Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

General Certificate of Secondary Education
Foundation Tier and Higher Tier
June 2011

Science A

Unit Physics P1a (Energy and Electricity)

Physics

Unit Physics P1a (Energy and Electricity)

PHY1AP

F&H

Tuesday 28 June 2011 Morning Session

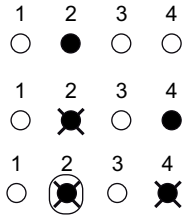
For this paper you must have:
- a black ball-point pen
- an objective test answer sheet.

You may use a calculator.

Time allowed
- 30 minutes

Instructions
- Fill in the boxes at the top of this page.
- Check that your name, candidate number and centre number are printed on the separate answer sheet.
- Check that the separate answer sheet has the title 'Physics Unit 1a' printed on it.
- Attempt **one Tier only**, **either** the Foundation Tier **or** the Higher Tier.
- Make sure that you use the correct side of the separate answer sheet; the Foundation Tier is printed on one side and the Higher Tier on the other.
- Answer **all** the questions for the Tier you are attempting.
- Record your answers on the separate answer sheet only.
- Do all rough work in this book, **not** on your answer sheet.

Instructions for recording answers
- Use a **black ball-point pen**.
- For each answer **completely fill in the circle** as shown.
- Do **not** extend beyond the circles.
- If you want to change your answer, **you must** cross out your original answer, as shown.
- If you change your mind about an answer you have crossed out and now want to choose it, draw a ring around the cross as shown.



Information
- The maximum mark for this paper is 36.

Advice
- Do **not** choose more responses than you are asked to. You will lose marks if you do.
- Make sure that you hand in both your answer sheet and this question paper at the end of the test.
- If you start to answer on the wrong side of the answer sheet by mistake, make sure that you cross out **completely** the work that is not to be marked.

You must do **one Tier** only, **either** the Foundation Tier **or** the Higher Tier.
The Higher Tier starts on page 18 of this booklet.

FOUNDATION TIER

Section One

Questions **ONE** to **FIVE**.

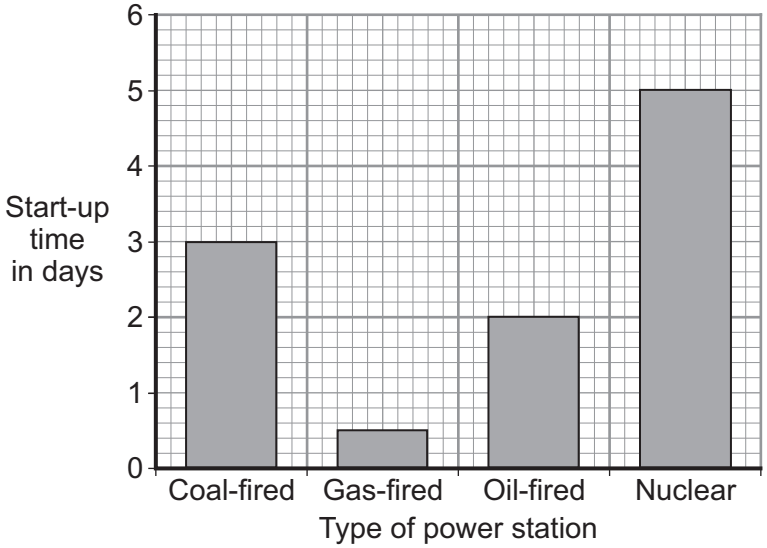
In these questions, match the letters, **A**, **B**, **C** and **D**, with the numbers **1**–**4**.

Use **each** answer only **once**.

Mark your choices on the answer sheet.

QUESTION ONE

The bar chart shows the start-up times for four types of power station.



Match the types of power station, **A**, **B**, **C**, and **D**, with the sentences **1**–**4** in the table.

A coal-fired

B gas-fired

C nuclear

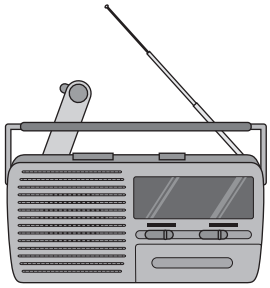
D oil-fired

1	It has a start-up time of three days.
2	It could be used to meet an unexpected increase in demand.
3	It has the longest start-up time.
4	It uses a liquid fuel.

QUESTION TWO

The diagram shows a wind-up radio. The radio has the following features:

- hand-turned generator
- rechargeable battery
- lamp.



