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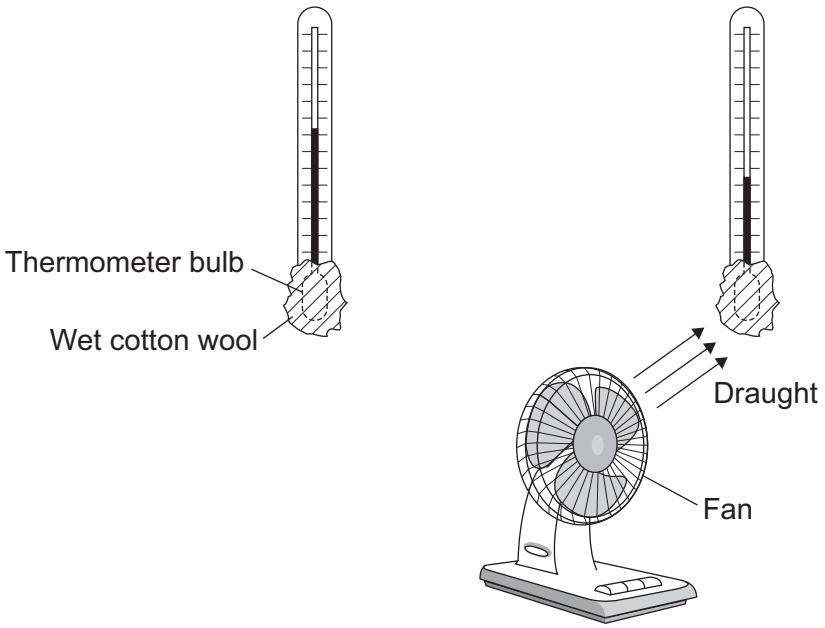
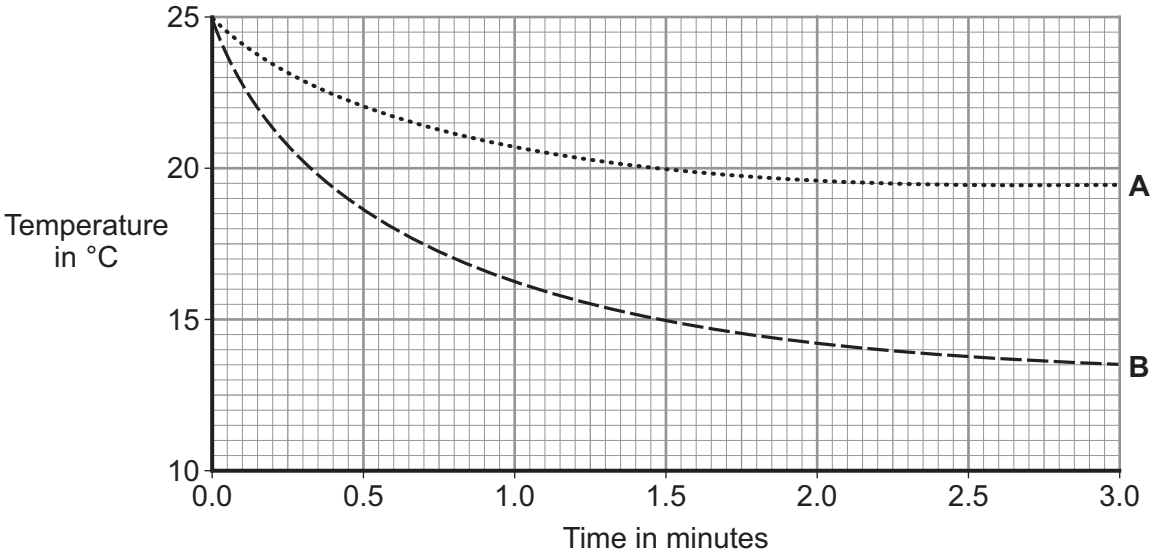
Answer **all** questions in the spaces provided.

1 The diagram shows two thermometers. The bulb of each thermometer is covered with a piece of wet cotton wool. One of the thermometers is placed in the draught from a fan.



The graph shows how the temperature of each thermometer changes with time.



1 (a) Which of the graph lines, **A** or **B**, shows the temperature of the thermometer placed in the draught?

Write the correct answer in the box. ☐

Explain, in terms of evaporation, the reason for your answer.

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(3 marks)

1 (b) A wet towel spread out and hung outside on a day without wind dries faster than an identical wet towel left rolled up in a plastic bag.

Explain why.

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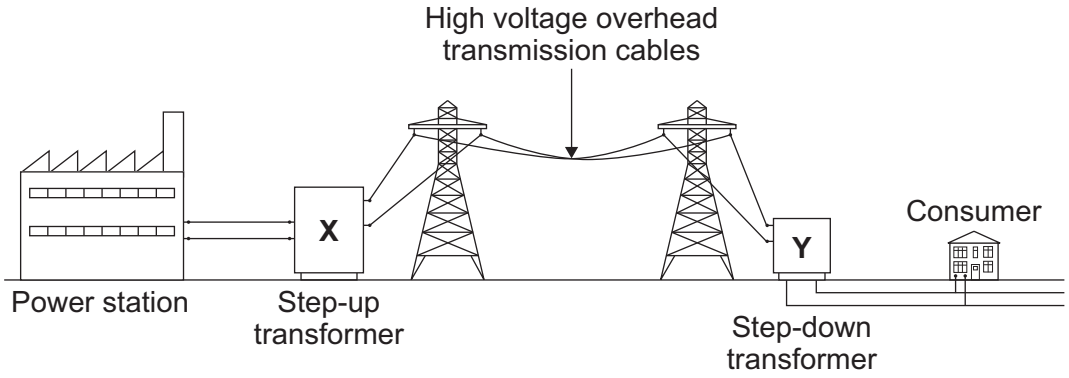
(2 marks)

5

Turn over for the next question

2 The diagram shows the National Grid system.



2 (a) The National Grid includes step-up transformers.

Explain why.

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(2 marks)

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

Over the next 10 years, more than 300 kilometres of new high voltage transmission cables are to be added to the National Grid. Most of the new cables will be suspended from pylons and run overhead while the rest will be buried underground.

Outline the advantages and disadvantages of both overhead transmission cables and underground transmission cables.

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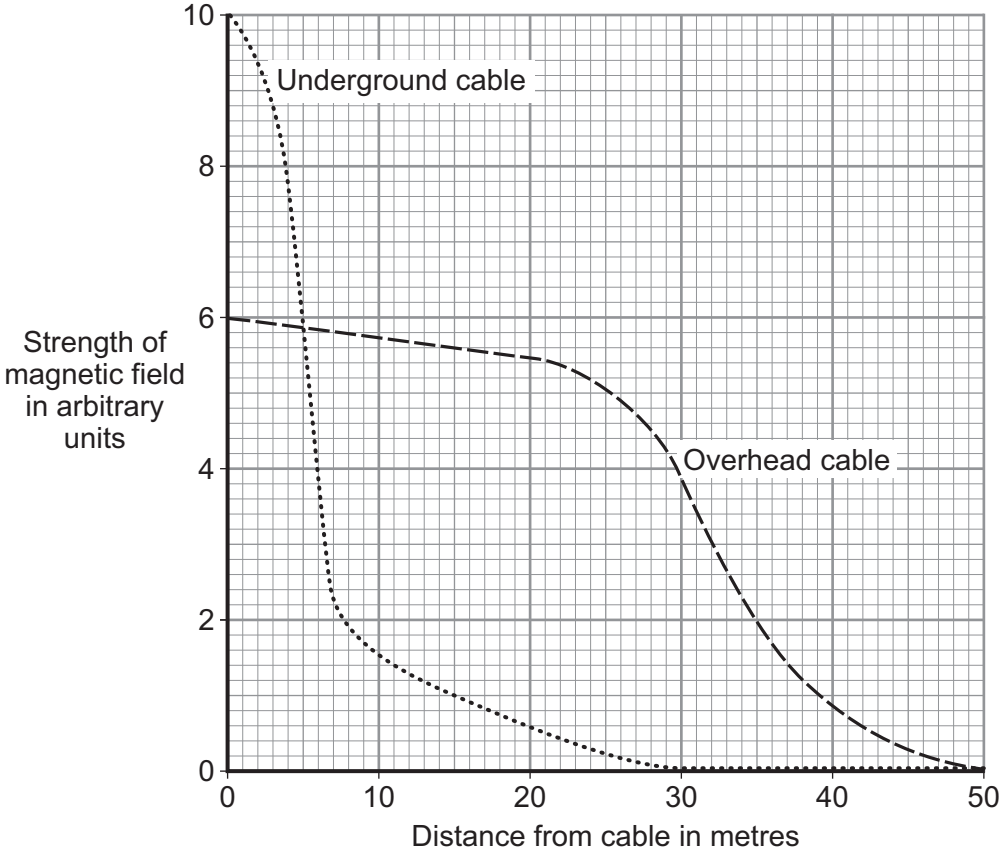
(6 marks)

Question 2 continues on the next page

2 (c) When an electric current flows through a transmission cable, a magnetic field is produced.

The graph shows how the strength of the magnetic field varies with distance from both overhead and underground transmission cables that carry the same current.



What conclusions may be drawn from this graph?

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(2 marks)

2 (d) Some people think that, because of the magnetic fields, living close to transmission cables is dangerous to health. Laboratory studies on mice and rats exposed to magnetic fields for two or more years found that the magnetic fields had no effect on the animals' health.

Draw a ring around the correct answer in the box to complete the sentence.

Using animals in scientific research raises

economic
environmental
ethical

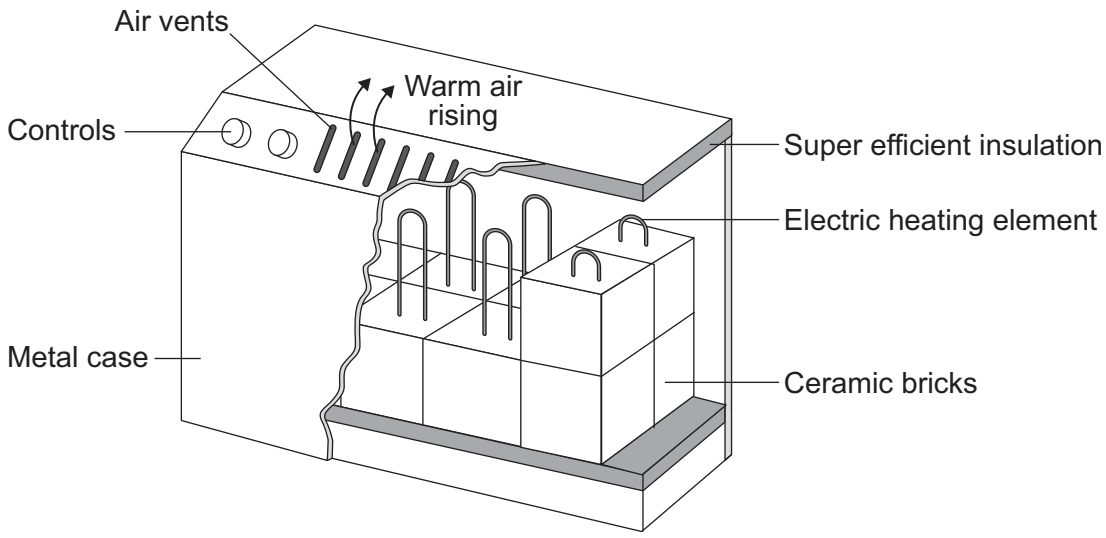
issues.

(1 mark)

11

Turn over for the next question

3 The diagram shows how one type of electric storage heater is constructed. The heater has ceramic bricks inside. The electric elements heat the ceramic bricks during the night. Later, during the daytime, the ceramic bricks transfer the stored energy to the room.



3 (a) In winter, the electricity supply to a 2.6 kW storage heater is switched on each day between midnight and 7 am. Between these hours, electricity costs 5 p per kilowatt-hour.

Calculate the daily cost of using the storage heater.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

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Cost = ... p

(3 marks)

3 (b) Homes with electric storage heaters have a separate meter to measure the electricity supplied between midnight and 7 am. Another meter measures the electricity supplied at other times. This electricity supplied at other times costs 15 p per kilowatt-hour.

Electricity companies encourage people to use electricity between midnight and 7 am by selling the electricity at a lower cost.

Suggest why.

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(1 mark)

3 (c) By 7 am, the temperature at the centre of the ceramic bricks is about 800 °C. The temperature of the outside metal casing is about 80 °C.

The ceramic bricks are surrounded by 'super-efficient' insulation.

Explain why.

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(2 marks)

3 (d) At 7 am, the electricity supply switches off and the temperature of the ceramic bricks starts to fall. The temperature of the bricks falls by 100 °C over the next four hours. During this time, 9 000 000 J of energy are transferred from the bricks.

Calculate the total mass of ceramic bricks inside the heater.

Specific heat capacity of the ceramic bricks = 750 J/kg °C.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

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Mass = ... kg

(2 marks)

8

4 (a) Water waves are transverse waves. Sound waves are longitudinal waves.

4 (a) (i) Explain the difference between a transverse wave and a longitudinal wave.

You may include labelled diagrams in your answer.

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(3 marks)

4 (a) (ii) Name **one** type of wave that may be either transverse or longitudinal.

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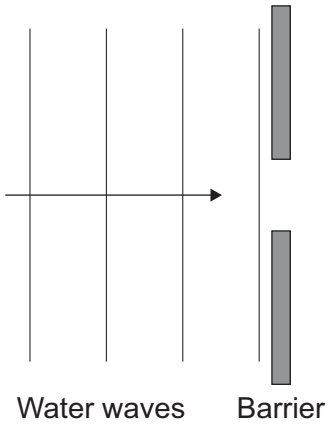
(1 mark)

4 (b) The diagram shows water waves in a ripple tank moving towards a gap in a barrier.

