CAMBRIDGE IGCSE™ PHYSICS 0625 | TOPIC 1.7

FREE SAMPLE

Energy, Work & Power

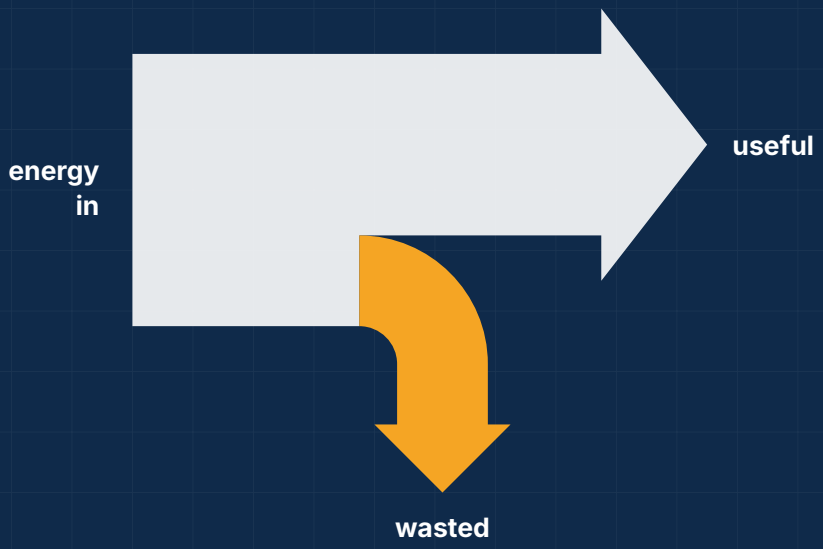
Free sample: knowledge organiser and Worksheet 1 with answers

Energy stores | Sankey diagrams | Kinetic & potential energy | Work & power

Energy resources | Efficiency | Exam-style questions

$$P = W / t$$

$$W = Fd$$



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Free sample

Full pack: worksheets, exam paper, answers

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Knowledge organiser

ENERGY, WORK AND POWER ON ONE PAGE

Energy stores

kinetic **gravitational potential**
chemical **elastic (strain)**
internal (thermal) **nuclear** **electrostatic**

e.g. a moving car; a raised book; fuel and food; a stretched spring; a hot drink

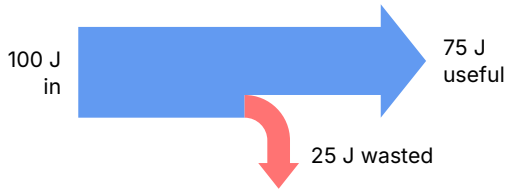
Ways energy is transferred

by forces (mechanical work done)
by electric currents (electrical work done)
by heating
by waves: electromagnetic, sound and others

Conservation of energy

Energy cannot be created or destroyed, only transferred between stores. The total stays the same. Wasted energy usually heats the surroundings.

SUPPLEMENT A **Sankey diagram** shows each transfer as an arrow whose width is proportional to the energy:



Equations

$W = Fd = \Delta E$ work done (J)

$P = \frac{W}{t} = \frac{\Delta E}{t}$ power (W)

SUPPLEMENT $E_k = \frac{1}{2}mv^2$ kinetic energy (J)

SUPPLEMENT $\Delta E_p = mg\Delta h$ g.p.e. change (J)

SUPPLEMENT efficiency $= \frac{\text{useful output}}{\text{total input}}$ ($\times 100$ %); use energy or power for both

Energy resources for generating electrical power

Resource	How it works	Renewable?	Main drawback
fossil fuels, biofuels	burn fuel to heat water → steam turns a **turbine** → turns a **generator**	fossil: no; bio: yes	CO_2 emissions (fossil fuels also run out)
nuclear fuel	fission heats water → steam → turbine → generator	no	radioactive waste; high cost
wind	wind turns the blades, which turn a generator	yes	unreliable: only works when windy
hydroelectric	water falls from behind a dam through turbines	yes	floods valleys; needs a suitable site
tides; waves	moving water turns turbines	yes	few suitable sites; affects habitats
geothermal	hot rocks heat water → steam → turbine	yes	only in a few places
solar cells	light → electrical energy directly	yes	no output at night; large area

Solar panels heat water directly (they do not generate electricity). SUPPLEMENT The Sun is the source of all these except **geothermal, nuclear and tidal** (waves are driven by the wind); the Sun releases energy by nuclear **fusion**.

Worked example

Question. A motor lifts a 200 N load through 3.0 m in 4.0 s. Calculate the work done and the useful power.