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

A chemical

B electrical

C kinetic

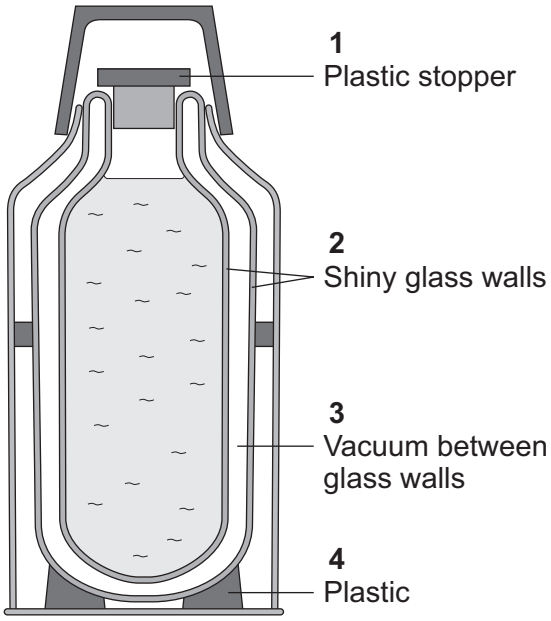
D light

1	given out by the lamp
2	produced by the generator
3	stored in the battery
4	involved in turning the handle for the generator

Turn over for the next question

QUESTION THREE

The diagram shows a vacuum flask that is used to keep liquids hot.



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

A prevents hot air from rising from the flask

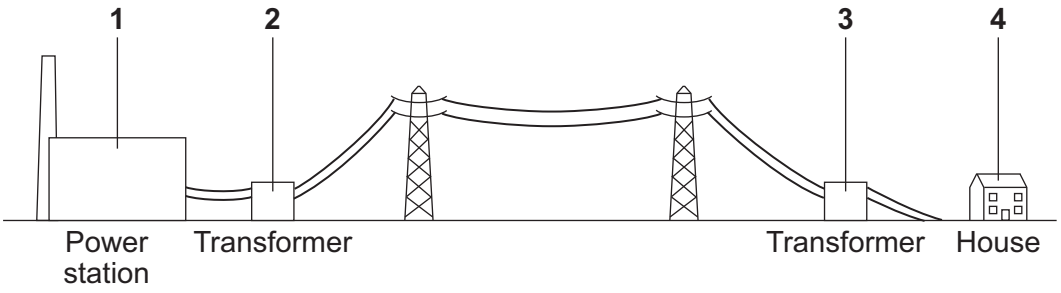
B reduces heat loss by conduction through the base

C reduces heat loss by radiation

D prevents heat loss by conduction and convection

QUESTION FOUR

The diagram shows part of the National Grid.



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

A This is where the electricity is being generated.

B This is where the electricity is being used.

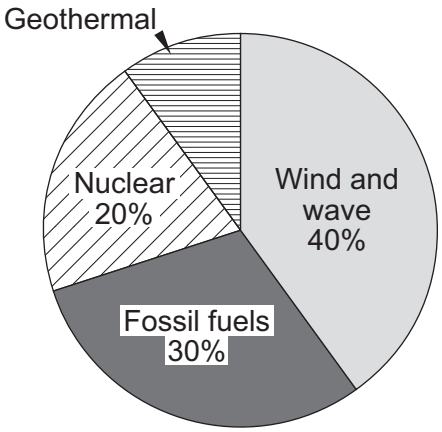
C This is where the voltage is decreased.

D This is where the voltage is increased.

Turn over for the next question

QUESTION FIVE

The pie chart shows how a country's electricity demands are met using different energy sources.



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

A 10 %

B 20 %

C 40 %

D 50 %

The percentage of electricity generated from non-renewable sources is . . . **1** . . . .

The percentage of electricity generated from geothermal sources is . . . **2** . . . .

The percentage of electricity generated using a source that produces radioactive waste is . . . **3** . . . .

The percentage of electricity generated using the kinetic energy of the source directly is . . . **4** . . . .

Turn over for the next question

Section Two

Questions **SIX** to **NINE**.

Each of these questions has four parts.

In each part choose only **one** answer.

Mark your choices on the answer sheet.

QUESTION SIX

The following is an extract from a newspaper in 2008.

> **Renewable energy projects at risk**
>
> The 'credit crunch' is making it difficult for companies to borrow money for large building projects.

6A Which of the following energy sources is renewable?

1 coal

2 nuclear

3 oil

4 tides

6B The newspaper reported that groups of people around the country were protesting about plans to build wind farms. The protestors said that wind farms are noisy and a danger to birds.

The reasons for the protests are . . .

1 economic.

2 environmental.

3 ethical.

4 political.

6C Some wind energy companies had to delay their building plans because of the difficulty in raising money.

The reason for the delay was . . .

1 economic.

2 environmental.

3 ethical.

4 political.

6D There was a sharp fall in the price of oil towards the end of 2008.

Despite this fall, there were no suggestions that any new oil-fired power stations should be built.

This was because . . .

1 oil reserves are decreasing.

2 oil-fired power stations produce radioactive waste.

