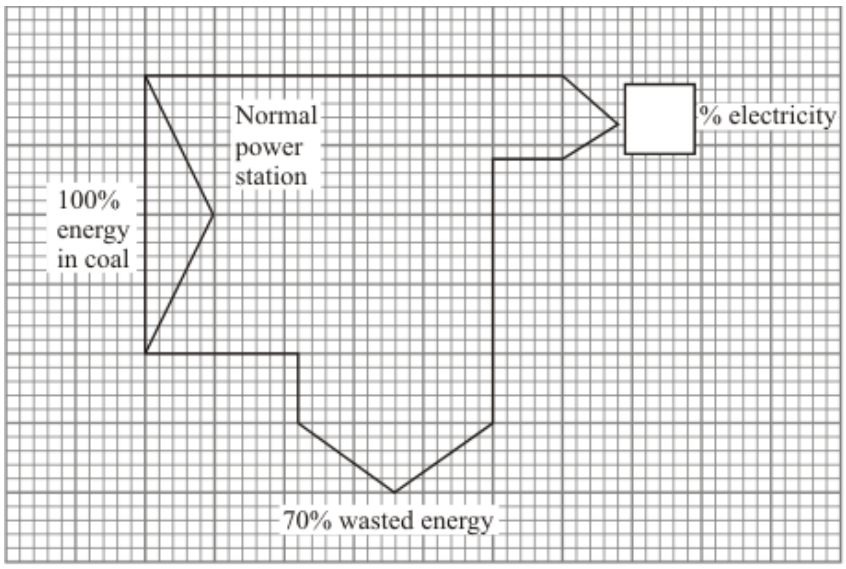
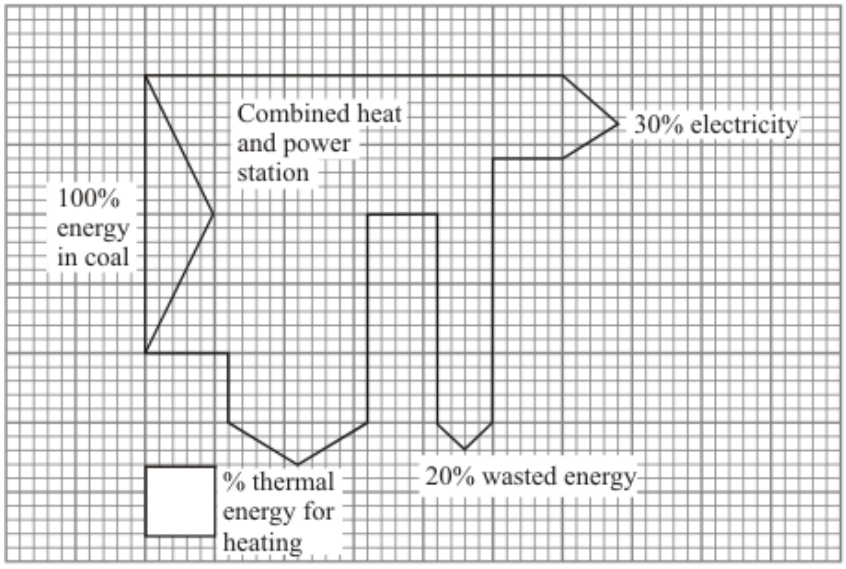
# Energy transfers - sankey diagrams and efficiency

116 minutes

116 marks

**Q1.** Power stations are usually not very efficient. A lot of energy is wasted as thermal energy. The diagrams show the percentage of energy transferred by two coal-burning power stations.




(a) Write the **two** missing figures in the boxes on the diagrams.

**(2)**

(b) Which power station is the most efficient **overall**, the normal power station or the combined heat and power station? Give reasons for your answer.

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**(2)**

(c) Some heat energy released from burning coal on an open fire is emitted by radiation. Tick (✓) the main type of electromagnetic radiation emitted by hot coal.

| Type of electromagnetic radiation | Tick (✓) |
|---|---|
| gamma | |
| infra red | |
| ultraviolet | |
| X-ray | |

**(1)**

(d) Radiation can be reflected or absorbed when it strikes a surface. What type of surface is a poor reflector but a good absorber of radiation?

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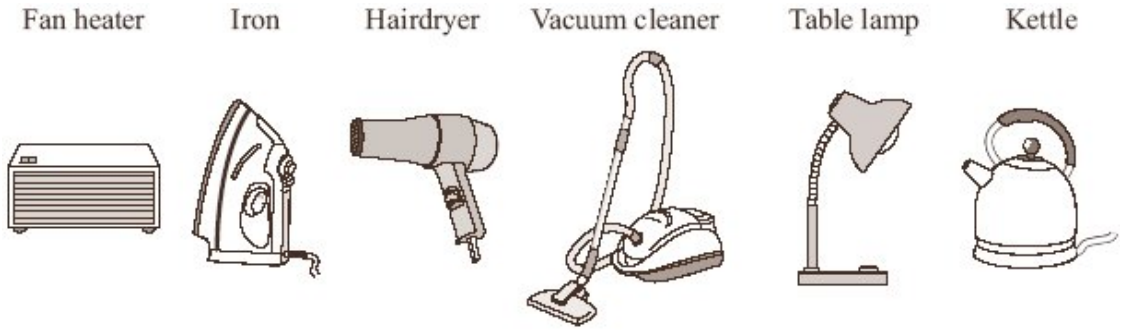
**(1)**

**(Total 6 marks)**

**Q2.** 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) Complete the following sentence using **one** of the words from the box.

| **chemical** | **heat** | **kinetic** | **sound** |
|---|---|---|---|

Energy that is not usefully transformed by the fan heater is wasted as

..... energy.

**(1)**

(c) The table gives information about two different fan heaters.

| | **Useful energy transferred each second in joules** | **Wasted energy transferred each second in joules** |
|---|---|---|
| Fan heater **L** | 1200 | 10 |
| Fan heater **M** | 1200 | 20 |

Complete the following sentence by drawing a ring around the line in the box that is correct.

Fan heater **L**

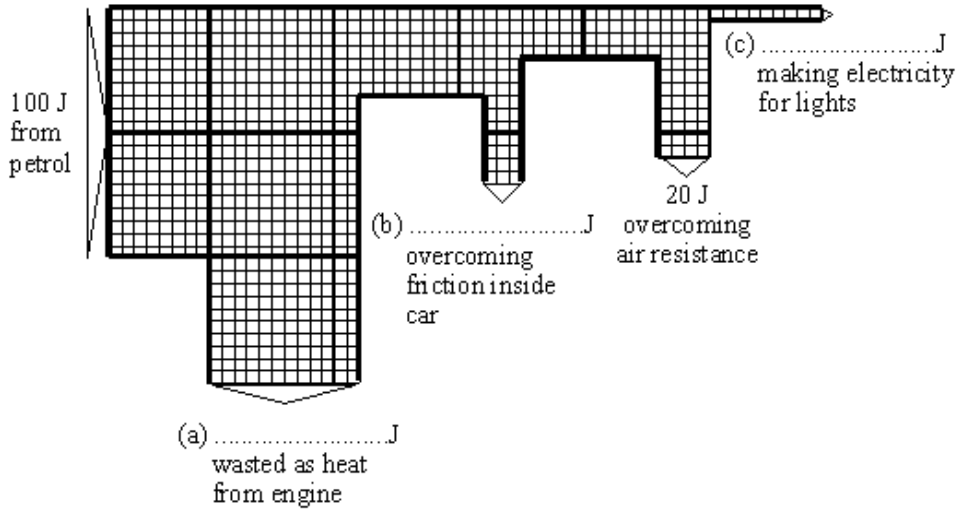
| |
|---|
| is more efficient than |
| has the same efficiency as |
| is less efficient than |

fan heater **M**.

