New Document 2

Standard Demand

Name: _____

Class: _____

Date: _____

Time: **323 minutes**

Marks: **322 marks**

Comments:

1 Scientists sometimes replace one scientific model with a different model.

For example, in the early 20th Century the plum pudding model of the atom was replaced by the nuclear model of the atom.

Explain what led to the plum pudding model of the atom being replaced by the nuclear model of the atom.

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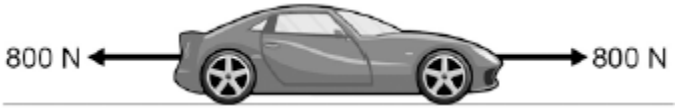
(Total 6 marks)

2 The figure below shows the horizontal forces acting on a car.



(a) Which **one** of the statements describes the motion of the car?

Tick **one** box.

It will be slowing down. ☐

It will be stationary. ☐

It will have a constant speed. ☐

It will be speeding up. ☐

(1)

(b) During part of the journey the car is driven at a constant speed for five minutes.

Which one of the equations links distance travelled, speed and time?

Tick **one** box.

distance travelled = speed + time ☐

distance travelled = speed × time ☐

distance travelled = speed − time ☐

distance travelled = speed ÷ time ☐

(1)

(c) During a different part of the journey the car accelerates from 9m / s to 18m / s in 6 s.

Use the following equation to calculate the acceleration of the car.

$$\text{acceleration} = \frac{\text{change in velociy}}{\text{time taken}}$$

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acceleration = ... m / s^2

(2)

(d) Which equation links acceleration, mass and resultant force?

Tick **one** box.

resultant force = mass + acceleration ☐

resultant force = mass × acceleration ☐

resultant force = mass − acceleration ☐

resultant force = mass ÷ acceleration ☐

(1)

(e) The mass of the car is 1120 kg. The mass of the driver is 80 kg.

Calculate the resultant force acting on the car and driver while accelerating.

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Resultant force = ... N

(2)

(f) Calculate the distance travelled while the car is accelerating.

Use the correct equation from the Physics Equation Sheet.

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Distance = ... m

(3)

(g) A car driver sees a fallen tree lying across the road ahead and makes an emergency stop.

The braking distance of the car depends on the speed of the car.

For the same braking force, explain what happens to the braking distance if the speed doubles.

You should refer to kinetic energy in your answer.

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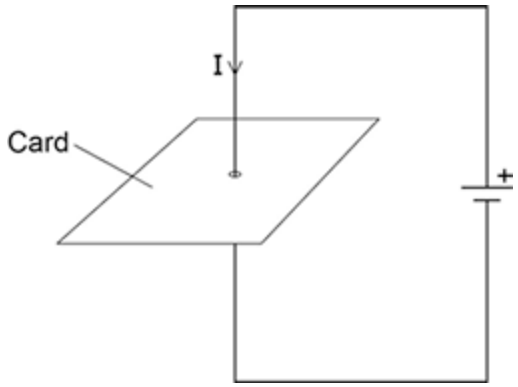
(4)

(Total 14 marks)

3 **Figure 1** shows a straight wire passing through a piece of card.

A current (I) is passing down through the wire.

Figure 1



(a) Describe how you could show that a magnetic field has been produced around the wire.

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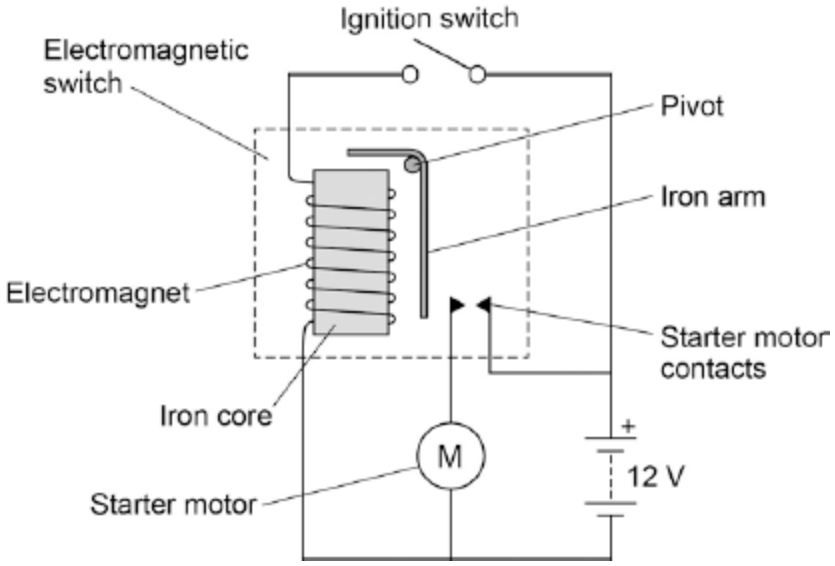
(2)

(b) **Figure 2** shows the ignition circuit used to switch the starter motor in a car on.

The circuit includes an electromagnetic switch.

Figure 2



Explain how the ignition circuit works.

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(4)
(Total 6 marks)

4 The data given in the table below was obtained from an investigation into the refraction of light at an air to glass boundary.

Angle of incidence	Angle of refraction
20°	13°
30°	19°
40°	25°
50°	30°

Describe an investigation a student could complete in order to obtain similar data to that given in the table above.

Your answer should consider any cause of inaccuracy in the data.

A labelled diagram may be drawn as part of your answer.

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(Total 6 marks)

5 **Figure 1** shows a straight wire passing through a piece of card.

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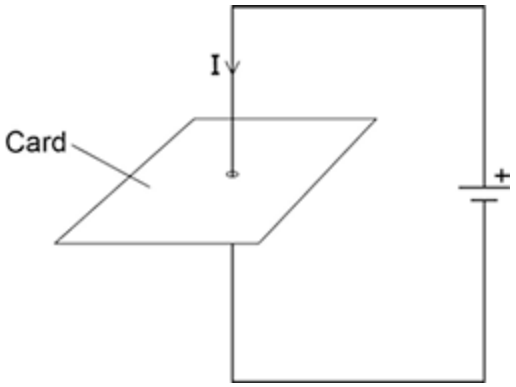

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(2)

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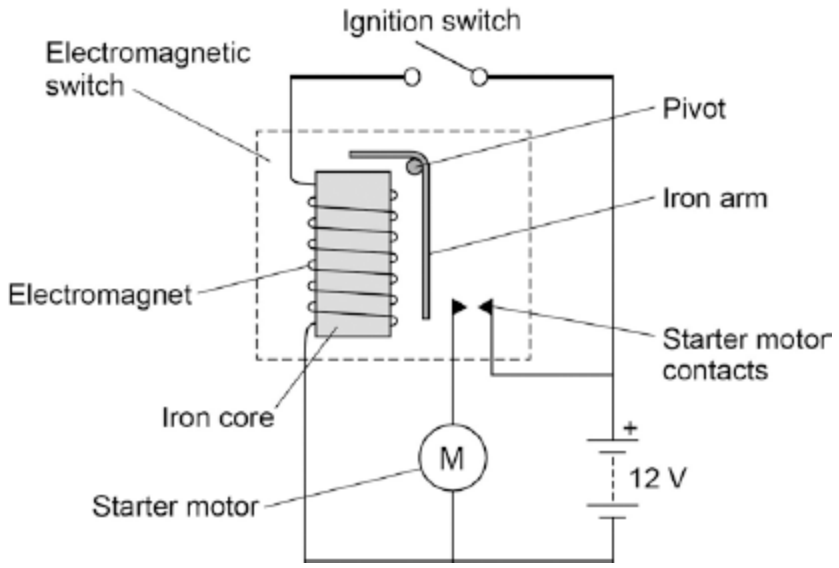
Figure 2



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Your answer should consider any cause of inaccuracy in the data.

A labelled diagram may be drawn as part of your answer.

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(6)

(b) State the reason why light is refracted as it crosses from air into glass.

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(1)

(Total 7 marks)

7 A small community of people live in an area in the mountains.
The houses are not connected to the National Grid.

The people plan to buy an electricity generating system that uses either the wind or the flowing water in a nearby river.

Figure 1 shows where these people live.

Figure 1

© Brian Lawrence/Getty Images

(a) It would not be economical to connect the houses to the National Grid.
Give **one** reason why.

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(1)

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

Information about the two electricity generation systems is given in **Figure 2**.

Figure 2

The wind turbine costs £50 000 to buy and install.
The hydroelectric generator costs £20 000 to buy and install.
The average power output from the wind turbine is 10 kW.
The hydroelectric generator will produce a constant power output of 8 kW.

Compare the advantages and disadvantages of the two methods of generating electricity.

Use your knowledge of energy sources as well as information from **Figure 2**.

(6)
(Total 7 marks)

8 Alpha particles, beta particles and gamma rays are types of nuclear radiation.

(a) Describe the structure of an alpha particle.

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(1)

(b) Nuclear radiation can change atoms into ions by the process of ionisation.

(i) Which type of nuclear radiation is the least ionising?

Tick (✓) **one** box.

alpha particles ☐

beta particles ☐

gamma rays ☐

(1)

(ii) What happens to the structure of an atom when the atom is ionised?

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(1)

(c) People working with sources of nuclear radiation risk damaging their health.

State **one** precaution these people should take to reduce the risk to their health.

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(1)

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

The type of radiation emitted from a radioactive source can be identified by comparing the properties of the radiation to the properties of alpha, beta and gamma radiation.

Describe the properties of alpha, beta and gamma radiation in terms of their:

- penetration through materials
- range in air
- deflection in a magnetic field.

(6)

(Total 10 marks)

9 (a) Electromagnets are often used at recycling centres to separate some types of metals from other materials.

Give **one** reason why an electromagnet would be used rather than a permanent magnet.

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(1)

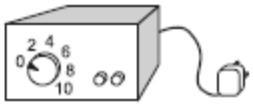
(b) **In this question you will gain marks for using good English, organising information clearly and using scientific words correctly.**

Some students want to build an electromagnet.

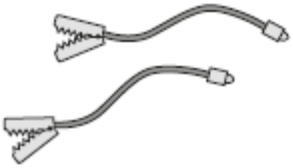
The students have the equipment shown below.

Insulated wire

Iron nail

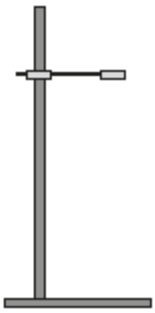


Power supply



Connecting leads

Steel paperclips



Wooden clamp and stand

Describe how the students could build an electromagnet. Include in your answer how the students should vary and test the strength of their electromagnet.

(6)

(Total 7 marks)

10 The early Universe contained only the lightest element.

(a) Use the correct answer from the box to complete the sentence.

hydrogen	**iron**	**uranium**

The early Universe contained only ..... .

(1)

(b) Use the correct answer from the box to complete the sentence.

main sequence star	**protostar**	**supernova**

The heaviest elements are formed only in a ..... .

(1)

(c) Use the correct answer from the box to complete the sentence.

red giant	**red super giant**	**white dwarf**

Only a star much bigger than the Sun can become a ..... .

(1)

(d) The Universe now contains a large variety of different elements.

Describe how this happened.

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(4)

(Total 7 marks)

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

A householder wants to reduce her energy bills. She collected information about a number of ways of reducing energy used. The information is shown in the table.

Ways of reducing energy used	**Cost to buy and install in £**	**Money saved per year in £**
Install an energy-efficient boiler	2 000	320
Insulate the loft	400	200
Install double-glazed windows	12 000	120
Install cavity wall insulation	415	145

Use the information in the table to compare the different ways of reducing the energy used. Your answer should include some calculations.

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(6)

(b) Increasing the amount of insulation in a house affects the total U-value of the house.

(i) What is meant by the term ‘U-value’?

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(1)

(ii) How is the U-value affected by increasing the amount of insulation?

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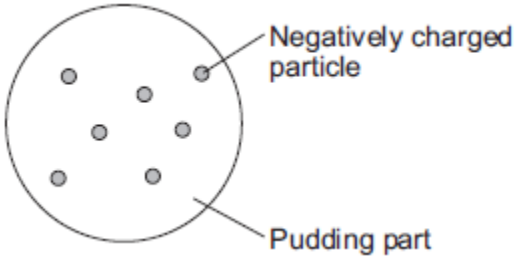
(1)
(Total 8 marks)

12 (a) Over 100 years ago, scientists thought the atom was like a 'plum pudding'.
The diagram below shows the plum pudding model of the atom.



The scientists knew that an atom has negatively charged particles. They also knew that an atom has no overall charge.

What did the scientists conclude about the **charge** on the 'pudding part' of the atom?

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(1)

(b) Two scientists named Rutherford and Marsden devised an experiment to investigate the plum pudding model of the atom. The experiment involved firing alpha particles at a thin sheet of gold. The scientists measured how many of the alpha particles were scattered.

Using the plum pudding model, the scientists predicted that only a few of the alpha particles would be scattered by more than 4°.

Over several months, more than 100 000 measurements were made.

(i) The results from this experiment caused the plum pudding model to be replaced by a new model of the atom.

Explain why.

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(2)

(ii) Suggest **one** reason why other scientists thought this experiment provided valid evidence for a new model of the atom.

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(1)

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

Describe the model now used for the structure of an atom.

In your answer you should:

- give details of the individual particles that make up an atom
- include the relative masses and relative charges of these particles.

Do **not** include a diagram in your answer.

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(6)
(Total 10 marks)

13 (a) Complete the following sentences.

Ultrasound waves have a minimum frequency

of ..... hertz.

The wavelength of an X-ray is about the same as

the diameter of ..... .

(2)

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

The images show one medical use of ultrasound and one medical use of X-rays.

©monkeybusinessimages/iStock/Thinkstock

© targovecom/iStock/Thinkstock

Compare the medical uses of ultrasound and X-rays.

Your answer should include the risks, if any, and precautions, if any, associated with the use of ultrasound and X-rays.

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(6)
(Total 8 marks)

14 Solid, liquid and gas are three different states of matter.

(a) Describe the difference between the solid and gas states, in terms of the arrangement and movement of their particles.

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(4)

(b) What is meant by ‘specific latent heat of vaporisation’?

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(2)

(c) While a kettle boils, 0.018 kg of water changes to steam.

Calculate the amount of energy required for this change.

Specific latent heat of vaporisation of water = 2.3×10^6 J / kg.

