why did I drop marks?

After marking the exam practice, write the question numbers you got wrong in the right row.

Reason I lost marks	Question numbers	What to do next
I didn't know or remember it (knowledge gap)		Flashcards and brain dumps
I knew it but misread the question or command word		Underline command words
Maths slip: units, rearranging, standard form		Redo the "we do / you do" pages
I ran out of time or didn't finish		Timed practice: 1 mark per minute

METACOGNITION

Two things I'm now confident about

METACOGNITION

One thing I still need to work on, and how I'll fix it

e.g. 'Rearranging equations → redo the Grade 7+ questions and use the website's Aim higher section.'

SPACED PRACTICE

Book my next spaced sessions

Write the dates in the planner at the front: +2 days, +1 week, +3 weeks.

Extra practice

Retrieval · answers in the answer booklet

1 Fill the gap: Energy that spreads out into the surroundings is said to be _____. [1]

Final review

RETRIEVAL PRACTICE | SPACED PRACTICE | GRADE 4 | GRADE 5 | GRADE 7

Final review: test yourself on the whole topic

Do these without your notes, a week after finishing the booklet. Mark them with the answer booklet and add any you got wrong to your 'still to learn' list on the reflect page.

Each question shows its target grade. Aim to get every Grade 4 and 5 question right before moving on to Grade 7+.

Extra practice

Retrieval · answers in the answer booklet

1 Grade 7+ Evaluate replacing a coal-fired power station with a wind farm. [5]

2 Grade 5 A lamp is supplied with 60 J of energy each second and transfers 9 J each second by light. Calculate its efficiency and state how much energy is wasted each second. [3]

3 Grade 7+ A 0.2 kg ball is dropped from a height of 1.8 m. Ignoring air resistance, calculate its speed just before it hits the ground. (g = 9.8 N/kg) [3]

4 Grade 5 Give two ways to reduce the rate of energy transfer from a house. Explain how each one works. [4]