

Energy stores and transfer pathways

AQA GCSE Combined Trilogy 8464 and Separate Physics 8463 | Both tiers | Paper 1

Worked answers | Both qualifications and tiers | 28 parts | 44 marks

Specification points covered

8463 4.1.1.1 / 8464 6.1.1.1: energy stores, systems and transfer pathways
8463 4.1.1.2 / 8464 6.1.1.2: selected gravitational potential and kinetic energy
8463 4.1.2.1 / 8464 6.1.2.1: conservation and dissipation of energy
8463 4.1.2.2 / 8464 6.1.2.2: efficiency ratios and comparisons

A repair café tests a hand-cranked hoist, a battery-powered trolley and a hot-water dispenser. You will account for their energy changes and correct trainee explanations before the equipment returns to use.

Original PhysicsUK practice, not an official AQA resource. Both qualifications and tiers throughout. 28 parts, 44 marks. Credit equivalent physical explanations. Name objects, stores and pathways; energy dissipated to surroundings is not destroyed. The energy blocks use a common horizontal scale, not scaled arrow widths.

1 Naming stores precisely

The team observes a raised load, warming water and an accelerating trolley.

1(a) A load is raised above its starting position. Name the energy store that increases. **[1 mark]**

Answer / mark points: The gravitational potential energy store of the load–Earth system. [1] Accept the load's gravitational potential energy store in GCSE wording.

1(b) The dispenser warms water without boiling it. Name the energy store of the water that increases. **[1 mark]**

Answer / mark points: Its thermal / internal energy store. [1] “Heat” describes transfer due to a temperature difference, not a separate stored substance.

1(c) A trainee says the accelerating trolley stores more “electrical energy”. Correct this statement by naming the store that increases and the battery store that decreases. **[2 marks]**

Answer / mark points: The trolley's kinetic energy store increases. [1]
The battery's chemical energy store decreases. [1] Electrical is a transfer pathway in this account, not the name of the trolley's energy store.



2 Accounting for the hoist

A hand-cranked hoist raises a 40 kg load through 1.5 m. Use $g = 10 \text{ N kg}^{-1}$. The load starts and finishes at rest. The operator transfers 1000 J mechanically to the hoist and load during the lift. Ignore changes in stores other than those discussed.

2(a) Calculate the increase in the load's gravitational potential energy. **[1 mark]**

Answer / mark points: $E_p = mgh = 40 \times 10 \times 1.5 = 600 \text{ J}$. [1] This is the increase for the specified height change.

2(b) Calculate the energy transferred to thermal stores of the hoist and surroundings during the lift. **[1 mark]**

Answer / mark points: $1000 - 600 = 400 \text{ J}$. [1] Both endpoint kinetic energies are zero; the unaccounted input is not destroyed.

2(c) Name the transfer pathway by which the turning hand crank raises the load. **[1 mark]**

Answer / mark points: Mechanically / by mechanical work done by forces. [1] Gravitational potential is a store, not this transfer pathway.

2(d) A trainee says the 600 J gained in (a) is kinetic energy because the load moved. Explain why this is wrong at the end of the lift. **[2 marks]**

Answer / mark points: The load finishes at rest, so its kinetic energy is zero. [1]
The 600 J is an increase in gravitational potential energy because its height has increased. [1]
Moving during the process does not establish a final kinetic store.

2(e) The hoist becomes warm. Explain what happened to the energy in (b) and why calling it "destroyed energy" is wrong. **[2 marks]**

Answer / mark points: The thermal stores of the hoist and surroundings increase through unwanted transfers associated with friction/heating. [1]
Energy is conserved: it is dissipated into less useful stores rather than destroyed. [1] Require an actual destination, not just "lost".

2(f) A mechanical lock now holds the stationary load at the same height. Explain why its gravitational potential energy is not used up and no continuing lifting work is required. **[2 marks]**

Answer / mark points: Its height is unchanged, so its gravitational potential energy store remains unchanged. [1]
There is no displacement against its weight, so no continuing mechanical lifting work is done. [1]
This is a passive lock, not a person actively holding a load.



3 Choosing the trolley system

The trolley starts from rest on a level floor. Total moving mass is 120 kg and final speed is 2.0 m s^{-1} . Its battery's chemical store decreases by 400 J; the trolley's thermal store increases by 80 J. In this model, only heating transfers energy across the drawn boundary. There is no other energy supply.

