AQA GCSE Physics | 8463

SPECIFICATION POINT 4.1.2.2

Efficiency

Past-paper questions

Tier	**Higher**
Question groups	**90**
Available paper years	**2004–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

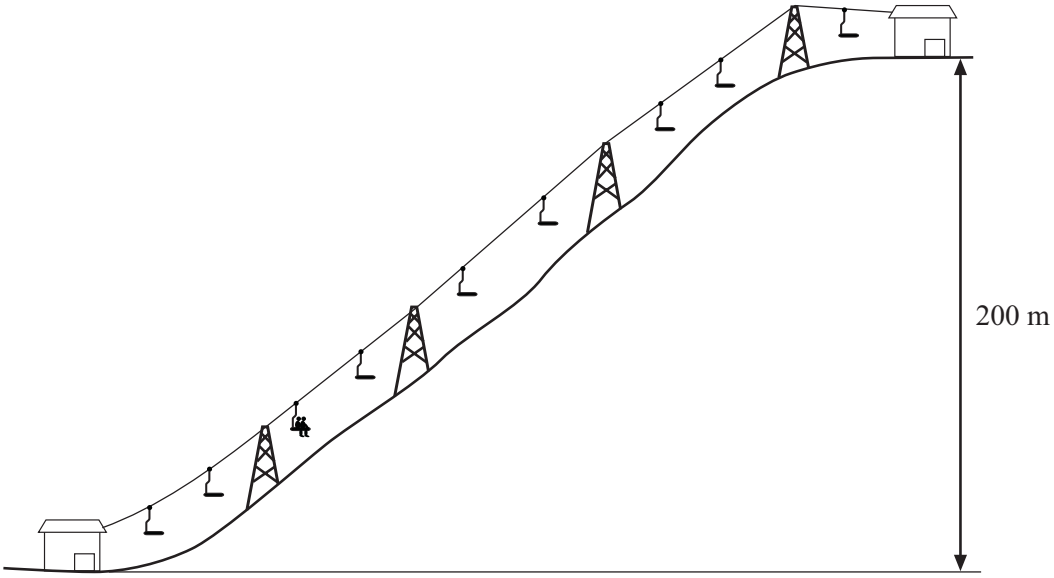
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.1.2.2 Efficiency

Question 01

June 2004 | 3451H | Original Q6 | Legacy

6 (a) A chair lift carries two skiers, Greg and Jill, to the top of a ski slope. Greg weighs 700 N and Jill weighs 500 N.



(i) Write down the equation that links distance moved, force applied and work done.

.....

(1 mark)

(ii) Calculate the work done to lift Greg and Jill through a vertical height of 200 m.
Show clearly how you work out your answer and give the unit.

.....

.....

.....

work done =.....

(3 marks)

4.1.2.2 Efficiency

Question 01 · continued

MARGIN BLANK

(b) The chair takes 5 minutes to move from the bottom to the top of the ski slope.

Use the following equation to calculate the power required to lift Greg and Jill to the top of the ski slope. Show clearly how you work out your answer.

$$\text{power} = \frac{\text{work done}}{\text{time taken}}$$

.....

.....

power = ...watts

(2 marks)

(c) The chair lift is driven by an electric motor.

(i) Why would the power output of the electric motor need to be larger than your answer to part (b)?

.....

.....

(1 mark)

(ii) Complete the following sentence.

When the ski lift is working ..... energy supplied to the motor is usefully transferred as gravitational ..... energy. *(1 mark)*

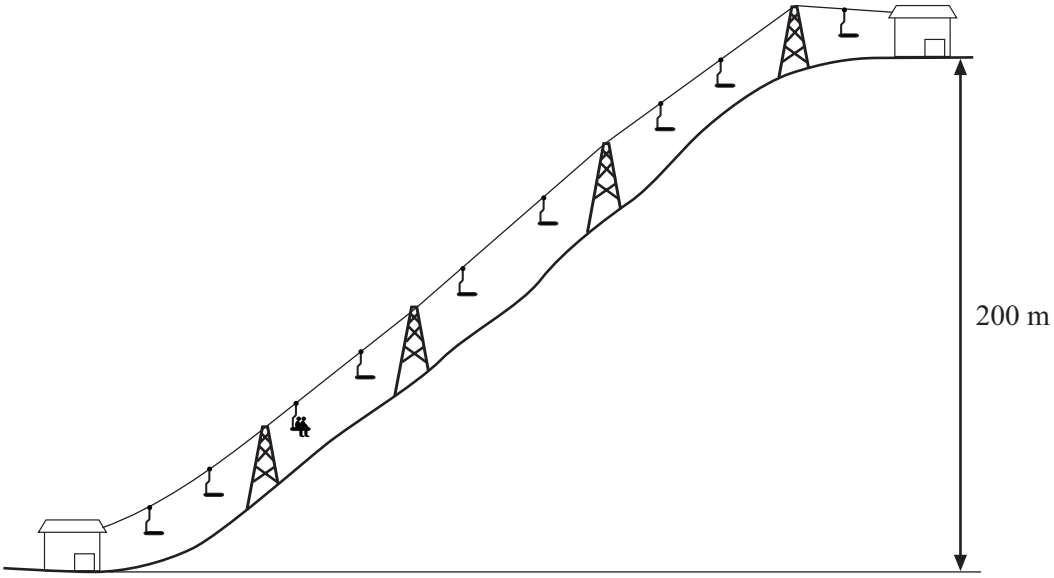
8

4.1.2.2 Efficiency

Question 02

June 2004 | 3462H3 | Original Q6 | Legacy

6 (a) A chair lift carries two skiers, Greg and Jill, to the top of a ski slope. Greg weighs 700 N and Jill weighs 500 N.



(i) Write down the equation that links distance moved, force applied and work done.

.....

(1 mark)

(ii) Calculate the work done to lift Greg and Jill through a vertical height of 200 m.
Show clearly how you work out your answer and give the unit.

.....

.....

.....

work done =.....

(3 marks)

4.1.2.2 Efficiency

Question 02 · continued

MARGIN BLANK

(b) The chair takes 5 minutes to move from the bottom to the top of the ski slope.

Use the following equation to calculate the power required to lift Greg and Jill to the top of the ski slope. Show clearly how you work out your answer.

$$\text{power} = \frac{\text{work done}}{\text{time taken}}$$

.....

.....

power = ...watts

(2 marks)

(c) The chair lift is driven by an electric motor.

(i) Why would the power output of the electric motor need to be larger than your answer to part (b)?

.....

.....

(1 mark)

(ii) Complete the following sentence.

When the ski lift is working ..... energy supplied to the motor is usefully transferred as gravitational ..... energy. *(1 mark)*

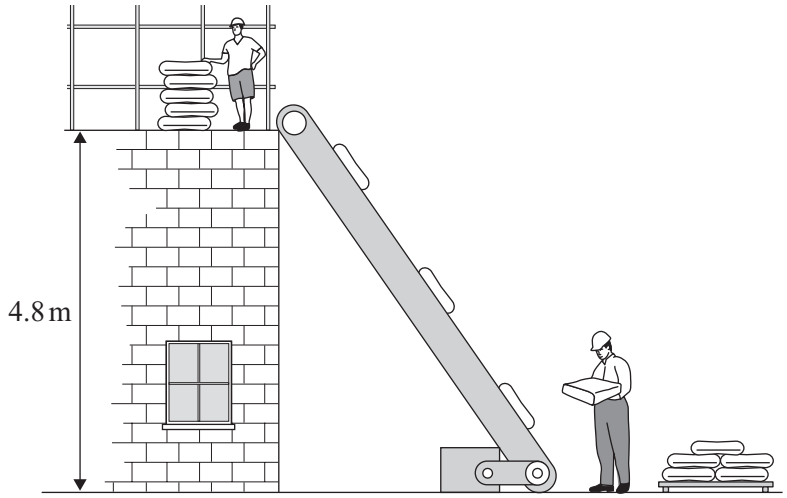
8

4.1.2.2 Efficiency

Question 03

June 2005 | 3451 | Original Q13 | Legacy

13 A machine is used to lift materials on a building site.



(a) (i) Write down the equation that links change in gravitational potential energy, change in vertical height and weight.

.....

(1 mark)

(ii) A 25 kg bag of cement is lifted from the ground to the top of the building.
Calculate the gain in the gravitational potential energy of the bag of cement.

(On Earth a 1 kg mass has a weight of 10 N.)

.....

.....

Change in gravitational potential energy = ... joules
(2 marks)

(b) The conveyor belt delivers six bags of cement each minute to the top of the building.

(i) Calculate the useful energy transferred by the machine each second.

.....

.....

.....

Useful energy transfer each second = ... J
(1 mark)

4.1.2.2 Efficiency

Question 03 · continued

MARGIN BLANK

(ii) The machine is 40 % efficient.
Use the following equation to calculate the total energy supplied to the machine each second. Show how you work out your answer.

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

.....

.....

Total energy supplied each second = ... J
(2 marks)

6

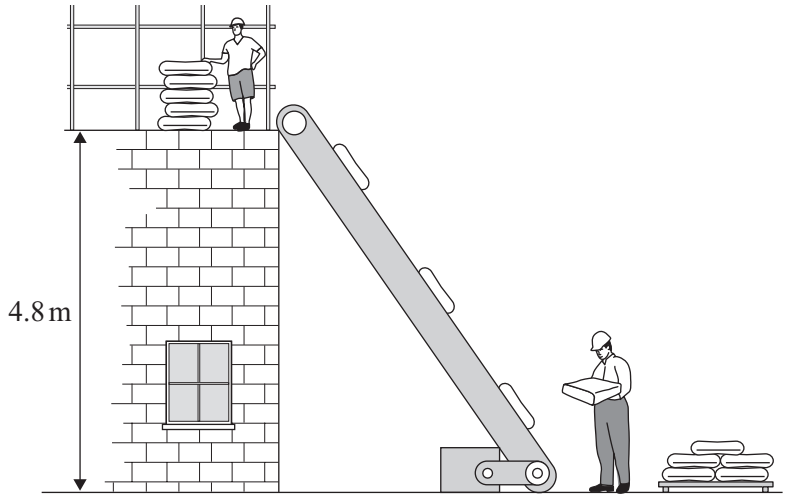
TURN OVER FOR THE NEXT QUESTION

4.1.2.2 Efficiency

Question 04

June 2005 | 3462 | Original Q10 | Legacy

10 A machine is used to lift materials on a building site.



(a) (i) Write down the equation that links change in gravitational potential energy, change in vertical height and weight.

.....

(1 mark)

(ii) A 25 kg bag of cement is lifted from the ground to the top of the building.
Calculate the gain in the gravitational potential energy of the bag of cement.

(On Earth a 1 kg mass has a weight of 10 N.)

.....

.....

Change in gravitational potential energy = ... joules
(2 marks)

(b) The conveyor belt delivers six bags of cement each minute to the top of the building.

(i) Calculate the useful energy transferred by the machine each second.

.....

.....

.....

Useful energy transfer each second = ... J
(1 mark)

4.1.2.2 Efficiency

Question 04 · continued

June 2005 | 3462 | Original Q10 | Legacy

MARGIN BLANK

(ii) The machine is 40 % efficient.
Use the following equation to calculate the total energy supplied to the machine each second. Show how you work out your answer.

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

.....

.....

Total energy supplied each second = ... J
(2 marks)

6

TURN OVER FOR THE NEXT QUESTION

4.1.2.2 Efficiency

Question 05

March 2007 | PHY1A | Original Q3 | Legacy

QUESTION THREE

Electrical appliances usefully transform only part of the energy that is supplied to them. The rest of the energy is wasted.

Chefs often use electric mixers to combine ingredients.



3A A mixer **usefully** transforms electrical energy to . . .

1 kinetic energy.

2 light energy.

3 sound energy.

4 thermal energy.

4.1.2.2 Efficiency

3B The energy that is **not** usefully transformed by the mixer is wasted as . . .

1 heat and sound.

2 heat only.

3 sound and kinetic energy.

4 sound only.

3C Which of the following statements is **false**?

1 The energy transformed by the mixer becomes difficult to use for other energy transformations.

2 The energy transformed by the mixer ends up making the surroundings a little warmer.

3 The energy transformed by the mixer ends up very spread out.

4 The energy transformed by the mixer no longer exists.

3D A second mixer transforms useful energy at the same rate as this one however, it wastes more energy.

This means that the second mixer . . .

1 costs less per minute to run.

2 is less efficient.

3 is more efficient.

4 transforms energy at a slower rate.

4.1.2.2 Efficiency

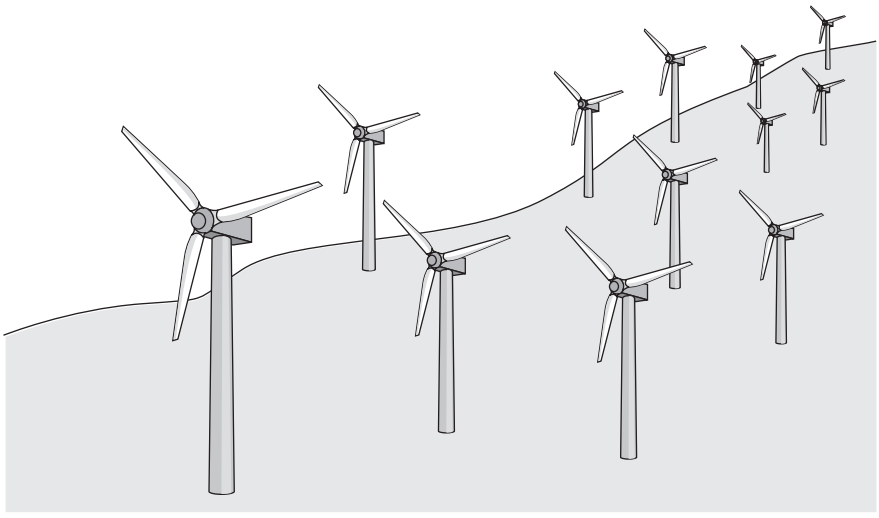
Question 06

March 2007 | PHY1A | Original Q6 | Legacy

QUESTION SIX

Wind turbines on Coldharbour site

The drawing shows part of a wind farm which will supply electricity to a small town.



6A Which type of energy is transformed from the wind to generate electricity?

1 elastic potential

2 gravitational potential

3 kinetic

4 sound

6B Where would you **least** expect to find a wind farm?

1 in a town

2 offshore – out at sea

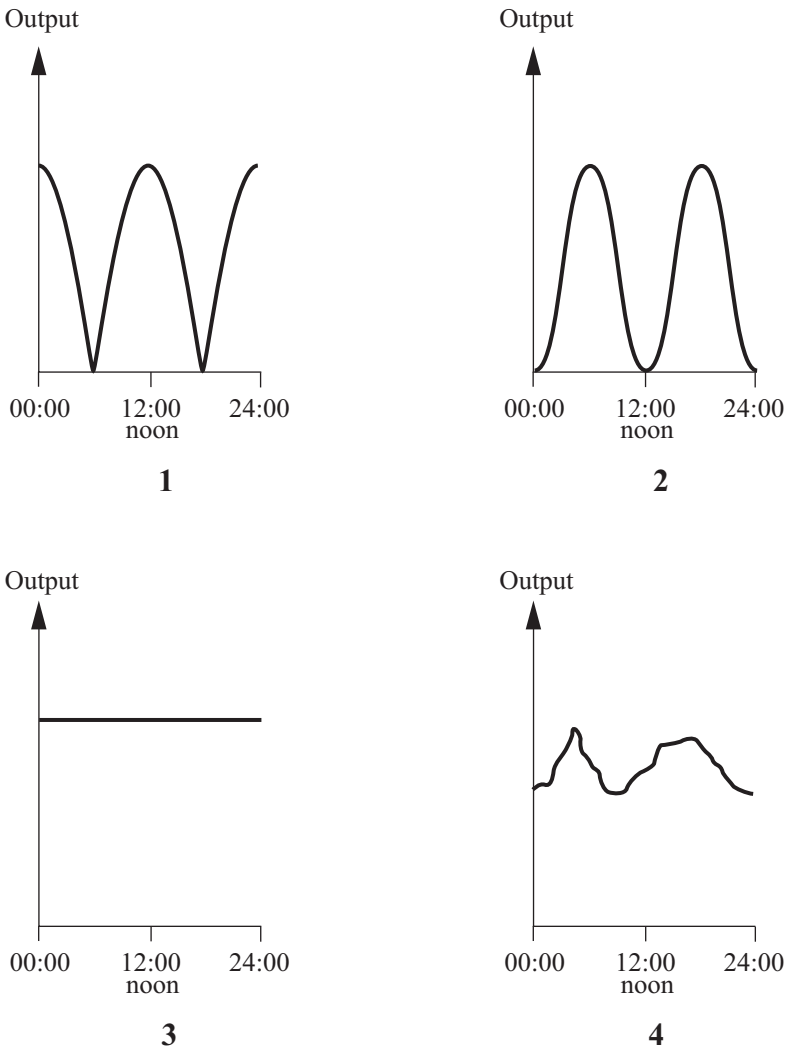
3 on a coastal cliff

4 on the top of a hill

4.1.2.2 Efficiency

Question 06 · continued

6C Which graph is most likely to show the output from a wind farm over one day?



6D There are 10 000 homes in the town. The average electrical power input into each home is 0.5 kW. The average useful power output of the wind farm is 5 MW.

Why is this insufficient to meet the needs of the town?

1 0.5 kW × 10 000 is more than 5 MW.

2 5 MW is less than 0.5 kW × 10 000.

3 Supply and demand will often not coincide.

4 The wind farm wastes energy because it is noisy.

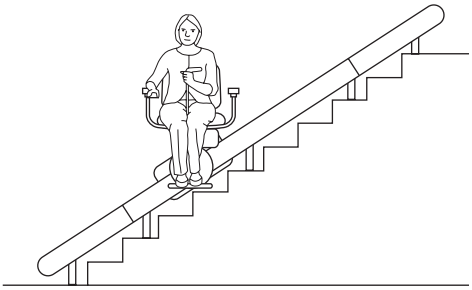
4.1.2.2 Efficiency

Question 07

June 2007 | PHY1A | Original Q2 | Legacy

QUESTION TWO

The drawing shows a woman being moved upstairs by a stair lift.



Match words, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A electrical energy

B gravitational potential energy

C sound energy

D thermal energy

As the stair lift moves upwards, . . . **1** . . . is usefully transformed to . . . **2** . . . .

Some energy is wasted, mainly as . . . **3** . . . , but also as . . . **4** . . . .

4.1.2.2 Efficiency

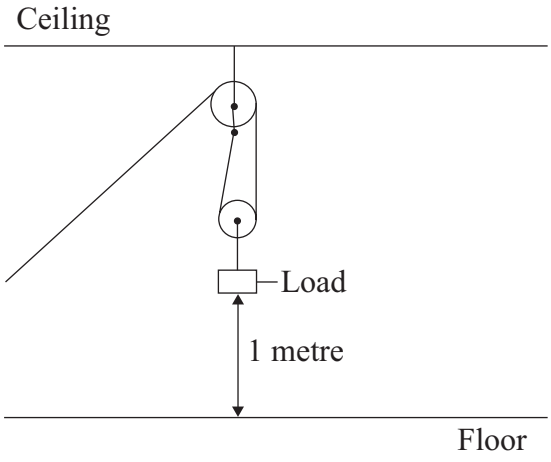
Question 08

June 2007 | PHY1A | Original Q6 | Legacy

QUESTION SIX

A student investigated a pulley system used to lift different loads. The student calculated the useful energy transferred by the pulley system for each load as it was lifted one metre. She then calculated the efficiency of the pulley system using the following equation.

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



The table shows the student's results.

Useful energy transferred by the pulley system (in J)	Total energy supplied to the pulley system (in J)	Calculated efficiency
1.00	3.33	0.30
2.00	4.16	0.48
3.00	5.00	
4.00	5.05	0.79
5.00	6.25	0.80

4.1.2.2 Efficiency

Question 08 · continued

6A What was the efficiency when the useful energy transferred by the pulley system was 3 J?

1 0.15

2 0.167

3 0.60

4 1.67

6B Which value of total energy supplied to the pulley system is probably anomalous?

1 3.33 J

2 4.16 J

3 5.05 J

4 6.25 J

6C Using both your knowledge and the data in the table, suggest what would happen to the efficiency of the pulley system if the energy supplied continued to increase.

The efficiency would eventually . . .

1 exceed 1.00.

2 reach a maximum.

3 begin to decrease.

4 increase, then begin to decrease.

6D The difference between the useful energy transferred by the pulley system and the total energy supplied to the pulley system is called the . . .

1 effective energy.

2 transferred energy.

3 transformed energy.

4 wasted energy.

4.1.2.2 Efficiency

Question 09

June 2007 | PHY1H | Original Q6 | Legacy

6 (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.

.....

.....

.....

.....

.....

.....

(3 marks)

(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.

.....

.....

.....

.....

(2 marks)

5

4.1.2.2 Efficiency

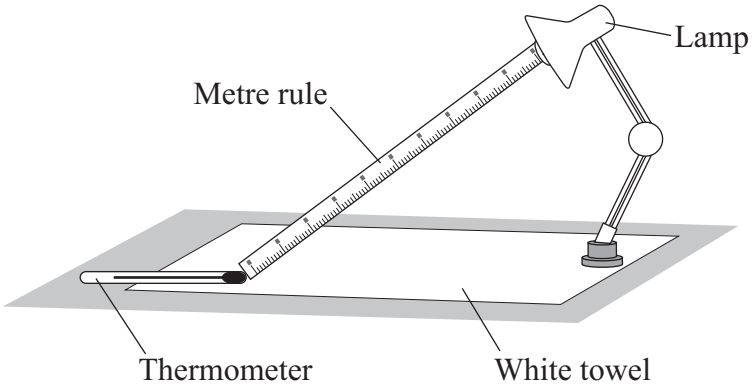
Question 10

November 2007 | PHY1A | Original Q3 | Legacy

QUESTION THREE

A student investigated the heat output from four different makes of lamp, **W**, **X**, **Y** and **Z**. Each lamp had the same power.

The diagram shows the apparatus she used.



- She recorded the initial temperature shown by the thermometer.
- She then switched on lamp **W**.
- Five minutes later, she recorded the final temperature shown by the thermometer.
- She repeated this procedure for lamps **X**, **Y** and **Z**.

The table shows her results.

Lamp	Initial temperature in °C	Final temperature in °C
W	17	27
X	18	26
Y	20	28
Z	22	29

4.1.2.2 Efficiency

Question 10 · continued

3A What kind of variable was the make of lamp?

1 categoric

2 continuous

3 dependent

4 ordered

3B Which of these was **not** a control variable in this investigation?

1 make of lamp

2 distance of thermometer from lamp

3 length of time the lamp was switched on

4 the white towel

3C Which lamp caused the largest rise in temperature in the thermometer?

1 **W**

2 **X**

3 **Y**

4 **Z**

3D Which lamp seems to be the most efficient in producing light?

1 **W**

2 **X**

3 **Y**

4 **Z**

4.1.2.2 Efficiency

Question 11

November 2007 | PHY1A | Original Q8 | Legacy

QUESTION EIGHT

Transformers are used in the National Grid.

8A Two types of transformer are used in various parts of the National Grid.

Which row in the table shows the correct locations of the two types of transformer?

	Between generators and power lines	Between power lines and substation	Between substation and people's homes
1	step-down	step-down	step-up
2	step-down	step-up	step-up
3	step-up	step-down	step-down
4	step-up	step-up	step-down

8B Transformers alter the potential difference across the power lines and the current through the power lines. These changes affect the efficiency of the power lines.

Which row in the table is correct?

	Potential difference across power lines	Current through power lines	Efficiency of transmission
1	decreased	decreased	decreased
2	decreased	increased	increased
3	increased	decreased	increased
4	increased	increased	increased

4.1.2.2 Efficiency

Question 11 · continued

8C The table shows the percentage of energy wasted as heat and sound by four different transformers.

Which transformer has the highest efficiency?

Transformer	Percentage of energy supplied to transformer which is wasted as sound	Percentage of energy supplied to transformer which is wasted as heat
1	1.1	7.4
2	1.2	4.7
3	1.3	5.4
4	1.4	6.9

8D The amount of electricity that a device transforms depends on the rate at which the device transforms energy and . . .

1 how long the device is switched on.

2 the current through the device.

3 the potential difference across the device.

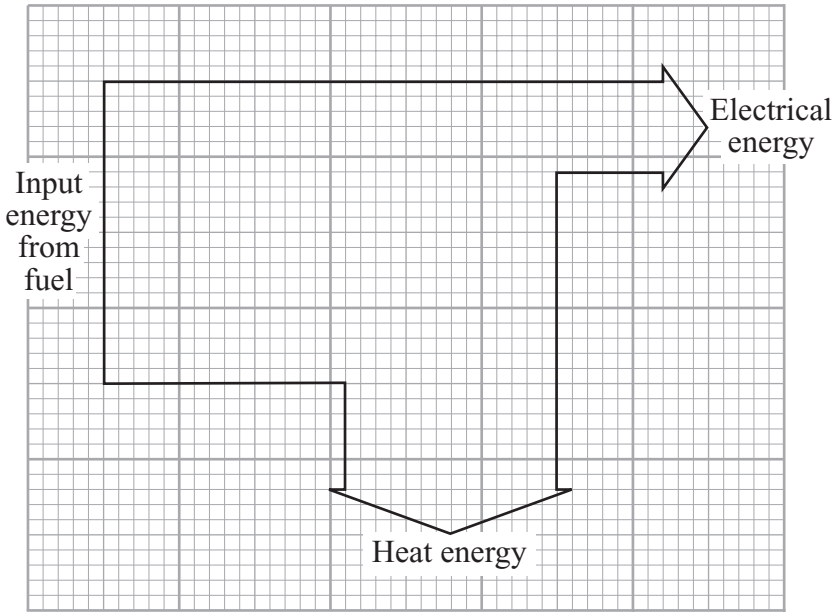
4 the power of the device.

4.1.2.2 Efficiency

Question 12

January 2008 | PHY1H | Original Q1 | Legacy

1 (a) The diagram shows the energy transformations in a fuel burning power station.



(i) Name **one** fuel that is burned to provide the energy source for a power station.

.....

(1 mark)

(ii) Use the diagram and the equation in the box to calculate the efficiency of the power station.

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

Show clearly how you work out your answer.

.....

.....

Efficiency = ...

(2 marks)

(iii) Name the process by which a nuclear fuel provides the energy needed to generate electricity in a nuclear power station.

.....

(1 mark)

Question 1 continues on the next page

4.1.2.2 Efficiency

Question 12 · continued

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(b) Electricity is distributed from power stations to consumers along the National Grid.

(i) Transformers are part of the National Grid. Transformers are *efficient* devices.

What is meant by a device being *efficient*?

.....

.....

(1 mark)

(ii) When electricity flows through a cable, some energy is transformed into heat.

Explain how the National Grid system reduces the amount of energy lost as heat.

.....

.....

.....

.....

(2 marks)

(c) Read this information taken from a recent newspaper article.

- Researchers have found that children living close to overhead power cables are more likely to develop leukaemia.
- The researchers studied two groups of children. One group had developed leukaemia, the other group was healthy.
- Although the researchers found a link, they are unable to explain why it happened. They say that the results may have happened by chance.
- Other factors that have not been investigated, such as the environment, the geographical area or the children's genes, could be important.
- A cancer research charity said that childhood leukaemia was most likely to be caused by factors that parents were unable to control.

(i) Why did the researchers study a group of healthy children?

.....

.....

(1 mark)

4.1.2.2 Efficiency

Question 12 · continued

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(ii) The information does not say how many children were studied.

Why should this data have been included in the article?

.....

.....

(1 mark)

(iii) The researchers could not be certain that the overhead power cables were responsible for the increased chance of children developing leukaemia.

Explain why.

.....

.....

.....

.....

(2 marks)

(iv) The results of the research carried out by scientists may worry some people.

What do you think scientists should do?

Put a tick (✓) in the box next to your choice.

Scientists should publish their research findings straight away. ☐

Scientists should not publish their research findings until they have found out as many facts as possible. ☐

Give a reason for your choice.

.....

.....

