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- (a) The table gives information about some ways of reducing the energy consumption in a house.

Method of reducing energy consumption	Installation cost in £	Annual saving on energy bills in £
Fit a new hot water boiler	1800	200
Fit a solar water heater	2400	100
Fit underfloor heating	600	50
Fit thermostatic radiator valves	75	20

Which way of reducing energy consumption is most cost effective over a 10-year period?

To obtain full marks you must support your answer with calculations.

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(3)

- (b) Explain why using an energy-efficient light bulb instead of an ordinary light bulb reduces the amount of carbon dioxide emitted into the atmosphere.

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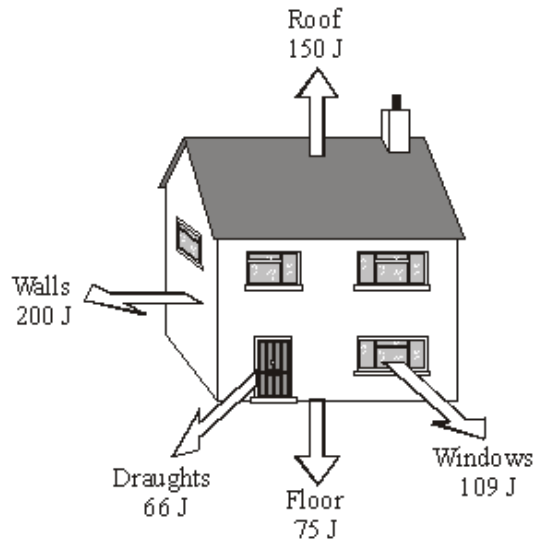
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(2)

(Total 5 marks)

- Q2.** (a) The diagram shows how much heat is lost each second from different parts of an uninsulated house.



- (i) Each year, the house costs £760 to heat.

How much money is being wasted because of heat lost through the roof?

Show clearly how you work out your answer.

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(2)

- (ii) Insulating the loft would cut the heat lost through the roof by 50 %.

The loft insulation has a payback time of $1\frac{1}{2}$ years.

How much did the loft insulation cost to buy?

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Cost of loft insulation = £

(1)

- (b) What happens to the wasted energy?

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(1)

(Total 4 marks)

- Q3.** The picture shows a food processor, which is used to grate, shred, liquidise and mix food. The table gives some information about the food processor.



Energy input	Electrical
Useful energy output	Kinetic
Power rating	1200 watts
Efficiency	0.8

- (a) The food processor is used for a total of 30 minutes a day.

Calculate the cost of the energy **wasted** by the food processor each day.

Electricity costs 15 p per kilowatt-hour.

Write down the equations you use, and then show clearly how you work out your answer.

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Cost of **waste** energy = p

(4)

- (b) Explain what happens to the waste energy.

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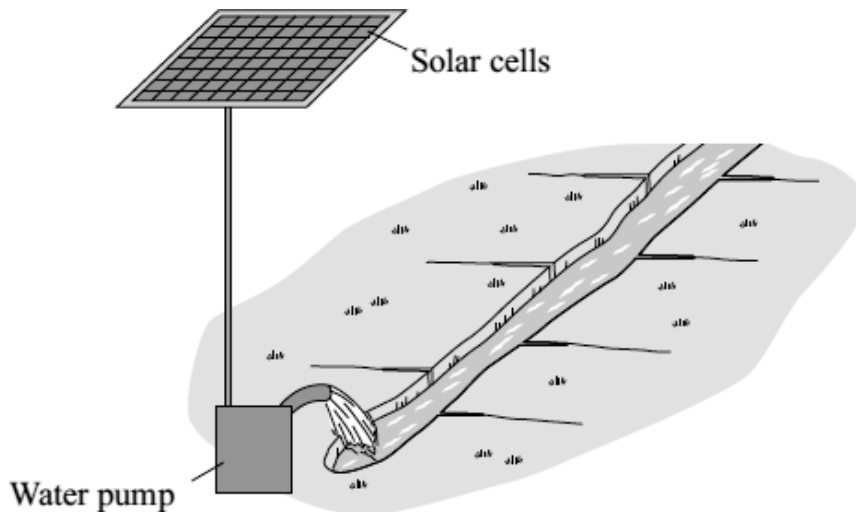
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(2)

(Total 6 marks)

- Q4.** 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)

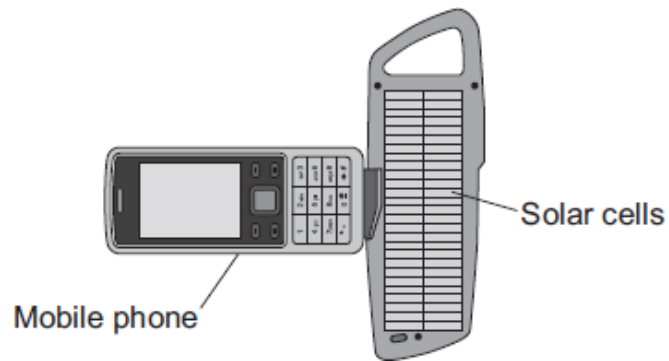
- (b) Give **one** reason why the area of solar cells needed will probably be greater than the answer to part (a)(ii).

