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Student number

Name

Date

Attempt/Time taken

# GCSE
# PHYSICS

## Topic Paper: 1.2.2 & 1.3 Efficiency, national and global energy resources Part 2

Time allowed: 50 minutes

**Materials**

For this paper you must have:

- the Periodic Table/Data Sheet, provided as an insert (enclosed)
- a ruler with millimetre measurements
- a calculator, which you are expected to use where appropriate.

**Instructions**

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

**Information**

- The Periodic Table/Data Sheet is provided as in insert.
- You are reminded of the need for good English and clear presentation in your answers.
- When answering questions you need to make sure that your answer:
  - is clear, logical, sensibly structured
  - fully meets the requirements of the question
  - shows that each separate point or step supports the overall answer.

**43 Marks**

**Q6.** (a) Solar energy is a *renewable* energy source used to generate electricity.

(i) What is meant by an energy source being *renewable?*

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**(1)**

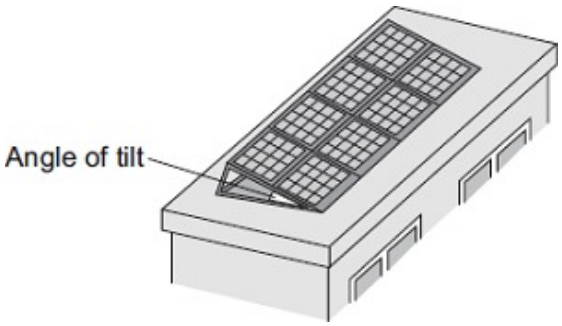
(ii) Name **two** other renewable energy sources used to generate electricity.

1 .....

2 .....

**(1)**

(b) A householder uses panels of solar cells to generate electricity for his home.
The solar cells are tilted to receive the maximum energy input from the Sun.




The data in the table gives the average energy input each second (in J/s), to a 1 $m^2$ area of solar cells for different angles of tilt and different months of the year.

| **Month** | **Angle of tilt** | | | |
|---|---|---|---|---|
| | 20° | 30° | 40° | 50° |
| February | 460 | 500 | 480 | 440 |
| April | 600 | 620 | 610 | 600 |
| June | 710 | 720 | 680 | 640 |
| August | 640 | 660 | 640 | 580 |
| October | 480 | 520 | 500 | 460 |
| December | 400 | 440 | 420 | 410 |

(i) Use the data in the table to describe how the average energy input to the solar cells depends on the angle of tilt.

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**(2)**

(ii) The total area of the solar cell panels used by the householder is 5 $m^2$.

The efficiency of the solar cells is 0.18.

Use the equation in the box to calculate the average **maximum** electrical energy available from the solar cell panels each second in June.

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Show clearly how you work out your answer.

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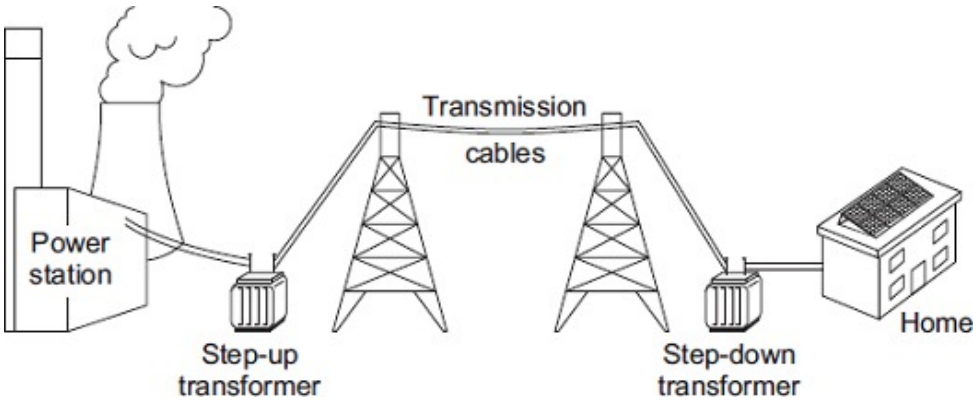
Maximum energy = ..... joules/second

**(3)**

(c) The diagram shows part of the National Grid.




(i) Even though the householder uses solar cells to generate electricity for his home, the home stays connected to the National Grid.

Give **one** reason why the householder should stay connected to the National Grid.

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**(1)**

(ii) The step-up transformer increases the efficiency of the National Grid.

Explain how.

