St Benedict's Catholic High School
Science Department

# Science Revision Booklet
# Year 11
# AQA
# Physics Foundation

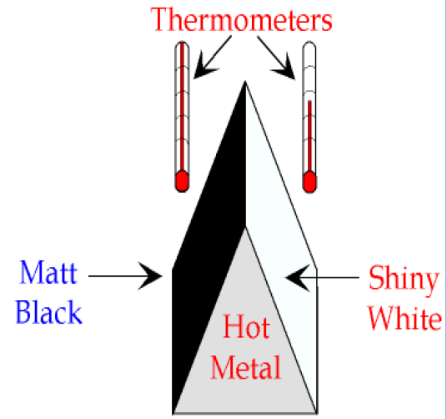
# P1.1 Energy Transfer by Heating Process

## Thermal Radiation

- Thermal radiation is energy transfer by electromagnetic waves
- All objects emit thermal radiation
- The hotter an object is, the more thermal radiation it emits

## Surfaces and Radiation

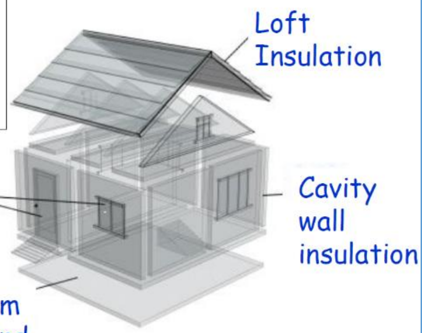
Dark matt surfaces are better emitters and absorbers of thermal radiation than light shiny surfaces

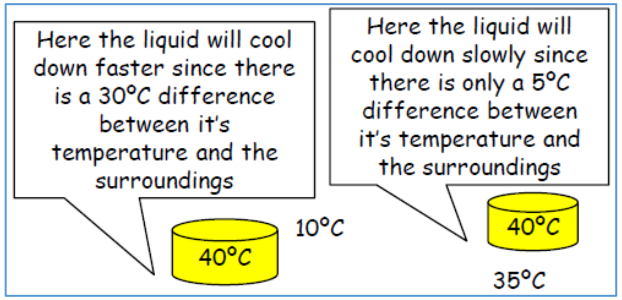



## Conduction

- Conduction in a metals is due to the many free electrons transferring energy inside the metal.
- Non-metals are poor conductors because they do not contain free electrons.
- Materials like fibreglass are good insulators because they have pockets of trapped air.

## How to prevent heat loss from a house



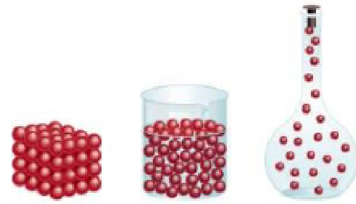

## Kinetic theory

In **solids** the particles are packed very close together. They vibrate about fixed positions

In **liquids** the particles are close together but not as close as they are in solids. They can move around in any direction and are not fixed in position.

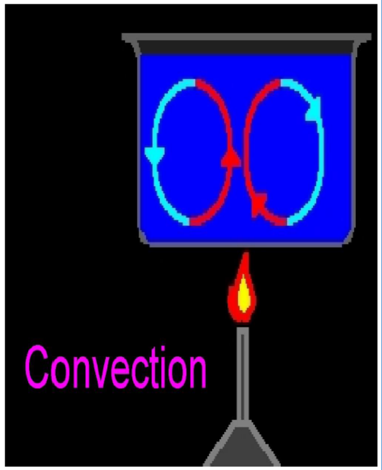
In **gases** the particles are very far apart with large distances between them. They move around very quickly in all directions

**More energy = more vibrations**



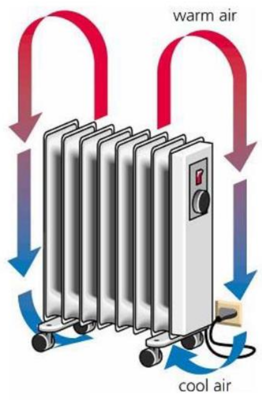
## Convection

- Convection takes place in only in liquids and gases. Heating a liquid or gas makes it less dense. Convection is due to a hot liquid or gas rising




## Heat Transfer

- A radiator has a large surface area so it can lose heat easily.
- Small objects lose heat more quickly than large objects



**Q1.** (a) Copper is a metal.
Explain how it conducts electricity.

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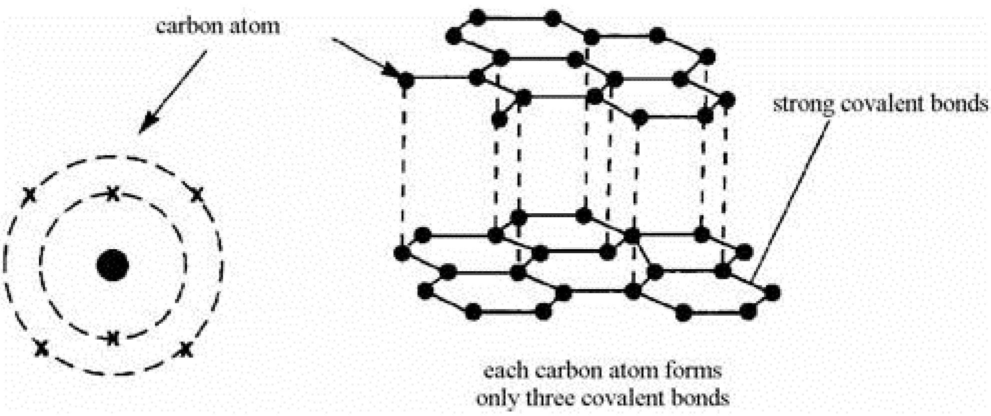
**(2)**

(b) Graphite is a non-metal.




Use the information to explain why graphite conducts electricity.

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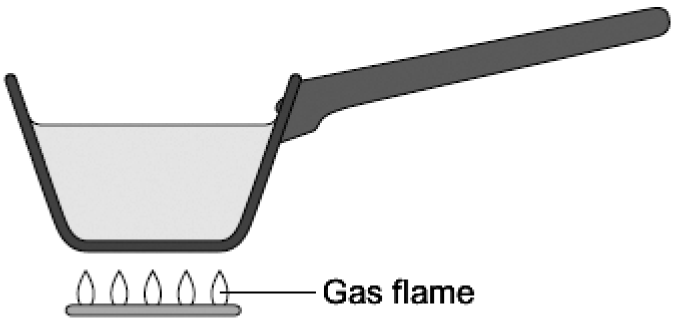
**(3)**
**(Total 5 marks)**

**Q2.** The diagram shows a metal pan being used to heat water.




Energy from the gas flame is transferred through the metal pan by conduction.