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(1)

(Total 4 marks)

- Q5.** (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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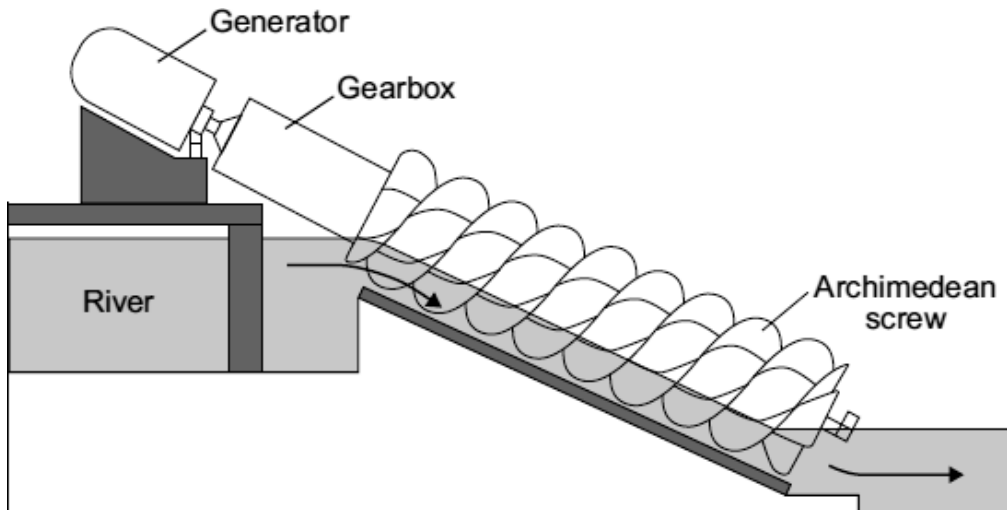
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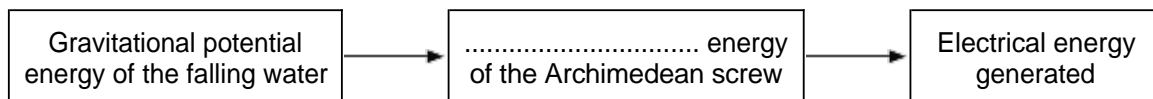
(Total 8 marks)

- Q6.** 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.



(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)

Q7. 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 °C
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.

$\begin{aligned}\text{energy transferred} &= \text{power} \times \text{time} \\ \text{total cost} &= \text{number of kilowatt-hours} \times \text{cost per kilowatt-hour}\end{aligned}$

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)

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) 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)

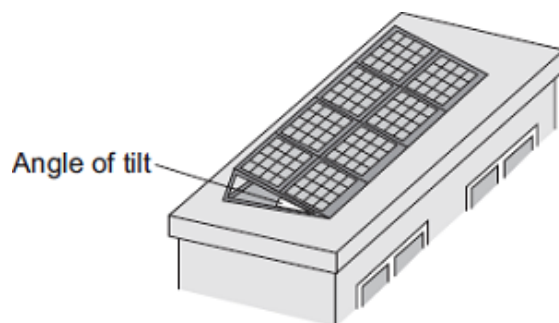
- (ii) Name **two** other renewable energy sources used to generate electricity.

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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 m².

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.

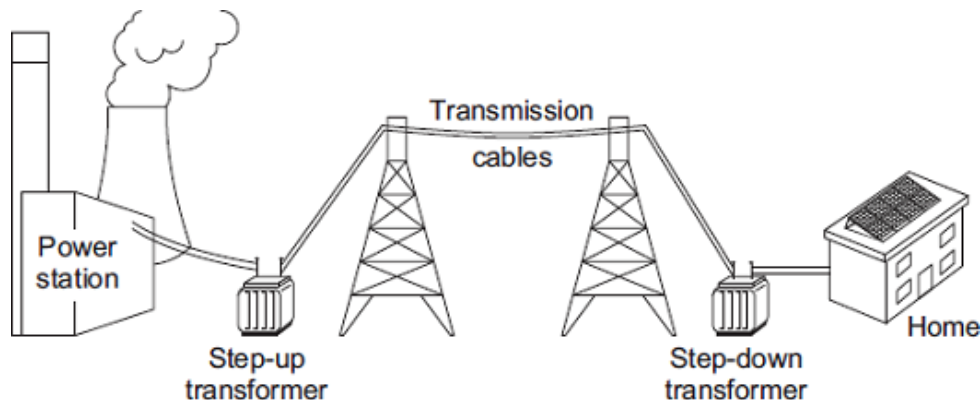
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Maximum energy = joules/second

(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)