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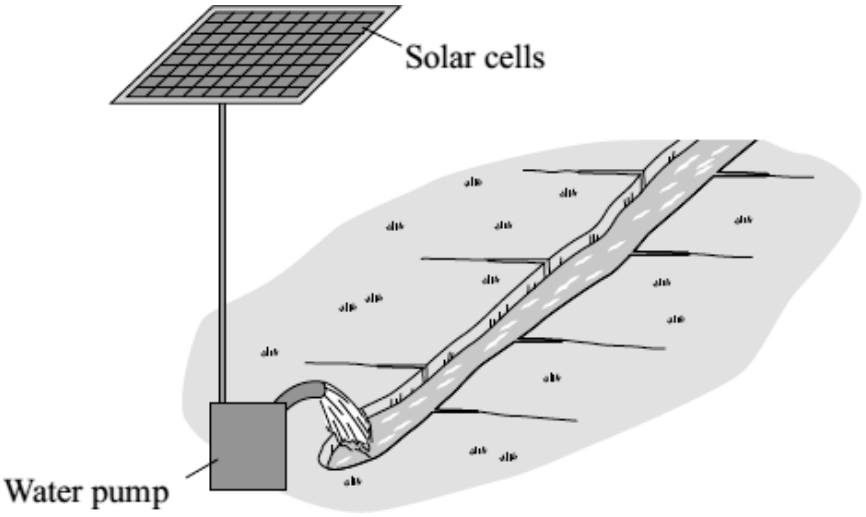
**(2)**

**(Total 10 marks)**

**Q7.** The farmers in a village in India use solar powered water pumps to irrigate the fields.




On average, a one square metre panel of solar cells receives 5 kWh of energy from the Sun each day.
The solar cells have an efficiency of 0.15

(a) (i) Use the following equation to calculate the electrical energy available from a one square metre panel of solar cells.

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Show clearly how you work out your answer.

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Electrical energy = ..... kWh

**(2)**

(ii) On average, each solar water pump uses 1.5 kWh of energy each day.

Calculate the area of solar cells required by one solar water pump.

Area = ..... square metres

**(1)**

(b) Give **one** reason why the area of solar cells needed will probably be greater than the answer to part (a)(ii).

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**(1)**
**(Total 4 marks)**

**Q8.** The table gives data about two types of low energy bulb.

| Type of bulb | Power input in watts | Efficiency | Lifetime in hours | Cost of one bulb |
|---|---|---|---|---|
| Compact Fluorescent Lamp (CFL) | 8 | 20% | 10 000 | £3.10 |
| Light Emitting Diode (LED) | 5 | | 50 000 | £29.85 |

(a) Both types of bulb produce the same useful power output.

(i) Calculate the useful power output of the CFL.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

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Useful power output = ..... W

**(2)**

(ii) Calculate the efficiency of the LED bulb.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

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Efficiency = .....

**(1)**

(b) Sketch and label a Sankey diagram for the CFL.

**(2)**

(c) LED bulbs are expensive. This is because of the large number of individual electronic LED chips needed to produce sufficient light from each bulb.

(i) Use the data in the table to evaluate the cost-effectiveness of an LED bulb compared to a CFL.

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**(2)**

(ii) Scientists are developing brighter and more efficient LED chips than those currently used in LED bulbs.

Suggest **one** benefit of developing brighter and more efficient LED chips.

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**(1)**
**(Total 8 marks)**

**Q9.** A homeowner had a new gas boiler installed.

(a) The following information is an extract from the information booklet supplied with the boiler.

| | |
|---|---|
| **Fuel** | Natural Gas |
| **Water temperature** | 60 ℃ |
| **Energy supplied to gas boiler** | 8.0 kJ/s (8.0 kW) |
| **Efficiency** | 0.95 |

(i) Use the equation in the box to calculate the energy transferred each second by the gas boiler to the water inside the boiler.

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Show clearly how you work out your answer.

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Energy transferred by the gas boiler each second = ..... kJ

**(2)**

(ii) The energy value of the gas used in a home is measured in kilowatt-hours (kWh).

The homeowner has a pre-payment meter and pays £30 into his account. With a pre-payment meter, gas costs 15p per kilowatt-hour.

Use the equations in the box to calculate the total number of hours that the gas boiler would operate for £30.

| |
|---|
| energy transferred = power × time |
| total cost = number of kilowatt-hours × cost per kilowatt -hour |

Show clearly how you work out your answer.

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Number of hours = .....

**(2)**

(b) Although the gas boiler is very efficient, some energy is wasted.

Explain what happens to the waste energy.