**(1)**
**(Total 5 marks)**

**Q3.** A car burns petrol as it travels along a flat road.

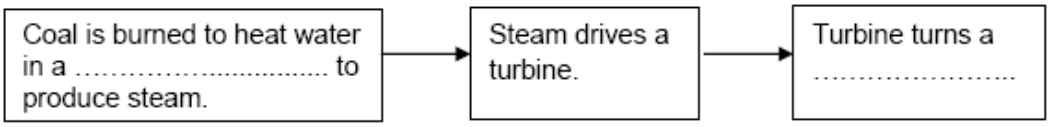
The diagram shows what happens to each 100 joules (J) of energy released by burning the petrol.




Complete the diagram by adding the missing numbers.

**(Total 3 marks)**

**Q4.** (a) The block diagram shows the important parts of a coal burning power station.

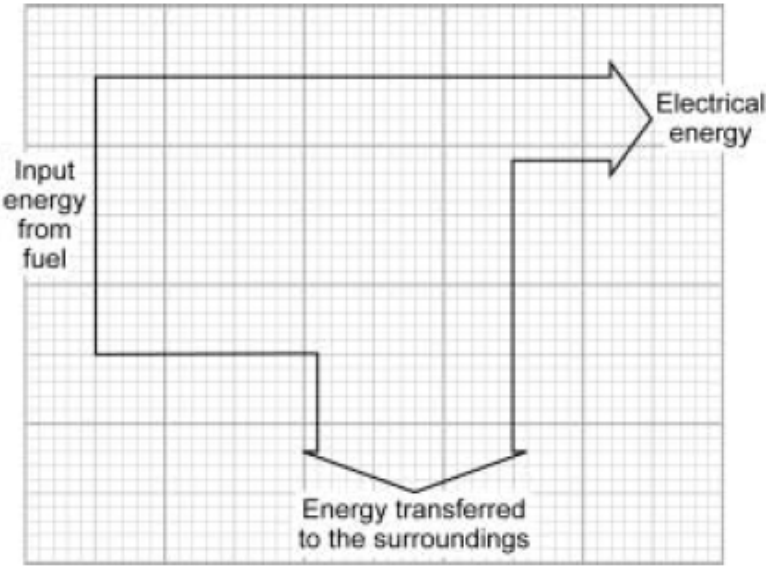



Use words from the box to complete the block diagram

| | | | |
|---|---|---|---|
| **boiler** | **condenser** | **furnace** | **generator** |

**(2)**

(b) The diagram shows the energy transformations in a coal burning power station.




Calculate the efficiency of the power station.
Write down the equation you use, and then show clearly how you work out your answer.

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.....

.....

Efficiency = .....

**(2)**

(c) Draw a ring around the correct answer to complete the following sentence.

If fewer coal burning power stations are used to generate electricity the amount of

carbon dioxide emitted into the atmosphere will

| |
|---|
| decrease. |
| not change. |
| increase. |

**(1)**

(d) Some types of power station generate electricity by burning a biofuel.

Give **one** example of a biofuel.

.....

**(1)**

(e) Nuclear power stations generate electricity without burning a fuel.

Name the process by which a nuclear fuel provides the energy needed to generate electricity.

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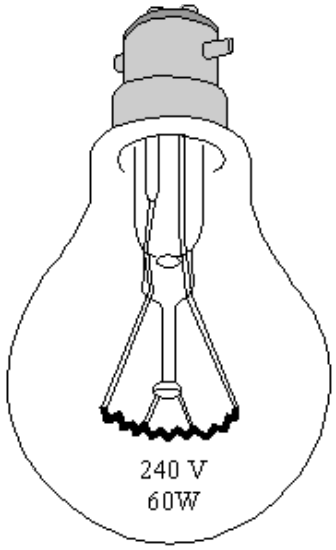
**(1)**

**(Total 7 marks)**

**Q5.** The diagram below shows a 60 watt electric light bulb.




(a) 60 W means that 60 joules of energy are transferred into the bulb each second. In use, how much energy is given **out** by the bulb each second?

..... J

**(1)**

(b) Describe the energy transfers which occur as it is used.

..... energy is transferred into ..... energy

and ..... energy.

**(2)**

(c) Some of the energy given out is wasted. Why is some of the energy wasted?

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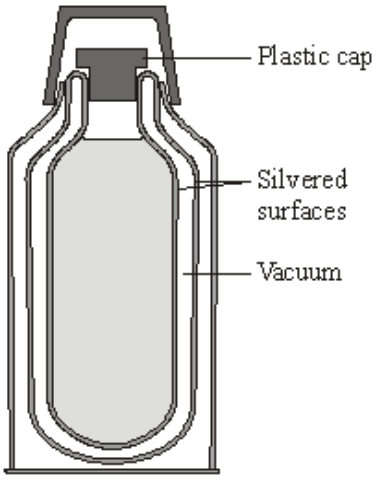
**(1)**

**(Total 4 marks)**

**Q6.** A vacuum flask is designed to reduce the rate of heat transfer.




(a) (i) Complete the table to show which methods of heat transfer are reduced by each of the features labelled in the diagram.

The first row has been done for you.

| Feature | Conduction | Convection | Radiation |
|---|---|---|---|
| vacuum | ✓ | ✓ | |
| silvered surfaces | | | |
| plastic cap | | | |

**(2)**

(ii) Explain why the vacuum between the glass walls of the flask reduces heat transfer by conduction and convection.

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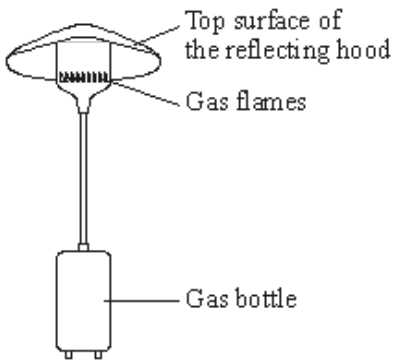
.....

**(2)**

(b) The diagram shows a gas flame patio heater.



