

Energy stores, Sankey diagrams and efficiency

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet

Name: _____ Date: _____ Class: _____

These 20 problems train you to name energy stores, follow transfers, calculate efficiency and read Sankey diagrams. You also find input and output energies, compare machines and judge ways of reducing waste. The problems move from recall to multi-step reasoning. They suit GCSE P1, IGCSE and NGSS HS-PS3-4.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE P1, HS-PS3-4

Problem 1 Name the store (easy)

State the main energy store in each case.

1. A stretched catapult band.
2. A cup of hot tea.
3. Diesel in a tractor tank.
4. Water in a reservoir high above a village.
5. A moving train.

Problem 2 Hydroelectric chain (easy)

Chiamaka studies a hydroelectric station near Jos. Put the stores and transfers in order: electrical energy in lamps, kinetic energy of the turbine, gravitational potential energy of the water, kinetic energy of the falling water.

1. Write the correct order, starting with the water in the lake.
2. Name the energy transfers that are wasted.

Problem 3 Fan motor (easy)

A fan motor takes in 400 J of electrical energy and gives out 300 J of kinetic energy.

1. Calculate the wasted energy.
2. Calculate the efficiency as a percentage.

Problem 4 Laptop charger (easy)

A laptop charger takes in 60 J of electrical energy. It transfers 9 J to the surroundings as thermal energy.

1. Calculate the useful energy output.
2. Calculate the efficiency.

Problem 5 Percentages and decimals (easy)

Complete the conversions.

1. Write an efficiency of 0.40 as a percentage.
2. Write an efficiency of 85 % as a decimal.
3. A student claims a motor is 110 % efficient. Explain why this is impossible.

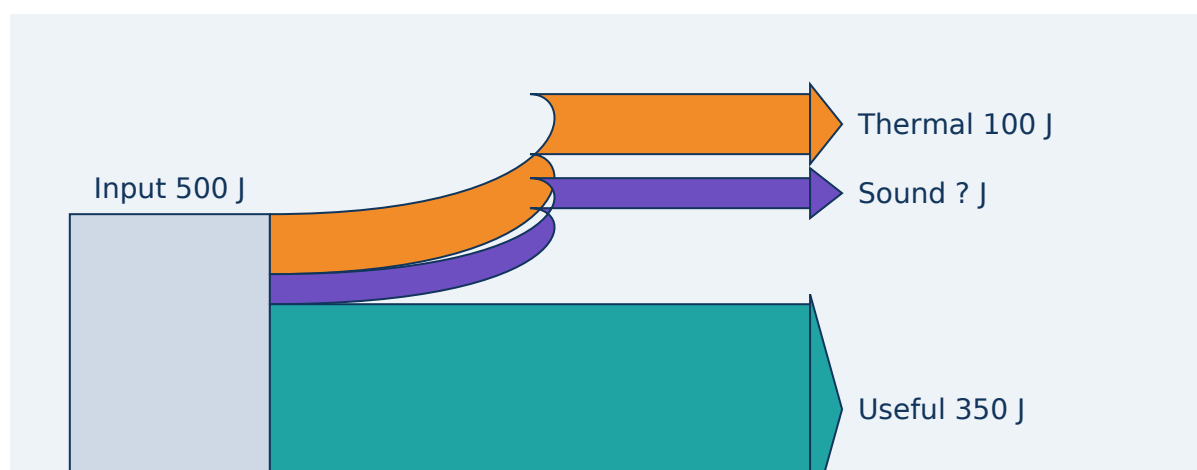
Problem 6 Pendulum swing (easy)

Mei lifts a pendulum bob to a height of 8.0 cm above its lowest point and releases it. On the first swing it rises to 7.0 cm on the other side.

1. Calculate the fraction of the gravitational potential energy retained.
2. State the percentage lost and name where it goes.

Problem 7 Workshop machine (medium)

The Sankey diagram shows a machine that takes in 500 J.



Sankey diagram of a workshop machine.

1. Calculate the wasted energy as sound.
2. Calculate the efficiency.
3. State how wide the sound arrow should be compared with the thermal arrow.