$W = Fd = 200 \times 3.0 = 600$ J
$P = W/t = 600 \div 4.0 = 150$ W

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Interactive simulations

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Explore the physics before (or after) you try the worksheets. Each simulation runs in any web browser on a phone, tablet or computer, with nothing to install. Scan the QR code, or click the link in the PDF.

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1.7.1 ENERGY

Roller Coaster Energy

Watch gravitational potential energy turn into kinetic energy, with or without friction.

Use with: Worksheet 2: Kinetic and potential energy

benfizikyapamiyorum.com/icdp/energy-coaster.html

Scan or click

1.7.1 ENERGY

Efficiency and Sankey Diagrams

Build a to-scale Sankey diagram for different devices and calculate efficiency.

Use with: Worksheet 1: Energy stores and transfers; Worksheet 4: Energy resources and efficiency

benfizikyapamiyorum.com/icdp/energy-sankey.html

How to get the most from them Make a prediction first, then test it in the simulation. Change one thing at a time and note what happens to the readings. Each simulation ends with a quick *Check yourself* question.

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Energy stores and transfers

WORKSHEET 1

CORE SUPPLEMENT

You will: name energy stores, describe how energy is transferred between them, apply the principle of conservation of energy and (Extended) interpret Sankey diagrams.

CORE all students SUPPLEMENT Extended (Supplement) students CHALLENGE stretch question

1 CORE Name the main energy store in each of these. [6]

(a) a stretched bungee cord _____

(b) a fully charged phone battery _____

(c) a car moving along a road _____

(d) water held behind a high dam _____

(e) a hot cup of tea _____

(f) uranium fuel in a nuclear reactor _____

2 CORE State how energy is transferred in each of these. Choose from: *by a force (mechanical work), by an electric current, by heating, by waves*. [4]

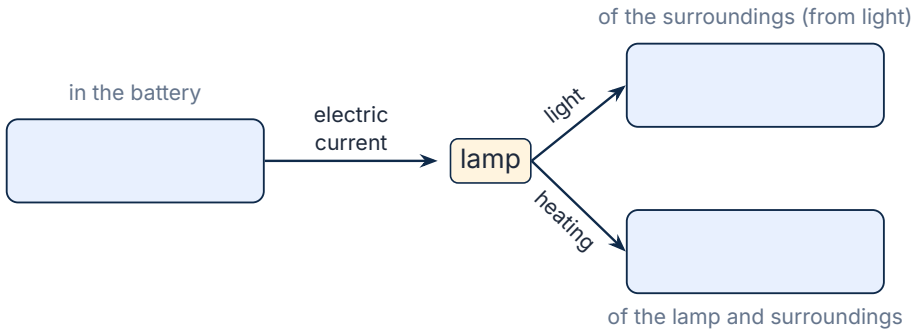
(a) a person lifts a box onto a shelf _____

(b) the mains supply makes a kettle element hot _____

(c) the hot element warms the water around it _____

(d) light from the Sun reaches a solar cell _____

3 CORE A torch uses a battery to light a lamp. Complete the energy flow diagram by writing the name of an energy store in each empty box. [3]



Hint: light is a way of transferring energy (by waves), not an energy store. When it is absorbed, the surroundings warm up.

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4 CORE This question is about the conservation of energy.

(a) State the principle of conservation of energy. [1]

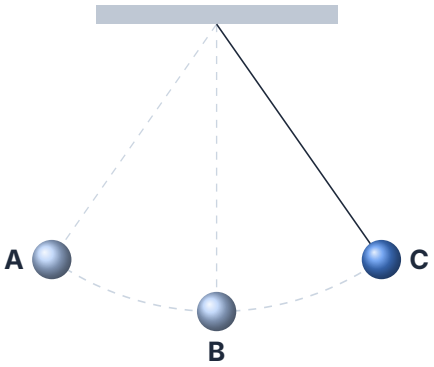
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(b) A ball is dropped onto a hard floor. Each bounce is lower than the one before. A student says: *"The ball loses energy, so energy is not conserved."* Explain why the student is wrong. [2]

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5 CORE A pendulum bob is released from rest at A. It swings through B, its lowest point, to C.



(a) Describe the energy changes as the bob swings from A to B and then from B to C. [3]

