

GCSE Physics (9 – 1)

Energy Transfers and Sankey Diagrams

Name:

Group:

Instructions

- Read each question carefully before you begin to answer it.
- Use black ink or black ball-point pen for your answers.
- Fill in the boxes at the top of this page with your name and group.
- Attempt to answer every question in the booklet.
- Answer the questions in the spaces provided – there may be more space than you need in some answer spaces.
- Calculators may be used for this booklet.
- For any calculations, you **must** show all your working.
- Any and all drawings or graphs should be completed in pencil.



For markers use	
Question	Mark
1	/4
2	/6
3	/6
4	/6
5	/15
6	/4
7	/4
Total	/45
%	
Grade	

Information

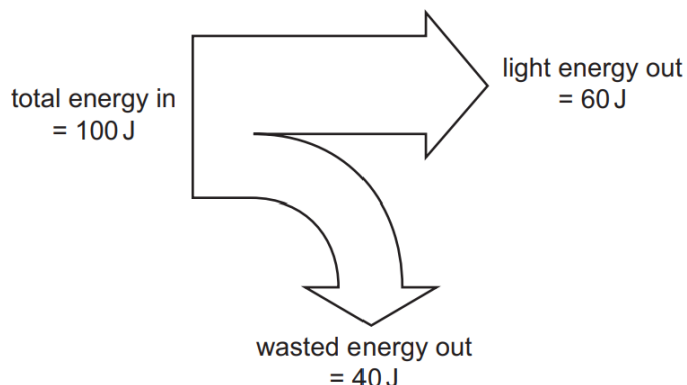
- The maximum mark for this paper is 45 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.



- To determine the efficiency of a device, we use Sankey diagrams to compare the amount of useful energy output against the energy dissipated to the surroundings.

Circle the letter of the correct answer for each for the following questions.

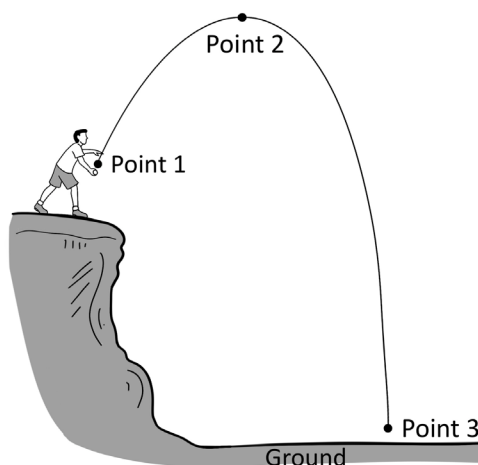
- The diagram shows the energy transferred in a lamp in one second.



Which type of wasted energy is produced by the lamp?

- | | | | |
|-------------------|---------------------------|----------------|--------------------------|
| A | B | C | D |
| Electrical energy | Chemical potential energy | Thermal energy | Nuclear potential energy |
- (1 mark)**

- A student throws a stone from the edge of a cliff. Its path is shown in the diagram below.



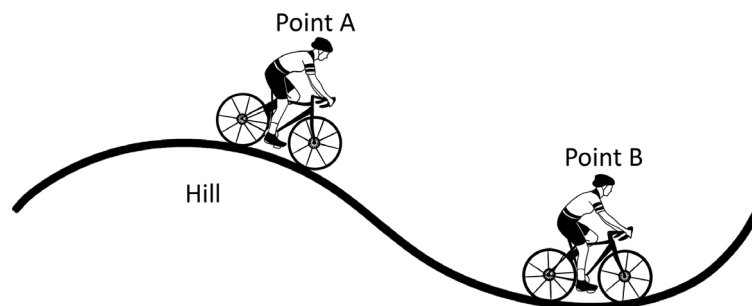
The table below shows the **main energy store** of the stone at three points in its flight.

Which row of the table is correct?

	Point 1	Point 2	Point 3
A	Kinetic energy	Gravitational potential energy	Kinetic energy
B	Gravitational potential energy	Kinetic energy	Gravitational potential energy
C	Kinetic energy	Kinetic energy	Gravitational potential energy
D	Gravitational potential energy	Gravitational potential energy	Kinetic energy

- A cyclist is stationary at the top of a high slope, point A. She rolls down the hill without pedalling.
- (1 mark)**

At the bottom of the hill, point B, she applies the brakes and comes to a complete stop.