(i) Explain why the top surface of the reflecting hood should be a light, shiny surface rather than a dark, matt surface.

.....

.....

.....

**(2)**

(ii) Most of the chemical energy in the gas is transformed into heat. A **small** amount of chemical energy is transformed into light.

Draw and label a Sankey diagram for the patio heater.

**(2)**

(iii) State why the total energy supplied to the patio heater must always equal the total energy transferred by the patio heater.

.....

.....

**(1)**

**(Total 9 marks)**

**Q7.** A wood burning stove is used to heat a room.

Photograph supplied by iStockphoto/Thinkstock

The fire in the stove uses wood as a fuel. The fire heats the matt black metal case of the stove.

(a) The air next to the stove is warmed by infrared radiation.

How does the design of the stove help to improve the rate of energy transfer by infrared radiation?

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.....

**(2)**

(b) Burning 1 kg of wood transfers 15 MJ of energy to the stove. The stove then transfers 13.5 MJ of energy to the room.

Calculate the efficiency of the stove.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

.....

.....

.....

Efficiency = .....

**(2)**

(c) Some of the energy from the burning wood is wasted as the hot gases leave the chimney and warm the air outside the house.

Name **one** other way energy is wasted by the stove.

.....

**(1)**

(d) Some people heat their homes using electric heaters. Other people heat their homes using a wood burning stove.

Give **two** environmental advantages of using a wood burning stove to heat a home rather than heaters that use electricity generated from fossil fuels.

1 .....

.....

2 .....

.....

**(2)**

(e) The metal case of the stove gets hot when the fire is lit.

Here is some information about the stove.

| | |
|---|---|
| Mass of metal case | 100 kg |
| Starting temperature of metal case | 20 °C |
| Final temperature of metal case | 70 °C |
| Specific heat capacity of metal case | 510 J/kg °C |

Calculate the energy required to raise the temperature of the metal case to 70 °C.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer and give the unit.

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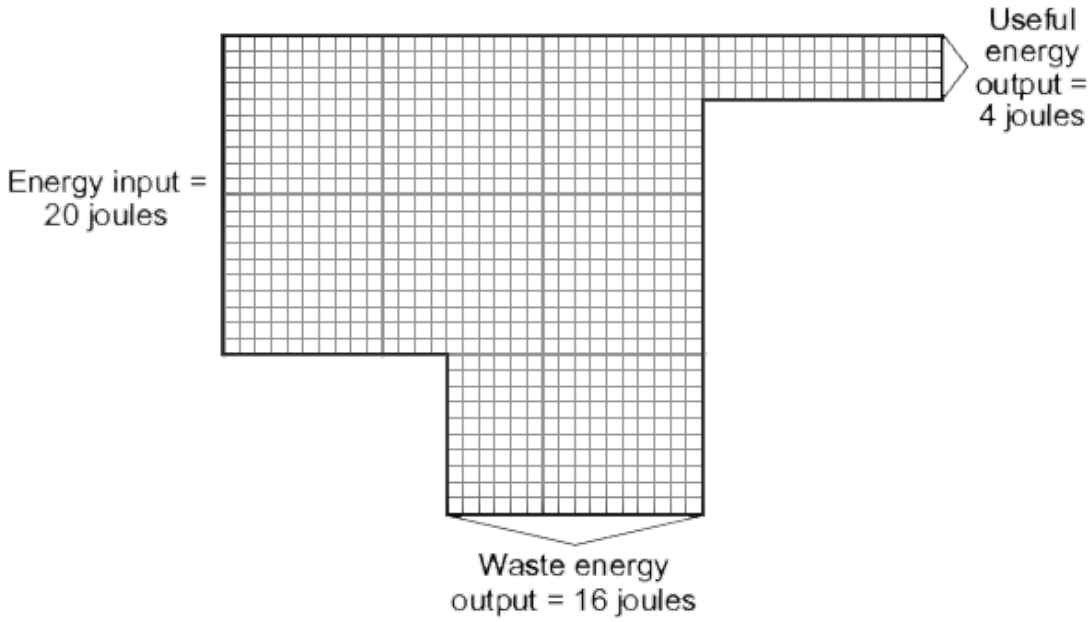
Energy required = .....

**(3)**

**(Total 10 marks)**

**Q8.** (a) The Sankey diagram for a low energy light bulb, known as a CFL, is shown below.




(i) What is the useful energy output that the CFL is designed to produce?

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**(1)**

(ii) What effect does the waste energy output have on the surrounding air?

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.....

**(1)**

(iii) Use the information in the diagram to calculate the efficiency of the CFL.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

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Efficiency = .....

**(2)**

(iv) CFLs contain mercury. Mercury is a poisonous substance.

It is important that old CFLs are sent for recycling and not thrown into a rubbish bin.

Suggest **one** reason why.

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.....

**(1)**

(b) A new type of low energy bulb uses light emitting diodes (LEDs).

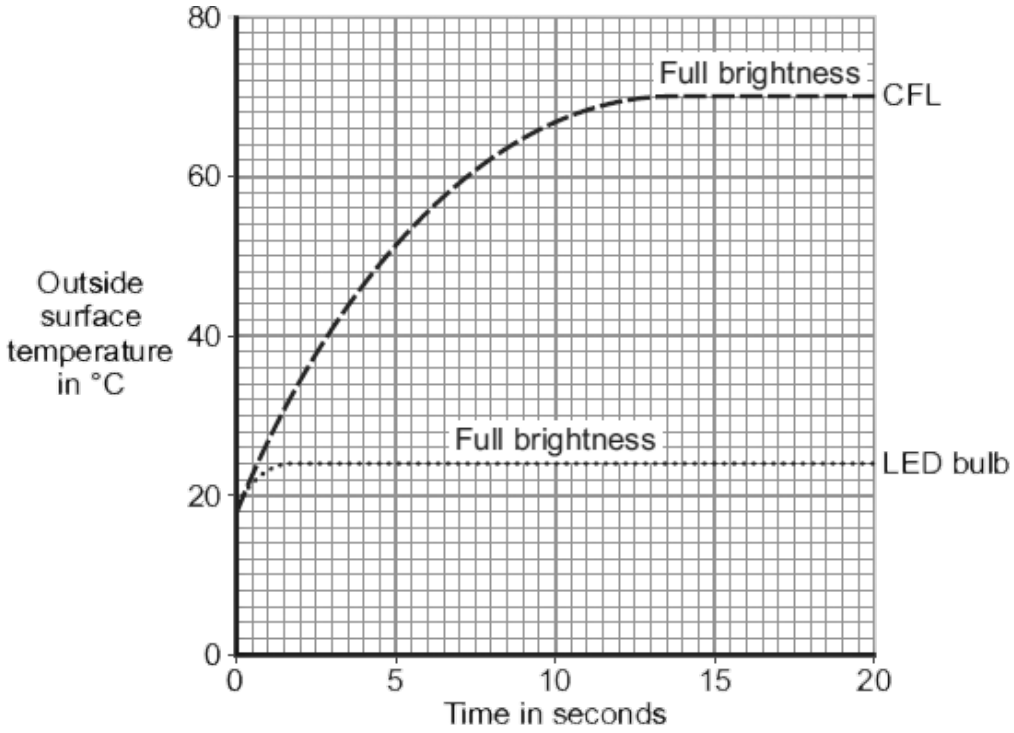
Draw a ring around the correct answer in the box to complete the sentence.

