

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										



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

Science A

Unit Physics P1a (Energy and Electricity)

Physics

Unit Physics P1a (Energy and Electricity)

PHY1AP
F&H

Wednesday 2 March 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

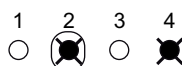
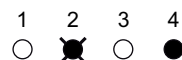
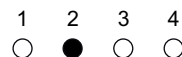
- 30 minutes

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 14 of this booklet.

FOUNDATION TIER

Section One

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

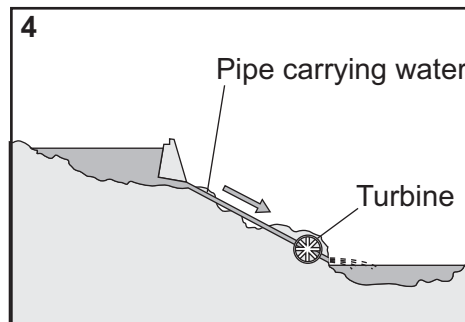
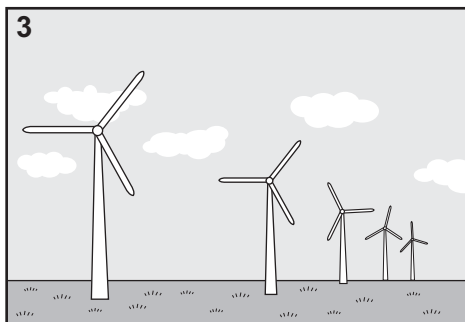
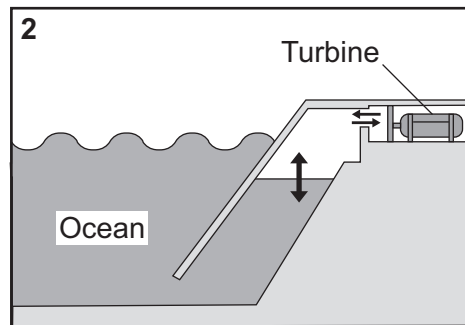
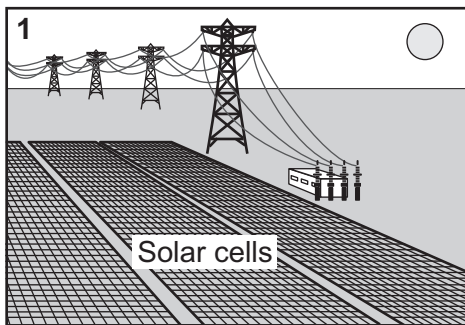
In these questions, match the letters, **A**, **B**, **C** and **D**, with the numbers **1–4**.

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

Mark your choices on the answer sheet.

QUESTION ONE

The diagrams show four types of power station. Each power station uses a different energy source to produce electricity.

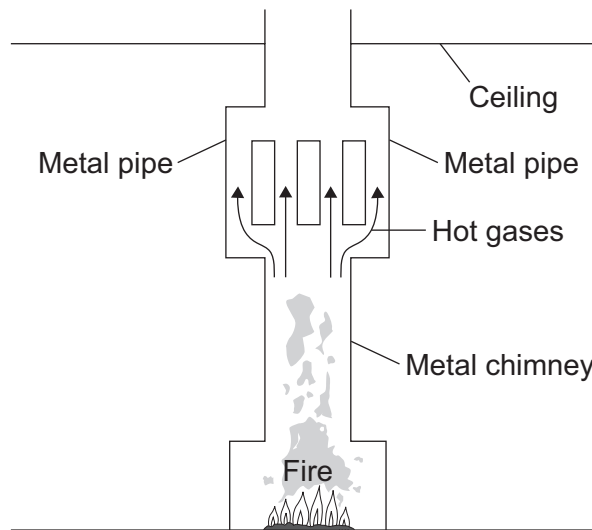


Match energy sources, **A**, **B**, **C** and **D**, with the power stations **1–4**.