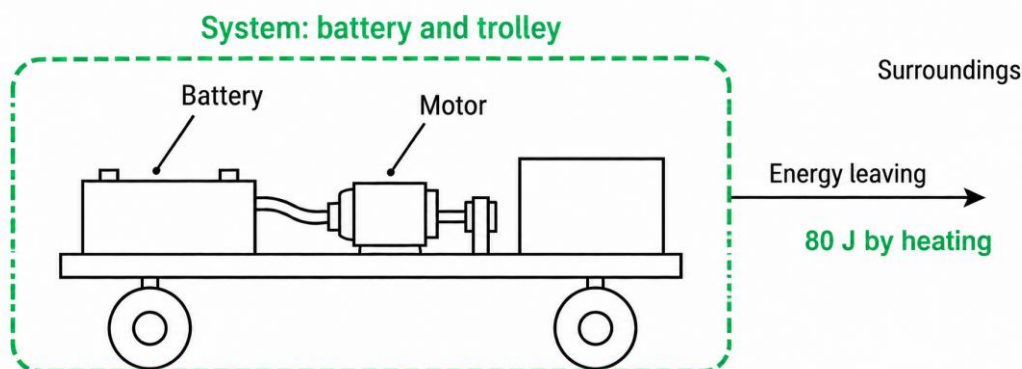


Figure 1

3(a) Name the pathway by which the battery transfers energy to the motor. **[1 mark]**

Answer / mark points: Electrically / work done when current flows. [1] Chemical names the battery store, not the transfer pathway.

3(b) Calculate the trolley's kinetic energy at its final speed. **[1 mark]**

Answer / mark points: $E_k = 0.5mv^2 = 0.5 \times 120 \times 2.0^2 = 240 \text{ J}$. [1] Square the speed, not the mass.

3(c) Use the energy changes to calculate the energy leaving the boundary during this start. **[1 mark]**

Answer / mark points: $400 - 240 - 80 = 80 \text{ J}$ leaves by heating. [1] Do not count the 80 J retained in the trolley's thermal store a second time.

3(d) A technician calls the drawn system closed because the battery is inside it. Explain why this is incorrect. **[2 marks]**

Answer / mark points: It is not closed for this interval. [1]
Energy crosses the boundary by heating to the surroundings (80 J); having the source inside does not prevent this. [1] Total energy inside this boundary decreases by 80 J.

3(e) In a later, separate test, the motor is switched off and the moving trolley is brought to rest by its brakes. Describe the changes in stores and the role of friction. Ignore height changes. **[3 marks]**

Answer / mark points: The trolley's kinetic energy store decreases. [1]
Work is done mechanically against friction at the brakes/wheels. [1]
Thermal stores of the brakes, wheels and/or floor increase. [1] Accept an appropriate set of warmed objects; the kinetic energy is not destroyed.



4 Tracing energy in the dispenser

The mains-powered dispenser heats water for cleaning. For (a) and (b), consider a cold-start interval before the water boils.

4(a) Describe the two transfer stages from the mains supply to the water. Include the heater in your answer. **[2 marks]**

Answer / mark points: Energy is transferred electrically from the mains to the heater. [1]
It is then transferred by heating from the hotter heater to the water, increasing the water's thermal store. [1] The mains is not an energy store in this local account.

4(b) Both the water and the dispenser's outer casing warm up. Explain why one increase is useful and the other is unwanted for this task. **[2 marks]**

Answer / mark points: Increasing the water's thermal store is useful because warming the cleaning water is the task. [1]
Increasing the casing's thermal store is unwanted because it does not heat the required water. [1]
Thermal energy changes are not automatically all wasted.

4(c) The dispenser is unplugged and its hot water cools in the room. Describe the energy changes in the water and the surroundings. **[2 marks]**

Answer / mark points: The water's thermal store decreases. [1]
Energy is transferred by heating to the cooler surroundings, increasing their thermal store. [1] Do not describe cold as an energy substance flowing into the water.

4(d) Now suppose the combined water-and-room system has no energy entering or leaving it. Explain how the water can cool while the total energy of this larger system stays constant. **[2 marks]**

Answer / mark points: Energy is redistributed internally from the water's thermal store to the room's thermal store. [1]
The loss from one equals the gain in the other, so the total energy of the stipulated closed system is conserved. [1] A single object cooling is not evidence that total energy is destroyed.



5 Completing the energy account

Figure 2 represents one cold-start test. The only energy supply is the stated electrical input; no other store decreases. “Other thermal transfers” increase the thermal stores of the casing and surroundings. Equal-width blocks have a common energy scale. The thin arrows show the account, not a physical direction or quantitative width.