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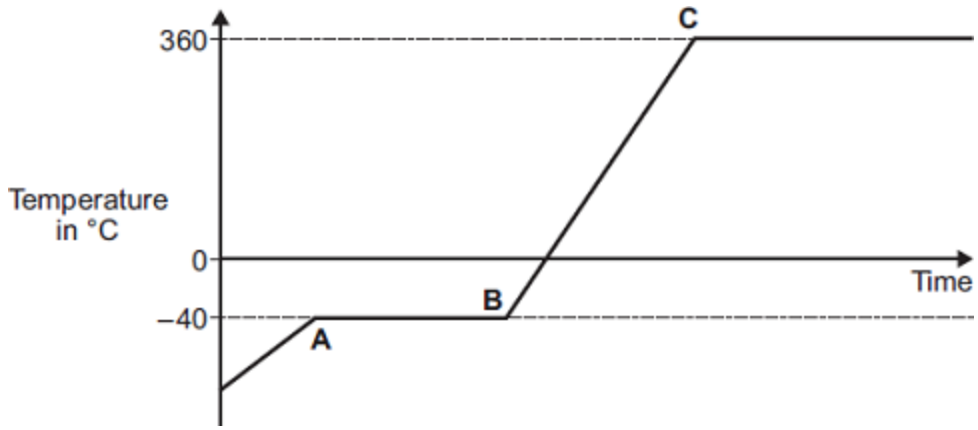
Energy required = ... J

(2)

(d) The graph shows how temperature varies with time for a substance as it is heated.

The graph is **not** drawn to scale.



Explain what is happening to the substance in sections **AB** and **BC** of the graph.

Section **AB** .....

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Section **BC** .....

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(4)
(Total 12 marks)

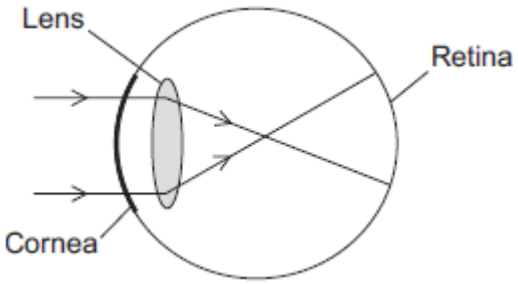
15 Lenses can be used to correct visual defects.

Figure 1 shows a child wearing glasses.
Wearing glasses allows a lens to correct a visual defect.

Figure 1

(a) **Figure 2** shows rays of light entering a child's eye and being focused at a point.
This point is not on the retina so the child sees a blurred image.

Figure 2



(i) What is the visual defect of this eye?

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(1)

(ii) Use the correct answer from the box to complete the sentence.

converging	convex	diverging

The type of lens used to correct this visual defect is a ..... lens.

(1)

(b) Visual defects may be corrected with eye surgery. A laser may be used in eye surgery.

Use the correct answer from the box to complete the sentence.

light	**sound**	**X-rays**

A laser is a concentrated source of ..... .

(1)

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

Lasers can be used to correct a visual defect by changing the shape of the cornea.

A knife is used to cut a flap in the cornea. The laser vaporises a portion of the cornea and permanently changes its shape. The flap is then replaced.

Most patients are back at work within a week. Driving may be unsafe for one to two weeks. Tinted glasses with ultraviolet protection are needed when out in the sun for the first three months.

Many people in their mid-40s need reading glasses. This is because the eye lens becomes less flexible with age. Laser surgery cannot cure this.

Laser surgery for both eyes costs £1000. A pair of glasses costs £250.

Describe the advantages and disadvantages of:

- having laser surgery to correct visual defects
- wearing glasses to correct visual defects.

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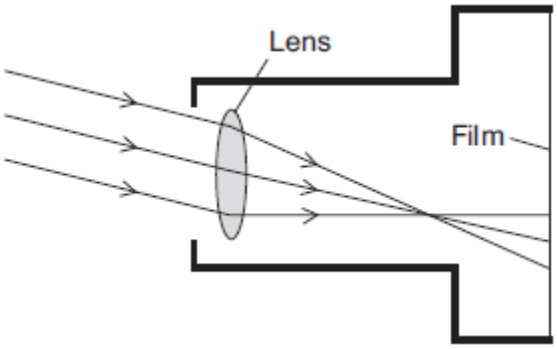
(6)

(d) **Figure 3** shows parallel rays of light, from a point on a distant object, entering a camera.

Figure 3



Describe the adjustment that has to be made to focus the image on the film.

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(2)

(Total 11 marks)

16 (a) A company is developing a system which can heat up and melt ice on roads in the winter. This system is called 'energy storage'.

During the summer, the black surface of the road will heat up in the sunshine.

This energy will be stored in a large amount of soil deep under the road surface.
Pipes will run through the soil. In winter, cold water entering the pipes will be warmed and brought to the surface to melt ice.

The system could work well because the road surface is black.

Suggest why.

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(1)

(b) (i) What is meant by specific latent heat of fusion?

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(2)

(ii) Calculate the amount of energy required to melt 15 kg of ice at 0 °C.

Specific latent heat of fusion of ice = 3.4×10^5 J/kg.

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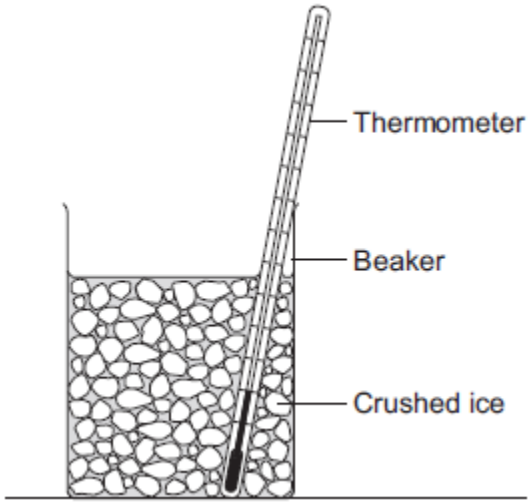
Energy = ... J

(2)

(c) Another way to keep roads clear of ice is to spread salt on them.
When salt is added to ice, the melting point of the ice changes.

A student investigated how the melting point of ice varies with the mass of salt added.

The figure below shows the equipment that she used.



The student added salt to crushed ice and measured the temperature at which the ice melted.

(i) State **one** variable that the student should have controlled.

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(1)

(ii) During the investigation the student stirred the crushed ice.

Suggest **two** reasons why.

Tick (✓) **two** boxes.

	Tick (✓)
To raise the melting point of the ice	
To lower the melting point of the ice	
To distribute the salt throughout the ice	
To keep all the ice at the same temperature	
To reduce energy transfer from the surroundings to the ice	

(2)

(iii) The table below shows the data that the student obtained.

Mass of salt added in grams	0	10	20
Melting point of ice in °C	0	-6	-16

Describe the pattern shown in the table.

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(1)

(d) Undersoil electrical heating systems are used in greenhouses. This system could also be used under a road.

A cable just below the ground carries an electric current. One greenhouse system has a power output of 0.50 kW.

Calculate the energy transferred in 2 minutes.

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Energy transferred = ... J

(3)

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

A local council wants to keep a particular section of a road clear of ice in the winter.

Describe the advantages and disadvantages of keeping the road clear of ice using:

- energy storage
- salt
- undersoil electrical heating.

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Extra space .....

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(6)
(Total 18 marks)

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

The information in the box is about the properties of solids and gases.

Solids:
- have a fixed shape
- are difficult to compress (to squash).

Gases:
- will spread and fill the entire container
- are easy to compress (to squash).

Use your knowledge of kinetic theory to explain the information given in the box.

You should consider:
- the spacing between the particles
- the movement of individual particles
- the forces between the particles.

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(Total 6 marks)

18 (a) Iceland is a country that generates nearly all of its electricity from renewable sources.

In 2013, about 80% of Iceland's electricity was generated using hydroelectric power stations (HEP).

Describe how electricity is generated in a hydroelectric power station. Include the useful energy transfers taking place.

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(4)

(b) The UK produces most of its electricity from fossil fuels.

Many people in the UK leave their televisions in 'stand by' mode when not in use, instead of switching them off.

It is better for the environment if people switch off their televisions, instead of leaving them in 'stand by' mode.

Explain why.

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(3)

(c) A scientist wrote in a newspaper:

'Appliances that do not automatically switch off when they are not being used should be banned.'

Suggest why scientists alone cannot make the decision to ban these appliances.

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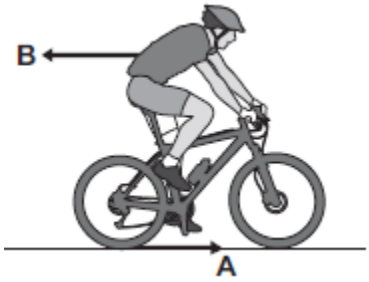
(1)
(Total 8 marks)

19 (a) **Figure 1** shows the horizontal forces acting on a moving bicycle and cyclist.

Figure 1



(i) What causes force **A**?

Draw a ring around the correct answer.

friction **gravity** **weight**

(1)

(ii) What causes force **B**?

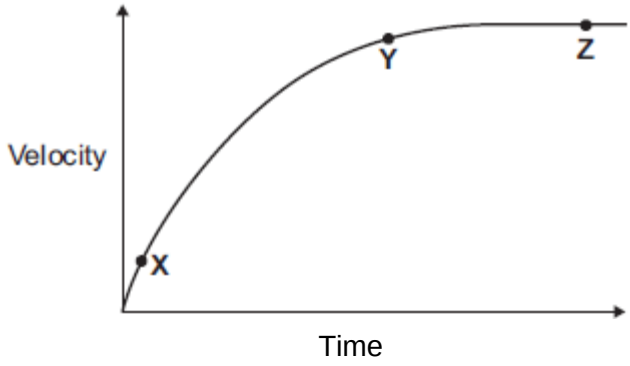
....

(1)

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

Figure 2 shows how the velocity of the cyclist changes during the first part of a journey along a straight and level road. During this part of the journey the force applied by the cyclist to the bicycle pedals is constant.

Figure 2



Describe how **and** explain, in terms of the forces **A** and **B**, why the velocity of the cyclist changes:

- between the points **X** and **Y**
- and between the points **Y** and **Z**, marked on the graph in **Figure 2**.

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Extra space .....

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(6)

(b) (i) The cyclist used the brakes to slow down and stop the bicycle.

A constant braking force of 140 N stopped the bicycle in a distance of 24 m.

Calculate the work done by the braking force to stop the bicycle. Give the unit.

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Work done = ...

(3)

(ii) Complete the following sentences.

When the brakes are used, the bicycle slows down. The kinetic energy of the

bicycle ..... .

At the same time, the ..... of the brakes increases.

(2)

(Total 13 marks)

20 Stars go through a life cycle.

Some stars will finish their life cycle as a black dwarf and other stars as a black hole.

(a) The table below gives the mass, relative to the Sun, of three stars, **J**, **K** and **L**.

Star	Mass of the star relative to the Sun
J	0.5
K	14.5
L	20.0

Which **one** of the stars, **J**, **K** or **L**, will become a black dwarf? .....

Give a reason for your answer.

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(2)

(b) Scientists can take the measurements needed to calculate the mass of many stars.

Scientists cannot calculate the mass of the star Betelgeuse.

They estimate that the star has a mass between 8 and 20 times the mass of the Sun.

(i) Betelgeuse is in the red super giant stage of its life cycle.

What will happen to Betelgeuse at the end of the red super giant stage?

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(1)

(ii) Suggest **one** reason why scientists can only estimate and **not** calculate the mass of Betelgeuse.

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(1)

(iii) In the future, it may become possible for scientists to calculate the mass of Betelgeuse.

Suggest **one** reason why.

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(1)

(c) Describe what happens to a star, after the main sequence period, for the star to eventually become a **black dwarf**.

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(5)
(Total 10 marks)

21 Waves may be longitudinal or transverse.

(a) Describe the differences between longitudinal waves and transverse waves.

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(3)

(b) Radio waves are electromagnetic waves.

Describe how radio waves are different from sound waves.

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(4)
(Total 7 marks)

22 Nuclear fission and nuclear fusion are two processes that release energy.

(a) (i) Use the correct answer from the box to complete each sentence.

Geiger counter	**nuclear reactor**	**star**

Nuclear fission takes place within a ..... .

Nuclear fusion takes place within a ..... .

(2)

(ii) State **one** way in which the process of nuclear fusion differs from the process of nuclear fission.

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(1)

(b) The following nuclear equation represents the fission of uranium-235 (U-235).

$$^{1}_{0}n + {}^{235}_{92}U \longrightarrow {}^{236}_{92}U \longrightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3\,{}^{1}_{0}n + \text{energy}$$

Chemical symbols:

Ba - barium

Kr - krypton

(i) Use the information in the equation to describe the process of nuclear fission.

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(4)

(ii) An isotope of barium is Ba-139.
Ba-139 decays by beta decay to lanthanum-139 (La-139).

Complete the nuclear equation that represents the decay of Ba-139 to La-139.

$$^{139}Ba \longrightarrow {}^{139}La + \text{.....}$$

(3)

(Total 10 marks)

23 Electrical circuits have resistance.

(a) Draw a ring around the correct answer to complete the sentence.

When the resistance of a circuit increases, the current in the circuit

decreases.
increases.
stays the same.

(1)

(b) Use the correct answer from the box to complete each sentence.

a filament bulb	**an LED**	**an LDR**

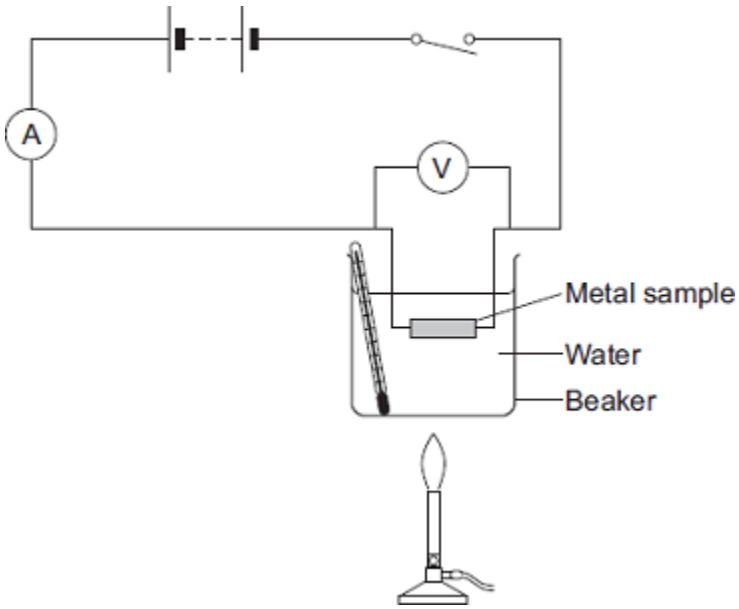
An electrical component which has a resistance that increases as the temperature increases is ..... .

