AQA GCSE Physics | 8463

SPECIFICATION POINT 4.2.3.2

Mains electricity

Past-paper questions

Tier	**Higher**
Question groups	**47**
Available paper years	**2003–2024**

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:** _____

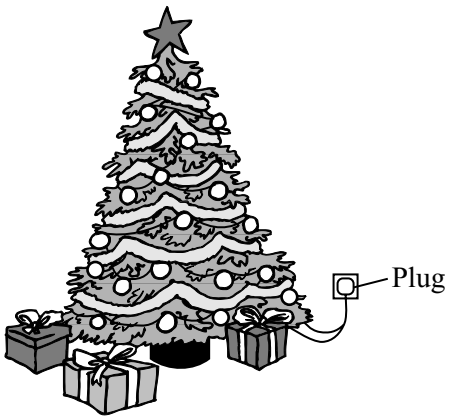
Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.2.3.2 Mains electricity

Question 01

June 2003 | 3451H | Original Q8 | Legacy

8 A set of Christmas tree lights is made from twenty identical lamps connected in series.



(a) Each lamp is designed to take a current of 0.25 A. The set plugs directly into the 230 V mains electricity supply.

(i) Write down the equation that links current, potential difference and resistance.

.....

(1 mark)

(ii) Calculate the resistance of **one** of the lamps. Show clearly how you work out your final answer and give the unit.

.....

.....

.....

.....

Resistance = ...

(4 marks)

(iii) What is the total resistance of the set of lights?

.....

Total resistance = ...

(1 mark)

(b) How does the resistance of a filament lamp change as the temperature of the filament changes?

.....

.....

(1 mark)

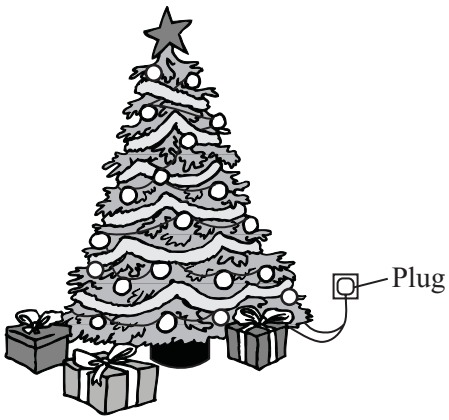
7

4.2.3.2 Mains electricity

Question 02

June 2003 | 3462H3 | Original Q6 | Legacy

6 A set of Christmas tree lights is made from twenty identical lamps connected in series.



(a) Each lamp is designed to take a current of 0.25 A. The set plugs directly into the 230 V mains electricity supply.

(i) Write down the equation that links current, potential difference and resistance.

.....

(1 mark)

(ii) Calculate the resistance of **one** of the lamps. Show clearly how you work out your final answer and give the unit.

.....

.....

.....

.....

Resistance = ...

(4 marks)

(iii) What is the total resistance of the set of lights?

.....

Total resistance = ...

(1 mark)

(b) How does the resistance of a filament lamp change as the temperature of the filament changes?

.....

.....

(1 mark)

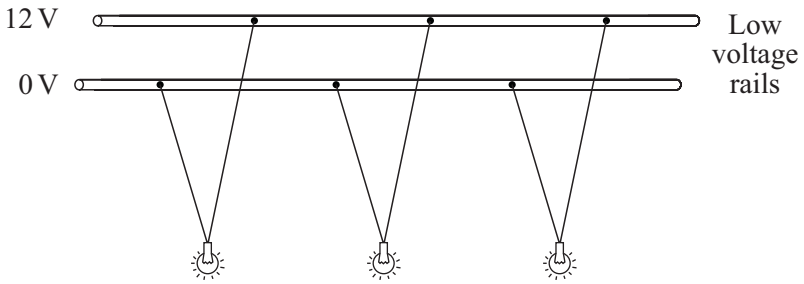
7

4.2.3.2 Mains electricity

Question 03

June 2004 | 3451H | Original Q13 | Legacy

13 (a) The diagram shows a 12 volt lighting system. Each lamp has a power of 32 watts.



(i) Write down the equation that links current, potential difference and power.

.....

(1 mark)

(ii) Calculate the input current to the lighting system. Show clearly how you work out your answer.

.....

.....

current =.....A

(2 marks)

(b) A transformer is used to reduce the 230 V a.c. mains to the 12 V supply required for the lighting system. The transformer has 1150 turns on its primary coil.

(i) Write down the equation which links the number of turns of each transformer coil to the voltage across each transformer coil.

.....

.....

(1 mark)

(ii) Calculate the number of turns on the secondary coil of the transformer. Show clearly how you work out your answer.

.....

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.....

number of turns on the secondary coil =.....

(2 marks)

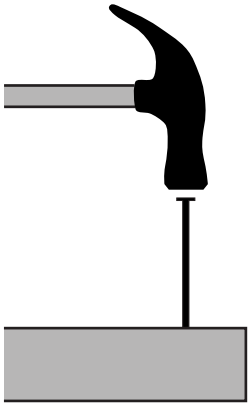
6

4.2.3.2 Mains electricity

Question 04

June 2004 | 3451H | Original Q16 | Legacy

16 (a) The diagram shows a hammer which is just about to drive a nail into a block of wood.



The mass of the hammer is 0.75 kg and its velocity, just before it hits the nail, is 15.0 m/s downward. After hitting the nail, the hammer remains in contact with it for 0.1 s. After this time both the hammer and the nail have stopped moving.

(i) Write down the equation, in words, which you need to use to calculate momentum.

.....

(1 mark)

(ii) What is the momentum of the hammer just before it hits the nail?

Show how you work out your answer and give the units and direction.

.....

.....

.....

Momentum = ...

(3 marks)

(iii) What is the change in momentum of the hammer during the time it is in contact with the nail?

.....

(1 mark)

4.2.3.2 Mains electricity

Question 04 · continued

MARGIN BLANK

(iv) Write down an equation which connects *change in momentum*, *force* and *time*.

.....

(1 mark)

(v) Calculate the force applied by the hammer to the nail.

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

.....

.....

.....

Force =.....

(3 marks)

(b) A magazine article states that:

"Wearing a seat belt can save your life in a car crash."

Use your understanding of momentum to explain how this is correct.

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(4 marks)

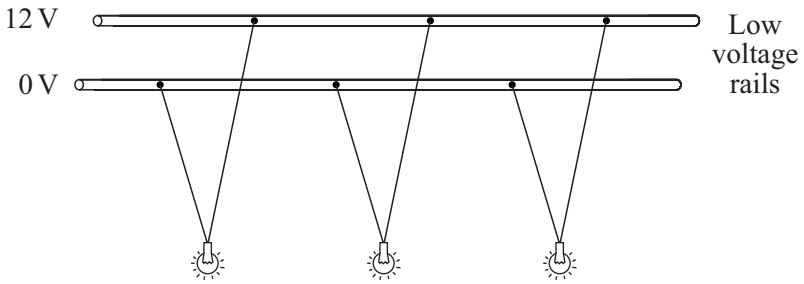
13

4.2.3.2 Mains electricity

Question 05

June 2004 | 3462H3 | Original Q11 | Legacy

11 (a) The diagram shows a 12 volt lighting system. Each lamp has a power of 32 watts.



(i) Write down the equation that links current, potential difference and power.

.....

(1 mark)

(ii) Calculate the input current to the lighting system. Show clearly how you work out your answer.

.....

.....

current =.....A

(2 marks)

(b) A transformer is used to reduce the 230 V a.c. mains to the 12 V supply required for the lighting system. The transformer has 1150 turns on its primary coil.

(i) Write down the equation which links the number of turns of each transformer coil to the voltage across each transformer coil.

.....

.....

(1 mark)

(ii) Calculate the number of turns on the secondary coil of the transformer. Show clearly how you work out your answer.

.....

.....

.....

number of turns on the secondary coil =.....

(2 marks)

6

4.2.3.2 Mains electricity

Question 06

November 2006 | PHY1A | Original Q9 | Legacy

QUESTION NINE

energy transferred (kilowatt-hour, kWh)	=	power (kilowatt, kW)	×	time (hour, h)
total cost	=	number of kilowatt-hours	×	cost per kilowatt-hour

A village is many kilometres away from a supply of mains electricity. The sun shines for at least a few hours nearly every day. The villagers want a supply of electricity for a radio receiver. The table shows the costs of two different ways of providing the electricity over a 20-year period.

Way of providing electricity	Equipment cost	Cost of a set of batteries	Number of sets of batteries needed
Solar cells and rechargeable batteries	£75.00	£12.50	4
'Throwaway' batteries	Zero	£2.75	80

9A What are the total costs over the 20-year period of the different ways of providing electricity?

	Solar cells and rechargeable batteries	'Throwaway' batteries
1	£87.50	£220.00
2	£87.50	£231.00
3	£125.00	£220.00
4	£125.00	£231.00

9B One disadvantage of using solar cells and rechargeable batteries is that . . .

1 new batteries are needed more often.

2 the radio could not be used at night.

3 they are more expensive in the long run.

4 they cost more in the first place.

4.2.3.2 Mains electricity

9C Another battery of solar cells has a maximum output of 1 kW. The battery, when used in the UK, produces, on average, 10 % of its maximum output. The battery costs £ 4000 and has an expected life of 200 000 hours. The cells have no maintenance costs.

What is the cost of each kilowatt-hour of electricity produced by the battery of solar cells when used in the UK?

1 20 p

2 25 p

3 40 p

4 50 p

9D Electricity from solar cells is more expensive than electricity generated in power stations.

Which of the following would make the cost of electricity from solar cells cheaper?

1 A decrease in the cost of fuel for normal types of power station.

2 Developing solar cells that are smaller.

3 Developing other alternative energy technologies.

4 Reducing the cost of solar cells by mass production.

END OF TEST

4.2.3.2 Mains electricity

Question 07

June 2007 | PHY1A | Original Q4 | Legacy

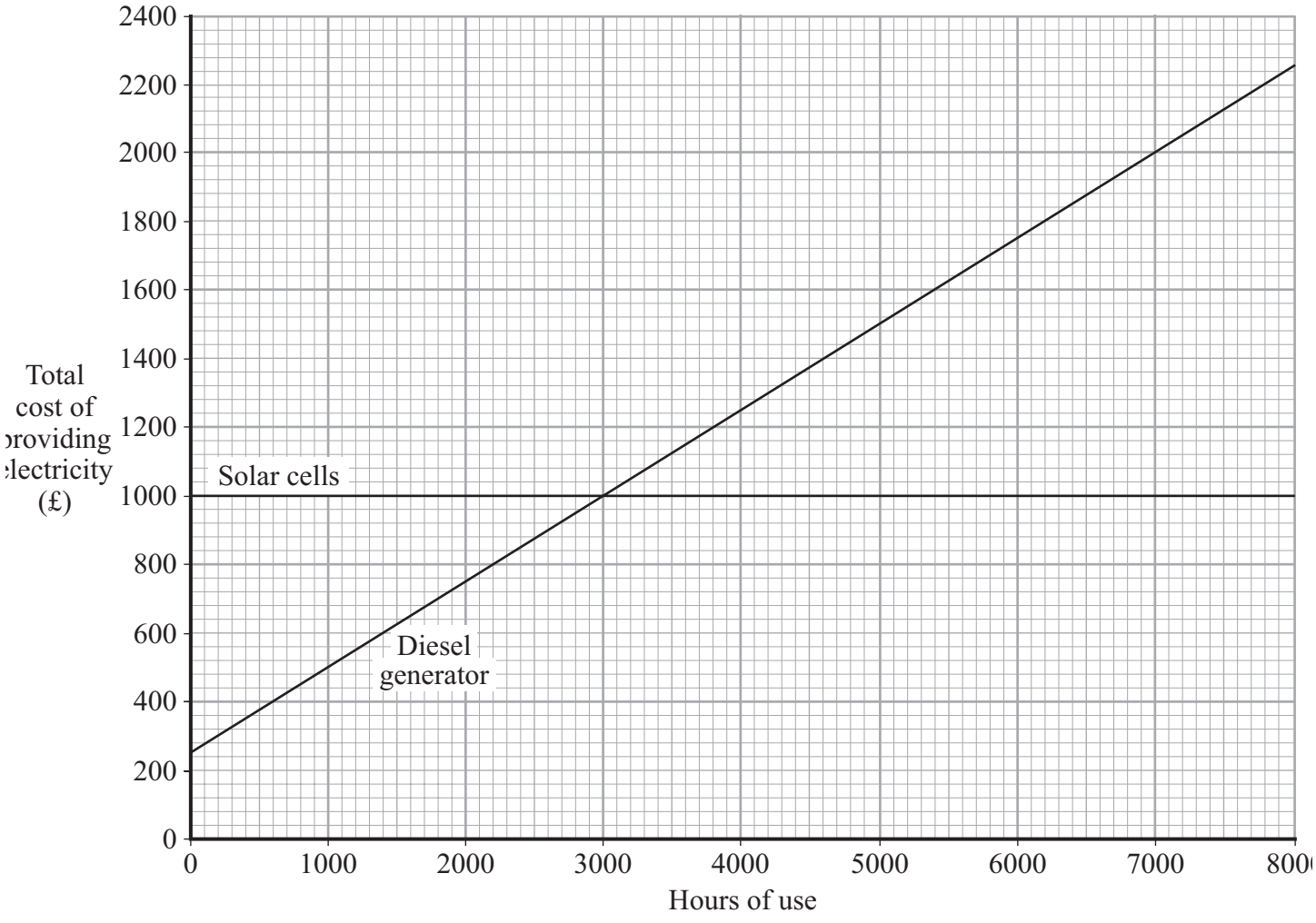
QUESTION FOUR

A remote village in South America is many kilometres from a mains electricity supply.