Which sequence correctly shows the **main energy transfers** that occur between point A and point B?

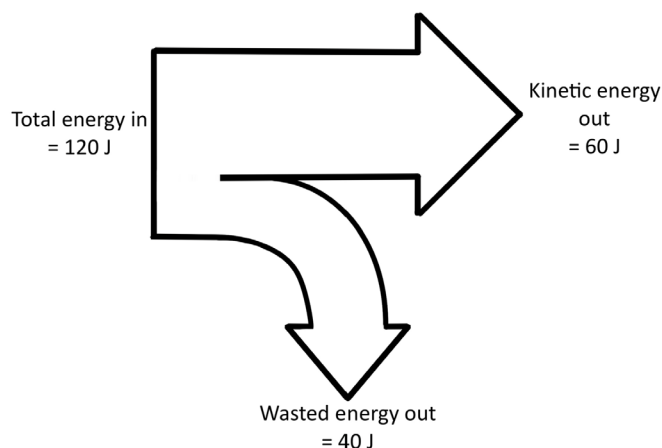
- A kinetic $\rightarrow$ gravitational potential $\rightarrow$ thermal
- B gravitational potential $\rightarrow$ kinetic $\rightarrow$ thermal
- C thermal $\rightarrow$ kinetic $\rightarrow$ gravitational potential
- D gravitational potential $\rightarrow$ thermal $\rightarrow$ kinetic

(1 mark)

d) A battery powered drone hovers in the air.



The Sankey diagram below shows the energy transfer from the battery.



Which statement is correct about the energy changes?

- A The useful energy is greater than the input energy.
- B The thermal energy is useful because it warms up the battery.
- C The input energy is equal to the kinetic energy plus the thermal energy.
- D The kinetic energy is the wasted energy.

(1 mark)

(Total for Question 1 is 4 marks)

2. An electric motor is used to lift a heavy load of bricks.

The motor is supplied with 500 Joules of electrical energy.

As the motor lifts the bricks, 300 Joules of energy is usefully transferred to the gravitational potential energy store of the bricks. The rest of the energy is wasted as heat and sound.

- a) Calculate the amount of energy that is wasted.

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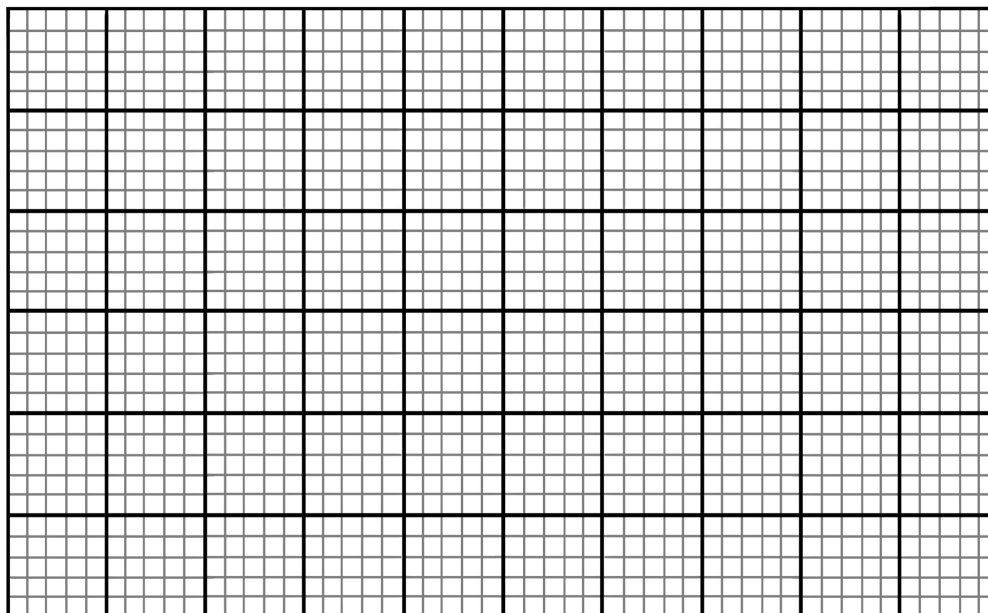
Wasted Energy = ... J

(1 mark)

- b) Complete the Sankey diagram below to represent the energy transfers for the electric motor.

