

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										



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

Science A
Unit Physics P1a (Energy and Electricity)
Physics
Unit Physics P1a (Energy and Electricity)

PHY1AP
F&H

Tuesday 15 November 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

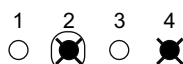
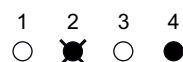
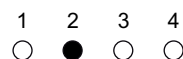
- 30 minutes

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 16 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

This question is about energy sources that are used to produce electricity.

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

- A** geothermal
- B** hydroelectric
- C** nuclear fuel
- D** wind

	Description
1	can be used only where there is a fast flow of water
2	is an unreliable energy source
3	uses heat produced under the ground
4	is a non-renewable energy source

QUESTION TWO

A gym uses exercise bikes to generate electricity.



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

- A** chemical
- B** electrical
- C** heat (thermal energy)
- D** kinetic

The bike riders transform . . . **1** . . . energy from food into . . . **2** . . . energy of the pedals.

A generator produces . . . **3** . . . energy.

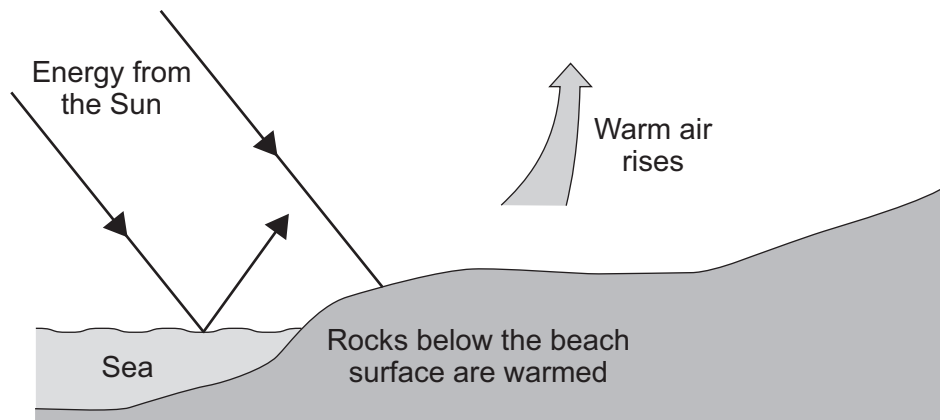
Some energy is wasted as . . . **4**

Turn over for the next question

Turn over ►

QUESTION THREE

The diagram shows some energy transfers at a warm sunny beach.



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

- A** conduction
- B** convection
- C** radiation
- D** reflection

Energy from the Sun is transferred through space by . . . **1**

Rocks below the beach surface are warmed up by . . . **2**

Warm air rises from the beach by . . . **3**

Energy, not absorbed by the sea, leaves the surface of the sea by . . . **4**

QUESTION FOUR

The energy from various sources can be used to drive turbines in power stations.

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

- A** coal-fired
- B** geothermal
- C** nuclear
- D** tidal

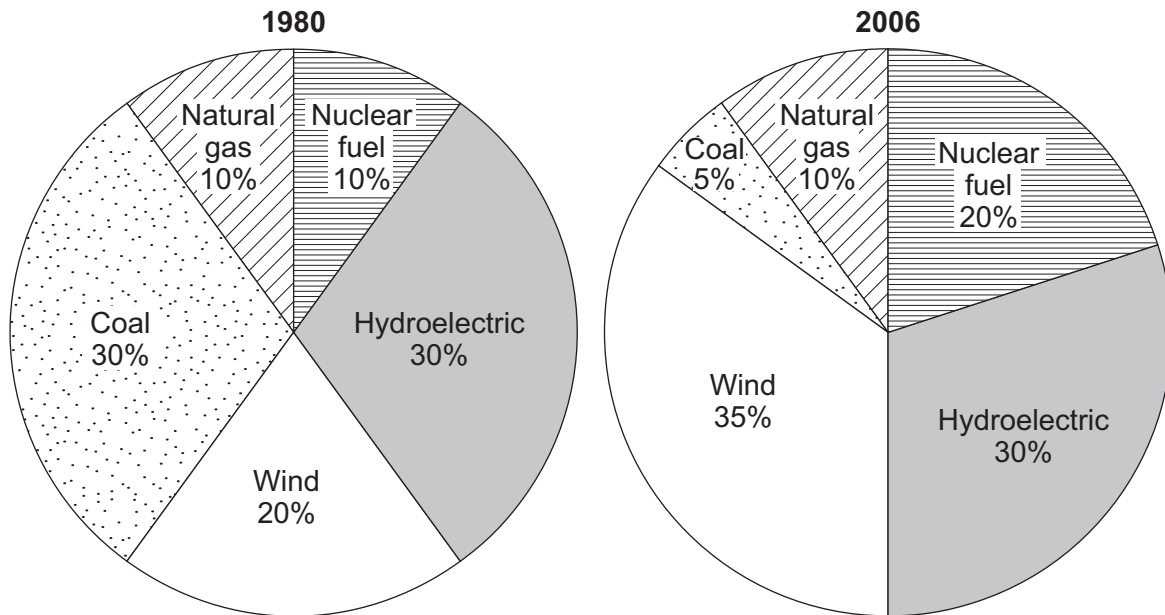
	The turbines are driven by . . .
1	moving water.
2	steam produced from water heated by burning a fuel.
3	steam produced from water heated by hot rocks.
4	steam produced from water heated by the fission of uranium.