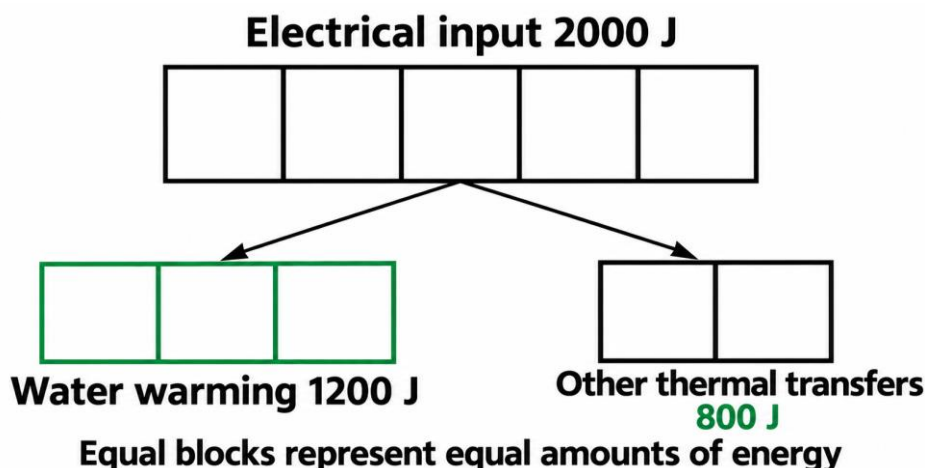


Figure 2

5(a) Calculate Q, the missing energy in Figure 2. [1 mark]

Answer / mark points: $Q = 2000 - 1200 = 800 \text{ J}$. [1] Equivalently, each of five equal input blocks is 400 J and the other branch contains two blocks.

5(b) Explain why the two lower strips together must account for all five input blocks in this model. [1 mark]

Answer / mark points: Energy is conserved, with no extra supply or decrease of another store: 3 useful blocks + 2 other blocks = 5 input blocks. [1] The numerical account must balance.

5(c) Calculate the efficiency of the intended water-heating transfer as a percentage. [1 mark]

Answer / mark points: Efficiency = $1200 / 2000 = 0.60 = 60\%$. [1] Use the intended useful transfer in the numerator.

5(d) A second record gives 2000 J input, 1200 J to the water and 950 J to other thermal stores. Use a calculation to explain why this record does not fit the stated model. [2 marks]

Answer / mark points: $1200 + 950 = 2150 \text{ J}$, which is 150 J more than the input. [1] This cannot be accounted for without an extra energy supply/store decrease or a measurement error; none is in the stated model. [1] It is not evidence of energy creation.

5(e) Do the diagonal arrows mean energy must travel diagonally downwards through the real dispenser? Explain. [1 mark]

Answer / mark points: No. The arrows organise the energy account; their direction on the page is not the spatial direction of transfer in the real apparatus. [1] It is a flow model, not an apparatus ray or force diagram.



6 Judging the repair claims

Table 1 compares two dispensers for the same task: increasing the thermal energy of an identical quantity of water by 1200 J. No heating times are given. The data account for the entire test interval.

Table 1

Dispenser	Total input / J	Useful water heating / J
A	2000	1200
B	1600	1200

6(a) Calculate the efficiency of dispenser B as a percentage. [1 mark]

Answer / mark points: Efficiency = $1200 / 1600 = 0.75 = 75\%$. [1]

6(b) Which dispenser requires less input energy for this task? Calculate the difference and explain why comparing them is fair. [2 marks]

Answer / mark points: B requires $2000 - 1600 = 400$ J less input. [1]
Both produce the same intended 1200 J thermal energy increase in the same quantity of water, so the useful task is matched. [1] Larger input does not mean better performance.

6(c) A trainee says B must finish heating sooner because it has the higher efficiency. Explain why the data do not establish this. [2 marks]

Answer / mark points: Efficiency compares the fraction of input transferred usefully, not the time taken. [1]
No heating times or transfer rates are given, so either device could complete the task sooner. [1] Do not calculate a heating time from energy alone.

6(d) Explain what makes energy dissipated to the room less useful for the café's intended tasks. [1 mark]

Answer / mark points: It becomes spread through the surroundings and is harder to gather and use for the intended task. [1] It still exists; do not claim no future transfer is possible.

6(e) In a new hoist test, a descending counterweight loses 900 J of gravitational potential energy. A second load gains 320 J of gravitational potential energy. The rest increases thermal stores. Explain why the gain of the raised load does not create energy, using a calculation in your answer. Both loads start and end at rest; there are no other energy changes. [3 marks]

Answer / mark points: The descending counterweight's gravitational potential store decreases by 900 J. [1]
Thermal increase = $900 - 320 = 580$ J. [1]
The 320 J gained by the raised load plus 580 J in thermal stores accounts for the 900 J decrease, so energy is redistributed, not created. [1] Both loads are at rest at the start and end of this stated account.

Review and improve

Check the chosen system boundary and task before labelling a transfer useful or unwanted. Efficiency is a fraction, not a heating time. Timing is estimated and untrials.

Continue your physics journey

Videos, practice and support for your next step

www.physicsuk.co.uk