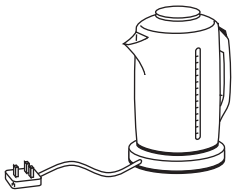
3 oil-fired power stations produce waste heat.

4 oil is difficult to transport.

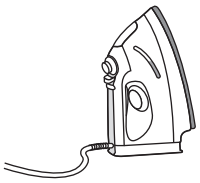
Turn over for the next question

QUESTION SEVEN

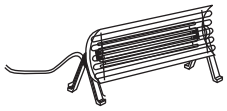
The diagrams show four electrical heating devices.



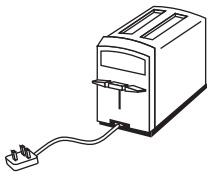
2 kW
Kettle



500 W
Iron



1 kW
Fire



0.5 kW
Toaster

7A Which two devices transform energy at the same rate?

1 the kettle and the iron

2 the iron and the toaster

3 the toaster and the fire

4 the fire and the kettle

7B The kettle is used for a total of 2 hours.

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

How much energy does the kettle transfer?

1 1 kWh

2 4 kWh

3 1000 kWh

4 4000 kWh

7C The fire is switched on for two hours and transfers 2 kWh of energy.

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

Electricity costs 14 p per kWh

What is the cost of using the electric fire for two hours?

1 7 p

2 14 p

3 28 p

4 56 p

7D The kettle casing is made of plastic.

A plastic kettle is more efficient than a metal kettle because . . .

1 plastic is an electrical insulator.

2 plastic is a thermal insulator.

3 plastic has a higher density than metal.

4 plastic is cheaper than metal.

Turn over for the next question

QUESTION EIGHT

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.

8A 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.

8B 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.

8C 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 52 years

8D 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.

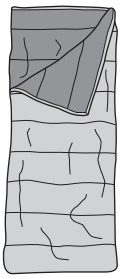
3 It can work all the time.

4 It does not require any space.

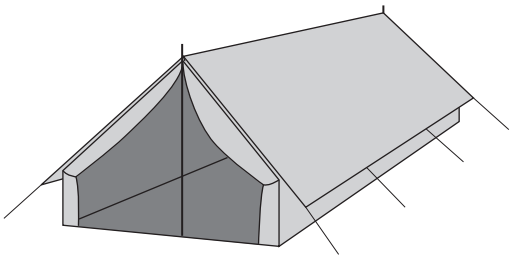
Turn over for the next question

QUESTION NINE

Some students are going camping. They will use sleeping bags in a tent.



Sleeping bag



Tent

9A The students have different makes of sleeping bag. They investigated which sleeping bag would keep them warmest.

- They placed a hot water bottle in each sleeping bag for an hour.
- They measured the temperature of the water in the hot water bottle at the start and after one hour.
- They calculated the fall in temperature of the water.

Why did they use hot water bottles in their investigation?

1 because people use hot water bottles to keep warm in bed

2 to see whether a sleeping bag would warm up its user

3 to represent a real person using the sleeping bag

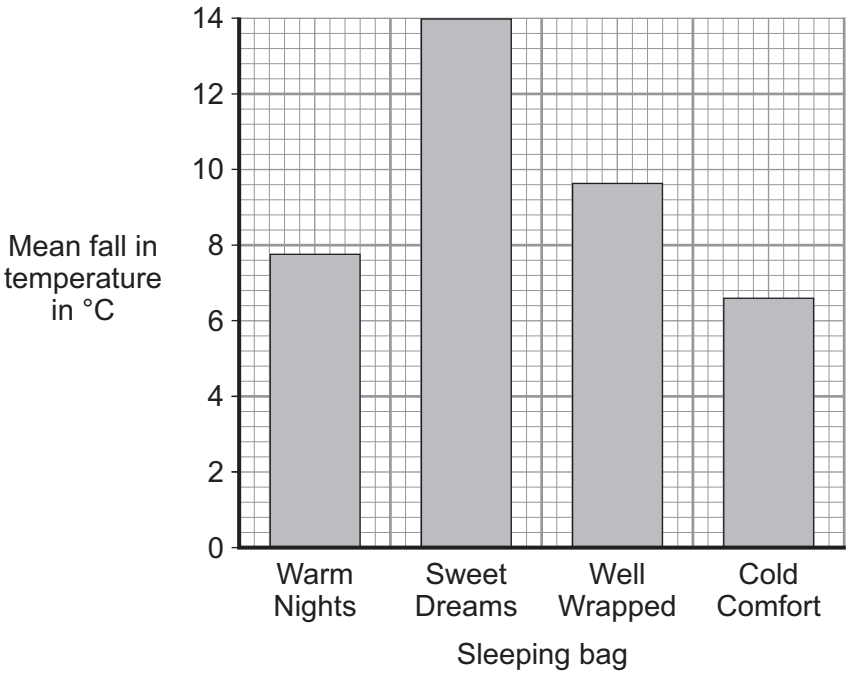
4 to see what would happen if the sleeping bag got wet inside

The students carried out the investigation three times.