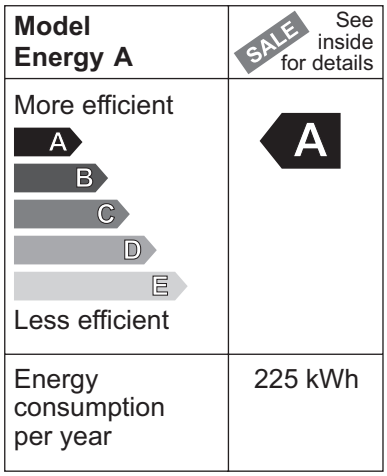
(1 mark)

12

4.1.2.2 Efficiency

Question 13

2 The diagram shows the label from a new freezer.



(a) An old freezer has an energy consumption per year of 350 kWh.

Use the equation in the box to calculate the extra cost of using the old freezer for one year compared with using a new 'A' rated freezer.

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

Assume 1 kilowatt-hour (kWh) of energy costs 12 p.

Show clearly how you work out your answer.

.....

.....

Extra cost per year = £ .....

(2 marks)

4.1.2.2 Efficiency

Question 13 · continued

BLANK

(b) The price of the new freezer was reduced in a sale.

Reducing the price reduces the payback time for replacing the old freezer from 12 years to 9 years.

Calculate, in pounds, how much the new freezer was reduced in the sale.

Show clearly how you work out your answer.

.....

.....

Price reduced by = £ .....

(2 marks)

(c) An advertisement in a shop claims that:

'Replacing an old freezer with a new 'A' rated freezer will benefit the environment.'

Do you agree that replacing the freezer will benefit the environment?

Answer yes or no. .....

Explain the reasons for your answer.

.....

.....

.....

.....

(2 marks)

6

4.1.2.2 Efficiency

Question 14

January 2008 | PHY1H | Original Q3 | Legacy

3 (a) In winter, energy is transferred from the warm air inside a house to the air outside.

(i) What effect will the energy transferred from the house have on the air outside?

.....

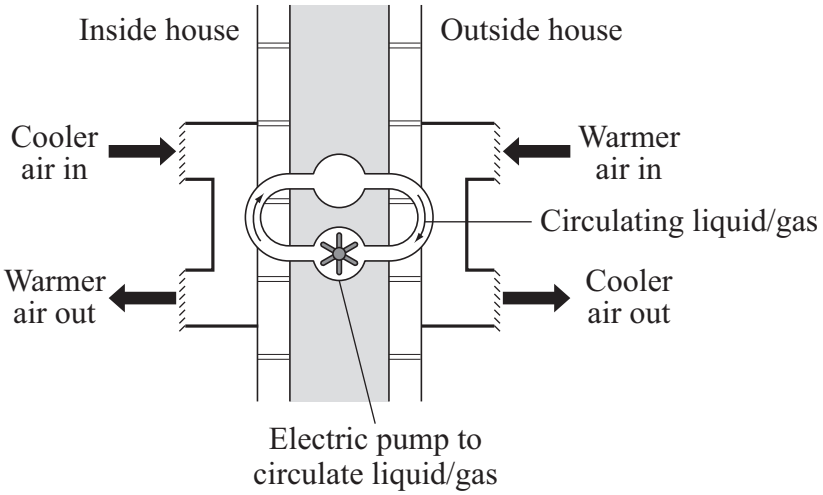
(1 mark)

(ii) What would happen to the energy transfer if the temperature inside the house were reduced? Assume the temperature outside the house does not change.

.....

(1 mark)

(b) To increase energy efficiency, a householder installs a heat exchanger to an outside wall of the house. The heat exchanger uses heat from the air outside to warm the inside of the house. The diagram shows the idea of the heat exchanger.



(i) Why does the heat exchanger cost money to run?

.....

(1 mark)

(ii) The heat exchanger is cost effective in reducing energy consumption. Explain why.

.....

.....

.....

.....

(2 marks)

5

4.1.2.2 Efficiency

Question 15

March 2008 | PHY1AP | Original Q8 | Legacy

QUESTION EIGHT

Many scientists think that changes to the ice caps are affecting global warming.

As the ice melts, dark particles accumulate at the surface of the ice. This reduces the amount of sunlight reflected from the surface of the ice. The extra heat taken in by the ice causes the release of frozen methane. Methane is a potent greenhouse gas.

8A The reduction in the amount of sunlight reflected by the ice caps causes more heat to be transferred to the ice by . . .

1 conduction.

2 convection.

3 insulation.

4 radiation.

8B In addition to methane, the other potent greenhouse gas is . . .

1 carbon monoxide.

2 carbon dioxide.

3 ozone.

4 sulfur dioxide.

4.1.2.2 Efficiency

Question 15 · continued

Changes to the ways in which electricity is generated could reduce global warming.

8C

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

Centralised power stations are large power stations that supply electricity over a wide area.

A centralised power station wastes two-thirds of the energy supplied to it.

The efficiency of a centralised power station is . . .

1 0.23

2 0.33

3 0.50

4 0.67

8D Smaller local power stations use the heat that would normally be lost in cooling towers to warm surrounding homes and offices.

A large centralised power station and a group of four smaller local power stations both use the same mass of coal to generate electricity.

In comparison to the large centralised power station, the group of local power stations would . . .

1 produce less carbon dioxide.

2 have less impact on the environment.

3 produce more electricity.

4 transfer the same amount of useful energy.

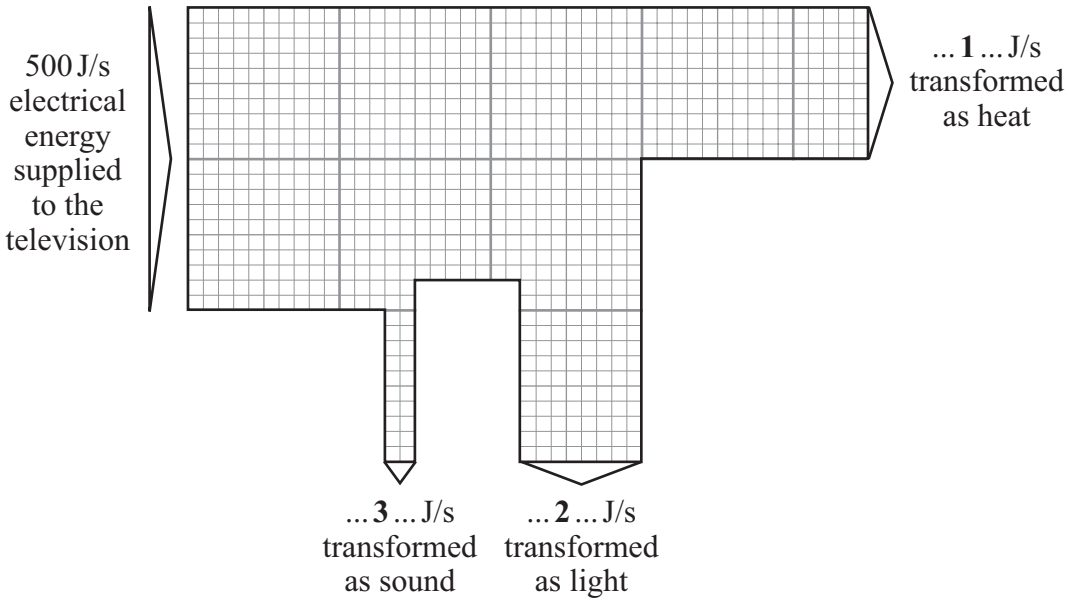
4.1.2.2 Efficiency

Question 16

June 2008 | PHY1AP | Original Q1 | Legacy

QUESTION ONE

The Sankey diagram shows the energy flow for a television.



The efficiency of the television is ... **4** ...

4.1.2.2 Efficiency

Question 16 · continued

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

Match figures, **A**, **B**, **C** and **D**, with the numbers **1–4** on the diagram.

A 0.50

B 50

C 200

D 250

Turn over for the next question

4.1.2.2 Efficiency

Question 17

June 2008 | PHY1H | Original Q4 | Legacy

4 (a) Solar energy is a *renewable* energy source that can be used to generate electricity.

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

.....

(1 mark)

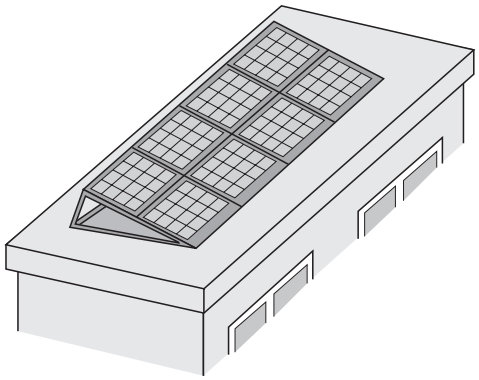
4 (a) (ii) Name **two** further renewable energy sources used to generate electricity.

1 .....

2 .....

(1 mark)

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



4.1.2.2 Efficiency

Question 17 · continued

for mark

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

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

.....

.....

.....

.....

(2 marks)

4 (b) (ii) The bank of solar cells used by the householder has an area of 8 m^2.

The efficiency of the solar cells is 0.15

Use the equation in the box to calculate the average **maximum** electrical energy available from the bank of solar cells 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.

.....

.....

Maximum energy = ... joules/second

(3 marks)

Question 4 continues on the next page

4.1.2.2 Efficiency

Question 17 · continued

for mark

4 (c) The graph shows how the householder's electrical energy needs change over one year.



Why would it be advisable for the householder to remain connected to the National Grid?

.....

.....

(1 mark)

8

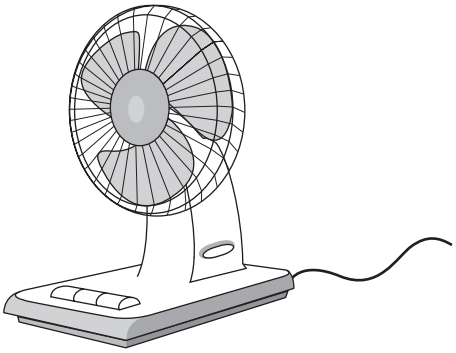
4.1.2.2 Efficiency

Question 18

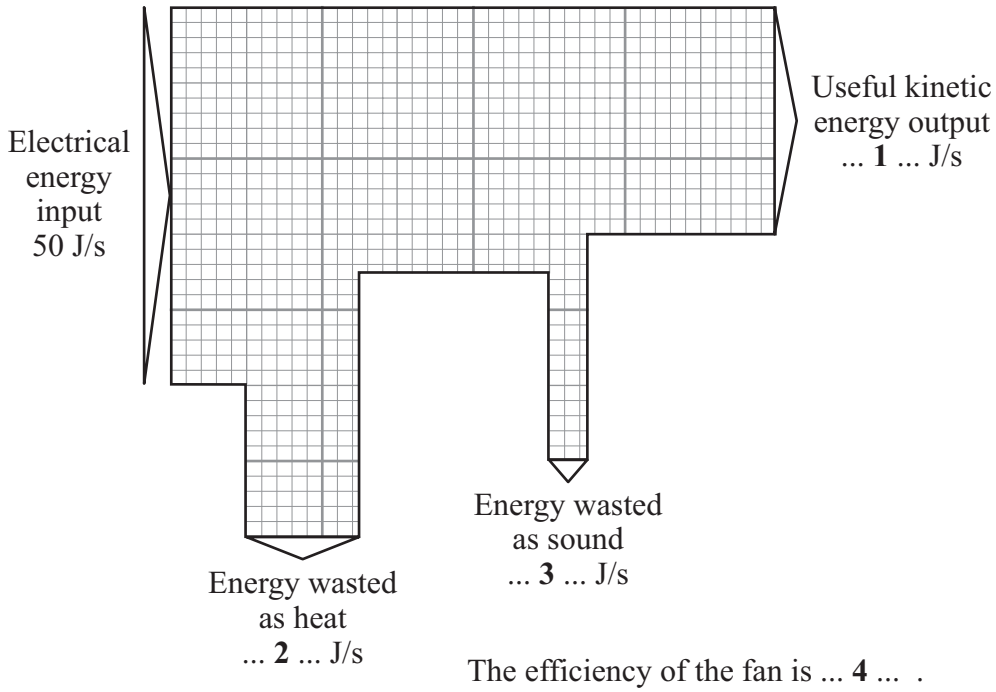
November 2008 | PHY1AP | Original Q1 | Legacy

QUESTION ONE

The diagram shows an electric fan.



The Sankey diagram gives the energy transformations for the fan.



The efficiency of the fan is ... **4** ... .

4.1.2.2 Efficiency

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

Match numbers, **A**, **B**, **C** and **D**, with the labels **1–4** on the Sankey diagram.

A 0.6

B 5

C 15

D 30

Turn over for the next question

4.1.2.2 Efficiency

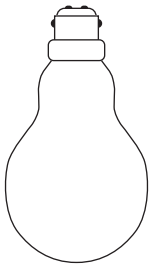
Question 19

November 2008 | PHY1AP | Original Q5 | Legacy

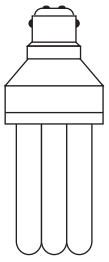
QUESTION FIVE

The diagram shows information about four types of electric lamp.

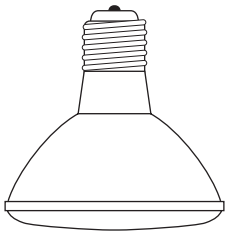
Each lamp produces the same amount of light energy in the same time.



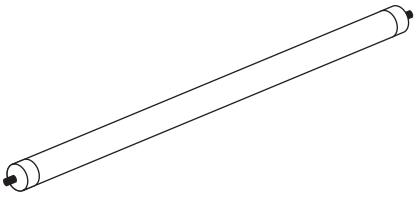
100 watt filament lamp
Average life = 1000 hours
Cost = £0.50



20 watt energy-saving lamp
Average life = 10 000 hours
Cost = £3.00



10 watt LED spotlight
Average life = 60 000 hours
Cost = £30.00



15 watt fluorescent tube
Average life = 5000 hours
Cost = £5.00

5A Which lamp is the most efficient?

1 100 watt filament lamp

2 20 watt energy-saving lamp

3 10 watt LED spotlight

4 15 watt fluorescent tube

4.1.2.2 Efficiency

Question 19 · continued

5B Which lamp would get the hottest when it is working?

1 100 watt filament lamp

2 20 watt energy-saving lamp

3 10 watt LED spotlight

4 15 watt fluorescent tube

5C Which lamp would be the cheapest to run for 1000 hours?

1 100 watt filament lamp

2 20 watt energy-saving lamp

3 10 watt LED spotlight

4 15 watt fluorescent tube

5D You want a lamp that will provide light for 60 000 hours. You realise that you may have to buy more than one lamp to last this long.

Which type of lamp would work out the cheapest to buy?

1 100 watt filament lamp

2 20 watt energy-saving lamp

3 10 watt LED spotlight

4 15 watt fluorescent tube

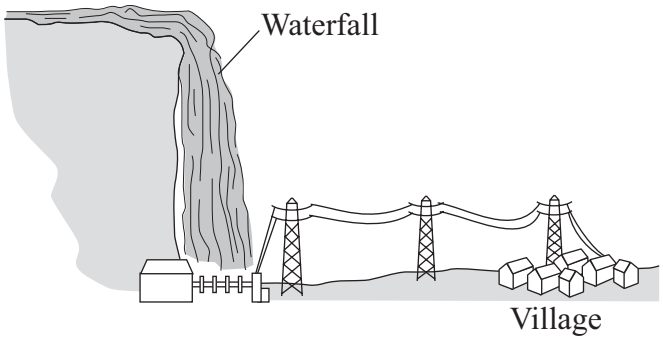
4.1.2.2 Efficiency

Question 20

November 2008 | PHY1AP | Original Q6 | Legacy

QUESTION SIX

The diagram shows a hydroelectric scheme.



A small mountain village lies near a waterfall.

The energy of the falling water is used to generate electricity for the village.

The table gives some information about the village and the electrical supply.

Efficiency of generating system	0.12
Energy of water entering turbines per second	10 000 kJ
Population of the village	1200
Average number of people per household	4
Average electrical demand per household	3.0 kW

6A The reason why the energy transformation is so inefficient is that . . .

1 the waterfall is not high enough.

2 water is a poor conductor of electricity.

3 heat is produced in the turbines.

4 maintenance costs are high.

4.1.2.2 Efficiency

Question 20 · continued

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

6B The electrical energy available to the village is . . .

1 833 kJ

2 1 200 kJ

3 83 300 kJ

4 120 000 kJ

6C The average power demand for the whole village is . . .

1 900 kW

2 3 600 kW

3 4 800 kW

4 14 400 kW

6D The total energy used by the village each day is, on average, 21 600 kWh. The daily maintenance cost of running the hydroelectric scheme is £1200.

What is the price, in pence per kWh, which must be charged to cover the daily maintenance costs?

$$\text{total cost} = \text{number of kilowatt-hours} \times \text{cost per kilowatt-hour}$$

1 2.8 p

2 5.6 p

3 11.2 p

4 22.4 p

4.1.2.2 Efficiency

Question 21

November 2008 | PHY1AP | Original Q9 | Legacy

QUESTION NINE

This question is about using electricity in the home.

9A When electricity is transmitted from a power station, it is stepped up from 25 kV to 300 kV.

This is done by a . . .

1 generator to decrease the current and make it safer.

2 generator to increase the current and make the electricity travel faster.

3 transformer to increase the current and reduce energy losses.

4 transformer to reduce the current and reduce energy losses.

The table shows the power ratings of four electrical appliances.

Fan heater	2 kW
Oven	3 kW
Kettle	2 kW
Microwave oven	0.75 kW

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

$$\text{energy transferred (kilowatt-hour, kWh)} = \text{power (kilowatt, kW)} \times \text{time (hour, h)}$$

$$\text{total cost} = \text{number of kilowatt-hours} \times \text{cost per kilowatt-hour}$$

The cost of electrical energy is 10 p per kilowatt-hour.

4.1.2.2 Efficiency

Question 21 · continued

9B The kettle is used for a total of 30 minutes a day. It has an efficiency of 0.9

What is the cost of the energy wasted by the kettle each day?

1 0.6 p

2 1.0 p

3 6.0 p

4 9.0 p

9C The fan heater has a heating element and a motor to turn the blades of the fan. The power rating of the heater is 1800 W. To cool a room in the summer, only the fan is used.

How much would it cost to use the fan to cool a room for 5 hours?

1 0.1 p

2 1.0 p

3 10.0 p

4 100.0 p

9D A bowl of cauliflower cheese is cooked in a microwave oven for 6 minutes on half power.

How much does it cost to cook the cauliflower cheese?

1 0.375 p

2 0.750 p

3 1.500 p

4 2.250 p

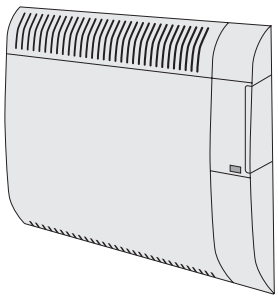
END OF TEST

4.1.2.2 Efficiency

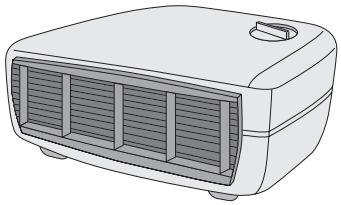
Question 22

January 2009 | PHY1H | Original Q2 | Legacy

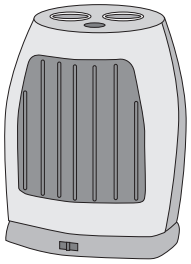
2 The pictures show three different types of electric heater.



400 W oil-filled panel heater (wall mounted)
- 3 heat settings
- Efficient background heat
- Safety overheat cut-out



3 kW fan heater
- 2 heat settings
- Power indicator light
- Cool air fan setting



1800 W ceramic heater
- 2 heat settings
- 8 hour timer
- Power indicator light
- Safety overheat cut-out

2 (a) The ceramic heater is run on full power for 5 hours.

Use the following equation to calculate, in kilowatt-hours, the amount of energy transferred from the mains to the heater.

energy transferred = power × time

Show clearly how you work out your answer.

.....

.....

Energy transferred = ... kilowatt-hours

(2 marks)

2 (b) Which heater will be the most expensive to run on its highest heat setting?

.....

(1 mark)

4.1.2.2 Efficiency

Question 22 · continued

for mark

2 (c) A heater is needed for a small office.

Comparing each type of heater with the other two, give **one** advantage of using each type of heater in the office.

oil-filled panel heater .....

.....

fan heater .....

.....

ceramic heater .....

.....

(3 marks)

6

Turn over for the next question

4.1.2.2 Efficiency

Question 23

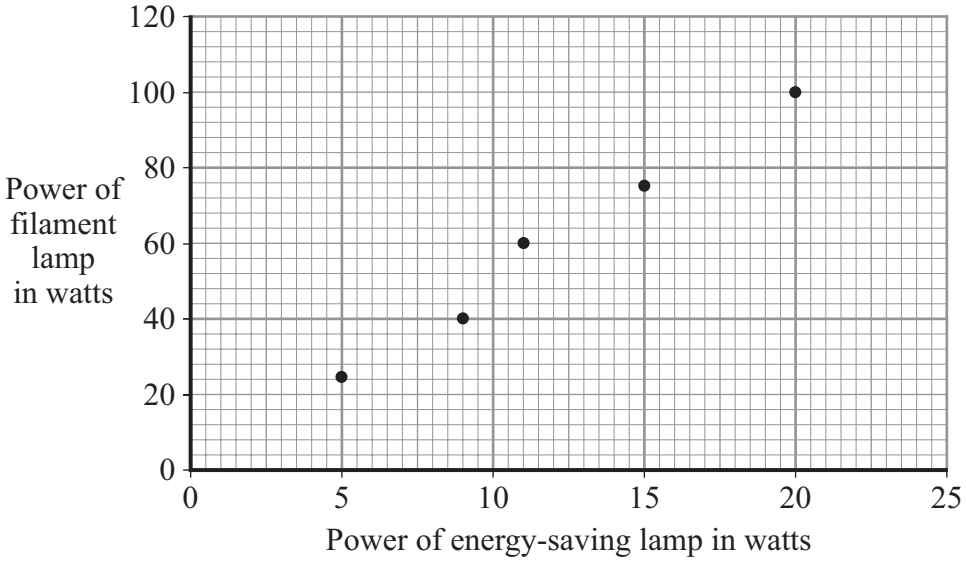
March 2009 | PHY1AP | Original Q9 | Legacy

QUESTION NINE

A householder bought an energy-saving lamp. She found the following table printed on its packaging.

Power of energy-saving lamp in W	Equivalent power of filament lamp in W
5	25
9	40
11	60
15	75
20	100

The graph shows the data.



9A To see if the power of the filament lamp is directly proportional to the power of the energy-saving lamp, you should . . .

1 draw a line of best fit.

2 draw a straight line of best fit and see whether it passes through (0,0).

3 plot more points and see whether a straight line is produced.

4 produce a bar chart and see whether there is a positive relationship.

4.1.2.2 Efficiency

Question 23 · continued

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

9B A 25 W lamp transforms 25 joules of electrical energy each second.

The efficiency of a 25 W energy-saving lamp is 0.6

How much energy does it waste each second?

1 10.0 J

2 15.0 J

3 41.2 J

4 62.5 J

9C The efficiency of a 100 W filament lamp is 0.15

From the data in the table on page 30, what is the approximate efficiency of the 20 W energy-saving lamp?

1 0.03

2 0.15

3 0.30

4 0.75

9D The government has recommended that the sale of filament lamps should be stopped.

Why is this?

1 to give shops new products to sell

2 to use less fuel for generating electricity

3 to make electricity cheaper to buy

4 to give householders brighter lamps

END OF TEST

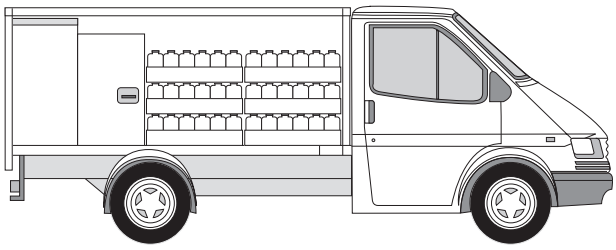
4.1.2.2 Efficiency

Question 24

June 2009 | PHY1AP | Original Q4 | Legacy

QUESTION FOUR

The diagram shows an electrically powered milk float.



In a milk float, batteries drive an electric motor.
A milk float travels 40 km a day.
The batteries are recharged overnight.

4A When the milk float is travelling along the road, the batteries transform . . .

1 electrical energy to kinetic energy.

2 kinetic energy to chemical energy.

3 chemical energy to electrical energy.

4 kinetic energy to electrical energy.

4B When charging the batteries, the battery charger transfers 1.5 kW of power for 5 hours.

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

The energy transferred to the batteries is . . .

1 0.3 kWh

2 3.3 kWh

3 7.5 kWh

4 75 kWh

4.1.2.2 Efficiency

Question 24 · continued

4C During a day, the electric motor usefully transfers 1600 kJ. The energy supplied to the electric motor is 4000 kJ.

What is the efficiency of the motor?

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

1 0.4

2 2.5

3 2400

4 5600

4D The milk float is said to be more ‘environmentally friendly’ than a petrol-driven vehicle.

This is because . . .

1 the batteries store energy.

2 it produces no harmful waste gases.

3 the batteries can be recharged many times.

4 the top speed is only 20 km/h.

4.1.2.2 Efficiency

Question 25

June 2009 | PHY1AP | Original Q7 | Legacy

QUESTION SEVEN

The table compares data for two types of lamp.

	Filament lamp	Compact fluorescent lamp (CFL)
Cost	80p	£3.00
Efficiency	0.2	0.8
Expected life	1000 hours	8000 hours

7A People may decide **not** to buy CFLs because CFLs are . . .

1 more expensive to buy.

2 more efficient.

3 cheaper to run.

4 longer lasting.

7B A filament lamp with a power rating of 100 W gives 2000 units of light.

What power rating would a CFL need to provide 2000 units of light?

1 8000 W

2 20 W

3 25 W

4 25 kW

4.1.2.2 Efficiency

Question 25 · continued

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

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

Electricity costs 15 p per kWh

7C What will be the cost of using a 100 W filament lamp during its expected life?

1 £1.50

2 £15.00

3 £150.00

4 £1500.00

7D In its lifetime, a security light is used for 15 000 hours.

How much would you expect to spend on buying CFLs for the security light in that time?

1 £5.63

2 £6.00

3 £12.00

4 £45.00

4.1.2.2 Efficiency

Question 26

June 2009 | PHY1AP | Original Q8 | Legacy

QUESTION EIGHT

This question is about the energy available from various fuels.

The table shows the amount of energy that 1 kg of different fuels can produce when the fuel energy is transformed.

Fuel	Energy available in MJ per kg
Uranium	70 million
Hydrogen	115
Gas	50
Oil	45
Coal	20
Wood	15

1 MJ = 1 million joules

8A What mass of coal, in kg, would provide the same amount of energy as 1 kg of uranium?

1 0.29

2 3.5

3 0.29 million

4 3.5 million

8B Which three fuels are non-renewable?

1 coal, gas and wood

2 coal, gas and uranium

3 gas, oil and wood

4 gas, uranium and wood

4.1.2.2 Efficiency

Question 26 · continued

8C Coal is burned at a rate of 100 kg per second in a power station. The overall efficiency of the power station is 0.3.

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

What is the energy output per second, in MJ, of this power station?

1 600

2 1400

3 1500

4 6700

8D A factory gets all of its energy by burning oil.

Only half of the energy from burning oil is transformed into useful energy.

For a working day, the energy required to run the factory is 10 800 MJ.

What is the mass of oil, in kg, needed each day?

1 24

2 48

3 240

4 480

4.1.2.2 Efficiency

Question 27

June 2009 | PHY1AP | Original Q9 | Legacy

QUESTION NINE

The following information is from a leaflet produced by a double-glazing company.

Change your single-glazed windows to our energy-efficient double glazed windows and save a massive £167 a year

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

9A The company assumes that energy costs 11p per kWh.

How much energy does the company claim would be saved each year by fitting its double-glazing?

1 15.2 kWh

2 1 520 kWh

3 1 837 kWh

4 183 700 kWh

9B Double glazing for a house costs £4000. A householder saves £200 in the first year after installing the double-glazing. Fuel prices rise steadily during that year.

The pay-back time is likely to be . . .