An electrical component which emits light only when a current flows through it in the forward direction is ..... .

(2)

(c) When some metals are heated the resistance of the metal changes.

The equipment for investigating how the resistance of a metal changes when it is heated is shown in the diagram.



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

Describe an investigation a student could do to find how the resistance of a metal sample varies with temperature. The student uses the equipment shown.

Include in your answer:

- how the student should use the equipment
- the measurements the student should make
- how the student should use these measurements to determine the resistance
- how to make sure the results are valid.

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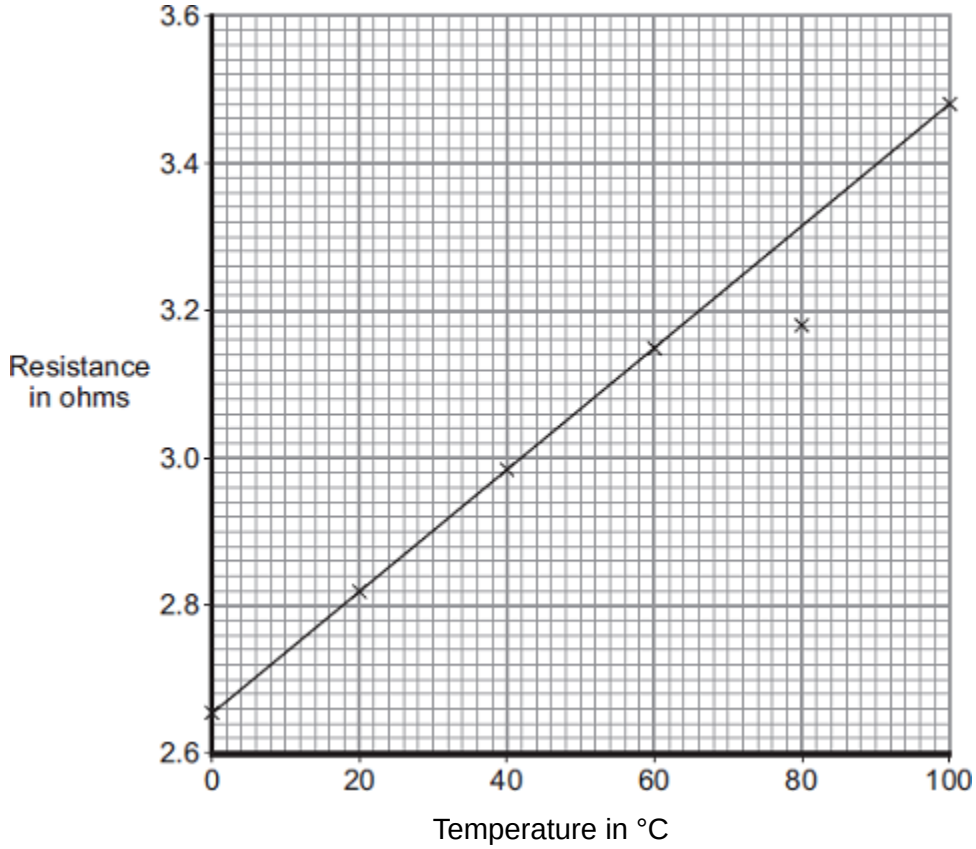
(6)

(d) The table shows some data for samples of four metals **P**, **Q**, **R** and **S**.

The metal samples all had the same cross-sectional area and were the same length.

Metal sample	Resistance at 0°C in ohms	Resistance at 100°C in ohms
P	4.05	5.67
Q	2.65	3.48
R	6.0	9.17
S	1.70	2.23

A graph of the results for one of the metal samples is shown.



(i) Which metal sample, **P**, **Q**, **R** or **S**, has the data shown in the graph? ☐

(1)

(ii) One of the results is anomalous. Circle this result on the graph.

(1)

(iii) Suggest a reason for the anomalous result.

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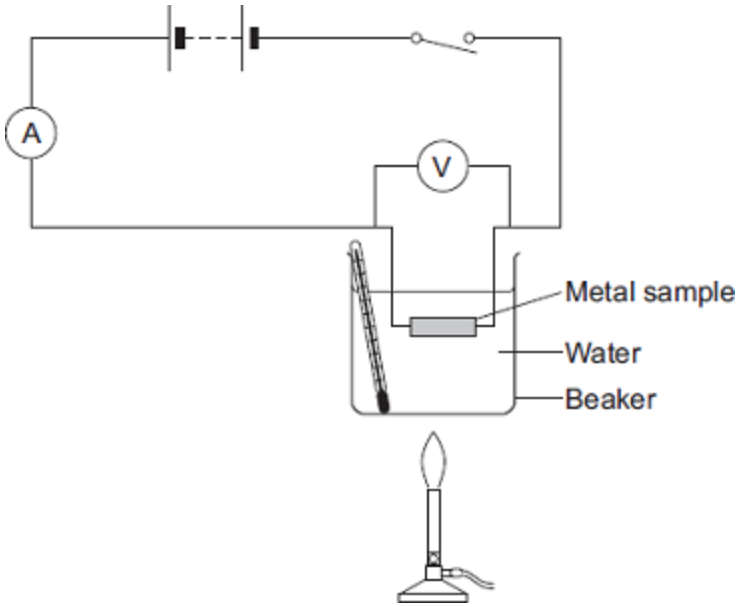
(1)

(iv) The same equipment used in the investigation could be used as a thermometer known as a 'resistance thermometer.'



Suggest **two** disadvantages of using this equipment as a thermometer compared to a liquid-in-glass thermometer.

1 .....

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2 .....

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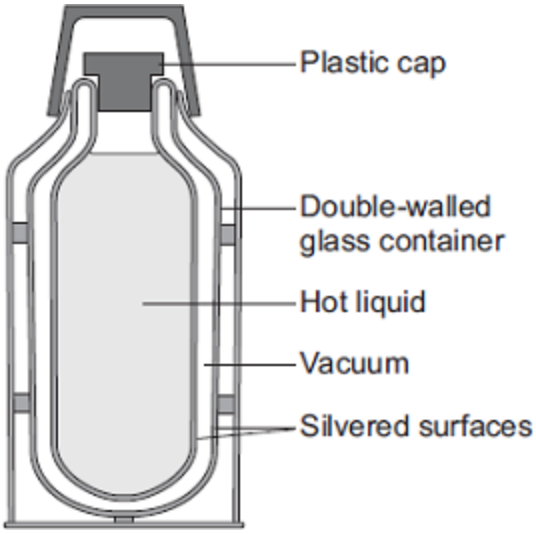
(2)

(Total 14 marks)

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

The diagram shows the structure of a vacuum flask.



A vacuum flask is designed to reduce the rate of energy transfer by heating processes.

Describe how the design of a vacuum flask keeps the liquid inside hot.

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(6)

(b) Arctic foxes live in a very cold environment.

© Purestock/Thinkstock

Arctic foxes have small ears.

How does the size of the ears help to keep the fox warm in a cold environment?

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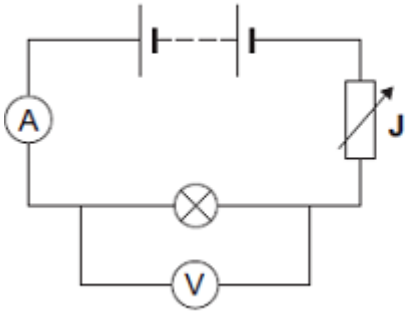
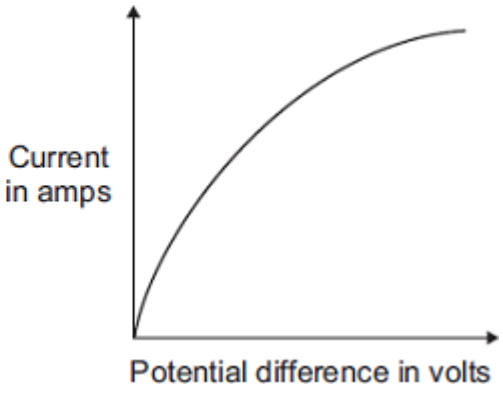
(2)
(Total 8 marks)

25 (a) The diagram shows the circuit used to obtain the data needed to plot the current–potential difference graph for a filament bulb.





(i) Why is the component labelled '**J**' included in the circuit?

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(1)

(ii) The resistance of the bulb increases as the potential difference across the bulb increases. Why?

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(1)

(iii) The bulb is at full brightness when the potential difference across the bulb is 12 V. The current through the bulb is then 3 A.

Calculate the power of the bulb when it is at full brightness and give the unit.

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Power = ...

(3)

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

The table gives data about two types of light bulb people may use in their homes.

Type of light bulb	Energy efficiency	Cost of one light bulb	Average lifetime in hours
Halogen	10%	£1.95	2 000
Light Emitting Diode (LED)	32%	£11.70	36 000

Both types of light bulb produce the same amount of light.

Evaluate, in terms of cost and energy efficiency, the use of the two types of light bulb.

To gain full marks you must compare both types of light bulb and conclude which light bulb would be the best to use.

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(6)
(Total 11 marks)

26 Ultrasound and X-rays are waves used in hospitals to create images of the inside of the human body. To produce the images below, the waves must enter the human body.

Ultrasound scan of an unborn child

© Isabelle Limbach/Thinkstock

X-ray of a broken bone

© itsmejust/iStock

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

Describe the features of ultrasound and X-rays, and what happens to each type of wave after it has entered the human body.

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(6)

(b) It would **not** be safe to use X-rays to produce an image of an unborn child.

Explain why.

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(2)

(c) Ultrasound can be used for medical treatments as well as for imaging.

Give **one** use of ultrasound for medical treatment.

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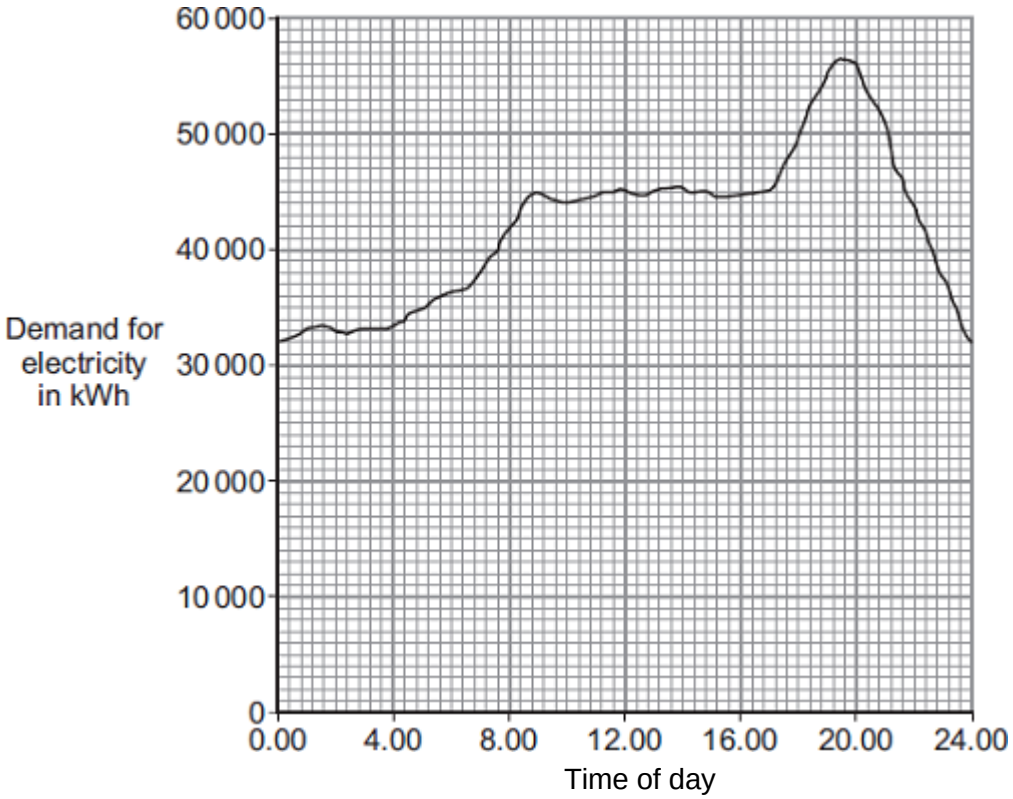
(1)
(Total 9 marks)

27 (a) The graph shows how the demand for electricity in the UK changes during one 24-hour period.



The table gives the start-up times for two types of power station.

Type of power station	Start-up time
Gas	A few minutes
Nuclear	Several days

How would these two types of power station be used to meet the demand for electricity during this 24-hour period?

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(3)

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

A farmer plans to generate all the electricity needed on her farm, using either a biogas generator or a small wind turbine.

The biogas generator would burn methane gas. The methane gas would come from rotting the animal waste produced on the farm. When burnt, methane produces carbon dioxide.

The biogas generator would cost £18 000 to buy and install. The wind turbine would cost £25 000 to buy and install.

The average power output from the wind turbine would be the same as the continuous output from the biogas generator.

Evaluate the advantages and disadvantages of the two methods of generating electricity.

Conclude, with a reason, which system would be better for the farmer to buy and install.

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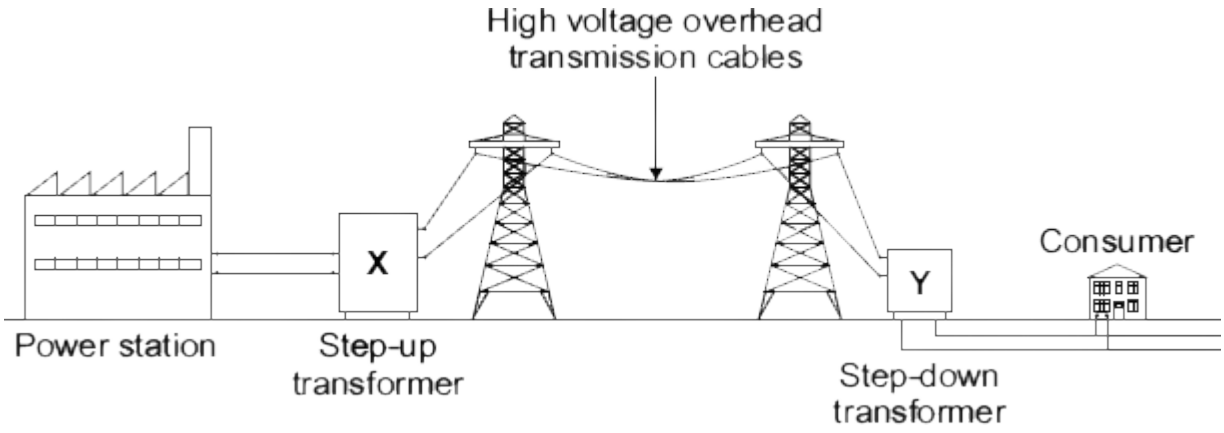
(6)
(Total 9 marks)

28 The diagram shows the National Grid system.



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

Explain why.

