

Exercise walk-through

1.5

Conservation and dissipation of energy (4.1.2.1, RP2)

AQA · GCSE · Physics

Five situations the specification names

Rising and falling

Describing a change: an object projected upwards trades kinetic for gravitational potential.

A vehicle slowing down empties kinetic and fills the thermal store of the brakes.

Collisions and currents

A moving object hitting an obstacle: kinetic empties, thermal stores fill.

A kettle: electrical work fills the thermal store of the water.

A worked chain from spring to speed

- 1 **Known** $k = 50 \text{ N/m}$, $e = 0.12 \text{ m}$, $m = 0.020 \text{ kg}$; all base units.
- 2 **Store** $E_e = \frac{1}{2}ke^2 = \frac{1}{2} \times 50 \times 0.12^2 = 0.36 \text{ J}$.
- 3 **Transfer** at release all E_e becomes E_k .
- 4 **Rearrange** $v = \sqrt{2E_k/m} = \sqrt{2 \times 0.36/0.020}$.
- 5 **Answer** $v = 6.0 \text{ m/s}$, 2 s.f., unit from $\sqrt{\text{J/kg}}$.

The stairs question, start to finish

- 1 **Known** $m = 60.0 \text{ kg}$, $h = 175 \text{ cm} = 1.75 \text{ m}$, $t = 1.40 \text{ s}$, $g = 9.8 \text{ N/kg}$.
- 2 **Energy** $E_p = mgh = 60.0 \times 9.8 \times 1.75 = 1029 \text{ J}$.
- 3 **Power** $P = E_p/t = 1029/1.40$.
- 4 **Answer** $P = 735 \text{ W}$.
- 5 **Check** her total power is higher: her body also heats and pushes air.

Exercises 2.1·2.3

2.1 A ball bounces on the floor and rises to a lower height each bounce. Explain, in terms of energy stores, where the “missing” energy goes. [2]

2.2 State what is meant by a closed system. [1]

2.3 A house loses energy through its walls. Give two changes to the walls that would reduce the rate of energy transfer, and name the property each change reduces. [2]

Exercises 2.1·2.3

2.1 A ball bounces on the floor and rises to a lower height each bounce. Explain, in terms of energy stores, where the “missing” energy goes. [2]

2.1 On each bounce some kinetic energy is transferred to thermal stores of the ball, the floor and the air (work done against friction/air resistance deforms and heats them); the energy is still there, dissipated in less useful stores, so the gravitational potential store refills less each bounce and the ball rises less high.

2.2 State what is meant by a closed system. [1]

2.2 A system from which (and into which) no energy is transferred – no energy enters or leaves it; the total energy of its stores is constant.

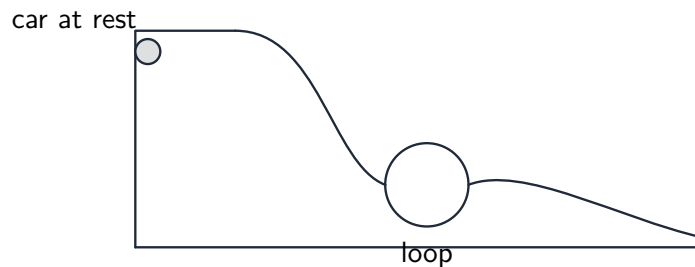
2.3 A house loses energy through its walls. Give two changes to the walls that would reduce the rate of energy transfer, and name the property each change reduces. [2]

2.3 Any two of: use a thicker wall (reduces the rate – thickness is the changed property); use a material with lower thermal conductivity; add cavity insulation (a second, trapped-air layer – air has very low thermal conductivity).

Exercise 3.1

3.1 A toy car is released from rest at the top of a track and does a loop. A student calculates that the car needs 0.20 J of kinetic energy at the bottom of the loop to complete it. In the real run, the car needs *more* than 0.20 J.

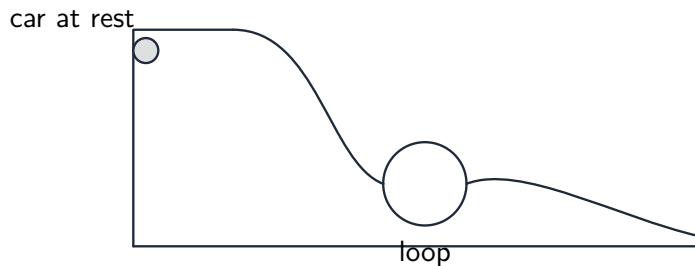
Explain why the real car needs more kinetic energy. Your answer should link the cause to the energy stores involved. [3]



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3.1 As the car runs along the track, work is done against friction between the wheels and the track and against air resistance. Some of the car's kinetic store is transferred to thermal stores of the track, wheels and surrounding air. So to arrive at the top of the loop with the required 0.20 J of gravitational potential energy, the car must start with more than 0.20 J – the extra covers the dissipated share.

Exercise 3.2

3.2 A student investigates insulating materials. The method: wrap a can of boiling water in one material; measure the time for the temperature to fall by 20°C ; repeat for the same thickness of each material.

(a) Identify the independent variable and the dependent variable. [2]

(b) Give two control variables. [2]

(c) The student uses two thermometers, A and B. Thermometer A has scale divisions of 2°C ; thermometer B has divisions of 0.5°C . Give one reason why B gives more reliable readings. [1]

(d) Material X: 450 s to fall 20°C . Material Y: 745 s. Explain what these results show about the thermal conductivity of X compared with Y. [2]

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3.2 (a) Independent: the type of insulating material. Dependent: the time for the temperature to fall by 20°C . (b) Any two: volume of water; starting temperature; same can/lid; same thickness of material; same room temperature. (c) B has a smaller scale division (higher resolution), so readings can be taken to nearer 0.5°C and uncertainty is smaller. (d) X's water fell by the same amount in less time, so energy crossed X at

Full solution 3.2

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Exercise 3.3

3.3 A sleeping-bag manufacturer tests three fills. Equal volumes of boiling water in identical sealed flasks, each wrapped in one fill, cool from 85°C . After 15 minutes the readings are: no wrap 57°C ; thin fill 63°C ; thick fill 71°C .

(a) Plot or sketch a results table row for each fill and state which fill is the best insulator. Justify your choice with the numbers. [3]

(b) The manufacturer claims: “doubling the thickness of our fill halves the energy lost.” Evaluate this claim using the data and the physics of energy transfer. [3]

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3.3 (a) Temperature falls: no wrap $85 - 57 = 28\text{ }^{\circ}\text{C}$; thin $85 - 63 = 22\text{ }^{\circ}\text{C}$; thick $85 - 71 = 14\text{ }^{\circ}\text{C}$ in the same 15 minutes. The thick fill leaves the highest final temperature ($71\text{ }^{\circ}\text{C}$) / the smallest fall, so it is the best insulator – the lowest rate of energy transfer

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