Explain the process of conduction through metals.

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

**Q3.Figure 1** shows a kettle a student used to determine the specific heat capacity of water.

**Figure 1**

© vladimirkim3722/iStock/Thinkstock

The student placed different masses of water into the kettle and timed how long it took for the water to reach boiling point.

The student carried out the experiment three times.

The student's results are shown in the table below.

| | Time for water to boil in seconds | | | | | |
|---|---|---|---|---|---|---|
| **Mass of water in kg** | **1** | **2** | **3** | **Mean** | **Mass × change in temperature in kg°C** | **Energy supplied in kJ** |
| 0.25 | 55 | 60 | 63 | 59 | 20 | 131 |
| 0.50 | 105 | 110 | 116 | 110 | 40 | 243 |
| 0.75 | 140 | 148 | 141 | 143 | 60 | 314 |
| 1.00 | 184 | 190 | 183 | 182 | 80 | 401 |
| 1.25 | 216 | 215 | 211 | 214 | 100 | 471 |
| 1.50 | 272 | 263 | 266 | 267 | 120 | 587 |
| 1.75 | 298 | 300 | 302 | | 140 | |

(a) Suggest how the student was able to ensure that the change in temperature was the same for each mass of water.

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**(2)**

(b) Calculate the uncertainty in the student's measurements of time to boil when the mass of water was 1.75 kg.

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Uncertainty = ...................................... s

**(2)**

(c) The power rating of the kettle is 2.20 kW.

Calculate the average electrical energy used by the kettle, in kJ, for 1.75 kg of water to reach boiling point.

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Average energy = .......................................... kJ

**(2)**

(d) Use information from the table above to calculate the change in temperature of the water during the investigation.

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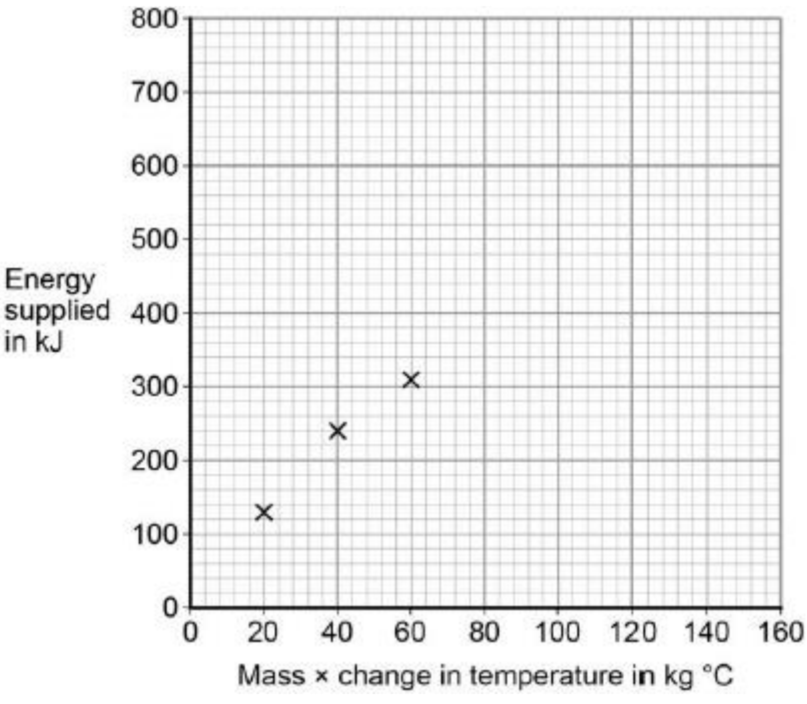
Change in temperature = ................................. °C

**(2)**

(e) The student plotted a graph of energy supplied in kJ against mass × change in temperature in kg °C.

**Figure 2** shows the graph the student plotted.

**Figure 2**




Use data from the table above to plot the four missing points.

Draw a line of best fit on the graph.

**(3)**

(f) Use the graph to determine the mean value of the specific heat capacity of water, for the student’s investigation.

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Specific heat capacity of water = ........................... J / kg °C

**(4)**

(g) The student’s value for the specific heat capacity of water was greater than the accepted value.

Suggest why.

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**(1)**

(h) The kettle used in the experiment had a label stating that the power rating of the kettle was 2.2 kW.

The student did not measure the power of the kettle.

Suggest why measuring the power of the kettle may improve the student’s investigation.

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**(1)**
**(Total 17 marks)**

# Energy and Efficiency

- Energy is measured in joules (J)

Efficiency of a device = $\frac{\text{Useful energy transferred by a device}}{\text{Total energy supplied to a device}}$