The villagers plan to pump water from the river and to use some of the water to irrigate fields.

They need an electricity supply to operate the pump.

The graph shows the total cost of two different ways of providing this electricity over time.



4A The graph shows that . . .

1 there are fuel costs but no maintenance costs for the solar cells.

2 there are maintenance costs but no fuel costs for the solar cells.

3 there are no fuel costs and no maintenance costs for the solar cells.

4 there are no fuel costs and no maintenance costs for the diesel generator.

4.2.3.2 Mains electricity

4B The price to buy the solar cells, compared with buying the diesel generator, is . . .

1 twice as much.

2 three times as much.

3 four times as much.

4 five times as much.

4C Providing electricity by diesel generator becomes more expensive than by solar cells after . . .

1 1000 hours of use.

2 2000 hours of use.

3 3000 hours of use.

4 4000 hours of use.

4D Maintenance of solar cells costs less than maintenance of the diesel generator mainly because . . .

1 solar cells have no moving parts.

2 solar cells do not produce exhaust gases.

3 solar cells operate at lower temperatures than diesel generators.

4 solar cells work only during the day.

4.2.3.2 Mains electricity

Question 08

June 2008 | PHY1BP | Original Q6 | Legacy

QUESTION SIX

This question is about a smoke detector which contains a radioactive source.

Americium-241 is used because it emits alpha particles and has a half-life of 432 years.

6A Why is an alpha source the safest one to use in a domestic smoke detector?

1 Alpha particles are absorbed by a few centimetres of air.

2 Alpha particles do not cause any ionisation.

3 Alpha particles are completely harmless to humans.

4 Alpha particles are not deflected by a magnet.

6B What is an alpha particle?

1 a helium nucleus

2 a hydrogen nucleus

3 a proton

4 an electron

6C Why is the half-life of americium-241 considered to be suitable for use in a smoke detector?

1 It has a long half-life, and so will not need replacing.

2 An isotope with a very short half-life would not provide enough energy.

3 An isotope with a much longer half-life would give off too much energy.

4 An isotope with a much shorter half-life would give off beta particles.

6D The half-life of americium-241 is 432 years.

A source contains 1 gram of americium-241.

How long will it be before only 0.25 g of americium-241 remains?

1 108 years

2 216 years

3 648 years

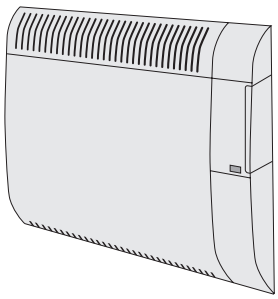
4 864 years

4.2.3.2 Mains electricity

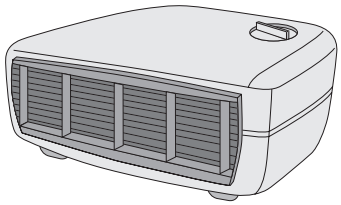
Question 09

January 2009 | PHY1H | Original Q2 | Legacy

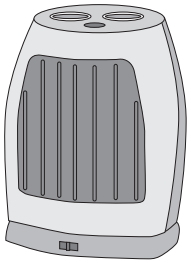
2 The pictures show three different types of electric heater.



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)

4.2.3.2 Mains electricity

Question 09 · 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

4.2.3.2 Mains electricity

Question 10

January 2009 | PHY2H | Original Q5 | Legacy

5 (a) Describe the difference between an alternating current (a.c.) and a direct current (d.c.).

.....

.....

.....

.....

(2 marks)

5 (b) The diagram shows the information plate on the bottom of an electric wallpaper steamer.

230 V a.c.	50 Hz	2.3 kW

5 (b) (i) Use the equation in the box to calculate the current used by the steamer.

power = current × potential difference

Show clearly how you work out your answer.

.....

.....

Current ..... A

(2 marks)

5 (b) (ii) Which **one** of the following fuses should be used inside the plug of the steamer?

Draw a ring around your answer.

1 A **3 A** **5 A** **10 A** **13 A**

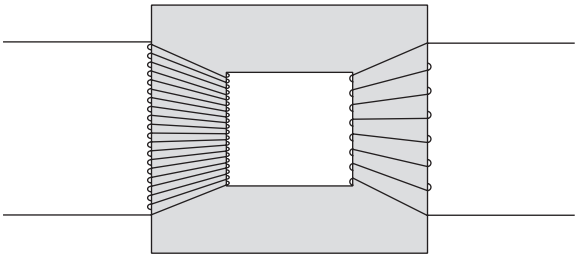
(1 mark)

5

4.2.3.2 Mains electricity

Question 11

3 (a) The basic structure of a transformer is a primary coil of insulated wire, an iron core and a secondary coil of insulated wire.



3 (a) (i) Why is the core made of iron?

.....

.....

(1 mark)

3 (a) (ii) Explain how a transformer works.

.....

.....

.....

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.....

.....

.....

.....

(4 marks)

4.2.3.2 Mains electricity

Question 11 · continued

for mark

3 (b) A small step-down transformer is used in the charger for an electric screwdriver.

The input to the transformer is 230 V a.c. mains supply and the output is 5.75 V a.c. There are 3200 turns on the primary coil.

Use the equation in the box to calculate the number of turns on the transformer's secondary coil.

$$\frac{\text{p.d. across primary}}{\text{p.d. across secondary}} = \frac{\text{number of turns on primary}}{\text{number of turns on secondary}}$$

Show clearly how you work out your answer.

.....

.....

Number of turns = ...

(2 marks)

7

4.2.3.2 Mains electricity

Question 12

June 2009 | PHY1H | Original Q1 | Legacy

1 (a) The table lists the names of seven telescopes. Each one of the telescopes is designed to detect a different one of the seven types of electromagnetic wave.
The table is incomplete.

Name of telescope	Type of wave detected
HESS	Gamma
XMM Newton	X-ray
FUSE	Ultraviolet
William Herschel	Visible light
Spitzer	
SPT	Microwave
Lovell	Radio

1 (a) (i) Which **one** of the telescopes is designed to detect the type of wave with the shortest wavelength?

.....

(1 mark)

1 (a) (ii) What type of wave is the Spitzer telescope designed to detect?

.....

(1 mark)

1 (b) The William Herschel telescope is on the Earth's surface. Another telescope, the Hubble telescope, which also detects visible light, orbits the Earth.

How is the image produced by the Hubble telescope better than the image produced by the William Herschel telescope?

.....

Give a reason for your answer.

.....

.....

(2 marks)

4.2.3.2 Mains electricity

Question 12 · continued

for mark

1 (c) Some types of electromagnetic wave are absorbed by water.
The SPT telescope is located in the Antarctic, which is a dry environment.

Explain why it is better to have this type of telescope in a dry environment rather than in a wet, humid environment.

.....

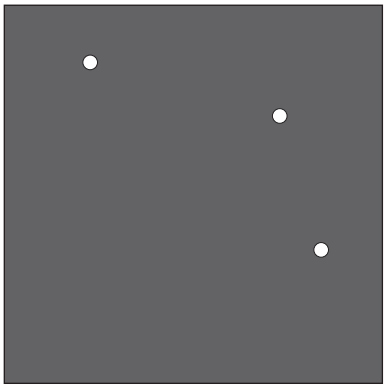
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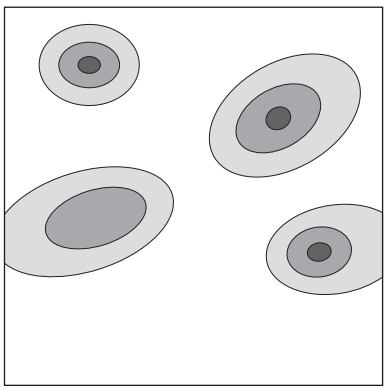
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(2 marks)

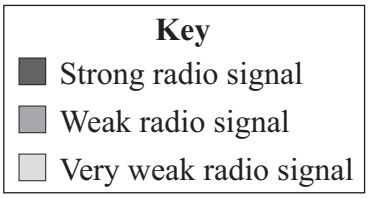
1 (d) The pictures represent the images produced using a visible light telescope and a radio telescope. Both images are of the same part of the sky. The shading on the radio telescope image represents the strength of the radio signals.



Visible light image



Radio telescope image



Suggest what extra information can be gained from the radio telescope image compared with the visible light image.

.....

.....

(1 mark)

7

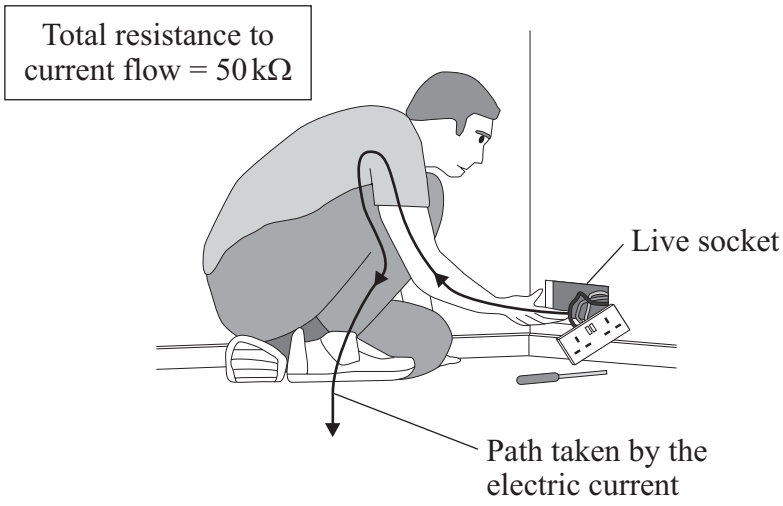
4.2.3.2 Mains electricity

Question 13

June 2009 | PHY2H | Original Q6 | Legacy

6 The diagram shows someone accidentally touching the live wire inside a dismantled 230 volt mains electricity socket.

A current flows through the person giving him an electric shock.



6 (a) (i) Use the equation in the box to calculate the current that will flow through the person.

potential difference = current × resistance

Show clearly how you work out your answer.

.....

.....

Current = ... A

(2 marks)

6 (a) (ii) Rubber is a good insulator.

Explain why it is a good idea for electricians to wear rubber soled boots when working.

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.....

.....

(2 marks)

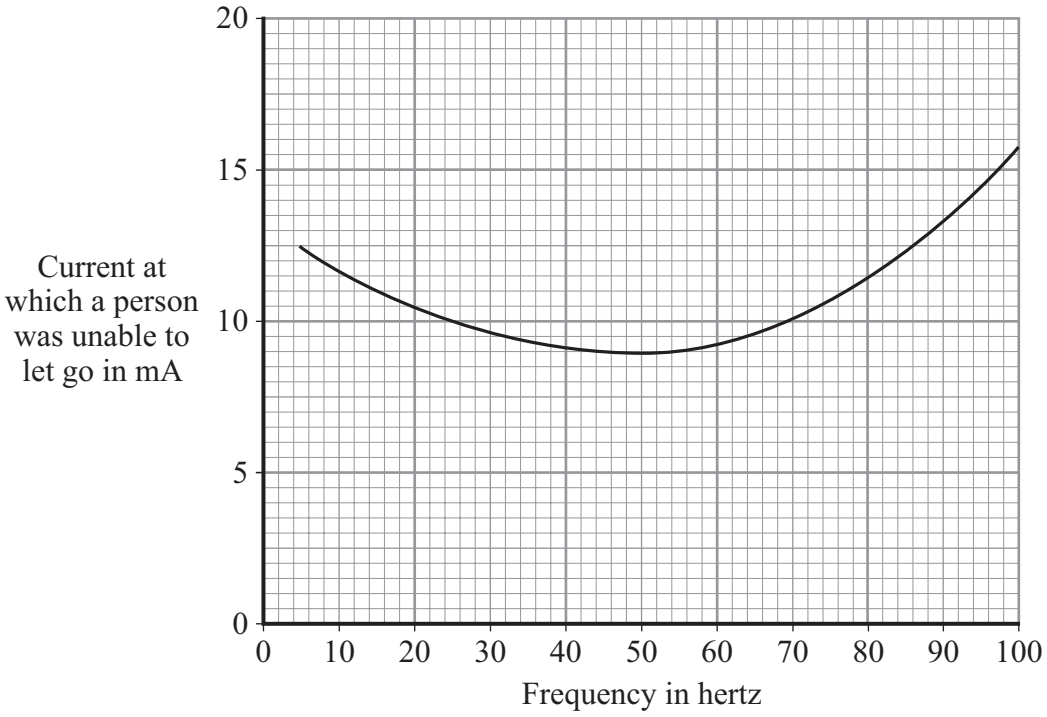
Question 13 · continued

for mark

6 (b) If the current flowing through a person is too high, the person cannot let go of the electrical source.

Different people were tested to see whether the ability to let go of an electrical source depended on the frequency of the current.

The results of the test are shown in the graph.



6 (b) (i) What is the frequency of the mains electricity supply in the UK?

.....

(1 mark)

6 (b) (ii) From a safety point of view, is the frequency of the UK mains electricity supply suitable?