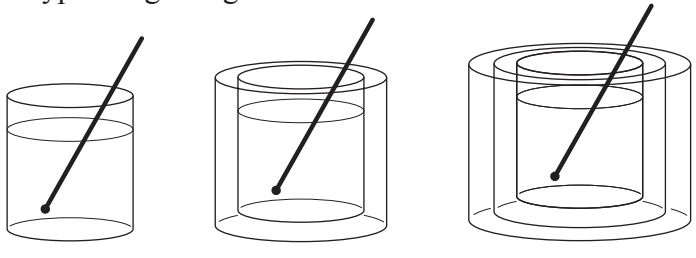
1 exactly 20 years.

2 more than 20 years if fuel prices continue to rise.

3 less than 20 years if fuel prices continue to rise.

4 less than 20 years if fuel prices fall steadily over the next few years.

9C Some students investigated the effectiveness of double and triple glazing. They let 100 cm^3 of boiling water cool in a glass beaker for 20 minutes. They repeated the cooling with the beaker placed inside another one and then inside two beakers. The students also looked up the U-value of different types of glazing on the Internet.



Single glazing | Double glazing | Triple glazing

Question 27 · continued

The results are shown in the table.

	Single glazing	Double glazing	Triple glazing
Temperature in °C after 20 minutes	68	81	88
U-value	1.0	0.5	0.3

Which of these conclusions should the students draw from their results?

1 Double glazing is more effective than triple glazing and a greater U-value means a larger heat loss.

2 Double glazing is more effective than triple glazing and a greater U-value means a smaller heat loss.

3 Triple glazing is more effective than double glazing and a smaller U-value means a larger heat loss.

4 Triple glazing is more effective than double glazing and a smaller U-value means a smaller heat loss.

9D One student stated that the investigation was not realistic. He said that:

- there is a difference between the area of a window and the surface area of the beakers
- the temperature difference across a window is different from the temperature difference across the beakers.

The table compares a window with the beakers in the experiment.

Which row in the table is correct?

	Surface area of window		Temperature difference across window	
	Compared with the beaker	**Effect on rate of heat transfer**	**Compared with the beaker**	**Effect on rate of heat transfer**
1	larger	slower	larger	slower
2	smaller	slower	larger	faster
3	larger	faster	smaller	slower
4	smaller	faster	smaller	faster

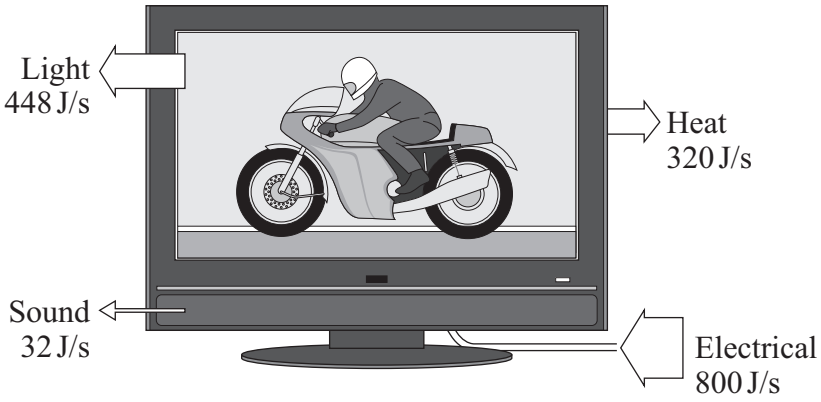
END OF TEST

4.1.2.2 Efficiency

Question 28

June 2009 | PHY1H | Original Q3 | Legacy

3 (a) The diagram shows the energy transformations produced by a TV.



3 (a) (i) Use the information in the diagram and the equation in the box to calculate the efficiency of the TV.

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

Show clearly how you work out your answer.

.....

.....

Efficiency = ...

(2 marks)

3 (a) (ii) What eventually happens to the useful energy transferred by the TV?

.....

.....

(1 mark)

Question 3 continues on the next page

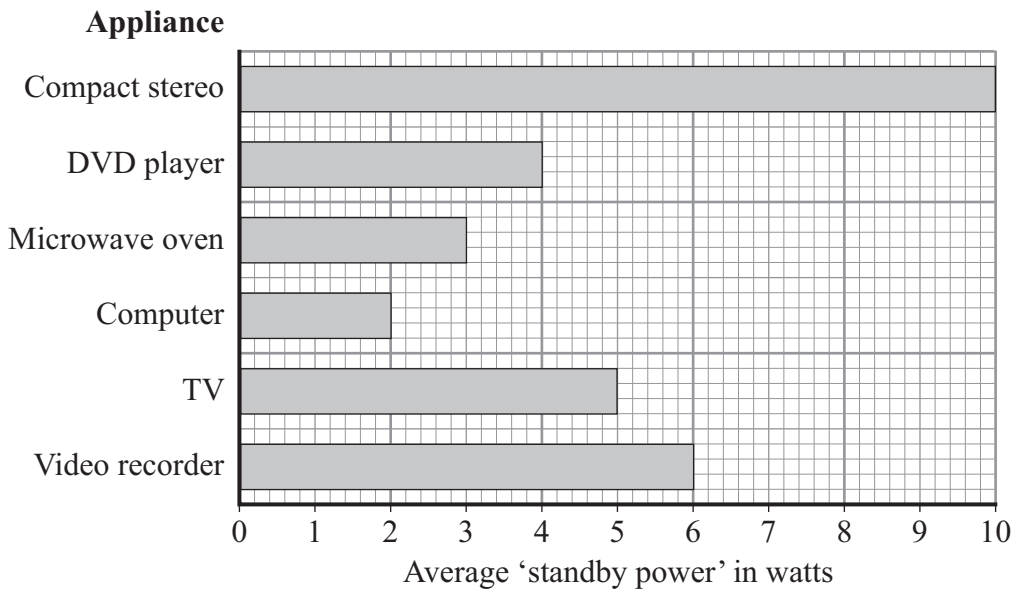
4.1.2.2 Efficiency

Question 28 · continued

for mark

3 (b) Electrical appliances left on standby use energy.

The bar chart shows the power for the appliances that one family leaves on standby when they go on holiday.



The family is on holiday for a total of 175 hours.

3 (b) (i) Use the information in the bar chart and the equation in the box to calculate the energy wasted by leaving the compact stereo on standby while the family is on holiday.

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

Show clearly how you work out your answer.

.....

.....

Energy wasted = ... kilowatt-hours

(2 marks)

4.1.2.2 Efficiency

Question 28 · continued

for mark

3 (b) (ii) Electricity costs 12 p per kilowatt-hour.

Use the equation in the box to calculate the cost of leaving the compact stereo on standby while the family is on holiday.

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

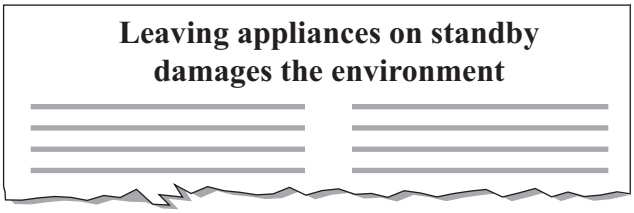
Show clearly how you work out your answer.

.....

Cost = ... p

(1 mark)

3 (c) A headline from a recent newspaper article is shown below.



Explain why leaving appliances on standby damages the environment.

.....

.....

.....

.....

(2 marks)

8

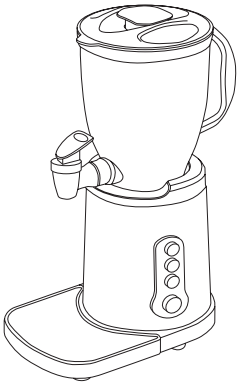
4.1.2.2 Efficiency

Question 29

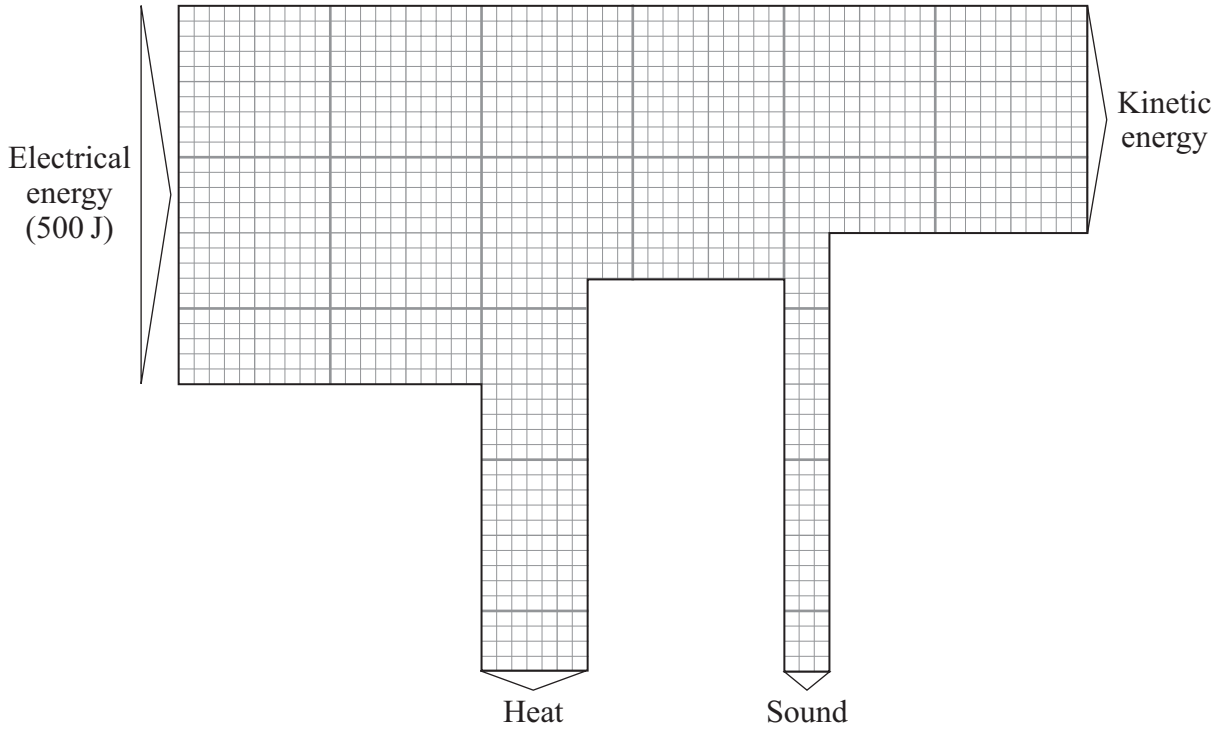
November 2009 | PHY1AP | Original Q1 | Legacy

QUESTION ONE

The diagram shows a smoothie maker.



The Sankey diagram shows the energy transfers that take place each second in this smoothie maker.



4.1.2.2 Efficiency

Question 29 · continued

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

Match figures, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A 0.6

B 140

C 200

D 300

The kinetic energy produced each second is . . . **1** . . . J.

The heat produced each second is . . . **2** . . . J.

The total energy wasted each second is . . . **3** . . . J.

The efficiency of the smoothie maker is . . . **4** . . . .

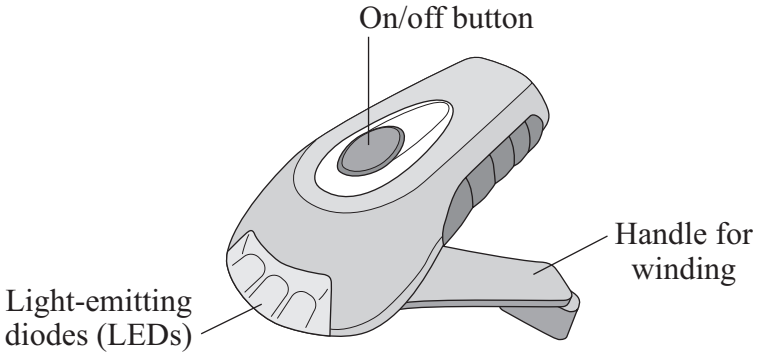
4.1.2.2 Efficiency

Question 30

November 2009 | PHY1AP | Original Q2 | Legacy

QUESTION TWO

The diagram shows a torch which contains a rechargeable battery. The battery is recharged by winding the handle.



Match words, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A chemical

B electrical

C kinetic

D light

When the user winds the handle, the useful energy transformation is from . . . **1** . . . energy to . . . **2** . . energy which is stored in the battery.

When the torch is switched on, the useful output from the battery is . . . **3** . . . energy and the useful output from the LEDs is . . . **4** . . . energy.

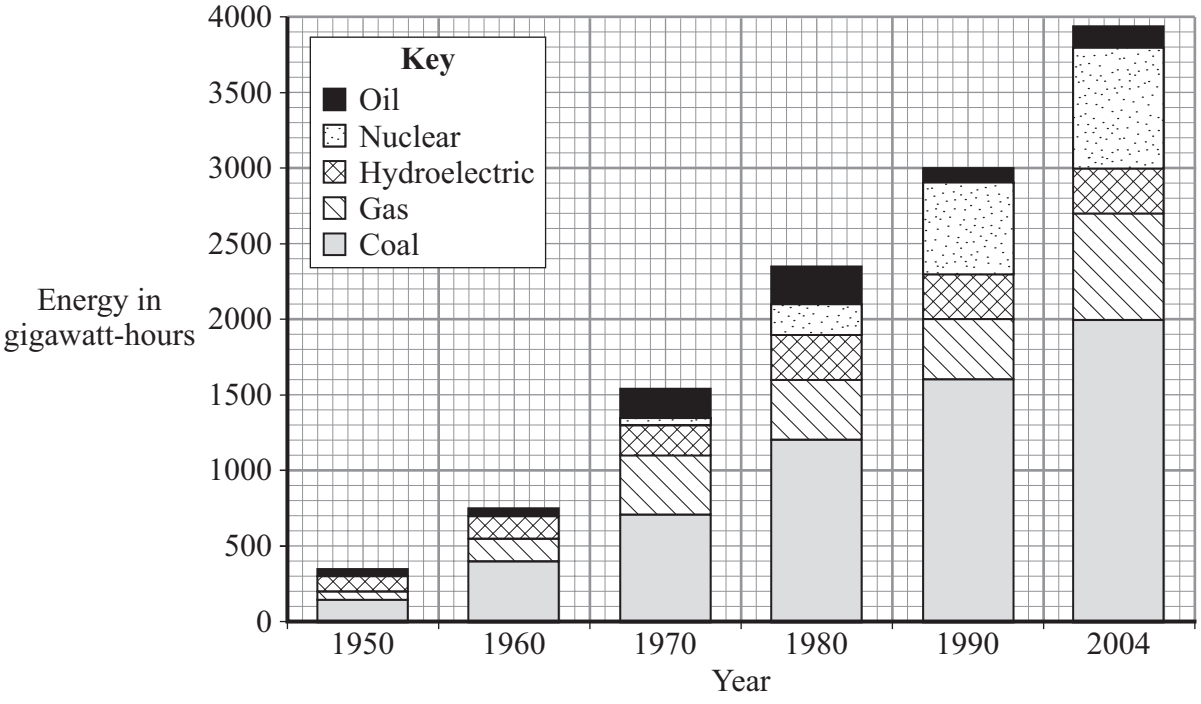
4.1.2.2 Efficiency

Question 31

November 2009 | PHY1AP | Original Q6 | Legacy

QUESTION SIX

The bar chart shows the generation of electricity, in gigawatt-hours for a certain country, from five different energy sources between 1950 and 2004.



6A Of the following energy sources, which one produced the greatest amount of electricity in 1980?

1 gas

2 hydroelectric

3 nuclear

4 oil

6B In 1990, which of the following energy sources was producing approximately 600 gigawatt-hours of electricity?

1 coal

2 gas

3 hydroelectric

4 nuclear

4.1.2.2 Efficiency

Question 31 · continued

6C Which of the following useful energy transformations takes place in power stations using coal, oil, gas and uranium?

1 kinetic to chemical

2 chemical to heat

3 electrical to kinetic

4 heat to kinetic

6D In 2004, over 50% of the electricity was generated using coal as the fuel. The government of the country is committed to reducing carbon dioxide emissions.

Which row in the table shows how the energy sources used for generating electricity may change in the next 10 years?

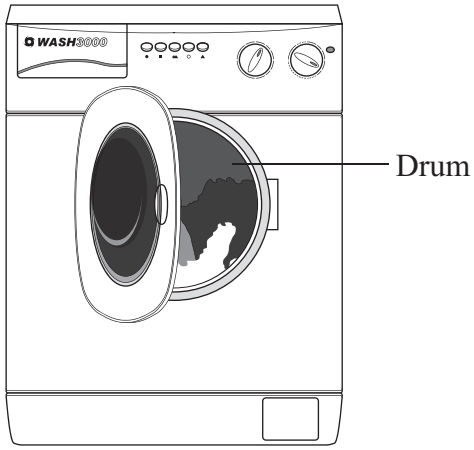
	Increased use	Decreased use
1	coal and gas	hydroelectric and nuclear
2	wave and wind	coal and gas
3	gas and nuclear	coal and wind
4	tidal and wave	nuclear and wind

4.1.2.2 Efficiency

Question 32

January 2010 | PHY1H | Original Q2 | Legacy

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.



2 (a) Complete the following sentences.

2 (a) (i) An electric motor is designed to transform electrical energy into

..... energy.

(1 mark)

2 (a) (ii) Some of the electrical energy supplied to the motor is wasted as

..... energy and ..... energy.

(1 mark)

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

.....

.....

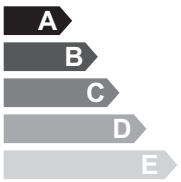
(1 mark)

4.1.2.2 Efficiency

Question 32 · continued

for mark

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

<table>
<tr><td colspan="2">Model – Wash 3000
Energy A</td></tr>
<tr><td>More efficient


Less efficient</td><td>
</td></tr>
<tr><td>Energy
consumption
kWh/wash cycle
(based on 40 °C wash)</td><td>1.1</td></tr>
</table>

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

Explain what being *more energy efficient* means.

.....

.....

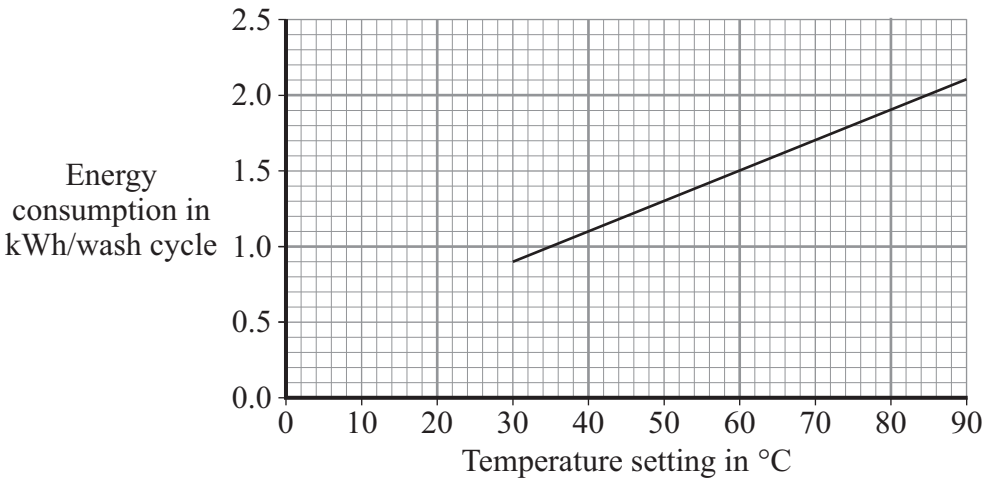
.....

.....

(2 marks)

Question 2 continues on the next page

2 (d) 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.



2 (d) (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.

.....

.....

Money saved = ... p
(2 marks)

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

.....

.....
(1 mark)

8

4.1.2.2 Efficiency

Question 33

January 2010 | PHY1H | Original Q5 | Legacy

5 Over the next 15 years, some of the older nuclear power stations will be closed down, and the process of *decommissioning* will start. In the same period, several countries plan to build a number of new nuclear power stations.

5 (a) (i) What does it mean to *decommission* a nuclear power station?

.....

.....

(1 mark)

5 (a) (ii) How does *decommissioning* affect the overall cost of electricity generated using nuclear fuels?

.....

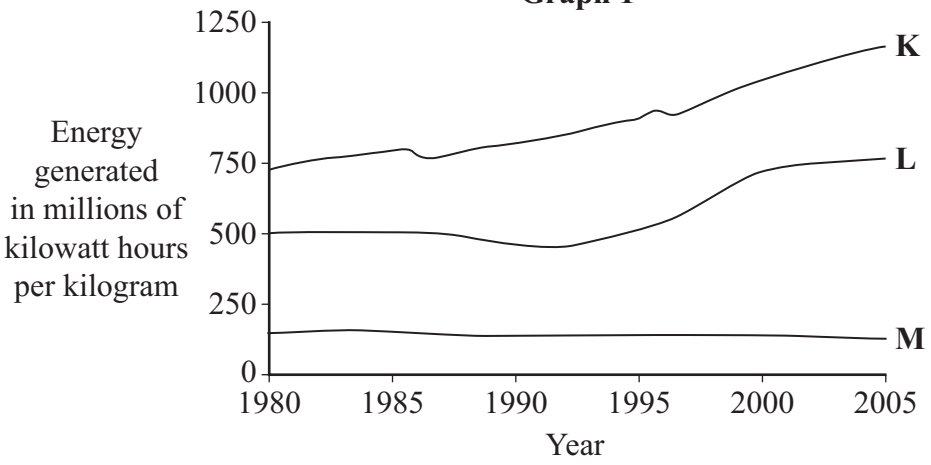
.....

(1 mark)

5 (b) Uranium is a fuel used in nuclear power stations to generate electricity.

Graph 1 compares how the electricity generated from one kilogram of nuclear fuel changed between 1980 and 2005 in three different types of nuclear power station.

Graph 1



5 (b) (i) Compare the efficiency of the three types of power station, **K**, **L** and **M**, between 1980 and 2005.

.....

.....

.....

.....

(2 marks)

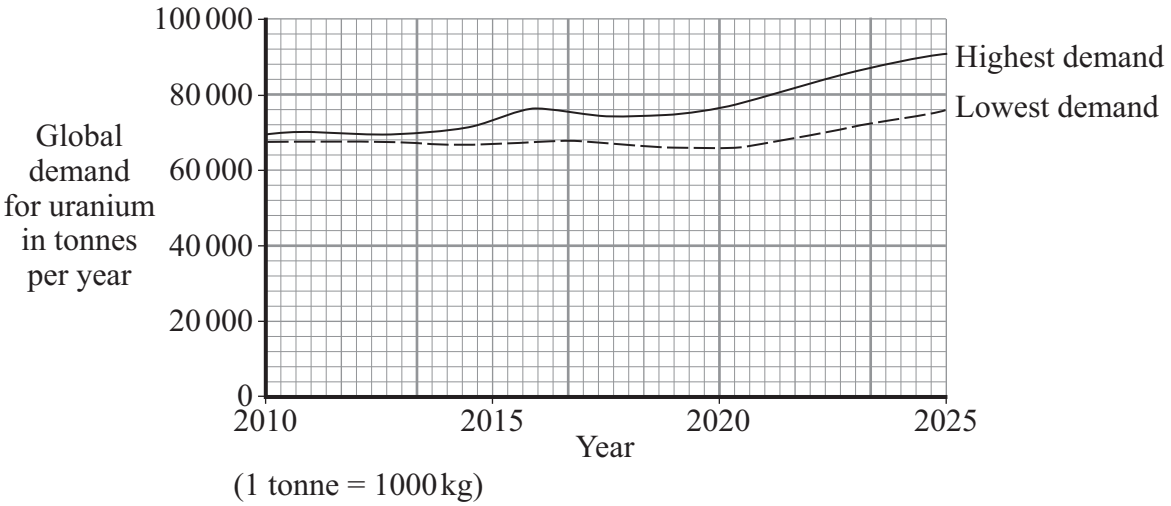
4.1.2.2 Efficiency

Question 33 · continued

for mark

Graph 2 shows two different predictions for the global growth in uranium demand over the next 15 years.

Graph 2



(1 tonne = 1000 kg)

5 (b) (ii) Suggest reasons why it is **not** possible to predict accurately how much uranium will be needed in 2025.

.....

.....

.....

.....

(2 marks)

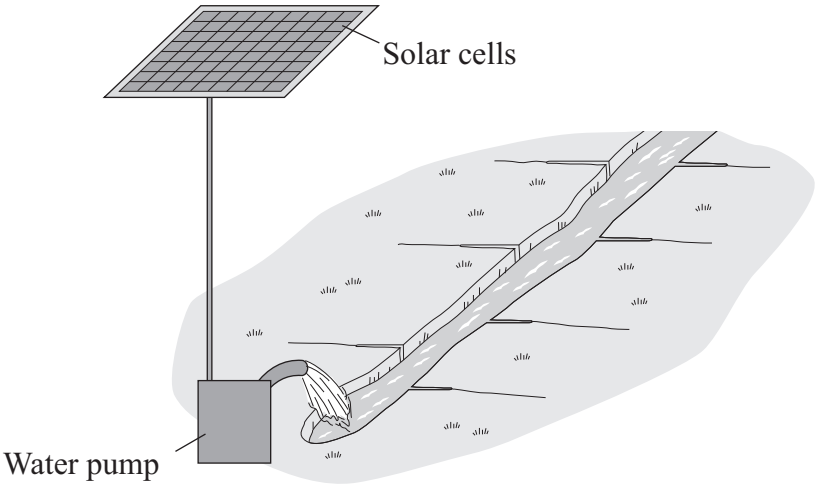
6

4.1.2.2 Efficiency

Question 34

January 2019 | PHY1H | Original Q7 | Legacy

7 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

7 (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 marks)

7 (a) (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 mark)

4.1.2.2 Efficiency

Question 34 · continued

for mark

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

.....

.....

(1 mark)

4

4.1.2.2 Efficiency

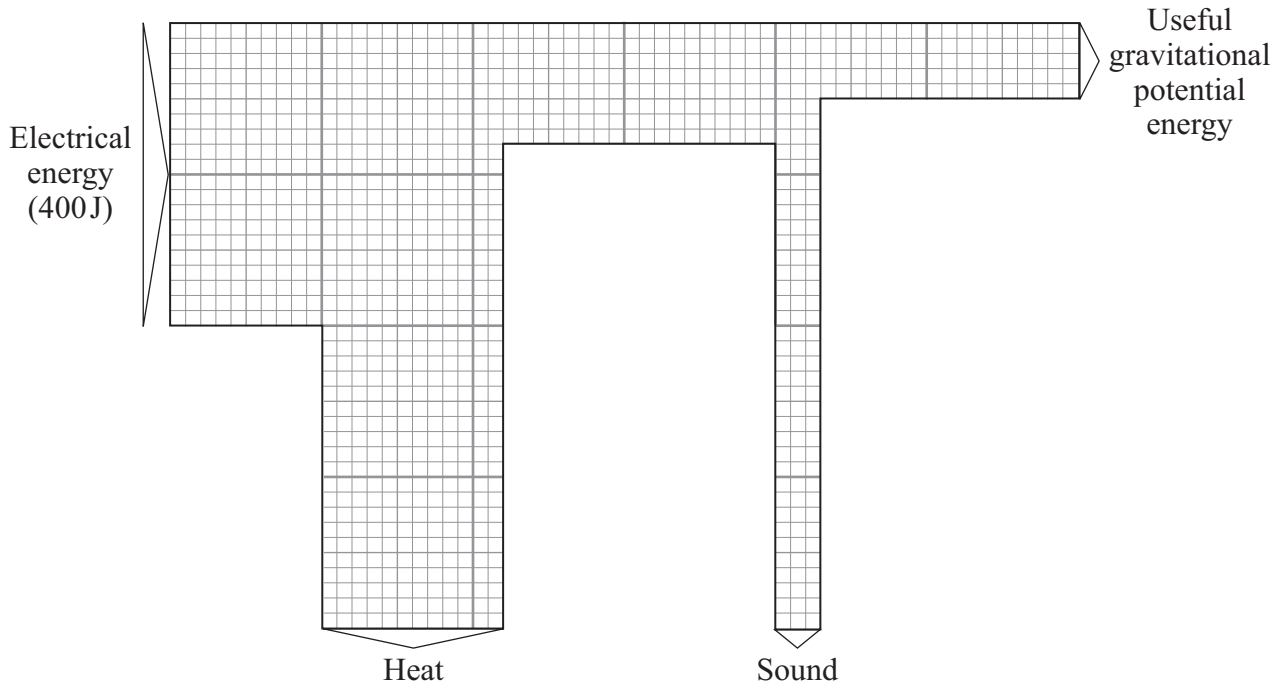
Question 35

March 2010 | PHY1AP | Original Q1 | Legacy

QUESTION ONE

An electric motor is used to lift a weight.