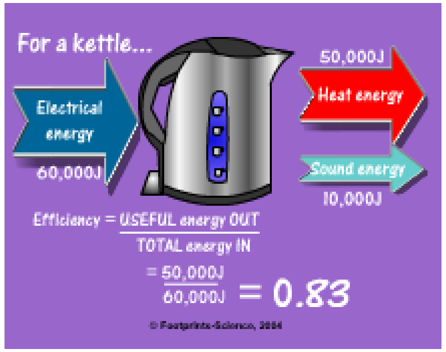
## Forms of Energy

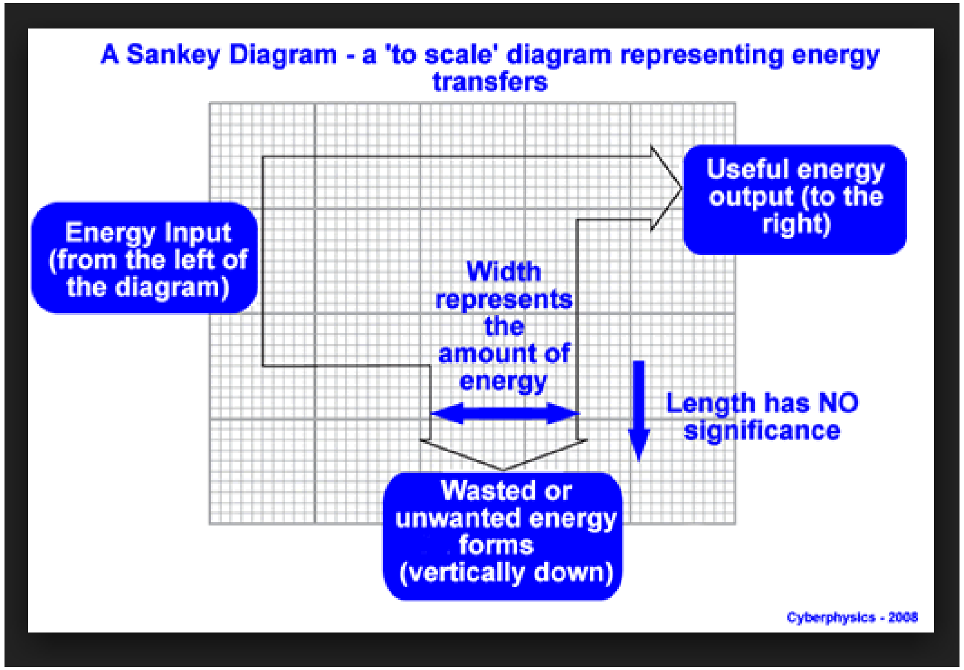
- Nuclear
- Kinetic
- Light
- Thermal
- Sound
- Chemical
- Gravitational

P1.2 Energy and efficiency

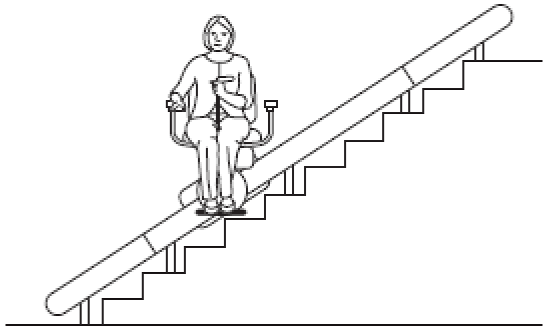
## Conservation of Energy

- Energy can be transformed from one form into another or from one place to another.
- Electrical Energy → Heat Energy
- Energy cannot be created or destroyed

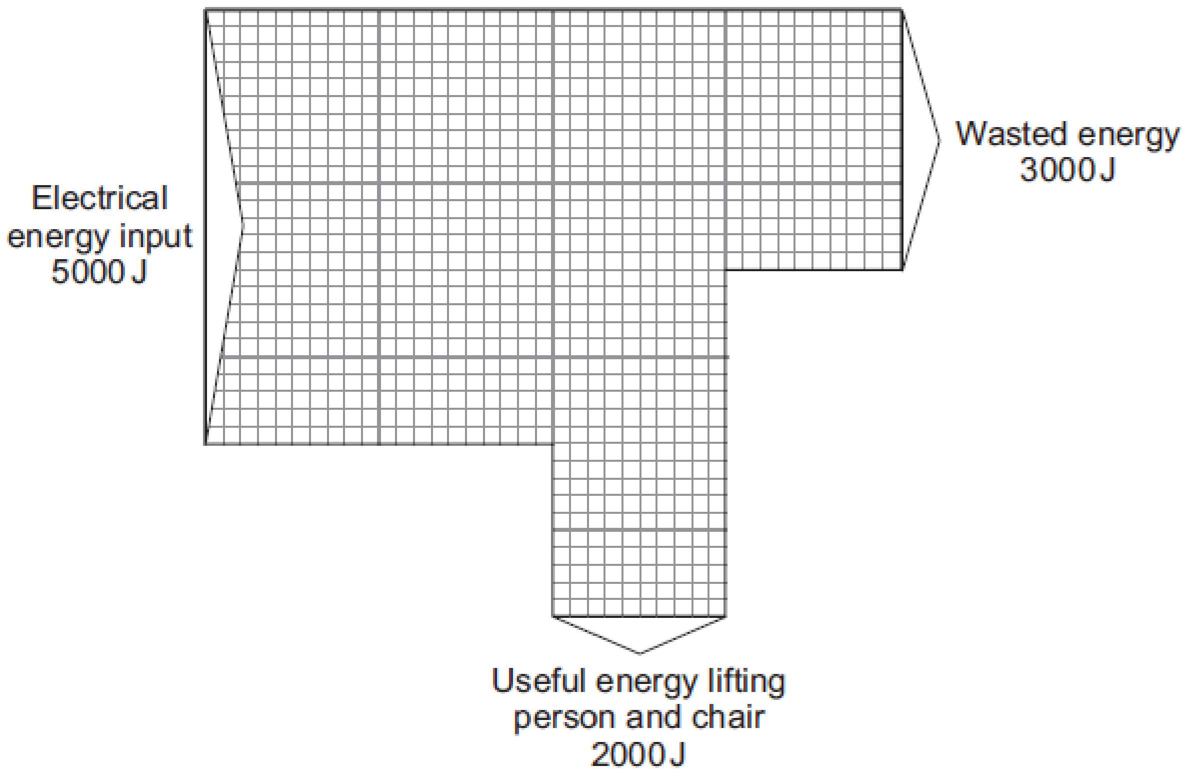


**1** A person uses a stairlift to go upstairs. The stairlift is powered by an electric motor.



The Sankey diagram shows the energy transfers for the electric motor.




(a) Complete the following sentence.

The electric motor wastes energy as ............................................ energy.

**(1)**

(b) Use the equation in the box to calculate the efficiency of the electric motor.

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

Show clearly how you work out your answer.

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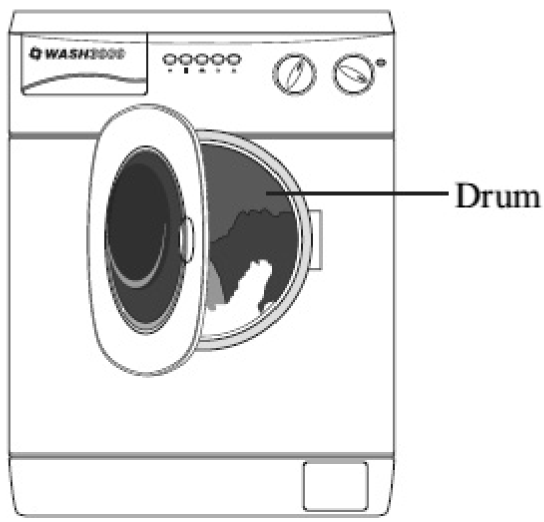
Efficiency = ............................................

**(2)**
**(Total 3 marks)**

**2** The picture shows a new washing machine. When the door is closed and the machine switched on, an electric motor rotates the drum and washing.