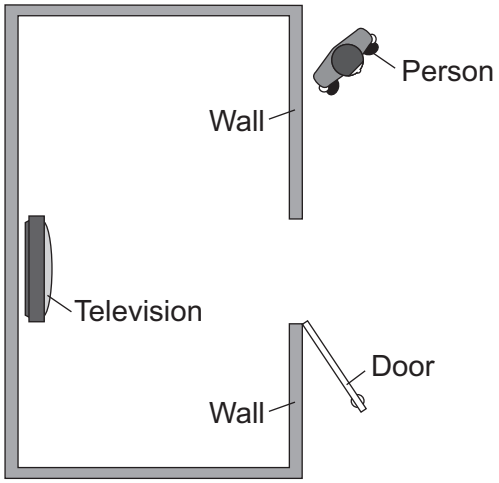
The water waves diffract as they pass through the gap.

Complete the diagram to show the diffracted water waves.



(1 mark)

4 (c) A television is switched on inside a room. A person outside the room can hear the television, but only when the door is open.



When the door is open, the person can hear the sound but cannot see the television.

Explain why.

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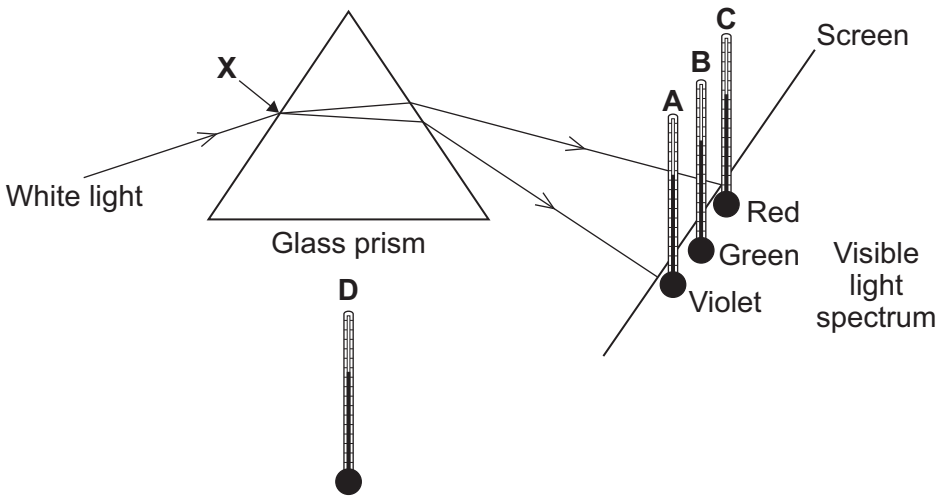
(2 marks)

7

Turn over for the next question

5 The diagram shows the apparatus that a student used to investigate the heating effect of different wavelengths of light.



5 (a) (i) What process happens at the point labelled **X** on the diagram?

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(1 mark)

5 (a) (ii) The student put thermometer **D** outside of the light spectrum.

Suggest why.

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(1 mark)

5 (a) (iii) The table gives the position and reading of each thermometer 10 minutes after the investigation started.

Thermometer	Position of thermometer	Temperature in °C
A	in violet light	21
B	in green light	22
C	in red light	24
D	outside the spectrum	20

What should the student conclude from the data in the table?

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(2 marks)

5 (b) A similar investigation completed in 1800 by the scientist Sir William Herschel led to the discovery of infrared radiation.

Suggest how the student could show that the spectrum produced by the glass prism has an infrared region.

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(2 marks)

Question 5 continues on the next page

5 (c) A person emits infrared radiation at a frequency of 3.2×10^{13} Hz.

Calculate the wavelength of the infrared radiation that a person emits.

Take the speed of infrared radiation to be 3.0×10^{8} m/s.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

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Wavelength = ... m

(2 marks)

5 (d) A thermal imaging camera detects infrared radiation. Electronic circuits inside the camera produce a visible image of the object emitting the infrared radiation.

At night, police officers use thermal imaging cameras to track criminals running away from crime scenes.

Thermal imaging cameras work better at night than during the day.

Explain why.

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(2 marks)

10

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

6 The table gives data about two types of low energy bulb.

Type of bulb	Power input in watts	Efficiency	Lifetime in hours	Cost of one bulb
Compact Fluorescent Lamp (CFL)	8	20 %	10 000	£3.10
Light Emitting Diode (LED)	5		50 000	£29.85

6 (a) Both types of bulb produce the same useful power output.

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

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

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Useful power output = ... W

(2 marks)

6 (a) (ii) Calculate the efficiency of the LED bulb.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

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Efficiency = ...

(1 mark)

6 (b) Sketch and label a Sankey diagram for the CFL.

(2 marks)

6 (c) LED bulbs are expensive. This is because of the large number of individual electronic LED chips needed to produce sufficient light from each bulb.

6 (c) (i) Use the data in the table to evaluate the cost-effectiveness of an LED bulb compared to a CFL.

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(2 marks)

6 (c) (ii) Scientists are developing brighter and more efficient LED chips than those currently used in LED bulbs.

Suggest **one** benefit of developing brighter and more efficient LED chips.

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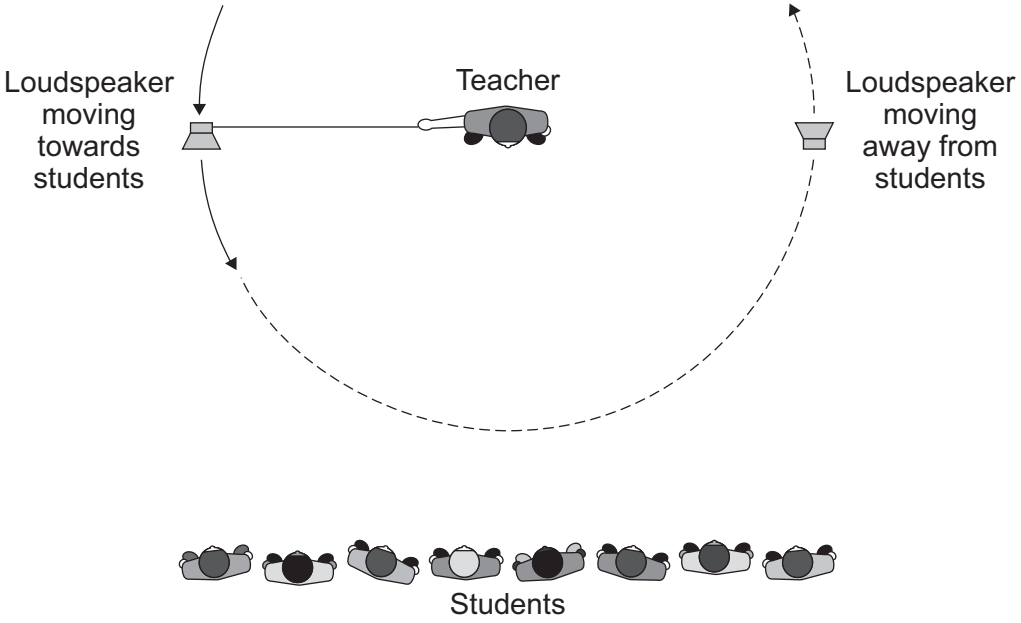
(1 mark)

8

7 The diagram shows a teacher using a loudspeaker to demonstrate the Doppler effect. The loudspeaker, which produces a note of constant frequency, is swung around in a circle.



7 (a) What is the Doppler effect?

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(2 marks)

7 (b) This demonstration of the Doppler effect can be used as a model for the *red-shift* observed in the light spectra from distant galaxies.

What is red-shift and what does the size of the red-shift tell us about distant galaxies?

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(3 marks)

5

Turn over for the next question

8 (a) Nuclear fuels and the wind are two of the energy sources used to generate electricity in the UK.

Explain the advantages of using energy from nuclear fuels to generate electricity rather than using energy from the wind.

Include in your answer a brief description of the process used to generate electricity from nuclear fuels.

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(4 marks)

8 (b) In the UK, most electricity is generated in power stations that emit carbon dioxide into the atmosphere. The impact of these power stations on the environment could be reduced by the increased use of 'carbon capture' technology.

Describe how 'carbon capture' would prevent the build-up of carbon dioxide in the atmosphere.

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(2 marks)

6

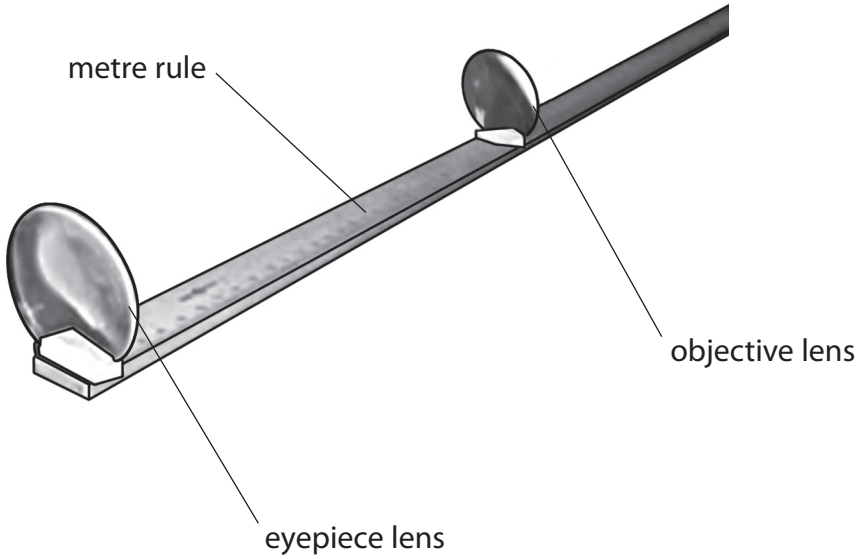
END OF QUESTIONS

Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Refracting telescope

1 The diagram shows a simple telescope which can be made in the laboratory.



(a) Complete the sentence by putting a cross (☒) in the box next to your answer.

The type of lens used as the objective lens is

(1)

☐ **A** concave

☐ **B** converging

☐ **C** diverging

☐ **D** reflecting

(b) The objective lens produces an image of a distant object.

(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

The image produced by the objective lens is

(1)

☐ **A** the right way up and smaller

☐ **B** the right way up and bigger

☐ **C** upside down and smaller

☐ **D** upside down and bigger

(ii) Describe how the position of this image can be shown.

(2)

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(c) State the purpose of the eyepiece.

(1)

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(d) The telescope is used to look at the planet Venus.
Assume that the distance from Venus to the Earth is 39 000 000 km.
The speed of light is 300 000 000 m/s.

Calculate the time it takes for light to travel from Venus to the Earth.

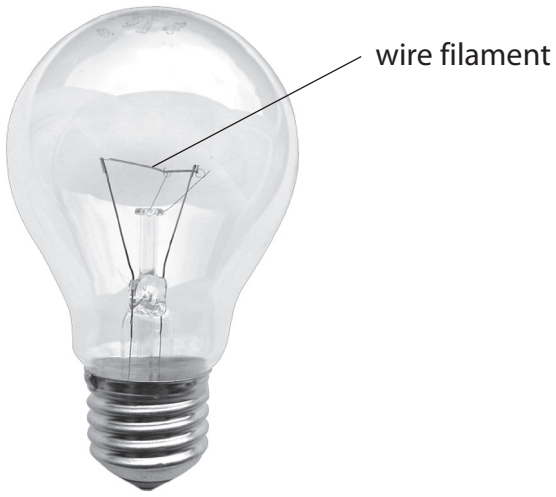
(3)

time = ... s

(Total for Question 1 = 8 marks)

Lamps

2 This lamp has a wire filament that glows white hot when it is in use.



(a) A 100 W filament lamp is 15% efficient.

(i) Explain the meaning of the term **15% efficient**.

(2)

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(ii) Draw a labelled energy flow diagram to show what happens to 100 J of electrical energy supplied to the lamp.

(2)

(b) Many people choose to buy expensive low-energy lamps instead of cheaper filament lamps.

Give **two** reasons for this.

(2)

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(c) When a filament lamp is in use, the temperature of the wire filament remains at 2500 °C.

Explain why this temperature remains constant.

(3)

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(Total for Question 2 = 9 marks)

Elephants and infrasound

3 (a) Sound travels through the air as longitudinal waves.

Describe how the air particles move when a sound wave passes.

(2)

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(b) Elephants call to each other using infrasound.
People cannot hear these infrasound calls.

Which of the following statements is the reason that people cannot hear infrasound?

Put a cross (☒) in the box next to your answer.

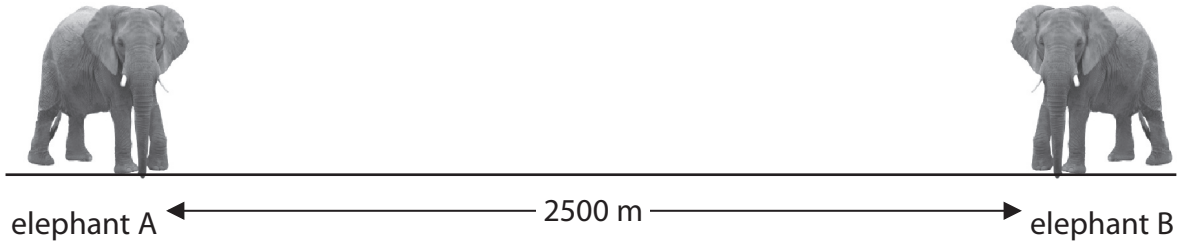
(1)

- ☒ **A** the amplitude of infrasound is too big
- ☒ **B** the frequency of infrasound is too low
- ☒ **C** the speed of infrasound is too fast
- ☒ **D** the wavelength of infrasound is too short

(c) Both infrasound waves and ultrasound waves are types of sound waves.
They are used by animals to communicate.