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(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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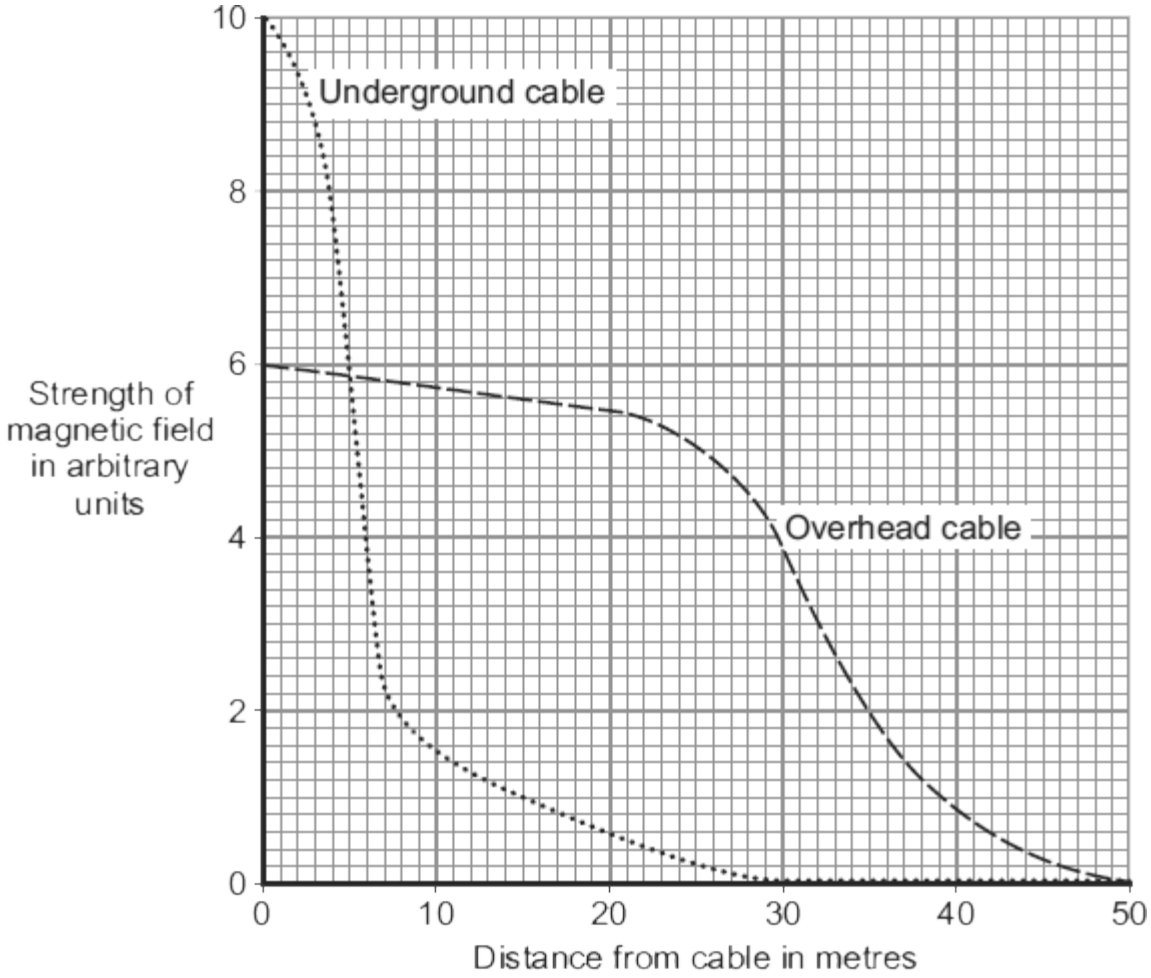
(6)

(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)

(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)

(Total 11 marks)

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

(i) What is geothermal energy?

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(1)

(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)

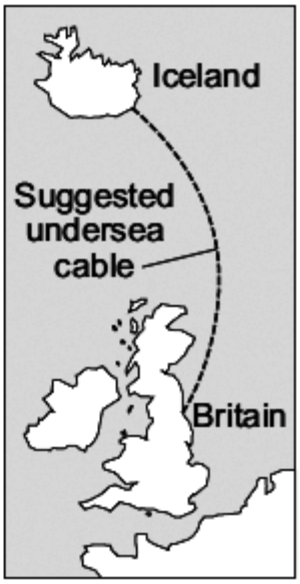
(b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

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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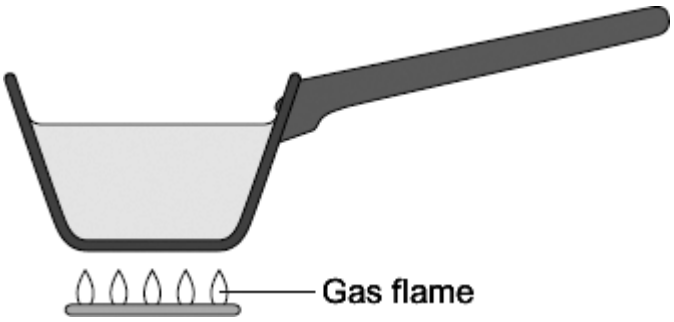
(6)
(Total 9 marks)

30 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)
(Total 4 marks)

31 (a) The diagram shows the forces acting on a parachutist in free fall.

The parachutist has a mass of 75 kg.

Calculate the weight of the parachutist.

gravitational field strength = 10 N/kg

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

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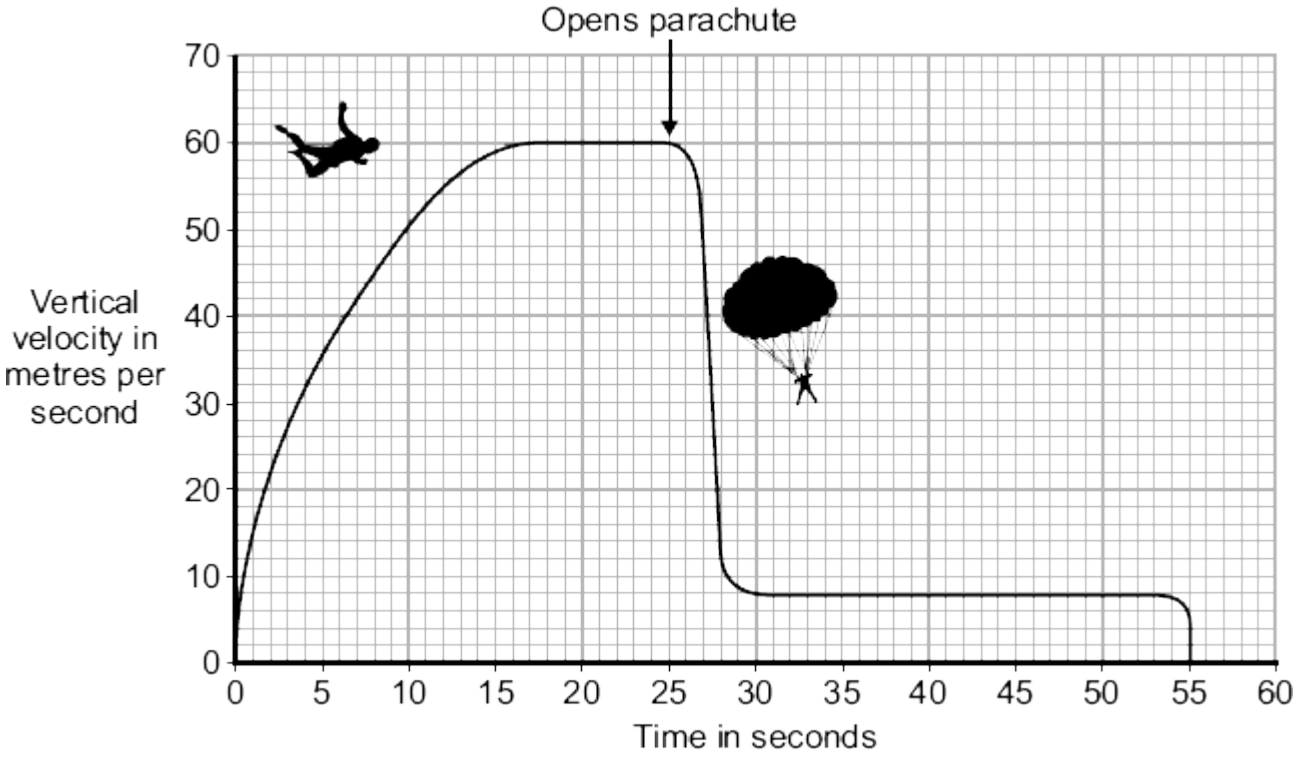
.....

Weight = ...

(3)

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

The graph shows how the vertical velocity of a parachutist changes from the moment the parachutist jumps from the aircraft until landing on the ground.



Using the idea of forces, explain why the parachutist reaches a terminal velocity and why opening the parachute reduces the terminal velocity.

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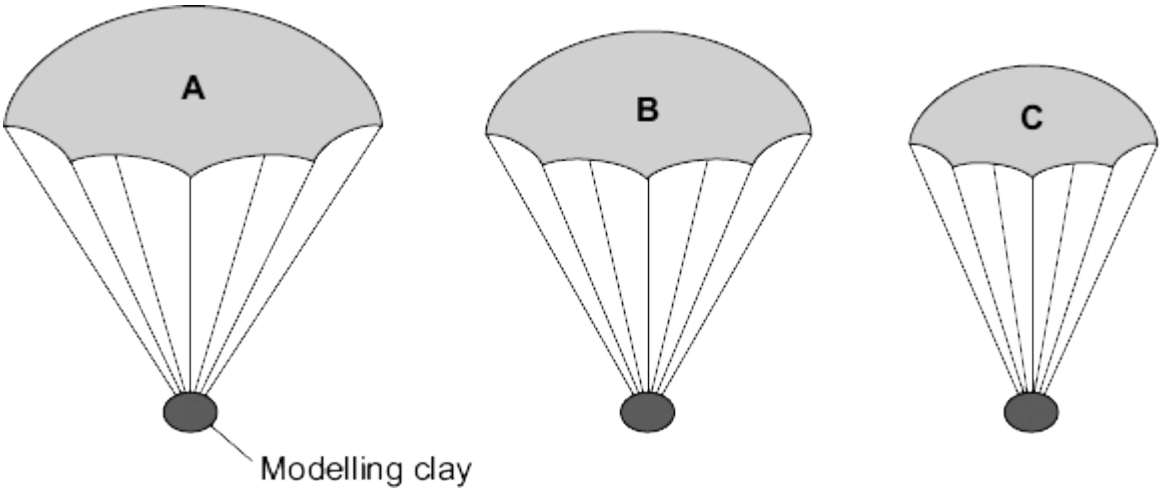
(6)

(c) A student wrote the following hypothesis.

'*The larger the area of a parachute, the slower a parachutist falls.*'

To test this hypothesis the student made three model parachutes, **A**, **B** and **C**, from one large plastic bag. The student dropped each parachute from the same height and timed how long each parachute took to fall to the ground.



(i) The height that the student dropped the parachute from was a control variable.

Name **one** other control variable in this experiment.

.....

(1)

(ii) Use the student's hypothesis to predict which parachute, **A**, **B** or **C**, will hit the ground first.

Write your answer in the box.

Give a reason for your answer.

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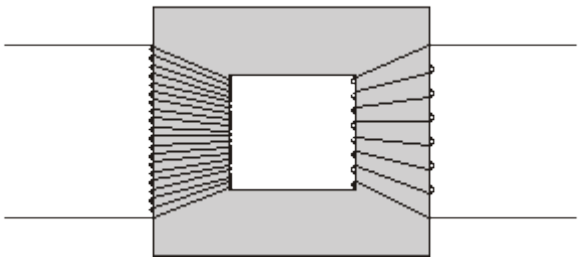
(2)
(Total 12 marks)

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



(i) Why is the core made of iron?

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(1)

(ii) Explain how a transformer works.

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(4)

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

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

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

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

Show clearly how you work out your answer.

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Number of turns = ...

(2)

(Total 7 marks)

33 (a) Name a material that could be used to make the outside case of the plug.

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Give a reason for your choice.

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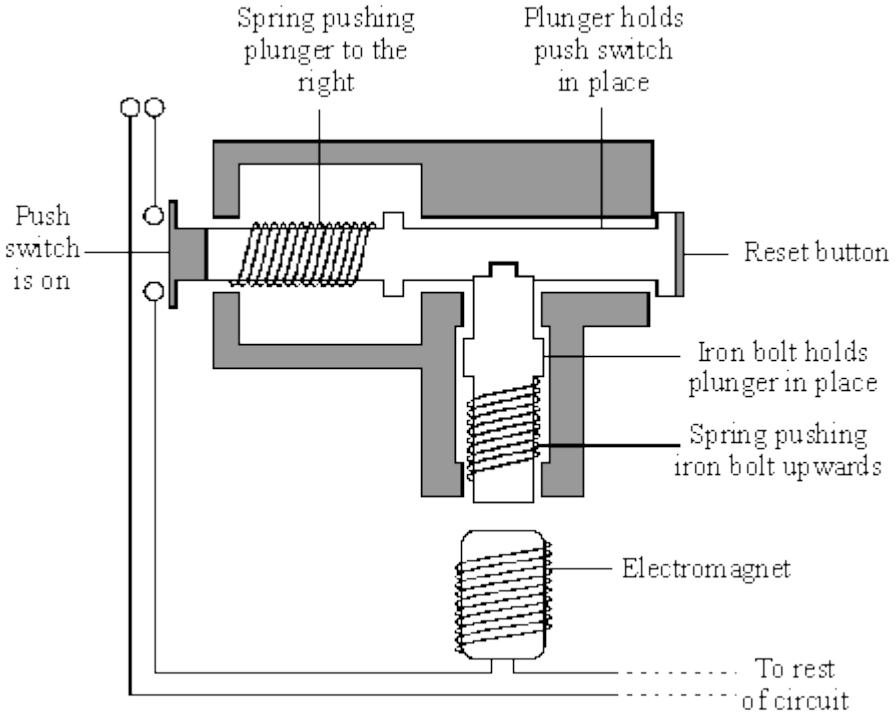
(2)

(b) *To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

Some electrical circuits are protected by a circuit breaker. These switch the circuit off if a fault causes a larger than normal current to flow. The diagram shows one type of circuit breaker. A normal current (15 A) is flowing.