The Sankey diagram shows the energy transformations that take place each second in the electric motor.



Match figures, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A 0.25

B 60

C 100

D 240

4.1.2.2 Efficiency

Question 35 · continued

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

The useful gravitational potential energy gained each second is . . . **1** . . . J.

The heat (thermal energy) produced each second is . . . **2** . . . J.

The sound energy produced each second is . . . **3** . . . J.

The total energy wasted each second is 300 J. The efficiency of the electric motor is . . . **4** . . . .

4.1.2.2 Efficiency

Question 36

March 2010 | PHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about useful energy transformations by different electrical devices.

Match devices, **A**, **B**, **C** and **D**, with the useful energy transformations **1–4** in the table.

A computer monitor

B loudspeaker

C microphone

D solar cell

	Useful energy transformations
1	electrical energy into light energy
2	sound energy into electrical energy
3	electrical energy into sound energy
4	light energy into electrical energy

4.1.2.2 Efficiency

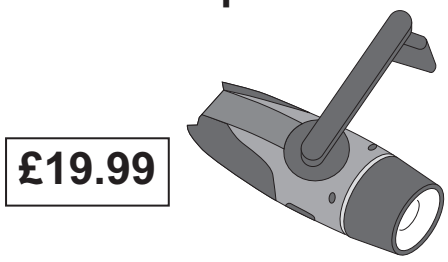
Question 37

March 2010 | PHY1AP | Original Q6 | Legacy

QUESTION SIX

Read this advertisement for a wind-up torch.

Wind-up Torch



This torch is always ready to go. Simply wind the handle for just 1 minute and this will power your torch for up to 2 hours of use.

The torch also has a mobile phone connection that will power mobile phones for up to 7 minutes of talk-time for every 1 minute of winding.

You won't have to scrabble around in the dark looking for your torch. The 1 minute of winding also powers a standby light for up to 2 months.

The wind-up torch is strong, splash-proof and eco-friendly.

6A The wind-up torch and a power station both generate electricity.

Which feature of the power station process is the equivalent of the torch's winding handle?

1 boiler

2 generator

3 steam

4 turbine

4.1.2.2 Efficiency

Question 37 · continued

6B The source of energy for the operator of the torch's winding handle is food.

Which of these forms of energy is **not** involved in the chain of useful energy transformations for the torch as it is wound up?

1 chemical

2 electrical

3 kinetic

4 thermal

6C What feature of the wind-up torch enables the advertisement to claim that it is eco-friendly?

1 It can be used to power mobile phones.

2 It has a standby light.

3 It is splash-proof.

4 It produces no waste products when in use.

6D A dog owner uses a conventional torch every night. The torch she uses is powered by 4 batteries. She has to replace the batteries every 3 months. The batteries cost 75p each.

If she bought this wind-up torch, how long would the pay-back time be?

1 between 6 months and 1 year

2 between 1 year and 1.5 years

3 between 1.5 years and 2 years

4 between 2 years and 2.5 years

4.1.2.2 Efficiency

Question 38 June 2010 | PHY1AP | Original Q4 | Legacy

QUESTION FOUR

The UK government has decided that filament lamps must be replaced by energy-saving lamps. Some people want to continue using filament lamps. Below are some of the arguments for using each type of lamp.

Filament lamps	Energy-saving lamps
• Filament lamps cost only 42 p; energy-saving lamps are more expensive. • Filament lamps reach full brightness almost immediately; energy-saving lamps take a long time to warm up. • The extra heat given out from a filament lamp helps to warm the room.	• An 11 watt energy-saving lamp gives as much light as a 60 watt filament lamp. • Energy-saving lamps produce very little waste energy; filament lamps have an efficiency of only 0.1. • Energy-saving lamps are cheaper to use. • Energy-saving lamps last about 7 times longer than filament lamps.

4A Filament lamps are less efficient than energy-saving lamps.

This means that they . . .

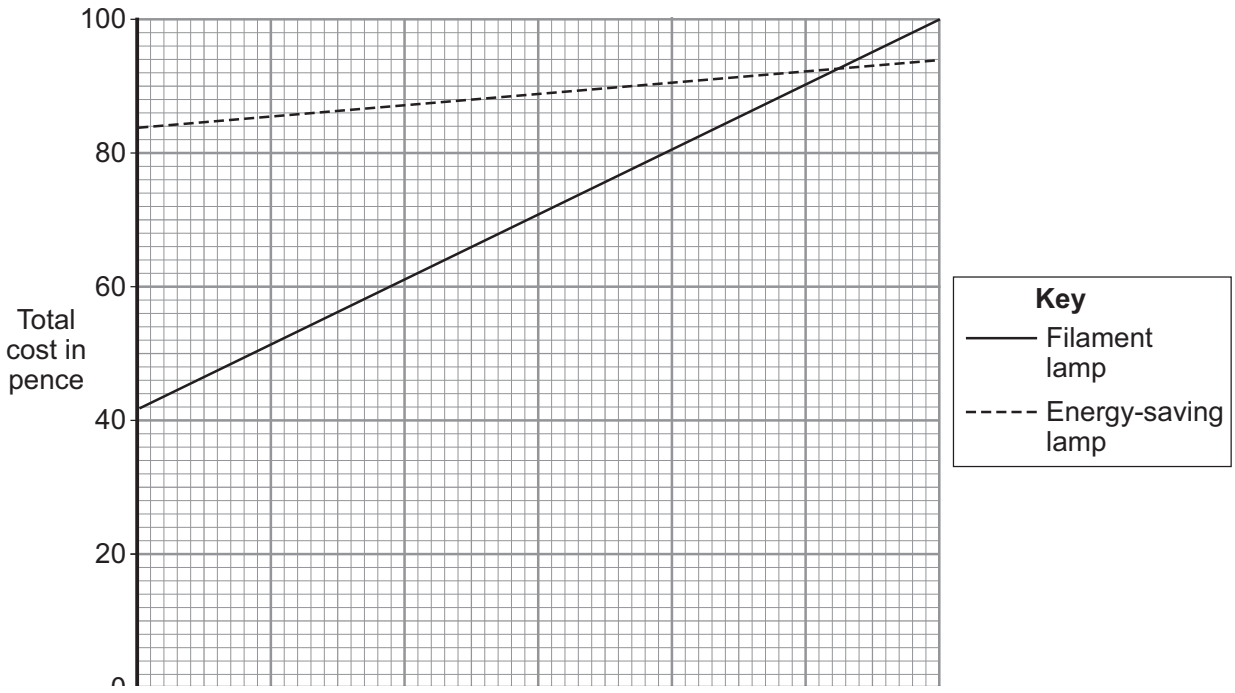
1 cost less.

2 do not last as long.

3 have a larger input power for the same light output.

4 reach full brightness straight away.

The graph shows the total cost of buying and using each type of lamp.



4.1.2.2 Efficiency

Question 38 · continued

4B The graph shows that the cost of buying an energy-saving lamp compared with buying a filament lamp is . . .

1 half as much.

2 twice as much.

3 the same.

4 four times as much.

4C An energy-saving lamp becomes more economical than a filament lamp after . . .

1 86 hours of use.

2 93 hours of use.

3 103 hours of use.

4 105 hours of use.

4D Supporters of filament lamps believe that the 'waste' heat from each lamp is used to heat their houses. They believe that this saves on their heating costs. They say that the total energy used to **light and heat** their houses would not be reduced by using energy-saving lamps.

To find out if they are correct, it is necessary to compare the costs . . .

1 in a small house using filament lamps and in a large house using energy-saving lamps.

2 in a small house using energy-saving lamps and in a large house using filament lamps.

3 using two identical houses with filament lamps in one and energy-saving lamps in the other.

4 using some filament lamps and some energy-saving lamps in the same house.

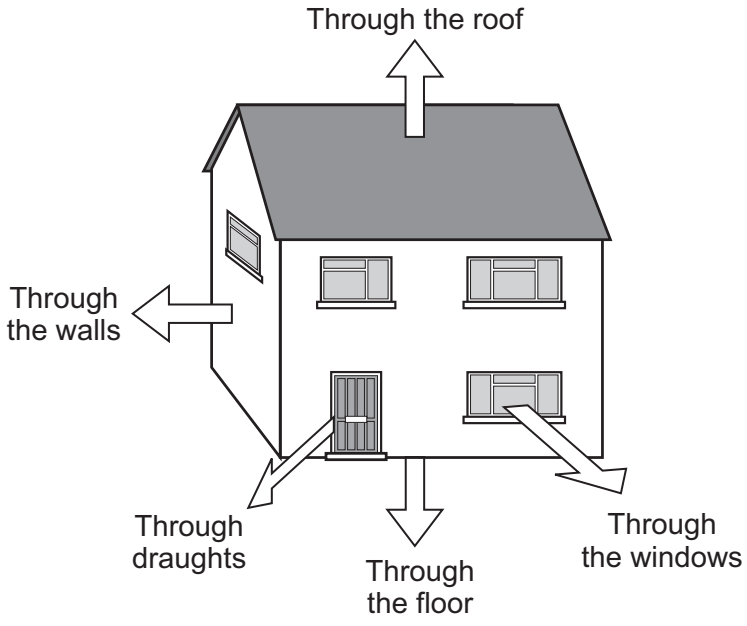
4.1.2.2 Efficiency

Question 39

June 2010 | PHY1AP | Original Q5 | Legacy

QUESTION FIVE

The diagram shows the ways in which energy can be lost from a house.



5A This house is losing heat at a rate of 30 kW.

What power must be supplied by the central heating system to maintain a steady temperature?

1 less than 30 kW

2 30 kW

3 60 kW

4 more than 60 kW

5B One day, the central heating boiler uses 10 kWh of energy.

The efficiency of the central heating boiler is 0.9

How much of the energy from the fuel is usefully transferred?

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

1 1 kWh

2 9 kWh

3 10 kWh

4 11kWh

4.1.2.2 Efficiency

Question 39 · continued June 2010 | PHY1AP | Original Q5 | Legacy

5C What happens to the energy that is **not** usefully transferred?

1 It is stored in the boiler until needed.

2 It is turned mainly into sound energy.

3 It warms the air surrounding the house.

4 It leaves the house in the form of light energy.

5D In the UK, the government has ruled that central heating boilers must have an efficiency of at least 0.9

Why might the government wish to raise this figure above 0.9?

Because . . .

1 householders would have to pay more for their energy supplies.

2 it would help to conserve energy supplies.

3 it would help to protect the ozone layer.

4 more polluting gases would be produced.

4.1.2.2 Efficiency

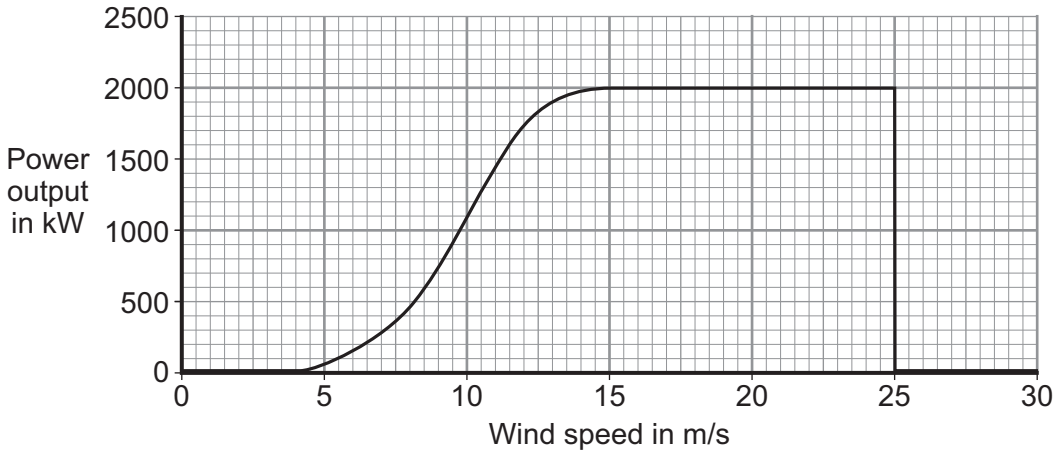
Question 40

June 2010 | PHY1AP | Original Q7 | Legacy

QUESTION SEVEN

A wind turbine can be used to produce electricity.

The graph shows how the power output of a particular turbine varies with wind speed.



The turbine is designed to operate best at a minimum wind speed of 15 m/s. This is called the rated wind speed.

7A How much energy would be transferred if the turbine operated at its rated wind speed for 2 hours?

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

1 2 kWh

2 4 kWh

3 2000 kWh

4 4000 kWh

7B The turbine will work only when the wind speed is above a value called the cut-in wind speed. The turbine shuts down when the wind speed reaches a certain value.

Which row in the table gives the correct wind speeds?

	Cut-in wind speed	Shut-down wind speed
1	4 m/s	15 m/s
2	9 m/s	20 m/s
3	4 m/s	25 m/s
4	13 m/s	25 m/s

4.1.2.2 Efficiency

Question 40 · continued

7C What happens to the energy of the wind at speeds lower than the cut-in speed and higher than the shut-down speed?

1 It will all be transformed into heat.

2 It will all be transformed into sound.

3 It will be stored in the turbine for future use.

4 It will stay as kinetic energy of moving air.

7D The efficiency of this turbine is 0.7

How many kilowatt-hours of wind energy would be needed to produce 10 kilowatt-hours of electrical energy?

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

1 7.0

2 9.3

3 10.7

4 14.3

4.1.2.2 Efficiency

Question 41 June 2010 | PHY1AP | Original Q9 | Legacy

QUESTION NINE

In a recent speech, a politician called for a European energy policy that gives sustainable, affordable and secure energy resources. The issues in the policy are given in the table.

	Policy issue
L	Break the dependency on fossil fuels, which are damaging the atmosphere
M	Guarantee realistic and stable costs to customers
N	Free citizens from dependence on unreliable energy suppliers

9A Which row in the table below describes correctly the issues in the energy policy?

	L	M	N
1	economic	environmental	political
2	environmental	economic	political
3	environmental	environmental	economic
4	economic	economic	environmental

9B The politician also stated that the electricity would be transferred by energy-efficient cables.

The cables would be *energy-efficient* so that . . .

1 energy would be created along the cables.

2 energy would be transformed along the cables.

3 energy loss in the cables would be kept to a minimum.

4 energy would be destroyed along the cables.

9C Part of the policy is to transfer electricity from renewable sources along a 'Super Grid'. This *Super Grid* could use transformers to achieve energy efficiency.

Just before the electricity entered the *Super Grid*, the transformer would . . .

1 decrease the voltage and decrease the current.

2 decrease the voltage and increase the current.

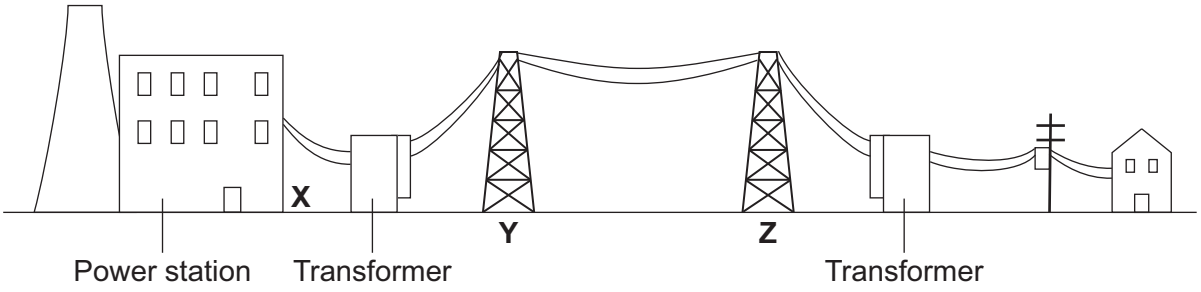
3 increase the voltage and decrease the current.

4 increase the voltage and increase the current.

4.1.2.2 Efficiency

Question 41 · continued

9D In the UK, electricity is transferred by the National Grid.



Which row in the table could give the correct voltages at **X**, **Y** and **Z**?

	X	Y	Z
1	25 kV	400 kV	25 kV
2	25 kV	400 kV	400 kV
3	400 kV	25 kV	25 kV
4	400 kV	400 kV	25 kV

END OF TEST

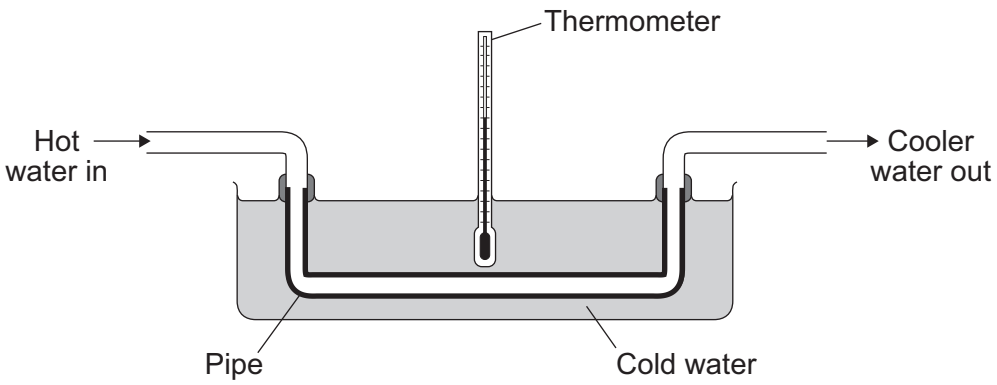
4.1.2.2 Efficiency

Question 42

June 2010 | PHY1H | Original Q1 | Legacy

1 Heat exchangers are devices that are used to transfer heat from one place to another.

The diagram shows a simple heat exchanger used by a student in an investigation. Heat is transferred from the hot water inside the pipe to the cold water outside the pipe.



1 (a) By which process is heat transferred from the hot water inside the pipe to the cold water outside the pipe?

.....

(1 mark)

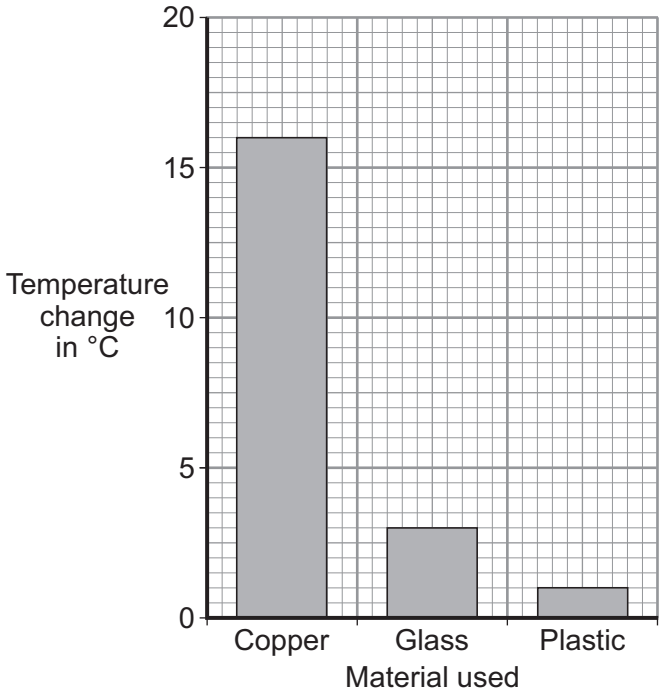
1 (b) The student wanted to find out if the efficiency of a heat exchanger depends on the material used to make the pipe. The student tested three different materials. For each material, the rate of flow of hot water through the pipe was kept the same.

The results obtained by the student are recorded in the table and displayed in the bar chart.

Material	Temperature of the cold water at the start in °C	Temperature of the cold water after 10 minutes in °C
Copper	20	36
Glass	20	23
Plastic	20	21

4.1.2.2 Efficiency

Question 42 · continued



1 (b) (i) The rate of flow of hot water through the pipe was one of the control variables in the investigation.

Give **one** other control variable in the investigation.

.....

(1 mark)

1 (b) (ii) Why did the student draw a bar chart rather than a line graph?

.....

.....

(1 mark)

1 (b) (iii) Which **one** of the three materials made the best heat exchanger?

.....

Give a reason for your answer.

.....

.....

.....

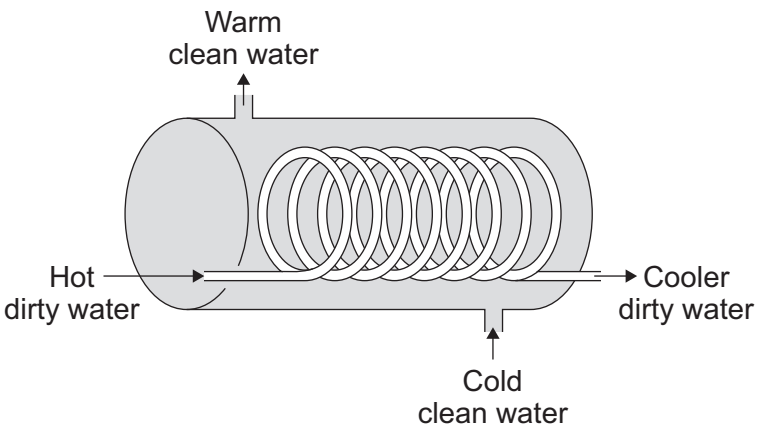
(2 marks)

Question 1 continues on the next page

4.1.2.2 Efficiency

Question 42 · continued

1 (c) The student finds a picture of a heat exchanger used in an industrial laundry.
The heat exchanger uses hot, dirty water to warm cold, clean water.



Why does this heat exchanger transfer heat faster than the heat exchanger used by the student in the investigation?

.....

.....

(1 mark)

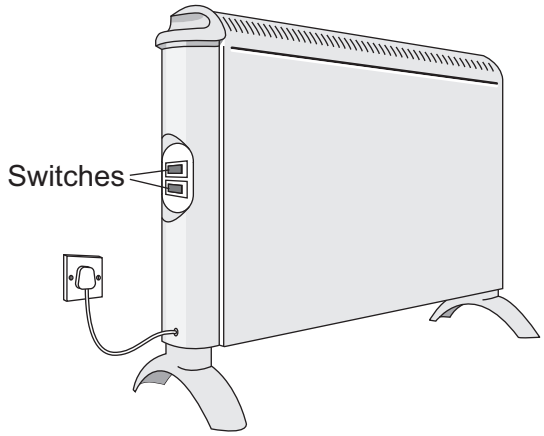
6

4.1.2.2 Efficiency

Question 43

June 2010 | PHY1H | Original Q3 | Legacy

3 (a) The diagram shows two switches on a room heater. The heater has three power settings. The power produced by two of the settings is given in the table.



Setting	Power in watts
Low	700
Medium	1400
High	

3 (a) (i) When both switches are on, the heater works at the high power setting.

What is the power of the heater, in kilowatts, when it is switched to the **high** power setting?

.....

Power = ... kilowatts
(1 mark)

3 (a) (ii) The heater is used on the **high** power setting. It is switched on for $1\frac{1}{2}$ hours.

Use the equation in the box to work out the energy transferred from the mains to the heater in $1\frac{1}{2}$ hours.

energy transferred = power × time

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

.....

.....

.....

Energy transferred = ...
(3 marks)

4.1.2.2 Efficiency

Question 43 · continued

3 (a) (iii) This type of heater is a very efficient device.

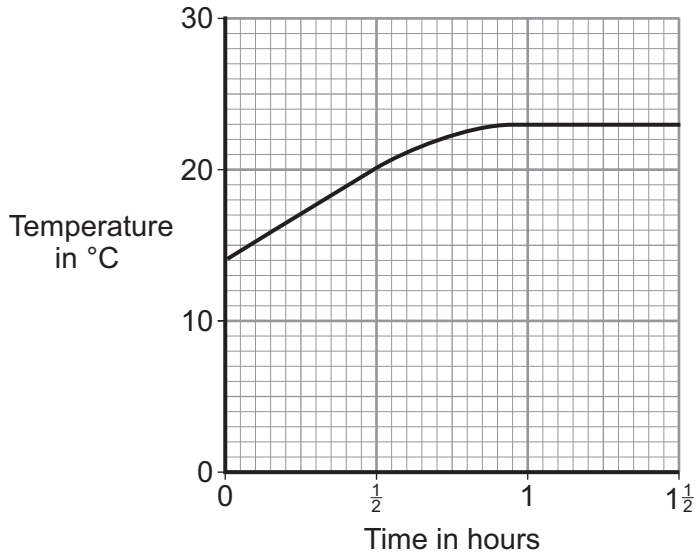
What is meant by a device being very efficient?

.....

.....

(1 mark)

3 (b) The graph shows how the temperature of a room changes during the $1\frac{1}{2}$ hours that the heater is used.



After 1 hour, the temperature of the room has become constant, even though the heater is still switched on.

Explain why.

.....

.....

.....

.....

(2 marks)

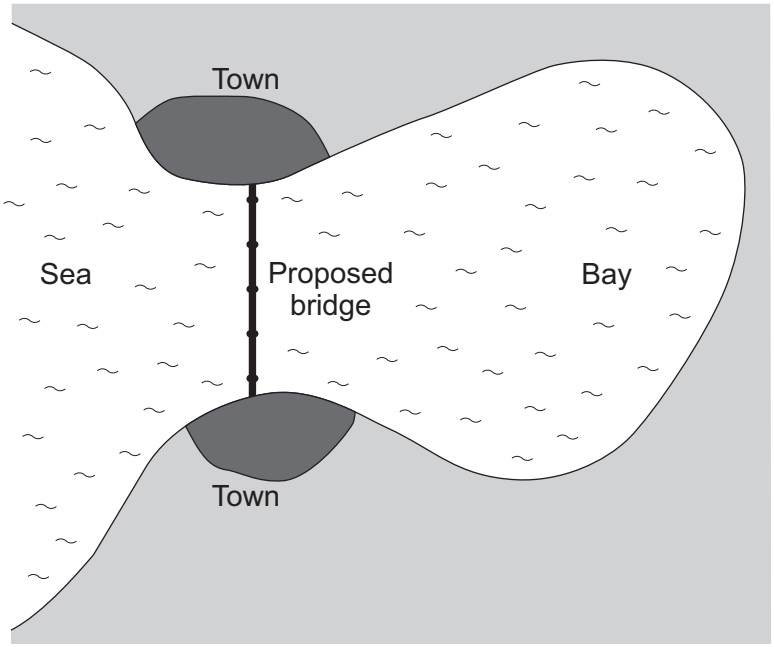
7

4.1.2.2 Efficiency

Question 44

June 2010 | PHY1H | Original Q5 | Legacy

5 The map shows the positions of two towns on either side of a very large coastal bay in England. The map also shows where a bridge may be built to link the towns. The road journey from one town to the other is about 60 kilometres at present.



5 (a) It is estimated that building turbines and generators inside the legs of the bridge would produce enough electricity for both towns. In addition, enough electricity would be generated to run electric buses over the bridge between the two towns.

5 (a) (i) If the bridge is built, what form of renewable energy will be used to generate the electricity?

.....

(1 mark)

5 (a) (ii) Most people living in the area are in favour of the proposed bridge.

Suggest **three** reasons why people would be in favour of building the bridge and the associated electricity generating scheme.

Reason 1 .....

.....

Reason 2 .....

.....

Reason 3 .....

.....