The results of their investigation are given in the table.

	Temperature of water in °C			
Name of sleeping bag	**At start**	**After one hour 1st time**	**After one hour 2nd time**	**After one hour 3rd time**
Warm Nights	60.0	53.5	51.0	52.5
Sweet Dreams	60.0	48.5	42.0	47.5
Well Wrapped	60.0	51.0	49.5	50.5
Cold Comfort	60.0	54.5	52.5	53.0

9B The students plotted a bar chart of their results.



From this chart, which sleeping bag would keep a person warmest at night?

1 Warm Nights

2 Sweet Dreams

3 Well Wrapped

4 Cold Comfort

9C The students thought the 42.0 °C result for the Sweet Dreams sleeping bag was anomalous.

What does *anomalous* mean?

1 It does not fit the pattern of the other results.

2 It is the only reliable result.

3 It was not as precise as the other results.

4 It is the smallest value in the table.

Question 9 continues on the next page

9D The students repeated the experiment for the Sweet Dreams sleeping bag.

Their results are shown in the table.

	Temperature of water in °C			
Name of sleeping bag	**At start**	**After one hour 1st time**	**After one hour 2nd time**	**After one hour 3rd time**
Sweet Dreams	60.0	48.5	48.0	47.5

What is the mean fall in temperature, in °C, for this sleeping bag?

1 51.0

2 48.0

3 12.0

4 11.5

END OF TEST

There are no questions printed on this page

You must do **one Tier** only, **either** the Foundation Tier **or** the Higher Tier.
The Foundation Tier is earlier in this booklet.

HIGHER TIER

Section One

Questions **ONE** and **TWO**.

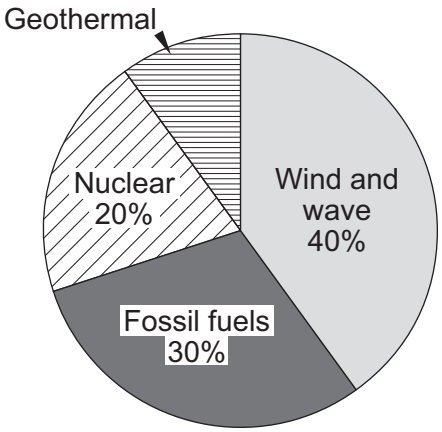
In these questions, match the letters, **A**, **B**, **C** and **D**, with the numbers **1**–**4**.

Use **each** answer only **once**.

Mark your choices on the answer sheet.

QUESTION ONE

The pie chart shows how a country's electricity demands are met using different energy sources.



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

A 10 %

B 20 %

C 40 %

D 50 %

The percentage of electricity generated from non-renewable sources is . . . **1** . . . .

The percentage of electricity generated from geothermal sources is . . . **2** . . . .

The percentage of electricity generated using a source that produces radioactive waste is . . . **3** . . . .

The percentage of electricity generated using the kinetic energy of the source directly is . . . **4** . . . .

QUESTION TWO

This question is about four electrical devices.

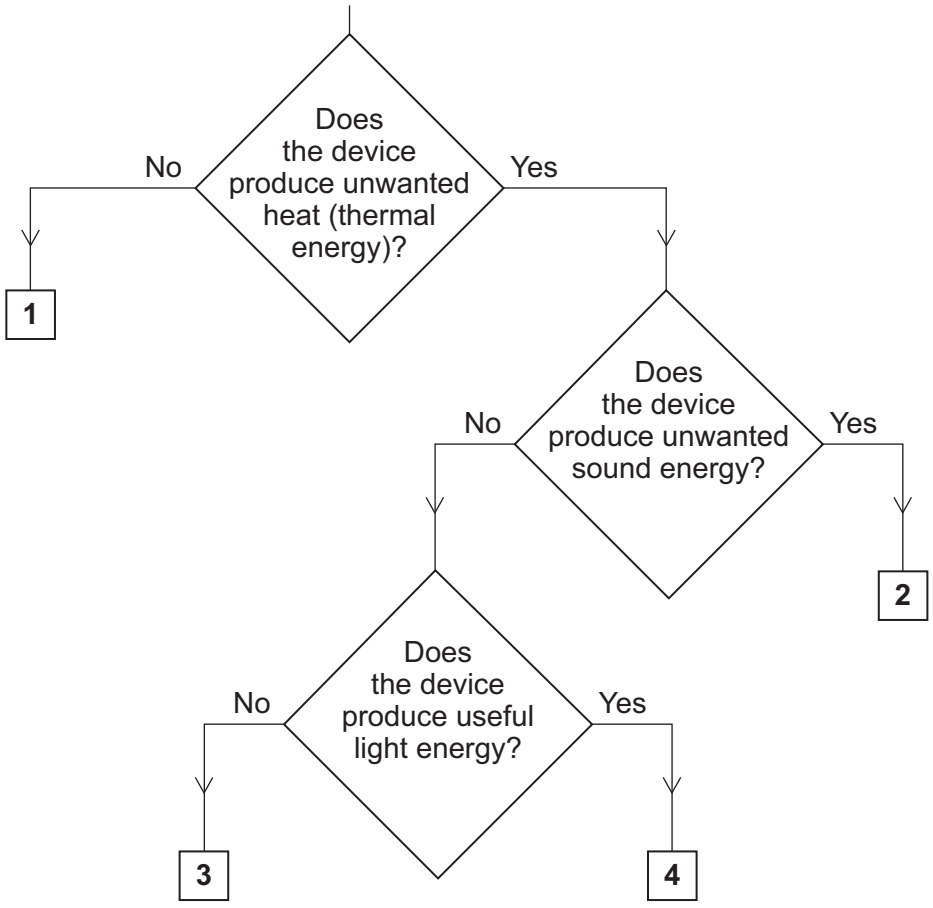
Match the devices, **A**, **B**, **C** and **D**, with the numbers **1**–**4** in the flow chart.