- A** falling water
- B** sunlight
- C** waves
- D** wind

QUESTION TWO

The diagram shows a special design of chimney inside a house.



The metal chimney divides into four thinner pipes. These thinner pipes join up again just below the ceiling.

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

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

The chimney is made of metal and this helps to transfer heat by . . . **1**

Hot gases from the fire rise up the chimney by . . . **2**

The chimney is split into four pipes to increase the surface area.

The large surface area increases the rate of heat transfer from the metal surface by . . . **3**

The transfer of heat to the room is helped because there is no . . . **4** . . . on the outside of the metal chimney.

Turn over ►

QUESTION THREE

The picture shows a mobile phone.

The phone can be left switched on in 'silent' mode. In this mode, the phone vibrates when there is a call.



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

- A** electrical
- B** kinetic
- C** light
- D** sound

The output from the screen of the mobile phone is . . . **1** . . . energy.

When the phone is used, the loudspeaker produces . . . **2** . . . energy.

When the phone is used, the microphone produces . . . **3** . . . energy.

When a call is received in 'silent' mode, the mobile phone produces . . . **4** . . . energy.

QUESTION FOUR

This question is about different types of power station.

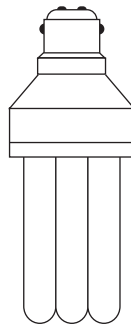
Match power station types, **A**, **B**, **C** and **D**, with the statements **1–4** in the table.

- A** coal-fired
- B** geothermal
- C** nuclear
- D** wind farm

1	produces greenhouse gases
2	produces long-lasting radioactive waste
3	uses heat from underground
4	the energy source drives a turbine directly

QUESTION FIVE

The diagram shows a compact fluorescent lamp (CFL).



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

- A** economical
- B** efficient
- C** environmental
- D** ethical

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

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

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

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

Turn over ►

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

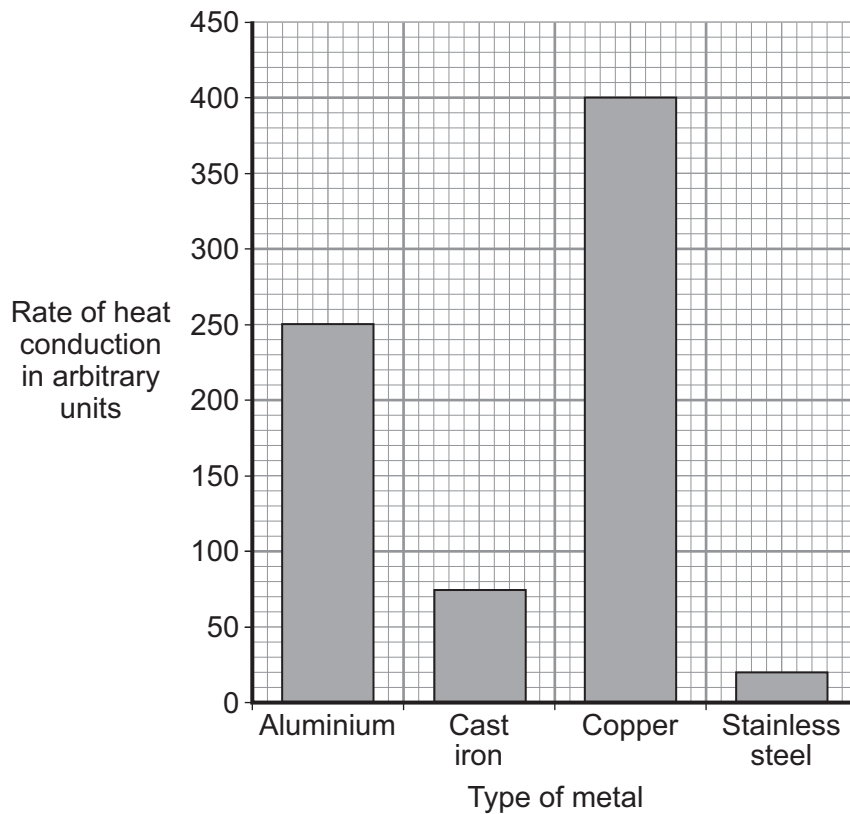
Each of these questions has four parts.