LED bulbs are more efficient than CFLs. This means that LED bulbs

waste | a smaller / the same / a bigger | proportion of the input energy compared to CFLs.

**(1)**

(c) The graph shows how the outside surface temperatures of a CFL and an LED bulb change after they are switched on.




Apart from a higher efficiency, suggest **one** advantage of using an LED bulb rather than a CFL.

.....

.....

**(1)**

(d) At the moment, LED bulbs are much more expensive to buy than CFLs.

Which **two** of the following would a homeowner need to know to decide whether it would be cost-effective to replace a CFL with an equally bright LED bulb?

Tick (✓) **two** box.

The number of hours each bulb lasts before needing to be replaced ☐

The power of each bulb in watts ☐

The voltage of the mains electricity supply ☐

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

**Q9.** Complete the following sentences.

A TV set is designed to transfer electrical energy into .....

energy and ..... energy.

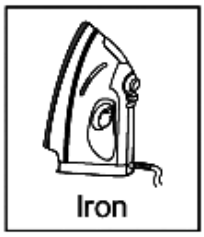
A hair dryer is designed to transfer electrical energy into .....

energy and ..... energy.

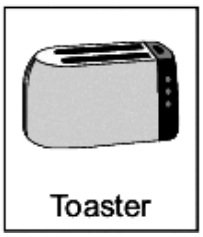
**(Total 4 marks)**

**Q10.** The appliances shown below transfer electrical energy to other types of energy.









(a) The vacuum cleaner is designed to transfer electrical energy to kinetic energy.

Three more of the appliances are also designed to transfer electrical energy to kinetic energy. Which **three**?

Draw a ring around each correct appliance.

**3**

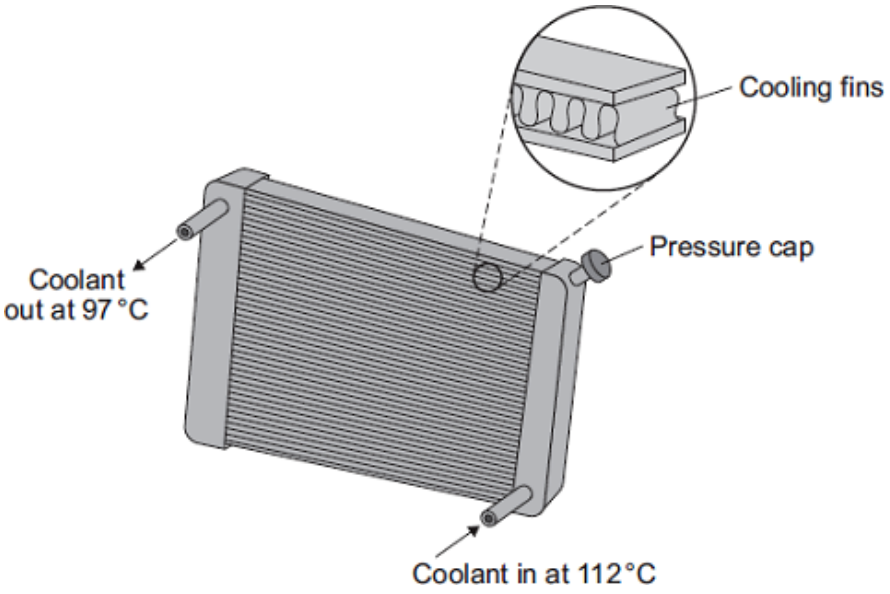
(b) Which **two** of the following statements are true?

Tick (✓) **two** boxes.

| | |
|---|---|
| Appliances only transfer part of the energy usefully. | ☐ |
| The energy transferred by appliances will be destroyed. | ☐ |
| The energy transferred by appliances makes the surroundings warmer. | ☐ |
| The energy output from an appliance is bigger than the energy input. | ☐ |

**(2)**
**(Total 5 marks)**

**Q11.** The diagram shows a car radiator. The radiator is part of the engine cooling system.




Liquid coolant, heated by the car engine, enters the radiator. As the coolant passes through the radiator, the radiator transfers energy to the surroundings and the temperature of the coolant falls.

(a) Why is the radiator painted black?

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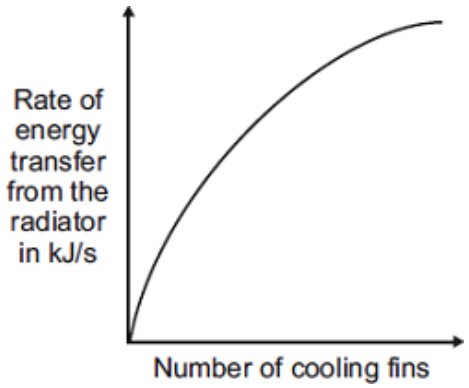
.....

.....

**(2)**

(b) Different radiators have different numbers of cooling fins along the length of the radiator.

The sketch graph shows how the number of cooling fins affects the rate of energy transfer from the radiator.




The number of cooling fins affects the rate of energy transfer from the radiator.

Explain how.

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**(2)**

(c) When the car engine is working normally, 2 kg of coolant passes through the radiator each second. The temperature of the coolant falls from 112 °C to 97 °C.

Calculate the energy transferred each second from the coolant.

Specific heat capacity of the coolant = 3800 J/kg °C.

Use the correct equation from the Physics Equations Sheet.

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Energy transferred each second = ..... J

**(3)**

(d) On cold days, some of the energy transferred from a hot car engine is used to warm the air inside the car. This is a useful energy transfer.

What effect, if any, does this energy transfer have on the overall efficiency of the car engine?

Draw a ring around the correct answer.

| **decreases the efficiency** | **does not change the efficiency** | **increases the efficiency** |
|---|---|---|

Give a reason for your answer.

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**(2)**
**(Total 9 marks)**

**Q12.** A gas burner is used to heat some water in a pan.


Of the energy released by the burning gas by the time the water starts to boil:

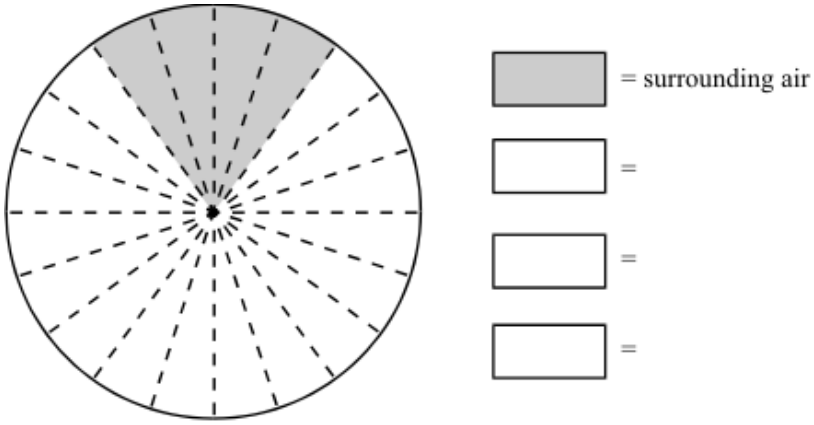
60% has been transferred to the **water**.