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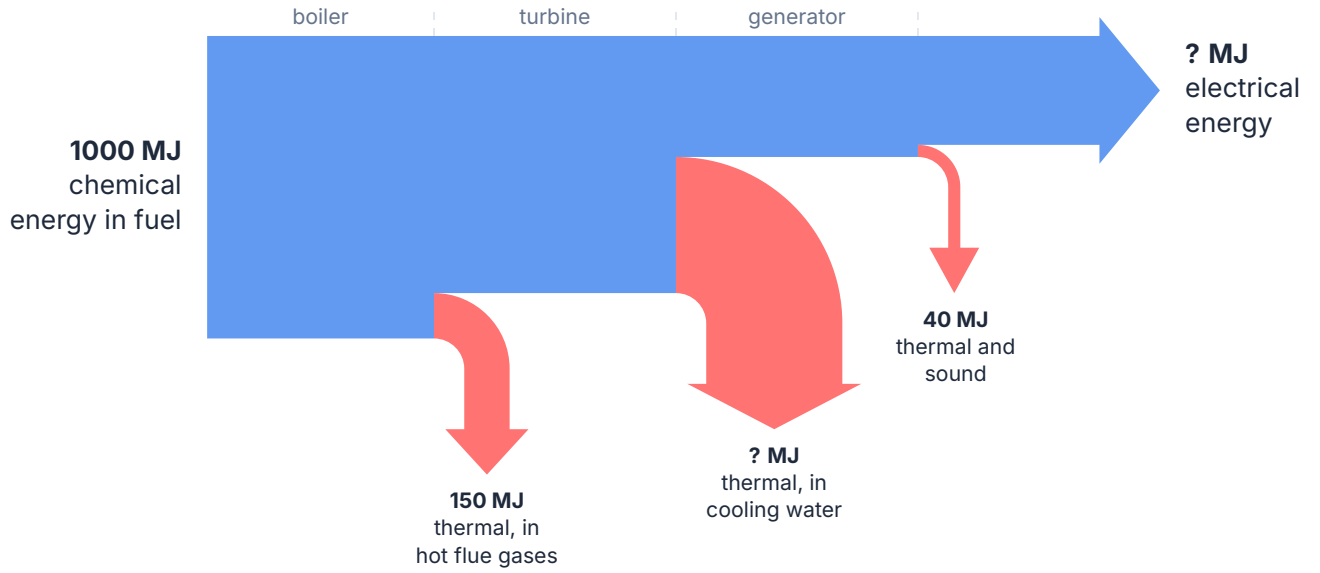
(b) The swings get gradually smaller until the bob stops. Explain what happens to its energy. [2]

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6 SUPPLEMENT The Sankey diagram shows the energy transfers in a fossil-fuel power station each second.



(a) The turbine passes 400 MJ of energy to the generator each second. Calculate the energy transferred to the cooling water each second. [1]

energy = _____

(b) Calculate the electrical energy output each second. [1]

energy = _____

(c) Calculate the total energy wasted each second. [1]

energy = _____

(d) Explain how the diagram shows that energy is conserved. [1]

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Exam tip Energy is never used up. It is transferred from one store to others, and the total stays the same. "Wasted" energy usually ends up in the internal (thermal) store of the surroundings.

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Answers: Worksheet 1

Mark codes: B1 independent mark C1 method mark, implied by a correct final answer A1 correct answer with unit. Accept answers that round correctly; allow error carried forward from earlier parts.

Worksheet 1 – Energy stores and transfers

1 **(a)** elastic (strain) B1 **(b)** chemical B1
(c) kinetic B1 **(d)** gravitational potential B1
(e) internal (thermal) B1 **(f)** nuclear B1

2 **(a)** by a force (mechanical work) B1
(b) by an electric current (electrical work) B1
(c) by heating B1
(d) by waves (light, electromagnetic radiation) B1

3 Battery: **chemical** B1; top: **internal (thermal)** of the surroundings B1; bottom: **internal (thermal)** of the lamp and surroundings B1

4 **(a)** Energy cannot be created or destroyed; it is only transferred from one store to others (the total stays the same). B1
(b) The total energy is the same; at each bounce some energy is transferred to the internal (thermal) store of the ball, floor and air B1, and by sound waves; so less is left in the ball's kinetic and g.p.e. stores. B1

5 **(a)** A to B: gravitational potential → kinetic B1; maximum kinetic energy at B B1; B to C: kinetic → gravitational potential. B1
(b) Air resistance (and friction at the pivot) do work B1; the energy is transferred to the internal (thermal) store of the surroundings. B1

6 **(a)** $1000 - 150 - 400 = \mathbf{450\ MJ}$ B1
(b) $400 - 40 = \mathbf{360\ MJ}$ B1
(c) $150 + 450 + 40 = \mathbf{640\ MJ}$ B1
(d) The widths of the output arrows add up to the width of the input arrow (total energy out = total energy in). B1

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Get the full pack

You have just used Worksheet 1. The full Energy, Work & Power pack contains:

- **Worksheet 1:** Energy stores and transfers
- **Worksheet 2:** Kinetic and potential energy
- **Worksheet 3:** Work and power
- **Worksheet 4:** Energy resources and efficiency
- **Multiple-choice practice:** 10 Paper 1/2-style questions
- **Practical skills:** an Alternative to Practical (Paper 6) question
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