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

QUESTION SIX

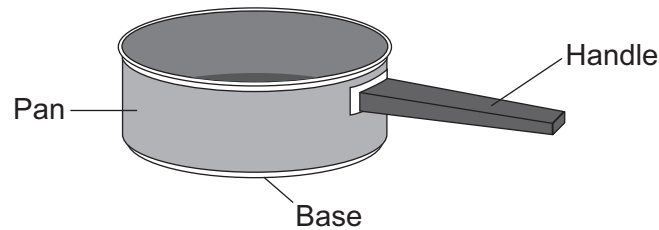
A manufacturer tested four different metals to find out how good the metals are at conducting heat.

The bar chart shows the results.

**6A** Why are the results shown on a bar chart rather than a line graph?

- 1 The rate of heat conduction is a categoric variable.
- 2 The rate of heat conduction is a continuous variable.
- 3 The type of metal is a categoric variable.
- 4 The type of metal is a continuous variable.

The diagram shows the main parts of a saucepan.



6B In terms of conducting heat, which metal would be best for making the base of the saucepan?

- 1 aluminium
- 2 cast iron
- 3 copper
- 4 stainless steel

6C The pan and the handle of some saucepans are made from the same metal. The user of the saucepan does not want to burn their hand when they pick up the hot saucepan.

Which metal would be best to use for this type of saucepan?

- 1 aluminium
- 2 cast iron
- 3 copper
- 4 stainless steel

6D How is heat conducted through the handle?

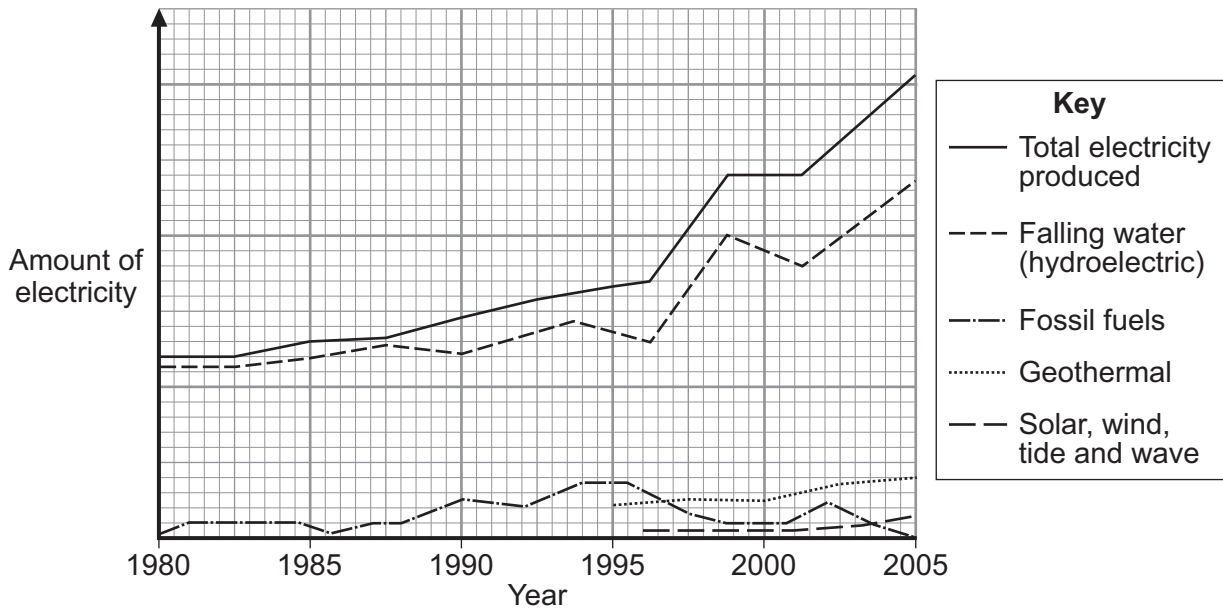
- 1 Atoms move from one end of the handle to the other.
- 2 Conduction currents pass along the handle.
- 3 Energy is passed from atom to atom.
- 4 Waves of radiation pass along the handle.