Turn over for the next question

Turn over ►

QUESTION FIVE

The two pie charts show the relative proportions of energy sources used to generate electricity in a European country. One is for 1980; the other one is for 2006.



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

- A** coal
- B** natural gas
- C** nuclear fuel
- D** wind

	Between 1980 and 2006, the relative proportion of . . .
1	this non-renewable energy source decreased in use.
2	this non-renewable energy source doubled in use.
3	this non-renewable energy source was unchanged in use.
4	this renewable energy source had the greatest increase in use.

Turn over for the next question

Turn over ►

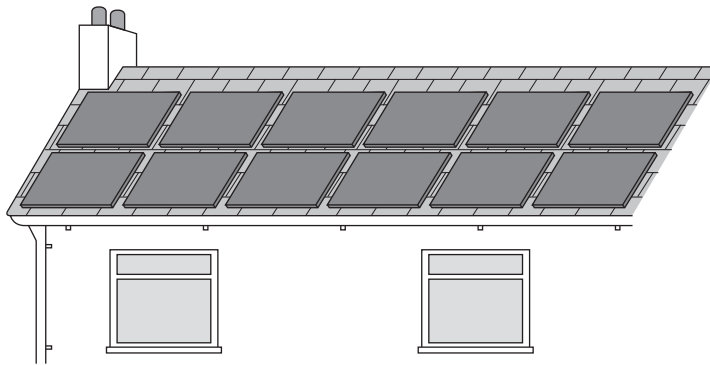
Section TwoQuestions **SIX** to **NINE**.

Each of these questions has four parts.

In each part choose only **one** answer.Mark your choices on the answer sheet.

QUESTION SIX

The diagram shows a group of solar cells on the roof of a building.

**6A** The energy transformation in a solar cell is . . .

- 1 electrical to light.
- 2 electrical to heat.
- 3 heat to electrical.
- 4 light to electrical.

6B There are twelve 180 watt solar cells on the roof.

The maximum power output of the group of solar cells is . . .

- 1 15W
- 2 15kW
- 3 2160W
- 4 2160kW

6C The solar cells will provide 1600 kilowatt-hours (kWh) of electrical energy per year.

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

Electricity from the mains supply costs 15p per kWh

How much money will be saved per year by using the solar cells rather than the mains supply?

- 1 £2.40
- 2 £24
- 3 £240
- 4 £24 000

6D Energy from the solar cells is cheaper than energy from the mains supply because there are no . . .

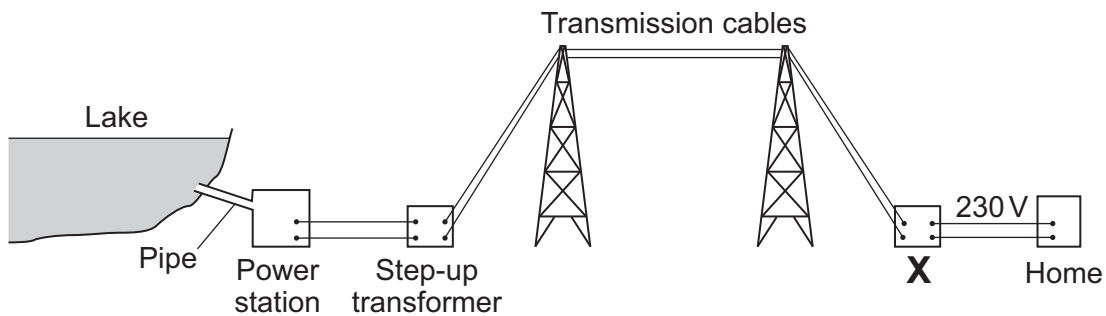
- 1 fuel costs.
- 2 habitats destroyed.
- 3 polluting gases given off.
- 4 radioactive waste products.

Turn over for the next question

Turn over ►

QUESTION SEVEN

The diagram shows a hydroelectric power station connected to the National Grid.



7A The step-up transformer increases the . . .

- 1 current.
- 2 energy.
- 3 power.
- 4 voltage.

7B Using a step-up transformer . . .

- 1 makes the transmission cables warmer.
- 2 makes the electricity move faster.
- 3 reduces the energy loss in the transmission cables.
- 4 reduces the risk of electrocution.

7C The voltage across the transmission cables is 400 000 volts. Before the electricity can be used in homes, it is reduced to 230 volts. The device that does this is labelled **X** on the diagram.

Device **X** is a . . .

- 1 boiler.
- 2 generator.
- 3 step-down transformer.
- 4 thermal circuit breaker.

7D Each second, the water taken from the lake supplies 4 200 000 joules of energy to the power station.

The power station produces 2 520 000 joules of electrical energy each second.

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

The efficiency of the power station is . . .

1 0.2

2 0.4

3 0.6

4 1.7

Turn over for the next question

Turn over ►

QUESTION EIGHT

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

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

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

Car engine	Engine size in litres	Power in kilowatts (kW)	Fuel consumption in litres per 100 kilometres	Carbon dioxide (CO ₂) emission in grams per kilometre
P	1.2	45	5.8	138
Q	1.2	52	5.8	138
R	1.4	60	6.3	150
S	1.6	78	6.9	164

8A Based on this data, which engine is the **least** fuel-efficient?

- 1 **P**
- 2 **Q**
- 3 **R**
- 4 **S**

8B To make a fair comparison of fuel consumption, the four engines should have been tested . . .