Two elephants use infrasound waves for long distance communication.
The distance between these two elephants is 2500 m.

not to scale



Elephant A emits an infrasound call.
When elephant B hears the infrasound, it calls back.
Elephant A hears the answering call from elephant B.
The speed of infrasound is 340 m/s.

(i) Show that the minimum time for elephant A to call and hear an answer from elephant B is about 15 s.

(3)

(ii) An elephant's infrasound call has a range of 4000 m.
Each infrasound call lasts between 2 s and 10 s.
Each elephant usually waits about 30 s before it calls again.

Suggest a reason why elephants wait 30 s before calling again.

(1)

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(d) Describe a use of infrasound that does not involve animals.

(2)

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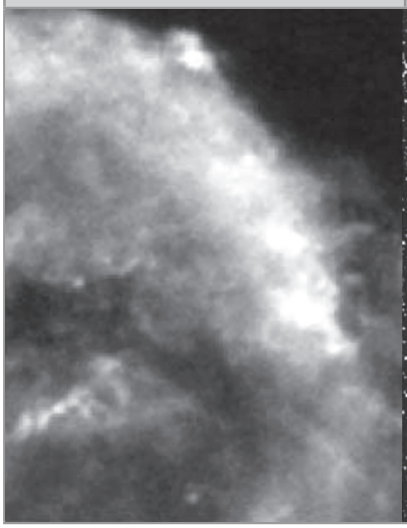
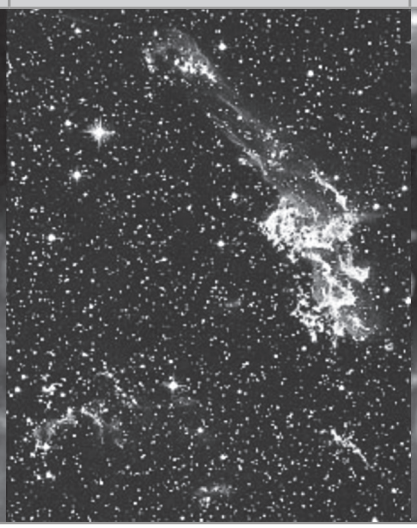
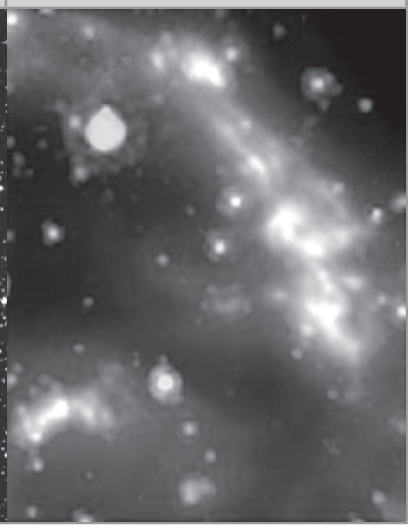
(Total for Question 3 = 9 marks)

Looking at our Universe

4 (a) Chandra, Hubble and Spitzer are space telescopes.

The photographs show exactly the same part of the Universe observed using the different telescopes.

The main object shown in each photograph is the same supernova.

Chandra's image using X-rays	Hubble's image using visible light	Spitzer's image using infrared
		

(i) Complete the sentence by putting a cross (☒) in the box next to your answer.

A supernova is

(1)

☒ **A** a star in its main sequence

☒ **B** the appearance of a new star

☒ **C** the explosion of a massive star

☒ **D** the explosion of a white dwarf

(ii) The waves that the three telescopes use are

X-rays

visible light

infrared

Complete the table by arranging these three waves in order of decreasing wavelength.

(1)

longest wavelength →		**shortest wavelength**
.....	.....	.....

(iii) Astronomers use different types of telescope, like Chandra, Hubble and Spitzer.

Explain how using these different telescopes gives a better understanding of the Universe.

(3)

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(b) Most space telescopes orbit the Earth but the Spitzer telescope stays behind the Earth to hide from the Sun.

Suggest why this is necessary.

(2)

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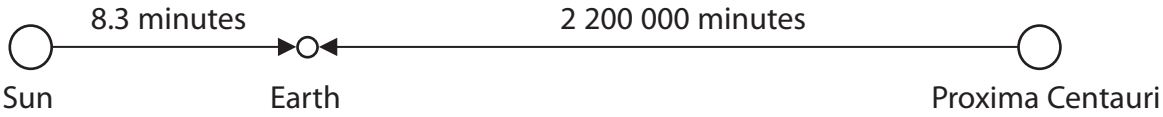
(c) Outside our Solar System, the star closest to Earth is called Proxima Centauri.
Light from this star takes 2 200 000 minutes to reach the Earth.
Light from the Sun takes 8.3 minutes to reach the Earth.
The speed of light is 18 000 000 km/minute.

not to scale



(i) By calculation, compare the distance of Proxima Centauri from the Earth with the distance of the Sun from the Earth.

(2)

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(ii) A light year is the distance that light travels in one year.

Astronomers usually give the distance from stars as a number of light years instead of a number of kilometres.

Suggest a reason for this.

(1)

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(Total for Question 4 = 10 marks)

Power from the wind

5 A windfarm generates electrical power from the wind.

(a) State **one** disadvantage of using the wind to generate electrical power.

(1)

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(b) A windfarm generates 322 MW of electrical power.

The windfarm is connected to a transmission line at a potential difference of 132 kV.

(i) Calculate the current from the windfarm.

(3)

current = ... A

(ii) The windfarm produces 322 MW of power.
The windfarm is to be extended by adding 75 improved turbines.
The extended windfarm will then produce a total of 539 MW.

Calculate the power produced by each improved turbine.

(2)

power = ... MW

*(c) There is a plan to replace the existing transmission line from the windfarm with one at the higher potential difference of 400 kV.

The new transmission line will cross more than 200 km of mountains.
The cables will hang 50 m above the ground from 600 new, taller pylons.
Eventually, about 1000 of the old, shorter pylons will be removed.

Discuss the advantages and disadvantages of this plan.

(6)

(Total for Question 5 = 12 marks)

Electromagnetic waves

6 (a) The diagram shows the parts of the electromagnetic spectrum.

radio waves	microwaves	infrared	visible light	ultraviolet	X-rays	gamma rays

(i) Which parts of the electromagnetic spectrum are used for both communication and cooking?

Put a cross (☒) in the box next to your answer.

(1)

☒ **A** infrared and microwaves

☒ **B** infrared and radio waves

☒ **C** microwaves and radio waves

☒ **D** radio waves and X-rays

(ii) Fluorescent substances absorb ultraviolet and emit visible light.

Complete the sentence by putting a cross (☒) in the box next to your answer.

Visible light has a

(1)

☒ **A** faster speed than ultraviolet

☒ **B** higher frequency than ultraviolet

☒ **C** lower frequency than ultraviolet

☒ **D** smaller wavelength than ultraviolet

(b) Ultraviolet radiation and infrared radiation are emitted by the Sun and reach the surface of the Earth.

(i) Describe a harmful effect of ultraviolet radiation.

(2)

(ii) Explain why ultraviolet radiation is likely to be more dangerous to humans than infrared radiation.

(2)

*(c) Herschel discovered invisible rays beyond one end of the visible spectrum.
Ritter discovered invisible rays beyond the other end of the visible spectrum.

Compare and contrast the two experiments leading to these discoveries.
You may draw labelled diagrams to help with your answer.

(6)

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS

Answer ALL questions

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Weight lifting

1 The picture shows a weight lifter.

(a) In one lift, he does 5040 J of work against gravity.

(i) One lift takes 4 seconds.

Complete the sentence by putting a cross (☒) in a box next to your answer.

The power used to lift the weight is

(1)

☒ **A** 1260 W

☒ **B** 2016 W

☒ **C** 12600 W

☒ **D** 20160 W

(ii) The weight he lifts has a mass of 240 kg.
Gravitational Field Strength = 10 N/Kg
The energy gained by the mass is equal to the work done when lifting it.

Calculate the height he lifts this mass.

(3)

height = ... m

(b) After lifting the mass, he must hold it steady for 3 seconds.
During this time, he does no work on the mass.

State why he does no work on the mass in this time.

(1)

.....

.....

(c) After the 3 seconds, the weight lifter drops the mass.
The velocity of the mass just before it hits the floor is 6.4 m/s.

Calculate the momentum of the mass just before it hits the floor.
State the unit.

(3)

momentum = ... unit = ...

(Total for Question 1 = 8 marks)

Electrostatics

2 A light, polystyrene ball is coated with a thin layer of metal.
Diagram 1 shows the ball on a metal plate.
In diagram 2, the plate has been charged and the ball is rising to hit the earthed lid.

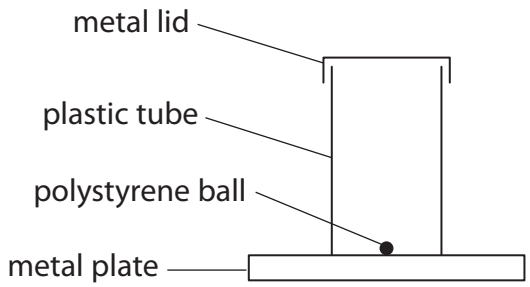

diagram 1

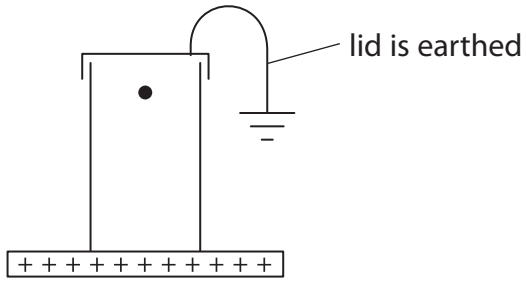

diagram 2

(a) (i) State the sign of the charge on the ball as it moves upwards.

(1)

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(ii) Explain why the ball moves upwards.

(2)

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(b) The ball discharges when it hits the earthed lid.

Explain how the ball loses its charge.

(2)

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(c) The ball continues to move up and down between the charged plate and the earthed lid.

Explain why the ball continues to move up and down.

(2)

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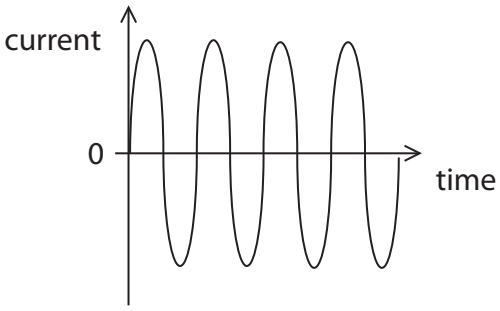
(d) The current in the wire connected to earth may be described by a graph.

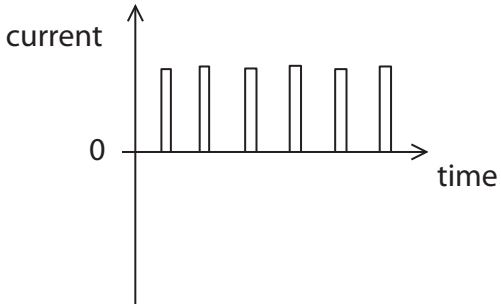
Which of these graphs best shows the current in the earth wire?

Put a cross (☒) in the box next to your answer.

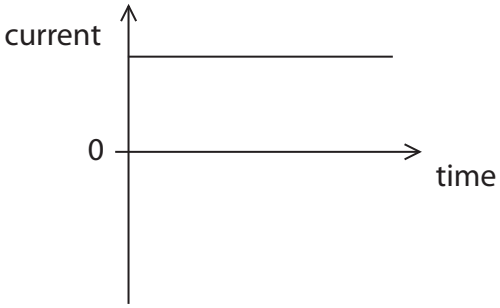
(1)



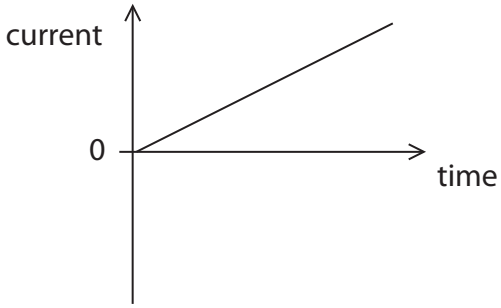
☒ **A**



☒ **B**



☒ **C**



☒ **D**

(Total for Question 2 = 8 marks)

Heating a greenhouse

3 A greenhouse contains an electric heater.

(a) The heater makes good use of the heating effect of an electric current.

Give an example of a device where the heating effect of an electric current is a **disadvantage**.

(1)

.....

.....

(b) This label is attached to the heater.

230 V 500 W
50 Hz

Use this information to calculate the expected current in the heater.

(3)

current = ... A

(c) Complete the sentence by putting a cross (☒) in the box next to your answer.

The potential difference across the heater can be measured either in volts or in

(1)

- ☒ **A** amps per ohm
- ☒ **B** amps per joule
- ☒ **C** coulombs per ohm
- ☒ **D** joules per coulomb

(d) When a charge flows in a resistor, the resistor becomes hot.

Explain why the resistor becomes hot.