Problem 8 Gas boiler (medium)

A boiler is 85 % efficient. It takes in 40 MJ of chemical energy.

1. Calculate the useful thermal energy.
2. Calculate the wasted energy.

Problem 9 Finding the input (medium)

A motor in a rice mill is 60 % efficient and delivers 1800 J of useful kinetic energy.

1. Rearrange the efficiency equation to make the input energy the subject.
2. Calculate the input energy.

Problem 10 Which charger is better? (medium)

Charger A takes in 12.0 J and delivers 9.6 J. Charger B takes in 15.0 J and delivers 12.3 J.

1. Calculate the efficiency of each charger.
2. Calculate the wasted energy of each charger.
3. State which charger is more efficient and comment on its wasted energy.

Problem 11 Scooter motor power (medium)

The motor of an electric scooter takes in 600 W of electrical power and gives out 480 W of mechanical power.

1. Calculate the efficiency.
2. Calculate the power wasted.
3. Calculate the energy wasted in 15 minutes.

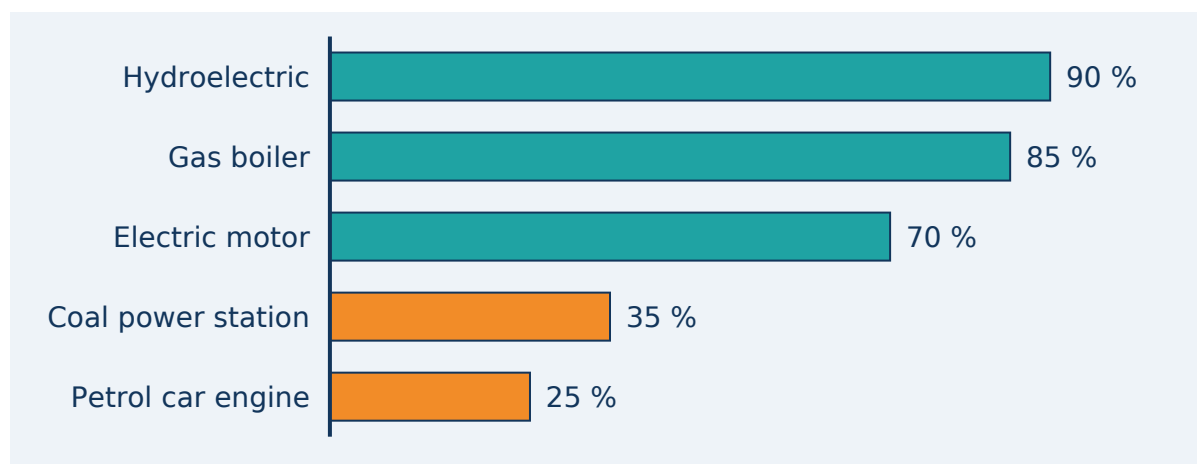
Problem 12 Lift motor (medium)

A lift motor raises a load of 600 kg through 20 m and takes in 168 000 J of electrical energy. Use $g = 9.8 \text{ N/kg}$.

1. Calculate the gain in gravitational potential energy.
2. Calculate the efficiency of the motor.

Problem 13 Comparing converters (medium)

Use the bar chart of efficiencies.



Efficiencies of five energy converters.

1. Calculate the energy wasted by a petrol car engine for every 1000 J of chemical energy.
2. Calculate how much input energy a coal power station needs to produce 500 J of electrical energy.
3. State which converter is the most efficient.

Problem 14 Insulating a room (medium)

Aarav in Pune heats a room with a 2.0 kW heater. The room loses thermal energy at 1.5 kW. Loft insulation cuts this loss by 40 %.

1. Calculate the new rate of loss in watts.
2. Calculate the energy lost in one hour before insulation.
3. Calculate the energy saved in one hour by the insulation.

Problem 15 Chain oil (medium)

Bilal oils the chain of his bicycle and finds it easier to pedal.

1. Explain in terms of energy why oil improves the efficiency.
2. State where the wasted energy goes before and after oiling.