- 1 with different fuels.
- 2 at the same speed.
- 3 over different distances.
- 4 on the same day of the week.

8C The tests were carried out under strict conditions. The conditions were set by an independent team of engineers.

This made sure that the results were . . .

- 1 biased in favour of the government.
- 2 biased in favour of the manufacturer.
- 3 biased in favour of the motorist.
- 4 unbiased.

8D In Britain, people who buy cars with low carbon dioxide emissions pay less road tax to the government.

This is because the government is concerned about . . .

- 1 economic issues.
- 2 environmental issues.
- 3 ethical issues.
- 4 social issues.

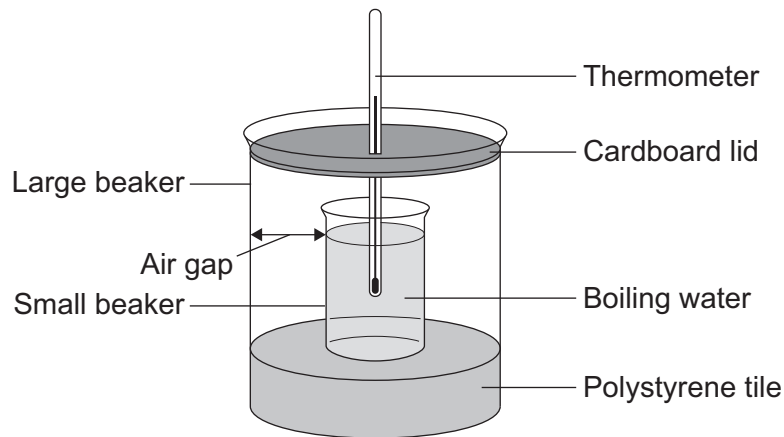
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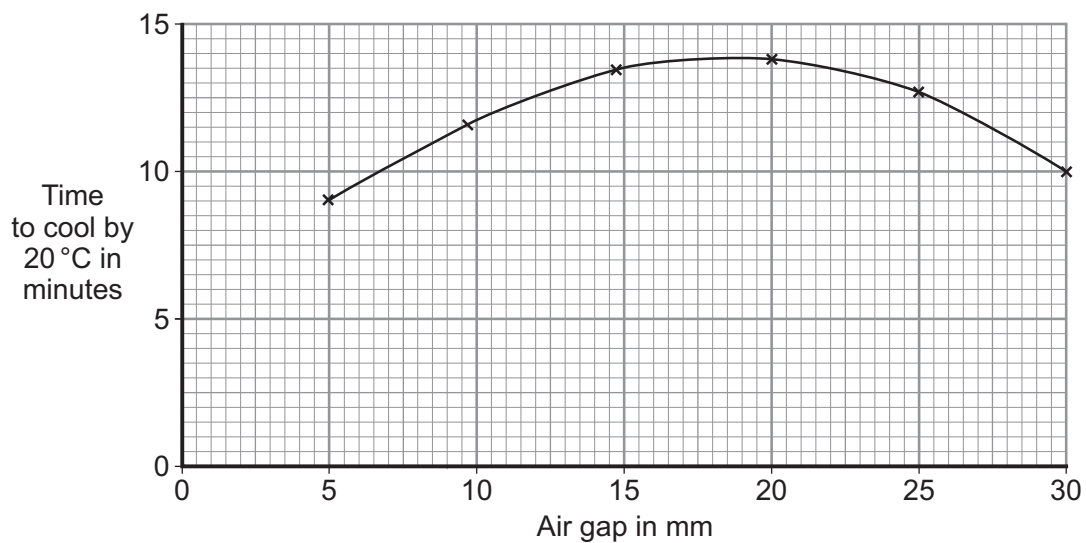
QUESTION NINE

A student wanted to find out if the width of the air gap in a double-glazed window affects the rate of heat transfer through the window.

He predicted that the wider the air gap, the lower the rate of heat transfer. To test his prediction, he set up the following experiment.



- He put a small beaker inside a large beaker.
- He put 80 cm^3 of boiling water into the small beaker.
- He put a cardboard lid on the large beaker.
- He used a stopwatch to measure the time taken for the water to cool by 20°C .
- He measured the diameter of each beaker and calculated the width of the air gap.
- He used different sizes of large beaker to change the width of the air gap. Each time, he used the same small beaker and the same thermometer.
- He plotted his results on a graph.



9A Which was the independent variable in the experiment?

- 1 the time taken for the water to cool by 20 °C
- 2 the size of the small beaker
- 3 the size of the cardboard lid
- 4 the width of the air gap

9B Which of these helped to make the test fair?

- 1 He used the same small beaker each time and changed the large beaker.
- 2 He used the same large beaker each time and changed the small beaker.
- 3 He changed the size of both beakers to keep the same width of air gap each time.
- 4 He changed the size of both beakers to change the width of air gap every time.

9C The results did not support the student's prediction.

What should he do to improve the reliability of the experiment?

- 1 join the points on the graph dot to dot
- 2 repeat each measurement and calculate the mean
- 3 use a more accurate stopwatch
- 4 use a more accurate thermometer

9D Which of these conclusions can be made from the student's results?

- 1 The rate of cooling is greatest when the air gap is between 15 mm and 22 mm.
- 2 The wider the air gap, the faster the water cools.
- 3 The narrower the air gap, the faster the water cools.
- 4 The rate of cooling is least when the air gap is between 15 mm and 22 mm.