20% has been transferred to the **surrounding air**.

13% has been transferred to the **pan**.

7% has been transferred to the **gas burner** itself.

(a) Use the above information to complete the pie-chart.




**(3)**

(b) Some of the energy released by the burning gas is wasted.

(i) What happens to this wasted energy?

.....

.....

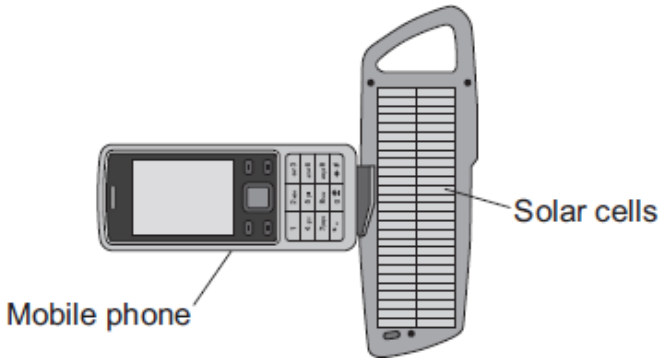
**(2)**

(ii) What percentage (%) of the energy from the gas is wasted? Answer: ..... %

**(1)**

**(Total 6 marks)**

**Q13.** (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.

.....

.....

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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.....

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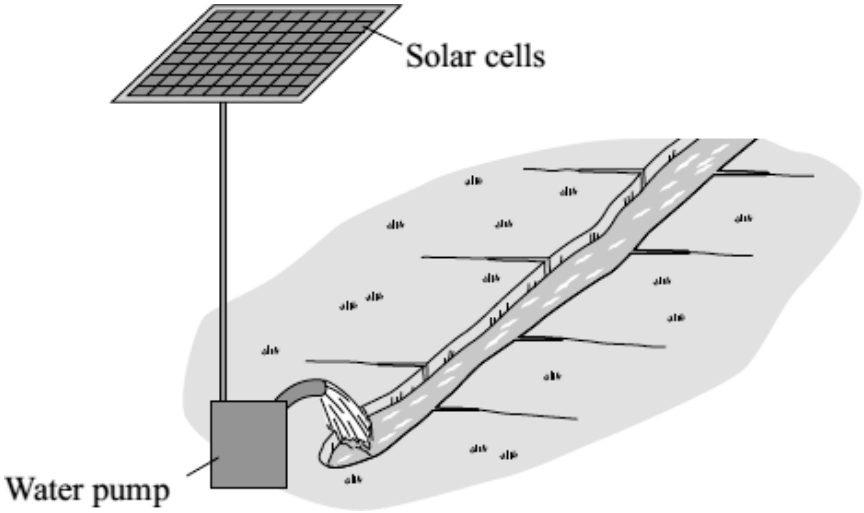
**(2)**
**(Total 8 marks)**

**Q14.** 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.

.....

.....

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).

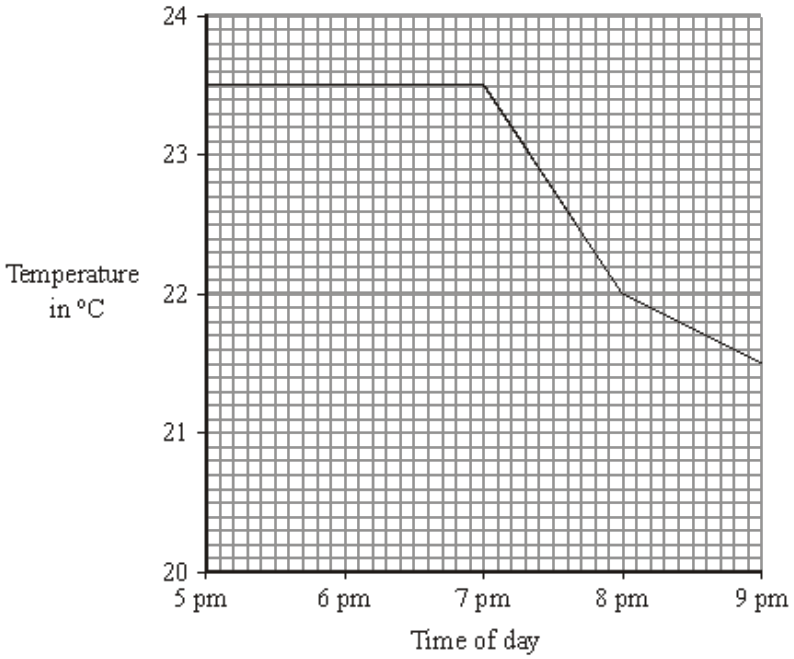
.....

.....

**(1)**

**(Total 4 marks)**

**Q15.** (a) The graph shows the temperature inside a flat between 5 pm and 9 pm. The central heating was on at 5 pm.




(i) What time did the central heating switch off?

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**(1)**

(ii) Closing the curtains reduces heat loss from the flat.

What time do you think the curtains were closed?

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Give a reason for your answer.

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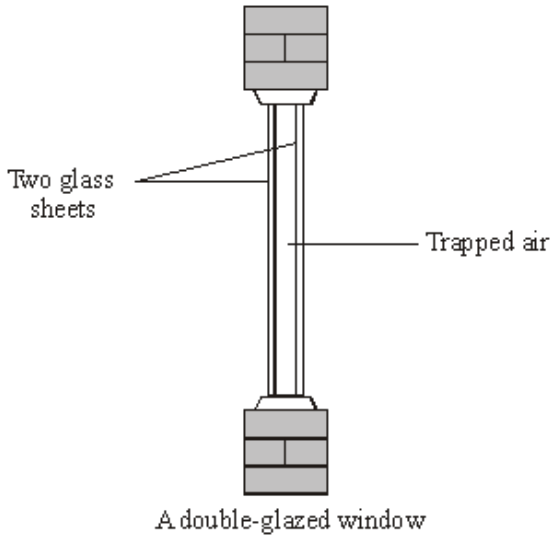
**(2)**

(b) Less heat is lost through double-glazed windows than through single-glazed windows.