Use the scale of each small square on the grid represents 25 Joules of energy.

In your diagram you **must** label the arrows for the useful energy and the wasted energy.



(3 marks)

- c) Calculate the efficiency of the electric motor.

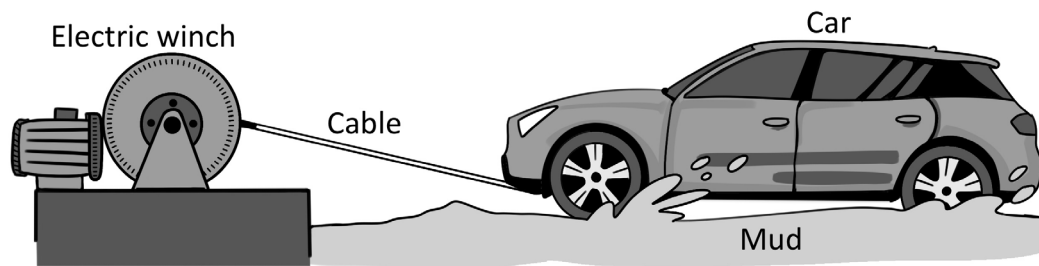
$$\text{Efficiency} = \frac{\text{Useful Output Energy}}{\text{Total Input Energy}} \times 100$$

Efficiency = ... %

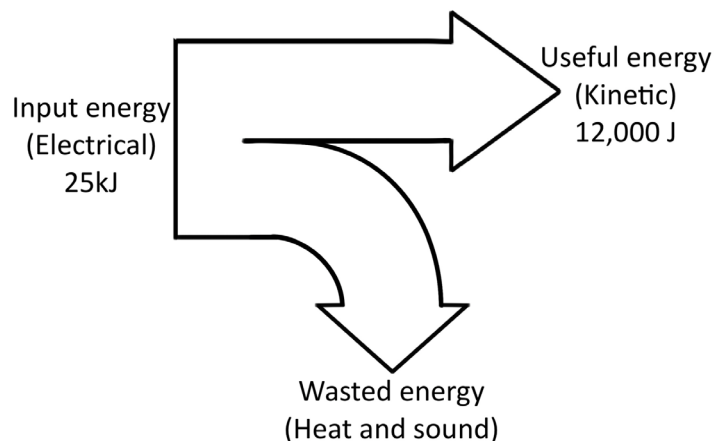
(2 marks)

(Total for Question 2 is 6 marks)

3. An electric winch is used to pull a car out of some mud.



The diagram shows the energy transfers for the winch over a period of 10 seconds.



a) Calculate the energy wasted by the winch.

Wasted energy = ... J
(2 marks)

b) Calculate the efficiency of the winch.

Efficiency = ... %
(2 marks)

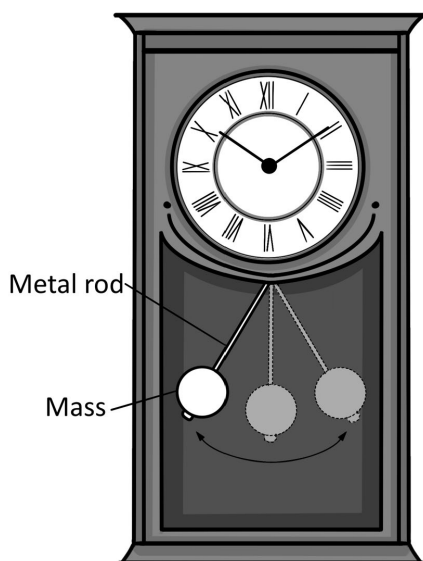
c) Suggest what happens to the wasted energy from this system.