END OF TEST

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**.

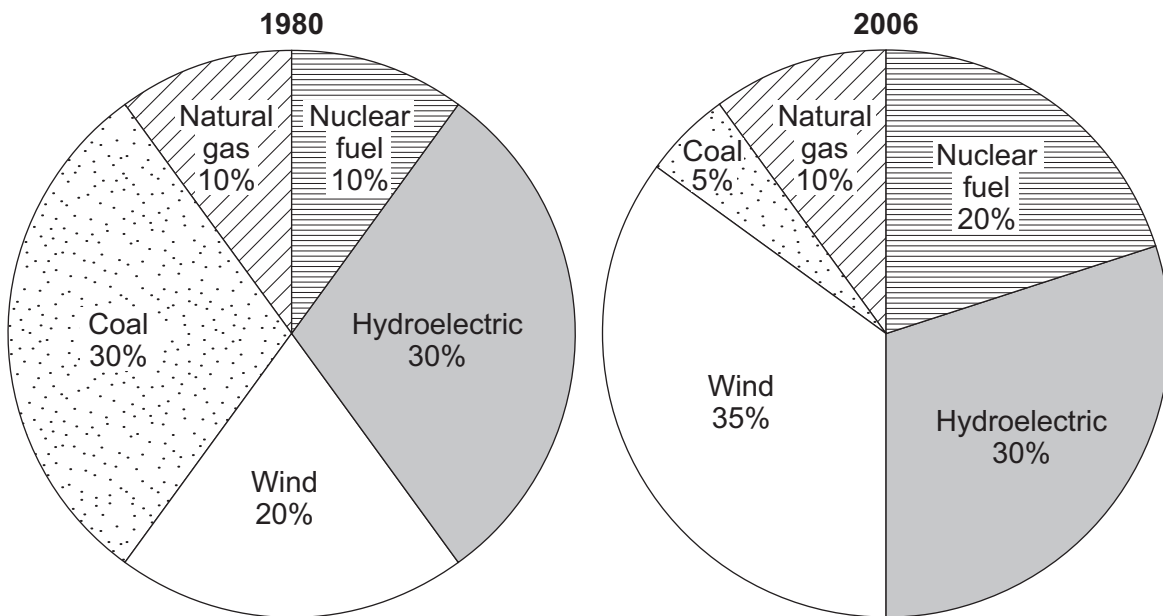
In these questions, match the letters, **A**, **B**, **C** and **D**, with the numbers **1–4**.

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

Mark your choices on the answer sheet.

QUESTION ONE

The two pie charts show the relative proportions of energy sources used to generate electricity in a European country. One is for 1980; the other one is for 2006.



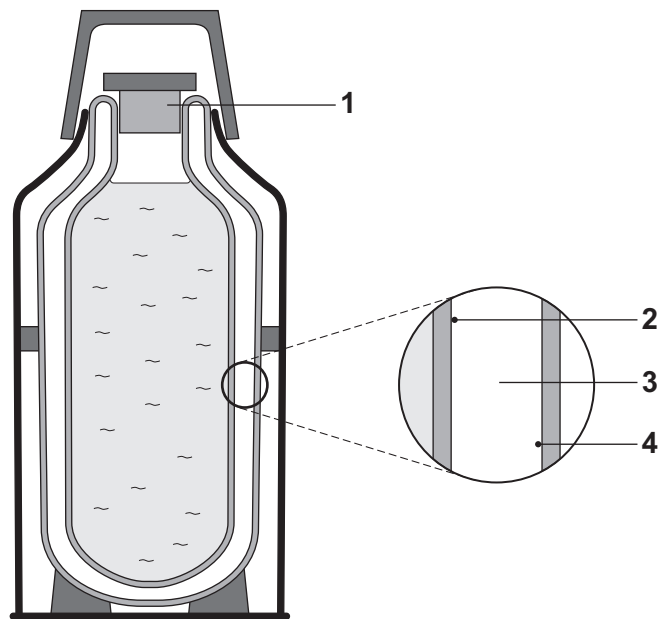
Match energy sources, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

- A** coal
- B** natural gas
- C** nuclear fuel
- D** wind

	Between 1980 and 2006, the relative proportion of . . .
1	this non-renewable energy source decreased in use.
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4	this renewable energy source had the greatest increase in use.

QUESTION TWO

The diagram shows a vacuum flask being used to keep a drink hot.



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

- A** stopper to reduce convection
- B** shiny surface to reflect radiation back into the drink
- C** shiny surface to reduce heat loss by radiation
- D** vacuum to reduce conduction and convection

Turn over for the next question

Turn over ►

Section TwoQuestions **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

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

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

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P	1.2	45	5.8	138
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S	1.6	78	6.9	164

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

- 1 **P**
- 2 **Q**
- 3 **R**
- 4 **S**

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

- 1 with different fuels.
- 2 at the same speed.
- 3 over different distances.
- 4 on the same day of the week.

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

This made sure that the results were . . .

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

This is because the government is concerned about . . .