Complete the following sentences by choosing the correct words from the box. Each word may be used once or not at all.

| | | | | | |
|---|---|---|---|---|---|
| **conduction** | **conductor** | **convection** | **evaporation** | **insulator** | **radiation** |

Air is a good ..... . When trapped between two sheets of glass it reduces heat loss by ..... and .....

**(3)**

(c) The table gives information about three types of house insulation.

| Type of insulation | Cost to install | Money save each year on heating bills | Payback time |
|---|---|---|---|
| Double glazing | £4000 | £200 | 20 years |
| Loft insulation | £300 | £100 | 3 years |
| Cavity wall insulation | £600 | £150 | |

(i) Use the information in the table to calculate the payback time for cavity wall insulation.

.....

**(1)**

(ii) Explain why people often install loft insulation before installing double glazing or cavity wall insulation.

.....

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.....

.....

**(2)**

**(Total 9 marks)**

##

(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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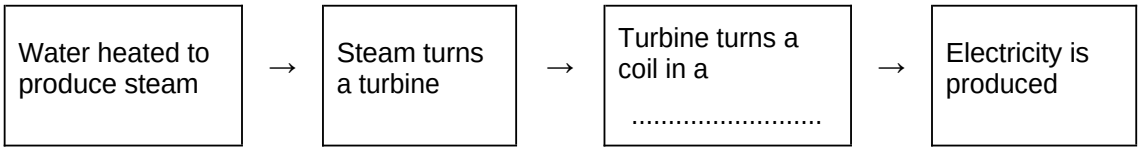
**(2)**

**(Total 5 marks)**

##

(a) In Britain most power stations burn fuel to produce heat. The diagram shows the stages by which the heat is transferred into electrical energy.
Complete the diagram by filling in the missing word.




**(1)**

(b) A fuel burning power station uses 2000 joules of fuel energy to generate 600 joules of electrical energy. The rest of the fuel energy is wasted as heat.

(i) For every 600 joules of electrical energy generated, how much fuel energy is wasted as heat?

.....

.....

**(1)**

(ii) Use the following equation to calculate the efficiency of the power station.
Show clearly how you work out your answer.

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

.....

.....

efficiency = .....

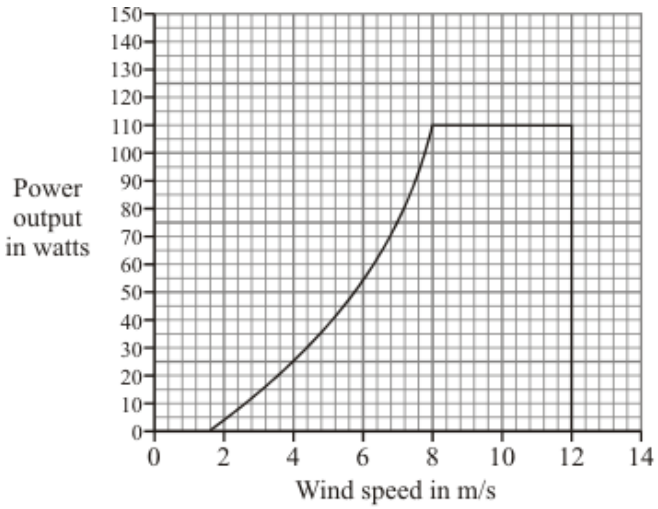
**(2)**

(c) List **A** gives three energy resources used to generate electricity. List **B** gives environmental problems that may be caused by using different energy resources. Draw a straight line from each energy resource in List **A** to the environmental problem it may cause in List **B**. Draw **three** lines only.

| List A<br>Energy resource | List B<br>Environmental problem that may be caused |
|---|---|
| Wind | Destroys the habitat of wading birds in river estuaries |
| Tides | Produces a lot of noise |
| Falling water (hydroelectricity) | Produces the gas sulphur dioxide |
| | Floods land used for farming or forestry |

**(3)**

(d) A small wind generator is used to charge a battery. The graph shows the power output of the generator at different wind speeds.




(i) What is the maximum power produced by the generator?

..... watts

**(1)**

(ii) The generator is designed to stop if the wind speed is too high.

At what wind speed does the generator stop working?

..... m/s

**(1)**

(iii) Give **one** disadvantage of using a wind generator to charge a battery.

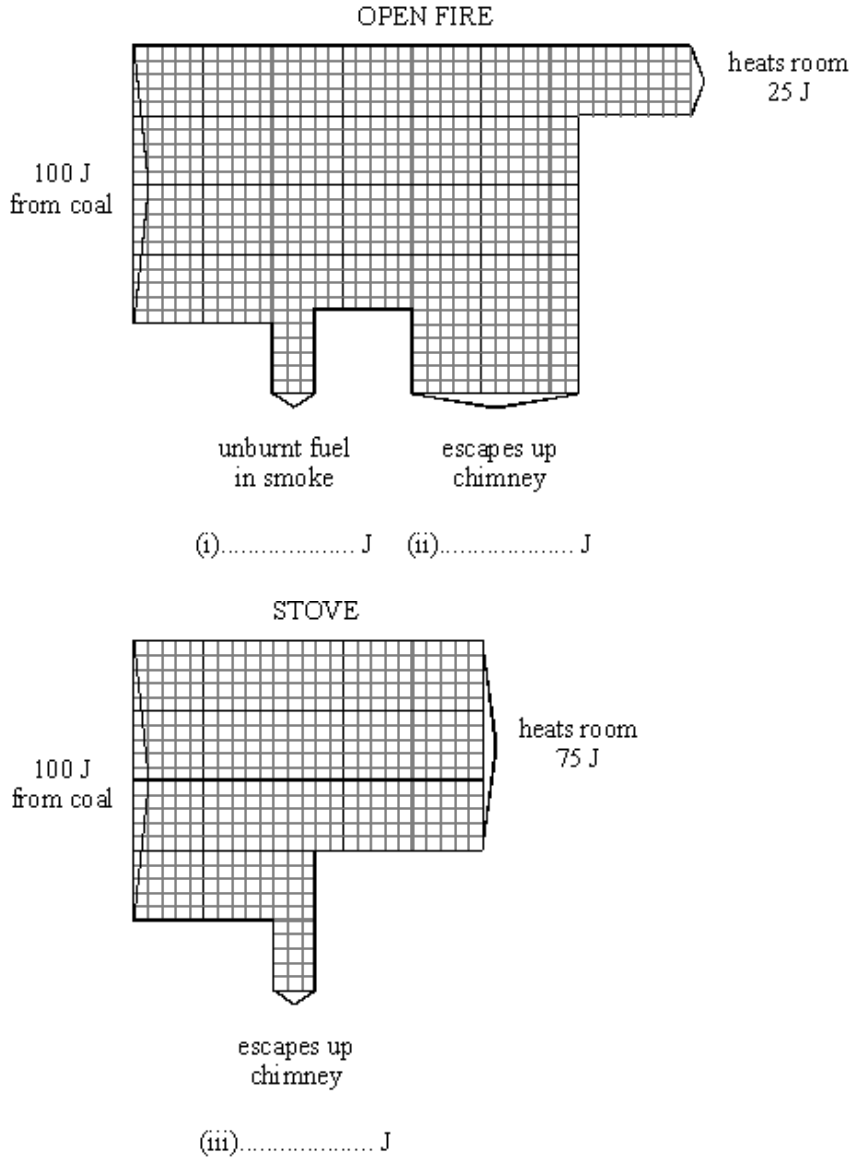
.....