Give a reason for your answer.

.....

.....

(1 mark)

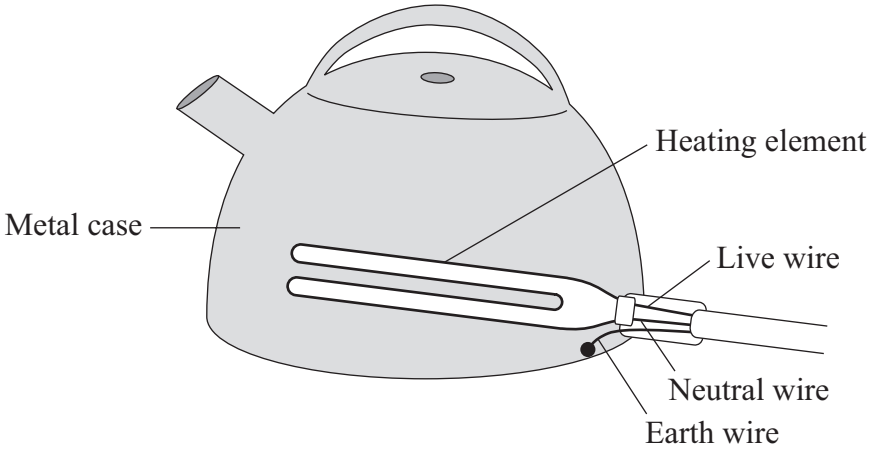
Question 6 continues on the next page

4.2.3.2 Mains electricity

Question 13 · continued

for mark

6 (c) The diagram shows how the electric supply cable is connected to an electric kettle. The earth wire is connected to the metal case of the kettle.



If a fault makes the metal case live, the earth wire and the fuse inside the plug protect anyone using the kettle from an electric shock.

Explain how.

.....

.....

.....

.....

(2 marks)

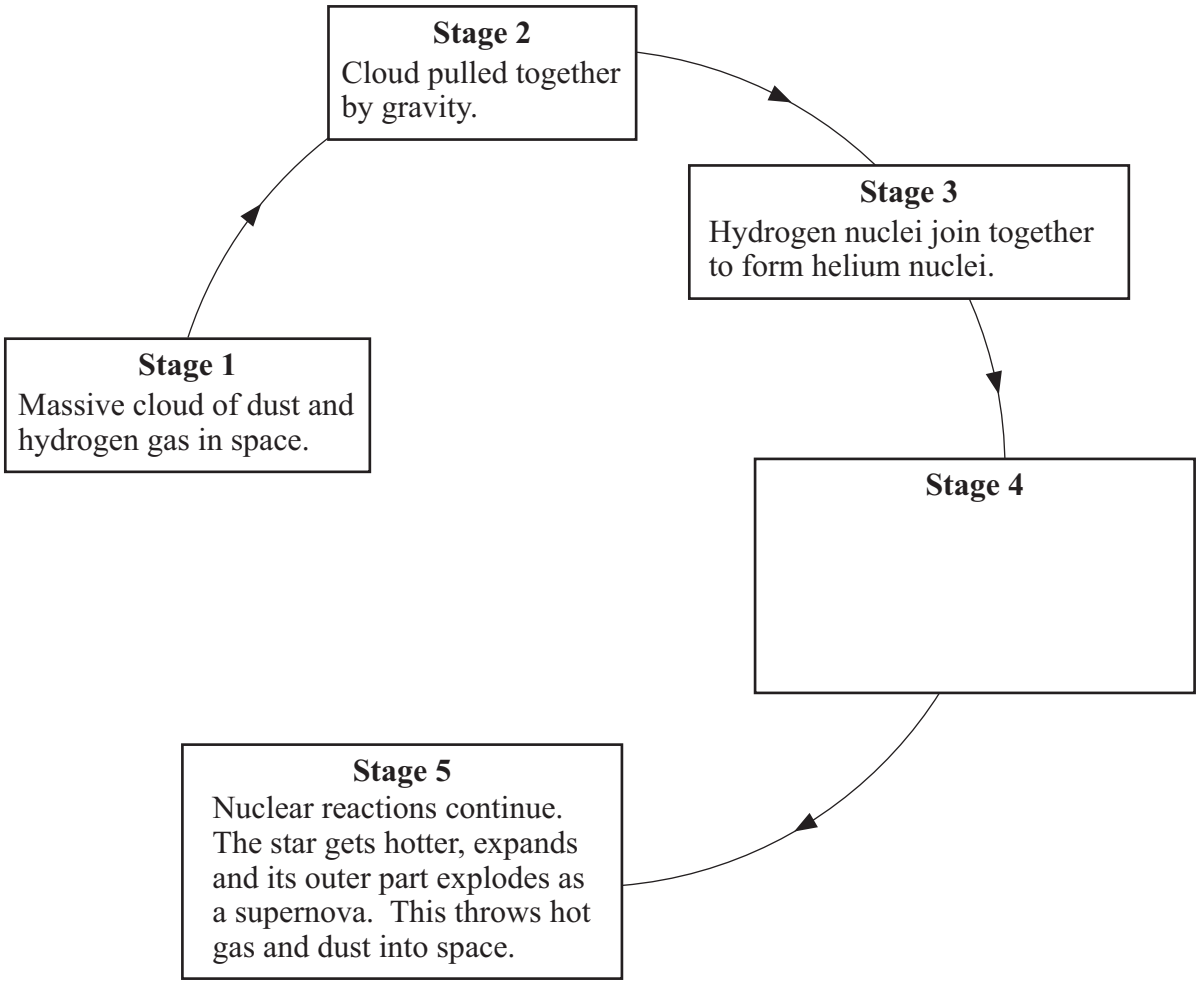
8

4.2.3.2 Mains electricity

Question 14

June 2009 | PHY3H | Original Q4 | Legacy

4 The diagram shows part of the life cycle of a star which is much bigger than the Sun.



4.2.3.2 Mains electricity

Question 14 · continued

for mark

4 (a) (i) What is the relationship between the masses of the dust and gas in the cloud in **Stage 2** and the force of gravity between them?

.....

.....

(1 mark)

4 (a) (ii) What is the relationship between the distance apart of the dust and gas in the cloud in **Stage 2** and the force of gravity between them?

.....

.....

(1 mark)

4 (b) In **Stage 3** the star remains stable for millions of years.

Explain why.

.....

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.....

.....

(2 marks)

4 (c) What happens in **Stage 4**?

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.....

.....

(2 marks)

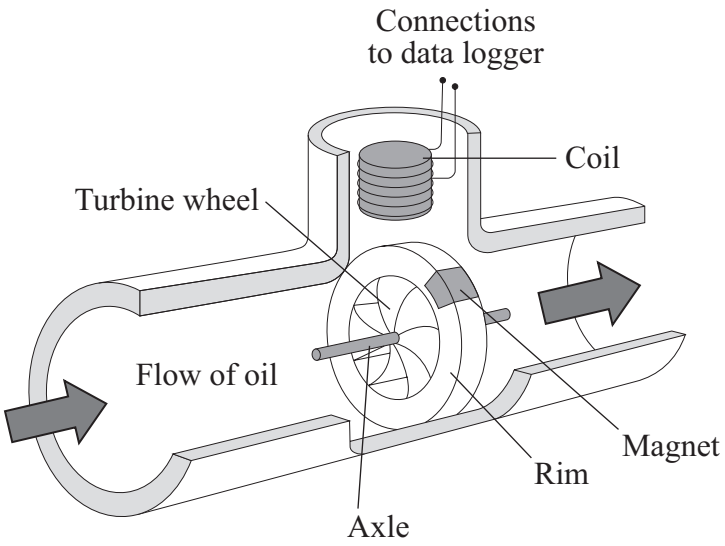
6

4.2.3.2 Mains electricity

Question 15

January 2010 | PHY3H | Original Q6 | Legacy

6 The diagram shows the inside of an oil pipeline and a student's design for a meter to measure the flow of oil.



As oil flows through the pipeline, the oil rotates a turbine wheel. Above the turbine wheel is a coil of wire connected to a data logger. There is a magnet in the rim of the turbine wheel. The turbine wheel spins and this induces a varying potential difference (p.d.) across the ends of the coil. This varying p.d. is recorded by the data logger.

6 (a) Complete the sentence by writing in the space.

The faster the oil flows through the pipeline, the ..... the maximum p.d. across the coil.

(1 mark)

6 (b) Explain why a varying p.d. is induced across the coil even when the rate of flow of oil remains constant.

.....

.....

.....

.....

.....

.....

(3 marks)

4.2.3.2 Mains electricity

Question 15 · continued

for mark

6 (c) Suggest **two** changes to the design of the meter which would increase the maximum p.d. across the coil for the same flow of oil.

Change 1 .....

.....

Change 2 .....

.....

(2 marks)

6

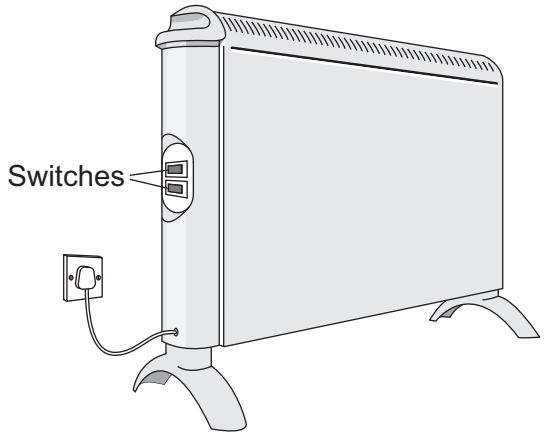
Turn over for the next question

4.2.3.2 Mains electricity

Question 16

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)

4.2.3.2 Mains electricity

Question 16 · continued

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

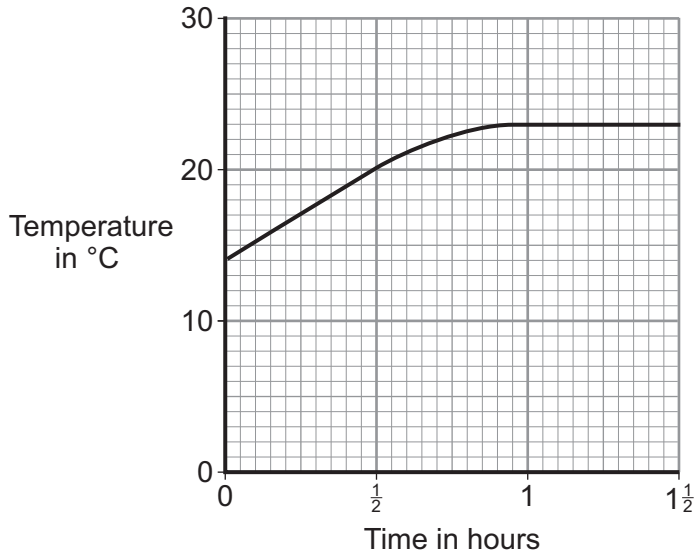
What is meant by a device being very efficient?

.....

.....

(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)

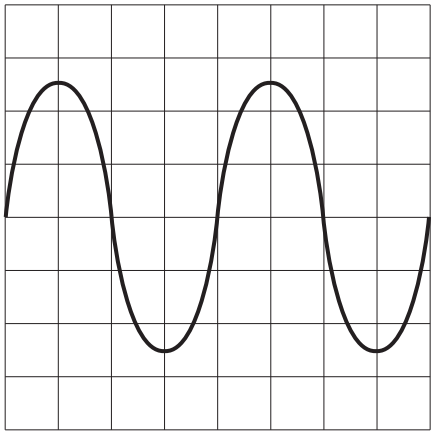
7

4.2.3.2 Mains electricity

Question 17

June 2010 | PHY2H | Original Q6 | Legacy

6 An oscilloscope is connected to an alternating current (a.c.) supply.
The diagram shows the trace produced on the oscilloscope screen.



Each horizontal division on the oscilloscope screen represents 0.002 s.

6 (a) Calculate the frequency of the alternating current supply.

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

.....

.....

.....

Frequency = ...

(3 marks)

6 (b) What is the frequency of the a.c. mains electricity supply in the UK?

.....