(a) What happens to the energy wasted by the electric motor?

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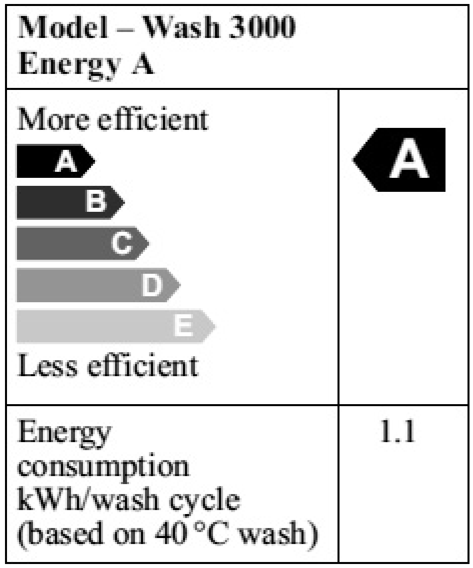
**(1)**

(b) The diagram shows the label from the new washing machine.




An 'A' rated washing machine is *more energy efficient* than a 'C' rated washing machine.

Explain what being *more energy efficient* means.

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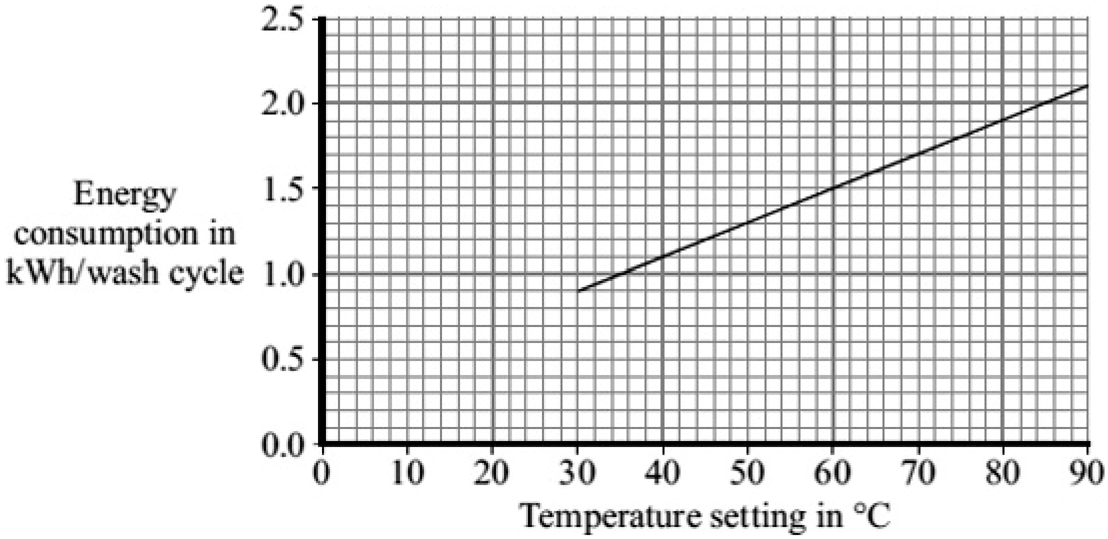
**(2)**

(c) The graph shows that washing clothes at a lower temperature uses less energy than washing them at a higher temperature. Using less energy will save money.




(i) Electricity costs 12 p per kilowatt-hour (kWh).
The temperature setting is turned down from 40 °C to 30 °C.

Use the graph and equation in the box to calculate the money saved each wash cycle.

| |
|---|
| total cost = number of kilowatt-hours × cost per kilowatt-hour |

Show clearly how you work out your answer.

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Money saved = .................................................. p

**(2)**

(ii) Suggest why reducing the amount of energy used by washing machines could reduce the amount of carbon dioxide emitted into the atmosphere.

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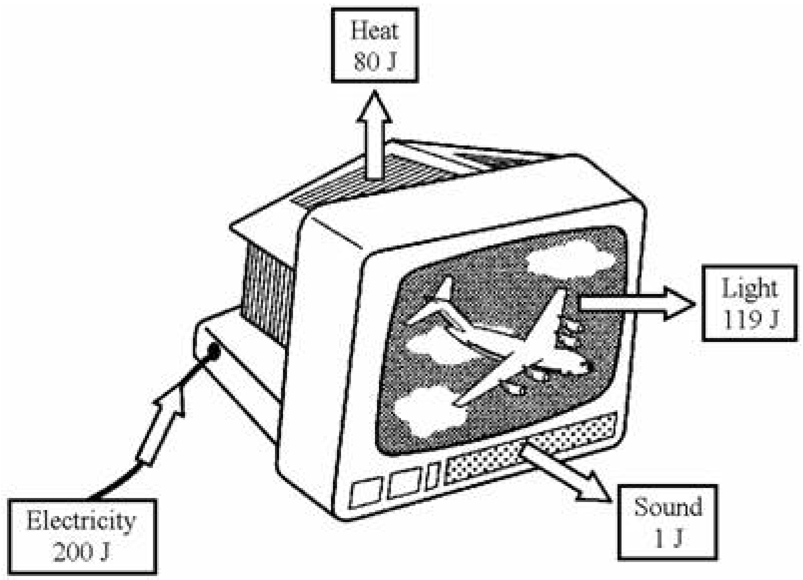
**(1)**
**(Total 6 marks)**

**3** (a) The drawing shows the energy transferred each second by a television set.




(i) What form of energy is transferred as waste energy by the television set?

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**(1)**

(ii) What effect will the waste energy have on the air around the television set?

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**(1)**

(iii) Calculate the efficiency of the television set.