Source: adapted from V. PRUDEN and K. HIRST, *AQA GCSE Sceince*

Explain what happens when a current larger than 15A flows. The answer has been started for you.

When the current goes above 15 A, the electromagnet becomes stronger and

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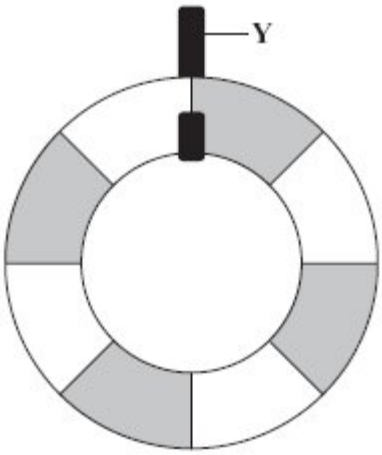
(3)
(Total 5 marks)

34 (a) The diagram shows a lifebelt. It is hanging freely from hook **Y**.

(i) On the diagram, mark with an **X** the point where you think the centre of mass of the lifebelt will be.



(1)

(ii) Explain why you have chosen this point.

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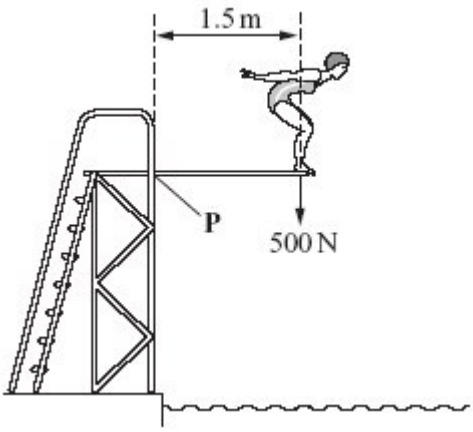
(2)

(b) The drawing shows Susan on a diving board. She is 1.5 metres from point **P** and she weighs 500 N.



Calculate her moment (turning effect) about point **P**.
Show clearly how you work out your answer and give the unit.

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.....

Moment about **P** = ...

(3)

(c) Susan has a case with wheels.

When she packs this case, she puts the heaviest items at the end where the wheels are. This means that the heaviest items are less likely to crush the other contents and it helps her to find things when she opens the case.

Explain another advantage of packing her case in this way.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

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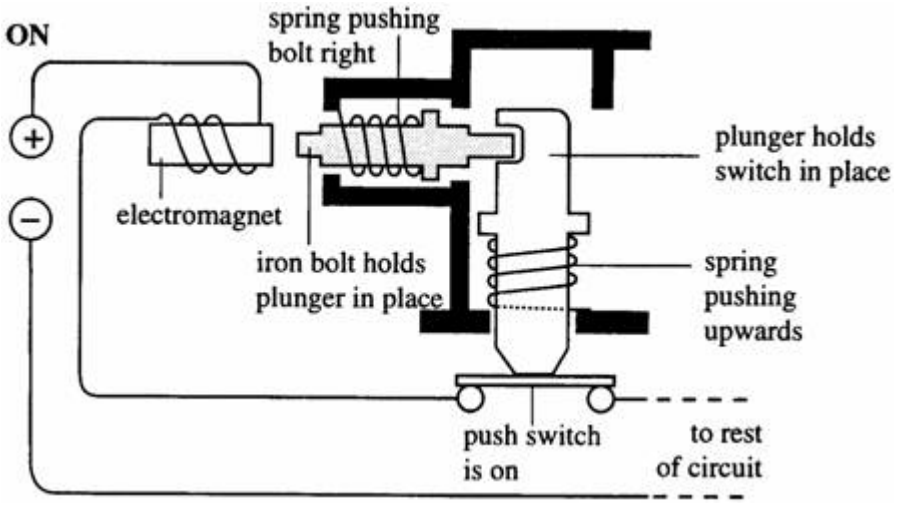
(4)
(Total 10 marks)

35 A fault in an electrical circuit can cause too great a current to flow. Some circuits are switched off by a circuit breaker.



One type of circuit breaker is shown above. A normal current is flowing.
Explain, in full detail, what happens when a current which is bigger than normal flows.

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(Total 4 marks)

36 State and explain the advantages and disadvantages of using nuclear power stations to produce electricity.

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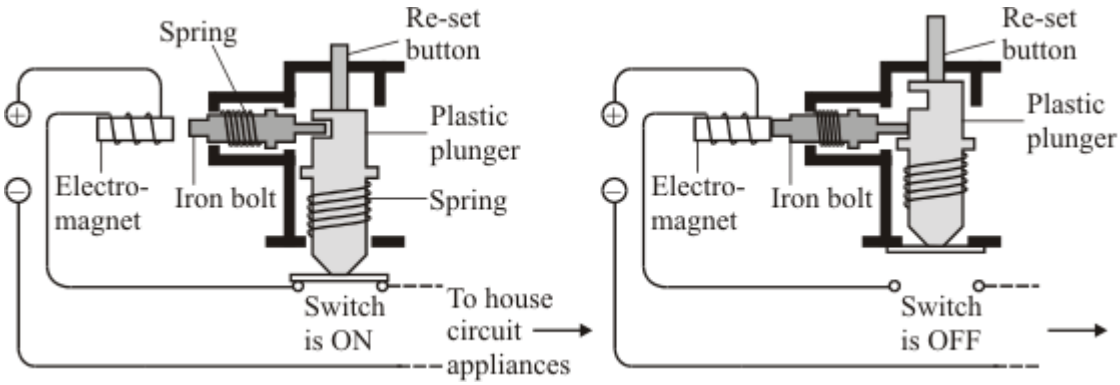
(Total 4 marks)

37 Circuit breakers help to make the electricity supply in homes safer.
A circuit breaker is an automatic safety switch. It cuts off the current if it gets too big.



Describe, in as much detail as you can, how this circuit breaker works.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

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(Total 6 marks)

1

Level 3 (5–6 marks):
A detailed and coherent explanation is provided. The student gives examples that argue a strong case and demonstrate deep knowledge. The student makes logical links between clearly identified, relevant points.

Level 2 (3–4 marks):
An attempt to link the description of the experiment and the results with differences between the two models. The student gives examples of where the plum pudding model does not explain observations. The logic used may not be clear.

Level 1 (1–2 marks):
Simple statements are made that the nuclear model is a better model. The response may fail to make logical links between the points raised.

0 marks:
No relevant content.

Indicative content

- alpha particle scattering experiment
- alpha particles directed at gold foil
- most alpha particles pass straight through
- (so) most of atom is empty space
- a few alpha particles deflected through large angles
- (so) mass is concentrated at centre of atom
- (and) nucleus is (positively) charged
- plum pudding model has mass spread throughout atom
- plum pudding model has charge spread throughout atom

[6]

2

(a) It will have a constant speed.

1

(b) distance travelled = speed × time

1

(c) $a = \frac{18 - 9}{6}$

1

$a = 1.5$

*allow 1.5 with no working shown for **2** marks*

1

(d) resultant force = mass × acceleration

1

(e) $F = (1120+80) \times 1.5$

1

$F = 1800$ (N)

*allow 1800 with no working shown for **2** marks*

1

*accept their 10.3 × 1200 correctly calculated for **2** marks*

(f) $18^2 - 9^2 = 2 \times 1.5 \times s$

1

$s = 18^2 - 9^2 / 2 \times 1.5$

1

$s = 81$ (m)

1

*allow 81 (m) with no working shown for **3** marks*

*accept answer using their 10.3 (if not 1.5) correctly calculated for **3** marks*

(g) **Level 2 (3–4 marks):**
A detailed and coherent explanation is provided. The response makes logical links between clearly identified, relevant points that include references to the numerical factor.

Level 1 (1–2 marks):
Simple statements are made. The response may fail to make logical links between the points raised.

0 marks:
No relevant content.

Indicative content

- doubling speed increase the kinetic energy
- kinetic energy increases by a factor of 4
- work done (by brakes) to stop the car increases
- work done increases by a factor of 4
- work done is force × distance and braking force is constant
- so if work done increases by 4 then the braking distance must increase by 4

4

[14]

3

(a) move a (magnetic / plotting) compass around the wire

1

the changing direction of the compass needle shows a magnetic field has been produced

OR

sprinkle iron filings onto the card (1)

tapping the card will move the filings to show the magnetic field (pattern) (1)

1

(b) **Level 2 (3–4 marks):**
A detailed and coherent explanation is provided. The response makes logical links between clearly identified, relevant points that explain how the ignition circuit works.

Level 1 (1–2 marks):
Simple statements are made. The response may fail to make logical links between the points raised.

0 marks:
No relevant content.

Indicative content

- closing the (ignition) switch causes a current to pass through the electromagnet
- the iron core (of the electromagnet) becomes magnetised
- the electromagnet / iron core attracts the (short side of the) iron arm
- the iron arm pushes the (starter motor) contacts (inside the electromagnetic switch) together
- the starter motor circuit is complete
- a current flows through the starter motor (which then turns)

4

[6]

4

Level 3 (5–6 marks):
A detailed and coherent plan covering all the major steps is provided. The steps in the method are logically ordered. The method would lead to the production of valid results.

A source of inaccuracy is provided.

Level 2 (3–4 marks):
The bulk of a method is described with mostly relevant detail. The method may not be in a completely logical sequence and may be missing some detail.

Level 1 (1–2 marks):
Simple statements are made. The response may lack a logical structure and would not lead to the production of valid results.

0 marks:
No relevant content.

Indicative content

place a glass block on a piece of paper

draw around the glass block and then remove from the paper

draw a line at 90° to one side of the block (the normal)

use a protractor to measure and then draw a line at an angle of 20° to the normal

replace the glass block

using a ray box and slit point the ray of light down the drawn line

mark the ray of light emerging from the block

remove the block and draw in the refracted ray

measure the angle of refraction with a protractor

repeat the procedure for a range of values of the angle of incidence

possible source of inaccuracy

the width of the light ray

which makes it difficult to judge where the centre of the ray is

[6]

5

(a) move a (magnetic / plotting) compass around the wire

1

the changing direction of the compass needle shows a magnetic field has been produced

OR

sprinkle iron filings onto the card (1)

tapping the card will move the filings to show the magnetic field (pattern) (1)

1

(b) **Level 2 (3–4 marks):**
A detailed and coherent explanation is provided. The response makes logical links between clearly identified, relevant points that explain how the ignition circuit works.

Level 1 (1–2 marks):
Simple statements are made. The response may fail to make logical links between the points raised.

0 marks:
No relevant content

Indicative content

- closing the (ignition) switch causes a current to pass through the electromagnet
- the iron core (of the electromagnet) becomes magnetised
- the electromagnet / iron core attracts the (short side of the) iron arm
- the iron arm pushes the contacts (inside the electromagnetic switch) together
- the starter motor circuit is complete
- a current flows through the starter motor (which then turns)

4

[6]

6

(a) **Level 3 (5–6 marks):**
A detailed and coherent plan covering all the major steps is provided. The steps in the method are logically ordered. The method would lead to the production of valid results.

A source of inaccuracy is provided.

Level 2 (3–4 marks):
The bulk of a method is described with mostly relevant detail. The method may not be in a completely logical sequence and may be missing some detail.

Level 1 (1–2 marks):
Simple statements are made. The response may lack a logical structure and would not lead to the production of valid results.

0 marks:
No relevant content.

Indicative content

place a glass block on a piece of paper

draw around the glass block and then remove from the paper

draw a line at 90° to one side of the block (the normal)

use a protractor to measure and then draw a line at an angle of 20° to the normal

replace the glass block

using a ray box and slit point the ray of light down the drawn line

mark the ray of light emerging from the block

remove the block and draw in the refracted ray

measure the angle of refraction with a protractor

repeat the procedure for a range of values of the angle of incidence

possible source of inaccuracy

the width of the light ray

which makes it difficult to judge where the centre of the ray is

6

(b) velocity / speed of the light decreases

allow velocity / speed of the light changes

1

[7]

7 (a) any **one** from:

- high cost of installing overhead power lines or underground cables or pylons
- high cost as (very) long cables needed
- amount of electricity required is too low

allow not enough (surplus) electricity would be generated

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.

Level 3 (5 – 6 marks):
clear comparison of advantages **and** disadvantages of **each** method

Level 2 (3 – 4 marks):
at least **one** advantage **and one** disadvantage is stated for **one** method **and** a different advantage **or** disadvantage is stated for the other method

Level 1 (1 – 2 marks):
at least **one** advantage **or one** disadvantage of either method

Level 0 (0 marks):
No relevant information

examples of physics points made in the response

Advantages of both methods:
- both renewable sources of energy
- both have no fuel (cost)
- both have very small (allow 'no') running costs
- no carbon dioxide produced

accept carbon neutral

accept no greenhouse gases

accept doesn't contribute to global warming

Advantages of wind:
- higher average power output

produces more energy is insufficient

Advantages of hydroelectric:
- constant / reliable power (output)
- lower (installation) cost

Disadvantages of wind:
- higher (installation) cost
- variable / unreliable power output
- (may) kill birds / bats

Disadvantages of hydroelectric:
- lower power output
- (may) kill fish or (may) damage habitats
- more difficult to set up (within river)

Disadvantages of both methods:
- (may be) noisy
- visual pollution

ignore payback time unless no other relevant points made

ignore time to build for both

6

[7]

8 (a) 2 protons and 2 neutrons

accept 2p and 2n

accept (the same as a) helium <u>nucleus</u>

symbol is insufficient

do not accept 2 protons and neutrons

1

(b) (i) gamma rays

1

(ii) loses/gains (one or more) <u>electron(s)</u>

1

(c) any **one** from:

- wear protective clothing
- work behind lead/concrete/glass shielding
- limit time of exposure
- use remote handling

accept wear mask/gloves

wear goggles is insufficient

wear protective equipment/gear is insufficient

accept wear a film badge

accept handle with (long) tongs

accept maintain a safe distance

accept avoid direct contact

1

(d) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.