Turn over ►

QUESTION SEVEN

Costa Rica is a country in Central America.

The graph shows how the sources used for generating electricity in Costa Rica have changed since 1980. It also shows how the total amount of electricity produced has changed.



7A Which of the following has been the main energy source since 1980?

- 1 falling water (hydroelectric)
- 2 fossil fuels
- 3 geothermal
- 4 solar, wind, tide and wave

7B Which energy source was first used in 1995?

- 1 falling water (hydroelectric)
- 2 fossil fuels
- 3 geothermal
- 4 solar, wind, tide and wave

7C The graph shows . . .

- 1 a decrease in the total amount of electricity produced.
- 2 an increase in the total amount of electricity produced.
- 3 that the total amount of electricity produced has remained unchanged.
- 4 no clear trend in the total amount of electricity produced.

7D We can conclude from the graph that in producing electricity, Costa Rica . . .

- 1 does not produce much polluting gas.
- 2 does not use renewable energy sources.
- 3 has very few mountains.
- 4 uses mainly fossil fuels.

Turn over for the next question

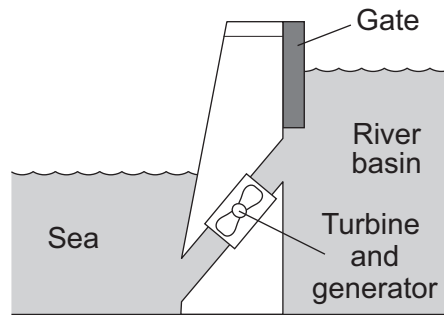
Turn over ►

QUESTION EIGHT

It is estimated that the total energy available from the world's tides could provide about 5 % of the electricity generated worldwide.

One method of using the energy of tides is to build a barrage across a river.

The diagram shows a tidal barrage.



Tide going out

- As the tide rises, the gate is opened to let seawater into the river basin.
- At high tide the gate is closed, trapping water in the river basin.
- As the tide goes out, the gate is opened and water flows through the turbine.

8A Which energy transformations take place as the water flows from the river basin through the turbine and the generator to the sea?

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

8B From the information above, one of the advantages of a tidal barrage over a wind farm is that it . . .

- 1 can be built anywhere.
- 2 generates electricity all the time.
- 3 has low building costs.
- 4 uses a predictable energy source.

-
- 8C** Environmentalists claim that one of the **disadvantages** of tidal power stations is that they . . .
- 1 cause noise pollution.
 - 2 destroy the habitat of wading birds.
 - 3 produce gases that pollute the atmosphere.
 - 4 produce radioactive waste.

- 8D** A cheaper way to use tidal energy is to use underwater currents to drive turbines. This is the same idea as a wind farm, but it works under water.

One report states that electricity generated by underwater currents would be four times as expensive as electricity generated by a wind farm.

The cost of electricity, from cheapest to most expensive, would be . . .

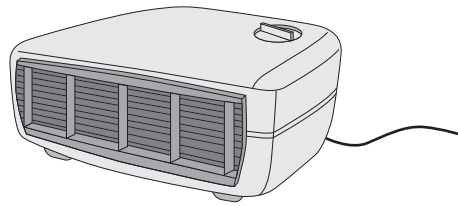
- 1 tidal barrage, underwater current, wind farm.
- 2 underwater current, wind farm, tidal barrage.
- 3 wind farm, tidal barrage, underwater current.
- 4 wind farm, underwater current, tidal barrage.