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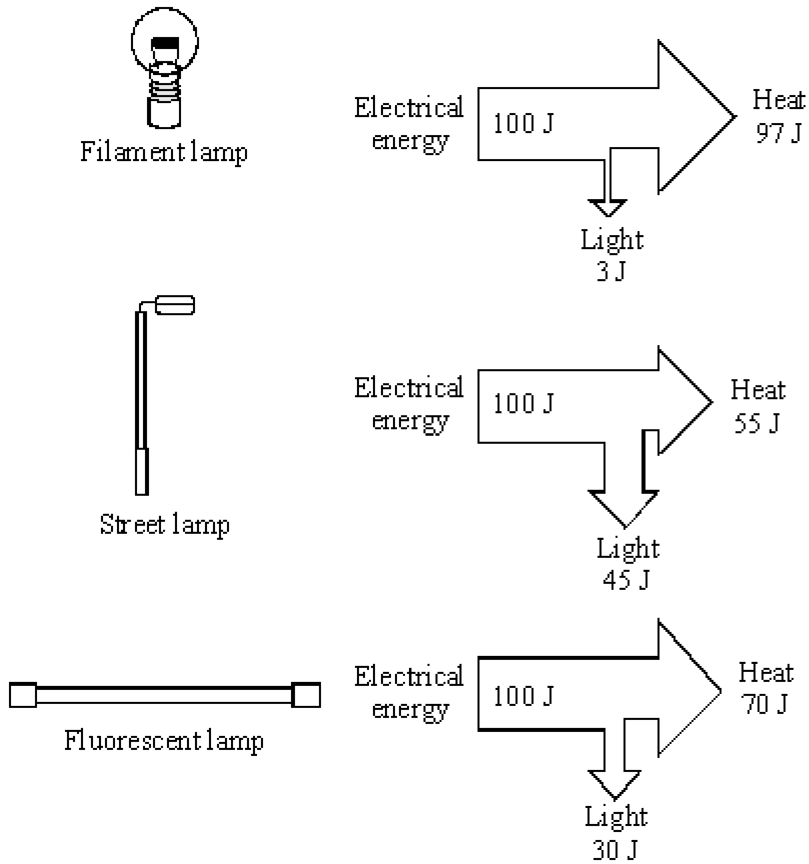
Efficiency = ............................................................

**(2)**

(b) The diagrams show the energy transferred each second for three different types of lamp. For each lamp the electrical energy input each second is 100 joules.




Which type of lamp is the most efficient?

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Give a reason for your choice.

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

# Electrical Power

- The unit of power is the watt (W) which is equal to 1 joule per second

- $$\text{Power} = \frac{\text{Energy transferred}}{\text{Time taken}}$$

**Electricity Costs**

Measured in kilowatt-hours (kWh) the cost per unit also needs to be known.

**Energy used (kWh) = power (kW) x time (hours)**

**Take care with units!**

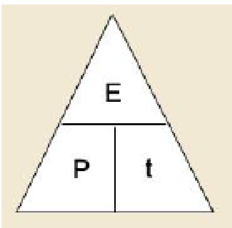
P1.3 Usefulness of electrical appliances

**Power**

**Power (W)=** $\frac{\textbf{energy (J)}}{\textbf{time (s)}}$

Power is the rate at which energy is transferred.

1 watt means 1 joule of energy is transferred every second.

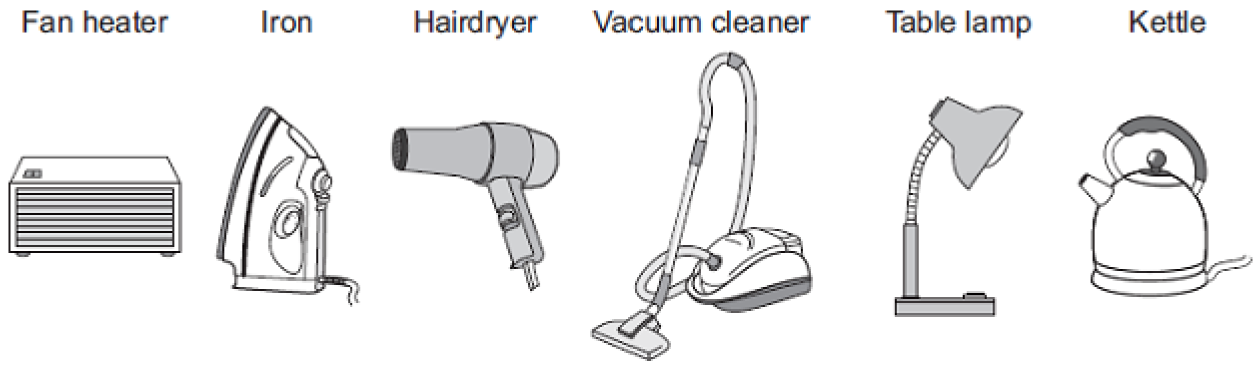



## Using Electrical Energy

$$\text{Energy Transferred} = \frac{\text{Power of device}}{\text{Time in Use}}$$

$$\text{Total Cost} = \frac{\text{Number of Kilowatt hours}}{\text{Cost Per Kilowatt}}$$

**1** The pictures show six different household appliances.




(a) Four of the appliances, including the fan heater, are designed to transform electrical energy into heat.

Name the other **three** appliances designed to transform electrical energy into heat.

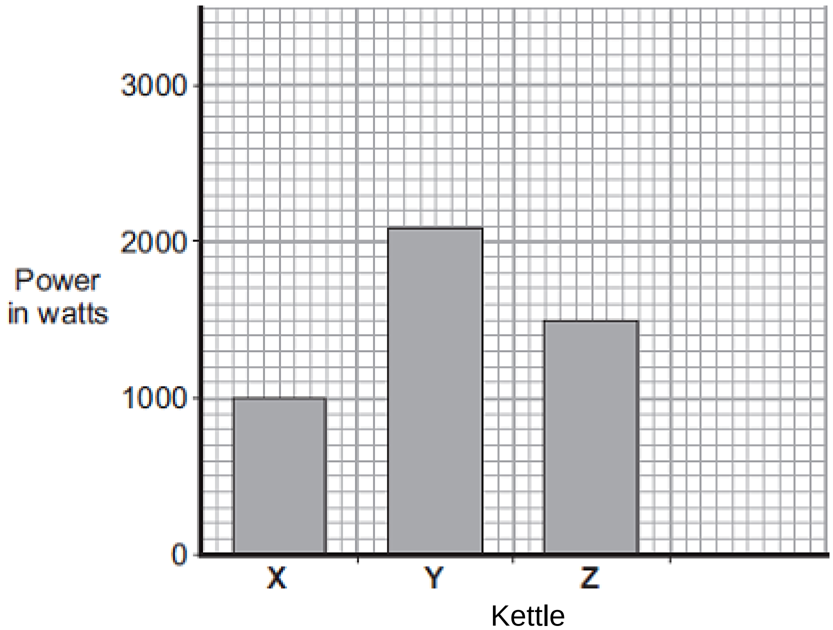
1 ..........................................................................................................

2 ..........................................................................................................

3 ..........................................................................................................

**(3)**

(b) The bar chart shows the power of three electric kettles, **X**, **Y** and **Z**.




(i) In one week, each kettle is used for a total of 30 minutes.