A food mixer

B iron

C radio

D television



Section Two

Questions **THREE** to **NINE**.

Each of these questions has four parts.

In each part choose only **one** answer.

Mark your choices on the answer sheet.

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 52 years

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.

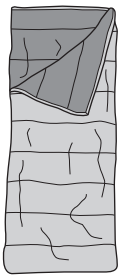
3 It can work all the time.

4 It does not require any space.

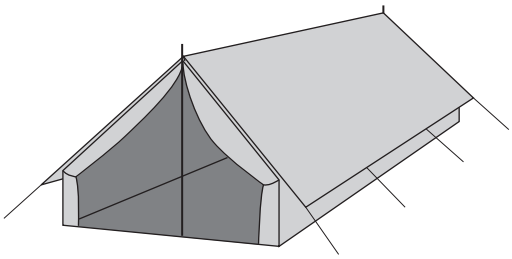
Turn over for the next question

QUESTION FOUR

Some students are going camping. They will use sleeping bags in a tent.



Sleeping bag



Tent

4A The students have different makes of sleeping bag. They investigated which sleeping bag would keep them warmest.

- They placed a hot water bottle in each sleeping bag for an hour.
- They measured the temperature of the water in the hot water bottle at the start and after one hour.
- They calculated the fall in temperature of the water.

Why did they use hot water bottles in their investigation?

1 because people use hot water bottles to keep warm in bed

2 to see whether a sleeping bag would warm up its user

3 to represent a real person using the sleeping bag

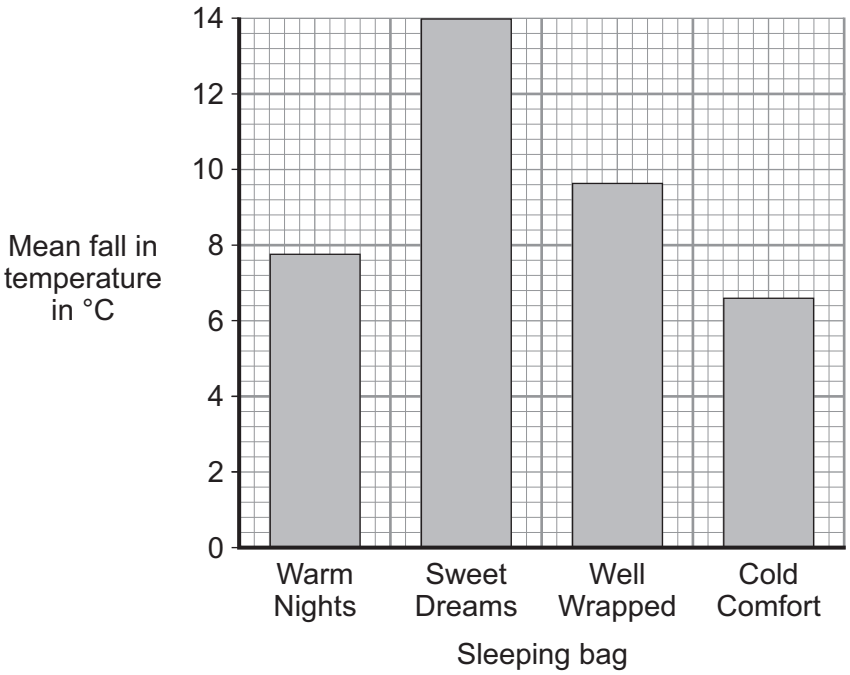
4 to see what would happen if the sleeping bag got wet inside

The students carried out the investigation three times.