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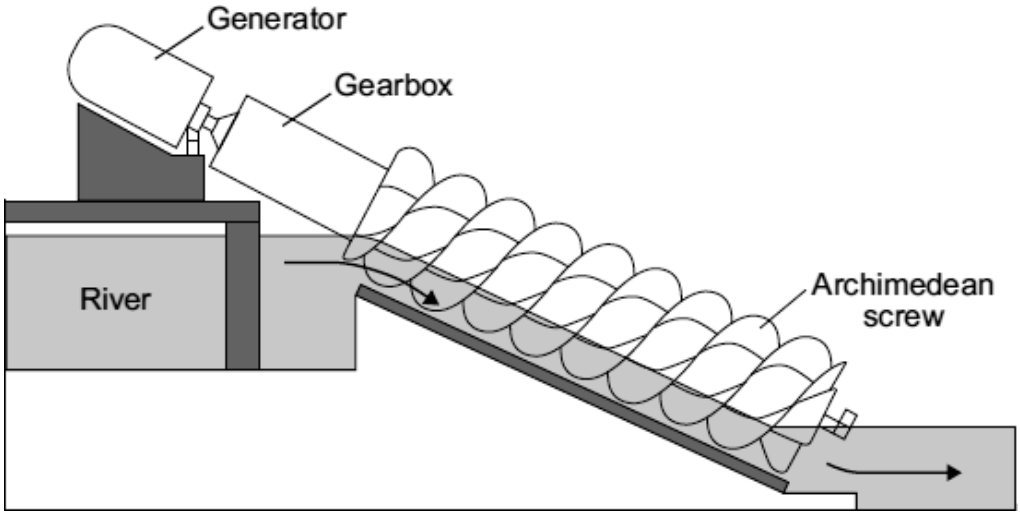
**(2)**
**(Total 6 marks)**

**Q10.** The diagram shows a small-scale, *micro-hydroelectricity* generator which uses the energy of falling river water to generate electricity. The water causes a device, called an Archimedean screw, to rotate.
The Archimedean screw is linked to the generator by a gearbox.




(a) Each second, the *micro-hydroelectricity* generator transforms 80 000 joules of gravitational potential energy into 60 000 joules of electrical energy.

(i) Fill in the missing word to complete the energy transformation diagram.

| | | | | |
|---|---|---|---|---|
| Gravitational potential energy of the falling water | → | ..... energy of the Archimedean screw | → | Electrical energy generated |

**(1)**

(ii) Use the equation in the box to calculate the efficiency of the *micro-hydroelectricity* generator.

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Show clearly how you work out your answer.

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Efficiency = .....

**(2)**

(b) The power output from a conventional large-scale hydroelectric power station is 100 000 times more than the power output from a micro-hydroelectric system.

Give **one** disadvantage of a conventional large-scale hydroelectric power station compared to the micro-hydroelectric system.

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**(1)**

(c) The electricity generated by a micro-hydroelectric system is transferred via a transformer directly to local homes. The electricity generated by a conventional large-scale hydroelectric power station is transferred to the National Grid, which distributes the electricity to homes anywhere in the country.

(i) What is the National Grid?

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**(1)**

(ii) Explain why transferring the electricity directly to local homes is more efficient than using the National Grid to distribute the electricity.

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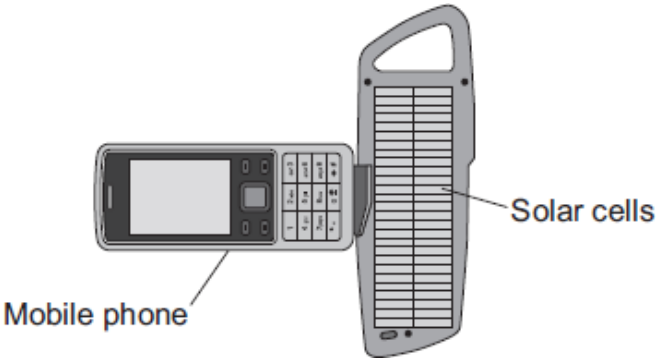
**(2)**

**(Total 7 marks)**

**Q11.** (a) The diagram shows a solar powered device being used to recharge a mobile phone.




On average, the solar cells produce 0.6 joules of electrical energy each second.
The solar cells have an efficiency of 0.15.

(i) Use the following equation to calculate the average energy input each second to the device.

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Show clearly how you work out your answer.

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Average energy input each second = ..... J/s

**(2)**

(ii) Draw a labelled Sankey diagram for the solar cells.
The diagram does **not** need to be drawn to scale.

**(1)**

(iii) Energy from the Sun is stored by a rechargeable battery inside the device.

Suggest **one** factor that would affect the time it takes to fully charge the battery.

Give a reason for your answer.

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**(2)**

(b) Scientists have developed a new type of solar cell with an efficiency of over 40 %.
The efficiency of the solar cell was confirmed independently by other scientists.

Suggest why it was important to confirm the efficiency independently.

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**(1)**

(c) The electricity used in homes in the UK is normally generated in a fossil fuel power station.

Outline some of the advantages of using solar cells to generate this electricity.

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**(2)**
**(Total 8 marks)**