Exercise walk-through

1.1 Energy stores and systems (4.1.1.1)

AQA · GCSE · Physics

Energy stores and systems

- A ball thrown upwards: its kinetic store empties and the gravitational potential store fills. At the top, it stops for an instant.
- A car hitting a wall: the kinetic store empties; the thermal stores of the car and wall fill, and some energy is carried away by sound.
- A battery-powered toy car speeding up: the chemical store of the battery empties; the kinetic store of the car fills.

Specific heat capacity

- When a substance is heated, the energy in its thermal store increases and its temperature rises:
- ΔE is the change in thermal energy in J, m the mass in kg and $\Delta\theta$ the temperature change in °C.
- The **specific heat capacity** c is the energy needed to raise the temperature of 1 kg of a substance by 1 °C, in J/kg °C.
- This equation is on the equations sheet.

$$\Delta E = m\,c\,\Delta\theta$$

Power

- **Power** is the rate at which energy is transferred, or the rate at which work is done.
- A more **powerful** motor lifts the same load through the same height in less time.
- P is **power** in watts, E energy transferred in J, W the **work done** in J and t the time in s.
- A transfer of 1 J per second is a power of 1 **watt** (W).

$$P = \frac{E}{t} \qquad P = \frac{W}{t}$$

Exercise 2.1

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.

energy stores

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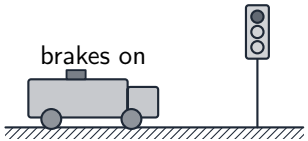
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energy stores

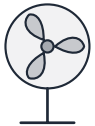
2.1 (a) kinetic. (b) gravitational potential. (c) elastic potential.

Exercise 2.2

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

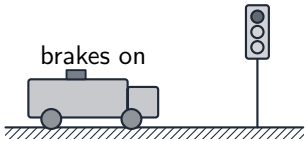


2.3 An electric fan runs for one minute. State the way energy enters the fan's system, and name the store that fills inside the fan as it runs. [2]

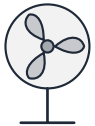


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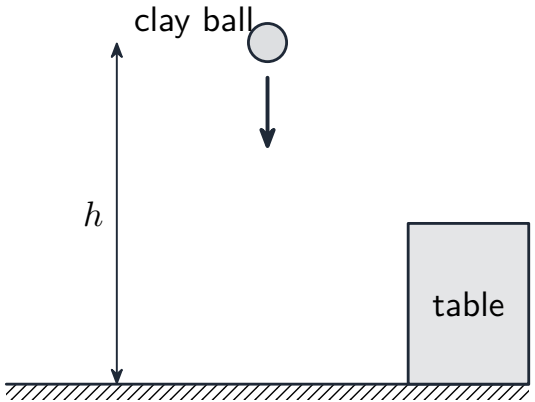


2.2 The kinetic store of the car empties; the thermal store of the brakes (and tyres, surroundings) fills – energy is dissipated by friction between the brake pads and wheels.

2.3 Energy enters by work done when a current flows (electrical work). The thermal store of the motor and surroundings fills as the fan runs – the kinetic store of the blades also fills as they spin up, then stays steady.

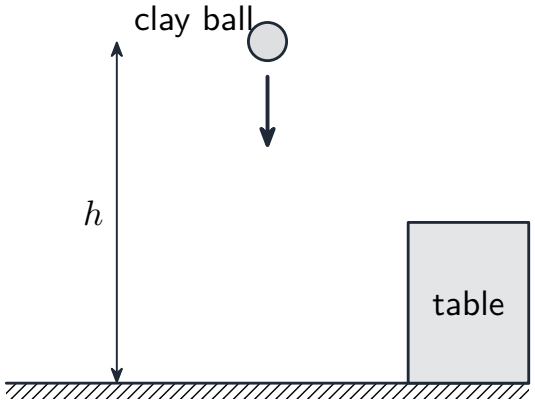
Exercise 3.1

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]



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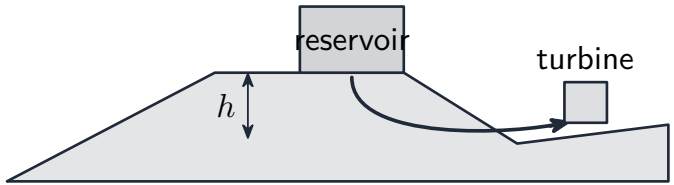
3.1 While falling: the gravitational potential store of the ball empties and its kinetic store fills. On impact: the kinetic store empties. The thermal store of the ball, the table and the surrounding air fills – the energy is dissipated, not destroyed.

Setup for exercise 3.2

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]



Exercise 3.2

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]

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3.2 (a) Pumped uphill: gravitational potential store fills. Running down: gravitational potential store of the water empties; the kinetic store fills as it passes the turbine – the question asks for the store that empties, which is gravitational potential. (b) A system is an object or group of objects chosen for study; here the lake, dam and water (the energy changes of the lake–water system are tracked, while the grid outside it is the surrounding).

3.3 (a) Input arrow 5 cm for 90 kJ; useful arrow $90 - 27 = 63$ kJ wide $\Rightarrow 63/90 \times 5 = 3.5$ cm; wasted arrow 27 kJ wide $\Rightarrow 27/90 \times 5 = 1.5$ cm; arrows labelled in kJ with the useful one marked, and the two output widths adding to the input width. (b) The useful arrow is wider ($45/90 \times 5 = 2.5$ cm) and the wasted arrow narrower; the two still add to 5 cm because the input is unchanged.