Turn over for the next question

Turn over ►

QUESTION NINE

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



Fan heater

- 9A** The fan heater usefully transforms electrical energy to . . .
- 1 kinetic and sound energy.
 - 2 light and thermal energy.
 - 3 sound and light energy.
 - 4 thermal and kinetic energy.
- 9B** Energy that is not usefully transformed by the fan heater is wasted as . . .
- 1 chemical energy.
 - 2 kinetic energy.
 - 3 sound energy.
 - 4 thermal energy.
- 9C** The fan heater moves hot air around the room.
- This method of heat transfer is sometimes called forced . . .
- 1 conduction.
 - 2 convection.
 - 3 evaporation.
 - 4 radiation.

9D The fan heater transfers 3 kWh of energy as it warms a room.

total cost	=	number of kilowatt-hours	×	cost per kilowatt-hour
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Electricity costs 15p per kWh

What is the cost of this energy?

- 1 5p
- 2 45p
- 3 £5
- 4 £45

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**.

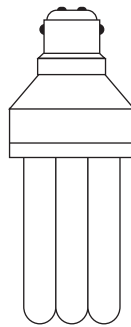
In these questions, match the letters, **A**, **B**, **C** and **D**, with the numbers **1–4**.

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

Mark your choices on the answer sheet.

QUESTION ONE

The diagram shows a compact fluorescent lamp (CFL).



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

- A** economical
- B** efficient
- C** environmental
- D** ethical

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

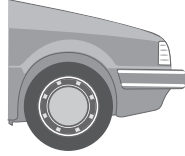
Over time, CFLs cost less to buy and use, making them more . . . **2** . . . than filament lamps.

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

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

QUESTION TWO

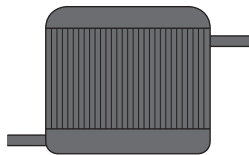
This question is about controlling some forms of radiation.

1

Car headlight has a shiny coating inside

2

Camera is matt black inside

3

Car radiator is painted matt black

4

Soil is covered with black plastic

Match statements, **A**, **B**, **C** and **D**, with diagrams 1–4.

- A** is designed to increase the rate at which infra red radiation is absorbed
- B** is designed to increase the rate at which infra red radiation is emitted
- C** is designed to improve the ability to reflect visible light
- D** is designed to prevent the reflection of visible light

Turn over for the next question

Turn over ►

Section TwoQuestions **THREE** to **NINE**.

Each of these questions has four parts.

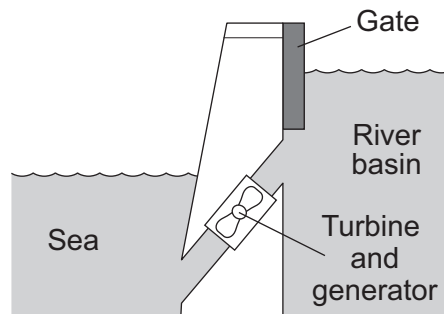
In each part choose only **one** answer.Mark your choices on the answer sheet.

QUESTION THREE

It is estimated that the total energy available from the world's tides could provide about 5% of the electricity generated worldwide.

One method of using the energy of tides is to build a barrage across a river.

The diagram shows a tidal barrage.

**Tide going out**

- As the tide rises, the gate is opened to let seawater into the river basin.
- At high tide the gate is closed, trapping water in the river basin.
- As the tide goes out, the gate is opened and water flows through the turbine.

3A Which energy transformations take place as the water flows from the river basin through the turbine and the generator to the sea?

