

Covering teacher guide

Energy transfers and conservation

Start here / subject briefing

Before this lesson: Consolidation after pupils have met stores, pathways, conservation and simple system boundaries. The supplied hoist gain avoids an omitted energy-equation calculation. Both tiers use the same route.

Energy is conserved in a complete account: a store decrease or input is matched by increases and outgoing transfers. Dissipation spreads energy into less useful stores, usually thermal stores of surroundings, without destroying it. For a stated closed boundary no energy crosses, although stores inside can exchange energy. A smaller system may gain or lose energy across its boundary. Useful versus unwanted depends on the intended task.

Words and symbols you will need

Term	Plain-English meaning
Store / transfer pathway	A store belongs to an object/system; electrically, mechanically, heating or radiation describes transfer.
Conserved	Not created or destroyed in a complete account.
Dissipated	Spread into less useful stores; still present.
Boundary / closed	Which objects are included; closed here means no energy enters or leaves that boundary.
Useful / unwanted, J	Useful serves the stated task; all account values use joules for the same interval.

Help pupils choose a method

1. Name the task, time interval and objects inside the boundary.
2. List distinct inputs/store decreases, internal increases and outgoing transfers. Balance the account without double counting.
3. Check boundary crossings separately from conservation; decide usefulness from the intended task, and name receiving stores.

Use the supplied model - pupil page 2

Use page 2's full 600 J battery account. The 420 J load increase and 180 J thermal increase sum to 600 J. Raising the load is useful; the thermal increase still exists. The transfer from battery to motor is electrical, not an electrical store.

$420 + 180 = 600$ J, equal to the battery store decrease, so the full account conserves energy. The useful increase is the raised load's gravitational potential store; 180 J is dissipated to thermal stores. The battery transfers energy electrically to the motor. No new energy is created.

If pupils are still stuck

Use the matching Say/Ask/Expect coaching and named new retry in its replacement time. If still insecure, help label the boundary and sort the supplied numbers into internal increases or crossing transfers. Record the exact remaining error for the usual teacher; next-lesson follow-up stays outside today's 60 minutes.

Turn to teacher page 2 for the timed run sheet. Keep this guide separate from the pupil booklet.

Run the lesson from this page

Energy transfers and conservation

Print the complete 8-page pupil booklet, one per pupil, stapled in order. Double-sided printing is fine.

Read teacher page 1, then use the timed run sheet on page 2. Keep the 10-page teacher guide separate from pupil copies.

Pupils need pens, a ruler and a calculator. Reading, data and figures are supplied. No login, pupil devices or practical apparatus are required.

Min	Pupil page / Q	Read aloud / check	Next action and answer key
0-5	1 / 1-3	Start from memory. Check the three responses at 5 minutes.	If insecure A uses the first 2 reading minutes. Answers: teacher page 3. Coaching: page 7.
5-15	2 / reading	Read the account/boundary rules and complete lift model.	Check A if used; then continue reading.
15-20	3 / 4	Choose a letter and justify both store changes; stop.	If insecure B replaces questions 5-6. Answers: teacher page 3. Coaching: page 8.
20-30	3-4 / 5-9	Apply the hoist givens, then explain heating/cooling in the dispenser.	If B was used leave 5-6 blank. The 600 J hoist gain is supplied. Answers: teacher page 4.
30-33	5 / 10	Complete the toy-boundary account independently and pause.	If insecure C replaces 11-12. Answers: teacher page 4. Coaching: page 9.
33-45	6-7 / 11-16	Use Figure 2, test the second record, then explain dissipation and counterweight.	If C was used leave 11-12 blank; complete 13-16. Include every stated term once. Answers: teacher page 5.
45-55	8 / 17	Correct practice in a different colour and explain a correction.	Share only practice answers. Require named stores/boundaries. Answers: teacher page 5.
55-60	8 / 18	Cover earlier pages and answer question 18 independently.	Collect all booklets; check afterwards. D is next lesson only. Answers: teacher page 6. Coaching: page 10.

Estimated 60 minutes. Practice: 10 minutes, a 3-minute boundary check and 12 minutes. A uses reading time; B replaces 5-6; C replaces 11-12; D is next lesson only. Timings are not classroom-trialled.