(1 mark)

4

4.2.3.2 Mains electricity

Question 18

June 2010 | PHY2H | Original Q7 | Legacy

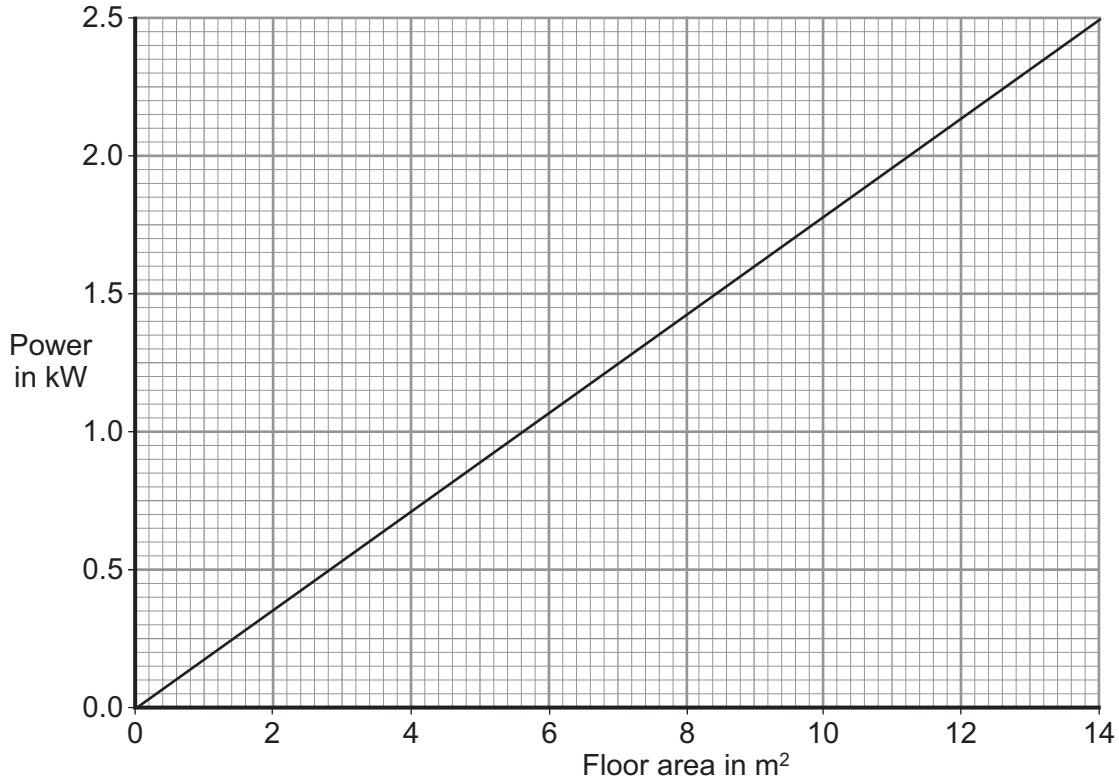
7 A homeowner has installed electric underfloor heating in the kitchen. When the heating is switched on, an electric current flows through wires running under the tiled floor surface.

7 (a) What is an electric current?

.....

(1 mark)

7 (b) The graph shows how the power output of an underfloor heating system depends on the area of the floor that is heated.



The area of the homeowner's kitchen floor is 9.0 m^2.

Use the graph and the equation in the box to calculate the current drawn from the 230 V mains supply by the heating system.

power = current × potential difference

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

.....

.....

.....

.....

Current = ...

(4 marks)

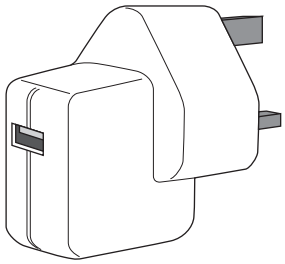
5

4.2.3.2 Mains electricity

Question 19

June 2010 | PHY3H | Original Q3 | Legacy

3 The diagram shows a USB power adapter which plugs into a 230 V a.c. mains socket.



The adapter contains a small step-down transformer.

3 (a) The core of the transformer is made of laminated soft iron.

Why is iron used?

.....

.....

(1 mark)

3 (b) The coils of the transformers are made of insulated copper wire.

Why is the wire insulated?

.....

.....

(1 mark)

4.2.3.2 Mains electricity

Question 19 · continued

3 (c) There are 500 turns on one coil of the transformer and 20 000 turns on the other coil.

Use the equation in the box to calculate the p.d. across the secondary coil.

$$\frac{\text{p.d. across primary}}{\text{p.d. across secondary}} = \frac{\text{number of turns on primary}}{\text{number of turns on secondary}}$$

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

.....

.....

.....

p.d. across the secondary = ...

(3 marks)

5

Turn over for the next question

4.2.3.2 Mains electricity

Question 20

June 2010 | PHY3H | Original Q8 | Legacy

8 Every star goes through a 'life cycle'.

8 (a) Describe how a star forms.

.....

.....

.....

.....

.....

(2 marks)

8 (b) During a long period of its life, a star remains in a stable state.

Explain why a star remains stable.

.....

.....

.....

.....

.....

(2 marks)

8 (c) Some stars are much more massive than the Sun.

Describe what will happen to a star, originally much more massive than the Sun, after it reaches its red giant stage.

.....

.....

.....

.....

.....

(2 marks)

6

4.2.3.2 Mains electricity

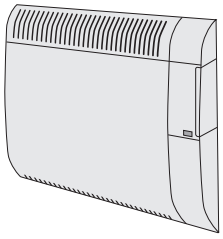
Question 21

November 2010 | PHY1AP | Original Q9 | Legacy

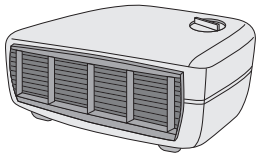
QUESTION NINE

The pictures show three different types of electric heater.

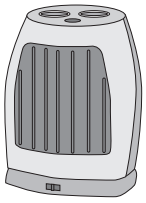
400 W oil-filled panel heater
- 3 heat settings
- Efficient background heat
- Safety overheat cut-out



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

Question 21 · 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.

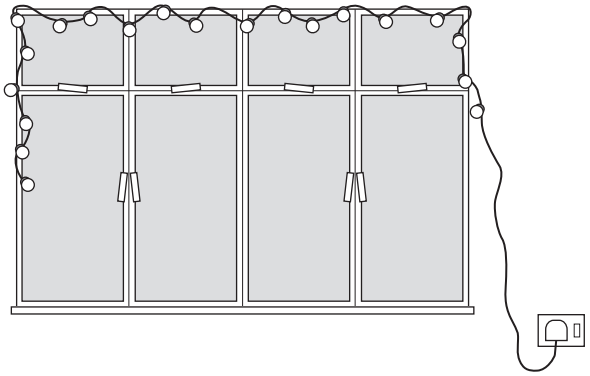
4 The fan heater's case becomes warm during use.

END OF TEST

4.2.3.2 Mains electricity

Question 22

6 A set of lights consists of 20 lamps connected in series to the 230 V mains electricity supply.



6 (a) When the lights are switched on and working correctly, the current through each lamp is 0.25 A.

6 (a) (i) What is the total current drawn from the mains supply?

.....

(1 mark)

6 (a) (ii) Use the equation in the box to calculate the charge passing through **one** of the lamps in 5 minutes.

charge = current × time

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

.....

.....

.....

.....

Total charge = ...

(3 marks)

4.2.3.2 Mains electricity

Question 22 · continued

6 (b) One of the lamps in the set is a fuse lamp. This contains a filament which melts if a fault occurs. A short time after the lights are switched on, a fault causes the filament inside the fuse lamp to melt and all the lamps go out.

The householder cannot find another fuse lamp so connects a piece of aluminium foil across the contacts inside the fuse lamp holder.
When switched on, the nineteen remaining lamps work.
What the householder has done is dangerous.

Explain why.

.....

.....

.....

.....

(2 marks)

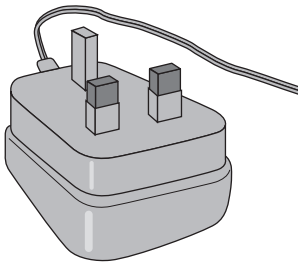
6

Turn over for the next question

4.2.3.2 Mains electricity

Question 23

4 (a) The drawing shows the plug for operating a radio from the mains.



This plug contains a transformer. There are 4600 turns on its primary coil and 200 turns on its secondary coil. The plug is used on the mains supply and has a potential difference (p.d.) of 230 V across its primary coil.

Use the equation in the box to calculate the p.d. across the secondary coil of the transformer.

$$\frac{\text{p.d. across primary}}{\text{p.d. across secondary}} = \frac{\text{number of turns on primary}}{\text{number of turns on secondary}}$$

Show clearly how you work out your answer.

.....

.....

.....

.....

p.d. across secondary = ... V

(2 marks)

4 (b) The coils of the transformer are made of insulated wire.

Why is the wire insulated?

.....

.....

(1 mark)

4.2.3.2 Mains electricity

Question 23 · continued

4 (c) (i) What material is the core of a transformer made from?

.....

(1 mark)

4 (c) (ii) Why is the core made from this material?

.....

.....

(1 mark)

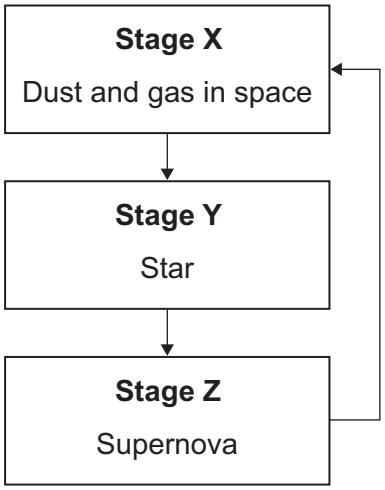
5

Turn over for the next question

4.2.3.2 Mains electricity

Question 24

8 The flowchart shows a simple version of the life cycle of a star that is much more massive than the Sun.



8 (a) What causes the change from **Stage X** to **Stage Y**?

.....

(1 mark)

8 (b) For most of its time in **Stage Y**, the star is stable.

Explain why the star remains stable.

.....

.....

.....

.....

(2 marks)

8 (c) (i) Explain how a star is able to produce energy in **Stage Y**.

.....

.....

.....

.....

(2 marks)

4.2.3.2 Mains electricity

Question 24 · continued

8 (c) (ii) Why is a star in **Stage Y** able to give out energy for millions of years?

.....

.....

(1 mark)

8 (d) What happens to the elements produced in a supernova?

.....

.....

(1 mark)

7

4.2.3.2 Mains electricity

Question 25

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.

4.2.3.2 Mains electricity

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

4.2.3.2 Mains electricity

Question 26

June 2011 | PHY1AP | Original Q3 | Legacy

QUESTION THREE

Some dairy farmers have installed electrical generators that run on methane gas.

- Methane gas is produced from rotting vegetation and animal waste.
- On farms, the rotting process takes place in a digester.
- Methane produced in this way is a biofuel called biogas.
- Burning methane produces carbon dioxide and water.
- The electrical generators can be installed in a farm building.

3A Methane is called a biofuel because . . .

1 it is a renewable fuel.

2 it comes from living things.

3 it produces carbon dioxide and water.

4 it is made in a digester.

3B Farmers have been encouraged to install their own biogas generators because . . .

1 this would reduce the amount of fuel used in power stations.

2 this would reduce the amount of animal waste produced.

3 biogas is a non-renewable fuel.

4 this would use less electricity.

3C A farmer's weekly electricity bill using the mains supply is £290. The biogas generator costs £15 000 to install.

The biogas generator provides all of the farmer's electricity.

What is the pay-back time?

1 1.0 years

2 4.3 years

3 5.2 years

4 58 years

4.2.3.2 Mains electricity

Question 26 · continued

3D It would have been cheaper for the farmer to install a wind turbine generator.

What is the advantage of the biogas generator over the wind turbine generator?

1 It uses a renewable energy source.

2 It produces water.

3 It can work all the time.

4 It does not require any space.

Turn over for the next question

4.2.3.2 Mains electricity

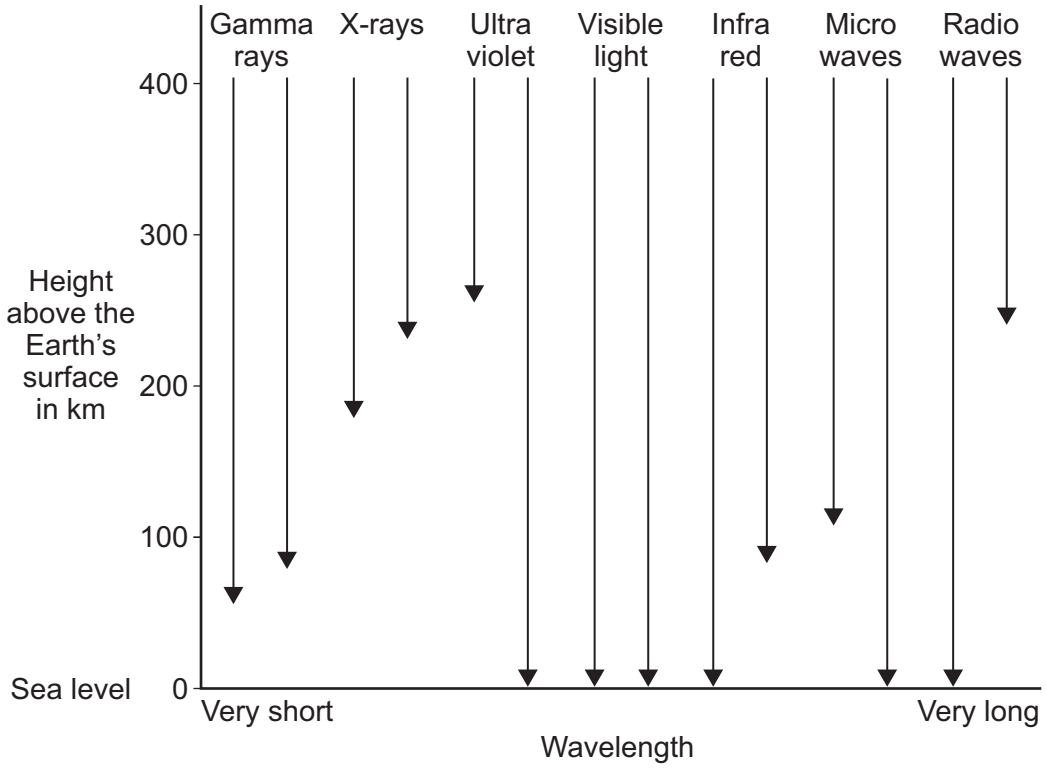
Question 27

June 2011 | PHY1BP | Original Q4 | Legacy

QUESTION FOUR

Telescopes can be based on the Earth's surface or put into orbit in space.