(2)

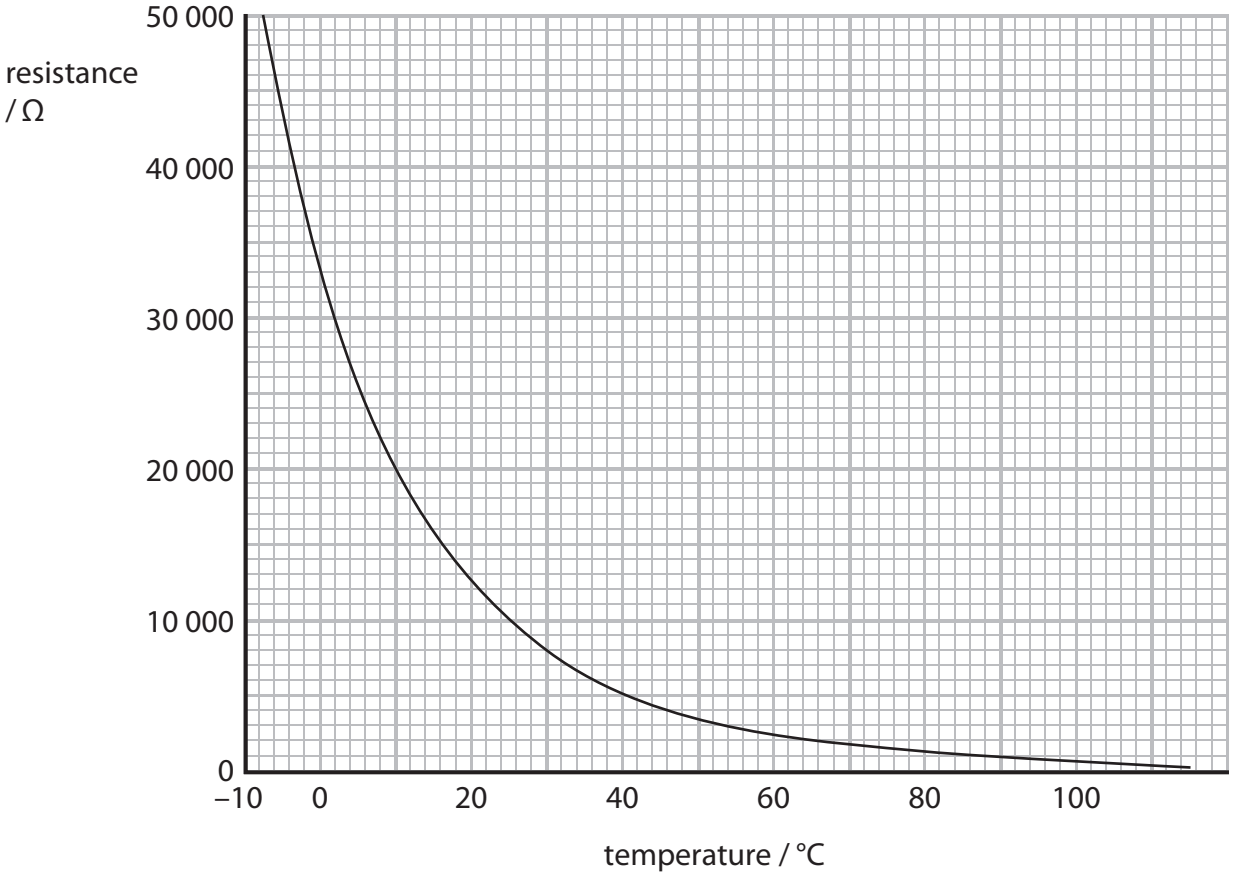
.....

.....

.....

.....

(e) A thermistor is used to control the heater.
The graph shows how the resistance of the thermistor changes with temperature.



When the temperature is 10 °C, the current in the thermistor is 0.60 mA.

Calculate the potential difference across the thermistor at 10 °C.

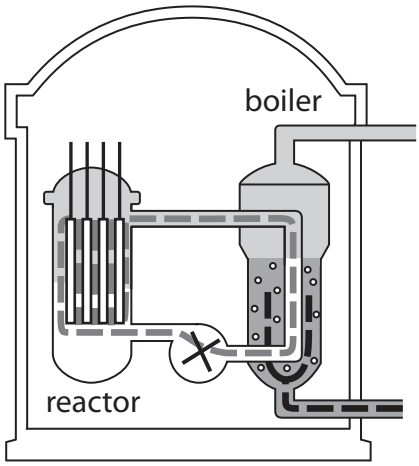
(3)

potential difference = ... V

(Total for Question 3 = 10 marks)

Nuclear energy

4 Electricity is generated in a nuclear power station.
The diagram shows the first stages in this process.



(a) The thermal energy released in the reactor is used to generate steam.

Describe how the steam is used to generate electricity.

(2)

.....

.....

.....

.....

(b) Energy is released by a nuclear chain reaction.

Describe how the fission of a uranium-235 nucleus can start off a chain reaction.
You may draw a diagram to help with your answer.

(3)

(c) One of the products of the fission of uranium-235 is barium-142.

Which of these could be a product of the same reaction?

Put a cross (☒) in the box next to your answer.

(1)

- ☒ **A** krypton-91
- ☒ **B** krypton-95
- ☒ **C** krypton-98
- ☒ **D** krypton-100

(d) Barium-142 emits beta radiation.
Beta radiation is ionising.

Explain what happens when beta radiation ionises.

(2)

(e) A fusion reaction does not have radioactive products.
However, it needs large amounts of energy to make it happen.

Explain why large amounts of energy are needed to make a fusion reaction happen.

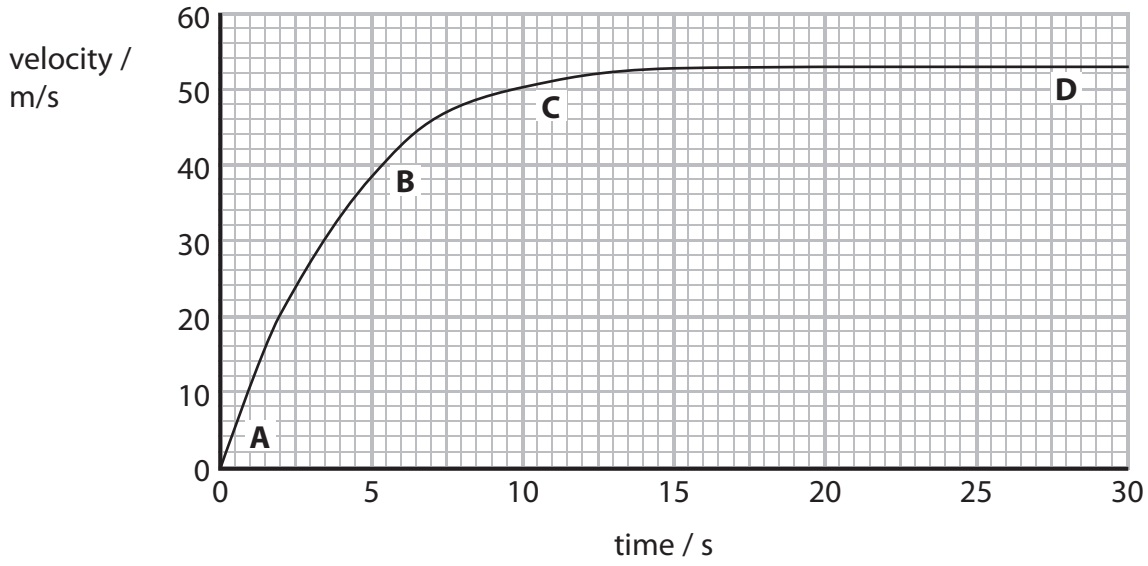
(2)

(Total for Question 4 = 10 marks)

Parachuting

5 Christine is a free-fall parachutist.

This is a velocity–time graph for her jump.



(a) Complete the sentence by putting a cross (☒) in a box next to your answer.

On the graph, the greatest acceleration is at

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(b) Estimate how far Christine falls in the first 2 s.

(3)

Christine falls = ... m

(c) Explain the difference between velocity and speed.

(2)

.....

.....

.....

.....

*(d) The graph shows how Christine's velocity changes from the time she leaves the plane until she reaches terminal velocity.

Explain, in terms of forces, why her velocity changes as shown in the graph.

(6)

.....

.....

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(Total for Question 5 = 12 marks)

Radioactivity and health

6 (a) Radioactive materials can be a risk to health.
Some food contains radioactive material.

Explain why people can eat this food without serious risk.

(2)

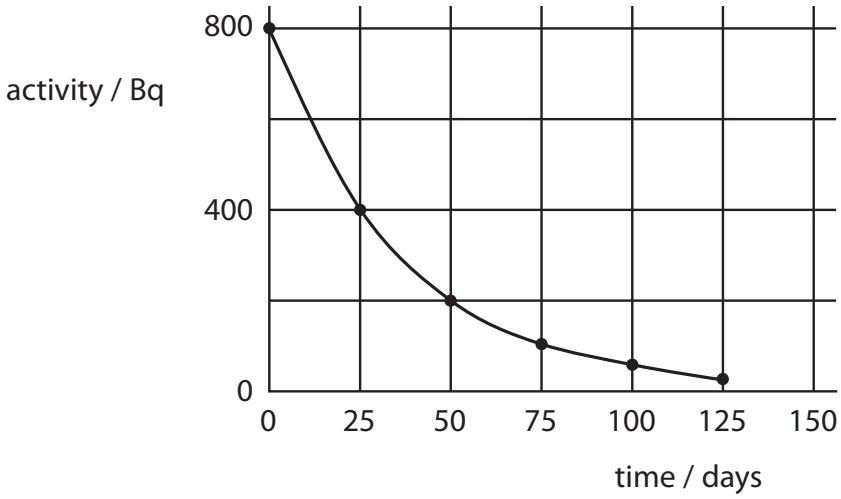
.....

.....

.....

.....

(b) A radioactive material can be used to help diagnose heart disease.
The graph shows the decay curve for this material.



(i) A scientist measures the activity of a sample of this material as 400 Bq.
Some time later, he measures the activity as 100 Bq.

Put a cross (☒) in the box next to your answer.

The time between the two measurements is about

(1)

☒ **A** 25 days

☒ **B** 50 days

☒ **C** 75 days

☒ **D** 100 days

(ii) Estimate the activity that should appear on the graph for a time of 150 days.

(1)

activity at 150 days = ... Bq

(c) Half-life is an important factor to consider when choosing isotopes for medical treatments.

Explain what **half-life** means.

(2)

.....

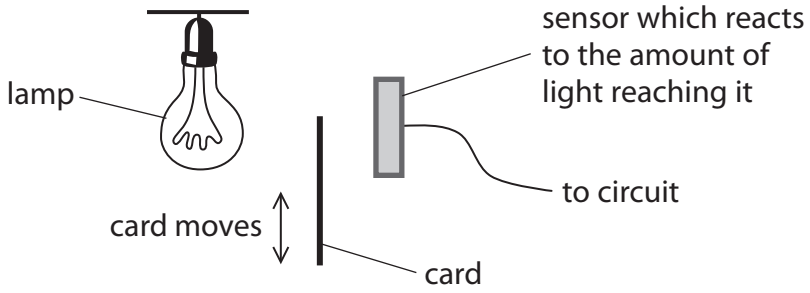
.....

.....

.....

*(d) A teacher decides to model how a machine checks the level of the liquid in medicine bottles.
The machine uses a radioactive source to sound an alarm when the level of liquid becomes too low.

He sets up the arrangement shown.



The piece of card can be moved up and down between the lamp and the detector.
Each part of the teacher's arrangement corresponds to a part of the machine.

By comparing the parts of the teacher's arrangement to the parts of the machine, discuss how effective this model is.

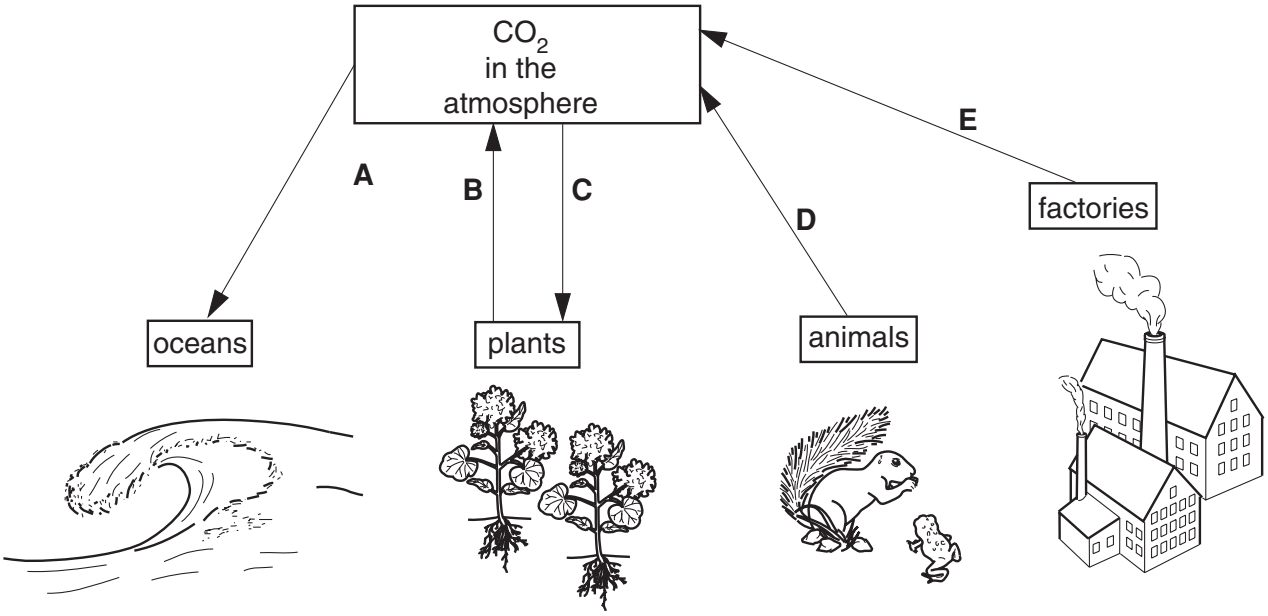
(6)

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS

Answer **all** the questions.