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

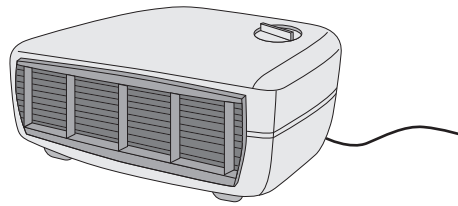
-
- 3B** From the information above, one of the advantages of a tidal barrage over a wind farm is that it . . .
- 1 can be built anywhere.
 - 2 generates electricity all the time.
 - 3 has low building costs.
 - 4 uses a predictable energy source.
- 3C** Environmentalists claim that one of the **disadvantages** of tidal power stations is that they . . .
- 1 cause noise pollution.
 - 2 destroy the habitat of wading birds.
 - 3 produce gases that pollute the atmosphere.
 - 4 produce radioactive waste.
- 3D** A cheaper way to use tidal energy is to use underwater currents to drive turbines. This is the same idea as a wind farm, but it works under water.
- One report states that electricity generated by underwater currents would be four times as expensive as electricity generated by a wind farm.
- The cost of electricity, from cheapest to most expensive, would be . . .
- 1 tidal barrage, underwater current, wind farm.
 - 2 underwater current, wind farm, tidal barrage.
 - 3 wind farm, tidal barrage, underwater current.
 - 4 wind farm, underwater current, tidal barrage.

Turn over for the next question

Turn over ►

QUESTION FOUR

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



Fan heater

- 4A** The fan heater usefully transforms electrical energy to . . .
- 1 kinetic and sound energy.
 - 2 light and thermal energy.
 - 3 sound and light energy.
 - 4 thermal and kinetic energy.
- 4B** Energy that is not usefully transformed by the fan heater is wasted as . . .
- 1 chemical energy.
 - 2 kinetic energy.
 - 3 sound energy.
 - 4 thermal energy.
- 4C** The fan heater moves hot air around the room.
- This method of heat transfer is sometimes called forced . . .
- 1 conduction.
 - 2 convection.
 - 3 evaporation.
 - 4 radiation.

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

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

Electricity costs 15p per kWh

What is the cost of this energy?

- 1 5p
- 2 45p
- 3 £5
- 4 £45

Turn over for the next question

Turn over ►

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)
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1 3 kWh

2 12 kWh

3 333 kWh

4 12000 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
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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.

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

Which statement about these cars is true?

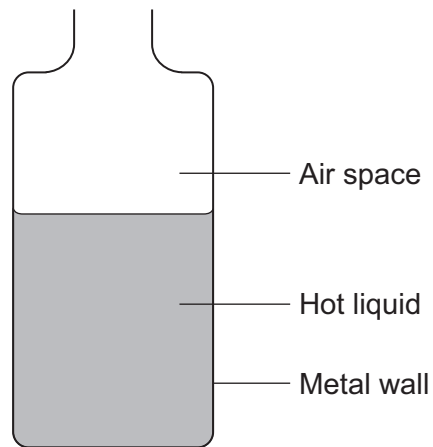
- 1 They are not responsible for producing any atmospheric pollution.
- 2 They produce more atmospheric pollution than petrol-engine cars.
- 3 They produce no atmospheric pollution while being driven.
- 4 They produce no atmospheric pollution but a lot of noise pollution.

Turn over for the next question

Turn over ►

QUESTION SIX

The diagram shows a flask containing a hot liquid.



6A Heat is transferred through the air space above the hot liquid.

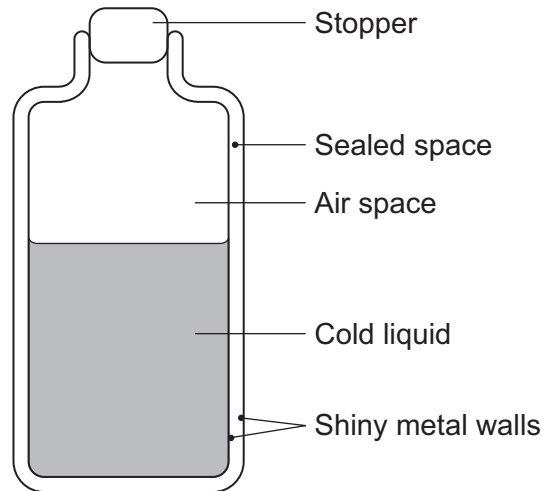
The air particles just above the hot liquid . . .

- 1 contract to become smaller.
- 2 expand to become bigger.
- 3 move further apart, making the air less dense.
- 4 move closer together, making the air denser.

6B Heat is transferred through the metal wall because . . .