The diagram shows how far electromagnetic waves penetrate the Earth's atmosphere. For some types of electromagnetic radiation, longer and shorter waves penetrate the atmosphere to different depths.



4A Telescopes on Earth detect **all** wavelengths of . . .

1 radio waves only.

2 visible light only.

3 radio waves and visible light.

4 visible light and X-rays.

4B Which of the following statements about the use of telescopes in space is true?

1 The atmosphere distorts the image produced by the telescope.

2 The telescopes are affected by light pollution from the Earth.

3 The telescopes can detect electromagnetic waves that cannot reach the Earth's surface.

4 The telescopes are easy to repair and maintain.

4.2.3.2 Mains electricity

Question 27 · continued

The table gives information about some space telescopes. Each telescope detects a different type of electromagnetic radiation.

Telescope	Wavelength detected in nanometres
INTEGRAL	less than 0.01
Chandra	0.01 – 20
FUSE	20 – 400
Hubble	400 – 700
Spitzer	1000 – 1 000 000

4C The Hubble telescope detects visible light.

Which telescope detects infra red radiation?

1 Chandra

2 FUSE

3 INTEGRAL

4 Spitzer

4D Which telescope detects X-rays?

1 Chandra

2 FUSE

3 INTEGRAL

4 Spitzer

4.2.3.2 Mains electricity

Question 28

June 2011 | PHY2H | Original Q1 | Legacy

1 **Diagram 1** shows a hairdryer.
Diagram 2 shows how the heaters and fan of the hairdryer are connected to a 3-pin plug.
The hairdryer does not have an earth wire.

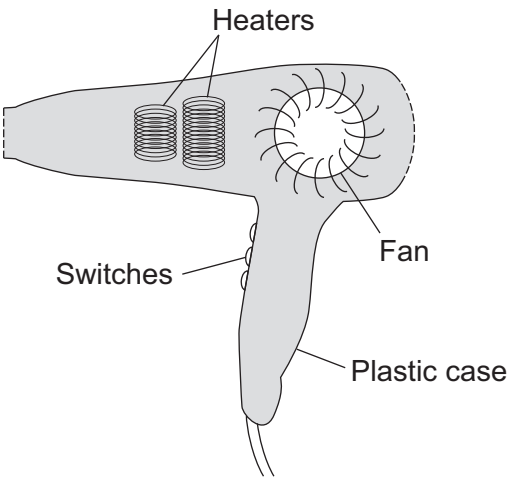


Diagram 1

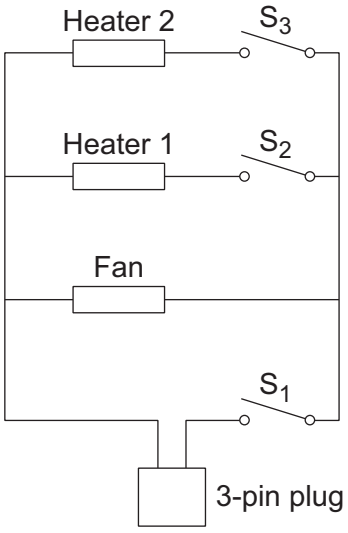


Diagram 2

1 (a) What colour is the insulation around the wire connected to the live pin inside the plug?

.....

(1 mark)

1 (b) Why does the hairdryer **not** need an earth wire?

.....

.....

(1 mark)

1 (c) All the switches are shown in the OFF position.

1 (c) (i) Which switch or switches have to be ON to make:

(1) only the fan work; .....

(2) heater 2 work? .....

(2 marks)

4.2.3.2 Mains electricity

Question 28 · continued

1 (c) (ii) The heaters can only be switched on when the fan is also switched on.

Explain why.

.....

.....

.....

.....

.....

(2 marks)

1 (d) The table shows the current drawn from the 230 volt mains electricity supply when different parts of the hairdryer are switched on.

	Current in amps
Fan only	1.0
Fan and heater 1	4.4
Fan and both heaters	6.5

Use the equation in the box to calculate the maximum power of the hairdryer.

power = current × potential difference

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

.....

.....

Maximum power = ...

(3 marks)

9

4.2.3.2 Mains electricity

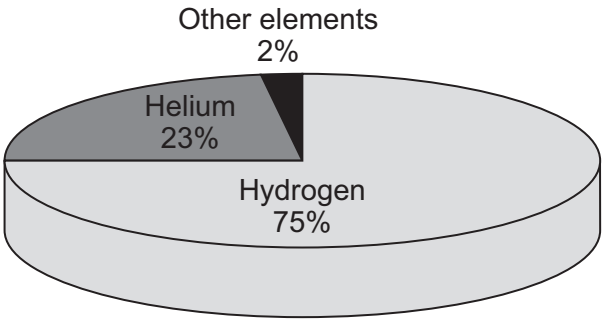
Question 29

June 2011 | PHY3H | Original Q6 | Legacy

6 This passage is from a web page.

Our nearest star, the Sun

The pie chart shows the proportions of chemical elements in the Sun.



Most of the Sun's helium has been produced from the Sun's hydrogen by the process of nuclear fusion. This process also produces vast quantities of energy. The process takes place in the core of the Sun at a temperature of about 15 million °C and has been going on for about 4.5 billion years. During this period of time, the Sun has remained stable and scientists think that it will remain stable for several billion years into the future.

6 (a) Explain why the Sun remains stable.

.....

.....

.....

.....

(3 marks)

6 (b) A scientific opinion is expressed on this web page.

Identify this opinion and suggest how scientists could justify it.

.....

.....

.....

.....

(2 marks)

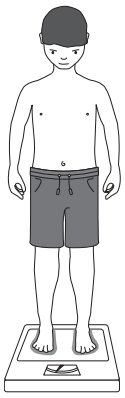
5

4.2.3.2 Mains electricity

Question 30

June 2012 | PH2HP | Original Q7 | Legacy

7 (a) The picture shows a person using a set of electronic 'Body Fat Scales'. When the person stands on the scales, a small, harmless, electric current passes through the person's body. The scales then calculate the resistance of the person's body and convert the resistance into a *prediction* of body fat content.



7 (a) (i) The scales contain two 3 V cells joined in series.

Calculate the resistance of a person's body, if when he stands on the scales, a current of 0.12 mA passes through his body.

1000 mA = 1 A

Use the correct equation from the Physics Equations Sheet.

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

.....

.....

.....

Resistance = ...

(3 marks)

4.2.3.2 Mains electricity

Question 30 · continued

7 (a) (ii) The scales can only produce a *prediction* of body fat content and not an accurate measurement.

Suggest why.

.....

.....

.....

(1 mark)

7 (a) (iii) It is recommended that the scales are **not** used immediately after a person has drunk a large amount of water.

Suggest why.

.....

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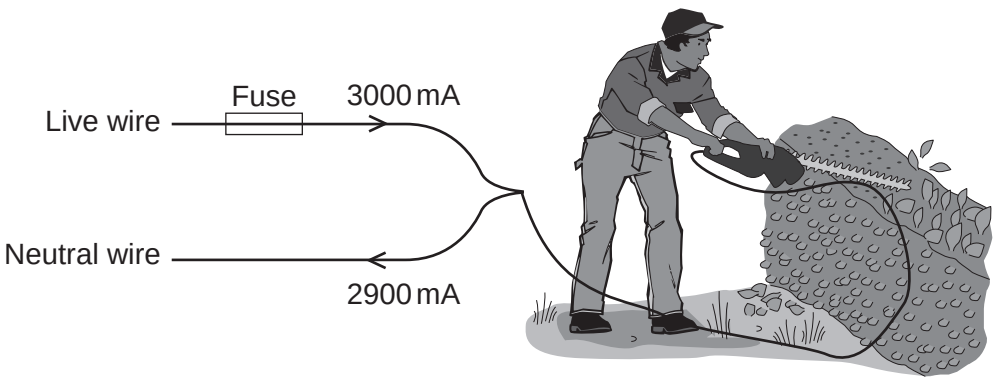
(2 marks)

Question 7 continues on the next page

4.2.3.2 Mains electricity

Question 30 · continued

7 (b) The diagram shows how someone could get an electric shock from accidentally cutting into an electric cable. If this happens, and a Residual Current Circuit Breaker (RCCB) is being used, the circuit will switch off automatically.



7 (b) (i) A faulty appliance or circuit can be switched off by a RCCB or a fuse.

Compare the action of a RCCB with the action of a fuse.

.....

.....

.....

.....

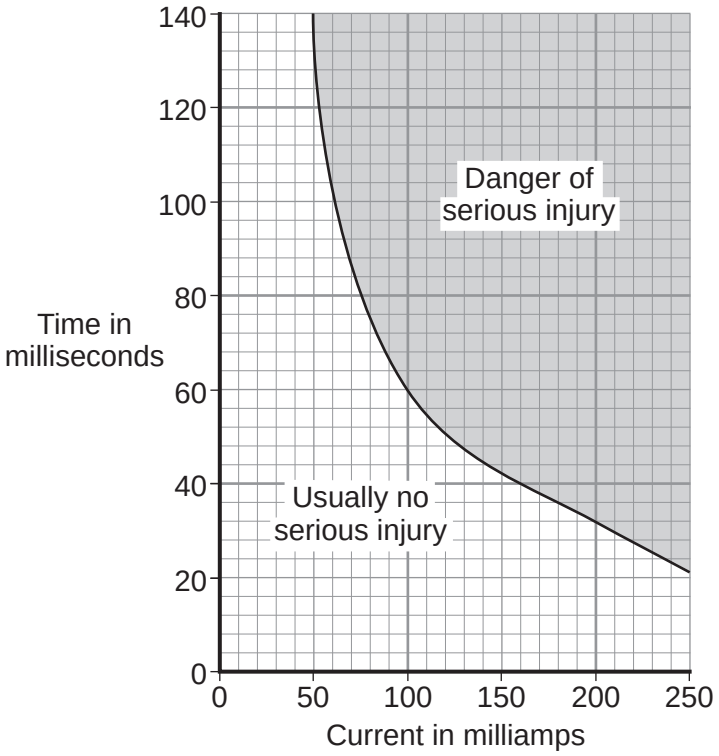
.....

(2 marks)

4.2.3.2 Mains electricity

Question 30 · continued

7 (b) (ii) The graph shows how the severity of an electric shock depends on the size of the current and the time that the current flows through the body.



Using the RCCB helps prevent an electric shock seriously injuring the person using the hedge trimmers.

Using information from both the diagram and the graph explain how.

.....

.....

.....

.....

.....

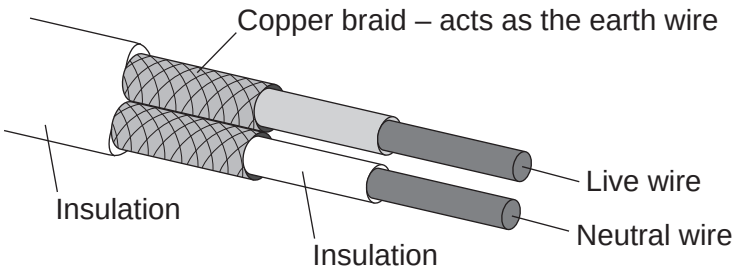
(2 marks)

10

4.2.3.2 Mains electricity

Question 31

6 The diagram shows the structure of a cable. The cable is part of an undersoil heating circuit inside a large greenhouse.



6 (a) The cable is connected to the mains electricity supply through a residual current circuit breaker (RCCB). If the cable is accidentally cut the RCCB automatically switches the circuit off.

6 (a) (i) What is the frequency of the mains electricity supply in the UK?

.....

(1 mark)

6 (a) (ii) What happens, as the cable is cut, to cause the RCCB to switch the circuit off?

.....

.....

.....

.....

(2 marks)

6 (a) (iii) A circuit can also be switched off by the action of a fuse.

Give **one** advantage of using a RCCB to switch off a circuit rather than a fuse.

.....

.....

(1 mark)

4.2.3.2 Mains electricity

Question 31 · continued

6 (b) The 230 volt mains electricity supply causes a current of 11 amps to flow through the cable.

6 (b) (i) Calculate the amount of charge that flows through the cable when the cable is switched on for 2 hours and give the unit.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Charge = ...

(3 marks)

6 (b) (ii) Calculate the energy transferred from the cable to the soil in 2 hours.

Use the correct equation from the Physics Equations Sheet.

.....

.....

Energy transferred =..... J

(2 marks)

6 (c) The heating circuit includes a thermistor. The thermistor is buried in the soil and acts as a thermostat to control the increase in the temperature of the soil.

Describe how an **increase** in the temperature of the soil affects the thermistor.

.....

.....

.....

.....