Which kettle costs the most to use?

Put a tick (✓) next to your answer.

**X** ☐

**Y** ☐

**Y** ☐

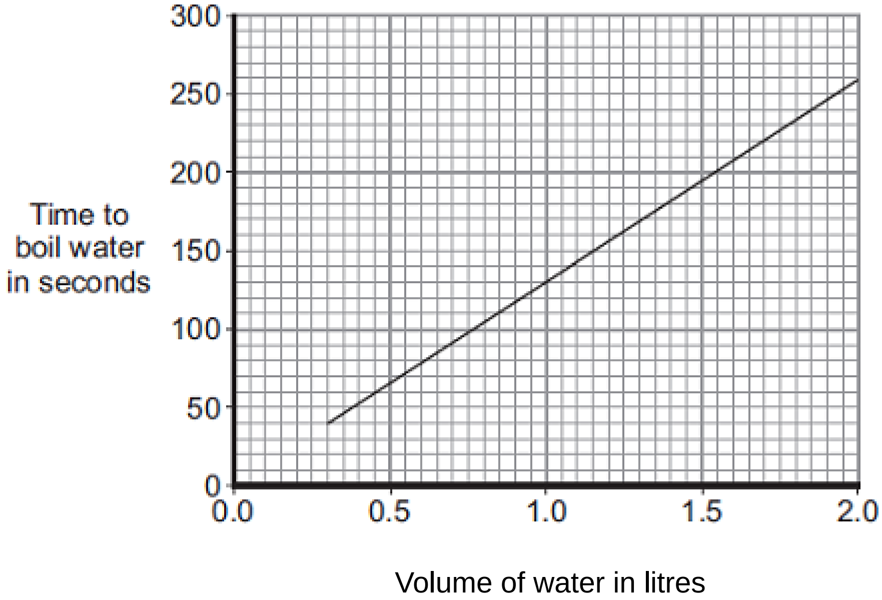
**(1)**

(ii) A new 'express boil' kettle boils water faster than any other kettle.

Draw a fourth bar on the chart to show the possible power of an 'express boil' kettle.

**(1)**

(c) The graph shows how the time to boil water in an electric kettle depends on the volume of water in the kettle.




A householder always fills the electric kettle to the top, even when only enough boiling water for one small cup of coffee is wanted.

Explain how the householder is wasting money.

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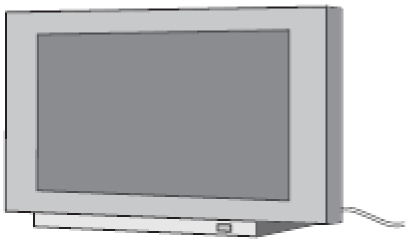
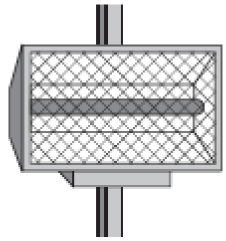
**(3)**
**(Total 8 marks)**

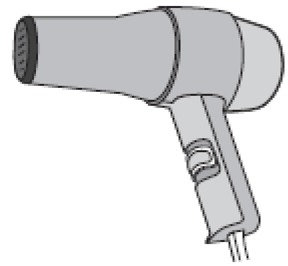
**2** The data included in the diagrams gives the power of the electrical appliances.



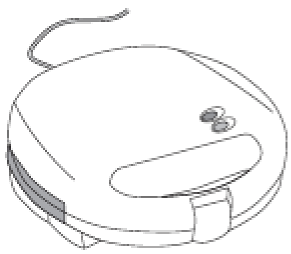
TV
160 W



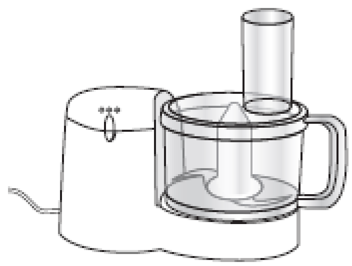
Radiant heater
1.0 kW



Hairdryer
1100 W



Sandwich toaster
1.1 kW



Food processor
0.4 kW

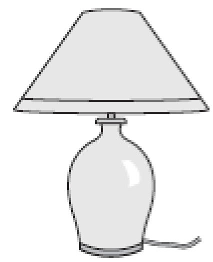


Table lamp
40 W

(a) (i) Which appliance is designed to transform electrical energy to light and sound?

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**(1)**

(ii) Which **two** appliances transform energy at the same rate?

................................................. and .................................................

**(1)**

(b) During one week, the food processor is used for a total of 3 hours.

(i) Use the equation in the box to calculate the energy transferred, in kilowatt-hours, by the food processor in 3 hours.

| | | | | |
|---|---|---|---|---|
| energy transferred (kilowatt-hour, kWh) | = | power (kilowatt, kW) | × | time (hour, h) |

Show clearly how you work out your answer.

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Energy transferred = .................................. kWh

**(2)**

(ii) Electricity costs 15 pence per kilowatt-hour.

Use the equation in the box to calculate the cost of using the food processor for 3 hours.

| | | | | |
|---|---|---|---|---|
| total cost | = | number of kilowatt-hours | × | cost per kilowatt-hour |

Show clearly how you work out your answer.

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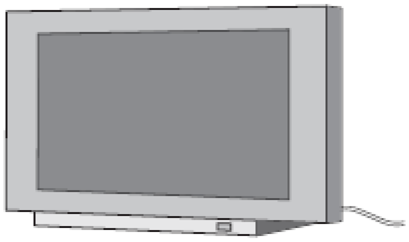
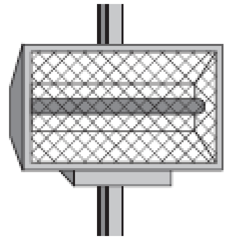
Cost = .................................. pence

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

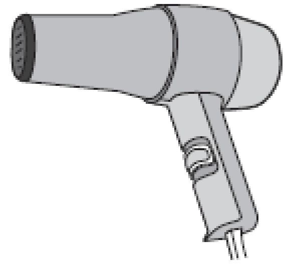
**3** The data included in the diagrams gives the power of the electrical appliances.