- 1 economic issues.
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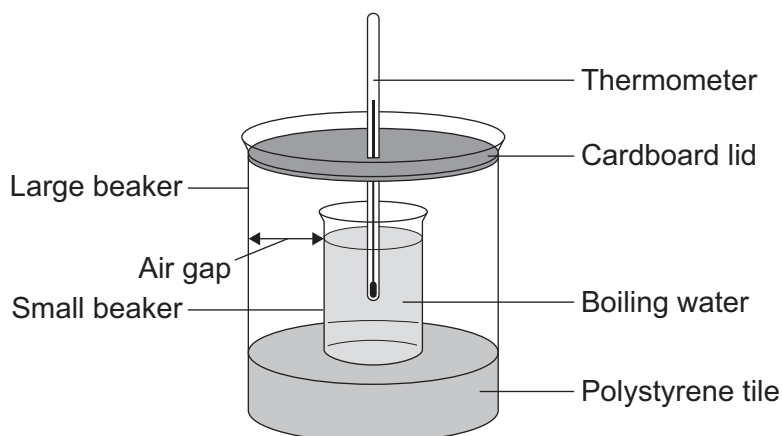
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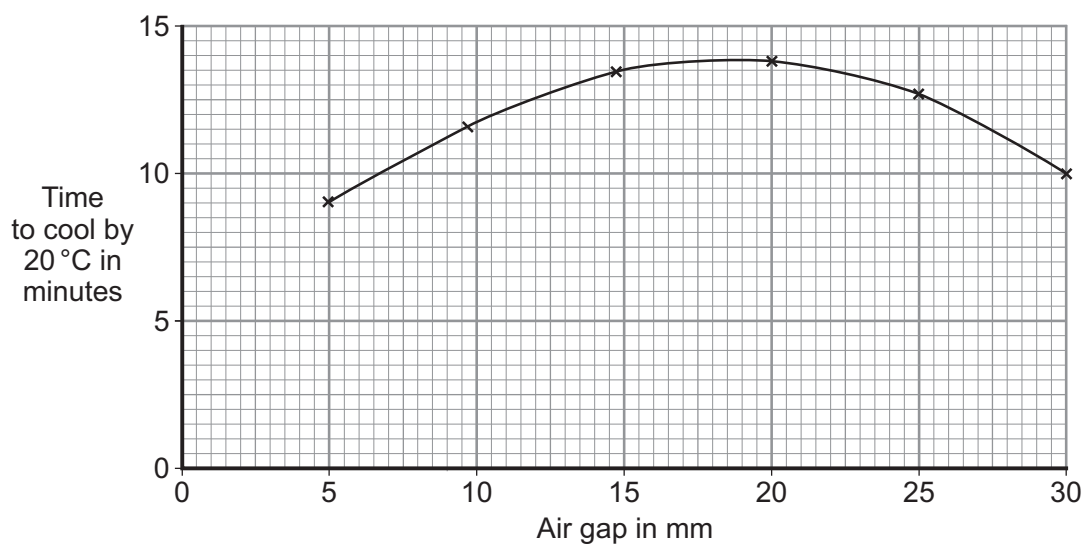
QUESTION FOUR

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- He used different sizes of large beaker to change the width of the air gap. Each time, he used the same small beaker and the same thermometer.
- He plotted his results on a graph.



4A Which was the independent variable in the experiment?

- 1 the time taken for the water to cool by 20°C
- 2 the size of the small beaker
- 3 the size of the cardboard lid
- 4 the width of the air gap

4B Which of these helped to make the test fair?

- 1 He used the same small beaker each time and changed the large beaker.
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What should he do to improve the reliability of the experiment?

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- 2 The wider the air gap, the faster the water cools.
- 3 The narrower the air gap, the faster the water cools.
- 4 The rate of cooling is least when the air gap is between 15 mm and 22 mm.

Turn over for the next question

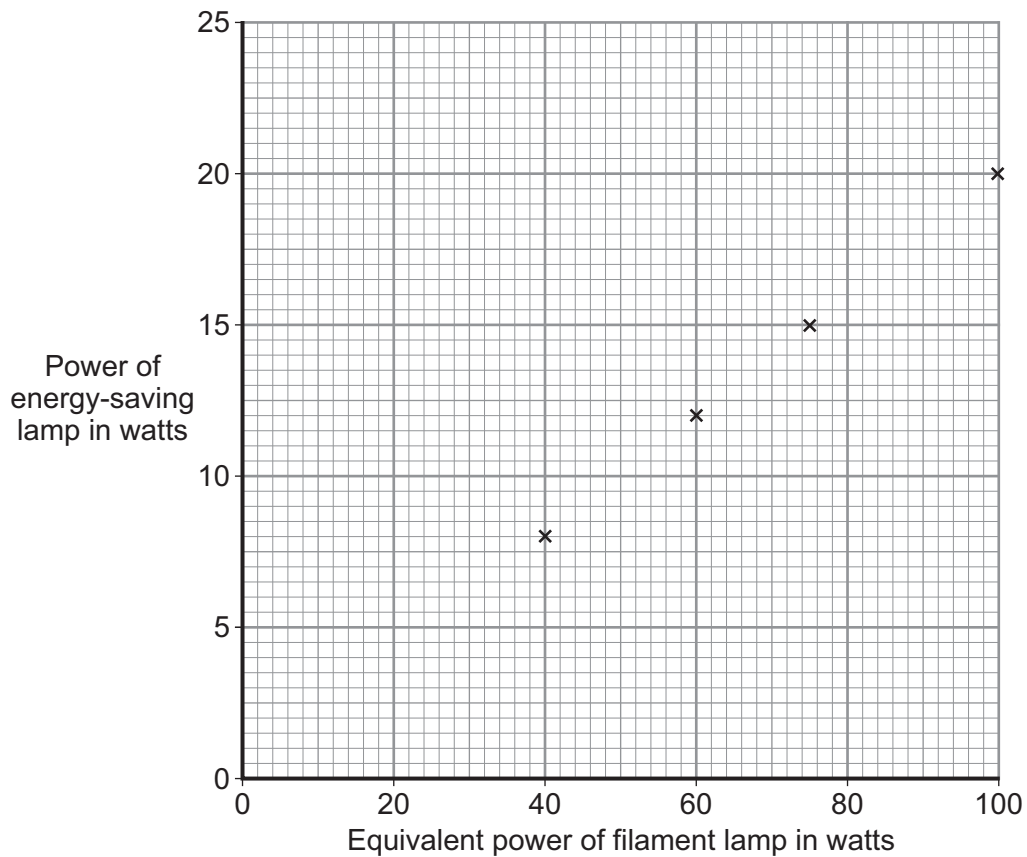
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QUESTION FIVE

