AQA GCSE Physics 8463 | Energy transfers in a system solutions

Matching solutions and teaching prompts for the class review

Specification points covered

- 4.1.2.1 — use conservation of energy and describe dissipation in closed and open systems.
- 4.1.2.1 — explain how insulation and thermal conductivity affect unwanted energy transfers.
- Required practical activity 2 — investigate the effectiveness of thermal insulators.

Use these solutions for the 15-20 minute review: reveal enough working for pupils to diagnose errors, then model the clearest route to a full-mark answer.

1. Energy in systems
(a) State the principle of conservation of energy. [2]
(b) State what is meant by a closed system. [1]

Answer / mark points: (a) Energy cannot be created or destroyed (1); it can only be transferred between stores or redistributed (1). (b) A closed system is one in which no energy is transferred into or out of the system (1).

Teacher prompt / common error: Common error: 'no energy moves' is not a definition of a closed system; internal transfers may still occur.

2. Hot soup is placed in an uninsulated delivery container and cools during a journey. Describe the energy changes for the soup, container and surroundings. [4]

Answer / mark points: The thermal energy store of the hot soup decreases (1). Energy is transferred by heating through the container walls and lid (1). The thermal stores of the container, air and wider surroundings increase (1). The energy becomes more spread out/dissipated and is less useful for keeping the soup hot; it has not been destroyed (1).

Teacher prompt / common error: Insist on 'transferred by heating', not 'heat energy is lost'.

3. Container walls are available in the same material but in different thicknesses.
(a) Explain what is meant by a material having low thermal conductivity. [2]
(b) Explain why a thicker wall reduces the rate of unwanted energy transfer. [2]

Answer / mark points: (a) A low-thermal-conductivity material transfers energy by conduction slowly / gives a low energy-transfer rate for a given temperature difference and thickness (2). (b) A thicker wall gives a longer path and greater thermal resistance (1), so less energy is transferred through the wall each second / the transfer rate decreases (1).

Teacher prompt / common error: Common error: thickness does not stop energy transfer; it reduces the rate.

4. Plan an investigation to compare the effectiveness of different insulation thicknesses around identical food containers. You may use hot water instead of soup. [6]

Answer / mark points: One mark for each of six valid linked elements: use identical containers with measured insulation thicknesses; add the same mass/volume of hot water; use the same starting temperature; fit identical lids and keep surface area/material/apparatus the same; record temperature at equal time intervals for a fixed total time; use a thermometer/data logger safely and consistently; repeat each thickness and calculate a mean; compare temperature drop or cooling rate, where a smaller drop/rate means better insulation. Maximum 6.

Teacher prompt / common error: A list of apparatus is not a plan. Pupils must say what changes, what is measured and how results are compared fairly.

5. Each container starts at 80 °C. The final temperatures after 20 minutes are shown.
(a) Calculate the temperature drop for 10 mm foam. [1]
(b) Calculate its mean cooling rate in °C per minute. [2]
(c) Identify the lining that gives the lowest energy-transfer rate. [1]
(d) Explain which two results give the fairest test of the effect of foam thickness. [2]

Lining	Final temperature / °C
None	61
5 mm foam	69
10 mm foam	73
10 mm wool	71
Answer / mark points: (a) 80 − 73 = 7 °C (1). (b) Cooling rate = 7/20 = 0.35 °C min^{-1} (equation/substitution 1, answer with unit 1). (c) 10 mm foam (1), because it has the smallest drop/highest final temperature. (d) Compare 5 mm foam with 10 mm foam (1) because the material and other conditions are the same and only thickness changes (1).	
Teacher prompt / common error: Common error: comparing 10 mm foam with 10 mm wool tests material, not thickness.	

6. The final-temperature test for 10 mm foam is repeated four times.
(a) Identify the anomalous result. [1]
(b) Calculate the mean of the valid results. [2]
(c) Explain why repeats and a mean improve the evidence. [1]

Repeat	Final temperature / °C
1	73
2	72
3	61
4	74
Answer / mark points: (a) 61 °C / repeat 3 (1). (b) Mean = (73 + 72 + 74)/3 = 73 °C (2). (c) Repeats reveal anomalous/random variation and a mean reduces the effect of random error, improving reliability (1).	
Teacher prompt / common error: Ask why 61 °C is anomalous: it is far from the cluster of three mutually consistent values.	

7. A cycle-delivery company requires the soup to remain above 70 °C after 20 minutes. A 10 mm foam liner finishes at 73 °C, costs £1.10 and has mass 180 g. A 10 mm wool liner finishes at 71 °C, costs £0.75 and has mass 120 g. A reflective liner has no test data. Recommend a liner for the company and justify your choice. [5]

Answer / mark points: A fully justified answer earns up to 5: both foam and wool meet the >70 °C requirement (1); foam gives the higher final temperature / smaller drop (1); wool is 60 g lighter and £0.35 cheaper (1); a defensible choice linked to the company's cycling, cost or thermal priorities (1); states that the reflective liner cannot yet be recommended because comparable test data are missing / it should be tested under the same conditions (1). Either foam or wool may be chosen if evidence is weighed.
Teacher prompt / common error: There is no single required choice. The mark is for evidence-led trade-offs and recognising missing evidence.

8. The factory conveyor that seals the containers has hot, noisy bearings. Explain how lubrication could improve the efficiency of the conveyor without breaking the principle of conservation of energy. [4]

Answer / mark points: Lubrication reduces friction in the bearings (1). Less energy is transferred by heating to the bearings/surroundings and possibly by sound (1). A greater fraction of the input energy is transferred usefully to moving the conveyor, so efficiency increases (1). Total energy is still conserved; it is redistributed differently rather than created or saved from existence (1).
Teacher prompt / common error: Common error: lubrication changes the useful fraction; it does not create energy.