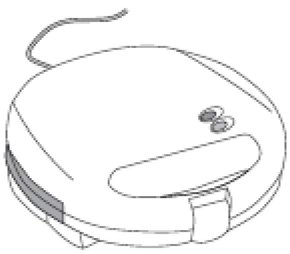
TV
160 W



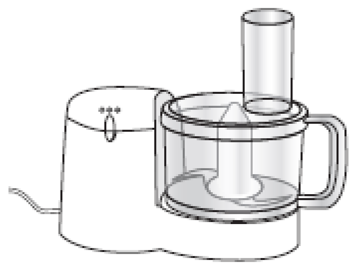
Radiant heater
1.0 kW



Hairdryer
1100 W



Sandwich toaster
1.1 kW



Food processor
0.4 kW

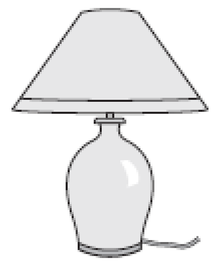


Table lamp
40 W

(a) (i) Which of the appliances are designed to transform electrical energy to kinetic energy?

...............................................................................................................

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**(1)**

(ii) Which of the appliances waste energy as heat?

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**(1)**

(b) Leaving the radiant heater switched on is likely to lead to more carbon dioxide being emitted into the atmosphere than leaving the table lamp on for the same length of time.

Explain why.

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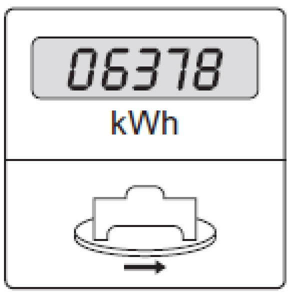
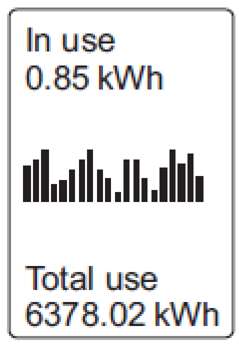
**(2)**

(c) A homeowner decides to monitor the amount of electrical energy used in his home. He can do this by using the home’s electricity meter or by using a separate electronic device.

The table gives some information about each method.

| **Electricity meter** | **Electronic device** |
|---|---|
| Records to the nearest kilowatt-hour | Records to the nearest 1/100th kilowatt-hour |
| Homeowner takes readings at regular intervals | Energy use recorded continuously and stored for one year |
| | Displays a graph showing energy use over a period of time |
|  |  |

(i) Complete the following sentence.

The reading given by the electronic device is more ............................................... than the reading given by the electricity meter.

**(1)**

(ii) Suggest how data collected and displayed by the electronic device could be useful to the homeowner.

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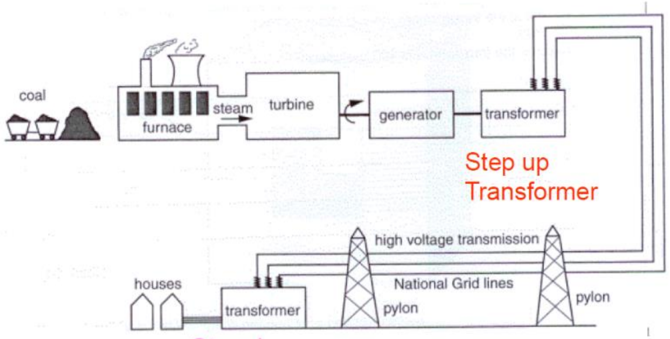
**(3)**
**(Total 8 marks)**

# P1.4 Methods we used to generate Electricity

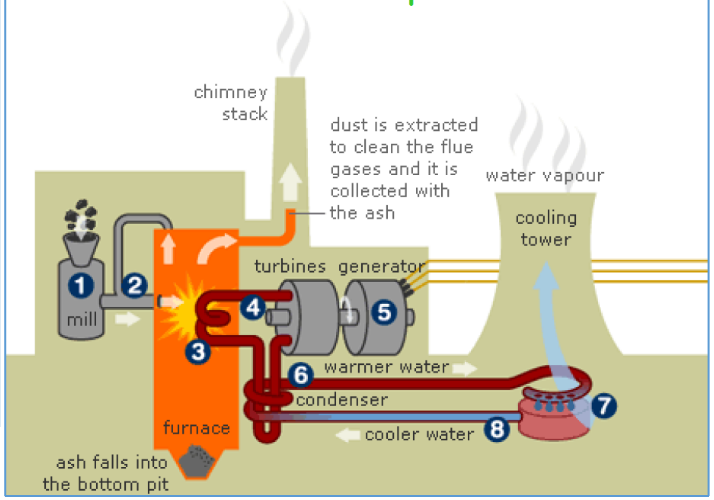
## The National Grid




Step up Transformer

Step down Transformer

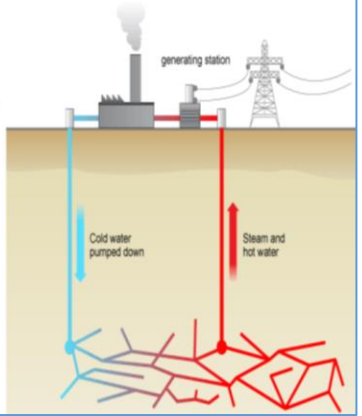
## Inside a fossil fuel power station




## Energy from the Earth

Geothermal energy comes from hot rocks deep inside the Earth.

The rocks are hot because they contain radioactive substances




## Energy from the Sun

We can convert solar energy into electricity using solar cells or we can use it to heat water in solar heating panels

## Energy from Wind

- A wind turbine is an electricity generator on top of a tall tower
- The amount of electricity generator depends on the amount of wind

## Energy from Water

- A <u>wave generator</u> is a floating generator turned by waves
- A <u>tidal generator</u> traps water when the tide comes in and uses it to generate electricity
- <u>Hydroelectricity generators</u> are turned by water running down hill

## Energy and the Environment

- Fossil fuels produce greenhouse gases
- Nuclear power produces radioactive waste
- Renewable energy resources can affect animal and plant life

**1** Electricity can be generated using various energy sources.

(a) Give **one** advantage and **one** disadvantage of using nuclear power stations rather than gas-fired power stations to generate electricity.

Advantage ........................................................................................................

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Disadvantage ...................................................................................................

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**(2)**

(b) (i) A single wind turbine has a maximum power output of 2 000 000 W.

The wind turbine operated continuously at maximum power for 6 hours.

Calculate the energy output in kilowatt-hours of the wind turbine.

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Energy output = ........................................ kWh

**(2)**

(ii) Why, on average, do wind turbines operate at maximum power output for only 30% of the time?

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**(1)**

(c) An on-shore wind farm is made up of many individual wind turbines.

They are connected to the National Grid using underground power cables.

Give **one** advantage of using underground power cables rather than overhead power cables.