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

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

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



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

- 1 draw a line of best fit and see if it passes through (0,0).
- 2 change the watts to kilowatts.
- 3 produce a bar chart.
- 4 use a different scale.

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

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

- 1 8W
- 2 18W
- 3 30W
- 4 35W

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

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

- 1 0.03
- 2 0.15
- 3 0.30
- 4 0.75

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

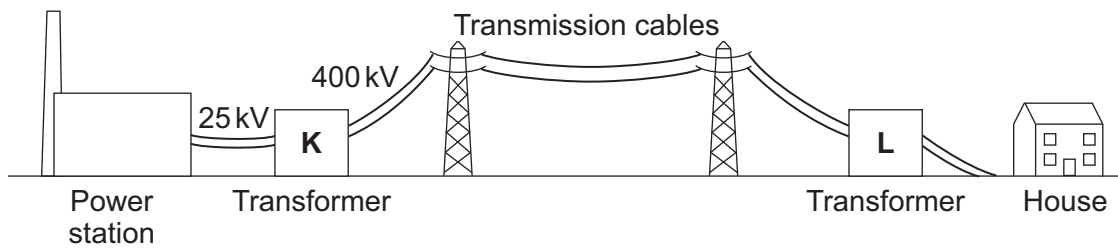
Most energy-saving lamps contain toxic chemicals. Safety campaigners say that energy-saving lamps must be disposed of carefully.

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

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

QUESTION SIX

Electricity is transmitted around the country through the National Grid.



6A The voltage from the power station is stepped up from 25 kV to 400 kV in transformer **K** so that . . .

- 1 the current decreases.
- 2 the current increases.
- 3 the current travels faster.
- 4 the current travels more slowly.

6B Increasing the voltage also . . .

- 1 increases energy losses from the cables.
- 2 makes the National Grid more efficient.
- 3 makes the National Grid safer.
- 4 means a step-down transformer is not needed.

6C Which row of the table shows what happens in transformer **L**?

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

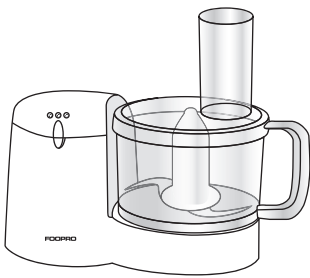
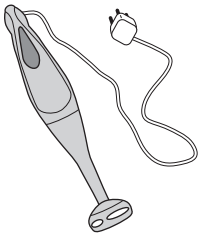
- 6D** The amount of electrical energy that a device transfers depends on . . .
- 1 the current flowing through the device only.
 - 2 for how long the device is switched on only.
 - 3 the power of the device only.
 - 4 the power of the device and for how long it is switched on.

Turn over for the next question

Turn over ►

QUESTION SEVEN

A food mixer and a hand-held blender can both be used for making soup. The ingredients are cooked and then processed to produce a smooth soup. Processing is done by metal blades spinning in the soup.

	Food mixer	Hand-held blender
		
Power rating	500 W	300 W
Volume of soup	300–500 cm ³	Up to 2000 cm ³
Feature	Lid	No lid

7A Which one of the following describes advantages of using the hand-held blender rather than the food mixer for making soup?

- 1 The hand-held blender can mix smaller volumes of soup and does not splash.
- 2 The hand-held blender uses more power and may splash hot soup on the user.
- 3 The hand-held blender can mix larger volumes of soup and does not splash.
- 4 The hand-held blender uses less power and can mix larger volumes of soup.

7B How much more does it cost to use the food mixer for 1 hour rather than the hand-held blender?

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

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

Electricity costs 15p per kilowatt-hour

- 1 3p
- 2 4.5p
- 3 7.5p
- 4 30p

7C As the soup is being processed, it cools down.

Which soup will probably cool down the quickest?

- 1 the soup processed by the food mixer, because it has a lid that stops convection
- 2 the soup processed by the food mixer, because the container is made of plastic
- 3 the soup processed by the hand-held blender, because there is no lid to stop convection
- 4 the soup processed by the hand-held blender, because the soup is not as hot

7D The processed soup is put into a saucepan and reheated.

Heat is transferred through the soup because the soup at the bottom of the saucepan . . .