Level 3 (5 – 6 marks):
There is a description of all three types of radiation in terms of at least two of their properties
or
a full description of two types of radiation in terms of all three properties.

Level 2 (3 – 4 marks):
There is a description of at least two types of radiation in terms of some properties
or
a full description of one type of radiation in terms of all three properties
or
the same property is described for all three radiations

Level 1 (1 – 2 marks):
There is a description of at least one type of radiation in terms of one or more properties.

Level 0 (0 marks):
No relevant information

examples of physics points made in the response

alpha particles
- are least penetrating
- are stopped by paper / card

- have the shortest range
- can travel (about) 5cm in air

- are (slightly) deflected by a magnetic field
- alpha particles are deflected in the opposite direction to beta particles by a magnetic field

beta particles
- (some are) stopped by (about) 2mm (or more) of aluminium/metal
- can travel (about) 1 metre in air
- are deflected by a magnetic field
- beta particles are deflected in the opposite direction to alpha particles by a magnetic field

accept (some are) stopped by aluminium foil

gamma rays
- are the most penetrating
- are stopped by (about) 10cm of lead
- have the longest range
- can travel at least 1 km in air
- are not deflected by a magnetic field

6

[10]

9 (a) an electromagnet can be switched off

accept a permanent magnet cannot be switched off

or

an electromagnet is stronger

accept control the strength

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.

Level 3 (5 – 6 marks):
there is a description of how the electromagnet is made
and
there is a description of how the strength of the electromagnet can be varied
and
there is a description of how the strength of the electromagnet can be tested

Level 2 (3 – 4 marks):
there is a description of how the electromagnet is made
and either
there is a description of how the strength of the electromagnet can be varied
or
there is a description of how the electromagnet can be tested

Level 1 (1 – 2 marks):
there is a basic description of how to make an electromagnet
or
there is a basic description of how the strength of the electromagnet can be varied
or
there is a basic description of how the electromagnet can be tested

Level 0 (0 marks):
No relevant / correct content

examples of the points made in the response

Details of how to make an electromagnet
- wrap the wire around the nail
- connect the wire to the power supply (with connecting leads and croc clips)
- switch on the power supply

accept a current should be sent along the wire

Details of how to vary the strength of the electromagnet
- change the number of turns (on the coil)
- change the current (through the coil)
- change the separation of the turns

allow change the potential difference (across the coil)

accept wrap the coil more tightly

Details of how to test the electromagnet
- suspend paperclips from the electromagnet
- the more paperclips suspended, the stronger the electromagnet is
- clamp the electromagnet at different distances from the paperclip(s)
- the further the distance from which paperclips can be attracted the stronger the electromagnet is
- test before and after making alterations to change the strength
- compare the results from before and after making alterations
- use de-magnetised paper clips

accept count the number of paperclips

*with different current **or** p.d. **or** no. of turns*

***or** core and see if the number changes/increases*

6

[7]

10 (a) hydrogen

1

(b) supernova

1

(c) red super giant

1

(d) any **four** from:
- fusion takes place within stars
- hydrogen formed into helium
- fusion continued and formed larger elements
- elements heavier than iron were formed in supernova
- (heavy) elements were scattered by the supernova explosion.

accept light elements formed

4

[7]

11 (a) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks
No relevant information

Level 1 (1-2 marks)
There is a relevant statement about an energy saving method

Level 2 (3-4 marks)
There is at least one clear comparison of energy saving methods and their cost effectiveness with an appropriate calculation

Level 3 (5-6 marks)
There is a comparison of energy saving methods and their cost effectiveness with appropriate calculations. Comparison to include further detail.

examples of physics points made in the response

examples of relevant statements
- energy efficient boiler saves the most (energy / money) per year
- loft insulation costs the least to install
- double-glazing costs the most to install

examples of statements that include cost effectiveness
- loft insulation is the most cost effective in the long term
- double-glazing is the least cost effective
- loft insulation has the shortest payback time
- double-glazing has the longest payback time
- payback time calculated for any method

payback times:
energy efficient boiler: 6.25 years
loft insulation: 2 years
double glazing: 100 years
cavity wall insulation: 2.86 years

examples of further detail
- for cost effectiveness install in the following order: loft, cavity wall, boiler, double-glazing
- for reducing energy use install in the following order: boiler, loft, cavity wall, double glazing
- don't install double-glazing for insulation purposes
- double-glazing won't pay for itself in your lifetime
- justified choice of best / worst method

6

(b) (i) how effective a material is as an insulator

accept 'heat' for energy

accept how effective a material is at keeping energy in

accept the lower the U-value the better the insulator

accept the lower the U-value the lower the rate of energy transfer

1

(ii) (the U-value) decreases

1

[8]

12 (a) (an equal amount of) positive charge

*do **not** accept charge on the atom / nucleus is positive*

1

(b) (i) a (significant) number of alpha particles were scattered by more than 4°

or

alpha particles deflected backwards

accept (some) measurements / results were unexpected

1

measurements / results could not be explained by 'plum pudding' model

or

measurements / results did not support predictions

can be explained by the nuclear model is insufficient

accept measurements / results did not support hypothesis

1

(ii) many / (over)100 000 measurements / results taken

accept Rutherford(and Marsden) were respected scientists

or

scientists were respected

accept measurements / results taken over several months

the experiment was repeated many times is insufficient

1

(c) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.

0 marks
no relevant content

Level 1 (1−2 marks)
A brief description is given with some particles correctly named

Level 2 (3−4 marks)
A description is given with all three particles named
plus either
the polarity of charge associated with the
three particles
or
the relative mass of the three particles
or
the relative mass for one particle and the relative charge for one particle given

Level 3 (5−6 marks)
A more detailed description is given, naming the particles and polarity of charge
and either
the relative mass is given for at least two particles
or
the relative charge is given for at least two particles

Examples of the points made in the response

brief description
contains protons, neutrons and electrons

protons are positive
electrons are negative
neutrons are uncharged

has a nucleus

relative charge
proton +1
electron − 1
neutron 0

relative mass
proton 1
neutron 1
electron (about) 1 / 2000

accept protons and neutrons have the same mass

accept electrons have tiny / negligible mass
zero mass is neutral

more detailed description

protons and neutrons make up the nucleus
electrons orbit the nucleus
electrons are in shells
most of the atom is empty space
nucleus occupies a very small fraction of the volume of the atom
electrons orbit at a relatively large distance from the nucleus
most of the mass of the atom is contained in the nucleus
the nucleus as a whole is positively charged total number of protons in the nucleus equals the total number of electrons orbiting it in an atom

6

[10]

13 (a) 20,000

accept 20 kilo

or

20 k

or *20 001*

1

an atom

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer in the Marking Guidance and apply a 'best-fit' approach to the marking.

0 marks
no relevant content

Level 1 (1−2 marks)
At least one relevant statement is given for either type of wave

Level 2 (3−4 marks)
either
a use, risk and precaution is given for one type of wave
or
A medical use is given for both types of wave
plus
a risk or precaution for one type of wave

Level 3 (5−6 marks)
At least one medical use is given for both types of wave linked to the risks and any precautions necessary

Examples of the points made in the response

Medical use of X-rays

Any one from:

- Detecting bone fractures
- Detecting dental problems
- Killing cancer cells
- CT scanning.

Ignore details about how X-rays / ultrasound work

accept any specific use of X-rays, eg

- *detecting heart / lung disorders (with chest X-rays)*
- *mammograms / breast cancer detection*
- *detecting stones / bowel disease (with abdominal X-rays)*

Risks with X-rays

X-rays pose a risk / danger / hazard

accept are harmful

X-rays cause ionisation / damage to cells

or

mutate cells / cause mutations / increase chances of mutations

or

turn cells cancerous / produce abnormal growths / produce rapidly growing cells

or

kill cells

accept a description of what ionising is

instead of cell, any of these words can be used: DNA / genes / chromosomes / nucleus

accept (may) cause cancer

Operator precautions with X-rays

The X-ray operator should go behind a (metal / glass) screen / leave the room when making an X-ray / wear a lead lined apron

accept appropriate precautions for the patient e.g. limit the total exposure / dose (in one year)

wear a radiation badge is insufficient

Medical use of ultrasound

Any one from:

- Pre-natal scanning
- Imaging (a named body part).
- removal / destruction of kidney / gall stones
- removing plaque from teeth

cleaning teeth is insufficient

- accept examples of repair, eg alleviating bruising, repair scar damage, ligament / tendon damage, joint inflammation.

accept physiotherapy

*accept curing prostate cancer **or** killing prostate cancer cells*

Risks with ultrasound

Ultrasound poses no risk / danger / hazard (to the user / patient)

accept ultrasound is safer than using X-rays

Ultrasound is not ionising

or

Ultrasound does not damage (human) cells

Precautions with ultrasound

The operator needs to take no precautions when making an ultrasound scan

this can be assumed if it is stated that ultrasound is harmless or it is safer than using x-rays or it is non-ionising

6

[8]

14 (a) **solid**

particles vibrate about fixed positions

1

closely packed

accept regular

1

gas

particles move randomly

accept particles move faster

accept freely for randomly

1

far apart

1

(b) amount of energy required to change the state of a substance from liquid to gas (vapour)

1

unit mass / 1 kg

dependent on first marking point

1

(c) 41000 **or** 4.1×10^4 (J)

accept

41400 or 4.14×10^4

correct substitution of

$0.018 \times 2.3 \times 10^6$ *gains* ***1*** *mark*

2

(d) **AB**

changing state from solid to liquid / melting

1

at steady temperature

*dependent on first **AB** mark*

1

BC

temperature of liquid rises

1

until it reaches boiling point

*dependent on first **BC** mark*

1

[12]

15 (a) (i) short sight

accept myopia

1

(ii) diverging

1

(b) light

1

(c) Marks awarded for this answer will be determined by the quality of communication as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks
No relevant content

Level 1 (1–2 marks)
There is a basic description of one advantage ***or*** disadvantage of using **either** of the methods

Level 2 (3–4 marks)
There is a *description* of some advantages **and / or** disadvantages of using **both** methods
or
a full, detailed description of the advantages and disadvantages of using **either** of the methods.

Level 3 (5–6 marks)
There is a *clear description* of the advantages and disadvantages of using **both** methods.

examples of the points made in the response
extra information

laser surgery

advantages:

- *appearance*
- *permanent effect*
- no glasses which need changing

disadvantages:

- risks associated with surgery
- large cost
- not able to drive etc straightaway
- (still) might need glasses for reading

wearing glasses

advantages:

- able to function straightaway
- any problems easy to sort out

disadvantages:

- *easily broken*
- *easily lost*
- need changing
- overall cost might be greater if several changes in vision
- might eventually need two pairs of glasses

6

(d) move lens

1

closer to film

1

[11]

16 (a) (black) is a good absorber of (infrared) radiation

1

(b) (i) amount of energy required to change (the state of a substance) from solid to liquid (with no change in temperature)

melt is insufficient

1

unit mass / 1kg

1

(ii) 5.1×10^6 (J)

accept 5 x 10^6

*allow **1** mark for correct substitution ie $E = 15 \times 3.4 \times 10^5$*

2

(c) (i) mass of *ice*

allow volume / weight / amount / quantity of ice

1

(ii) to distribute the salt throughout the ice

1

to keep all the ice at the same temperature

1

(iii) melting point decreases as the mass of salt is increased

allow concentration for mass

accept negative correlation

*do **not** accept inversely proportional*

1

(d) 60 000 (J)

accept 60 KJ

*allow **2** marks for correct substitution ie $E = 500 \times 2.0 \times 60$*

*allow **2** marks for an answer of 1000 **or** 60*

*allow **1** mark for correct substitution ie*

*$E = 500 \times 2.0$ **or** $0.50 \times 2.0 \times 60$*

*allow **1** mark for an answer of 1*

3

(e) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks
No relevant content

Level 1 (1–2 marks)
There is *an attempt at a description of some advantages or disadvantages.*

Level 2 (3–4 marks)
There is a basic description of *some advantages* ***and / or*** *disadvantages for some of the methods*

Level 3 (5–6 marks)
There is a clear description of the advantages and disadvantages of all the methods.

examples of the points made in the response

extra information

energy storage

advantages:

- no fuel costs
- no environmental effects

disadvantages:

- expensive to set up and maintain
- need to dig deep under road
- dependent on (summer) weather
- digging up earth and disrupting habitats

salt spreading

advantages:

- easily available
- cheap

disadvantages:

- can damage trees / plants / drinking water / cars
- needs to be cleaned away

undersoil heating

advantages:

- not dependent on weather
- can be switched on and off

disadvantages:

- costly
- bad for environment

6

[18]

17 Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1–2 marks)
Considers either solid or gas and describes at least one aspect of the particles.

or

Considers both solids and gases and describes an aspect of each.

Level 2 (3–4 marks)
Considers both solids and gases and describes aspects of the particles.

or

Considers one state and describes aspects of the particles and explains at least one of the properties.

or

Considers both states and describes an aspect of the particles for both and explains a property for solids or gases.

Level 3 (5–6 marks)
Considers both states of matter and describes the spacing and movement / forces between the particles. Explains a property of both solids and gases.

examples of the points made in the response

extra information

Solids

- (particles) close together
- (so) no room for particles to move closer (so hard to compress)
- vibrate about fixed point
- strong forces of attraction (at a distance)
- the forces become repulsive if the particles get closer
- particles strongly held together / not free to move around (shape is fixed)

any explanation of a property must match with the given aspect(s) of the particles.

Gases

- (particles) far apart
- space between particles (so easy to compress)
- move randomly
- negligible / no forces of attraction
- spread out in all directions (to fill the container)

[6]

18 (a) water moves (from a higher level to a lower level)

1

transferring GPE to KE

1

rotating a turbine to turn a generator

accept driving or turning or spinning for rotating

moving is insufficient

1

transferring KE to electrical energy

*transferring GPE to electrical energy gains **1** mark of the **2** marks available for energy transfers*

1

(b) (TVs in stand-by) use electricity

accept power / energy

1

generating electricity (from fossil fuels) produces CO_2

accept greenhouse gas

accept sulfur dioxide

1

(CO_2) contributes to global warming

accept climate change for global warming

accept greenhouse effect if CO_2 given

accept acid rain if linked to sulfur dioxide

1

(c) a factor other than scientific is given, eg economic, political or legal

personal choice is insufficient

1

[8]

19 (a) (i) friction

1

(ii) air resistance

accept drag

friction is insufficient

1

(iii) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1–2 marks)
There is an attempt to explain in terms of forces A and B why the velocity of the cyclist changes between any two points
or
a description of how the velocity changes between any two points.