1 This diagram represents part of the Carbon Cycle.



(a) Match the following processes to the arrows in the diagram above.
Write the correct letter, **A**, **B**, **C**, **D** or **E**, in each box.

photosynthesis	☐
respiration	☐ ☐
combustion	☐
dissolving	☐

[3]

(b) There is concern over changes to the amount of carbon dioxide in the atmosphere.

(i) Before 1800 the amount of carbon dioxide was steady for thousands of years.

Which of the following statements explains why it was steady?

Put a tick (✓) in the box next to the correct answer.

The carbon dioxide going into the atmosphere was taken out again by plants and the oceans.	☐
There was no carbon dioxide produced before people built factories.	☐
The atmosphere was already full of carbon dioxide, so no more could fit in.	☐
Carbon dioxide was absorbed by forest fires.	☐

[1]

(ii) In the last 200 years the amount of carbon dioxide in the atmosphere has risen.

Which of the following statements best explain the **rise** of carbon dioxide?

Put a tick (✓) in the box next to **each** correct answer.

There are more factories now than in the past, as more countries have become developed.	☐
Scientists have developed a way of storing carbon dioxide underground.	☐
Environmental groups have been working to get more trees planted around the world.	☐
Forests have been burnt down to clear land for farming and new buildings.	☐
Scientists do not agree that the amount of carbon dioxide has risen over the last 200 years.	☐

[2]

(c) There is evidence to show that global warming is taking place.
Global warming could result in dramatic changes to our planet.

Which of the following could happen as a result of global warming?
Put a tick (✓) in the box next to **each** correct answer.

More people could get skin cancer due to increased levels of UV.	☐
Low lying lands could be at increased risk of flooding.	☐
There will be an increased chance of earthquakes occurring.	☐
Some parts of the world will find it more difficult to grow crops.	☐

[1]

(d) Carbon dioxide is a greenhouse gas found in the atmosphere.

Choose **two** other greenhouse gases that can also be found in the atmosphere.
Put ticks (✓) in the boxes next to the **two** best answers in the list below.

nitrogen	☐
water vapour	☐
argon	☐
oxygen	☐
methane	☐

[2]

[Total: 9]

[Turn over

2

Around 100 years ago many scientists believed that mountains on the Earth were caused by the surface of the Earth shrinking as it cooled down.

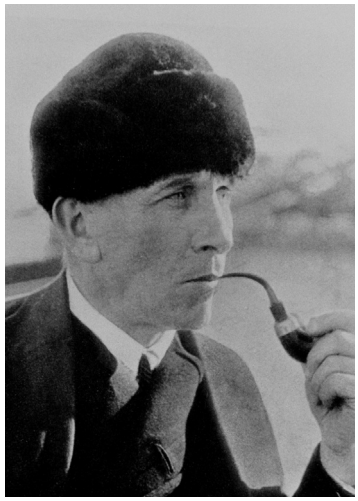
Alfred Wegener came up with a different idea to explain how mountains formed.

In 1912 Wegener presented his big idea to a meeting of geologists in Germany.

Wegener's big idea became known as continental drift.

He published a book that described his ideas in 1922.

After 'peer review' of his work his ideas were rejected by most geologists at the time.



(a) What is 'peer review'?

Make the best description you can by drawing **one** straight line from a box on the left to a box on the right.

The public look at your work …	… and they give their opinion.
Scientists look at your work …	… to see if it is interesting.
Your friends look at your work …	… and repeat the experiments.

[1]

(b) Read the following statements about continental drift.
Some statements are data, others are explanations.

Choose which statements are **data** about continental drift and mark them with a **D**.

The continents could have once been joined together.	☐
The outlines of the continents appear to fit like a jigsaw.	☐
Fossils found in Africa match those found in South America.	☐
A land bridge may once have joined Africa to South America.	☐

[2]

(c) What reasons did the geologists of Wegener's time have to reject his ideas?

Put ticks (✓) in the boxes next to the **two** best answers.

He was an outsider to their group.	☐
The evidence he provided was clearly wrong.	☐
They did not know how the continents could be moved.	☐
They agreed that similar fossils were found in Africa and South America.	☐

[2]

(d) The theory of plate tectonics has now taken Wegener's idea of continental drift further.

Plate tectonics can help to explain how mountains form, as is happening today in the Himalayas.

These sentences describing the process of mountain formation are not in the right order.

A Rocks on the upper plate buckle and fold.

B Two tectonic plates move towards each other.

C Tectonic plates are continually moving.

D When the plates collide, one slides under the other.

E This forces the land up, making a mountain chain.

Fill in the boxes to show the right order. The first one has been done for you.

C				

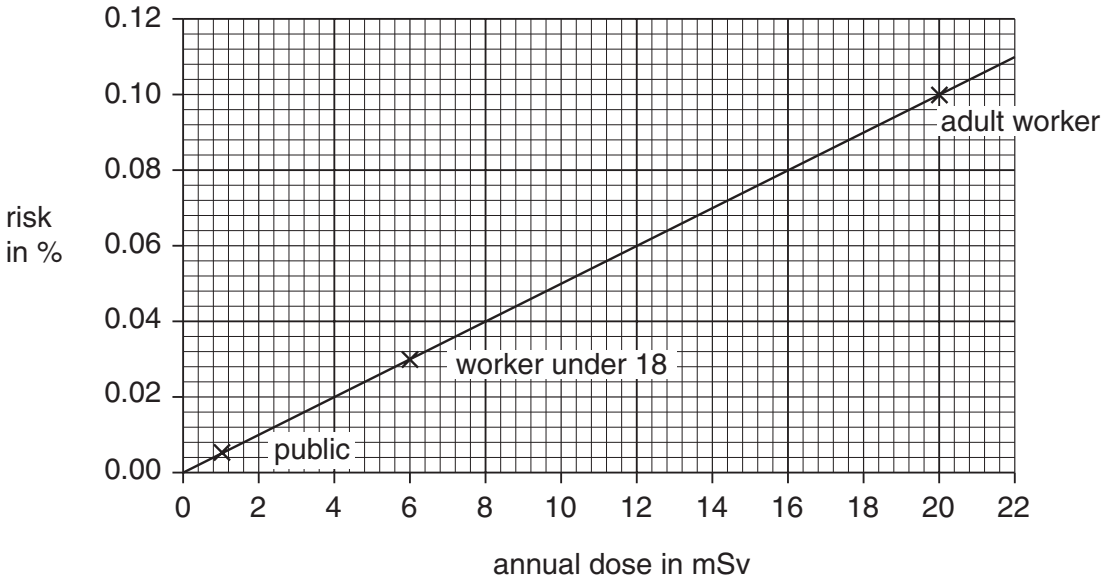
[3]

[Total: 8]

3 Workers in a nuclear power station have their radiation dose carefully monitored.

This chart shows how risk is related to radiation dose.

The **annual dose limits** for different categories of people are marked with a cross.



(a) Use the chart to answer the following questions.

(i) What dose produces a risk of 0.07%?

Put a (ring) around the correct answer.

10 mSv **12 mSv** **14 mSv** **16 mSv** [1]

(ii) If a worker receives a dose of 12 mSv, what is the risk?

Put a (ring) around the correct answer.

1 mSv **0.10%** **6 mSv** **0.06%** **20 mSv** **zero** [1]

(b) The annual dose limit for a worker in a nuclear power station is much higher than for a member of the public.

(i) When working out the annual dose limits the **ALARA** principle will have been applied.

What does the ALARA principle mean?

Put a tick (✓) in the box next to the **best** answer.

The risk is eliminated completely.	☐
The risk is assessed and recorded.	☐
The risk is reduced to a reasonable level.	☐
The risk is decided by the Government.	☐

[1]

(ii) How many times greater is the risk for an adult worker compared to a member of the public?

Put a (ring) around the correct answer.

3 **6** **10** **20** **40** [1]

(iii) Why might this increased dose not be seen as a problem for the owners of the nuclear power station?

Put ticks (✓) in the boxes next to the **two** best answers.

The owners are not required to consider the safety of their workers.	☐
The risk to an adult worker would still be very low.	☐
The owners supply their workers with protective clothing.	☐
The owners continually measure the dose that each worker receives.	☐
The power stations are normally built far from major centres of population.	☐

[2]

[Total: 6]

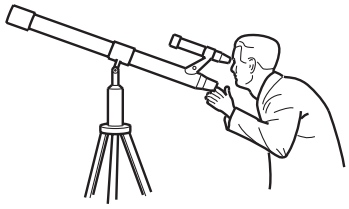
4

Heather takes part in an astronomy club at her school in London.

Heather has a friend called Stella.

Stella takes part in an astronomy club at her school in the Welsh countryside.

Both girls use the same type of telescope to observe the night sky.



(a) Heather does not see as much detail through the telescope as Stella.

Choose the best explanation for this from the list below.

Put a tick (✓) in the box next to the **best** answer.

Stella knows more about astronomy than Heather. ☐

Light pollution is interfering with Heather's observations. ☐

It rains more in the Welsh countryside. ☐

Stella's telescope is on top of a hill. ☐ [1]

(b) Heather's teacher tells her that looking at distant stars is like looking back in time.

What did Heather's teacher mean by this statement?

Put a tick (✓) in the box next to the **best** answer.

Stars have been around for a long time. ☐

Stars do not ever change their appearance. ☐

It takes time for light to reach us from the stars. ☐

New stars are being formed all the time. ☐ [1]

(c) Scientists can use more powerful telescopes, such as the Hubble space telescope, to view distant galaxies.

Scientists can work out how fast each of these galaxies is moving.

Draw straight lines to make correct sentences.
Link the boxes below to make the most **accurate** statements possible.

	… move at double the speed.
Galaxies that are closer …	… move more slowly.
Galaxies that are twice as far away …	… move more quickly.
	… move at half the speed.

[2]

[Total: 4]

5

No phones for kids?

A mobile phone designed for young children has been withdrawn from sale by the company that makes it.

A study found that people who regularly use a mobile phone for over 10 years are four times more likely to develop cancer of the ear. The study involved 750 people.

A spokesman for the mobile phone company said: 'The decision to withdraw the product is taken because of this new evidence. It suggests that long term exposure to radiation from mobile phones can damage health, especially in very young children.'

'Although we feel the product is safe if used as recommended with parental guidance, we are not experts in either radiation or medical fields. Any risk to our children is unacceptable.'

(a) What type of radiation is used by mobile phones to make a call?

answer ..... [1]

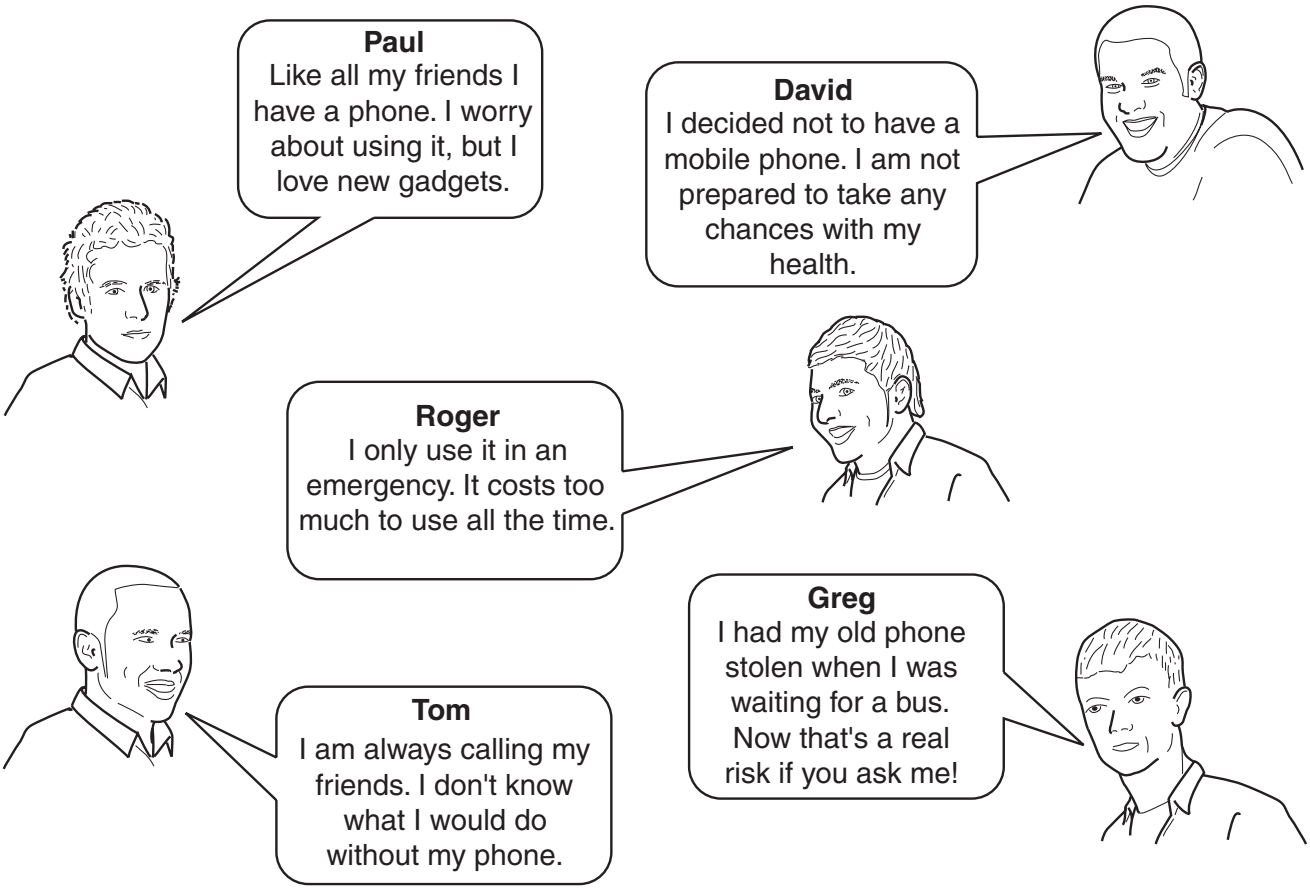
(b) The article identifies a correlation between two factors.