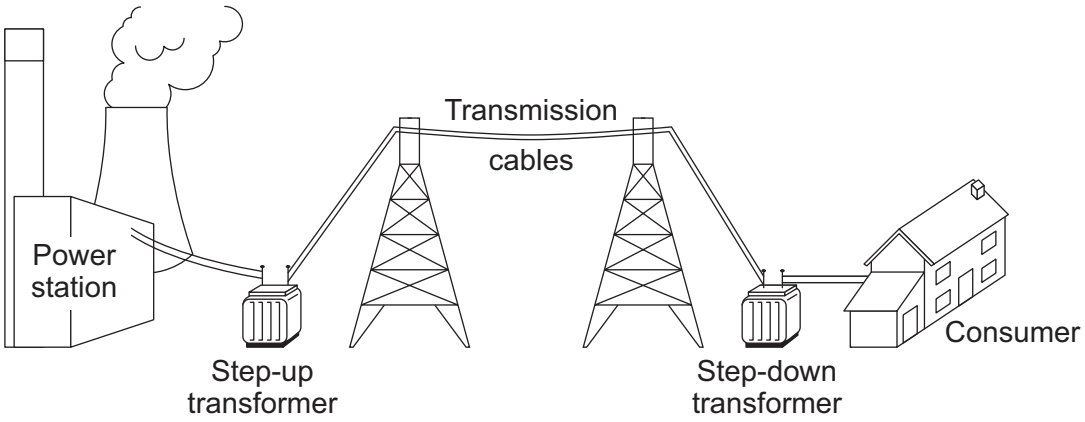
(3 marks)

4.1.2.2 Efficiency

Question 44 · continued

5 (b) Even with the proposed bridge, the two towns will need to stay connected to the National Grid.

The diagram shows part of the National Grid.



5 (b) (i) Give **one** reason why the towns need to stay connected to the National Grid.

.....

.....

(1 mark)

5 (b) (ii) Explain how the step-up transformer increases the efficiency of the National Grid.

.....

.....

.....

.....

(2 marks)

7

4.1.2.2 Efficiency

Question 45

QUESTION TWO

The drawing shows a mobile phone. This phone also has a digital camera.



Match the energy transformations, **A**, **B**, **C** and **D**, with the statements **1**–**4** in the table.

A electrical to light

B electrical to sound

C light to electrical

D sound to electrical

1	the useful energy transformation in the display screen
2	the useful energy transformation in the loudspeaker
3	the useful energy transformation in the microphone
4	the useful energy transformation in the digital camera

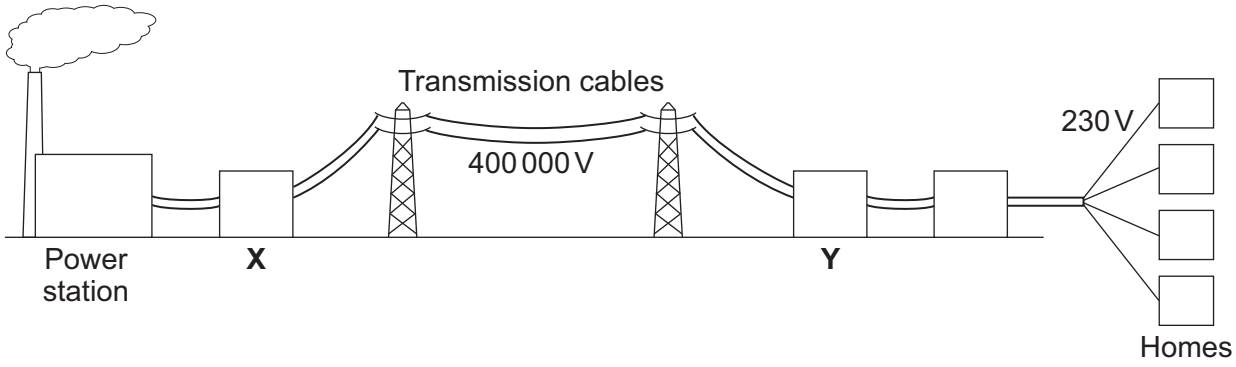
4.1.2.2 Efficiency

Question 46

November 2010 | PHY1AP | Original Q7 | Legacy

QUESTION SEVEN

The diagram shows a power station connected to the National Grid. The National Grid distributes the electrical energy to homes.



7A Which row in the table correctly describes the transformers **X** and **Y**?

	X	Y
1	step-down	step-down
2	step-down	step-up
3	step-up	step-down
4	step-up	step-up

7B Why is the voltage (potential difference) across the transmission cables of the National Grid very high?

1 so that the electricity travels faster

2 so that the electric current is large

3 to make the transmission of electricity safe

4 to reduce energy loss from the cables

7C A transformer changes both the voltage and the current.

Which row in the table correctly describes the changes of current in transformers **X** and **Y**?

	X	Y
1	decrease	decrease
2	decrease	increase
3	increase	decrease
4	increase	increase

4.1.2.2 Efficiency

Question 46 · continued

7D In the power station, the boiler has an efficiency of 0.75. The turbine and generator system have an efficiency of 0.80.

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

For every 1000 J of energy supplied to the boiler, what is the useful output energy from the turbine and generator system?

1 600 J

2 750 J

3 800 J

4 1670 J

Turn over for the next question

4.1.2.2 Efficiency

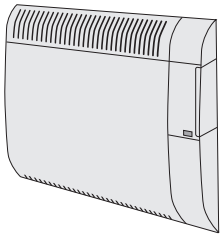
Question 47

November 2010 | PHY1AP | Original Q9 | Legacy

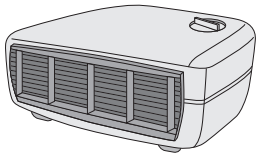
QUESTION NINE

The pictures show three different types of electric heater.

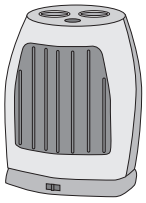
400 W oil-filled panel heater
- 3 heat settings
- Efficient background heat
- Safety overheat cut-out



3 kW fan heater
- 2 heat settings
- Power indicator light
- Cool air fan setting



1800 W ceramic heater
- 2 heat settings
- 8 hour timer
- Power indicator light
- Safety overheat cut-out



9A Two 400 W oil-filled panel heaters are both switched on in an office.

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

How much energy, in kWh, is transferred from the mains to the heaters in 12 hours?

1 4.8

2 9.6

3 2400

4 4800

9B The cost of using the ceramic heater during one week was £6.00. During this week, the heater transferred 40 kWh.

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

What was the cost per kWh of the electricity?

1 1.50p

2 6.67p

3 £0.15

4 £6.67

4.1.2.2 Efficiency

Question 47 · continued

9C When the fan heater is working at less than full power, 2 kilojoules of energy are usefully transferred every second. The efficiency of the fan heater at this power is 0.95.

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

How many joules of electrical energy are supplied to the fan heater each second?

1 0.000475

2 0.475

3 2.1

4 2105

9D The fan heater cannot be 100% efficient.

Why is this?

1 The fan heater is the most powerful of the four heaters.

2 The fan heater does not have a safety overheat cut-out.

3 The fan heater makes a noise.

4 The fan heater's case becomes warm during use.

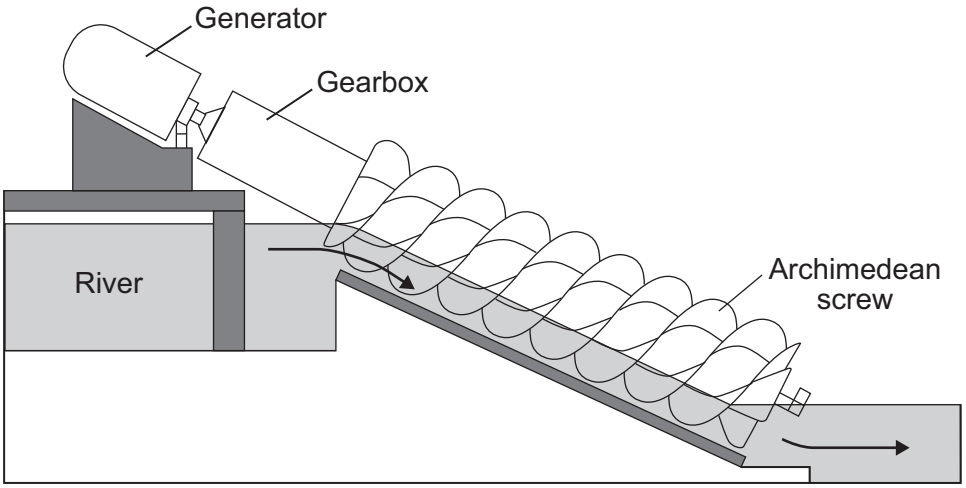
END OF TEST

4.1.2.2 Efficiency

Question 48

January 2011 | PHY1H | Original Q4 | Legacy

4 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.



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

4 (a) (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 mark)

4 (a) (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.

.....

.....

Efficiency = ...

(2 marks)

4.1.2.2 Efficiency

Question 48 · continued

4 (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.

.....

.....

(1 mark)

4 (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.

4 (c) (i) What is the National Grid?

.....

.....

(1 mark)

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

.....

.....

.....

.....

(2 marks)

7

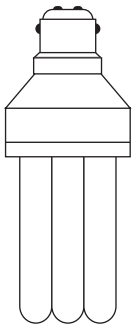
4.1.2.2 Efficiency

Question 49

March 2011 | PHY1AP | Original Q1 | Legacy

QUESTION ONE

The diagram shows a compact fluorescent lamp (CFL).



Match words, **A**, **B**, **C** and **D**, with the numbers **1**–**4** in the sentences.

A economical

B efficient

C environmental

D ethical

Compared with a filament lamp, a CFL transforms less electrical energy to produce the same amount of light energy each second. This makes the CFL more . . . **1** . . . .

Over time, CFLs cost less to buy and use, making them more . . . **2** . . . than filament lamps.

CFLs contain mercury and their disposal causes . . . **3** . . . problems.

Society must decide whether or not it is . . . **4** . . . to use CFLs even if there is a possible hazard to health.

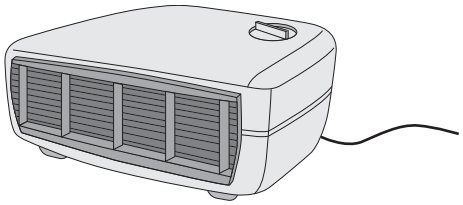
4.1.2.2 Efficiency

Question 50

March 2011 | PHY1AP | Original Q4 | Legacy

QUESTION FOUR

A fan heater is used to heat air and to move it around a room.



Fan heater

4A The fan heater usefully transforms electrical energy to . . .

1 kinetic and sound energy.

2 light and thermal energy.

3 sound and light energy.

4 thermal and kinetic energy.

4B Energy that is not usefully transformed by the fan heater is wasted as . . .

1 chemical energy.

2 kinetic energy.

3 sound energy.

4 thermal energy.

4C The fan heater moves hot air around the room.

This method of heat transfer is sometimes called forced . . .

1 conduction.

2 convection.

3 evaporation.

4 radiation.

4.1.2.2 Efficiency

Question 50 · continued

4D The fan heater transfers 3 kWh of energy as it warms a room.

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

Electricity costs 15p per kWh

What is the cost of this energy?

1 5p

2 45p

3 £5

4 £45

Turn over for the next question

4.1.2.2 Efficiency

Question 51 March 2011 | PHY1AP | Original Q5 | Legacy

QUESTION FIVE

A 'hybrid' car can run on petrol stored in a tank or on electricity stored in a rechargeable battery.

5A When the battery is completely 'flat', it has no energy stored in it. The battery of car **X** is connected to the mains electrical supply and receives energy at a rate of 2000 W. It takes 6 hours to fully charge the battery.

How much electrical energy is needed to fully charge the battery of car **X**?

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

1 3 kWh

2 12 kWh

3 333 kWh

4 12 000 kWh

5B A different hybrid car, **Y**, needs a different amount of electrical energy to charge its battery. The total cost of this electrical energy is £3.

Mains electricity costs 15 pence per kWh.

How much electrical energy is needed to fully charge the battery of car **Y**?

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

1 0.2 kWh

2 12 kWh

3 20 kWh

4 45 kWh

5C When the battery of car **Y** is fully charged, it can travel 100 km using the energy stored in its battery. Travelling the same distance using its petrol engine would require five times as much energy.

What does this tell you about the efficiency of the two methods of propelling car **Y**?

1 The electric motor is more efficient than the petrol engine.

2 The petrol engine is more efficient than the electric motor.

3 The petrol engine and the electric motor have the same efficiency.

4 It is impossible to compare the efficiency.

4.1.2.2 Efficiency

5D Some cars are all electric and have no petrol engine fitted.

Which statement about these cars is true?

1 They are not responsible for producing any atmospheric pollution.

2 They produce more atmospheric pollution than petrol-engine cars.

3 They produce no atmospheric pollution while being driven.

4 They produce no atmospheric pollution but a lot of noise pollution.

Turn over for the next question

4.1.2.2 Efficiency

Question 52

March 2011 | PHY1AP | Original Q7 | Legacy

QUESTION SEVEN

The table is taken from an advert for low-energy lamps.

Save up to 80 % of your electricity bill by switching to low-energy lamps		
Filament lamp	**Equivalent low-energy lamp**	**Power saving**
60 W	12 W	80 %
60 W	15 W	
100 W	20 W	80 %
100 W	24 W	76 %

7A A householder changes from using a 60 W filament lamp to using a 15 W low-energy lamp.

What is the percentage power saving made?

1 20 %

2 45 %

3 75 %

4 80 %

A 20 W low-energy lamp provides the same amount of light each second as a 100 W filament lamp.

7B The efficiency of a 100 W filament lamp is 0.15.

What is the efficiency of the 20 W low-energy lamp?

1 0.03

2 0.15

3 0.30

4 0.75

4.1.2.2 Efficiency

Question 52 · continued

7C How much money is saved over 200 hours by replacing a 100 W filament lamp with a 20 W low-energy lamp?

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

Electricity costs 15p per kWh

1 48p

2 60p

3 £2.40

4 £3.00

7D A householder is considering changing all her filament lamps for low-energy lamps. However, she says that the table in the advert does not contain enough information for her to know how much money she will save.

She needs to know . . .

1 how much each lamp costs and how long it lasts.

2 how long each lamp lasts and how much electricity costs per kWh.

3 how much electricity costs per kWh and how much each lamp costs.

4 how much each lamp costs, how long each lamp lasts and how much electricity costs per kWh.

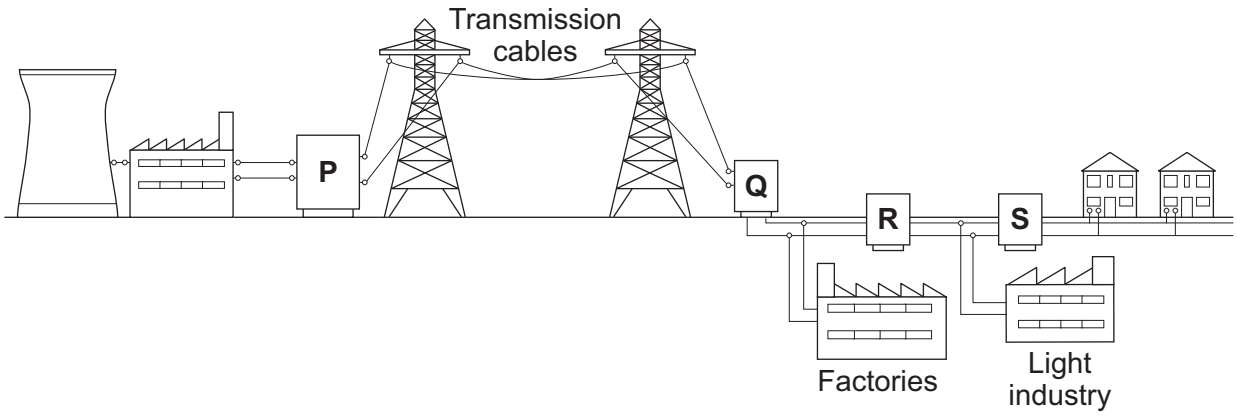
4.1.2.2 Efficiency

Question 53

March 2011 | PHY1AP | Original Q8 | Legacy

QUESTION EIGHT

The diagram shows a power station supplying electricity to the National Grid. There are four transformers in the system, labelled **P**, **Q**, **R** and **S**.



8A Which row in the table correctly describes each transformer?

	P	Q	R	S
1	step up	step down	step down	step down
2	step down	step up	step up	step up
3	step up	step down	step up	step down
4	step up	step up	step down	step down

8B The voltage across the overhead transmission cables is very high.

The best explanation for this is that . . .

1 it allows thinner cables to be used and the energy loss from the cables is reduced.

2 the energy loss from the cables is reduced and it allows the distance between pylons to be reduced.

3 the distance between the pylons can be reduced and thicker cables can be used.

4 it allows the current to travel more slowly and thicker cables can be used.

4.1.2.2 Efficiency

Question 53 · continued

8C Changing the voltage between the power station and the transmission cables using transformer **P** also changes the current flowing and the efficiency of distribution.

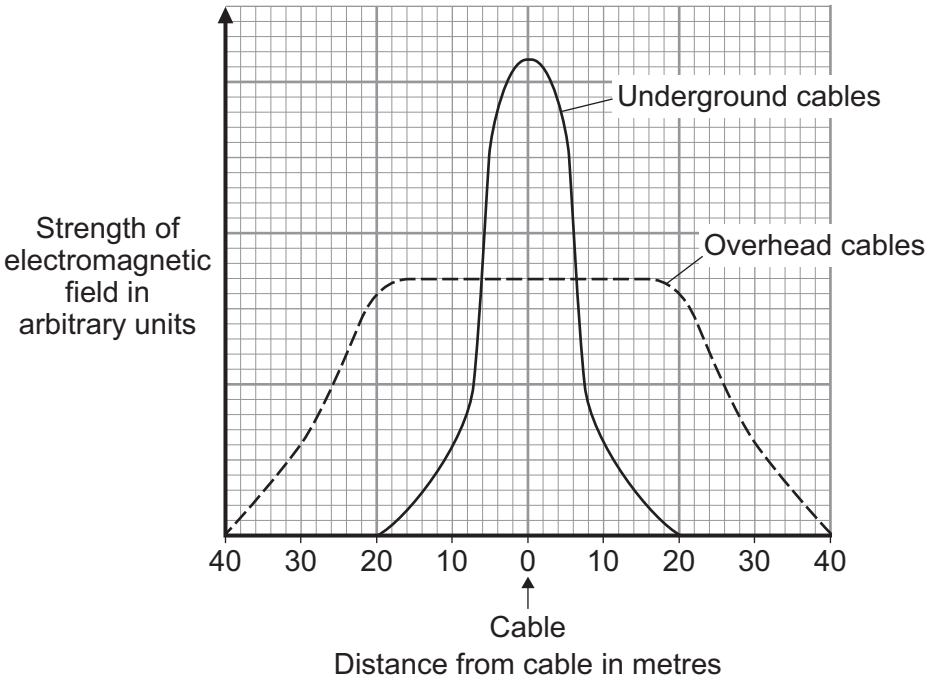
Which row of the table correctly shows these changes?

	Voltage	Current	Efficiency
1	increases	increases	increases
2	decreases	decreases	increases
3	decreases	decreases	decreases
4	increases	decreases	increases

8D Transmission cables can either be suspended from pylons above ground or they can be buried underground.

An electromagnetic field is produced when an electric current flows through a cable. Some people think that these fields can cause a health risk.

The graph shows how the strength of the electromagnetic field varies with distance from the cable for both overhead cables and underground cables.



Which of the following conclusions could be made from the graph?

1 When you are within 5 metres of the cable, the possible risk to health is bigger with an underground cable.

2 The possible health risk from overhead cables falls to zero when you are 20 metres away.

3 The biggest possible health risk from overhead cables occurs when you are 40 metres away.

4 Between 10 and 40 metres away, the biggest possible health risk is from underground cables.

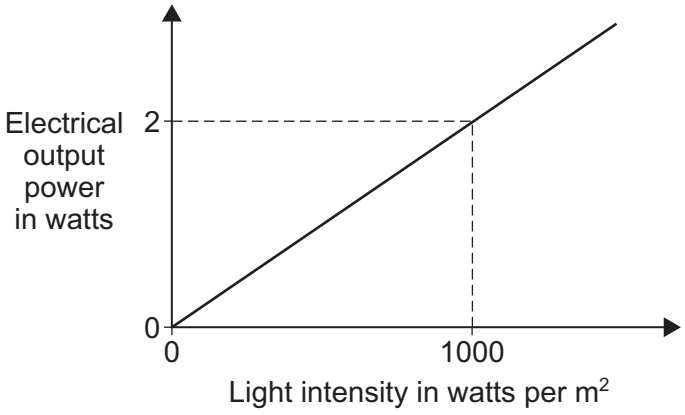
4.1.2.2 Efficiency

Question 54

March 2011 | PHY1AP | Original Q9 | Legacy

QUESTION NINE

The diagram shows the electrical output power of a typical solar cell as the light intensity on it changes. The solar cell has a surface area of 100 cm^2.



9A The graph shows that . . .

1 the output power is directly proportional to the light intensity.

2 the output power decreases as the light intensity increases.

3 as the light intensity decreases the output power increases.

4 the output power is not affected by the light intensity.

9B The output power of the solar cell is directly proportional to the area of the cell exposed to light.

A similar solar cell has an area of 50 cm^2. The light intensity was 1000 watts per $metre^2$.

What is the output power of this solar cell?

1 0 watts

2 1 watt

3 2 watts

4 4 watts

4.1.2.2 Efficiency

Question 54 · continued March 2011 | PHY1AP | Original Q9 | Legacy

A satellite in space uses solar energy as its power source.
The satellite needs 3 kJ of energy per second.
One square metre of solar cells on the satellite produces 250 joules of energy per second.

9C What area of solar cells is needed to power the satellite?

1 12 m^2

2 83 m^2

3 300 m^2

4 400 m^2

9D The efficiency of the solar cells is 0.2

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

Considering the total energy requirement of the satellite, how much solar energy falls on the solar cells each second?

1 15 J

2 600 J

3 15 kJ

4 600 kJ

END OF TEST

4.1.2.2 Efficiency

Question 55

June 2011 | PHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about four electrical devices.

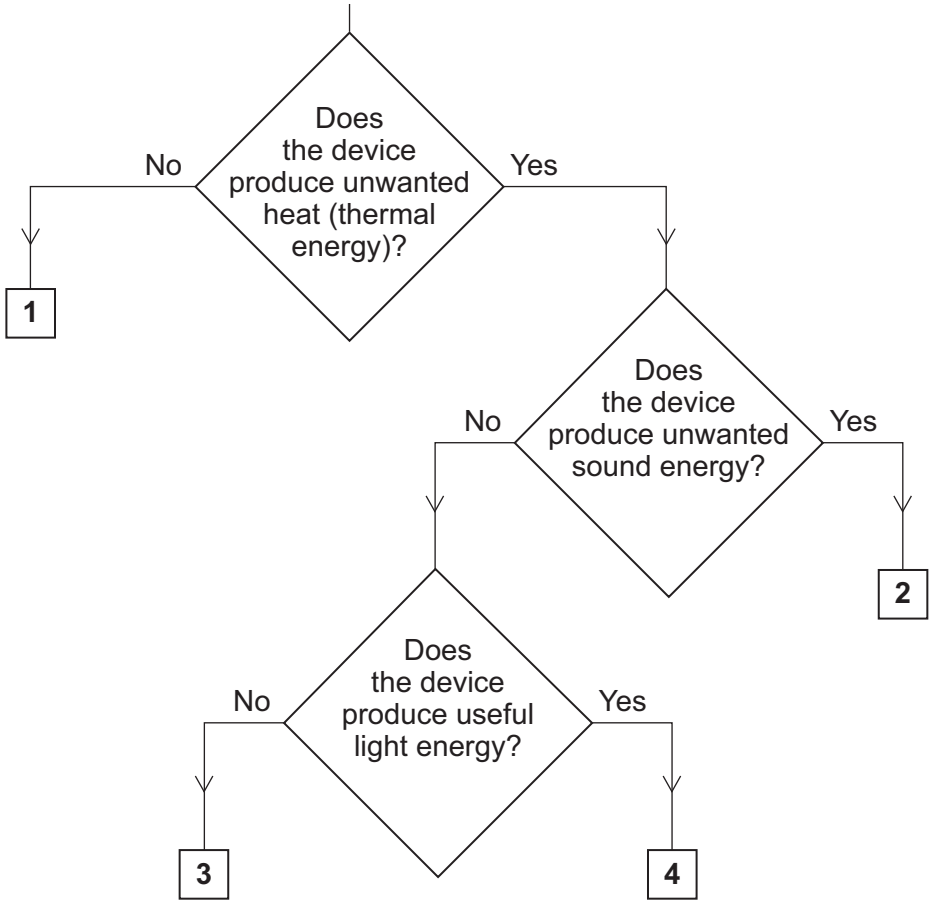
Match the devices, **A**, **B**, **C** and **D**, with the numbers **1**–**4** in the flow chart.

A food mixer

B iron

C radio

D television



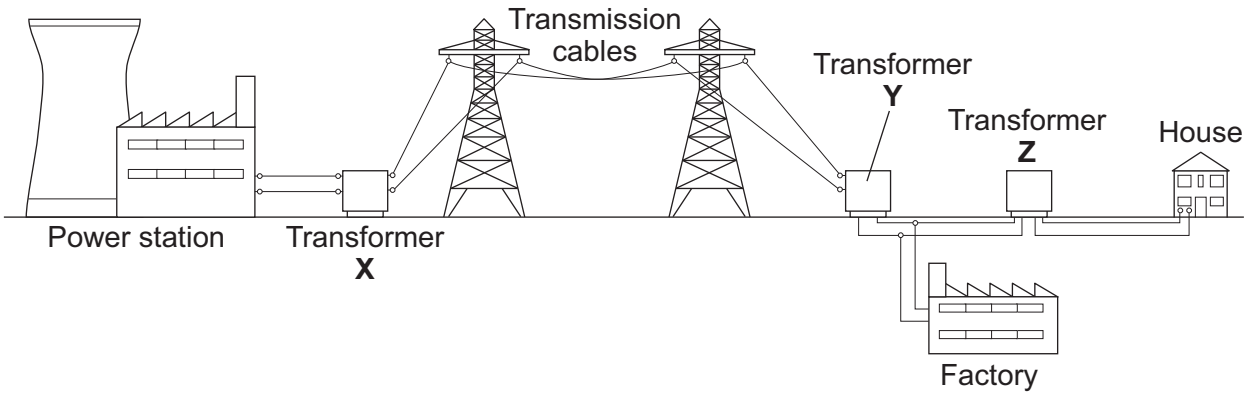
4.1.2.2 Efficiency

Question 56

June 2011 | PHY1AP | Original Q7 | Legacy

QUESTION SEVEN

Transformers are used in the National Grid.



7A Both step-up transformers and step-down transformers are used in the National Grid.

Which row in the table shows the correct types of transformer?

	Transformer X	Transformer Y	Transformer Z
1	step-up	step-down	step-up
2	step-up	step-up	step-up
3	step-up	step-down	step-down
4	step-up	step-up	step-down

7B Transformer **X** changes the voltage between the power station and the transmission cables. It also changes the current. These changes affect the efficiency of the transmission cables.

Which row in the table correctly describes the changes produced by transformer **X**?

	Voltage	Current	Efficiency of transmission
1	decreased	decreased	decreased
2	decreased	increased	increased
3	increased	decreased	increased
4	increased	increased	increased

4.1.2.2 Efficiency

Question 56 · continued

7C The table shows the percentage of energy wasted as heat and sound by four different transformers.

Which transformer has the highest efficiency?

Transformer	Percentage of energy supplied to transformer which is wasted as sound	Percentage of energy supplied to transformer which is wasted as heat
1	1.1	7.4
2	1.2	4.7
3	1.3	5.4
4	1.4	6.9

7D The amount of electricity that a device uses depends on the rate at which the device transforms energy and . . .

1 how long the device is switched on.

2 the current through the device.

3 the potential difference across the device.

4 the power of the device.

4.1.2.2 Efficiency

Question 57

June 2011 | PHY1AP | Original Q8 | Legacy

QUESTION EIGHT

The sources of energy used to generate electricity in the UK have changed over the years. The table gives information on the percentages of electrical energy consumed in the UK produced from various energy sources.