(2 marks)

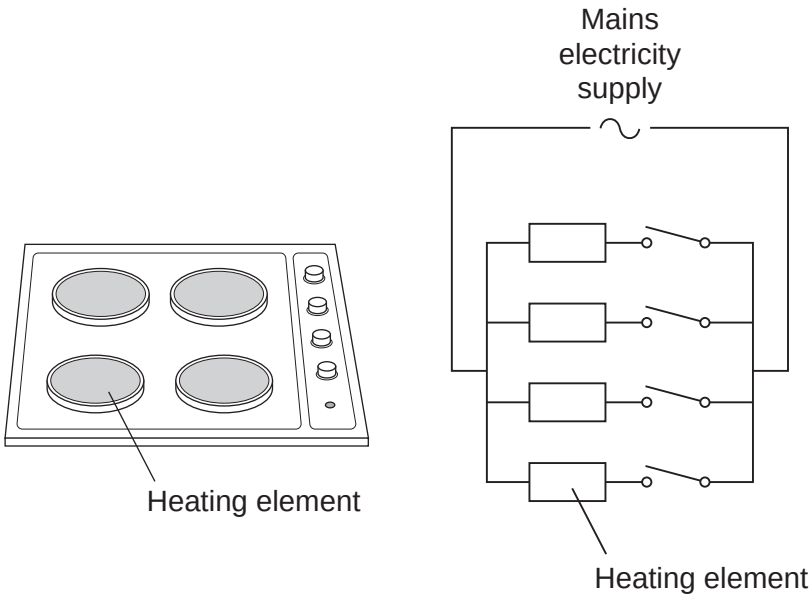
11

4.2.3.2 Mains electricity

Question 32

June 2013 | PH2HP | Original Q6 | Legacy

6 The picture shows an electric cooker hob. The simplified circuit diagram shows how the four heating elements connect to the mains electricity supply. The heating elements are identical.



When all four heating elements are switched on at full power the hob draws a current of 26 A from the 230 V mains electricity supply.

6 (a) Calculate the resistance of one heating element when the hob is switched on at full power.

Use the correct equation from the Physics Equations Sheet.

Give your answer to 2 significant figures.

.....

.....

.....

Resistance = ... Ω

(3 marks)

Question 6 continues on the next page

4.2.3.2 Mains electricity

Question 32 · continued

6 (b) The table gives the maximum current that can safely pass through copper wires of different cross-sectional area.

Cross-sectional area in mm^2	Maximum safe current in amps
1.0	11.5
2.5	20.0
4.0	27.0
6.0	34.0

6 (b) (i) The power sockets in a home are wired to the mains electricity supply using cables containing 2.5 mm^2 copper wires. Most electrical appliances are connected to the mains electricity supply by plugging them into a standard power socket.

It would **not** be safe to connect the electric cooker hob to the mains electricity supply by plugging it into a standard power socket.

Why?

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(2 marks)

6 (b) (ii) Describe the structure of the cable that should be used to connect the electric cooker hob to the mains electricity supply.

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(3 marks)

4.2.3.2 Mains electricity

Question 32 · continued

6 (c) Mains electricity is an alternating current supply. Batteries supply a direct current.

What is the difference between an alternating current and a direct current?

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(2 marks)

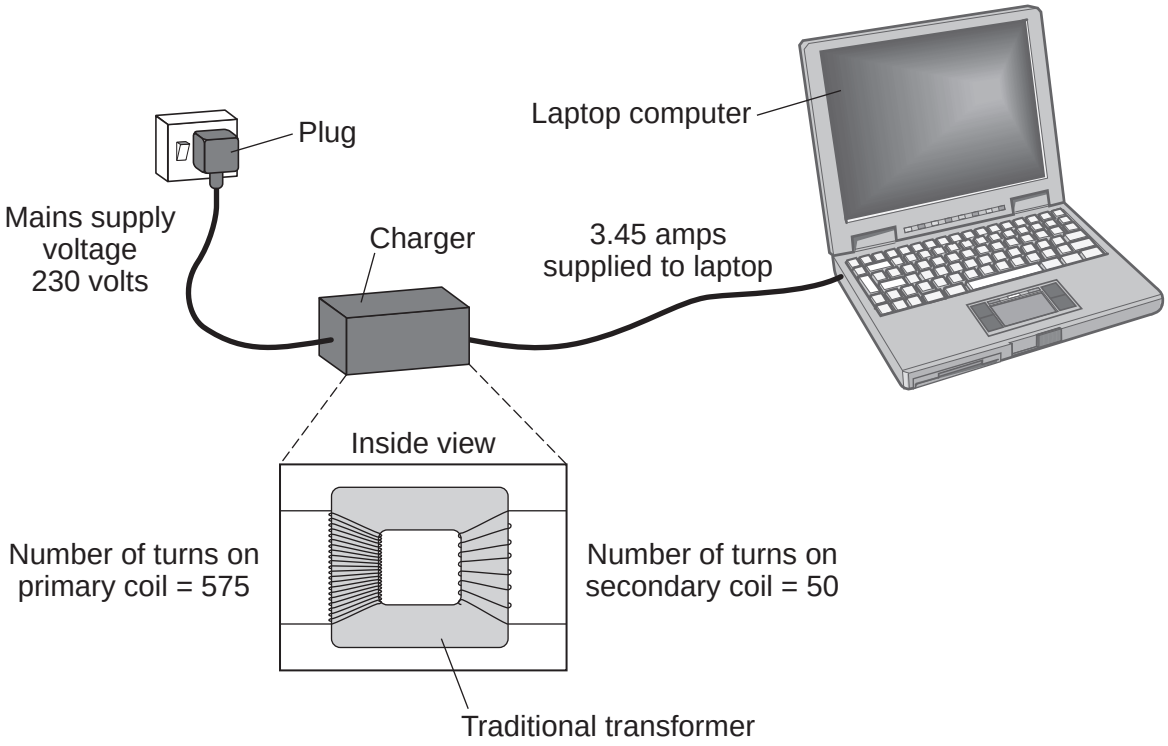
10

4.2.3.2 Mains electricity

Question 33

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)

4.2.3.2 Mains electricity

Question 33 · 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.

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.....

Current = ... A

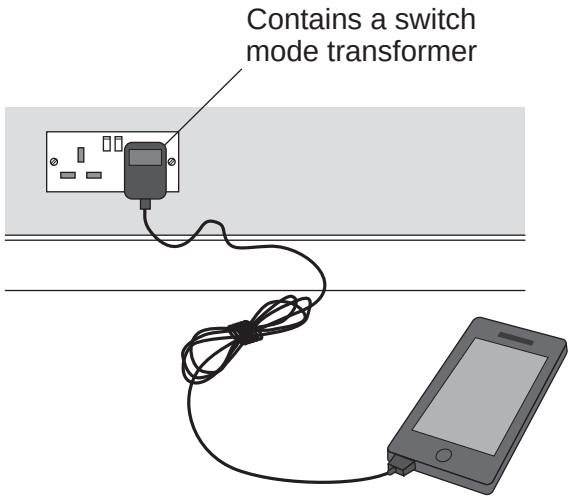
(2 marks)

Question 7 continues on the next page

4.2.3.2 Mains electricity

Question 33 · 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

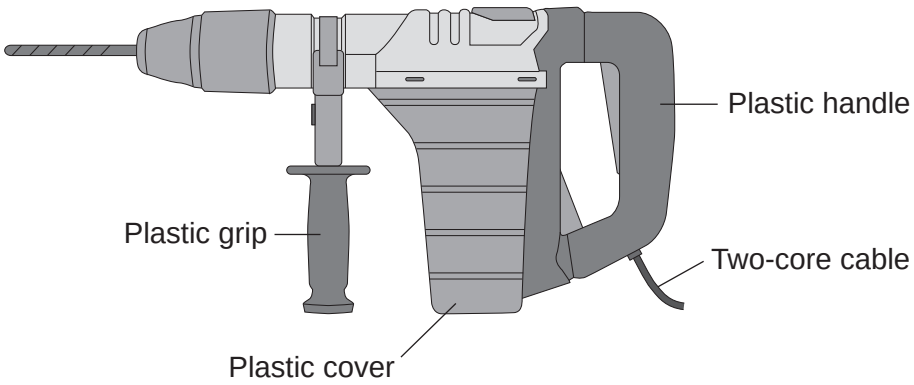
4.2.3.2 Mains electricity

Question 34

June 2014 | PH2HP | Original Q7 | Legacy

7 **Figure 8** shows an electric drill.

Figure 8



The information in the box is taken from the booklet supplied with the drill.

- This drill is fitted with a two-core cable
- Power supply: 230 V a.c. 50 Hz
- Power input: 1012 W
- Mass: 6 kg

7 (a) Why is it safe for this drill to be fitted with a two-core cable rather than a three-core cable?

[1 mark]

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.....

7 (b) Calculate the current drawn from the mains electricity supply by the drill.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

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Current = ... A

4.2.3.2 Mains electricity

Question 34 · continued

7 (c) It is advisable to use all 230 V power tools with a residual current circuit breaker (RCCB).

How does an RCCB operate?

[1 mark]

.....

.....

.....

4

4.2.3.2 Mains electricity

Question 35

June 2015 | PH2HP | Original Q3 | Legacy

3 Many countries use nuclear power stations to generate electricity.
Nuclear power stations use the process of nuclear fission to release energy.

3 (a) (i) What is nuclear fission?

[1 mark]

.....

.....

3 (a) (ii) Plutonium-239 is one substance used as a fuel in a nuclear reactor. For nuclear fission to happen, the nucleus must absorb a particle.

What type of particle must be absorbed?

[1 mark]

.....

3 (b) Nuclear **fusion** also releases energy.
Nuclear fusion happens at very high temperatures. A high temperature is needed to overcome the repulsion force between the nuclei.

3 (b) (i) Why is there a repulsion force between the nuclei of atoms?

[1 mark]

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.....

3 (b) (ii) Where does nuclear fusion happen naturally?

[1 mark]

.....

Question 35 · continued

3 (c) In 1991, scientists produced the first controlled release of energy from an experimental nuclear **fusion** reactor. This was achieved by fusing the hydrogen isotopes, deuterium and tritium.

Deuterium is naturally occurring and can easily be extracted from seawater. Tritium can be produced from lithium. Lithium is also found in seawater.

Table 2 gives the energy released from 1 kg of fusion fuel and from 1 kg of fission fuel.

Table 2

Type of fuel	Energy released from 1 kg of fuel in joules
Fusion fuel	3.4×10^{14}
Fission fuel	8.8×10^{13}

3 (c) (i) Suggest **two** advantages of the fuel used in a fusion reactor compared with plutonium and the other substances used as fuel in a fission reactor.

[2 marks]

1 .....

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.....

2 .....

.....

.....

3 (c) (ii) Some scientists think that by the year 2050 a nuclear fusion power station capable of generating electricity on a large scale will have been developed.

Suggest **one** important consequence of developing nuclear fusion power stations to generate electricity.

[1 mark]

.....

.....

.....

Question 3 continues on the next page

4.2.3.2 Mains electricity

Question 35 · continued

3 (d) Tritium is radioactive.

After 36 years, only 10 g of tritium remains from an original sample of 80 g.

Calculate the half-life of tritium.

Show clearly how you work out your answer.

[2 marks]

.....

.....

Half-life = ... years

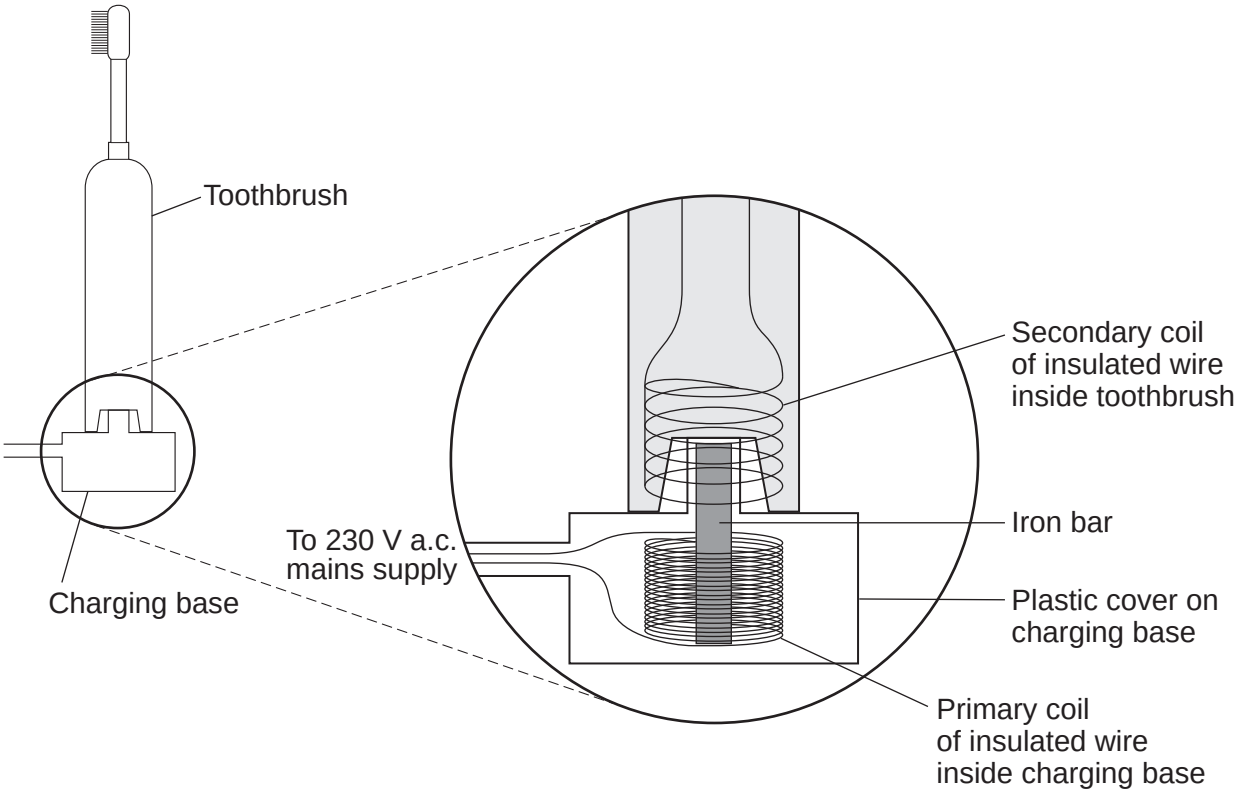
9

4.2.3.2 Mains electricity

Question 36

8 An electric toothbrush is charged by standing it on a separate charging base. **Figure 15** shows the inside of the electric toothbrush and the charging base.