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**(1)**
**(Total 6 marks)**

**2** Solar panels are often seen on the roofs of houses.

(a) Describe the action and purpose of a solar panel.

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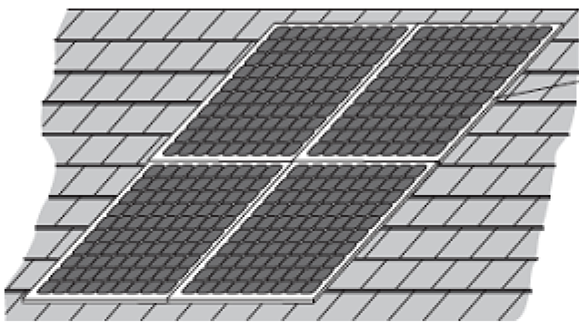
**(2)**

(b) Photovoltaic cells transfer light energy to electrical energy.

In the UK, some householders have fitted modules containing photovoltaic cells on the roofs of their houses.

Four modules are shown in the diagram.




The electricity company pays the householder for the energy transferred.

The maximum power available from the photovoltaic cells shown in the diagram is $1.4 \times 10^3$ W.

How long, in minutes, does it take to transfer 168 kJ of energy?

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.................................................... Time = ........................................ minutes

**(3)**

(c) When the modules are fitted on a roof, the householder gets an extra electricity meter to measure the amount of energy transferred by the photovoltaic cells.

(i) The diagram shows two readings of this electricity meter taken three months apart. The readings are in kilowatt-hours (kWh).

| | | | | | |
|---|---|---|---|---|---|
| 21 November | 0 | 0 | 0 | 4 | 4 |
| 21 February | 0 | 0 | 1 | 9 | 4 |

Calculate the energy transferred by the photovoltaic cells during this time period.

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Energy transferred = ....................................... kWh

**(1)**

(ii) The electricity company pays 40p for each kWh of energy transferred.

Calculate the money the electricity company would pay the householder.

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Money paid = .......................................

**(2)**

(iii) The cost of the four modules is £6000.

Calculate the payback time in years for the modules.

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Payback time = ....................................... years

**(3)**

(iv) State an assumption you have made in your calculation in part **(iii)**.

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**(1)**

(d) In the northern hemisphere, the modules should always face south for the maximum transfer of energy.

State **one** other factor that would affect the amount of energy transferred during daylight hours.

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**(1)**
**(Total 13 marks)**

**3** (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)**

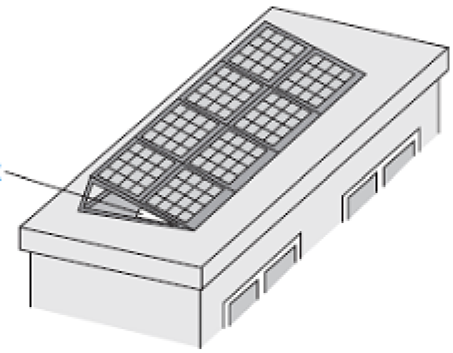
(ii) Name **two** other renewable energy sources used to generate electricity.

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.

Calculate the average **maximum** electrical energy available from the solar cell panels each second in June.

Show clearly how you work out your answer.

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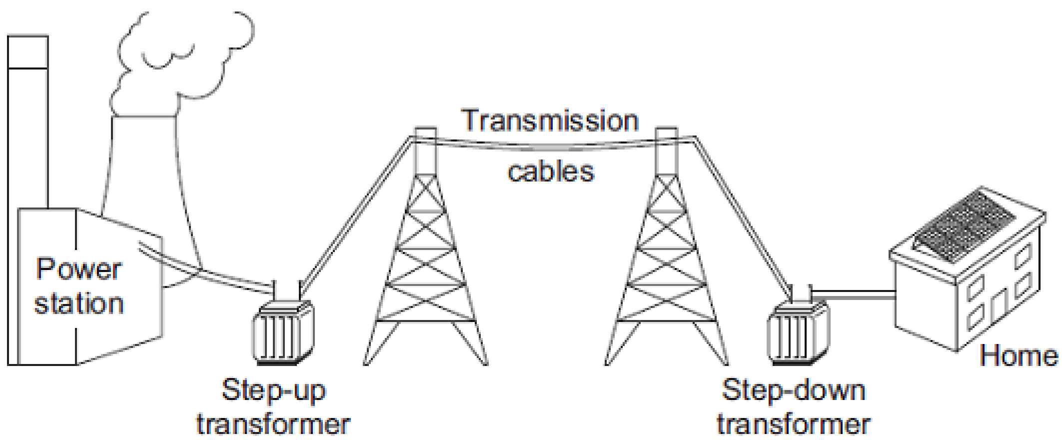
Maximum energy = ............................................. joules/second

**(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)**

**4** (a) Geothermal energy and the energy of falling water are two resources used to generate electricity.

(i) What is geothermal energy?

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**(1)**

(ii) Hydroelectric systems generate electricity using the energy of falling water.

A pumped storage hydroelectric system can also be used as a way of storing energy for future use.

Explain how.

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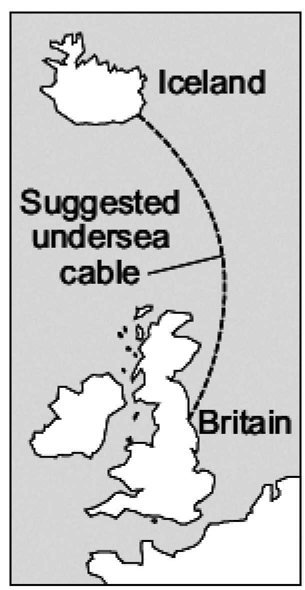
**(2)**

(b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Read the following extract from a newspaper.

**Britain may be switched on by Iceland**

Iceland is the only country in the world generating all of its electricity from a combination of geothermal and hydroelectric power stations. However, Iceland is using only a small fraction of its energy resources. It is estimated that using only these resources, the amount of electricity generated could be increased by up to four times.




To help supply the future demand for electricity in Britain, there are plans to build thousands of new offshore wind turbines. It has also been suggested that the National Grid in Britain could be linked to the electricity generating systems in Iceland. This would involve laying a 700 mile undersea electricity cable between Iceland and Britain.

Discuss the advantages and disadvantages of the plan to build thousands of offshore wind turbines around Britain **and** the suggested electricity power link between Britain and Iceland.

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**(6)**
**(Total 9 marks)**