Year \ Energy source	Coal	Oil	Gas	Nuclear	Hydroelectric	Other renewables
1965	65.0	28.4	5.0	1.0	0.6	0.0
1985	33.7	35.0	23.6	7.0	0.7	0.0
2005	33.0	1.0	40.0	19.0	1.0	3.5

8A In 1965, what was the percentage of electrical energy produced from sources that released polluting gases into the atmosphere?

1 1.6

2 65.0

3 93.4

4 98.4

8B The UK government wants to build more nuclear power stations.

Which row in the table gives a valid reason for, and a valid reason against, building more nuclear power stations?

	For	Against
1	Nuclear power stations have a long start-up time.	Nuclear power stations produce radioactive waste.
2	The energy available from 1 kg of nuclear fuel is much bigger than from other fuels.	Nuclear power stations have high decommissioning costs.
3	Nuclear power stations have low decommissioning costs.	Nuclear power stations produce radioactive waste.
4	The energy source is renewable.	The energy available from 1 kg of nuclear fuel is much smaller than from other fuels.

4.1.2.2 Efficiency

Question 57 · continued

8C The figures for 2005 do not add up to 100 %.

This is likely to be because about 2.5 % . . .

1 of the energy was lost in the National Grid transmission cables.

2 of the electricity was exported to other countries.

3 of the electricity was imported from other countries.

4 of the energy was generated by wind farms.

8D Governments would like householders to replace older electrical appliances with new ones that are more efficient.

This would result in . . .

1 more electricity being generated from renewable sources and lower greenhouse gas emissions.

2 less electricity being generated from renewable sources and higher greenhouse gas emissions.

3 less energy being used and lower greenhouse gas emissions.

4 more energy being used and higher greenhouse gas emissions.

4.1.2.2 Efficiency

Question 58

June 2011 | PHY1AP | Original Q9 | Legacy

QUESTION NINE

Solar cells are used to produce electricity on a large scale in places such as Australia and California. They are not used on a large scale in the UK.

9A Which of the following statements about solar cells being used to produce electricity on a large scale is correct?

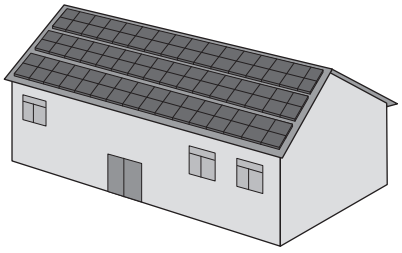
1 Solar cells need a large area of land because solar cells are not very efficient.

2 Solar cells need a large area of land because the Sun does not shine at night.

3 Solar cells need a small area of land because the Sun shines every day.

4 Solar cells need a small area of land because solar cells are very efficient.

9B The drawing shows an array of solar cells on the roof of a new village hall.



The solar cells produce more electricity than is needed by the hall.

The surplus electricity . . .

1 can be stored in the hall until it is needed.

2 can be stored in the solar cells until it is needed.

3 can be sold and transmitted by the National Grid.

4 is wasted energy and spreads out.

The amount of electricity produced each year by an array of solar cells depends on:

- the area of the array
- the angle of tilt of the array
- the direction that the array faces
- which part of the country the array is in.

4.1.2.2 Efficiency

Question 58 · continued

The map shows how much solar radiation, in kWh / m^2, falls on different parts of the UK each year.

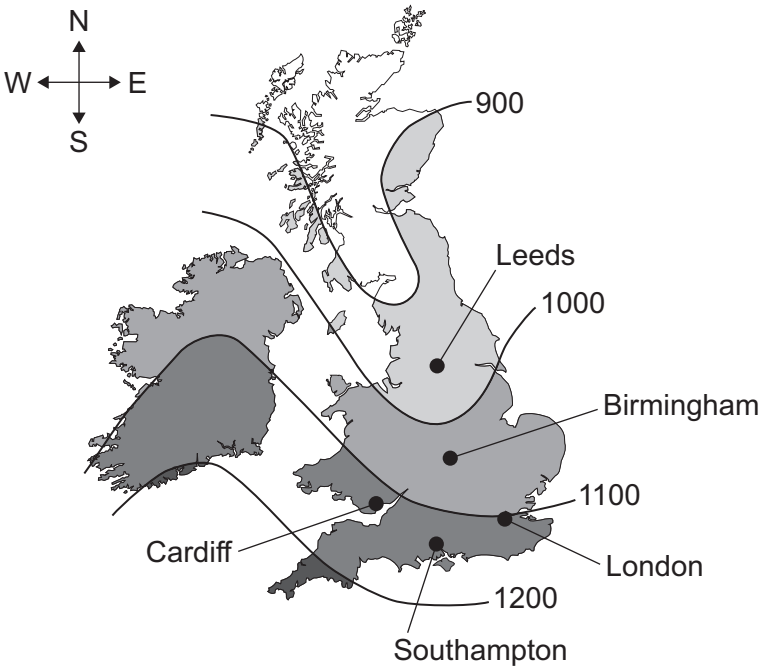


Table 1 gives figures for the annual solar radiation, in kWh / m^2, for London. The table also gives data for various angles of tilt and for various directions that an array faces.

Table 1

Angle of tilt of array to the horizontal	Direction that the array faces				
	South	South-west	West	North-west	North
30°	1042	997	886	762	709
45°	1023	968	829	666	621
60°	960	900	753	580	485
Vertical	724	684	565	427	360

9C Which row in **Table 2** gives the biggest amount of solar radiation?

Table 2

	Location	Angle of tilt in degrees	Direction that the array faces
1	Birmingham	30	South
2	Southampton	30	West
3	Leeds	60	West
4	Cardiff	30	South

Question 9 continues on the next page

4.1.2.2 Efficiency

Question 58 · continued

9D An array with an area of $20\,m^2$ is installed on a roof in London at an angle of 60°. The array faces south-west. The efficiency of the array is 0.2

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

What is the annual amount of electrical energy produced by the array?

1 3600 kWh

2 4500 kWh

3 18000 kWh

4 90000 kWh

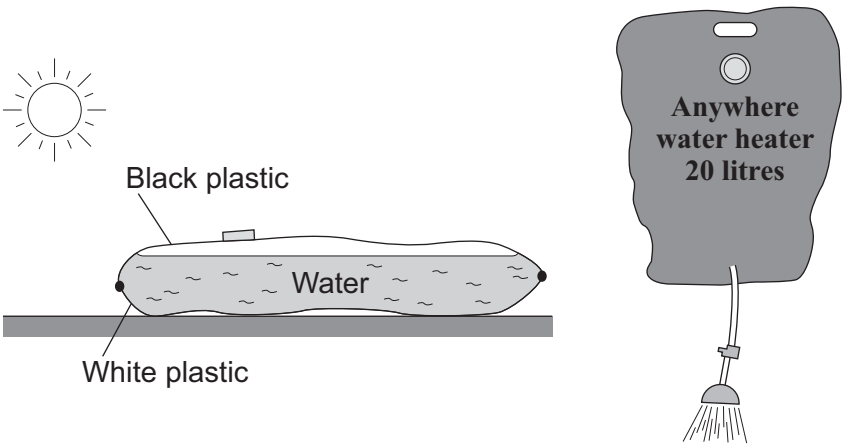
END OF TEST

4.1.2.2 Efficiency

Question 59

June 2011 | PHY1H | Original Q1 | Legacy

1 The diagram shows a simple type of portable shower. The water container is a strong plastic bag that is black on one side and white on the other. To warm the water, the bag is placed on the ground in direct sunlight, with the black side facing the Sun.



1 (a) (i) Name the process by which heat is transferred from the Sun to the outside of the bag.

.....

(1 mark)

1 (a) (ii) Explain why the black side of the bag and not the white side should face the Sun.

.....

.....

.....

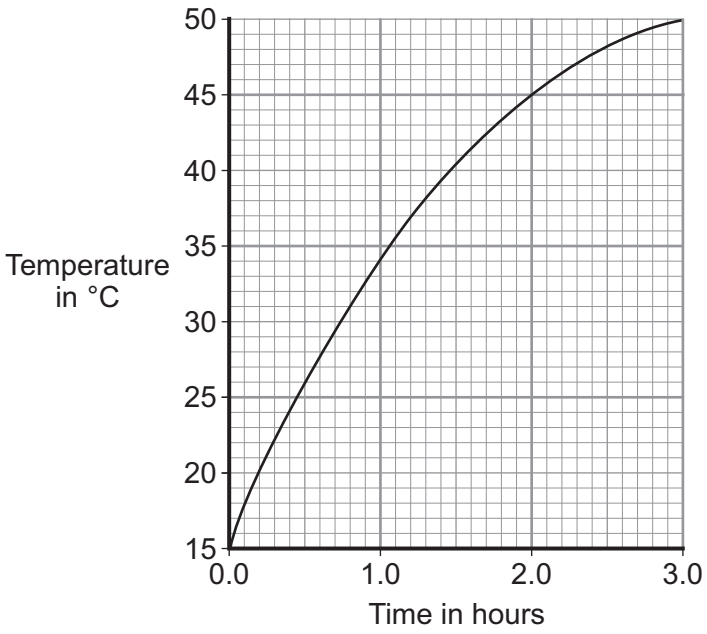
.....

(2 marks)

4.1.2.2 Efficiency

Question 59 · continued

1 (b) The graph shows how the temperature of the water inside a full bag increases after the bag is placed outside on a sunny day.



1 (b) (i) How long does it take for the water to reach 37 °C?

.....

(1 mark)

1 (b) (ii) Describe how the temperature of the water changes during the three hours.

.....

.....

(1 mark)

1 (c) A different manufacturer makes the same type of portable shower but uses a bag with a larger surface area. The bag is made from the same coloured plastics and holds the same amount of water.

1 (c) (i) To compare the efficiency of the two bags at heating water, several variables need to be controlled.

Name **two** variables that need to be controlled.

1 .....

2 .....

(2 marks)

1 (c) (ii) The second bag has a larger surface area.
Draw a line on the graph to show how the temperature of the water inside the second bag would change over the first hour.
Assume that the two bags are tested in exactly the same way.

(1 mark)

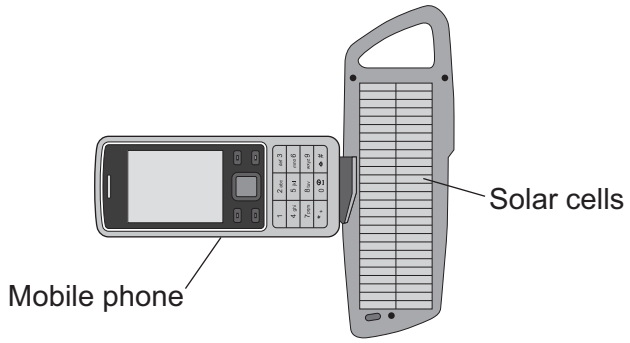
8

4.1.2.2 Efficiency

Question 60

June 2011 | PHY1H | Original Q4 | Legacy

4 (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.

4 (a) (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 marks)

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

(1 mark)

4.1.2.2 Efficiency

Question 60 · continued

4 (a) (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.

.....

.....

.....

.....

(2 marks)

4 (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.

.....

.....

(1 mark)

4 (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.

.....

.....

.....

.....

(2 marks)

8

4.1.2.2 Efficiency

Question 61

November 2011 | PHY1AP | Original Q3 | Legacy

QUESTION THREE

A particular model of car has a choice of four different engines.

The fuel consumption and the carbon dioxide emissions were measured for each engine.

The table gives some data about the four engines, **P**, **Q**, **R** and **S**.

Car engine	Engine size in litres	Power in kilowatts (kW)	Fuel consumption in litres per 100 kilometres	Carbon dioxide (CO_2) emission in grams per kilometre
P	1.2	45	5.8	138
Q	1.2	52	5.8	138
R	1.4	60	6.3	150
S	1.6	78	6.9	164

3A Based on this data, which engine is the **least** fuel-efficient?

1 **P**

2 **Q**

3 **R**

4 **S**

3B To make a fair comparison of fuel consumption, the four engines should have been tested . . .

1 with different fuels.

2 at the same speed.

3 over different distances.

4 on the same day of the week.

4.1.2.2 Efficiency

Question 61 · continued

3C The tests were carried out under strict conditions. The conditions were set by an independent team of engineers.

This made sure that the results were . . .

1 biased in favour of the government.

2 biased in favour of the manufacturer.

3 biased in favour of the motorist.

4 unbiased.

3D In Britain, people who buy cars with low carbon dioxide emissions pay less road tax to the government.

This is because the government is concerned about . . .

1 economic issues.

2 environmental issues.

3 ethical issues.

4 social issues.

4.1.2.2 Efficiency

Question 62

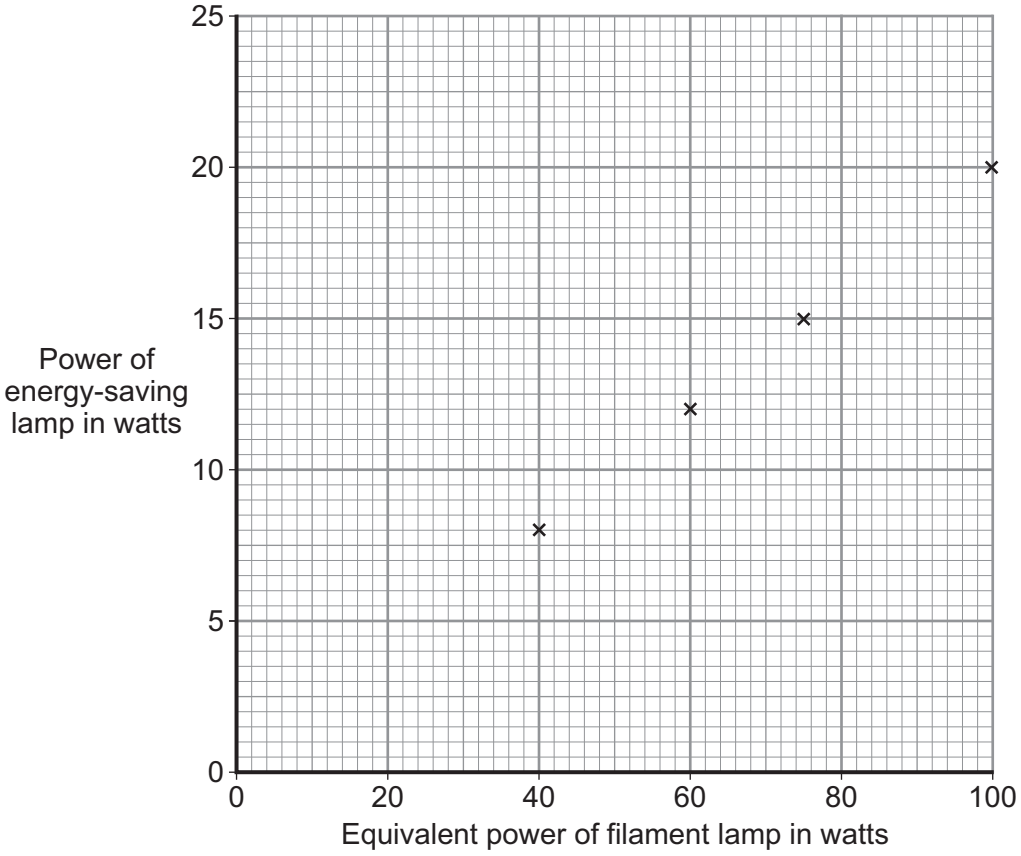
November 2011 | PHY1AP | Original Q5 | Legacy

QUESTION FIVE

A householder bought an energy-saving lamp. The following table was printed on the box.

Power of energy-saving lamp in W	Equivalent power of filament lamp in W
8	40
12	60
15	75
20	100

5A The graph shows the data given in the table.



To see if the power of the filament lamp is directly proportional to the power of the energy-saving lamp, you should . . .

1 draw a line of best fit and see if it passes through (0,0).

2 change the watts to kilowatts.

3 produce a bar chart.

4 use a different scale.

4.1.2.2 Efficiency

Question 62 · continued

5B Assume that the power of the filament lamp is directly proportional to the power of the energy-saving lamp.

What is the power of an energy-saving lamp that is equivalent to a 150 W filament lamp?

1 8 W

2 18 W

3 30 W

4 35 W

5C The efficiency of a 100 W filament lamp is 0.15.

What is the efficiency of a 20 W energy-saving lamp?

1 0.03

2 0.15

3 0.30

4 0.75

5D The government has decided to stop the sale of filament lamps. This is to save on the amount of fuel needed for making electricity.

Most energy-saving lamps contain toxic chemicals. Safety campaigners say that energy-saving lamps must be disposed of carefully.

Which row in the table correctly describes the types of issue given above that concern the government and safety campaigners?

	The Government	Safety campaigners
1	environmental	economic
2	economic	environmental
3	ethical	social
4	social	ethical

4.1.2.2 Efficiency

Question 63

June 2012 | PH1HP | Original Q1 | Legacy

1 A wood burning stove is used to heat a room.



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

1 (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?

.....

.....

.....

.....

(2 marks)

4.1.2.2 Efficiency

Question 63 · continued

1 (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 marks)

1 (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 mark)

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 marks)

Question 1 continues on the next page

4.1.2.2 Efficiency

Question 63 · continued

1 (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.

.....

.....

.....

.....

Energy required = ...

(3 marks)

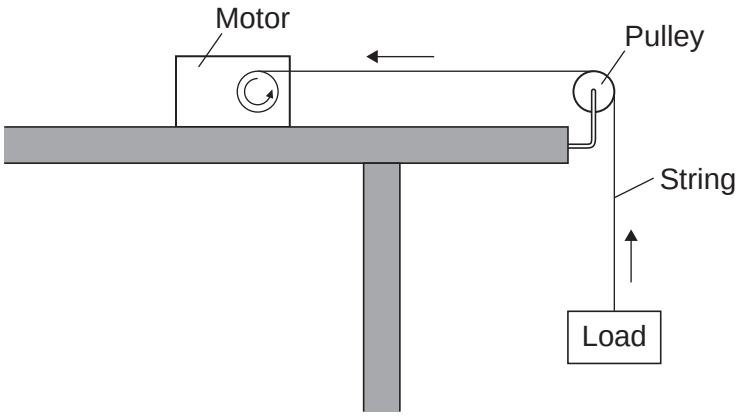
10

4.1.2.2 Efficiency

Question 64

June 2012 | PH1HP | Original Q2 | Legacy

2 A student uses an electric motor to lift a load.



In the motor, the electrical energy is transferred into other types of energy. Some of this energy is useful and the rest of the energy is wasted.

2 (a) (i) Name the useful energy output from the electric motor.

.....

(1 mark)

2 (a) (ii) What eventually happens to the wasted energy?

.....

.....

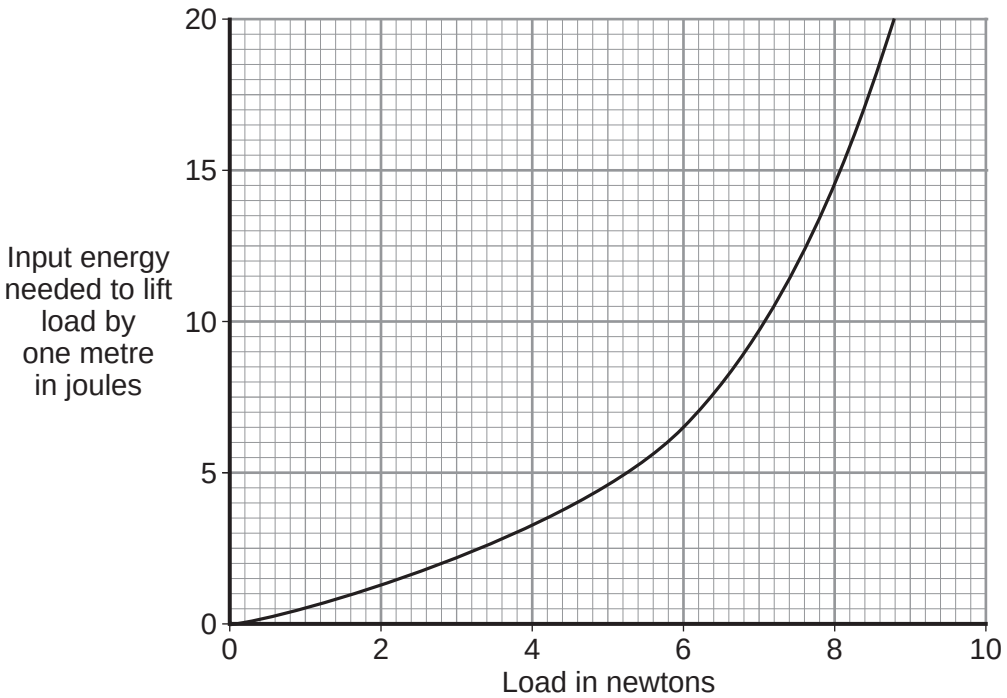
(1 mark)

Question 2 continues on the next page

4.1.2.2 Efficiency

Question 64 · continued

2 (b) The graph shows the input energy the motor needs to lift different loads by one metre.



What can you conclude from the graph about the relationship between the load lifted and the input energy needed?

.....

.....

.....

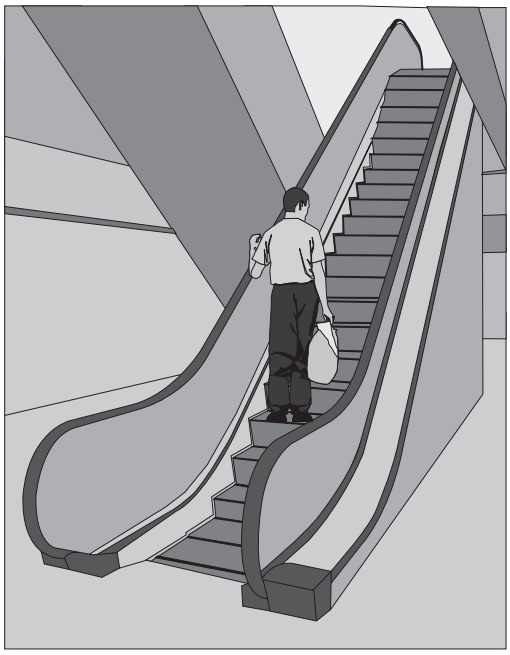
.....

(2 marks)

4.1.2.2 Efficiency

Question 64 · continued

2 (c) A shop uses escalators to lift customers to different floor levels. The escalators use electric motors. When the shop is not busy some escalators are turned off.
A sign tells the customers that the escalators are turned off to save energy.



2 (c) (i) Each escalator has one motor with an average power of 4000 W. The motor is turned on for an average of 8 hours each day, 6 days each week. Electricity costs 15 pence per kilowatt-hour.

Calculate the cost of the electricity used in an average week to run **one** escalator.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

.....

.....

.....

.....

Cost = ... pence
(3 marks)

2 (c) (ii) Give **one** environmental advantage to turning off electrical appliances when they are not being used.

.....

.....
(1 mark)

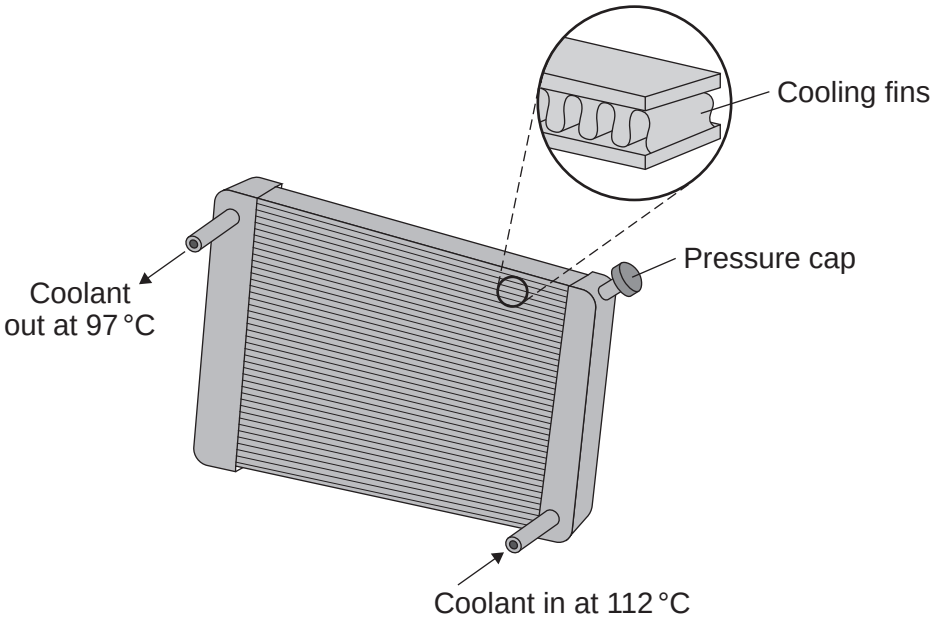
8

4.1.2.2 Efficiency

Question 65

January 2013 | PH1HP | Original Q2 | Legacy

2 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.

2 (a) Why is the radiator painted black?

.....

.....

.....

.....

(2 marks)

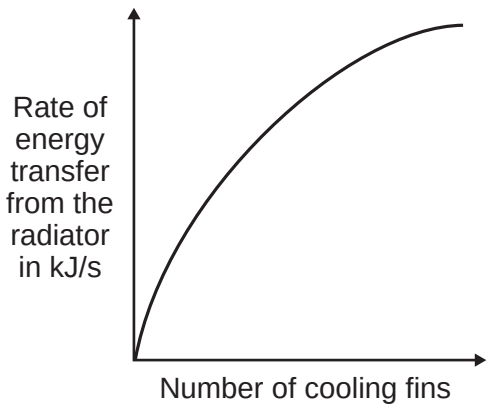
Question 2 continues on the next page

4.1.2.2 Efficiency

Question 65 · continued

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.

.....

.....

.....

.....

(2 marks)

4.1.2.2 Efficiency

Question 65 · continued

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.

.....

.....

.....

.....

Energy transferred each second = ... J

(3 marks)

2 (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.

.....

.....

.....

(2 marks)

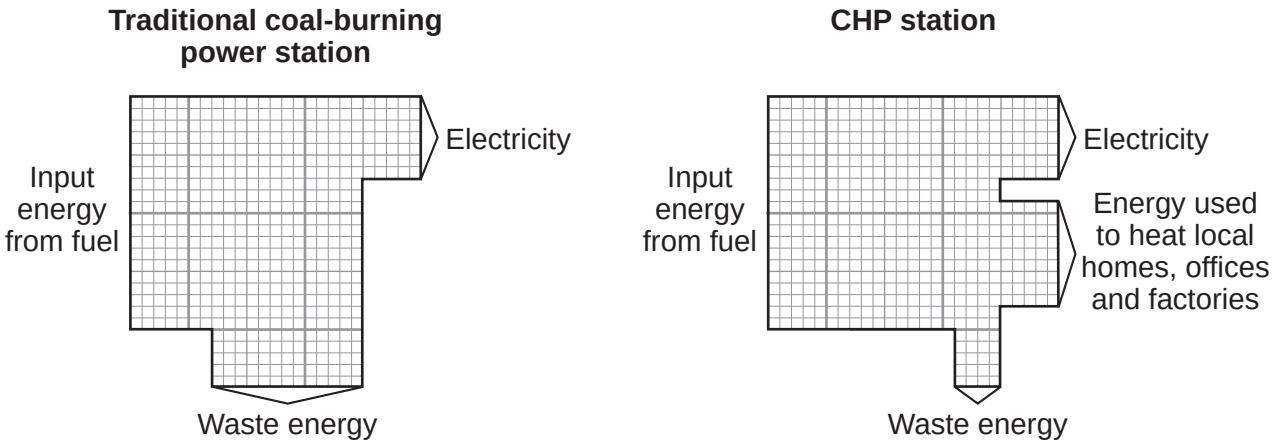
9

4.1.2.2 Efficiency

Question 66

June 2013 | PH1HP | Original Q1 | Legacy

1 The Sankey diagrams show the energy transfers in a traditional coal-burning power station and a combined heat and power (CHP) station.



1 (a) What effect does the waste energy from a power station have on the surroundings?

.....

.....

(1 mark)

1 (b) Calculate the efficiency of the CHP station.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Efficiency = ...

(2 marks)

4.1.2.2 Efficiency

Question 66 · continued

1 (c) Why is a CHP station more efficient than a traditional coal-burning power station?

.....

.....

.....

.....