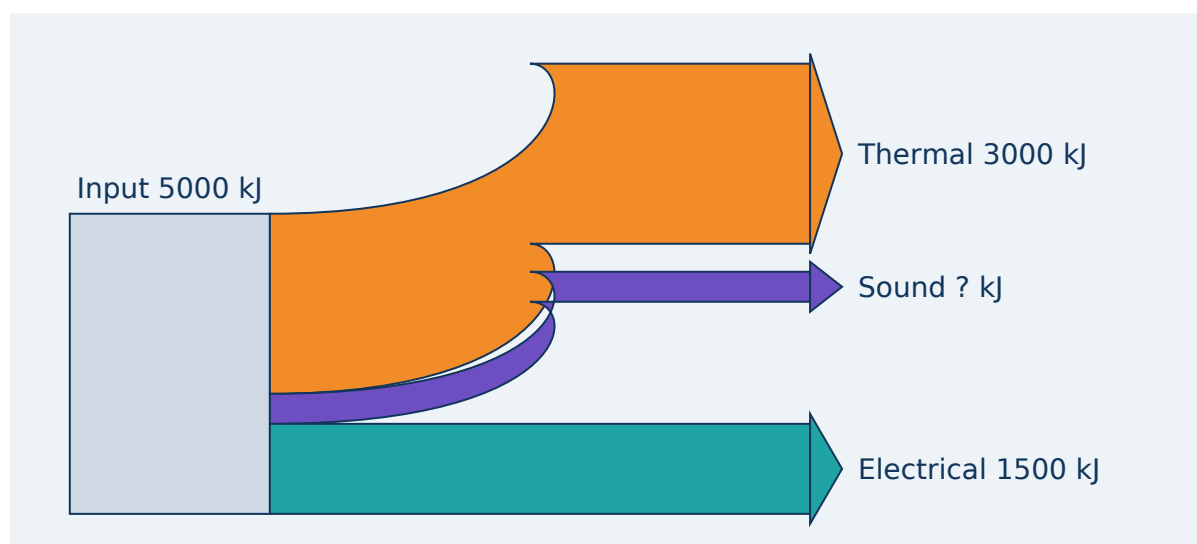
Problem 16 Two-stage power station (hard)

Water gives 2.0 MJ of gravitational potential energy to a turbine in a hydroelectric station. The turbine is 90 % efficient. The generator, which receives the turbine output, is 95 % efficient. Cables then deliver 94 % of the generator output to the town.

1. Calculate the energy output of the turbine.
2. Calculate the energy output of the generator.
3. Calculate the overall efficiency of the turbine and generator together.
4. Calculate the energy delivered to the town and the overall efficiency of the whole system.

Problem 17 Diesel generator (hard)

A diesel generator on a farm in Uganda is shown in the Sankey diagram.



Sankey diagram of a diesel generator on a farm.

1. Calculate the energy wasted as sound.
2. Calculate the efficiency.
3. The electrical output is delivered at a steady 5.0 kW. Calculate how long this takes.
4. Suggest two ways to improve the generator's efficiency.

Problem 18 Replacing a bulb (hard)

A filament bulb takes in 60 W and only 5 % of it becomes light. An LED lamp gives the same light output with an efficiency of 30 %. Each lamp is used for 5.0 hours per day for 30 days.

1. Calculate the light output of the filament bulb.
2. Calculate the power the LED lamp takes in for the same light output.
3. Calculate the energy saved in kWh over 30 days.
4. Convert the saving into joules (1 kWh = 3.6 MJ).

Problem 19 Spot the errors (hard)

A student writes three statements. Correct each one.

1. "My motor takes in 100 J and gives out 120 J, so it is 120 % efficient."
2. "The kettle uses up 200 J of energy, so that energy is gone."
3. "An electric heater is only 100 % efficient, so it is a terrible design."

Problem 20 Motor and load data (hard)

A toy motor raises different masses through 0.80 m. A joulemeter measures the electrical input. Use $g = 9.8 \text{ N/kg}$.

Mass lifted (kg)	Electrical input (J)
0.20	5.2
0.40	8.9
0.60	12.4
0.80	15.7

1. Calculate the gain in gravitational potential energy for each mass.
2. Calculate the efficiency for each mass.
3. Describe the pattern and suggest an explanation.