Figure 15



8 (a) An alternating potential difference (p.d.) across the coil in the charging base creates an alternating current in the coil inside the toothbrush.

Explain how.

[3 marks]

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4.2.3.2 Mains electricity

Question 36 · continued

8 (b) When the toothbrush is being charged, the p.d. across the primary coil in the charging base is 230 V.

The charging p.d. across the secondary coil in the toothbrush is 7.2 V.

The primary coil in the charging base has 575 turns of wire on its coil.

Calculate the number of turns on the secondary coil inside the toothbrush.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

.....

.....

.....

.....

Number of turns on the secondary coil = ...

5

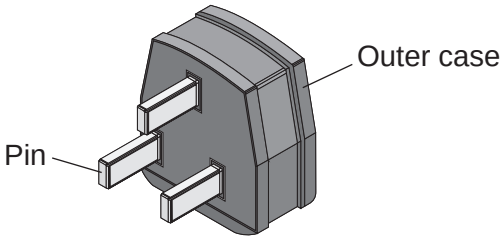
4.2.3.2 Mains electricity

Question 37

June 2016 | PH2HP | Original Q4 | Legacy

4 (a) A washing machine is connected to the mains electricity supply using a cable and three-pin plug.
Figure 9 shows a three-pin plug.

Figure 9



Name the materials used in the structure of a plug. Give the reason why each material is used.

[2 marks]

Pin _____

_____

Outer case _____

_____

4 (b) The three-pin plug contains a fuse. The fuse is connected to one of the wires inside the cable.

4 (b) (i) Which **one** of the wires inside the cable is the fuse connected to?

[1 mark]

_____

4 (b) (ii) The fuse is a thin wire inside a closed glass tube. The wire acts as a resistor.

What effect does a current through a wire have on the wire?

[1 mark]

_____

4.2.3.2 Mains electricity

Question 37 · continued

4 (b) (iii) The power of the washing machine varies between 0.7 kW and 2 kW depending on which part of the wash cycle is operating.

Calculate the maximum current drawn from the mains electricity supply by the washing machine.

The mains electricity supply is at a potential difference of 230 V.

Use the correct equation from the Physics Equations Sheet.

[2 marks]

Current = _____ A

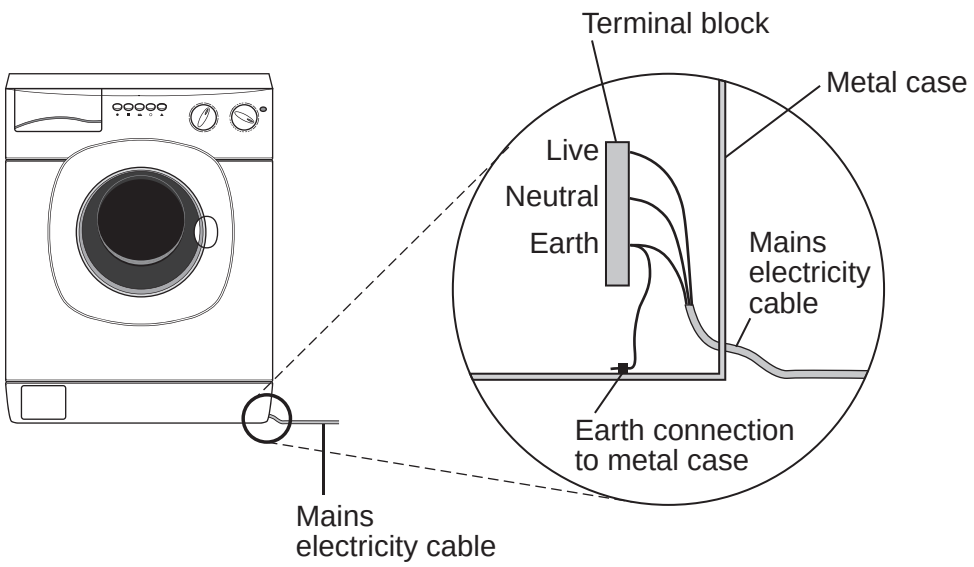
Question 4 continues on the next page

4.2.3.2 Mains electricity

Question 37 · continued

4 (c) **Figure 10** shows how the mains electricity cable is connected to the washing machine.
The earth wire is connected to the metal case of the washing machine.

Figure 10



If a fault makes the metal case live, the earth wire and fuse inside the plug prevent the mains cable from overheating and causing a fire.

Explain how.

[2 marks]

4 (d) New research has shown that many people underestimate the hazards of using mains electricity.

It is important that people do understand the hazards of using mains electricity.
Suggest why.

[1 mark]

9

4.2.3.2 Mains electricity

Question 38

June 2018 | 8463/1H | Original Q5

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

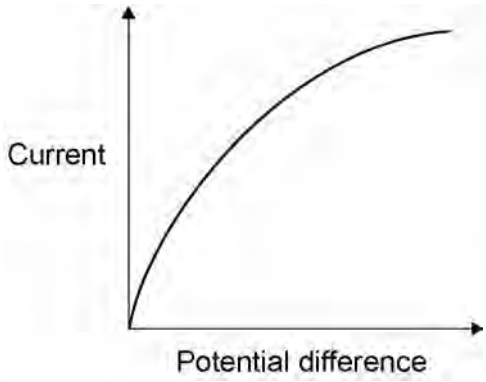
[2 marks]

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]

4.2.3.2 Mains electricity

Question 38 · 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]

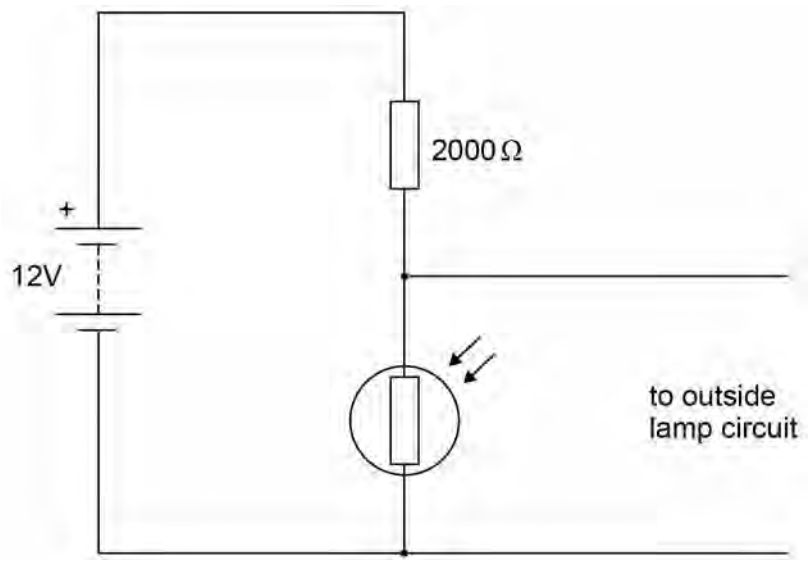
Question 5 continues on the next page

Question 38 · 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 _____

_____

_____

4.2.3.2 Mains electricity

Question 38 · 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

4.2.3.2 Mains electricity

Question 39

June 2018 | 8463/1H | Original Q9

0 9 **Figure 15** shows a coffee machine. The coffee machine uses an electric element to heat water.

Figure 15



0 9 . 1 The coffee machine has a metal case.

Why would it be dangerous for the live wire of the electric cable to touch the metal case?

[1 mark]

0 9 . 2 The power output of the coffee machine is 2.53 kW.

The mains potential difference is 230 V.

Calculate the current in the coffee machine.

[3 marks]

Current = _____ A

4.2.3.2 Mains electricity

Question 39 · continued

June 2018 | 8463/1H | Original Q9

0 9 . 3 The coffee machine heats water from 20 °C to 90 °C.

The power output of the coffee machine is 2.53 kW.

The specific heat capacity of water is 4200 J/kg °C.

Calculate the mass of water that the coffee machine can heat in 14 seconds.

[5 marks]

Mass = _____ kg

9

4.2.3.2 Mains electricity

Question 40

June 2018 | 8463/2H | Original Q5

0 5 **Figure 7** shows the apparatus a student used to investigate the reflection of light by a plane mirror.

The student drew four ray diagrams for each angle of incidence.

The student measured the angle of reflection from each diagram.

Table 2 gives the student's results.

Figure 7

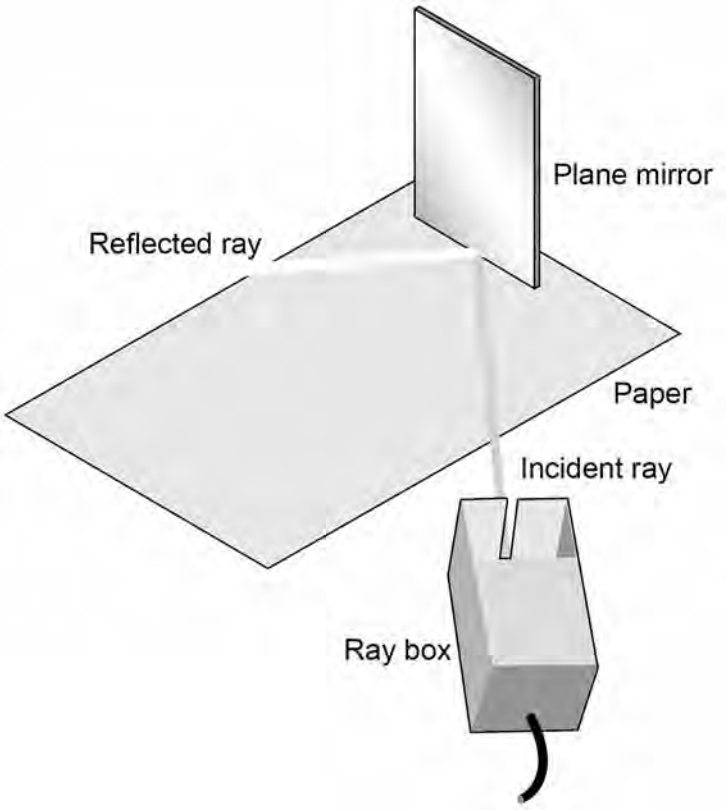


Table 2

	Angle of reflection			
Angle of incidence	**Test 1**	**Test 2**	**Test 3**	**Test 4**
20°	19°	22°	20°	19°
30°	31°	28°	32°	30°
40°	42°	40°	43°	41°
50°	56°	49°	53°	46°

4.2.3.2 Mains electricity

Question 40 · continued

0 5 . 1 For each angle of incidence, the angle of reflection has a range of values.

This is caused by an error.

What type of error will have caused each angle of reflection to have a range of values?

[1 mark]

0 5 . 2 Suggest what the student may have done during the investigation to cause each angle of reflection to have a range of values.

[1 mark]

0 5 . 3 Estimate the uncertainty in the angle of reflection when the angle of incidence is 50°.

Show how you determine your estimate.

[2 marks]

Uncertainty = ± _____ °

0 5 . 4 The student concluded that for a plane mirror, the angle of incidence is equal to the angle of reflection.

Explain whether you agree with this conclusion.

Use examples from the results in **Table 2** in your answer.

[2 marks]

4.2.3.2 Mains electricity

Question 40 · continued

0 5 . 5 What extra evidence could be collected to support the student's conclusion?

[1 mark]

0 5 . 6 State **one** change the student should make to the apparatus if he wants to use the same method to investigate diffuse reflection.