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(2 marks)

(Total for Question 3 is 6 marks)

4. A student investigates the motion of a pendulum in a large clock. She pulls the pendulum to one side and releases it. The pendulum swings through the lowest point to the opposite side.



A spring in the clock keeps the pendulum swinging without stopping.
Describe the energy changes that happen within the clock as the pendulum swings from side to side.

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(6 marks)

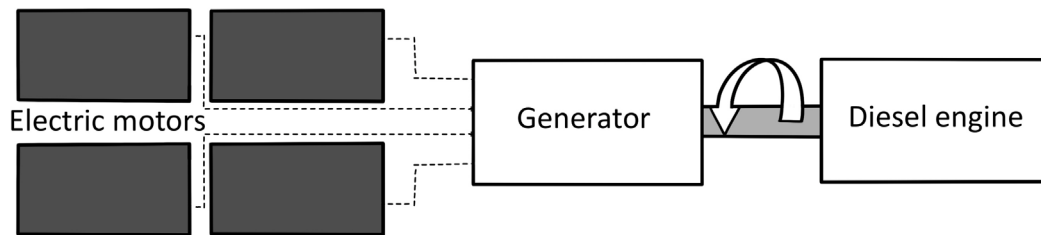
(Total for Question 4 is 6 marks)

5. A passenger ferry uses a diesel electric propulsion system.

A diesel engine burns fuel to turn a generator.

The generator produces electricity for electric motors, which rotate the ship's propellers.

The figure below shows the propulsion system of the ferry.



- a) The diesel fuel contains stored energy.
State the name of the energy store found in the fuel.

(1 mark)

- b) Draw one straight line from **each** part of the ferry's propulsion system to its useful energy transfer.

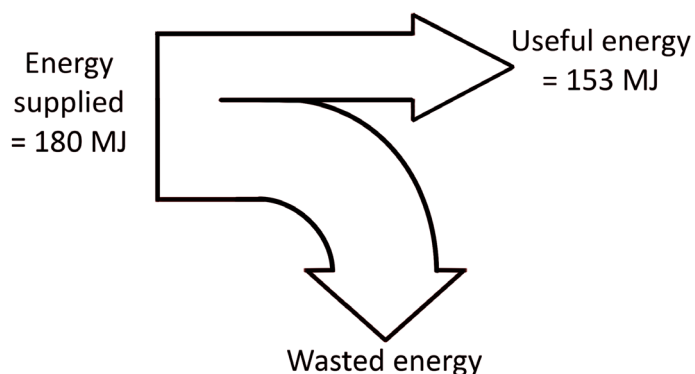
Ferry part	Useful energy transfer
Generator	Electrical to kinetic
Motor	Chemical to kinetic
Diesel engine	Chemical to electrical
	Kinetic to electrical
	Kinetic to chemical

(3 marks)

- c) Give **one** example of a non-useful or wasted energy transfer in the ferry's electric motor.

(1 mark)

The diagram below represents the energy transfers in the generator over a period of **1 minute**.



- d) Calculate the amount of energy wasted by the generator in this **1 minute period**.

Energy wasted = ... MJ
(1 mark)

- e) Calculate the efficiency of the generator.
Give your answer as a percentage.

Efficiency = ... %
(2 marks)

- f) Calculate the **input power** of the generator.

Power = ... unit:
(4 marks)

The electric motors on the ferry can get very hot.

The outer casing of the motors is painted black and shaped with metal fins.

- g) Explain how these two features help to keep the motor cool.