Entry and hinge - pupil pages 1 and 3

Match the pupil number. Accept equivalent correct wording. Keep this guide separate from pupils.

1. (pupil p1) $150 - 90 = 60$ J.

2. (pupil p1) No. The kinetic store decreases while thermal stores of brakes/surroundings increase through transfers associated with friction. Energy is conserved.

3. (pupil p1) The water's thermal-store increase is useful; casing warming is unwanted for this task.

4. (pupil p3) C. Energy redistributes internally: water -180 J, room $+180$ J, net change 0 J. The water alone loses energy, but the stipulated larger system's total stays constant.

Try again A - pupil page 1

Only if directed. Use the first 2 reading minutes, then continue on page 2.

(a) $240 - 150 = 90$ J. (b) No, thermal stores of surroundings increase. (c) Useful for the water-heating task.

Try again B - pupil page 3

Only if directed. Complete this instead of questions 5-6; then answer questions 7-9 on page 4.

Combined change $= -300 + 300 = 0$ J. Energy transfers internally to the room's thermal store; it is not destroyed.

First practice and boundary check

Match the pupil number. Accept equivalent correct wording. Keep this guide separate from pupils.

- 5. (pupil p3)** $1000-600=400$ J. The load starts/finishes at rest and no other changes are in the stated model.
- 6. (pupil p3)** Thermal stores of the hoist and surroundings increase through unwanted friction/heating transfers. Energy is conserved: it is dissipated into less useful stores, not destroyed. Name the receiving objects/stores.
- 7. (pupil p4)** Increasing the water's thermal store is useful for the intended water-heating task. Warming the casing is unwanted because it does not warm the required water. Thermal transfers are not automatically all unwanted.
- 8. (pupil p4)** Water's thermal store decreases; energy transferred by heating increases the cooler surroundings' thermal store. Do not describe cold as an energy substance entering the water.
- 9. (pupil p4)** Energy is redistributed internally from the water's thermal store to the room's thermal store. The loss from one equals the gain in the other, so total energy of the stipulated closed system is conserved.
- 10. (pupil p5)** Energy leaving $=500-200-100=200$ J by heating to outside surroundings. The toy-only system is not closed because energy crosses its boundary. The retained 100 J thermal increase is inside the toy, not part of the 200 J leaving. A larger account including receiving surroundings still conserves energy.

Try again C - pupil page 5

Only if directed. Complete this instead of questions 11-12; then continue with questions 13-16.

Leaving energy $=450-150-50=250$ J. Not closed: 250 J crosses its boundary by heating. The 50 J thermal increase stays inside the toy.

Diagram account, dissipation and review

Match the pupil number. Accept equivalent correct wording. Keep this guide separate from pupils.

- 11. (pupil p6)** $Q = 2000 - 1200 = 800$ J. Five equal input blocks each represent 400 J; the other branch contains two blocks.
- 12. (pupil p6)** Energy is conserved with no other supply or store decrease: 3 water-heating blocks + 2 other blocks = 5 input blocks. The complete energy account must balance.
- 13. (pupil p6)** $1200 + 950 = 2150$ J, which is 150 J more than the input. Without another supply/store decrease or measurement error, the record cannot fit the stated model. It is not evidence that energy was created.
- 14. (pupil p6)** No. The thin arrows organise the energy account; their direction on the page is not the real spatial direction of energy transfer. Equal blocks encode amounts; these thin arrows do not encode quantitative width.
- 15. (pupil p7)** It spreads through the surroundings and is harder to gather and use for the intended task. It still exists; less useful does not mean destroyed or that no later transfer is possible.
- 16. (pupil p7)** The counterweight store decreases by 900 J. Thermal increase = $900 - 320 = 580$ J. The raised load's 320 J plus 580 J in thermal stores accounts for the 900 J decrease, so energy is redistributed, not created.
- 17. (pupil p8)** Accept a corrected result with a physical reason, not a copied value. All-correct route: energy leaving the chosen system is received elsewhere; an enlarged complete account includes those gains, so total energy is conserved. The boundary determines the amount retained inside.

Independent exit and next-lesson follow-up

Match the pupil number. Accept equivalent correct wording. Keep this guide separate from pupils.