.....

**(1)**

**(Total 10 marks)**

**Q18.** The diagrams show what happens to each 100 joules of energy from burning coal on an open fire and in a stove.




(a) Add the missing figures to the diagrams.

**(3)**

(b) Which is more efficient, the open fire or the stove?
Give a reason for your answer.

.....

.....

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

**M1.** (a) 30(%)

**1**

50(%)

**1**

(b) combined heat and power station <u>as waste less energy</u>

**1**

correct reference to 20 % or 70 %

*accept some energy (50%) is used for heating*

**1**

(c) infra red ticked

**1**

(d) dark surfaces

*accept matt / dull / black surfaces*

**1**

**[6]**

**M2.** (a) iron

**1**

hairdryer

**1**

kettle

*answers can be in any order*

**1**

(b) sound

**1**

(c) is more efficient than

**1**

**[5]**

##

(a) 60

(b) 15

(c) 5

*each for 1 mark*
*credit 1 mark for (a) +(b)+ (c) = 80*
***or** (a) > (b) > (c) to maximum of 3*

**[3]**

**M4.** (a) boiler

**1**

generator

**1**

(b) 0.3 or 30%

*allow **1** mark for substitution of 2 correct values taken from the Sankey diagram into correct equation*

**2**

(c) decrease

**1**

(d) any named biofuel eg wood, ethanol, straw

**1**

(e) (nuclear) fission

**1**

**[7]**

**M5.** (a) 60

*for 1 mark*

**1**

(b) electrical to light

*gains 1 mark*

**but** electricity to light and heat

*gains 2 mark*

anything to heat and light

*gains 1 mark*

**2**

(c) (unwanted) heat produced

*for 1 mark*

**1**

**[4]**

**M6.** (a) (i) silvered surfaces

*more than the correct number of ticks in a row negates the mark*

radiation

**2**

plastic cap

conduction, convection (both required)

| | conduction | convection | radiation | |
|---|---|---|---|---|
| vacuum | ✓ | ✓ | | |
| silvered surfaces | | | ✓ | (1) |
| plastic cap | ✓ | ✓ | | (1) |

(ii)

*any mention of air or any other substance in a vacuum scores zero*

because there are no particles in a vacuum

*accept atoms / molecules for particles*
*accept vacuum is empty space*
*accept there is nothing in a vacuum*
*accept there is no air / gas in the vacuum*

conduction **and** convection need particles / medium

*need reference to both conduction **and** convection*
*accept correct descriptions*

**2**

(b) (i) less heat lost (to air above the heater)

*do **not** accept **no** heat lost*

light shiny surfaces are poor emitters (of radiation)

*accept radiators for emitters*
*references to reflection are neutral*

**or** dull, matt surfaces are good emitters (of radiation)

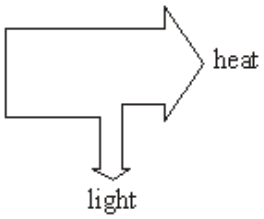
*do **not** credit answers which infer reflection from the underside of the hood*
*ignore correct reference to absorption*

**2**

(ii) correct diagram drawn with one output arrow narrower than the other

*ignore input*

arrows correctly labelled with energy form
eg




*flow charts score zero*

**2**

(iii) energy cannot be destroyed

*accept (principle of) conservation of energy*

*do **not** accept because energy cannot be lost without clarification*

**1**

**[9]**

**M7.** (a) any **two** from:

- black is a good emitter of (infrared radiation)

  *accept heat for radiation*

  *ignore reference to absorbing radiation*

- large surface (area)

- matt surfaces are better emitters (than shiny surfaces)

  *accept matt surfaces are good emitters*

  *ignore reference to good conductor*

**2**

(b) 90% or 0.9(0)

$$efficiency = \frac{useful\ energy\ out\ (\times 100\%)}{total\ energy\ in}$$

*allow 1 mark for correct substitution, ie* $\frac{13.5}{15}$

*provided no subsequent step shown*

*an answer of 90 scores **1** mark*

*an answer of 90 / 0.90 with a unit scores **1** mark*

**2**

(c) (producing) light

*allow (producing) sound*

**1**

(d) any **two** from:

- wood is renewable
  *accept wood grows again / quickly*
  *accept wood can be replanted*
- (using wood) conserves fossil fuels
  *accept doesn't use fossil fuels*
- wood is carbon neutral
  *accept a description*
  *cheaper / saves money is insufficient*

**2**

(e) $E = m \times c \times \theta$

2 550 000

*allow **1** mark for correct substitution*
*ie 100 × 510 × 50*
*provided no subsequent step shown*
*answers of 1 020 000, 3 570 000 gain **1** mark*

**2**

joules /J

*accept kJ / MJ*
*do **not** accept j*
*for full credit the unit and numerical answer must be consistent*

**1**

**[10]**

**M8.** (a) (i) light (energy)

*this answer only*

**1**

(ii) raises its temperature

*accept warms / heats it*
*accept air molecules / particles gain energy / move faster*
*do **not** accept heat*
*do **not** accept pollution*

**1**

(iii) $efficiency = \frac{useful\ energy\ out\ (\times 100\%)}{total\ energy\ in}$

20% or 0.2

*allow **1** mark for correct substitution ie* $\frac{4}{20}$ *provided that no subsequent step is shown*

*20 without % scores 1 mark, 20 **or** 0.2 with a unit scores 1 mark*

**2**

(iv) mercury can be recovered /reused / recycled

**or**

mercury (vapour) does not get into the atmosphere / environment / air

*accept to stop mercury poisoning the land / getting into the food chain / water supply*

*accept poisonous gas for mercury (vapour)*

*do **not** accept general poisoning*

*cause harm to the environment is insufficient*

**1**

(b) a smaller

**1**

(c) reaches full brightness faster

*accept brighter / switches on faster accept it does not get as hot*

*accept it will not burn someone who touches it*

*accept stays cool*

*accept temperature does not increase as much*

*accept temperature only goes to 24 (°C)*

*accept contains no mercury*

*do **not** accept wastes less energy*

**1**

(d) top two boxes both ticked

The number of hours each bulb lasts before needing to be replaced.

The power of each bulb in watts.