(2 marks)

1 (d) A CHP station is usually used to meet the demand for electricity within the local area. The electricity is not transmitted and distributed through the National Grid.

1 (d) (i) What is the National Grid?

Tick (✓) **one** box.

A system of cables and pylons. ☐

A system of cables and transformers. ☐

A system of cables, transformers and power stations. ☐

(1 mark)

1 (d) (ii) Using the electricity locally and not transmitting it through the National Grid increases the overall efficiency of a CHP station by 7%.

Give **one** reason why.

.....

.....

(1 mark)

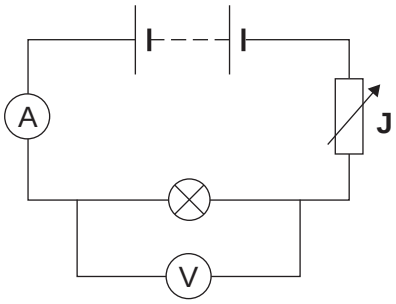
7

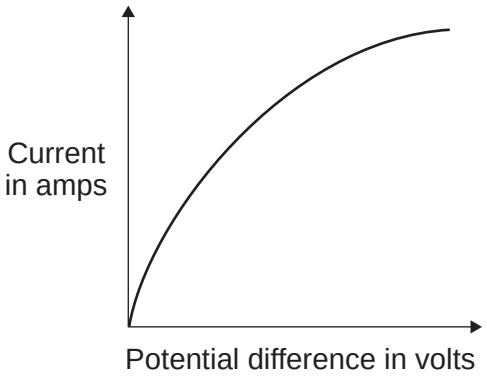
4.1.2.2 Efficiency

Question 67

June 2013 | PH2HP | Original Q2 | Legacy

2 (a) The diagram shows the circuit used to obtain the data needed to plot the current–potential difference graph for a filament bulb.





2 (a) (i) Why is the component labelled '**J**' included in the circuit?

.....

.....

(1 mark)

2 (a) (ii) The resistance of the bulb increases as the potential difference across the bulb increases. Why?

.....

.....

(1 mark)

2 (a) (iii) The bulb is at full brightness when the potential difference across the bulb is 12 V. The current through the bulb is then 3 A.

Calculate the power of the bulb when it is at full brightness and give the unit.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Power = ...

(3 marks)

4.1.2.2 Efficiency

Question 67 · continued

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

The table gives data about two types of light bulb people may use in their homes.

Type of light bulb	Energy efficiency	Cost of one light bulb	Average lifetime in hours
Halogen	10%	£1.95	2 000
Light Emitting Diode (LED)	32%	£11.70	36 000

Both types of light bulb produce the same amount of light.

Evaluate, in terms of cost and energy efficiency, the use of the two types of light bulb.

To gain full marks you must compare both types of light bulb and conclude which light bulb would be the best to use.

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(6 marks)

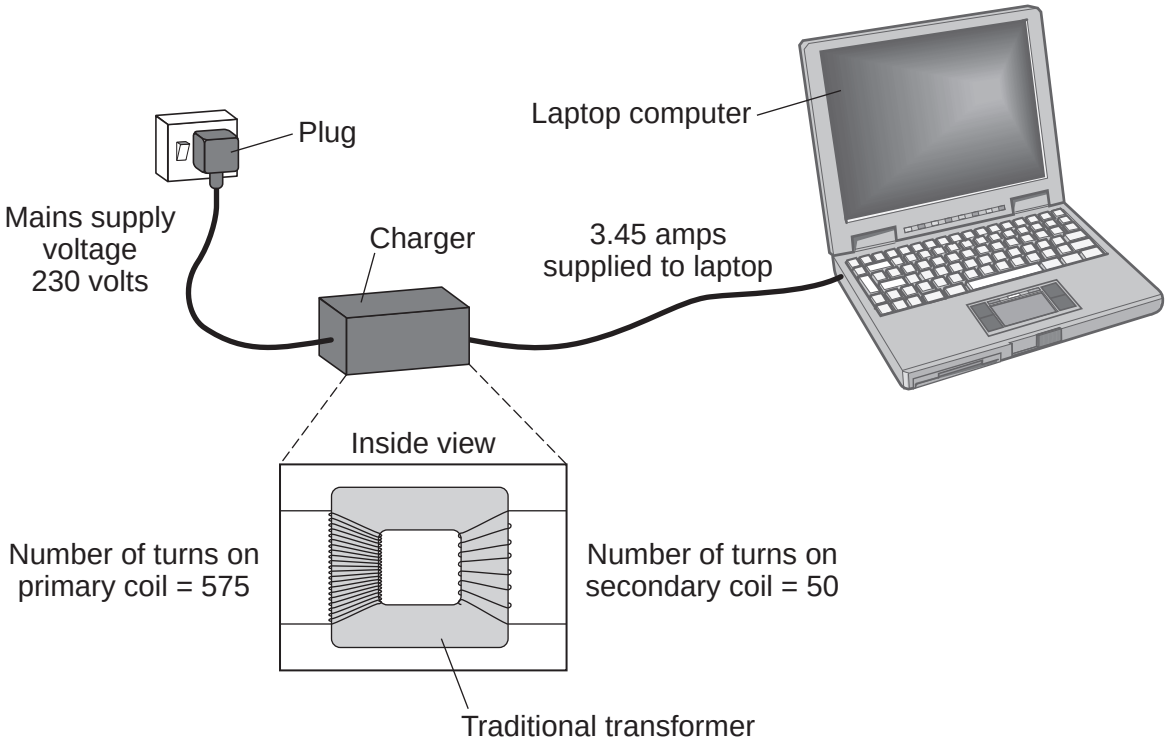
11

4.1.2.2 Efficiency

Question 68

June 2013 | PH3HP | Original Q7 | Legacy

7 Batteries inside laptop computers are charged using laptop chargers. The laptop charger contains a traditional transformer.



7 (a) The alternating current flowing through the primary coil of the transformer creates an alternating current in the secondary coil.

Explain how.

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(3 marks)

4.1.2.2 Efficiency

Question 68 · continued

7 (b) (i) Use information from the diagram to calculate the potential difference the charger supplies to the laptop.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

.....

Potential difference = ... V

(2 marks)

7 (b) (ii) Calculate the current in the primary coil of the transformer when the laptop is being charged.

Assume the transformer is 100% efficient.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

.....

Current = ... A

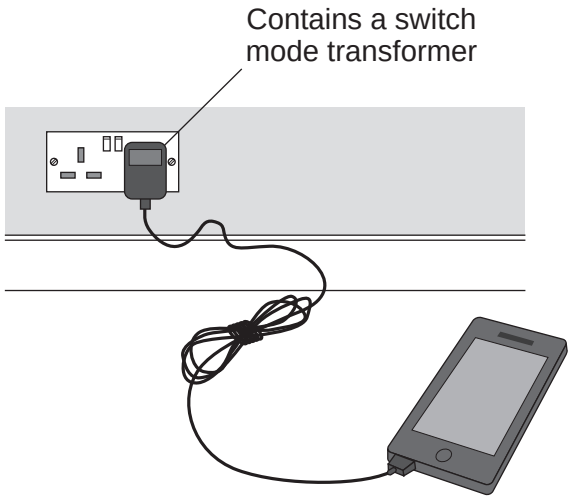
(2 marks)

Question 7 continues on the next page

4.1.2.2 Efficiency

Question 68 · continued

7 (c) Switch mode transformers can be used in mobile phone chargers.



Switch mode transformers and traditional transformers can both use the UK mains supply.

The switch mode transformer is smaller and lighter than the traditional transformer used in the laptop charger.

Give **one** other advantage of the switch mode transformer.

.....

.....

(1 mark)

7 (d) Laptop batteries and mobile phone batteries can only be recharged a limited number of times. After this, the batteries cannot store enough charge to be useful. Scientists are developing new batteries that can be recharged many more times than existing batteries.

Suggest **one** other advantage of developing these new batteries.

.....

.....

.....

(1 mark)

9

4.1.2.2 Efficiency

Question 69

June 2014 | PH1HP | Original Q5 | Legacy

5 (a) Iceland is a country that generates nearly all of its electricity from renewable sources.

In 2013, about 80% of Iceland's electricity was generated using hydroelectric power stations (HEP).

Describe how electricity is generated in a hydroelectric power station. Include the useful energy transfers taking place.

[4 marks]

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4.1.2.2 Efficiency

Question 69 · continued

5 (b) The UK produces most of its electricity from fossil fuels.

Many people in the UK leave their televisions in 'stand by' mode when not in use, instead of switching them off.

It is better for the environment if people switch off their televisions, instead of leaving them in 'stand by' mode.

Explain why.

[3 marks]

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.....

5 (c) A scientist wrote in a newspaper:

'Appliances that do not automatically switch off when they are not being used should be banned.'

Suggest why scientists alone cannot make the decision to ban these appliances.

[1 mark]

.....

.....

8

4.1.2.2 Efficiency

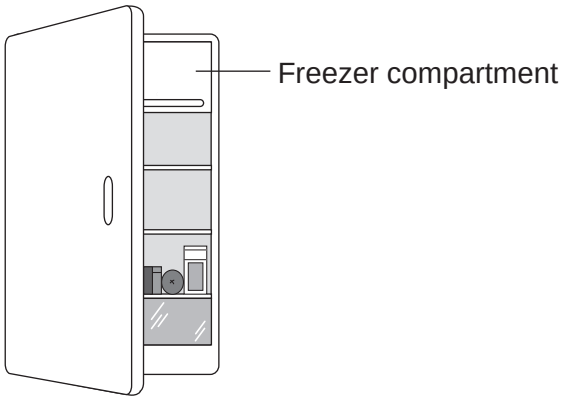
Question 70

June 2014 | PH1HP | Original Q6 | Legacy

6 (a) **Figure 6** shows a fridge with a freezer compartment.

The temperature of the air inside the freezer compartment is –5 °C.

Figure 6



The air inside the fridge forms a convection current when the fridge door is closed. Explain why.

[4 marks]

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4.1.2.2 Efficiency

Question 70 · continued

6 (b) **Table 1** shows information about four fridges.

Table 1

Fridge	Volume in litres	Energy used in one year in kWh
A	250	300
B	375	480
C	500	630
D	750	750

A householder concludes that the energy used in one year is directly proportional to the volume of the fridge.

Explain why her conclusion is **not** correct.

Use data from the table in your answer.

[2 marks]

.....

.....

.....

.....

6 (c) New fridges are more efficient than fridges made twenty years ago.

Give **one** advantage and **one** disadvantage of replacing an old fridge with a new fridge.

Ignore the cost of buying a new fridge.

[2 marks]

Advantage .....

.....

Disadvantage .....

.....

8

4.1.2.2 Efficiency

Question 71

June 2014 | PH1HP | Original Q8 | Legacy

8 **Table 2** shows information about different light bulbs.

The bulbs all have the same brightness.

Table 2

Type of bulb	Input power in watts	Efficiency
Halogen	40	0.15
Compact fluorescent (CFL)	14	0.42
LED	7	0.85

8 (a) (i) Calculate the useful power output of the CFL bulb.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

.....

.....

.....

Useful power output = ... watts

8 (a) (ii) Use your answer to part **(a)(i)** to calculate the waste energy produced each second by a CFL bulb.

[1 mark]

.....

Waste energy per second = ... joules

Question 8 continues on the next page

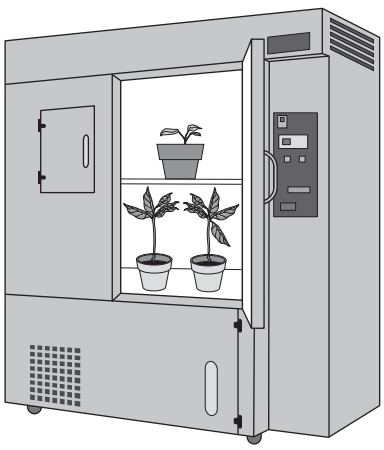
4.1.2.2 Efficiency

Question 71 · continued

8 (b) (i) A growth cabinet is used to investigate the effect of light on the rate of growth of plants.

Figure 9 shows a growth cabinet.

Figure 9



In the cabinet the factors that affect growth can be controlled.

A cooler unit is used to keep the temperature in the cabinet constant. The cooler unit is programmed to operate when the temperature rises above 20 °C.

The growth cabinet is lit using 50 halogen bulbs.

Changing from using halogen bulbs to LED bulbs would reduce the cost of running the growth cabinet.

Explain why.

[4 marks]

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.....

.....

4.1.2.2 Efficiency

Question 71 · continued

8 (b) (ii) A scientist measured the rate of growth of plants for different intensities of light.

What type of graph should be drawn to present the results?

[1 mark]

.....

Give a reason for your answer.

.....

.....

8 (c) **Table 3** gives further information about both a halogen bulb and an LED bulb.

Table 3

Type of bulb	Cost to buy	Lifetime in hours	Operating cost over the lifetime of one bulb
Halogen	£1.50	2 000	£16.00
LED	£30.00	48 000	£67.20

A householder needs to replace a broken halogen light bulb.

Compare the cost efficiency of buying and using halogen bulbs rather than an LED bulb over a time span of 48 000 hours of use.

Your comparison must include calculations.

[4 marks]

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12

4.1.2.2 Efficiency

Question 72

June 2015 | PH1HP | Original Q1 | Legacy

1 **Figure 1** shows a man using a leaf blower to move leaves.

Figure 1



The leaf blower is powered by an electric motor connected to a battery.

1 (a) Energy transfers take place when the leaf blower is being used.

Complete the following sentences.

[3 marks]

The battery stores ..... energy which is transferred into electrical energy.

The electric motor transfers electrical energy usefully into ..... energy.

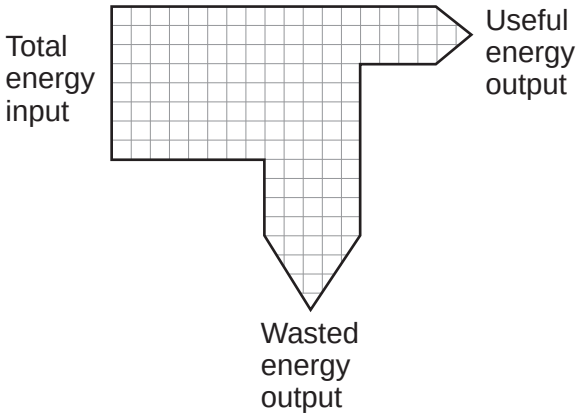
The motor wastes energy as ..... and as energy that heats the surroundings.

4.1.2.2 Efficiency

Question 72 · continued

1 (b) **Figure 2** shows a Sankey diagram for the leaf blower.

Figure 2



Use **Figure 2** to calculate the efficiency of the leaf blower.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

.....

.....

.....

Efficiency = ...

5

4.1.2.2 Efficiency

Question 73

June 2015 | PH1HP | Original Q2 | Legacy

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

A householder wants to reduce her energy bills. She collected information about a number of ways of reducing energy used. The information is shown in **Table 1**.

Table 1

Ways of reducing energy used	Cost to buy and install in £	Money saved per year in £
Install an energy-efficient boiler	2 000	320
Insulate the loft	400	200
Install double-glazed windows	12 000	120
Install cavity wall insulation	415	145

Use the information in **Table 1** to compare the different ways of reducing the energy used. Your answer should include some calculations.

[6 marks]

.....

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4.1.2.2 Efficiency

Question 73 · continued

Extra space .....

.....

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.....

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.....

2 (b) Increasing the amount of insulation in a house affects the total U-value of the house.

2 (b) (i) What is meant by the term 'U-value'?

[1 mark]

.....

.....

.....

2 (b) (ii) How is the U-value affected by increasing the amount of insulation?

[1 mark]

.....

8

4.1.2.2 Efficiency

Question 74

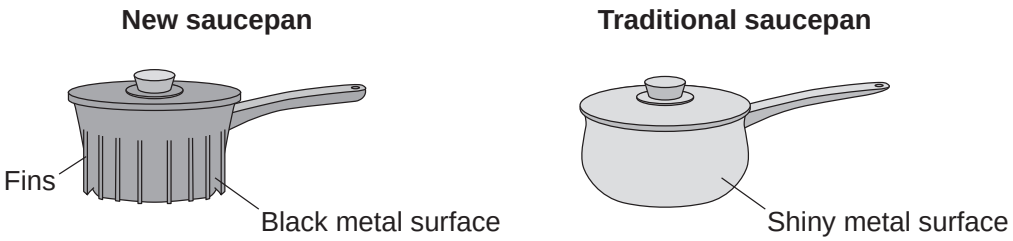
June 2016 | PH1HP | Original Q3 | Legacy

3 (a) Heating food in a saucepan over a gas flame is inefficient.
Suggest why.

[2 marks]

3 (b) A new saucepan has been designed that heats up food much faster than a traditional saucepan. **Figure 4** shows the two saucepans.

Figure 4



Describe how the features of the new saucepan cause the food to heat up faster than when the food is heated in the traditional saucepan.

[2 marks]

Fins

Black metal surface

3 (c) State the relationship between the temperature of the saucepan and the rate at which the saucepan emits infrared radiation.

[1 mark]

5

4.1.2.2 Efficiency

Question 75

June 2016 | PH1HP | Original Q6 | Legacy

6 All European Union countries are expected to generate 20% of their electricity using renewable energy sources by 2020.

The estimated cost of generating electricity in the year 2020 using different energy sources is shown in **Table 1**.

Table 1

Energy source	Estimated cost (in the year 2020) in pence per kWh
Nuclear	7.8
Solar	25.3
Tidal	18.8
Wind	10.0

France generated 542 billion kWh of electricity using nuclear power stations in 2011. France used 478 billion kWh of electricity and sold the rest of the electricity to other countries in 2011.

6 (a) France may continue generating large amounts of electricity using nuclear power stations instead of using renewable energy resources.

Suggest **two** reasons why.

[2 marks]

1 _____

_____

2 _____

_____

4.1.2.2 Efficiency

Question 75 · continued

6 (b) Give **two** disadvantages of generating electricity using nuclear power stations.

[2 marks]

1 _____

_____

2 _____

_____

6 (c) A panel of solar cells has an efficiency of 0.15.

The total power input to the panel of solar cells is 3.2 kW.

Calculate the useful power output of this panel of solar cells in kW.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

_____

_____

_____

_____

Useful power output = _____ kW

Question 6 continues on the next page

4.1.2.2 Efficiency

Question 75 · continued

6 (d) **Table 2** shows the manufacturing cost and efficiency of different types of panels of solar cells.

Table 2

Type of Solar Panel	Cost to manufacture a 1 m^2 solar panel in £	Efficiency in %
A	40.00	20
B	22.50	15
C	5.00	10

Some scientists think that having a low manufacturing cost is more important than improving the efficiency of solar cells.

Use information from **Table 2** to suggest why.

[2 marks]

8

4.1.2.2 Efficiency

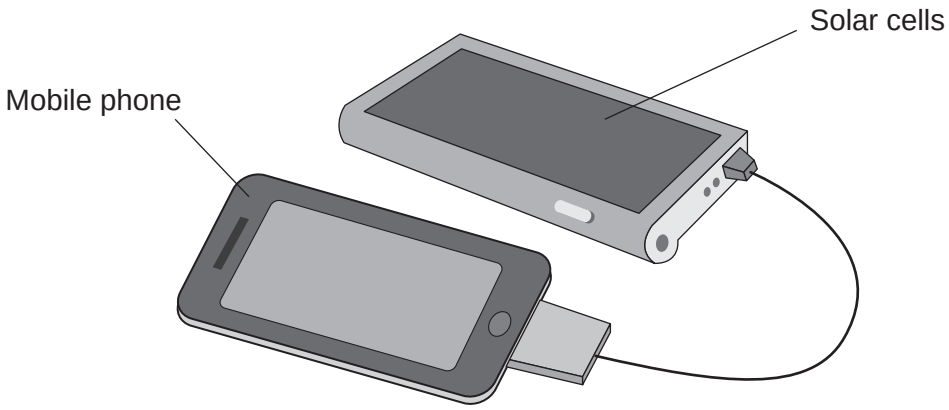
Question 76

June 2017 | PH1HP | Original Q6 | Legacy

6 **Figure 6** shows a mobile phone battery being charged using solar cells.

The useful power output of the solar cells is 2.5 W

Figure 6



6 (a) The efficiency of the solar cells is 40%.

Calculate the total power input to the solar cells.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

Total power input = _____ W

6 (b) The mobile phone battery can store 36 kJ of energy and was initially uncharged.

Calculate the minimum time, in hours, it would take to fully charge the mobile phone battery using these solar cells.

Use the correct equation from the Physics Equations Sheet.

[3 marks]

Time = _____ hours

4.1.2.2 Efficiency

Question 76 · continued

6 (c) Explain why the power **output** of the solar cells may be lower than 2.5 W

[2 marks]

6 (d) Explain why the time taken to recharge this mobile phone battery using these solar cells depends on whether the phone is switched on or off.

[2 marks]

9

4.1.2.2 Efficiency

Question 77

June 2018 | 8463/1H | Original Q5

0 5 . 1 Complete the sentence. Choose answers from the box.

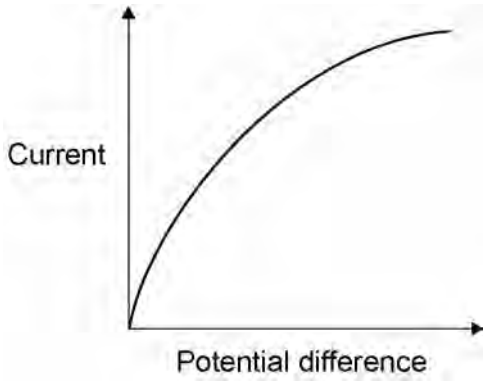
[2 marks]

charge	**potential difference**	**power**	**temperature**	**time**

The current through an ohmic conductor is directly proportional to the _____ across the component, provided that the _____ remains constant.

0 5 . 2 **Figure 7** shows a current – potential difference graph for a filament lamp.

Figure 7



Explain how the resistance of a filament lamp changes as the potential difference across it increases.

[3 marks]

4.1.2.2 Efficiency

Question 77 · continued

0 5 . 3 Many householders are replacing their filament lamps with LED lamps which are more energy efficient.

What does more energy efficient mean?

[1 mark]

Question 5 continues on the next page

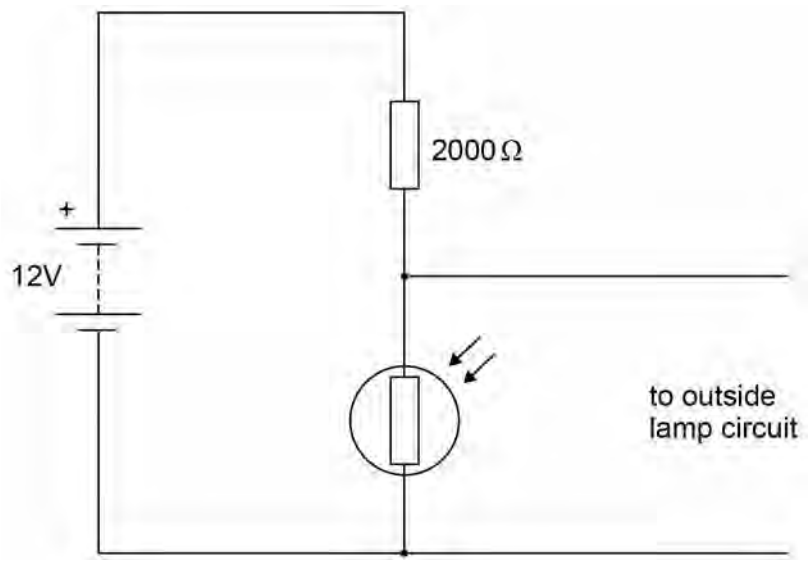
4.1.2.2 Efficiency

Question 77 · continued

A Light Dependent Resistor (LDR) is used to turn on an outside lamp when it gets dark.

Part of the circuit is shown in **Figure 8**.

Figure 8



0 5 . 4 The light intensity decreases.

What happens to the potential difference across the LDR and the current in the LDR?

[2 marks]

Potential difference _____

Current _____

0 5 . 5 What is the resistance of the LDR when the potential difference across it is 4 V?

Give a reason for your answer.

[2 marks]

Resistance = _____ Ω

Reason _____

_____

_____

4.1.2.2 Efficiency

Question 77 · continued

0 5 . 6 Calculate the current through the LDR when the resistance of the LDR is 5000 Ω.

Give your answer to 2 significant figures.

[4 marks]

Current = _____ A

14

Turn over for the next question

4.1.2.2 Efficiency

Question 78

June 2018 | 8463/1H | Original Q10

1 0 **Figure 16** shows a wind turbine.

Figure 16



1 0 . 1 At a particular wind speed, a volume of 2.3×10^4 m^3 of air passes the blades each second.

The density of air is 1.2 kg/m^3.

Calculate the mass of air passing the blades per second.

[3 marks]

Mass of air per second = _____ kg

1 0 . 2 The power output of the turbine is directly proportional to the kinetic energy of the air passing the blades each second.

Describe the effect on the power output when the wind speed is halved.

[3 marks]

4.1.2.2 Efficiency

Question 78 · continued

1 0 . 3 At a different wind speed, the wind turbine has a power output of 388 kW.

The mass of air passing the wind turbine each second is 13 800 kg.

Calculate the speed of the air passing the blades each second.

Assume that the process is 100% efficient.

[3 marks]

Speed of air = _____ m/s

9

4.1.2.2 Efficiency

Question 79

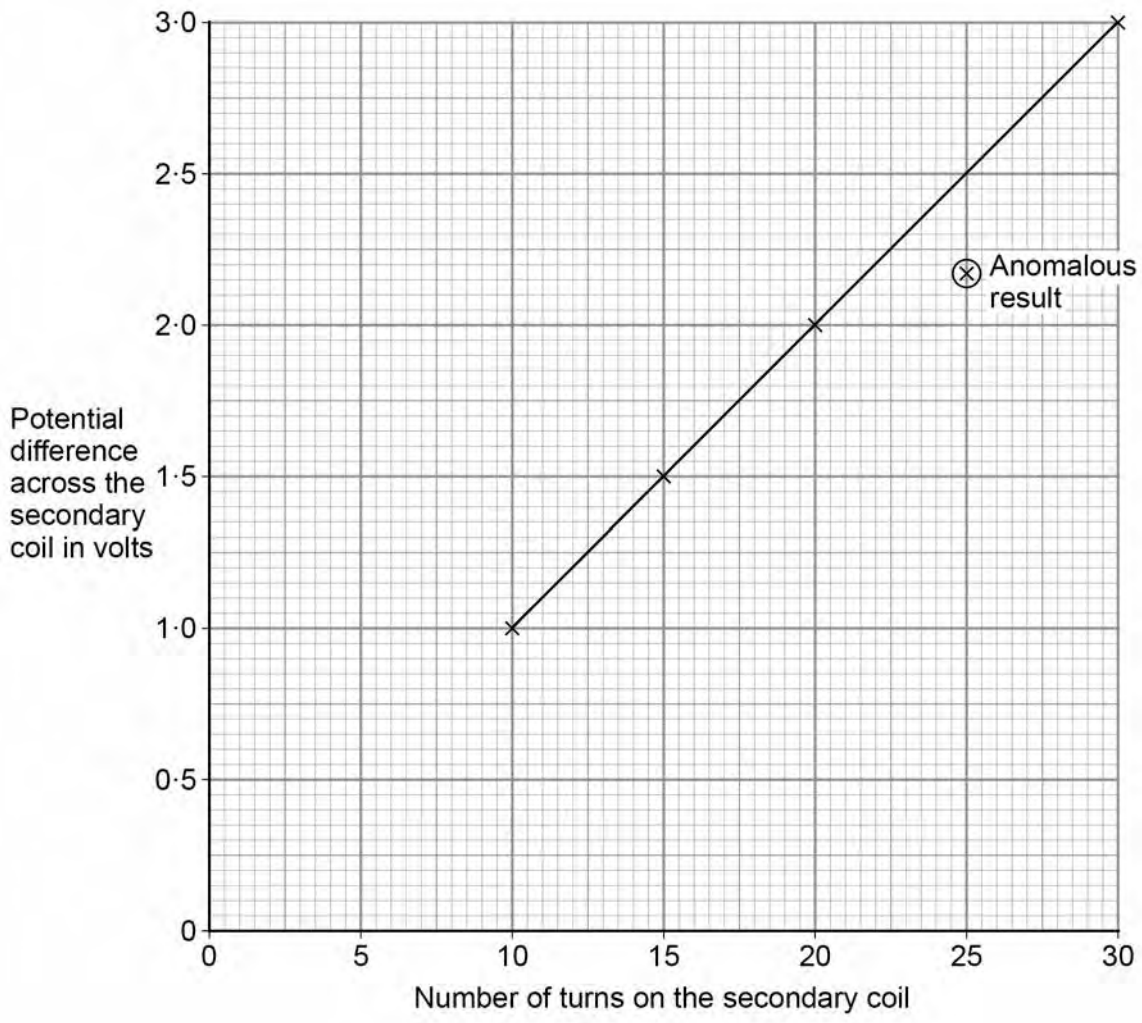
June 2018 | 8463/2H | Original Q7

0 7 A student used a simple transformer to investigate how the number of turns on the secondary coil affects the potential difference (p.d.) across the secondary coil.