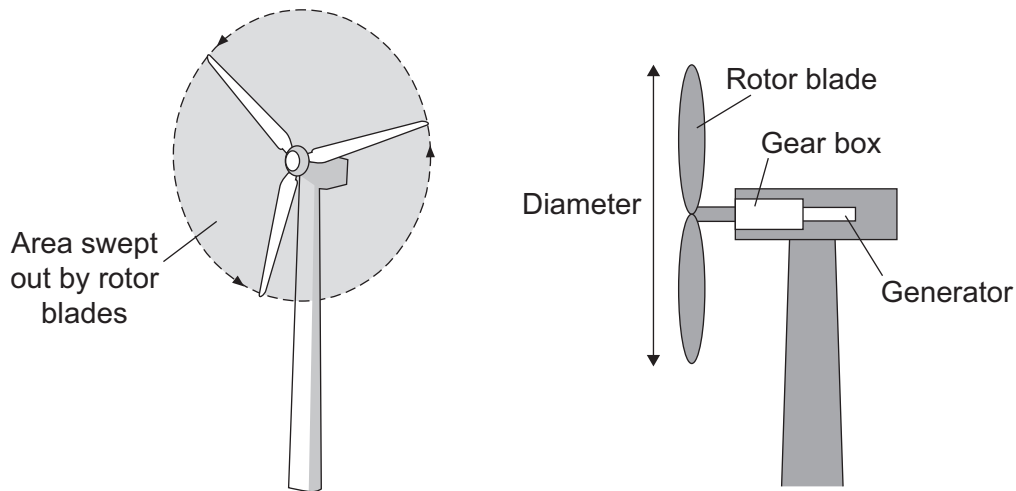
- 1 contracts, becomes less dense and falls.
- 2 expands, becomes more dense and falls.
- 3 contracts, becomes more dense and rises.
- 4 expands, becomes less dense and rises.

Turn over for the next question

Turn over ►

QUESTION EIGHT

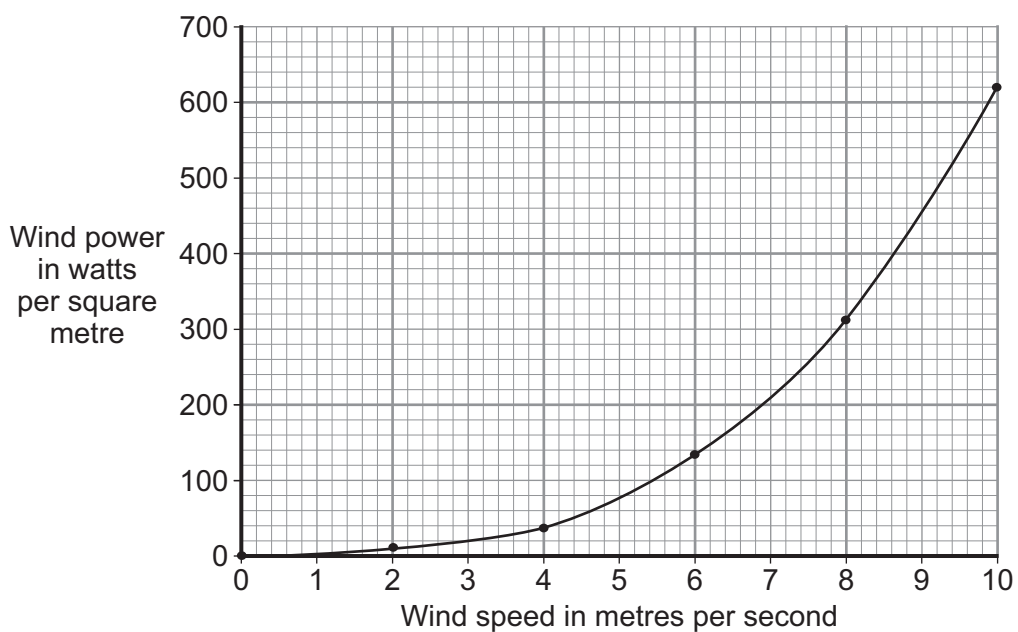
A wind turbine is an electrical generator. The rotor blades are connected to the generator through a gear box.



8A Which is the correct energy transformation for the wind turbine generator?

- 1 potential → electrical, thermal and sound
- 2 potential → kinetic, electrical and thermal
- 3 kinetic → electrical, thermal and sound
- 4 kinetic → chemical, electrical and thermal

8B The graph shows the power developed by the wind at different wind speeds. The power is measured in watts per square metre of area swept out by the rotor blades.



What wind power is developed by a wind speed of 5.5 metres per second when the rotor blades sweep out an area of 5 square metres?

- 1 20 W
- 2 27.5 W
- 3 100 W
- 4 500 W

8C The table shows how the power output of a wind turbine changes with the diameter of the rotor blade.

Rotor blade diameter in metres (m)	Power output in kilowatts (kW)
1	0.4
2	1.6
3	3.6
4	6.4
6	14.4
8	25.6
10	40.0

Which of the following statements is correct?

- 1 decrease the rotor blade diameter and the power output increases
- 2 double the rotor blade diameter and the power output doubles
- 3 double the rotor blade diameter and the power output trebles
- 4 double the rotor blade diameter and the power output quadruples

8D A small wind turbine on the roof of a house has an average power output of 1 kW. The average demand for a household is 10 kW.

Large wind farms can produce an average power output of 5 MW.