Draw **two** straight lines to make the correct correlation.

first factor		second factor
		the number of cases of ear cancer increases.
If mobile phone usage		
	decreases	the amount of street crime increases.
If the number of children		
	increases	there is no proven health risk.
If parental guidance		
		the phone is probably safe to use.

[2]

(c) A group of students are discussing their views on mobile phones.



(i) Which student has made a statement based on the **precautionary principle**?

answer ..... [1]

(ii) How could you **explain** the decision that Paul has made?

Put a tick (✓) in the box next to the **best** answer.

He is aware of a risk, but it doesn't bother him.	☐
He believes the benefit outweighs the risk.	☐
He is aware of a risk and decides not to go ahead.	☐
He believes that there is more risk than benefit.	☐

[1]

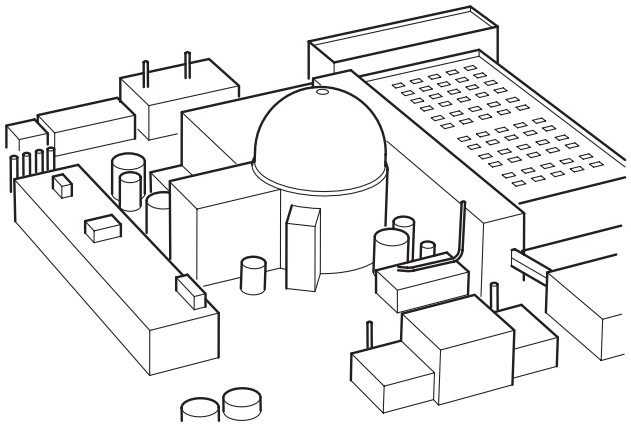
[Total: 5]

6

Nuclear power stations use uranium as a fuel.

Energy is released from the uranium by the process of nuclear fission.

Some people object to nuclear power stations because they produce radioactive waste.



(a) The nuclear fission process needs to be controlled to release the energy safely.
The following statements describe this control process. They are in the wrong order.

A Coolant is used to carry the heat energy away from the reactor.

B More neutrons are released.

C The uranium undergoes fission.

D Neutrons in the reactor collide with uranium.

E Some of these neutrons are absorbed by control rods.

Fill in the boxes to show the right order. The last one has been done for you.

				A

[3]

(b) The process of nuclear fission can carry on unaided once it is started.

Write the name for this type of reaction.

..... reaction [1]

(c) If more nuclear power stations were built, the risk of radioactive material contaminating the environment would increase.

Some people are **in favour** of building more nuclear power stations.

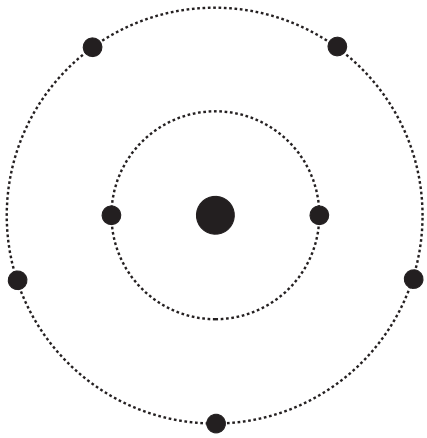
Put a tick (✓) in the box next to each statement that is a good argument to support their case.

The need for a reliable energy resource outweighs the risks.	☐
People might benefit from new employment opportunities.	☐
There is a problem with storing nuclear waste safely for as long as necessary.	☐
Nuclear power stations do not release large amounts of greenhouse gases.	☐

[2]

[Total: 6]

7 This diagram represents the particles that make up an atom.



not to scale

(a) What is the **central** core of the atom called?

answer ..... [1]

(b) This is an atom of nitrogen. Complete the sentence below.

All atoms of nitrogen contain the same number of .....

in the core of the atom. [1]

(c) This particular atom is radioactive. It emits beta radiation.

What effect does this have on the atom **after** the radiation is emitted?

Write **true** or **false** in the box next to each statement.

	true or **false**
The atom will have the same number of particles in its core.	
The atom will still be of the same element.	
The atom will have gained energy.	
The atom will have the same number of neutrons in its core.	

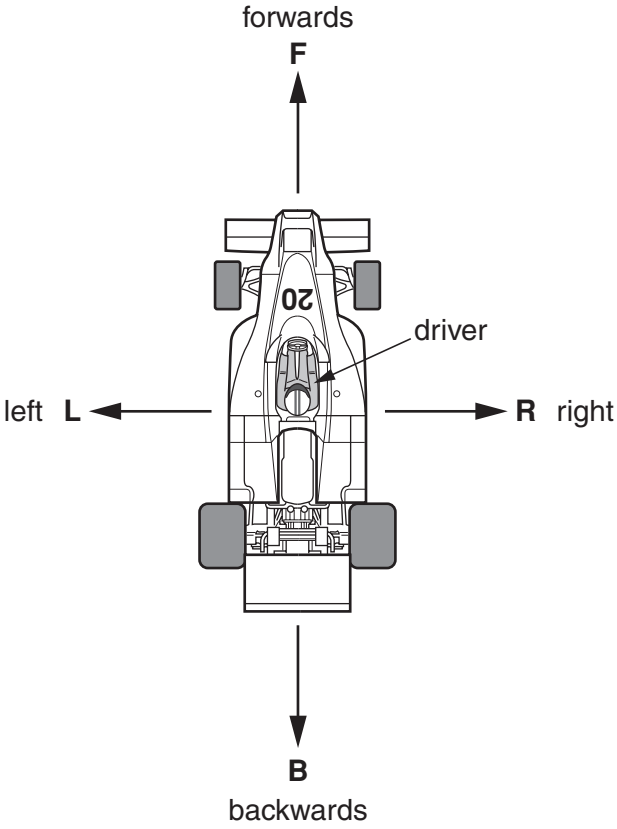
[2]

[Total: 4]

END OF QUESTION PAPER

Answer **all** the questions.

1 A driver in a car experiences forces in different directions as he drives forwards.



(a) (i) The car speeds up in a straight line.

Which force, **F**, **R**, **L** or **B**, does the car exert **on the driver**?

answer ..... [1]

(ii) The car slows down **and** turns left.

Which two forces, **F**, **R**, **L** or **B**, does the car exert **on the driver**?

..... and ..... [2]

(b) The car speeds up in a straight line.

Which force, **F**, **R**, **L** or **B**, does the driver exert **on the car**?

answer ..... [1]

[Total: 4]

2 Bobby throws a ball vertically in the air.

(a) The ball weighs 10 N.

(i) How much gravitational potential energy is gained by the ball when it goes up 2.5 m?

Put a (ring) around the correct answer.

0.04 J **2.5 J** **4 J** **25 J** **40 J** **250 J**

[1]

(ii) At the top of the throw the ball is stationary.

As the ball falls it loses gravitational potential energy, transferring it to kinetic energy.

Which equation correctly shows the velocity of the ball when all the energy has transferred to kinetic energy?

Put a tick (✓) in the correct box.

$\text{velocity} = \sqrt{\frac{2 \times \text{energy}}{\text{mass}}}$ ☐

$\text{velocity} = \frac{\text{energy}}{\text{mass}}$ ☐

$\text{velocity} = \sqrt{\text{energy} \times \text{mass}}$ ☐

$\text{velocity} = \sqrt{\frac{2 \times \text{energy}^2}{\text{mass}}}$ ☐

[1]

(iii) The velocity is actually less than that calculated by the equation in part **(ii)**.

Put a tick (✓) in the box next to the best explanation of this.

The mass increases as it falls. ☐

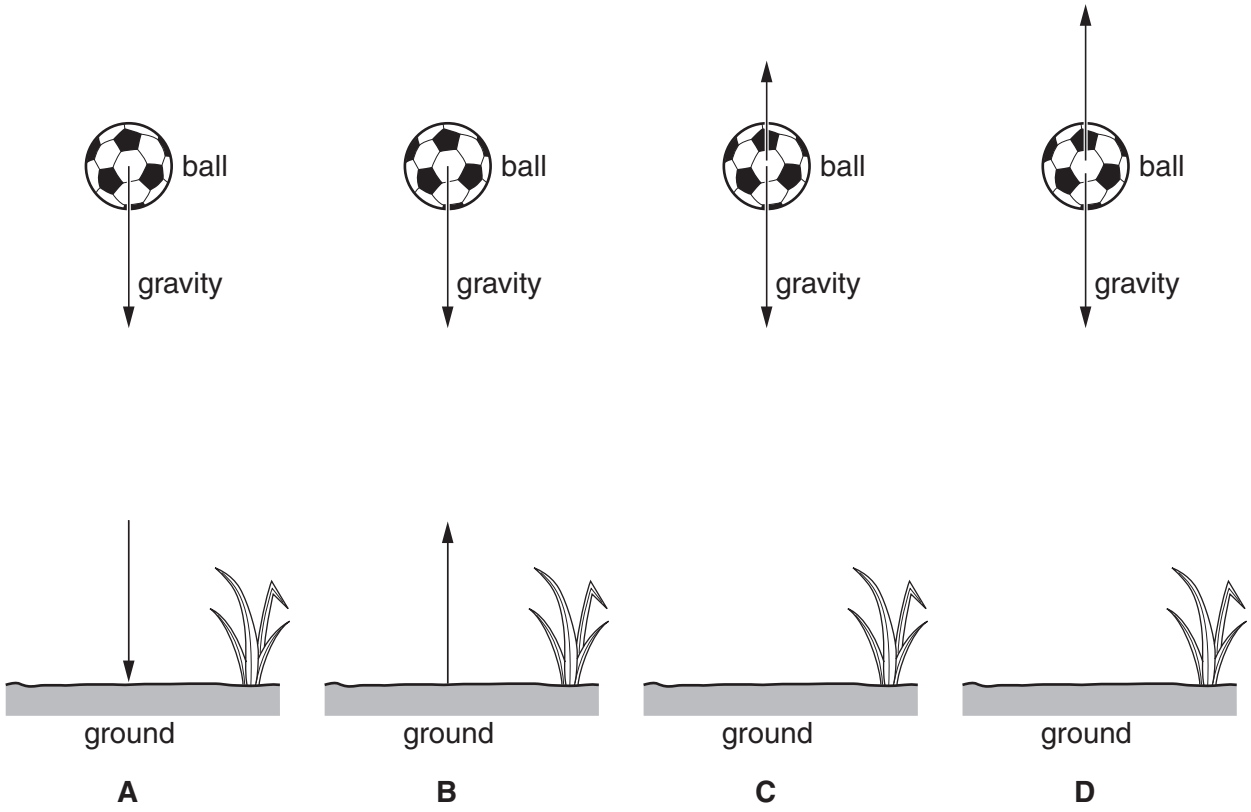
The air resistance increases as it falls. ☐

The momentum increases as it falls. ☐

The energy increases as it falls. ☐

[1]

(b) Gravity is the force pulling the ball down as it falls towards the ground.



The gravity force is one half of an interaction pair.

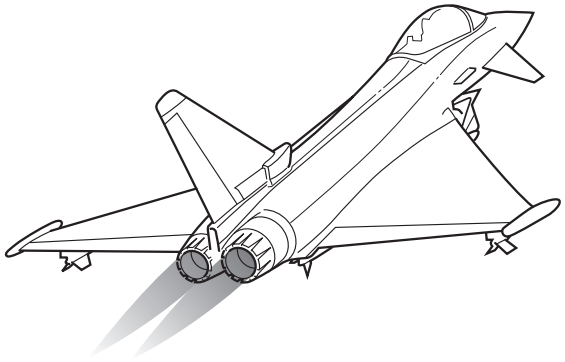
Which of these diagrams, **A**, **B**, **C** or **D**, correctly shows both forces of the interaction pair?

answer ..... [1]

[Total: 4]

[Turn over

3



A jet plane works by firing a stream of hot exhaust gas particles backwards.

(a) Some of the following statements are true and some are false. Complete the table with either **true** or **false**.

	true or **false**
The force on each gas particle equals the momentum of the jet plane.	
The change in momentum of the exhaust gas particles equals the change in momentum of the plane, ignoring air resistance.	
The force on one gas particle equals the total force on the jet plane.	
The change in momentum of the gas particles equals the force on the plane multiplied by the time for which it acts.	

[2]

(b) Which of the following would be needed to calculate the momentum of the **exhaust gases**?

Put a tick (✓) in each correct box.