The student kept the p.d. across the primary coil fixed at 2V.

Figure 12 shows the results collected by the student.

Figure 12



0 7 . 1 **Figure 12** contains one anomalous result.

Suggest **one** possible reason why this anomalous result occurred.

[1 mark]

4.1.2.2 Efficiency

Question 79 · continued

0 7 . 2 The transformer changes from being a step-down to a step-up transformer.

How can you tell from **Figure 12** that this happens?

[1 mark]

Question 7 continues on the next page

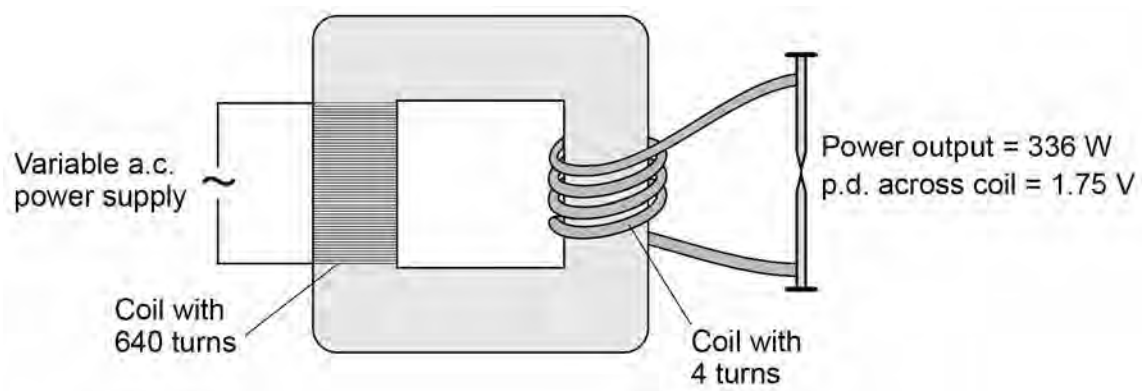
4.1.2.2 Efficiency

Question 79 · continued

A spot-welder is a device that uses a transformer to produce a large current to join sheets of metal together.

Figure 13 shows a transformer demonstrating how a large current can heat and join two nails together.

Figure 13



0 7 . 3 How does the amount of infrared radiation emitted by the nails change when the power supply is switched on?

[1 mark]

0 7 . 4 Calculate the current from the power supply needed to provide a power output of 336 W.

Use the data in **Figure 13**.

The transformer is 100% efficient.

[5 marks]

Current = _____ A

8

4.1.2.2 Efficiency

Question 80

June 2019 | 8463/1H | Original Q1

0 1 Light bulbs are labelled with a power input.

0 1 . 1 What does power input mean?

[1 mark]

Tick (✓) **one** box.

- The charge transferred each second by the bulb. ☐
- The current through the bulb. ☐
- The energy transferred each second to the bulb. ☐
- The potential difference across the bulb. ☐

0 1 . 2 Write down the equation which links current, potential difference and power.

[1 mark]

_____

0 1 . 3 A light bulb has a power input of 40 W

The mains potential difference is 230 V

Calculate the current in the light bulb.

[3 marks]

_____

_____

_____

Current = _____ A

4.1.2.2 Efficiency

Question 80 · continued

Table 1 shows information about three different light bulbs.

Table 1

Light bulb	Total power input in watts	Useful power output in watts	Efficiency
P	6.0	5.4	0.90
Q	40	2.0	0.05
R	9.0	**X**	0.30

0 1 . 4 Write down the equation which links efficiency, total power input and useful power output.

[1 mark]

0 1 . 5 Calculate the value of **X** in **Table 1**.

[3 marks]

X = _____ W

0 1 . 6 In addition to power input, light bulbs should also be labelled with the rate at which they emit visible light.

Suggest why.

[2 marks]

11

4.1.2.2 Efficiency

Question 81

June 2019 | 8463/1H | Original Q4

0 4 Electric cars have motors that are powered by a battery.

Diesel cars have engines that are powered by diesel fuel.

Table 2 compares one type of electric car with one type of diesel car.

Table 2

Power source	Energy density in MJ / kg	Mass of power source in kg	Total mass of car in kg	Time to recharge battery or refill fuel tank in minutes
Battery	0.95	280	1600	40
Diesel fuel	45	51	1500	3

0 4 . 1 The electric car has a range of 400 km with a fully charged battery.

The diesel car has a range of 1120 km with a full tank of diesel.

Explain the difference in the time needed to complete a 500 km journey using the electric car compared with the diesel car.

Assume both cars travel at the same speed.

[2 marks]

4.1.2.2 Efficiency

Question 81 · continued

0 4 . 2 Energy density is the amount of energy stored per kilogram of the energy source.

Show why the diesel car has a greater range than the electric car.

Use data from **Table 2**.

Assume the efficiency of the two cars is the same.

Include calculations in your answer.

[3 marks]

Question 4 continues on the next page

4.1.2.2 Efficiency

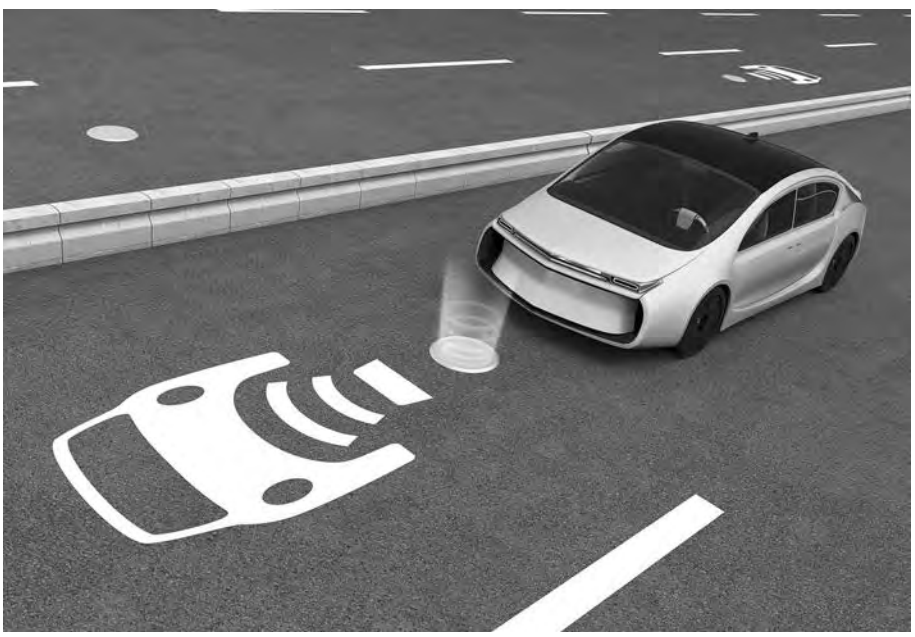
Question 81 · continued

Engineers have developed a way of charging electric cars while they are driving along the road.

Coils of wire buried under the road transfer energy to the car's battery as the car is passing over the coils.

Figure 6 shows a charging lane on a motorway.

Figure 6



0 4 . 3 Suggest **two** advantages of using this method to charge electric cars compared with plugging them into the mains electricity supply.

[2 marks]

1 _____

_____

_____

_____

2 _____

_____

_____

_____

4.1.2.2 Efficiency

Question 81 · continued

0 4 . 4 When electric cars are not being driven, energy stored in their batteries could be used to meet sudden peaks in electricity demand.

Suggest how.

[2 marks]

9

4.1.2.2 Efficiency

Question 82

June 2019 | 8463/1H | Original Q6

0 6 **Figure 7** shows a person using an electric lawn mower.

Figure 7



0 6 . 1 The lawn mower is connected to the mains electricity supply.

What is the frequency of the mains electricity supply in the UK?

[2 marks]

Frequency = _____ Unit _____

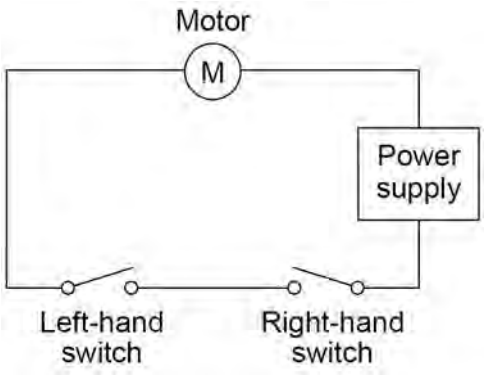
4.1.2.2 Efficiency

Question 82 · continued

The lawn mower has a switch on each side of the handle.

Figure 8 shows the circuit diagram for the lawn mower.

Figure 8



0 6 . 2 The motor in the lawn mower can only be turned on when the person using it holds the handle of the lawn mower with both hands.

Explain why.

[2 marks]

0 6 . 3 The power input to the motor is 1.8 kW

The resistance of the motor is 32 Ω

Calculate the current in the motor.

[3 marks]

Current = _____ A

4.1.2.2 Efficiency

Question 82 · continued

0 6 . 4 The useful power output from the motor is 1.5 kW

Calculate the time it takes for the motor to transfer 450 000 J of useful energy.

[3 marks]

Time = _____ seconds

1

4.1.2.2 Efficiency

Question 83

November 2020 | 8463/1H | Original Q2

0 2 **Figure 3** shows an LED torch.

Figure 3

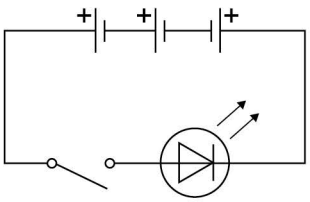


0 2 . 1 The torch contains one LED, one switch and three cells.

Which diagram shows the correct circuit for the torch?

[1 mark]

Tick (✓) **one** box.



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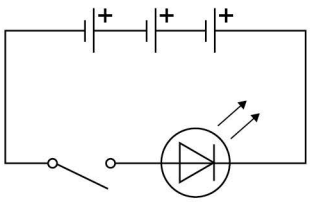
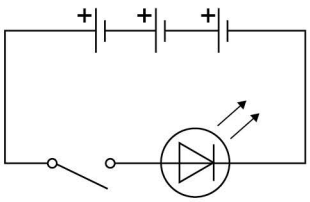


☐



☐

4.1.2.2 Efficiency

Question 83 · continued

0 2 . 2 Write down the equation which links charge flow (Q), current (I) and time (t).

[1 mark]

0 2 . 3 The torch worked for 14 400 seconds before the cells needed replacing.

The current in the LED was 50 mA.

Calculate the total charge flow through the cells.

[3 marks]

Total charge flow = _____ C

0 2 . 4 When replaced, the cells were put into the torch the wrong way around.

Explain why the torch did not work.

[2 marks]

Question 2 continues on the next page

4.1.2.2 Efficiency

Question 83 · continued

0 2 . 5 Write down the equation which links efficiency, total power input and useful power output.

[1 mark]

0 2 . 6 The total power input to the LED was 0.24 W.

The efficiency of the LED was 0.75

Calculate the useful power output of the LED.

[3 marks]

Useful power output = _____ W

11

4.1.2.2 Efficiency

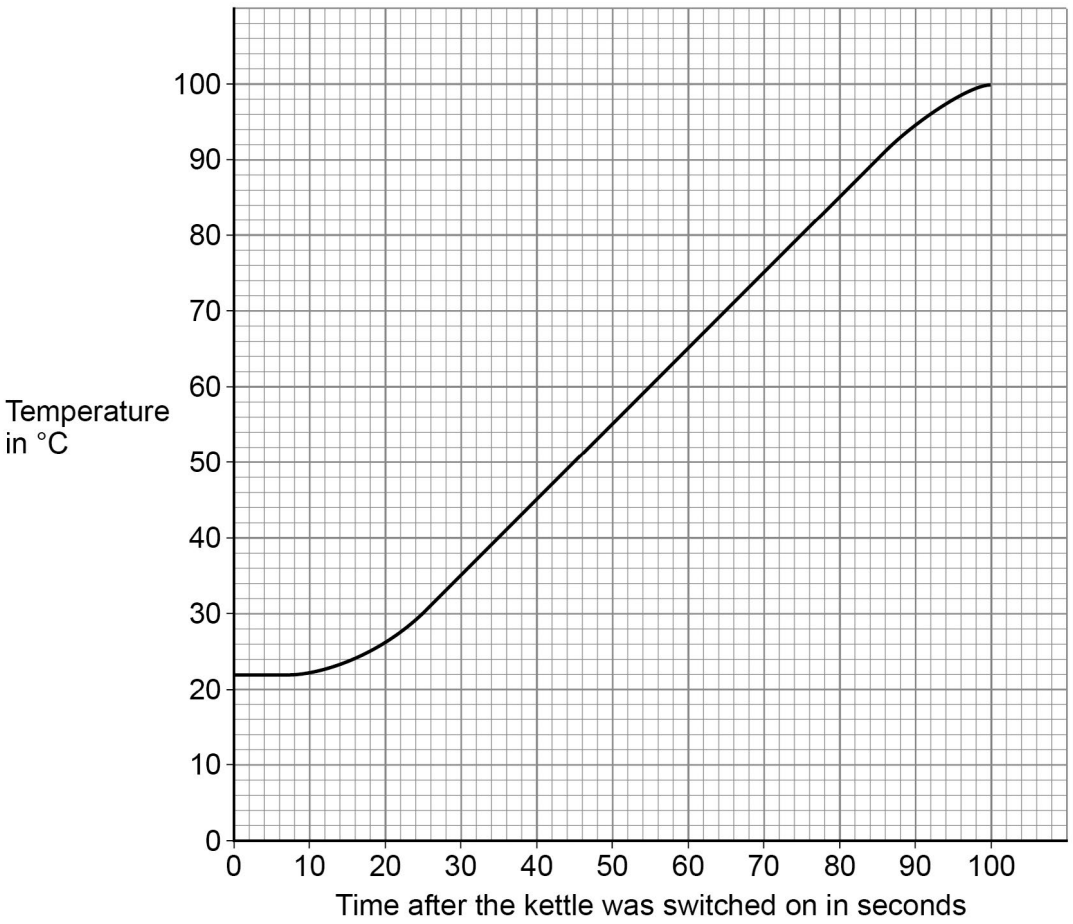
Question 84

November 2020 | 8463/1H | Original Q7

0 7 An electric kettle was switched on.

Figure 10 shows how the temperature of the water inside the kettle changed.

Figure 10



0 7 . 1 When the kettle was switched on the temperature of the water did **not** immediately start to increase.

Suggest **one** reason why.

[1 mark]

4.1.2.2 Efficiency

Question 84 · continued

0 7 . 2 The energy transferred to the water in 100 seconds was 155 000 J.

specific heat capacity of water = 4200 J/kg °C

Determine the mass of water in the kettle.

Use **Figure 10**.

Give your answer to 2 significant figures.

[5 marks]

Mass of water (2 significant figures) = _____ kg

0 7 . 3 The straight section of the line in **Figure 10** can be used to calculate the useful power output of the kettle.

Explain how.

[3 marks]

9

4.1.2.2 Efficiency

Question 85

November 2021 | 8463/1H | Original Q5

0 5 . 1 During one year, 1.25×10^{18} J of energy was transferred from the National Grid.

number of seconds in 1 year = 3.16×10^{7}

Calculate the mean energy transferred from the National Grid each second.

Give your answer to 3 significant figures.

[2 marks]

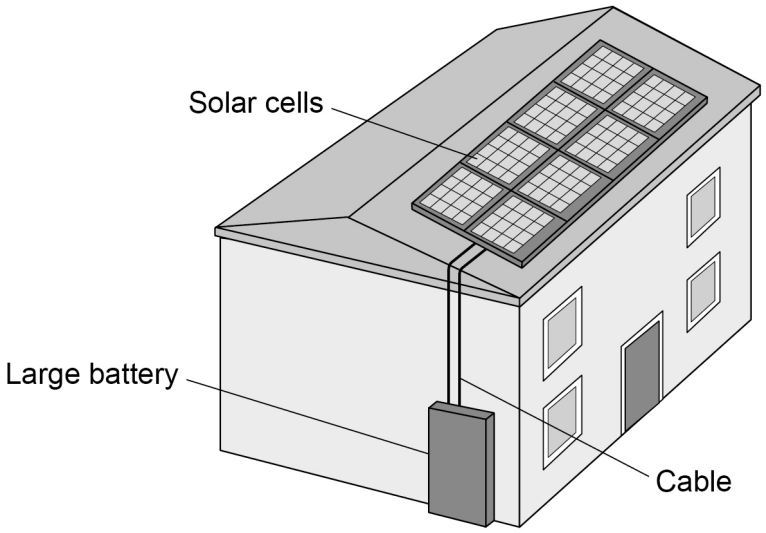
Energy each second (3 significant figures) = _____ J

Figure 5 shows a house with a solar power system.

The solar cells generate electricity.

When the electricity generated by the solar cells is not needed, the energy is stored in a large battery.

Figure 5



4.1.2.2 Efficiency

Question 85 · continued

0 5 . 2 The charge flow through the cable between the solar cells and the battery in 24 hours was 27 000 coulombs.

Calculate the mean current in the cable.

[4 marks]

Mean current = _____ A

0 5 . 3 At one time, the total power input to the solar cells was 7.8 kW.

The efficiency of the solar cells was 0.15

Calculate the useful power output of the solar cells.

[3 marks]

Useful power output = _____ W

Question 5 continues on the next page

4.1.2.2 Efficiency

Question 85 · continued

0 5 . 4 It is unlikely that **all** of the electricity that the UK needs can be generated by solar power systems.

Explain why.

[2 marks]

11

4.1.2.2 Efficiency

Question 86

June 2022 | 8463/1H | Original Q1

0 1 **Figure 1** shows a large wind farm off the coast of the UK.

Figure 1



The mean power output of the wind farm is 696 MW, which is enough power for 580 000 homes.

0 1 . 1 Calculate the mean power needed for 1 home.

Give your answer in watts.

[2 marks]

Mean power needed for 1 home = _____ W

4.1.2.2 Efficiency

Question 86 · continued

0 1 . 2 On one day the demand for electricity in the UK was 34 000 MW.

Suggest **two** reasons why wind power was not able to meet this demand.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

0 1 . 3 Some of the energy from the wind used to rotate a wind turbine is wasted.

An engineer oils the mechanical parts of a wind turbine.

Explain how oiling would affect the efficiency of the wind turbine.

[3 marks]

_____

_____

_____

_____

_____

0 1 . 4 In most homes in the UK there are many different electrical devices.

Explain why people should be encouraged to use energy efficient electrical devices.

[2 marks]

_____

_____

_____

_____

_____

9

4.1.2.2 Efficiency

Question 87

June 2022 | 8463/1H | Original Q3

0 3 An engineering company has invented pavement tiles that generate electricity as people walk on them.

Figure 3 shows someone walking on the pavement tiles.

Figure 3



Use the Physics Equations Sheet to answer questions **03.1** and **03.2**.

0 3 . 1 What equation links current (I), potential difference (V) and power (P)?

[1 mark]

Tick (✓) **one** box.

$P = \frac{V}{I}$ ☐

$P = V \times I$ ☐

$I = P \times V$ ☐

$V = I^2 \times P$ ☐

4.1.2.2 Efficiency

Question 87 · continued

0 3 . 2 When a person walks on a tile, a potential difference of 40 V is induced across the tile.

The power output of the tile is 4.4 W.

Calculate the current in the tile.

[3 marks]

Current = _____ A

Question 3 continues on the next page

4.1.2.2 Efficiency

Question 87 · continued

Use the Physics Equations Sheet to answer questions **03.3** and **03.4**.

0 3 . 3 What equation links efficiency, total power input and useful power output?

[1 mark]

Tick (✓) **one** box.

Efficiency = $\frac{\text{useful power output}}{\text{total power input}}$ ☐

Efficiency = $\frac{\text{total power input}}{\text{useful power output}}$ ☐

Efficiency = useful power output × total power input ☐

0 3 . 4 The tiles are used to power LED lights in the pavement.

An LED light has a total power input of 4.0 W.

The efficiency of the LED light is 0.85

Calculate the useful power output of the LED light.

[3 marks]

Useful power output = _____ W

8

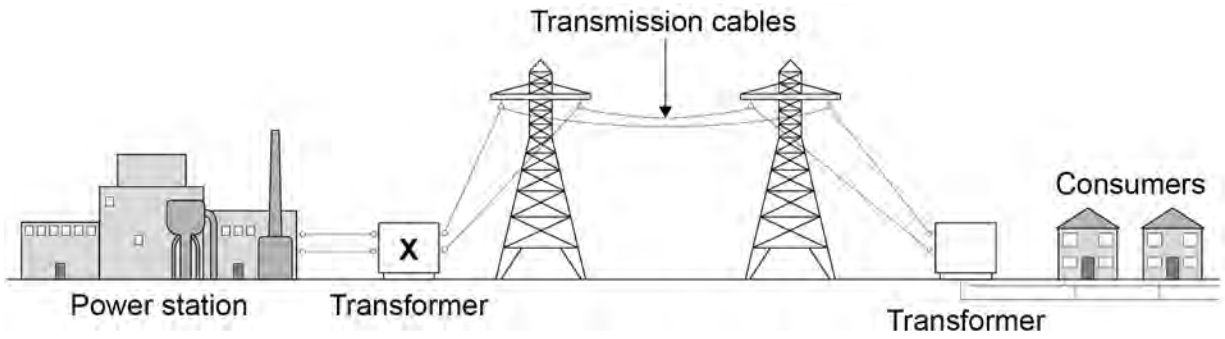
4.1.2.2 Efficiency

Question 88

June 2023 | 8463/1H | Original Q1

0 1 **Figure 1** shows how the National Grid connects a power station to consumers.

Figure 1



0 1 . 1 Complete the sentences.

[2 marks]

Transformer **X** causes the potential difference to _____ .

Transformer **X** causes the current to _____ .

Use the Physics Equations Sheet to answer questions **01.2** and **01.3**.

0 1 . 2 Which equation links current (I), power (P) and resistance (R)?

[1 mark]

Tick (✓) **one** box.

$P = \frac{I}{R}$ ☐

$P = \frac{I}{R^2}$ ☐

$P = I^2 R$ ☐

$P = IR$ ☐

4.1.2.2 Efficiency

Question 88 · continued

0 1 . 3 A transmission cable has a power loss of 1.60×10^9 W.

The current in the cable is 2000 A.

Calculate the resistance of the cable.

[3 marks]

Resistance = _____ Ω

Use the Physics Equations Sheet to answer questions **01.4** and **01.5**.

0 1 . 4 Write down the equation which links efficiency, total energy input and useful energy output.

[1 mark]

0 1 . 5 The total energy input to the National Grid from one power station is 34.2 GJ.

The National Grid has an efficiency of 0.992

Calculate the useful energy output from this power station to consumers in GJ.

[3 marks]

Useful energy output = _____ GJ

10

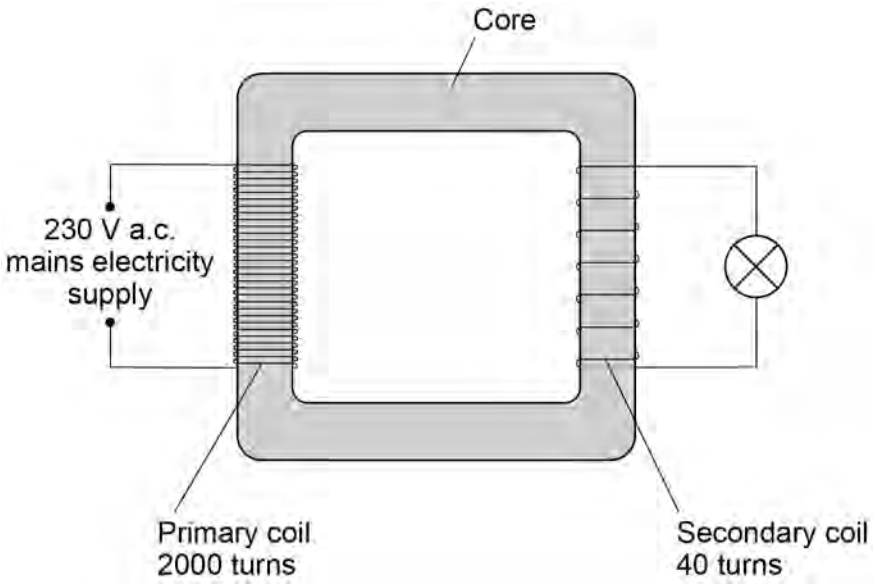
4.1.2.2 Efficiency

Question 89

June 2023 | 8463/2H | Original Q8

0 8 **Figure 21** shows a transformer used to power a lamp using the mains electricity supply.

Figure 21



0 8 . 1 What material is used to make the core of the transformer?

Give the reason for using this material.

[2 marks]

Material _____

Reason _____

_____

4.1.2.2 Efficiency

Question 89 · continued

0 8 . 2 Determine the current in the secondary coil when the power output of the transformer is 6.9 W.

The transformer is 100% efficient.

Use the Physics Equations Sheet.

[5 marks]

Current in the secondary coil = _____ A

7

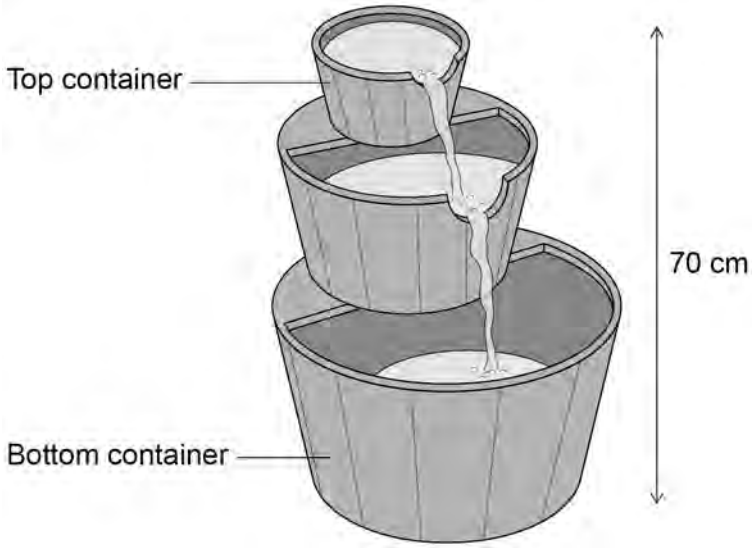
4.1.2.2 Efficiency

Question 90

June 2025 | 8463/1H | Original Q9

0 9 **Figure 11** shows a garden water feature.

Figure 11



The water feature has an electric motor that pumps water from the bottom container to the top container.

0 9 . 1 The pump transfers 0.343 J of gravitational potential energy to the water each second.

gravitational field strength = 9.8 N/kg

Determine the mass of water passing through the pump each second.

Use the Physics Equations Sheet.

[4 marks]

Mass = _____ kg

4.1.2.2 Efficiency

Question 90 · continued

0 9 . 2 The power of the pump motor is 4.86 W.

The resistance of the pump motor is 6.0 Ω.

Calculate the charge flow through the motor in 30 minutes.

Use the Physics Equations Sheet.

[6 marks]

Charge flow = _____ C

0 9 . 3 The pump motor breaks and is replaced with a new motor.

The new pump motor has the same power input, but has a greater efficiency.

Explain how the new pump motor would affect the flow of water in the water feature.

[2 marks]

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