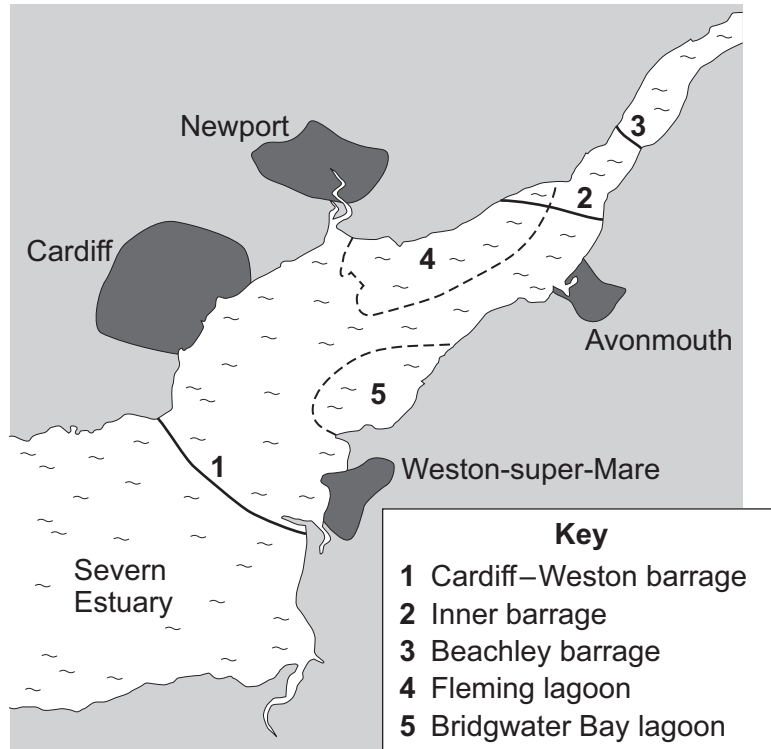
One of the **disadvantages** of using wind farms to provide all the electricity for a large city is that . . .

- 1 wind farms develop far too much power for a large city.
- 2 large numbers of turbines are needed, taking up a lot of land.
- 3 large numbers of turbines will produce a lot of carbon dioxide.
- 4 wind farms produce a lot of noise that is very harmful to birds.

Turn over ►

QUESTION NINE

The UK government is considering five schemes for generating electricity from the tides in the Severn estuary. Three of the schemes involve building a barrage across the estuary. The barrage would contain turbines and generators. The other two schemes would be lagoons, which enclose large areas of water, rather than having a barrier across the estuary.



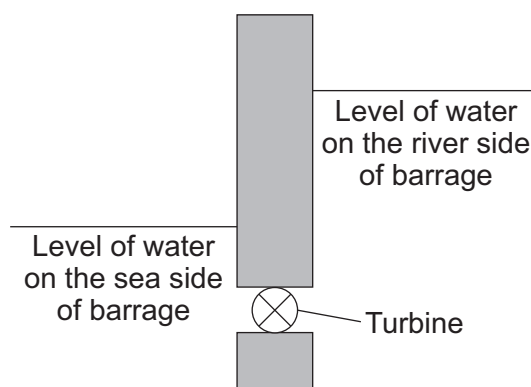
9A The table gives some information about the five schemes.

	Estimated building cost in billions of £	Maximum power produced in millions of watts (MW)	Annual carbon dioxide emission savings in millions of tonnes
Cardiff–Weston barrage	21.0	8.64	7.2
Inner barrage	3.2	1.05	1.2
Beachley barrage	2.3	0.62	0.7
Fleming lagoon	4.5	1.36	1.0
Bridgwater Bay lagoon	3.8	1.36	1.1

From the information in the table, which of the following statements is correct?

- 1 The Bridgwater Bay lagoon would produce the cheapest electricity and would be the cheapest to build.
- 2 The Beachley barrage would be the cheapest to build and would be the best at reducing global warming.
- 3 The Cardiff–Weston barrage would be the most expensive to build, would produce the most energy and would be the best at reducing global warming.
- 4 The Fleming lagoon would be the most expensive to build, would produce the most energy and would be the best at reducing global warming.

9B The diagram shows a section through a barrage.



As the tide comes in, water is trapped behind the barrage. Later, water is released to flow back through the turbine.

What is the main energy transformation as water is released to flow through the turbine?

- 1 electrical energy to gravitational potential energy
- 2 electrical energy to kinetic energy
- 3 gravitational potential energy to kinetic energy
- 4 kinetic energy to gravitational potential energy

Question 9 continues on the next page

Turn over ►

9C There are many arguments for and against the Cardiff–Weston barrage scheme.

Which row in the table of statements for and against the scheme gives two correct **environmental** issues?

	For the scheme	Against the scheme
1	It will increase the number of ships using Cardiff docks.	It will provide only a small percentage of the UK's electricity.
2	It will provide up to 1500 extra jobs.	It will cost many billions of pounds to build.
3	It will reduce the total harmful emissions from UK power stations.	It will destroy wildlife habitats and block fish migration routes.
4	It will reduce the amount of salt in the water in the Severn estuary.	It will attract more tourists to the area.

9D The UK uses about 360 terawatt-hours (TWh) of electricity each year. A barrage across the Severn estuary is expected to generate 18 TWh of electricity each year.

1 terawatt-hour is a very large unit of energy

What percentage of the UK's electricity would the barrage generate each year?

- 1** 2%
- 2** 5%
- 3** 20%
- 4** 80%

END OF TEST