18. (pupil p8) (a) $Q=900-500-300=100$ J. (b) No: 900 J enters electrically and 100 J leaves by sound, so energy crosses the boundary. Stores inside increase by 800 J. (c) The 300 J remains in thermal stores, not destroyed; it is unwanted for the specified task of raising the load.

Try again D - next lesson - pupil page 8

Leave this today. Your usual teacher may direct it next lesson.

Sound energy $=800-350-300=150$ J. The boundary is not closed: electrical input and sound output cross it. Thermal energy remains in stores; it is not destroyed and is unwanted for the stated load-lifting task.

Collect and follow up

Collect every named booklet with working and corrections. Use question 18 to distinguish arithmetic/account, boundary and usefulness/dissipation errors; report the exact difficulty and who needs Try again D.

Source provenance - for the usual teacher

Pupil question	Original worksheet part / page
5	WS-45 Q2(b) / source p2
6	WS-45 Q2(e) / source p2
7	WS-45 Q4(b) / source p4
8	WS-45 Q4(c) / source p4
9	WS-45 Q4(d) / source p4
11	WS-45 Q5(a) / source p5
12	WS-45 Q5(b) / source p5
13	WS-45 Q5(d) / source p5
14	WS-45 Q5(e) / source p5
15	WS-45 Q6(d) / source p6
16	WS-45 Q6(e) / source p6

Selected practice is reformatted from the maintained PhysicsUK worksheet. Required context is included; unassigned parts are omitted.

[Source worksheet](#) | [Maintained solutions](#) | [Revision notes](#)

The hoist's omitted Q2(a) result is explicitly supplied as 600 J. The note's lift model includes all 600/420/180 J data. Figure 2 is the maintained equal-block account; thin arrow widths/directions are not quantitative or physical.

Check 1: Entry

Question 1, Question 2, Question 3

Look for: Q1 60 J; Q2 kinetic decrease accounted for by thermal increases, not destruction; Q3 water warming is useful for its stated task.

If secure: Continue to page 2 reading and model.

If: The remaining transfer does not complete the 150 J account.

Likely issue: Input and output bookkeeping is insecure.

Say: In this complete model, the useful and other transfers must add to the one input. Subtract the useful amount to find the remainder.

Ask: In question 1, what must be added to 90 J to make 150 J?

Expect: 60 J, so $90+60=150$ J.

Next: Use page 2's account/store/usefulness rules. Complete Try again A on page 1 in the first 2 reading minutes. Pupil page 2, same-event and complete-account rules.

If: Calls brake heating destroyed energy or treats every thermal increase as unwanted.

Likely issue: Conservation or task-dependent usefulness is insecure.

Say: Warmed objects have increased thermal stores. Energy is still present. Whether that warming is useful depends on the intended task.

Ask: For questions 2-3, which objects receive energy, and which warming is the water heater intended to produce?

Expect: Brakes/surroundings gain thermal energy without destruction. Warming the water is useful; warming the casing is unwanted for that task.

Next: Use page 2's account/store/usefulness rules. Complete Try again A on page 1 in the first 2 reading minutes. Pupil page 2, useful/unwanted and dissipated definitions.

If the retry remains insecure, use the support guidance on teacher page 1 and record the precise difficulty for the usual teacher.

Check 2: Hinge

Question 4

Look for: C: water -180 J and room $+180\text{ J}$ give zero net change inside the stated closed boundary.

If secure: Start questions 5-9. Require complete accounts and named receiving stores.

If: A says 180 J is destroyed.

Likely issue: A loss from one object has been mistaken for loss of total energy.

Say: Look for the receiving store. The room gains exactly what the water loses, inside the same stated boundary.

Ask: In question 4, where is the 180 J lost by the water accounted for?

Expect: In the room's increased thermal store; it is not destroyed.

Next: Use page 2's closed-boundary rule and model. Complete Try again B on page 3 instead of questions 5-6. Pupil page 2, conservation and dissipation.

If: B counts only the water and says the combined total falls.

Likely issue: The stated larger system boundary has been ignored.

Say: The system includes both water and room. Count both changes, not the water's decrease alone.

Ask: For question 4, what is $-180+180$ for the complete water-and-room system?

Expect: 0 J net change: its total is unchanged.