The results of their investigation are given in the table.

	Temperature of water in °C			
Name of sleeping bag	**At start**	**After one hour 1st time**	**After one hour 2nd time**	**After one hour 3rd time**
Warm Nights	60.0	53.5	51.0	52.5
Sweet Dreams	60.0	48.5	42.0	47.5
Well Wrapped	60.0	51.0	49.5	50.5
Cold Comfort	60.0	54.5	52.5	53.0

4B The students plotted a bar chart of their results.



From this chart, which sleeping bag would keep a person warmest at night?

1 Warm Nights

2 Sweet Dreams

3 Well Wrapped

4 Cold Comfort

4C The students thought the 42.0 °C result for the Sweet Dreams sleeping bag was anomalous.

What does *anomalous* mean?

1 It does not fit the pattern of the other results.

2 It is the only reliable result.

3 It was not as precise as the other results.

4 It is the smallest value in the table.

Question 4 continues on the next page

4D The students repeated the experiment for the Sweet Dreams sleeping bag.

Their results are shown in the table.

	Temperature of water in °C			
Name of sleeping bag	**At start**	**After one hour 1st time**	**After one hour 2nd time**	**After one hour 3rd time**
Sweet Dreams	60.0	48.5	48.0	47.5

What is the mean fall in temperature, in °C, for this sleeping bag?

1 51.0

2 48.0

3 12.0

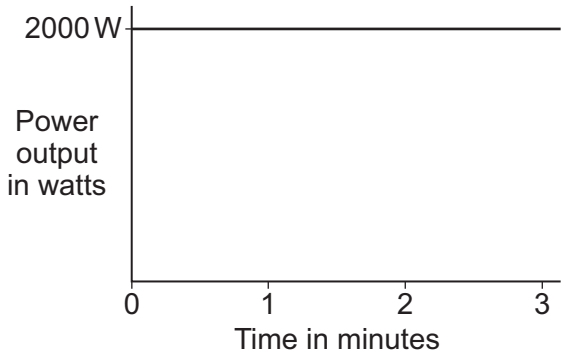
4 11.5

Turn over for the next question

QUESTION FIVE

An electric kettle has a power rating of 2000 W. It can boil 1 litre of water in 3 minutes.

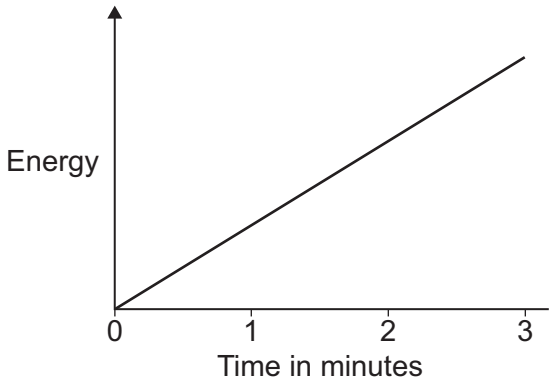
The graph shows how the power output of the kettle varies with time.



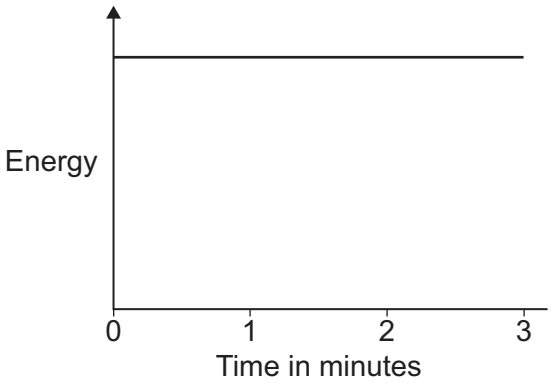
energy transferred (kilowatt-hour, kWh)	=	power (kilowatt, kW)	×	time (hour, h)

5A Which graph shows how the energy transferred by the kettle varies with time?