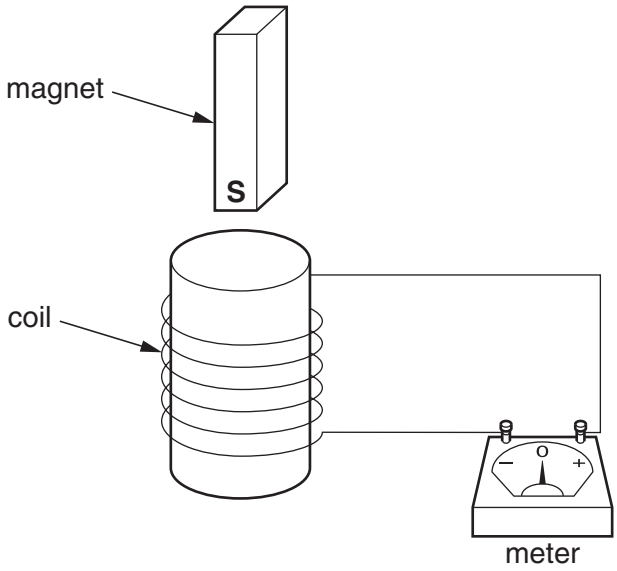
- mass of a single exhaust gas particle ☐
- weight of jet engine ☐
- number of exhaust gas particles ☐
- velocity of exhaust gas particles ☐
- force due to gravity ☐
- temperature of jet engine ☐

[3]

[Total: 5]

4 Electricity can be generated by moving a magnet in a coil of wire.

The diagram shows a magnet held above a coil of wire.



Experiments with this apparatus can show how the electricity is generated.

(a) Draw a straight line from each **experiment** to **what happens on the meter**.

The first line has been done for you.

experiment	**what happens on the meter**
push the South end of the magnet into the coil	needle flicks to right
pull the South end of the magnet out of the coil	needle does not move
push the North end of the magnet into the coil	needle flicks to left
hold the magnet still in the coil	

[3]

[Turn over

(b) What is the name for this method of producing a voltage?

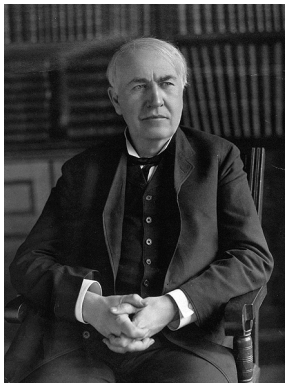
Put a (ring) around the correct answer.

deduction **induction** **reduction** **transformation**

[1]

[Total: 4]

5



Thomas Edison was the first person to set up a company to provide electricity to houses. He used a direct current (d.c.) supply.

(a) We now use an alternating current (a.c.) electricity supply.

Explain why we use a.c. and not d.c.

Put ticks (✓) in the boxes next to the **two** correct explanations.

d.c. is old fashioned ☐

it is easier to generate a.c. ☐

Thomas Edison was unpopular so people would not buy his d.c. electricity ☐

a.c. can be distributed more efficiently ☐

d.c. is more expensive because it can only travel in straight lines ☐

[2]

(b) The main advantage of Thomas Edison's d.c. system was that it used low voltages.

He thought this was safer than a.c.

What is the voltage used for the mains supply to homes in the United Kingdom?

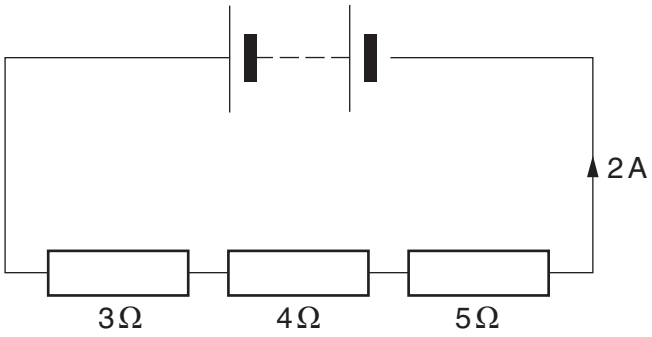
Put a (ring) around the correct answer.

12V **120V** **230V** **11 000V** **33 000V**

[1]

[Total: 3]

6 This question is about resistors in a series circuit.



(a) What is the voltage across the 3 Ω resistor?

voltage = ... V [1]

(b) Which resistor will have the highest voltage across it?

Put a (ring) around the correct answer.

3 Ω **4 Ω** **5 Ω** **all the same**

[1]

(c) Which statements describe how to find the voltage across the battery?

Put a tick (✓) in each of the **two** correct boxes.

find the total resistance and divide by the current	☐
add the voltage across each of the resistors together	☐
multiply the voltage across each resistor by its resistance	☐
multiply the current by the total resistance	☐
divide each resistance by the current and add the answers together	☐

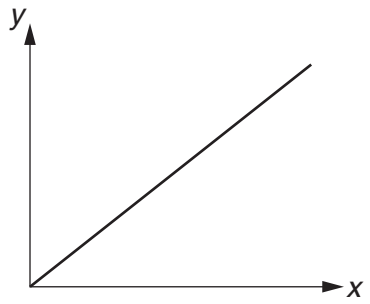
[2]

[Total: 4]

7 Sarah has been doing various electrical tests.

Unfortunately she forgot to label the axes (x and y) on her graphs.

A



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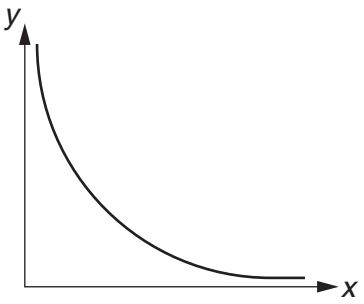
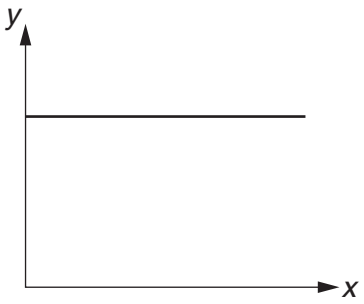


C



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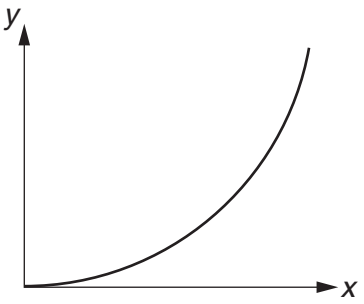

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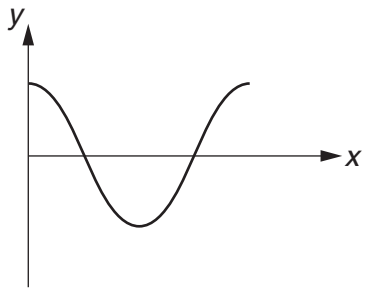


Write down the letter, **A**, **B**, **C**, **D** or **E**, of the graph that best fits each experiment.

Graphs may be used once, more than once or not at all.

(a) How the resistance of an LDR (y) changes with light intensity (x).

answer ..... [1]

(b) How the current (y) varies with the voltage (x) when the resistance does not change.

answer ..... [1]

(c) How the voltage across the coil of an a.c. generator (y) changes with time (x).

answer ..... [1]

(d) How the resistance of a thermistor (y) changes with temperature (x).

answer ..... [1]

(e) The brightness of a lamp (y) connected to a battery as the length of the connecting wires (x) is decreased.

answer ..... [1]

[Total: 5]

8 Here are different parts of the electromagnetic spectrum.

gamma radiation

infrared

microwaves

radio waves

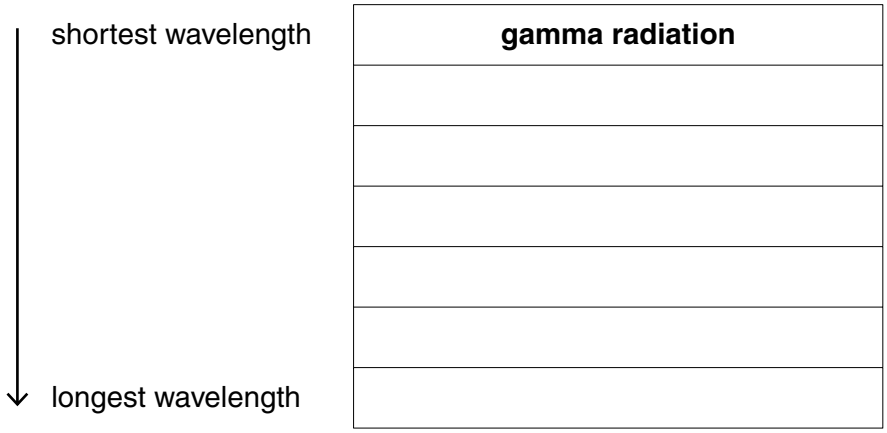
ultraviolet

visible light

X-rays

(a) Put the parts of the electromagnetic spectrum in order of **increasing wavelength**.

The first one has been done for you.



[3]

(b) Photons with the highest frequency have the most energy.

Write down the name of the part of the spectrum that has photons with the most energy.

answer ..... [1]

[Total: 4]

9 Waves can refract, diffract and interfere.

Each of the observations below can be explained by one of these processes.

Use straight lines to connect each **observation** to its correct **process** and each **process** to its correct **explanation**.

observation	process	explanation
TV signals received from behind a hill	refraction	waves add as they pass through each other
	diffraction	waves spread out from the edge of a barrier
spectrum formed by a prism	interference	waves change speed at a boundary

[4]

[Total: 4]

10 Hermione reads a passage about transmitting information. The diagrams of waves are missing from the passage.

Choose the **best** wave diagram to use for each missing diagram in the passage.

Write down the letter, **A**, **B**, **C**, **D**, **E** or **F**, for each diagram.

Diagrams may be used once, more than once or not at all.

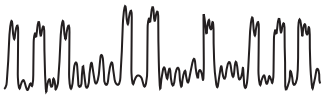
The last one has been done for you.

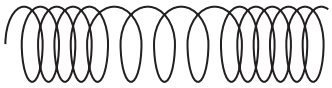
A 

B 

C 

D 

E 

F 

A sound wave is an analogue wave.

diagram …… [1]

The sound wave is converted into a digital code.

The digital signal is sent as a series of short pulses.

diagram …… [1]

Digital signals can be transmitted with higher quality than analogue signals.

As the signal is transmitted, it decreases in intensity and picks up noise.

diagram …… [1]

When the signal is received it is amplified.

diagram …… [1]

The signal is cleaned up to remove the noise.

diagram …… [1]

The digital signal is then decoded to reproduce the original sound wave.

diagram ……C……

[Total: 5]

END OF QUESTION PAPER

Do not write outside the box

Answer **all** questions in the spaces provided.

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

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

1 (a) The air next to the stove is warmed by infrared radiation.

How does the design of the stove help to improve the rate of energy transfer by infrared radiation?

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(2 marks)

1 (b) Burning 1 kg of wood transfers 15 MJ of energy to the stove. The stove then transfers 13.5 MJ of energy to the room.

Calculate the efficiency of the stove.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

.....

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Efficiency = ...

(2 marks)

1 (c) Some of the energy from the burning wood is wasted as the hot gases leave the chimney and warm the air outside the house.

Name **one** other way energy is wasted by the stove.

.....

(1 mark)

1 (d) Some people heat their homes using electric heaters. Other people heat their homes using a wood burning stove.

Give **two** environmental advantages of using a wood burning stove to heat a home rather than heaters that use electricity generated from fossil fuels.

1 .....

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2 .....

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(2 marks)

Question 1 continues on the next page

1 (e) The metal case of the stove gets hot when the fire is lit.

Here is some information about the stove.

Mass of metal case	100 kg
Starting temperature of metal case	20 °C
Final temperature of metal case	70 °C
Specific heat capacity of metal case	510 J/kg °C

Calculate the energy required to raise the temperature of the metal case to 70 °C.

Use the correct equation from the Physics Equations Sheet.

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

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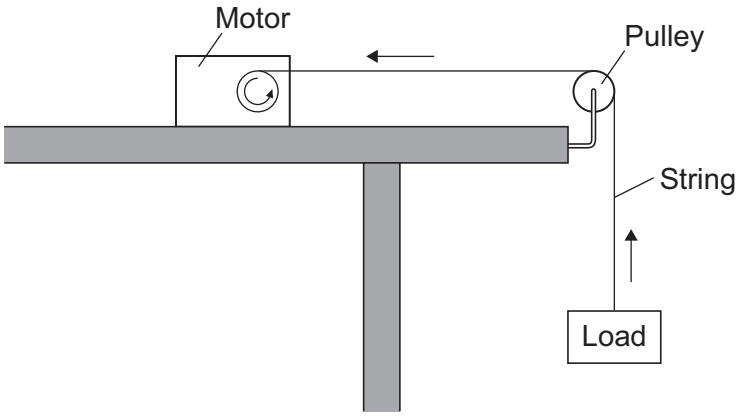
Energy required = ...