**1**

**[8]**

**M9.** light;
sound;
heat;
kinetic/movement

*for 1 mark each*

**[4]**

**M10.** (a) fan

**1**

drill

**1**

washing machine

*four circled including correct three scores **1** mark*

*five circled scores zero*

**1**

(b) Appliances only transfer part of the energy usefully

**1**

The energy transferred by appliances makes the surroundings warmer

**1**

**[5]**

**M11.** (a) (matt) black is a good <u>emitter</u> of infrared / radiation

*accept heat for infrared / radiation*
*ignore reference to good absorber*
*attracts heat negates this marking point*

**1**

to give maximum (rate of) energy transfer (to surroundings)

*accept temperature (of coolant) falls fast(er)*
*accept black emits more radiation for **1** mark*
*black emits most radiation / black is the best emitter of radiation for **2** marks*

**1**

(b) the fins increase the surface area

*accept heat for energy*

**1**

so increasing the (rate of) energy transfer
**or**
so more fins greater (rate of) energy transfer

**1**

(c) 114 000

*allow **1** mark for correct temperature change, ie 15 (°C)*
***or***
*allow **2** marks for correct substitution, ie 2 × 3 800 × 15*
*answers of 851 200 **or** 737 200 gain **2** marks*
***or***
*substitution 2 × 3800 × 112 **or** 2 × 3800 × 97 gains **1** mark*
*an answer of 114 kJ gains **3** marks*

**3**

(d) increases the efficiency

**1**

less (input) energy is wasted

*accept some of the energy that would have been wasted is (usefully) used*

**or**

more (input) energy is usefully used

*accept heat for energy*

**1**

**[9]**

**M12.** (a) 60% sector correct
other two sectors closer to 13:7 than 12:8 or 14:6
sectors correctly labelled (w.r.t rank order of size)
*each for 1 mark*

**3**

(b) (i) *ideas that wasted energy*
is transferred to surrounding air
pan
stove
is converted to another/correctly named energy form
*any 2 for 1 mark each*

**2**

(ii) 40
*for 1 mark*

**1**

**[6]**

**M13.** (a) (i) 4
*allow **1** mark for correct transformation and substitution*
*ie* $\frac{0.6}{0.15}$
*substitution only scores if no subsequent steps are shown*

**2**

(ii) diagram showing two output arrows with one arrow wider
than the other with the narrower arrow labelled
electrical / electricity / useful

**1**

(iii) any **one** from:

- time of day / year
- position of solar cells
- angle of solar cells (to the Sun)
- latitude
- cloud cover
- solar cells covered in dust / dirt

*accept charger for solar cells*
*accept any reasonable suggestion that would lead to a change in intensity of sun(light)*
*the weather is insufficient*
*do **not** accept any physical changes to the charger eg area*

**1**

causes a change in intensity of sun(light)

*accept brightness for intensity*

*accept a description of the reduction of intensity*

**1**

(b) any **one** from:

- to check reliability / validity / accuracy
- to avoid bias

**1**

(c) any **two** from:

- produce no / less (air) pollution

  *accept named pollutant*

  *accept produces no waste (gases)*
- energy is free

  *accept it is a free resource*

  *do **not** accept it is free*
- (energy) is renewable
- conserves fossil fuel stocks
- can be used in remote areas
- do not need to connect to the National Grid

**2**

**[8]**

**M14.** (a) (i) 0.75

*allow **1** mark for correct transformation and substitution*

*ie 0.15 = 5*

**2**

(ii) 2

*accept 1.5 ÷ their (a)(i) correctly calculated*

**1**

(b) any **one** from:

- seasonal changes
  *accept specific changes in conditions*
  *eg shorter hours of daylight in winter*

- cloud cover
  *accept idea of change*
  *must be stated or unambiguously implied*
  *eg demand for water will not (always) match supply of solar energy*
  *do **not** accept figures are average on its own*
  *do **not** accept solar panels are in the shade*

**1**

**[4]**

**M15.** (a) (i) 7pm
*accept 19.00 / 1900*

**1**

(ii) 8pm
*accept 20.00 / 2000*

**1**

temperature drops more slowly
*accept heat for temperature accept line is less steep*

**1**

(b) insulator

**1**

conduction *

**1**

convection *
** answers can be either way around*

**1**

(c) (i) 4 (years)

**1**

(ii) it is the cheapest / cheaper / cheap
*do **not** accept answers in terms of heat rising or DIY*

**1**

has the shortest / shorter payback time
*do **not** accept short payback time*

**1**

**[9]**

**M16.** (a) four calculations correctly shown

*200 × 10 – 1800 = £200*
*100 × 10 – 2400 = –£1400*
*50 × 10 – 600 = –£100*
*20 × 10 – 75 = 125*

*accept four final answers only **or** obvious rejection of solar water heater and underfloor heating, with other two calculations completed any 1 complete calculation correctly shown **or** showing each saving × 10 of all four calculations = 1 mark answers in terms of savings as a percentage of installation cost **may** score savings mark only*

**2**

hot water boiler

*correct answers only*

**1**

(b) less electricity / energy to be generated / needed from power stations

*accept less demand*

**1**

reduction in (fossil) fuels being burnt

*accept correctly named fuel*

*accept answer in terms of:*
*fewer light bulbs required because they last longer (1 mark)*
*less energy used / fuels burnt in production / transport etc. (1 mark)*

*ignore reference to $CO_2$ or global warming*

*ignore reference to conservation of energy*

**1**

**[5]**

**M17.** (a) generator

*accept dynamo*
*accept alternator*

**1**

(b) (i) 1400

*ignore units*

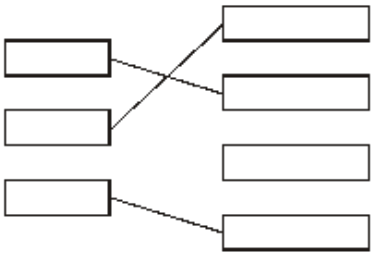
**1**

(ii) 0.3 or 30%

*any incorrect unit penalise **1** mark*
*allow **1** mark for the correct use of 600 **or** 0.3% **or** 30*

**2**

(c) **1** mark for each correct link



*if more than 3 lines are drawn, mark only*
*3 lines starting with those that are incorrect*

**3**

(d) (i) 110

*no tolerance*

**1**

(ii) 12

*no tolerance*

**1**

(iii) wind speed may be too low to operate the generator

*accept wind may not always blow*
*accept power depends on wind speed*
*accept does not generate if wind speed is too high*
*accept does not generate if wind speed is above 12 (m/s)*
*accept does not generate if wind speed is below 1.6 (m/s)*
*accept it is unreliable*
*do **not** accept answers referring to cost only*

**1**

**[10]**

**M18.** (a) (i) 15*

(ii) 60*

*[* if incorrect but (ii)>(i) <u>and</u> (i) + (ii) = 75 then credit 1 mark]*

(iii) 25

*each for 1 mark*

**3**

(b) *stove because*
more of the energy heats up room / heats the room more
**or**
less energy escapes up chimney / less energy wasted

*[Do not allow 'less waste' with the stove]*
***or***
*no un burnt fuel in smoke*
*reason for 1 mark*

**1**

**[4]**