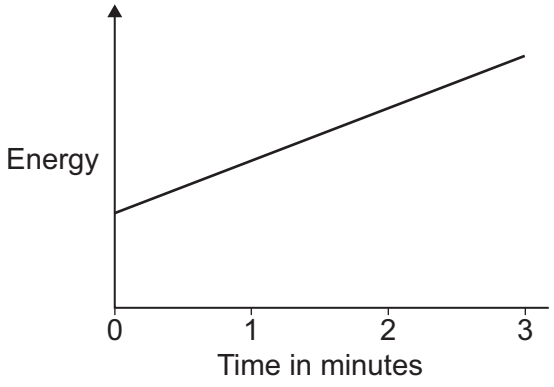
1



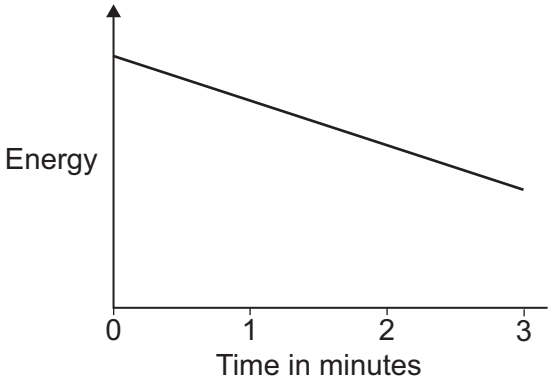
2



3



4



5B The energy transferred to boil the water is . . .

1 0.1 kWh

2 0.5 kWh

3 0.6 kWh

4 0.8 kWh

5C The 2000 W kettle is replaced by a 1000 W kettle. This second kettle is used to boil 1 litre of water.

Which row in the table shows what happens when a 1000 W kettle is used instead of a 2000 W kettle?

	Energy used to boil the water	**Time taken to boil the water**
1	stays the same	increases
2	stays the same	decreases
3	increases	stays the same
4	decreases	increases

5D It costs £7.50 to use the 1000 W kettle for 3 months. During this time, 50 kWh of electrical energy are transferred by the kettle.

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

What is the cost per kilowatt-hour of electrical energy?

1 3.75 p

2 7.00 p

3 11.25 p

4 15.00 p

Turn over for the next question

QUESTION SIX

Many people use a duvet on their beds to keep them warm at night.

Duvets contain fibres which trap small pockets of air. The pockets of air help to keep us warm because air is a poor thermal conductor. The fibres also reduce movement of the air. This reduces convection currents in the air.

6A Why is air a poor thermal conductor?

1 the air particles are close together

2 the air particles do not move

3 the air particles are far apart

4 there are no black surfaces in air

6B What causes convection currents?

1 warmed air expands, becomes more dense and falls

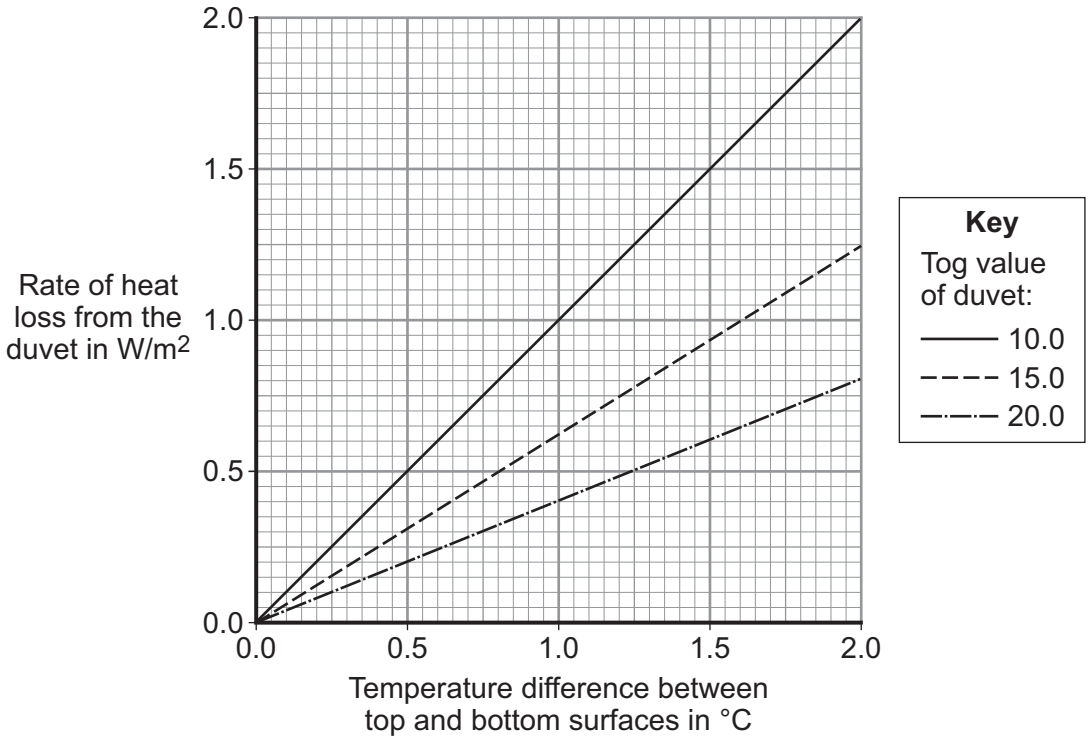
2 warmed air contracts, becomes less dense and rises

3 warmed air contracts, becomes more dense and rises

4 warmed air expands, becomes less dense and rises

The effectiveness of a duvet can be found by calculating the difference in temperature between the top and bottom surfaces of the duvet and the rate of heat loss from the duvet. The effectiveness of a duvet is measured in units called 'Togs'.