- 1 convection currents are set up in the metal.
- 2 the metal contains electrons that are free to move within the metal.
- 3 the particles in the liquid vibrate and collide with their neighbours.
- 4 the shiny metal is a good emitter of radiation.

The diagram shows another flask containing a cold liquid. This flask has two shiny metal walls with a sealed space between them.



6C What should the sealed space contain in order to keep the liquid cold for the longest time?

- 1 some air
- 2 some polystyrene
- 3 a vacuum
- 4 some water

6D The shiny metal walls help to keep the liquid cold for a long time.

This is because shiny surfaces are good . . .

- 1 absorbers of infra red radiation.
- 2 emitters of infra red radiation.
- 3 reflectors of infra red radiation.
- 4 transmitters of infra red radiation.

Turn over for the next question

Turn over ►

QUESTION SEVEN

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

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

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

What is the percentage power saving made?

- 1 20 %
- 2 45 %
- 3 75 %
- 4 80 %

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

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

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

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

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

total cost	=	number of kilowatt-hours	×	cost per kilowatt-hour
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Electricity costs 15p per kWh

- 1 48p
 - 2 60p
 - 3 £2.40
 - 4 £3.00
- 7D** A householder is considering changing all her filament lamps for low-energy lamps. However, she says that the table in the advert does not contain enough information for her to know how much money she will save.

She needs to know . . .

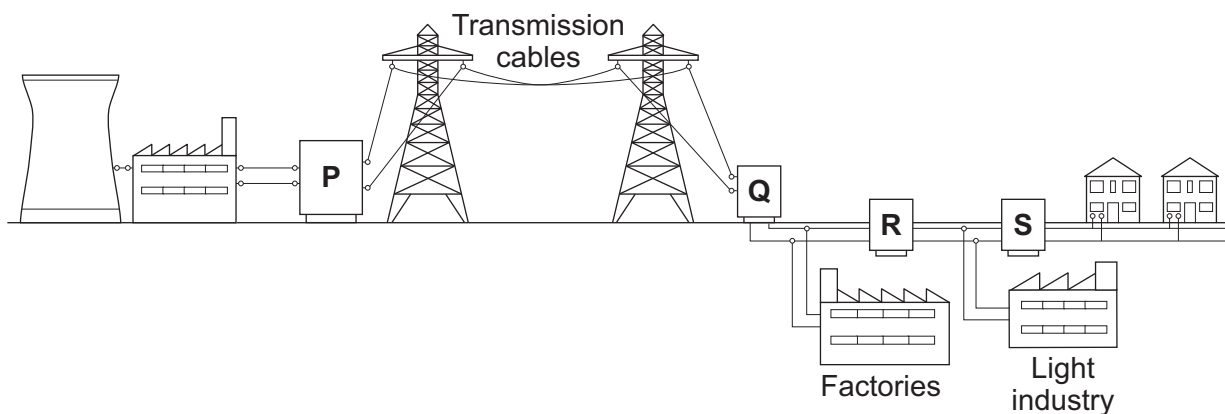
- 1 how much each lamp costs and how long it lasts.
- 2 how long each lamp lasts and how much electricity costs per kWh.
- 3 how much electricity costs per kWh and how much each lamp costs.
- 4 how much each lamp costs, how long each lamp lasts and how much electricity costs per kWh.

Turn over for the next question

Turn over ►

QUESTION EIGHT

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



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

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

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

The best explanation for this is that . . .

- 1** it allows thinner cables to be used and the energy loss from the cables is reduced.
- 2** the energy loss from the cables is reduced and it allows the distance between pylons to be reduced.
- 3** the distance between the pylons can be reduced and thicker cables can be used.
- 4** it allows the current to travel more slowly and thicker cables can be used.