Level 2 (3–4 marks)
There is an explanation in terms of forces A and B of how the velocity changes between X and Y and between Y and Z
or
a complete description of how the velocity changes from X to Z.
or
an explanation and description of velocity change for either X to Y or Y to Z

Level 3 (5–6 marks)
There is a clear explanation in terms of forces A and B of how the velocity changes between X and Z
and
a description of the change in velocity between X and Z.

examples of the points made in the response

extra information

X to Y

- at X force A is greater than force B
- cyclist accelerates
- and velocity increases
- as cyclist moves toward Y, force B (air resistance) increases (with increasing velocity)
- resultant force decreases
- cyclist continues to accelerate but at a smaller value
- so velocity continues to increase but at a lower rate

Y to Z

- from Y to Z force B (air resistance) increases
- acceleration decreases
- force B becomes equal to force A
- resultant force is now zero
- acceleration becomes zero

- velocity increases until…
- cyclist travels at constant / terminal velocity

accept speed for velocity throughout

6

(b) (i) 3360

*allow **1** mark for correct substitution,*

ie 140 × 24 provided no subsequent step

*accept 3400 for **2** marks if correct substitution is shown*

2

joule / J

*do **not** accept j*

*do **not** accept Nm*

1

(ii) decreases

accept an alternative word / description for decrease

do not accept slows down

1

temperature

accept thermal energy

accept heat

1

[13]

20 (a) J

reason only scores if J is chosen

1

(only) stars (about) the same / smaller size / mass as the Sun become black dwarfs

accept smaller than the Sun

accept it is the smallest

accept (only) small stars become black dwarfs

1

(b) (i) become a supernova

or

it will explode

ignore subsequent correct stages

1

(ii) cannot take measurements needed

or

do not have the technology

*do **not** accept cannot measure mass*

1

(iii) advances in (measuring) techniques / technology / knowledge

1

(c) any **five** from:

ignore any information up to the end of the main sequence

Apply the list rule if more than 5 points are made

- star expands (to become)
- a red giant

red supergiant is incorrect

- heavier elements are formed (by fusion)

elements heavier than iron are formed is incorrect

- star shrinks (to become)
- a white dwarf

supernova, neutron star, black hole are incorrect

- star cools / fades
- star stops emitting energy / radiation

star loses all energy is insufficient

5

[10]

21 (a) the oscillation / vibration (causing the wave)

a movement causes the wave is insufficient

1

for a transverse wave is perpendicular to the direction of <u>energy transfer</u>

accept direction of <u>wave travel</u>

1

and for a longitudinal wave is parallel to the direction of <u>energy transfer</u>

accept direction of <u>wave travel</u>

*if no marks awarded allow **1** mark for correctly linking perpendicular with transverse and parallel with longitudinal*

the marks may be scored by the drawing of two correctly labelled diagrams

1

(b) for radio waves:

accept converse for each mark

are transverse

1

travel at speed of light / higher speed

1

have greater frequencies

1

can travel through vacuum

*accept sound waves are not electromagnetic for **1** mark*

1

[7]

22 (a) (i) nuclear reactor

1

star

1

(ii) nuclei are joined (not split)

accept converse in reference to nuclear fission

*do **not** accept atoms are joined*

1

(b) (i) any **four** from:

- neutron
- (neutron) absorbed by U (nucleus)

  ignore atom
  *do **not** accept reacts*
  *do **not** accept added to*
- forms a larger nucleus
- (this larger nucleus is) unstable
- (larger nucleus) splits into two (smaller) nuclei / into Ba and Kr
- releasing three neutrons and energy

  accept fast-moving for energy

4

(ii) 56 (Ba)

1

57 (La)

*if proton number of Ba is incorrect allow **1** mark if that of La is 1 greater*

1

$^{0}_{-1}\beta$

accept e for β

$^{139}_{56}Ba \longrightarrow {}^{139}_{57}La + {}^{0}_{-1}\beta$

*scores **3** marks*

1

[10]

23 (a) decreases

1

(b) a filament bulb

allow bulb

1

an LED

1

(c) Marks awarded for this answer will be determined by the Quality of Communication (QoC) as well as the standard of the scientific response.

0 marks
No relevant content.

Level 1 (1−2 marks)
There is a basic description of the method. This is incomplete and would not lead to any useful results.

Level 2 (3−4 marks)
There is a description of the method which is almost complete with a few minor omissions and would lead to some results.

Level 3 (5−6 marks)
There is a detailed description of the method which would lead to valid results.
To gain full marks an answer including graph, or another appropriate representation of results, must be given.

examples of the physics points made in the response:

- read V and I
- read temperature
- apply heat

  allow hot water to cool
- read V and I at least one other temperature
- determine R from V / I
- range of temperatures above 50 °C

extra detail:
- use thermometer to read temperature at regular intervals of temperature
- remove source of heat and stir before taking readings
- details of attaining 0 °C or 100 °C
- last reading taken while boiling
- graph of R against T
- at least 3 different temperatures

6

(d) (i) Q

1

(ii) (80, 3.18)

1

(iii) any **one** from:

- measurement of V too small
- measurement of I too big
- incorrect calculation of R
- thermometer misread

allow misread meter

ignore any references to an error that is systematic

1

(iv) any **two** from:

- not portable

  allow requires a lot of equipment allow takes time to set up
- needs an electrical supply
- cannot be read directly

  accept it is more difficult to read compared to liquid-in-glass

2

[14]

24 (a) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking guidance.

0 marks
No relevant content.

Level 1(1-2 marks)
There is a basic explanation of **one** feature
or
a simple statement relating reduction in energy transfer to **one** feature.

Level 2(3-4 marks)
There is a clear explanation of **one** feature
or
a simple statement relating reduction in energy transfer to **two** features.

Level 3(5-6 marks)
There is a detailed explanation of at least **two** features
or
a simple statement relating reduction in energy transfer to all **four** features.

Examples of the points made in response

extra information

accept throughout:
heat for energy
loss for transfer

plastic cap:

- plastic is a poor conductor

  accept insulator for poor conductor

- stops convection currents forming at the top of the flask so stopping energy transfer by convection

- molecules / particles evaporating from the (hot) liquid cannot move into the (surrounding) air so stops energy transfer by evaporation

- plastic cap reduces / stops energy transfer by conduction / convection / evaporation

glass container:

- glass is a poor conductor so reducing energy transfer by conduction

- glass reduces / stops energy transfer by conduction

vacuum:

- both conduction and convection require a medium / particles

- so stops energy transfer between the two walls by conduction and convection

- vacuum stops energy transfer by conduction / convection

silvered surfaces:

- silvered surfaces reflect infrared radiation

  accept heat for infrared

- silvered surfaces are poor emitters of infrared radiation

- infrared radiation (partly) reflected back (towards hot liquid)

- silvered surfaces reduce / stop energy transfer by radiation

6

(b) (the ears have a) small surface area

ears are small is insufficient

1

so reducing energy radiated / transferred (from the fox)

accept heat lost for energy radiated

*do **not** accept stops heat loss*

1

[8]

25 (a) (i) to obtain a range of p.d. values

accept increase / decrease current / p.d. / voltage / resistance

accept to change / control the current / p.d. / voltage / resistance

to provide resistance is insufficient

a variable resistor is insufficient

*do **not** accept electricity for current*

1

(ii) temperature of the bulb increases

accept bulb gets hot(ter)

accept answers correctly

expressed in terms of collisions between (free) electrons and ions / atoms

bulb gets brighter is insufficient

1

(iii) 36

*allow **1** mark for correct substitution, ie 12 × 3 provided no subsequent step shown*

2

watt(s) / W

accept joules per second / J/s

*do **not** accept w*

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking guidance, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a basic comparison of either a cost aspect or an energy efficiency aspect.

Level 2 (3-4 marks)
There is a clear comparison of either the cost aspect or energy efficiency aspect
OR
a basic comparison of both cost and energy efficiency aspects.

Level 3 (5-6 marks)
There is a detailed comparison of both the cost aspect and the energy efficiency aspect.

For full marks the comparisons made should support a conclusion as to which type of bulb is preferable.

Examples of the points made in the response:

cost

- halogen are cheaper to buy
  simply giving cost figures is insufficient
- 6 halogen lamps cost the same as one LED
- LEDs last longer
- need to buy 18 / more halogen lamps to last the same time as one LED
- 18 halogens cost £35.10
- costs more to run a halogen than LED
- LED has lower maintenance cost (where many used, eg large departmental store lighting)

energy efficiency

- LED works using a smaller current
- LED wastes less energy
- LEDs are more efficient
- LED is 22% more energy efficient
- LED produces less heat
- LED requires smaller input (power) for same output (power)

6

[11]

26 (a) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking guidance, and apply a 'best-fit' approach to the marking.

0 marks
No relevant / correct content.

Level 1 (1-2 marks)
There is a basic description of either wave
OR
What happens to either wave when they enter the body. However there is little other detail.

Level 2 (3-4 marks)
There is either:
A clear description of BOTH waves
OR
A clear description as to what happens to BOTH waves inside the body
OR
A clear description of ONE of the waves with clear detail as to what happens to either wave inside the body.

Level 3 (5-6 marks)
There is a detailed description of BOTH of the waves
AND
A detailed description as to what happens to EITHER wave inside the body.

Examples of the points made in the response:

Description of an X-ray

- X-rays are electromagnetic waves / part of the electromagnetic spectrum
  *do **not** allow a description of a property – eg X-rays travel*
- X-rays are (very) high frequency (waves)
  through a vacuum / at the speed of light
- X-rays are (very) high energy (waves)
- X-rays have a (very) short wavelength
- Wavelength (of X-rays) is of a similar size to (the diameter of) an atom
- X-rays are a transverse wave
  correct description acceptable – oscillations / vibrations are perpendicular (at 90°) to direction of energy transfer
- X-rays are ionising radiation

Description of ultrasound

- ultrasound has a frequency above 20 000 (hertz)

  or

  ultra sound is above 20 000 hertz
- ultrasound is above / beyond the human (upper) limit (of hearing)
  accept ultrasound cannot be heard by humans
- ultrasound is a longitudinal wave
  correct description acceptable – oscillations / vibrations (of particles) are parallel (in same direction) to direction of energy transfer

Statement(s) as to what happens to X-rays inside the human body:

- X-rays are absorbed by bone
- X-rays travel through / are transmitted by tissue / skin

Statement as to what happens to ultrasound inside body:

- ultrasound is (partially) reflected at / when it meets a boundary between two different media
- travel at different speeds through different media

(b) (because the X-rays) are ionising

accept a description of what ionising is

1

(they will) damage cells

instead of cell, any of these words can be used:

DNA / genes / chromosomes / nucleus

or

mutate cells / cause mutations / increase chances of mutations

or

turn cells cancerous / produce abnormal growths / produce rapidly growing cells

*do **not** accept they can be dangerous (to human health)*

*do **not** accept damage to soft tissue*

or

kill cells

1

(c) any **one** from:

- removal / destruction of kidney / gall stones
- repair of damaged tissue / muscle

  accept examples of repair, eg alleviating bruising, repair scar damage, ligament / tendon damage, joint inflammation

  accept physiotherapy

  *accept curing prostate cancer **or** killing prostate cancer cells*
- removing plaque from teeth

  cleaning teeth is insufficient

1

[9]

27 (a) any **three** from:

- gas can be switched on (and off) quickly but nuclear cannot

  gas has a short start-up time alone is insufficient
- gas can be used to meet surges in demand

  accept specific times from graph, anything from 1700 to 2200
- gas can contribute to / meet the base load
- nuclear provides base load

  or

  nuclear is used to generate all of the time

3

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking guidance, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a brief description of one advantage **or** disadvantage of using either biogas or wind
or
makes a conclusion with a reason.

Level 2 (3-4 marks)
There is a description of some advantages **and / or** disadvantages for biogas **and / or** wind
or
there is a direct comparison between the two systems **and** at least one advantage / disadvantage
or
a detailed evaluation of one system only with a conclusion.

Level 3 (5-6 marks)
There is a clear and detailed comparison of the two systems.

There must be a clear conclusion of which system would be best with at least one comparative reason given for the choice made.

Examples of the points made in the response

extra information

Biogas

- renewable
- energy resource is free
- reliable energy source

  accept works all of the time
- does not depend on the weather
- uses up (animal) waste products
- concentrated energy source
- cheaper (to buy and install)

  accept once only
- shorter payback-time (than wind)
- adds carbon dioxide to the atmosphere

  when waste burns it produces carbon dioxide is insufficient
- contributes to the greenhouse effect

  or

  contributes to global warming
- no transport cost for fuels

Wind turbine

- renewable
- energy resource is free
- not reliable
- depends on the weather / wind
- will be times when not enough electricity generated for the farm's needs
- dilute energy source
- longer payback-time (than biogas)
- more expensive (to buy and install)

  accept once only
- does not produce any carbon dioxide

  accept does not pollute air

accept pollutant gases for carbon dioxide

produces visual or noise pollution is insufficient

harmful gases is insufficient

6

[9]

28 (a) increases the voltage (across the cables)

or

decreases the current (through the cables)

1

reducing energy losses (in cables)

accept heat for energy

*do **not** accept electricity for energy*

*do **not** accept no energy loss*

accept wires do not get as hot

or

increases efficiency of (electricity / energy) transmission

ignore reference to travel faster

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response.
Examiners should also refer to the Marking Guidance, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content

Level 1 (1-2 marks)
There is a brief description of one advantage or disadvantage of using either overhead or underground cables.

Level 2 (3-4 marks)
There is a description of some of the advantages **and / or** disadvantages for both overhead and underground cables, with a minimum of three points made. There must be at least **one** point for each type of cable.