The graph shows how the rate of heat loss from three duvets varies with the temperature difference between top and bottom surfaces of each duvet.



6C The graph shows that the rate of heat loss depends on . . .

1 the Tog value only.

2 the temperature difference only.

3 the area only.

4 the Tog value and the temperature difference.

6D Which of these Tog values would be the best for a duvet in a very cold climate?

1 5.0

2 10.0

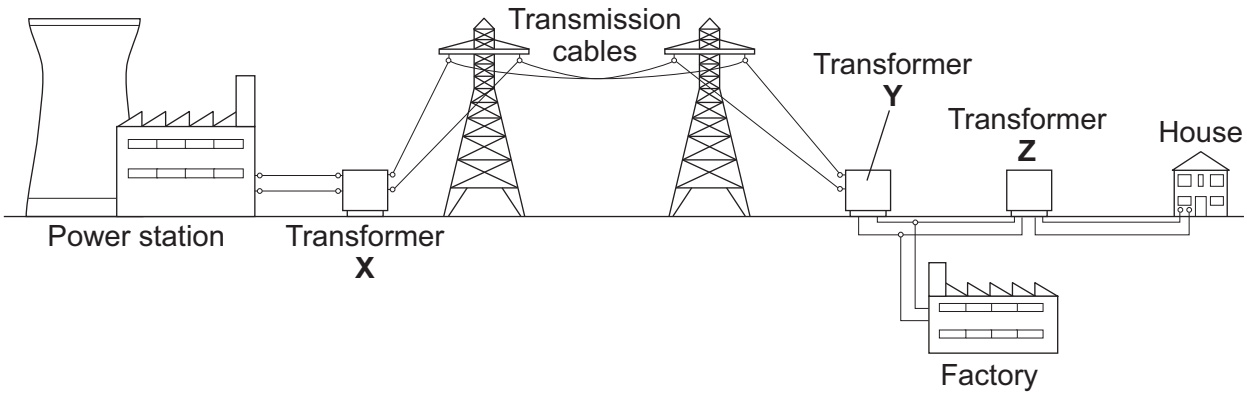
3 15.0

4 17.5

Turn over for the next question

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

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.

Turn over for the next question

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.

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.

Turn over for the next question

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?

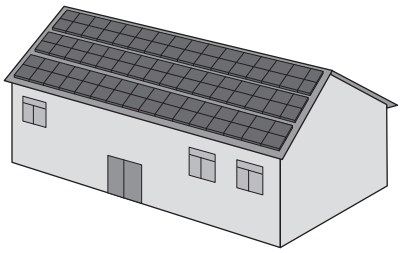
1 Solar cells need a large area of land because solar cells are not very efficient.

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.

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

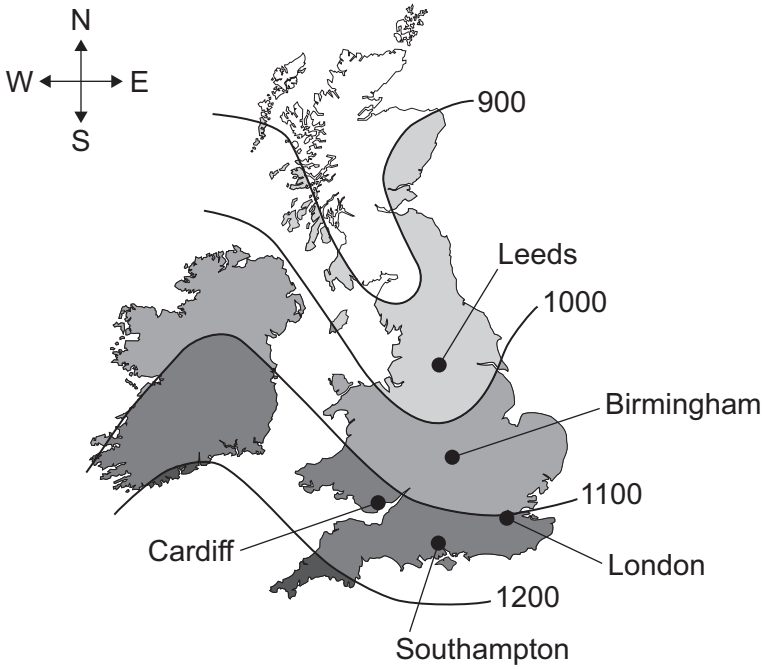


Table 1 gives figures for the annual solar radiation, in kWh / m^2, for London. The table also gives data for various angles of tilt and for various directions that an array faces.

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

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