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

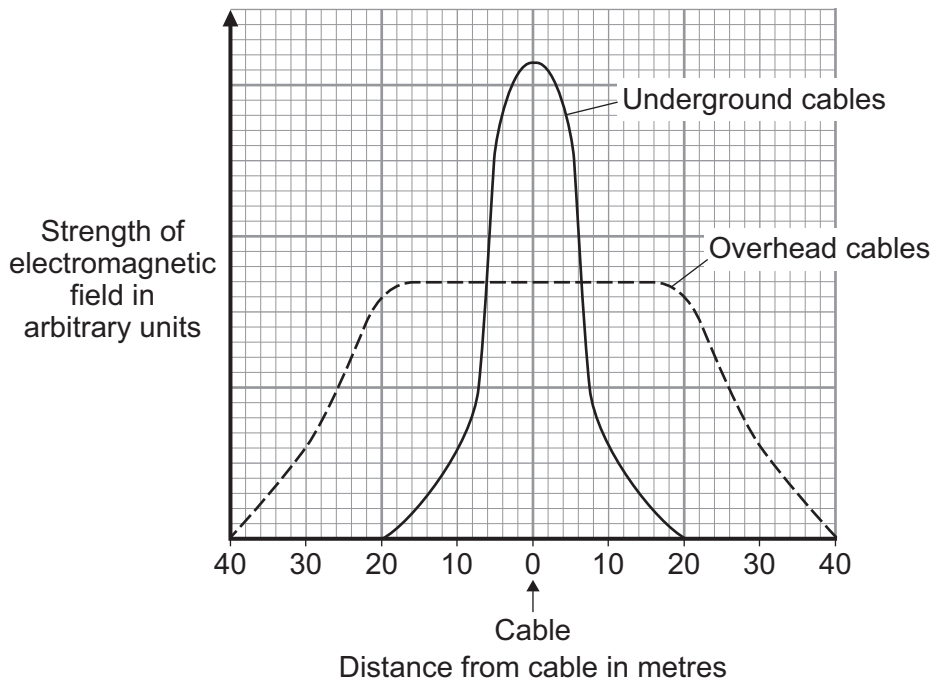
Which row of the table correctly shows these changes?

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

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

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

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



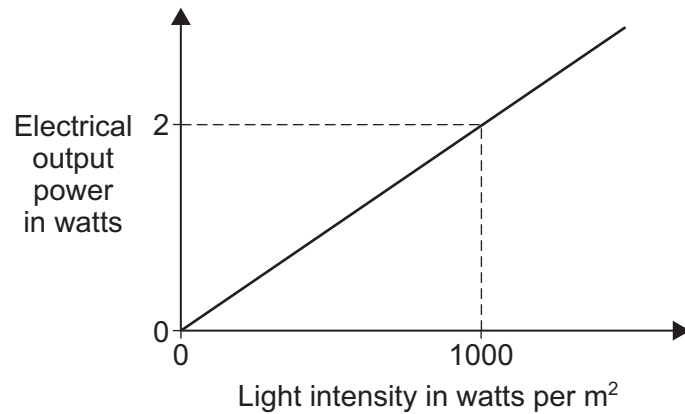
Which of the following conclusions could be made from the graph?

- When you are within 5 metres of the cable, the possible risk to health is bigger with an underground cable.
- The possible health risk from overhead cables falls to zero when you are 20 metres away.
- The biggest possible health risk from overhead cables occurs when you are 40 metres away.
- Between 10 and 40 metres away, the biggest possible health risk is from underground cables.

Turn over ►

QUESTION NINE

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



9A The graph shows that . . .

- 1 the output power is directly proportional to the light intensity.
- 2 the output power decreases as the light intensity increases.
- 3 as the light intensity decreases the output power increases.
- 4 the output power is not affected by the light intensity.

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

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

What is the output power of this solar cell?

- 1 0 watts
- 2 1 watt
- 3 2 watts
- 4 4 watts

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

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

- 1 12 m²
- 2 83 m²
- 3 300 m²
- 4 400 m²

9D The efficiency of the solar cells is 0.2

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

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

- 1 15 J
- 2 600 J
- 3 15 kJ
- 4 600 kJ

END OF TEST

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