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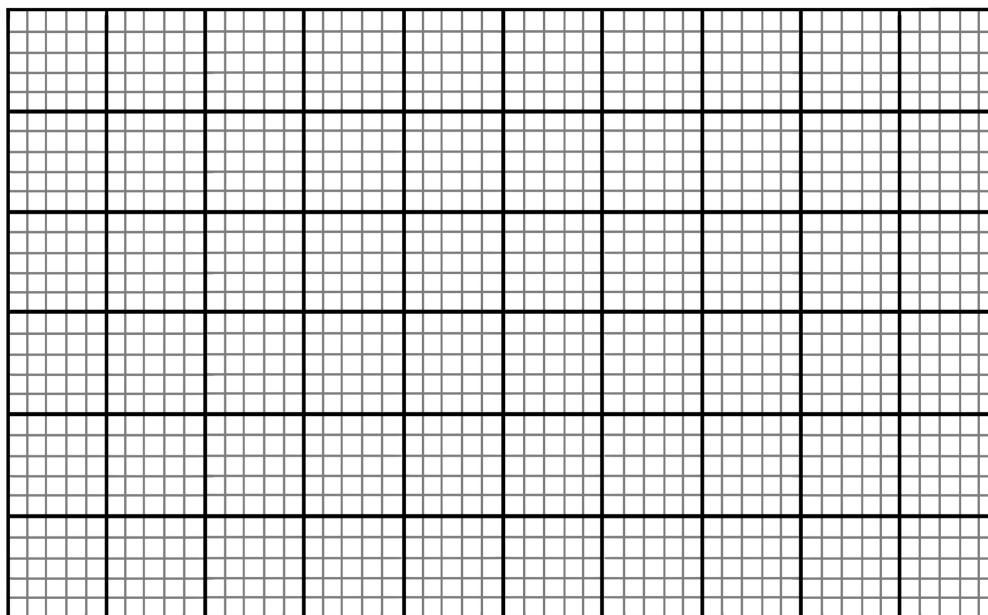
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(3 marks)

(Total for Question 5 is 15 marks)

6. A specialized electric motor is used to pull a heavy shutter door open.
During a single lift, 300 J of electrical energy is supplied to the motor.
Due to friction and electrical resistance, 60 J of energy is wasted as heat and sound.

Draw a Sankey diagram on the grid below to represent this energy transfer.



(4 marks)

(Total for Question 6 is 4 marks)

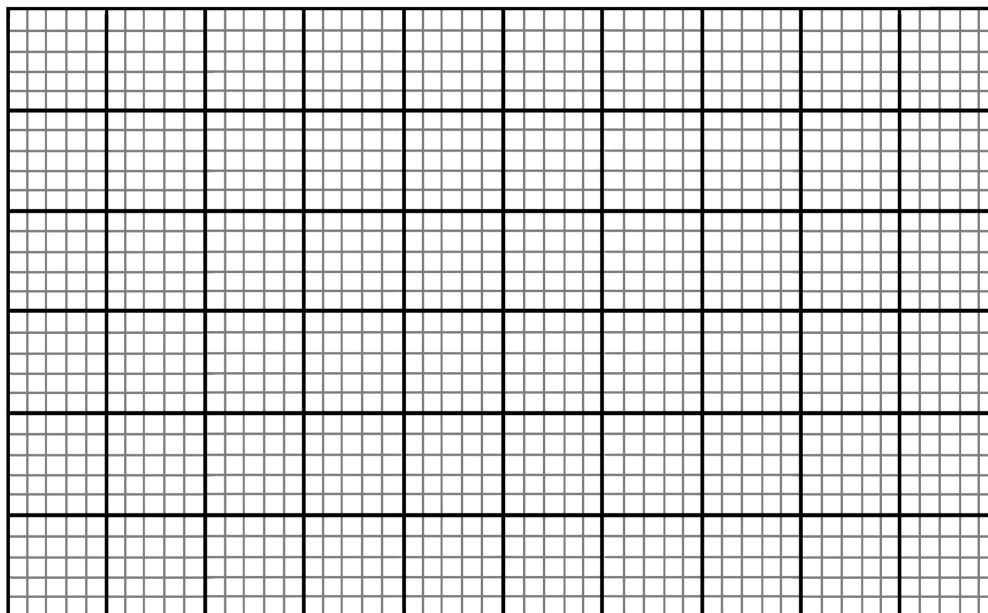
7. A modern electric kettle has an efficiency of 80%.

During a short burst of heating, the kettle uses 2000 J of electrical energy.

The useful energy is transferred to the thermal store of the water.

The remaining energy is wasted, heating the plastic body of the kettle and the surrounding air.

Draw a Sankey diagram on the grid below to represent this energy transfer.



(4 marks)

(Total for Question 7 is 4 marks)