

1.1 Energy stores and systems

Name: _____ Class: _____ Date: _____

Total: 19 marks

KEY WORDS system • energy stores • heating
 • work done by forces • work done when a current flows
 • Sankey diagram

Objective

Name energy stores, describe how they change in the situations AQA names, read a Sankey diagram, and state the three ways energy enters a system. These are original teaching questions for spec statement 4.1.1.1.

1 Key knowledge and worked examples

A **system** is an object or group of objects you choose to study. When the system changes, energy moves between **energy stores**. Name the store that fills and the store that empties.

Store	Fills when...	Unit symbol
kinetic	an object speeds up	E_k
gravitational potential	an object rises	E_p
elastic potential	a spring stretches or compresses	E_e
thermal (internal)	an object gets hotter	—
chemical	fuel or food holds energy	—
nuclear	a nucleus changes	—
electrostatic	charges separate	—

The exam accepts the words or the symbols: "thermal" or " E_k " both score.

Energy enters a system three ways: by **heating**, by **work done by forces**, and by **work done when a current flows**. Electricity details arrive in topic 2.

Five situations the specification names. Practise describing each with two stores:

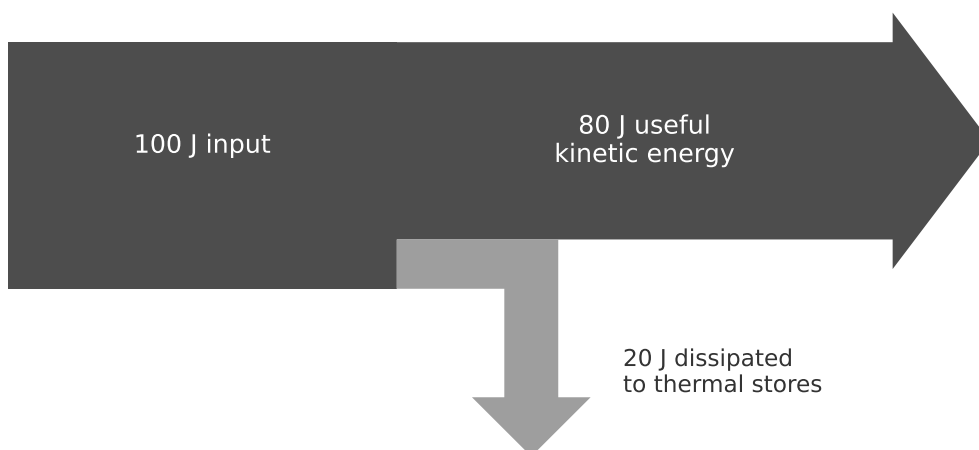
Situation	Store that empties	Store that fills
object projected upwards	kinetic	gravitational potential (top: kinetic smallest)
moving object hits an obstacle	kinetic	thermal of object and obstacle
object accelerated by a constant force	chemical (fuel) or electrical	kinetic
vehicle slowing down	kinetic	thermal of the brakes
kettle boils water	chemical at the power station → electrical	thermal of the water

Worked example. A kettle boils 0.50 kg of water for 3 minutes. Describe the energy changes.

- The system is the kettle and the water. Energy enters by work done when a current flows through the heating element (electrical work).
- The thermal store of the water fills: its temperature rises to 100 °C.
- At the boil the temperature stops rising: energy continues into the thermal store as the water separates into steam, and some is transferred to the surroundings by heating.

Sankey diagrams show energy on a common scale: arrow *width* is proportional to energy. Input on the left; it splits into useful and wasted outputs. The widths out always add to the width in.

Motor model: arrow shaft widths show energy



Width, not length, shows the energy.

Worked example. A motor takes 500 J and delivers 350 J to a lifting cable. What fraction is wasted?

- Known: input and useful output. Wasted energy is the difference.

$$E_{wasted} = 500 \text{ J} - 350 \text{ J} = 150 \text{ J}$$

- On a Sankey drawn to scale, the wasted arrow's width is $\frac{150}{500} = 0.3$ of the input arrow's width.

2 Practice

2.1 Name the energy store that increases in each case. [3]

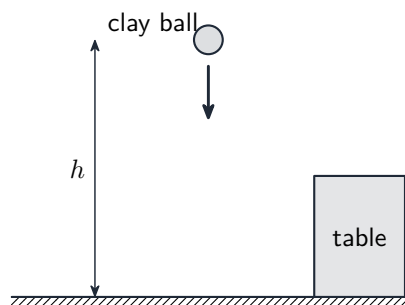
- (a) A cyclist speeds up on a flat road. (b) Water is pumped up into a mountain reservoir.
(c) A drawn catapult is held ready to fire.

2.2 A car brakes and stops at traffic lights. Describe the energy store changes in the car and its brakes. [2]

2.3 An electric fan runs for one minute. State the way energy enters the fan's system, and name the store that fills inside the fan as it runs. [2]

3 Exam-style questions

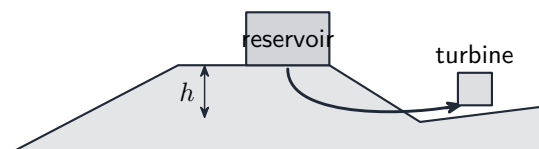
3.1 A student drops a soft clay ball from shoulder height onto a table. The ball stops dead without bouncing. Describe the changes in the way energy is stored, from the moment of release until the ball is at rest. [3]



3.2 A hydroelectric pumped-storage station pumps water uphill at night and releases it through turbines in the day.

(a) Name the store that fills when the water is pumped uphill, and the store that empties in the water while it runs down through the turbine. [2]

(b) The station's owners call the lake and dam "a system". Explain what is meant by a *system* in physics, using this example. [2]



3.3 A washing machine supplies 90 000 J to a drum of clothes. Of this, 27 000 J becomes useful kinetic energy of the drum; the rest is dissipated.

(a) Draw a Sankey diagram for the washing machine. Draw the input arrow 5 cm wide to scale, label the two output arrows with energies in kJ, and label which output is useful.[3]

(b) A second machine with the same input delivers 45 000 J usefully. State what is different about the widths of its two output arrows compared with the first machine. [2]