[1 mark]

8

4.2.3.2 Mains electricity

Question 41

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

4.2.3.2 Mains electricity

Question 41 · 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

4.2.3.2 Mains electricity

Question 42

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]

4.2.3.2 Mains electricity

Question 42 · 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

4.2.3.2 Mains electricity

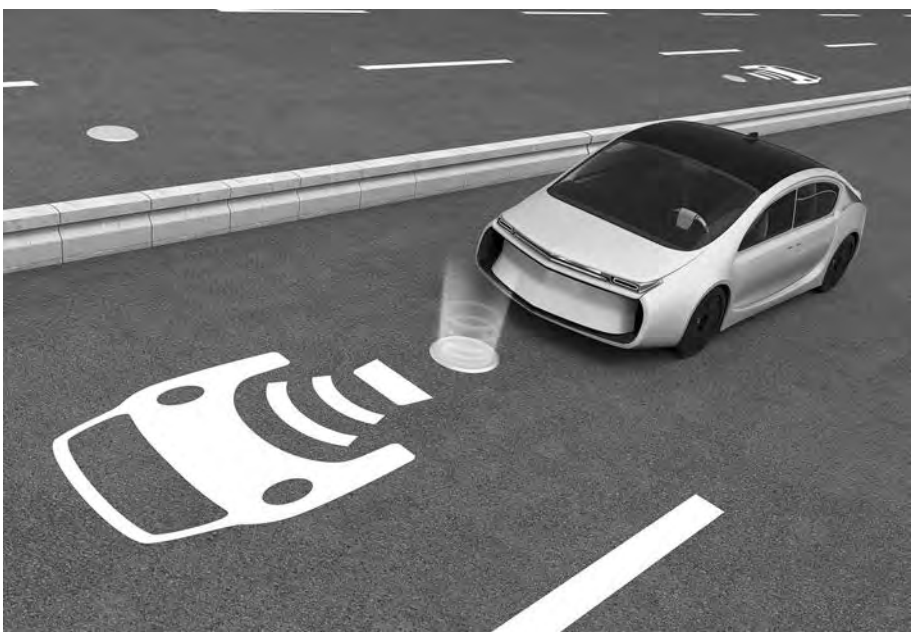
Question 42 · continued

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 _____

_____

_____

_____

4.2.3.2 Mains electricity

Question 42 · 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

4.2.3.2 Mains electricity

Question 43

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 _____

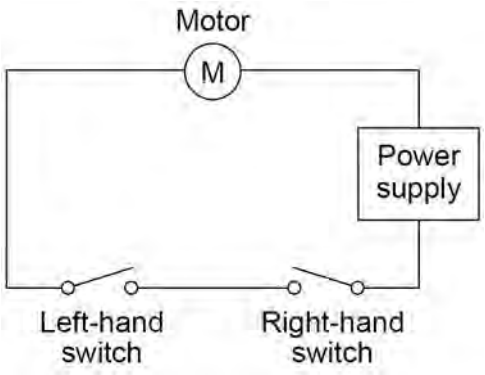
4.2.3.2 Mains electricity

Question 43 · 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

4.2.3.2 Mains electricity

Question 43 · 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

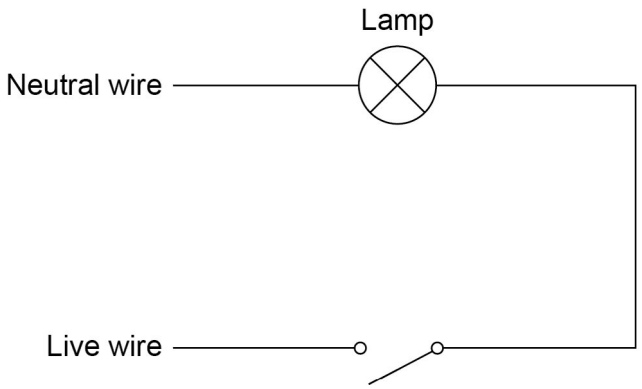
4.2.3.2 Mains electricity

Question 44

November 2020 | 8463/1H | Original Q9

0 9 **Figure 13** shows part of a mains electricity lighting circuit in a house.

Figure 13



0 9 . 1 A fault in the switch caused a householder to receive a mild electric shock before a safety device switched the circuit off.

The mean power transfer to the person was 5.75 W.

The potential difference across the person was 230 V.

Calculate the resistance of the person.

[5 marks]

Resistance = _____ Ω

4.2.3.2 Mains electricity

Question 44 · continued

0 9 . 2 An electrician replaced the switch.

The electrician would have received an electric shock unless the circuit was disconnected from the mains supply.

Explain why.

[3 marks]

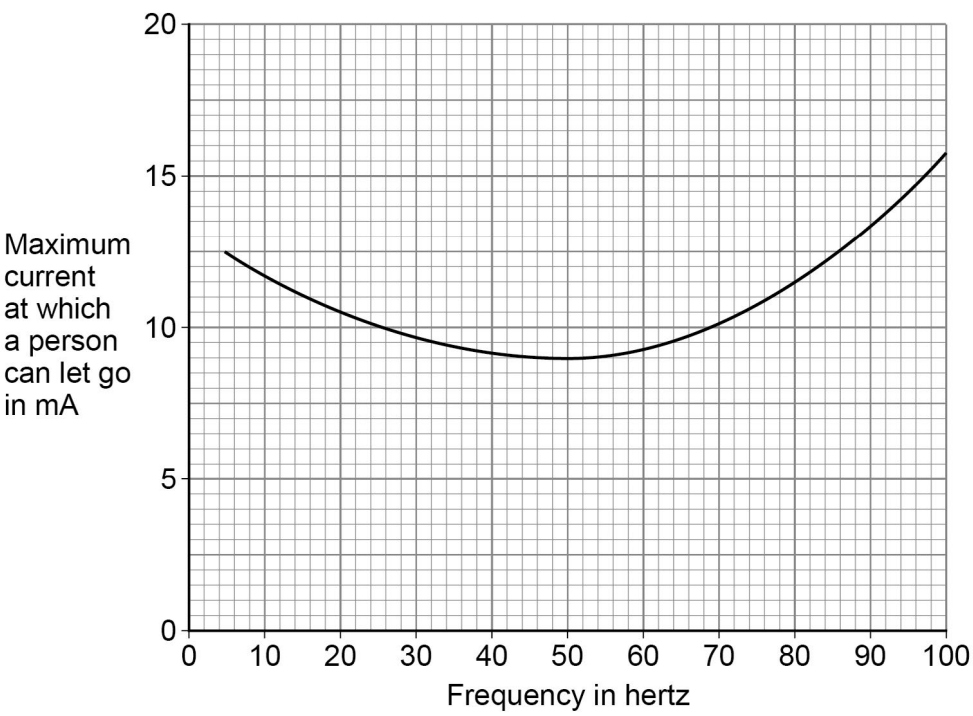
Question 9 continues on the next page

Question 44 · continued

0 9 . 3 The current from an electric shock causes a person's muscles to contract. The person cannot let go of the electrical circuit if the current is too high.

Figure 14 shows how the maximum current at which a person can let go depends on the frequency of the electricity supply.

Figure 14



The UK mains frequency is 50 Hz.

Explain why it would be safer if the UK mains frequency was **not** 50 Hz.

[2 marks]

10

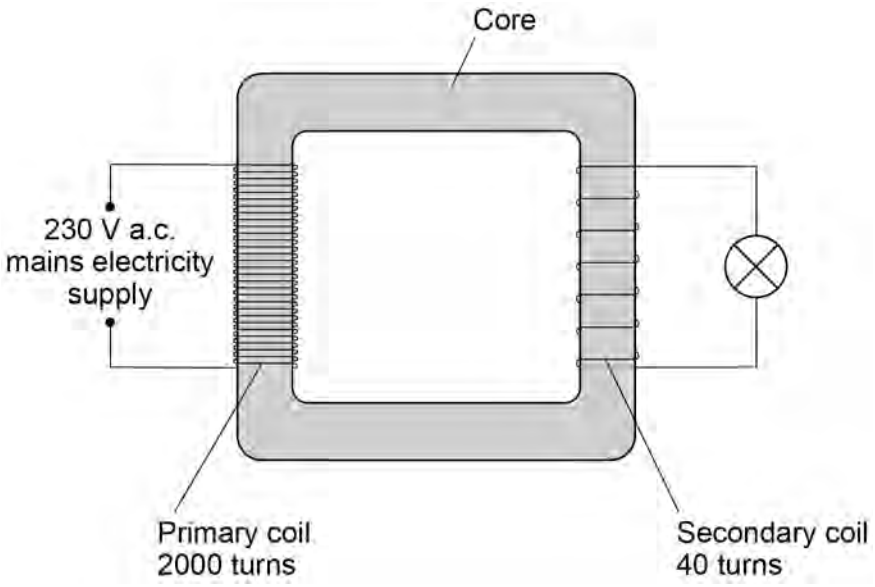
4.2.3.2 Mains electricity

Question 45

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 _____

_____

4.2.3.2 Mains electricity

Question 45 · 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

4.2.3.2 Mains electricity

Question 46

0 5 **Figure 7** shows a student putting a coin into a vending machine that sells food.

Figure 7



0 5 . 1 The vending machine is connected to the mains electricity supply.

What is the frequency and the potential difference of the mains electricity supply in the UK?

[2 marks]

Frequency = _____ Hz

Potential difference = _____ V

The vending machine identifies the value of the coin by measuring the resistance of the coin.

0 5 . 2 The power dissipated by the coin is 340 mW when the current in the coin is 0.75 A.

Calculate the resistance of the coin.

Use the Physics Equations Sheet.

[4 marks]

Resistance = _____ Ω

0 5 . 3 Coins that are dirty are **not** recognised by the vending machine.

Suggest **one** reason why.

[1 mark]

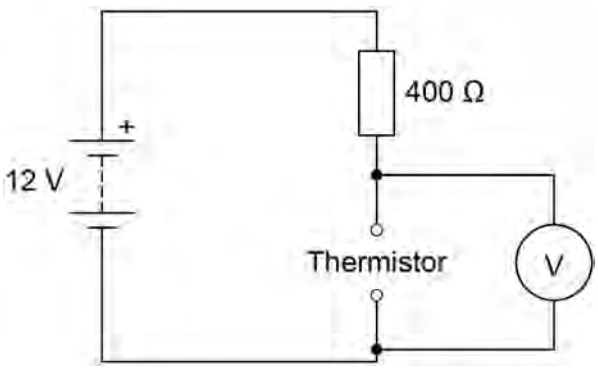
Question 5 continues on the next page

4.2.3.2 Mains electricity

Question 46 · continued

Figure 8 shows part of a different circuit that is used to monitor the temperature inside the vending machine.

Figure 8



0 5 . 4 The circuit symbol for a thermistor has not been included.

Draw the circuit symbol for a thermistor in the box below.

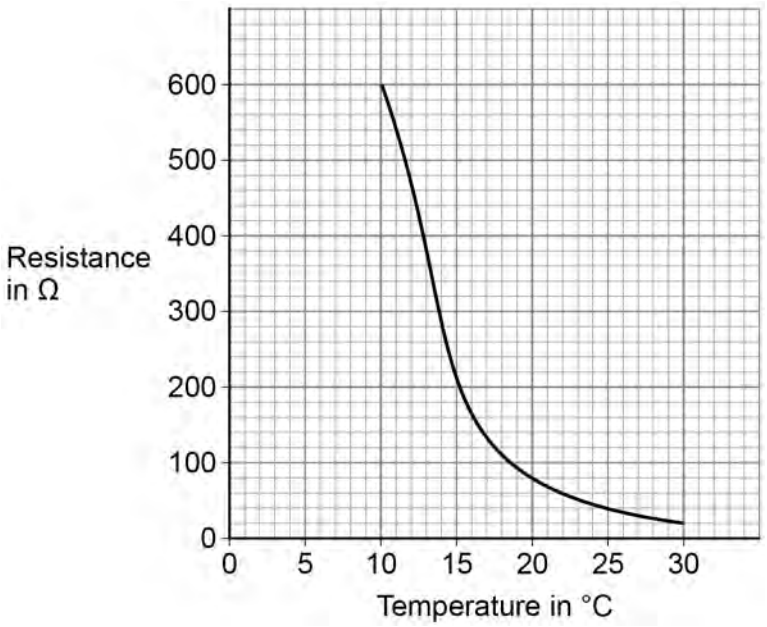
[1 mark]

4.2.3.2 Mains electricity

Question 46 · continued

Figure 9 shows how the resistance of the thermistor varies with temperature.

Figure 9



0 5 . 5 The cooling system inside the vending machine turns on when the temperature of the thermistor is above 20 °C.

Determine the potential difference across the thermistor when the temperature is 20 °C.

Use the Physics Equations Sheet.

[5 marks]

Potential difference = _____ V

13

4.2.3.2 Mains electricity

Question 47

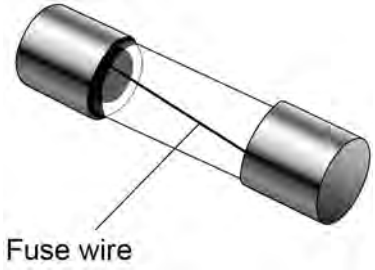
June 2024 | 8463/1H | Original Q10

1 0 The live wire in a three-core cable is connected to a fuse inside a plug.

A fuse contains a wire that is designed to melt when the current gets too great.

Figure 17 shows a fuse.

Figure 17



1 0 . 1 What colour is the insulation covering the live wire in a three-core cable?

[1 mark]

1 0 . 2 Draw the circuit symbol for a fuse in the box below.

[1 mark]

4.2.3.2 Mains electricity

Question 47 · continued

1 0 . 3 The fuse wire melts when there is a charge flow of 2.0 C for 400 ms.

Calculate the current in the fuse wire.

Use the Physics Equations Sheet.

[4 marks]

Current = _____ A

1 0 . 4 When the fuse wire is at its melting point, the additional energy needed to melt the wire is 1.02 J.

specific latent heat of fuse wire = 60 kJ/kg

Calculate the mass of the fuse wire.

Use the Physics Equations Sheet.

[4 marks]

Mass = _____ kg

Question 10 continues on the next page

4.2.3.2 Mains electricity

Question 47 · continued

1 0 . 5 The calculation in Question **10.4** assumes there is no energy transferred to the surroundings.

How would the time taken for the wire to melt be affected if some energy was transferred to the surroundings?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

Time taken would decrease ☐

Time taken would stay the same ☐

Time taken would increase ☐

Reason _____

_____

_____

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