(3 marks)

10

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



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

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

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(1 mark)

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

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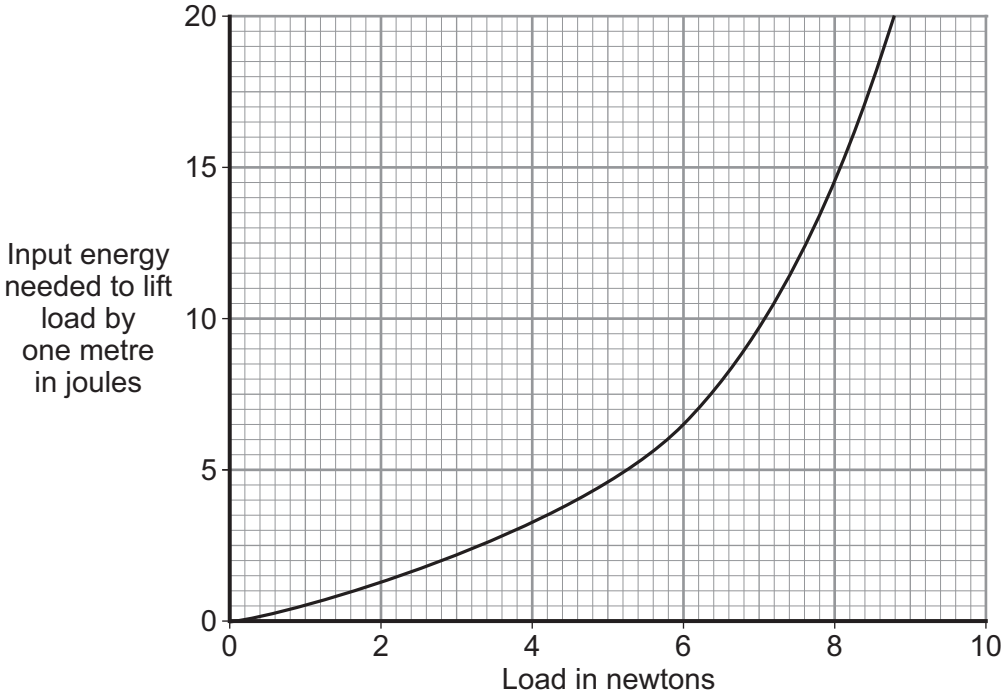
(1 mark)

Question 2 continues on the next page

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



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

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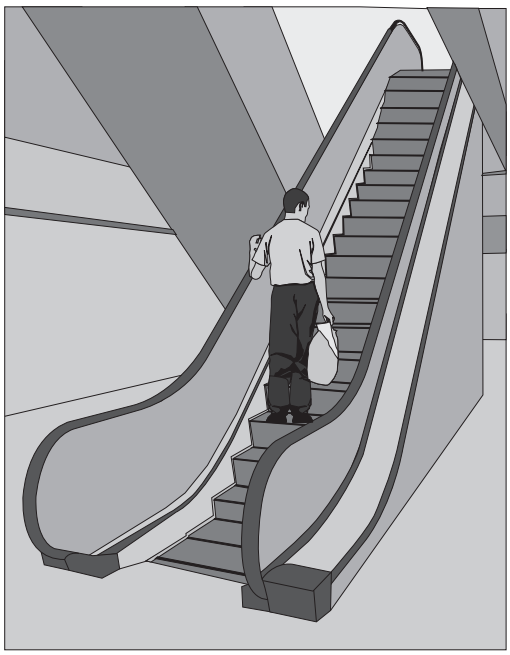
(2 marks)

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



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

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

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

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Cost = ... pence
(3 marks)

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

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(1 mark)

8

3 (a) Geothermal energy and the energy of falling water are two resources used to generate electricity.

3 (a) (i) What is geothermal energy?

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(1 mark)

3 (a) (ii) Hydroelectric systems generate electricity using the energy of falling water.

A pumped storage hydroelectric system can also be used as a way of storing energy for future use.

Explain how.

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(2 marks)

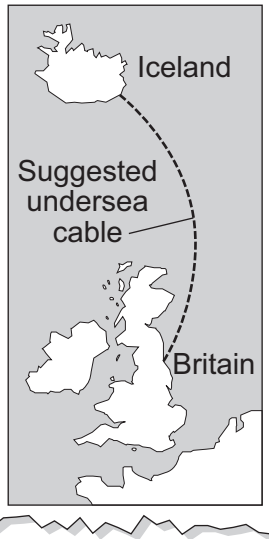
3 (b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate*.

Read the following extract from a newspaper.

Britain may be switched on by Iceland

Iceland is the only country in the world generating all of its electricity from a combination of geothermal and hydroelectric power stations. However, Iceland is using only a small fraction of its energy resources. It is estimated that using only these resources, the amount of electricity generated could be increased by up to four times.

To help supply the future demand for electricity in Britain, there are plans to build thousands of new offshore wind turbines. It has also been suggested that the National Grid in Britain could be linked to the electricity generating systems in Iceland. This would involve laying a 700 mile undersea electricity cable between Iceland and Britain.



Discuss the advantages and disadvantages of the plan to build thousands of offshore wind turbines around Britain **and** the suggested electricity power link between Britain and Iceland.

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(6 marks)

9

Turn over for the next question

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

4 Warm air inside a house contains water in the form of a gas. The water condenses onto cold surfaces such as windows. This leaves liquid water on the inside of the glass.

4 (a) Explain what happens to the particles when water changes from a gas to a liquid.

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(2 marks)

4 (b) Many houses in the UK have double-glazed windows.

Section through double-glazed window

U-value = 2.8 W/m^2 °C

Section through single-glazed window

U-value = 5.0 W/m^2 °C

If the window is double-glazed rather than single-glazed there is less condensation on the inside of the glass.

Explain why.

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(2 marks)

Question 4 continues on the next page

4 (c) Double glazing can be made using two pieces of normal glass with an air gap between them. Better insulating glass (Superglaze or G-type) can be used instead of normal glass. The size of the air gap can also be increased to improve insulation.

A company making double glazing provides some information about their products.

U-values for different types of double glazing

	Normal glass	**Superglaze**	**G-type**
6 mm air gap	3.1	2.7	2.6
12 mm air gap	2.8	2.2	2.0
16 mm air gap	2.7	2.0	1.8

For the same size window, under the same temperature conditions, the energy loss halves if the U-value is halved.

Cost of double glazing in £ per m^2

	Normal glass	**Superglaze**	**G-type**
6 mm air gap	90	110	160
12 mm air gap	100	130	185
16 mm air gap	110	155	210

4 (c) (i) The data the double glazing company produced is checked and confirmed independently by other scientists.

Suggest why it is important to confirm the data independently.

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(1 mark)

4 (c) (ii) A homeowner is going to replace his old single-glazed windows with new double-glazed windows.

Discuss the cost of fitting double glazing using better insulating glass compared with double glazing using normal glass.

Use the information given in the tables.

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(3 marks)

8

Turn over for the next question

5 Radio waves and microwaves are two types of electromagnetic wave.

Both waves:

- can be used for communications
- travel at the same speed through air.

5 (a) Give **two** more properties that are the same for both radio waves and microwaves.

1 .....

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2 .....

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(2 marks)

5 (b) Some satellites are used to transmit television programmes. Signals are sent to, and transmitted from, the satellites using microwaves.

What is the property of microwaves that allows them to be used for satellite communications?

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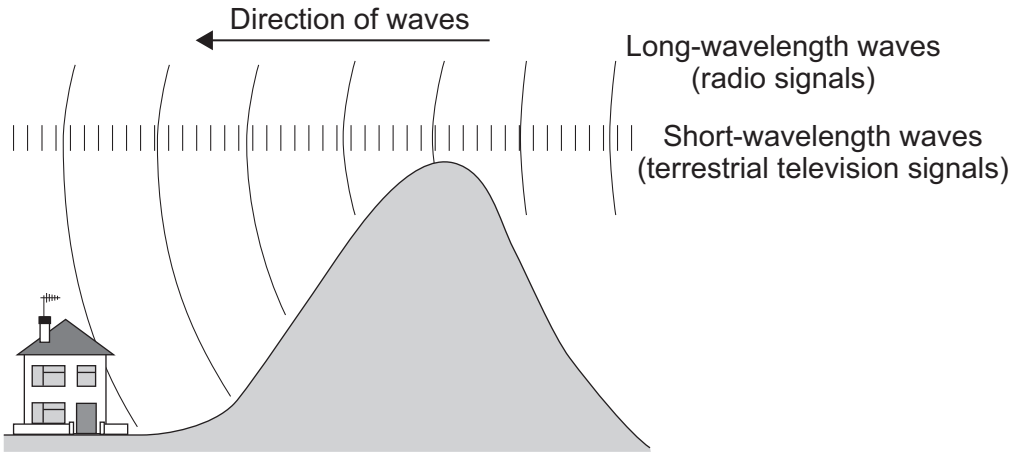
(1 mark)

5 (c) Terrestrial television does not use satellites.

Terrestrial television signals and radio signals both use radio waves.
Radio signals are transmitted at a longer wavelength than terrestrial television signals.



In hilly areas it may be possible to receive radio signals but not receive terrestrial television signals.

Explain why.

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(3 marks)

5 (d) Electromagnetic waves travel at a speed of 3.0×10^8 m/s.
A radio station transmits waves with a wavelength of 2.5×10^2 m.

Calculate the frequency of the radio waves.

Use the correct equation from the Physics Equations Sheet.

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

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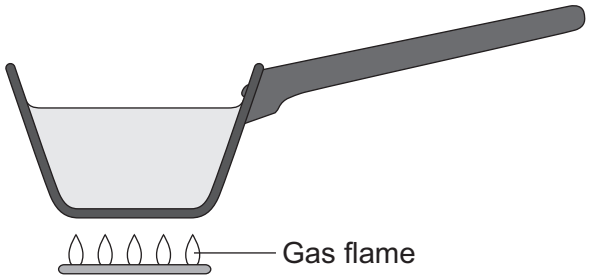
Frequency = ...

(3 marks)

9

Turn over for the next question

6 The diagram shows a metal pan being used to heat water.



Energy from the gas flame is transferred through the metal pan by conduction.

Explain the process of conduction through metals.

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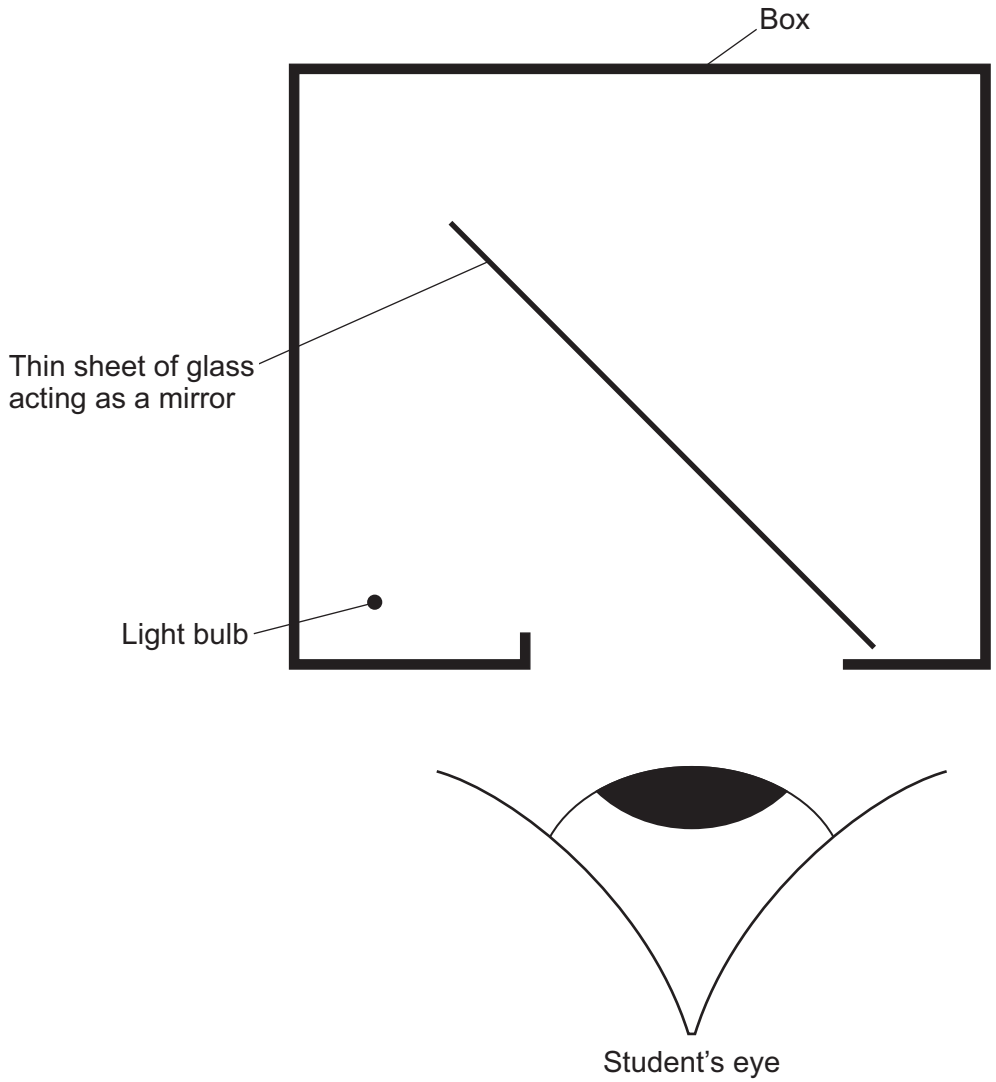
(4 marks)

4

7 The diagram shows a model used to demonstrate an illusion known as 'Pepper's Ghost'.

A small light bulb and thin sheet of glass are put inside a box. The thin sheet of glass acts as a mirror. Although the light bulb is switched on, a student looking into the box cannot see the bulb. What the student does see is a virtual image of the bulb.

View from above



7 (a) Use a ruler to complete a ray diagram to show how the image of the light bulb is formed. Mark and label the position of the image.

(4 marks)

7 (b) The image seen by the student is virtual.

Why?

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(1 mark)

5

8 (a) The 'Big Bang' theory uses red-shift as evidence to explain the beginning of the Universe.

How does the red-shift from distant galaxies provide evidence for the beginning of the Universe?

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(3 marks)

8 (b) Cosmic microwave background radiation (CMBR) is a type of electromagnetic radiation. CMBR fills the Universe. It was first discovered in 1965 by two astronomers called Penzias and Wilson.

8 (b) (i) What do scientists believe is the origin of CMBR?

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(1 mark)

8 (b) (ii) Why was the discovery of CMBR so important to the scientists believing the 'Big Bang' theory to be correct?

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(1 mark)

8 (b) (iii) How is the wavelength of CMBR likely to change, if at all, over the next billion years?

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Give a reason for your answer.

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(2 marks)

7

END OF QUESTIONS