Next: Use page 2's closed-boundary rule and model. Complete Try again B on page 3 instead of questions 5-6. Pupil page 2, closed-system rule.

If: D reverses the water's change, or C is selected without an account.

Likely issue: The direction of transfer is insecure or the correct letter may be a guess.

Say: The hot water is cooling, so its thermal store decreases. The cooler room receives that energy; equal and opposite changes cancel in the complete account.

Ask: Name both changes and their signs in question 4.

Expect: Water -180 J ; room $+180\text{ J}$; total change zero.

Next: Use page 2's closed-boundary rule and model. Complete Try again B on page 3 instead of questions 5-6. Pupil page 2, boundary and named-store methods.

If the retry remains insecure, use the support guidance on teacher page 1 and record the precise difficulty for the usual teacher.

Check 3: Mid Practice

Question 10

Look for: Q10 energy leaving=200 J; toy-only boundary not closed because heating crosses it. The 100 J toy thermal increase is retained inside.

If secure: Continue 11-16; keep internal gains separate from outgoing transfers.

If: Gives 300 J or another remainder after omitting/double-counting an internal increase.

Likely issue: Retained thermal energy and outgoing heating have been mixed.

Say: The spring decrease supplies two stated increases inside the toy and the energy leaving. Count the kinetic and retained thermal gains once each before finding the remainder.

Ask: In question 10, which increases stay inside the toy, and what is 500-200-100?

Expect: 200 J kinetic and 100 J toy thermal stay inside; 200 J leaves by heating.

Next: Use page 2, the boundary/account methods. Complete Try again C on page 5 instead of questions 11-12.

Pupil page 2, complete account and internal versus crossing transfers.

If: Calls the toy boundary closed because total energy is conserved.

Likely issue: Universal conservation has been confused with no transfer across a chosen boundary.

Say: Energy conservation applies to a complete account, but the toy-only boundary loses energy to outside surroundings. That makes this chosen system non-closed for the interval.

Ask: In question 10, is the receiving outside room included inside the toy boundary? What crosses it?

Expect: No. Heating transfers 200 J out, so the toy-only system is not closed.

Next: Use page 2, the boundary/account methods. Complete Try again C on page 5 instead of questions 11-12.

Pupil page 2, closed-system definition.

If the retry remains insecure, use the support guidance on teacher page 1 and record the precise difficulty for the usual teacher.

Check 4: Exit

Question 18

Look for: Q18 Q=100 J; boundary not closed because electrical input and sound output cross; 300 J remains in thermal stores and is unwanted for lifting.

If secure: Record independently secure account, boundary and usefulness reasoning.

If: Incorrect Q or describes missing/unwanted energy as destroyed.

Likely issue: The full energy account or conservation still needs follow-up.

Say: Count the raised-load and thermal increases before finding the remaining outgoing transfer. Every term belongs in the same complete interval account.

Ask: For question 18, what are 500+300 and 900-800? Where is the stated thermal energy?

Expect: 800 J in stated store increases; 100 J leaves by sound. The 300 J still exists in thermal stores.

Next: Next lesson revisit the corresponding page 2 rules, then complete Try again D independently on page 8.

Pupil page 2, complete account and dissipation.

If: Calls the boundary closed or claims the thermal increase is useful simply because energy is conserved.

Likely issue: Boundary crossings or usefulness relative to the intended task remains insecure.

Say: Check what crosses the actual boundary, then separately ask what the device is intended to do. Conservation does not make every output useful.

Ask: In question 18, which transfers cross the boundary and is the task to warm the room or raise a load?

Expect: Electrical energy enters and sound leaves, so it is not closed. The task is raising a load, so the thermal increase is unwanted for that task.

Next: Next lesson revisit the corresponding page 2 rules, then complete Try again D independently on page 8.

Pupil page 2, boundary and useful/unwanted rules.

If the retry remains insecure, use the support guidance on teacher page 1 and record the precise difficulty for the usual teacher.

Specification and review

AQA 8463: 4.1.2.1 | AQA 8464: 6.1.2.1. Both courses and tiers: conservation, complete energy accounts, task-dependent usefulness, dissipation and specified system boundaries. No efficiency ratios, energy-equation calculations or practical completion are assigned.

PhysicsUK original cover lesson. Reviewed 2026-10-31. Timings estimated.