Level 3 (5-6 marks)
There is a clear and detailed description of the advantages and disadvantages of overhead **and** underground cables, with a minimum of five points made. At least one advantage and one disadvantage for each type of cable.

examples of the points made in the response

marks may be gained by linking an advantage for one type of cable with a disadvantage for the other type of cable

eg

overhead cables are easy to repair = 1 mark

overhead cables are easier to repair = 1 mark

overhead cables are easier to repair than underground cables = 2 marks

Overhead
Advantages

- (relatively) quick / easy to repair / maintain / access
  easy to install is insufficient
  *do **not** accept easy to spot / see a fault*
- less expensive to install / repair / maintain
  less expensive is insufficient
- cables cooled by the air
  accept thermal energy / heat removed by the air
- air acts as electrical insulator
  accept there is no need for electrical insulation (around the cables)
- can use thinner cables
  difficult to reach is insufficient
  land beneath cables can still be used is insufficient

Disadvantages

- spoil the landscape
- greater risk of (fatal) electric shock
- damaged / affected by (severe) weather
  accept specific examples eg high winds, ice
  more maintenance is insufficient
- hazard to low flying aircraft / helicopters
  kites / fishing lines can touch them is insufficient
  hazard to aircraft is insufficient

Underground
Advantages

- cannot be seen
- no hazard to aircraft / helicopters
- unlikely to be / not damaged / affected by (severe) weather
  less maintenance is insufficient

(normally) no / reduced shock hazard
installed in urban areas is insufficient

Disadvantages

- repairs take longer / are more expensive
  accept harder to repair / maintain
  have to dig up for repairs is insufficient
- (more) difficult to access (cables)
  hard to locate (cables) is insufficient
  faults hard to find is insufficient
- (very) expensive to install
- thicker cables required
- need cooling systems
- need layers of electrical insulation
- land disruption (to lay cables)
  accept damage to environment / habitat(s)
  or
  cannot use land either side of cable path
  accept restricted land use

6

(c) examples of acceptable responses:

*allow **1** mark for each correct point*

- closest to cables field from underground is stronger
- field from overhead cables stronger after 5 metres
- field from underground cables drops rapidly
- field from overhead cables does not drop much until after 20 metres

  accept values between 20 and 30 inclusive
- overhead field drops to zero at / after 50 metres
- underground field drops to zero at / after 30 metres
- (strength of) field decreases with distance for <u>both</u> types of cable

  if suitably amplified this may score both marks

2

(d) ethical

1

[11]

29 (a) (i) energy from hot rocks in the Earth

accept heat that occurs naturally in the Earth

accept steam / hot water rising to the Earth's surface

accept an answer in terms of the energy released by radioactive decay in the Earth

heat energy is insufficient

1

(ii) water is pumped / moved

1

up (to a higher reservoir)

this mark point only scores if first mark point is awarded

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response.
Examiners should also refer to the Marking Guidance and apply a 'best-fit' approach to the marking.

0 marks
No relevant content

Level 1 (1-2 marks)
There is a brief description of at least one advantage or disadvantage for either the planned wind turbines or the suggested electricity power link.

Level 2 (3-4 marks)
There is a description of advantages and disadvantages for either the planned wind turbines or the suggested electricity power link.
or
A description of the advantages or disadvantages for both the planned wind turbines and the suggested electricity power link.

Level 3 (5-6 marks)
There is a clear and detailed description of at least one advantage and one disadvantage for both the planned wind turbines and suggested electricity power link.

examples of the points made in the response

Offshore wind turbines

advantages

- renewable (energy resource)
- low running costs
- energy is free
- no gas emissions (when in use)
  accept a named gas eg CO_2
  accept no fuel is burned
  accept less dependent on fossil fuels
- land is not used (up)

disadvantages

- unreliable – accept wind does not always blow
  ignore references to destroying or harming habitats
- hazard to birds / bats
- visual pollution – do not accept noise pollution
  *do **not** allow if clearly referring to onshore wind turbines*
  *do **not** accept spoils landscape*
- difficulty of linking turbines to the National Grid
- large initial cost
- difficult to erect / maintain
  accept a lot of maintenance needed
- CO_2 emissions in manufacture (of large number of turbines)

Suggested Link

advantages

- income for Iceland
- using Iceland's (available) energy (resources)
  accept using (Iceland's) renewable energy (resources)
  *do **not** accept reduce the amount of Iceland's wasted energy*
- provide electricity when wind does not blow / reliable
- provide electricity at times of peak demand
- even out fluctuations in supply
- excess electricity from Britain (windy days) to Iceland and used to pump water up to store energy
- Britain less dependent on fossil fuels
  accept Britain needs fewer (new) power stations
  accept conserves fossil fuels

disadvantages

- large initial cost
  accept expensive (to lay cables)
- power loss along a long cable
- (engineering) difficulties in laying / maintaining the cable
  accept difficult to repair (if damaged)

6

[10]

30

accept atoms / particles for ions throughout

(a metal has) free <u>electrons</u>
accept mobile for free

1

(kinetic) energy of (free) electrons increases
accept energy of ions increases
accept ions vibrate with a bigger amplitude
accept ions vibrate more
*do **not** accept electrons vibrate more*

1

(free) <u>electrons</u> move faster

1

or

electrons move through metal
accept electrons collide with other electrons / ions

(so) electrons transfer energy to other electrons / ions
accept ions transfer energy to neighbouring ions

1

[4]

31

(a) 750
*allow **1** mark for correct substitution, ie 75 × 10 provided no subsequent step shown*

2

newton(s) / N
*do **not** accept n*

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response.
Examiners should also refer to the Marking Guidance, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a brief attempt to explain why the velocity / speed of the parachutist changes.
or
the effect of opening the parachute on velocity/speed is given.

Level 2 (3-4 marks)
The change in velocity / speed is clearly explained in terms of force(s)
or
a reasoned argument for the open parachute producing a lower speed.

Level 3 (5-6 marks)
There is a clear and detailed explanation as to why the parachutist reaches terminal velocity
and
a reasoned argument for the open parachute producing a lower speed

examples of the physics points made in the response to explain first terminal velocity

- on leaving the plane the only force acting is weight (downwards)
  accept gravity for weight throughout
- as parachutist falls air resistance acts (upwards)
  accept drag / friction for air resistance
- weight greater than air resistance
  or
  resultant force downwards
- (resultant force downwards) so parachutist accelerates
- as velocity / speed increases so does air resistance
- terminal velocity reached when air resistance = weight
  accept terminal velocity reached when forces are balanced

to explain second lower terminal velocity

- opening parachute increases surface area
- opening parachute increases air resistance
- air resistance is greater than weight

- resultant force acts upwards / opposite direction to motion
- parachutist decelerates / slows down
- the lower velocity means a reduced air resistance

air resistance and weight become equal but at a lower (terminal) velocity

6

(c) (i) any **one** from:

- mass of the (modelling) clay
  accept size/shape of clay size/amount/volume/shape of clay
  accept plasticine for (modelling)clay
- material parachute made from
  accept same (plastic) bag
- number / length of strings

1

(ii) **C**

*reason only scores if **C** is chosen*

1

smallest (area) so falls fastest (so taking least time)

accept quickest/quicker for fastest

*if **A** is chosen with the reason given as 'the largest area so falls slowest' this gains **1** mark*

1

[12]

32 (a) (i) (quickly) becomes magnetized

***or** (quickly) loses its magnetism*

***or** 'it's (a) magnetic (material)'*

any reference to conduction of electricity/heat nullifies the mark

1

(ii) any **four** from:

- insulation prevents electricity/current flowing through the iron/core
  or *'insulation so electricity/current only flows in the wires/turns/coils'*
- alternating current/a.c. in the primary (coil)
- produces a changing magnetic field (in the iron/core)
- (and hence magnetic) field in the secondary (coil)
- induces/generates/produces an alternating potential difference/p.d./voltage across the secondary (coil)
- (and hence) alternating current/a.c. in the secondary (coil)

4

(b) 80 (turns)

or *credit (1) for any equation which if correctly evaluated would give 80 example*

example

$$\frac{230}{5.75} = \frac{3200}{number\ of\ turns}$$

2

[7]

33 (a) plastic or rubber

accept any named plastic
*do **not** accept wood*

1

it is a (good) insulator **or** it is a poor conductor

ignore mention of heat if in conjunction with electricity

1

(b) *The answer to this question requires ideas in good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme.*

Maximum of 2 marks if ideas not well expressed.

pulls iron bolt down **or** attracts the iron bolt **or** moves bolt out of plunger

answers in terms of charges attracting or repelling gain no credit

1

plunger pushed / moved to the right (by spring) **or** plunger released

1

push switch opens / goes to off / goes to right

accept circuit is broken

for maximum credit the points must follow a logical sequence

*3 correct points but incorrect sequence scores **2** marks only*

ignore reset action

1

[5]

34 (a) (i) **X** at the centre of the lifebelt

*measuring from the centre of **X**, allow 2 mm tolerance in any direction*

1

(ii) any **two** from:

if X is on vertical line below the hanger (but not at centre) can gain the first point only

below the point of suspension

*accept '(vertically) below **Y**'*

at the centre (of the lifebelt)

accept 'in the middle'

(because) the lifebelt / it is symmetrical

***or** (because) the mass / weight is evenly distributed*

2

(b) Nm **or** newton metre(s)

accept Newton metre(s)

*do **not** accept any ambiguity in the symbol ie NM, nM or nm*

1

750

(moment) = force × (perpendicular) distance (between line of action and pivot)

***or** (moment) = 500 × 1.5 gains **1** mark*

2

(c) Quality of written communication:

*for **2** of the underlined terms used in the correct context*

1

any **three** connected points from:

low(er) centre of mass / gravity

or *<u>centre of mass / gravity</u> will be close(r) to the wheels / axle / ground*

(more) <u>stable</u>

or *less <u>unstable</u>*

less likely to fall over

accept 'less likely to overturn'
*do **not** accept 'will not fall over'*

the <u>turning effect / moment</u> (of the weight of case) is less

or *so less effort is needed to hold the case*
ignore references to pulling the case

so the pull on her arm is less

3

[10]

35 electromagnet becomes <u>stronger</u> (*not* becomes magnetic) iron moves left – implied OK
plunger goes up push switch goes to off or circuit broken unless plunger moves down

for 1 mark each

[4]

36 Read all the answer first. See below.

Mark the first two advantages and disadvantages (√ or *X*) ignoring

neutral answers. Only allow a third advantage if there is only one disadvantage given. Only allow a third disadvantage if only one advantage is given.

max. 3 advantages (e.g. cheap fuel, good availability, saving fossil fuels, low running costs, reliable, more energy / kg, less fuel needed, no greenhouse gases emitted, no SO_2 causing acid rain)

max. 3 disadvantages (e.g. danger to health of local community, non renewable, high cost of decommissioning, long half life of waste materials, need for safe storage of waste, high cost of commissioning, danger involved in transporting fuel / waste)

max. 4 marks

[4]

37 Quality of written communication: One mark for correct sequencing.
bolt out ® plunger up ® switch off / circuit broken

1

any **five** from

- high current flows
- electromagnet is stronger
- the iron bolt is pulled out
- the plastic plunger moves up
- the switch is lifted / open / off
  accept circuit is broken
- no current flowing
- to re-set the plunger must be pushed down

5

[6]

7

Foundation

(a) Less than a tenth of students scored this mark. There seemed to be a general belief that the National Grid only supplies electricity generated by non-renewable sources so it wouldn't be appropriate considering the small community is planning to generate renewable electricity. Many students thought that visual pollution or damage to habitats counted as an economic reason, which was insufficient.

(b) Approximately half the students scored 3 or more marks for this question, the mean was 2.71 and a good range of responses were seen. It was pleasing to see that students didn't just re-state information given in the question, but added value and made comparisons, too. To achieve Level 1, students needed to make 1 or 2 statements which could have been advantages or disadvantages, or 1 of each. Comparison statements did not count as both an advantage and as a disadvantage. To achieve Level 2 students needed to have at least an advantage and a disadvantage of 1 method and either an advantage or a disadvantage of the other method. To achieve Level 3 students needed at least 1 advantage and 1 disadvantage of each method that were separate ideas. 'Both renewable' would count as one idea.

Higher

(a) A third of students correctly answered by describing reasons why connecting to the grid would be expensive, cost to build pylons, cables, etc. Responses which specified cost but without stating what was expensive were insufficient. Answers in terms of the ‘small community’ needed to state that either the amount of electricity required (from the National Grid), or the amount of electricity they may sell back (to the National Grid) was too low.

(b) Four fifths of students scored 4 or more marks, the mean for the question was 4.42 and a good range of responses were seen. Students who failed to give Level 3 responses usually did so because they didn’t give at least one advantage and one disadvantage for each energy source. Comparative responses in terms of cost, power output or reliability only counted as an advantage of one or as the disadvantage of the other source. Therefore, a minimum number of four separate ideas needed to be described in order to be counted as a Level 3 answer.

8 **Foundation**

(a) Nearly a quarter of the students did not attempt this question. Most of the students that did attempt the question scored zero.

(b) (i) Less than half of the students scored this mark.

(ii) There were very few correct answers to this question. Most of the incorrect answers were in terms of an atom changing size or shape or splitting into smaller fragments.

(c) A small majority of the students scored this mark by suggesting sensible precautions to limit the risk to their health from sources of radiation. However there were a large number of unacceptable suggestions such as 'wear a lead suit'.

(d) A large number of students did not attempt this question. Nearly one third of the students scored zero. The majority of the students that did score at least one mark were operating at Level 1 or 2 in terms of their knowledge, understanding, organisation of their answer and accuracy of their spelling, punctuation and grammar. Students scoring zero marks were either giving a reiteration of the question stem or a description of radiation properties or uses of radiation that were not relevant to this question. Of the three specific properties asked for, few candidates were able to provide creditable statements for the deflections (or not) of the radiations in a magnetic field. Many students thought that the radiations produced their own magnetic field or mistook deflection to mean reflection. References to positive and negative poles of a magnet were common. Of the other two properties, most candidates were able to order correctly the degree of penetration and often quote specific examples of the correct materials. Many candidates were also able to order the range of the radiations in air. However, in many cases, there were not specific references to what beta radiation could or could not actually do, other than be placed in the middle of the student's ordering.

Higher

(a) This was generally well done with almost half of the students scoring the mark although mention of electrons was frequent and negated the mark. Some students did not read the stem of the question carefully and described the properties of an alpha particle e.g. is ionising, and so did not score the mark. This question had one of the highest non-completion rates.

(b) (i) Nearly two thirds of the students scored this mark.

(ii) Only 40% of the students scored this mark. Many students confused ionisation with fission. Others knew that the atom would lose some parts but were not sure which so incorrectly guessed protons or neutrons so did not get the mark.

(c) Nearly four fifths of the students answered this correctly. However, students should think about how realistic their answers are when they write things like 'wear suits made out of lead'.

(d) There were mixed results on this question. Many students spent an unnecessary time discussing the ionising ability of the particles. Some students referred to the gold foil experiment, which didn't give relevant information. Most students did not gain full credit because they did not address all three properties (range, penetration, deflection in a magnetic field) for all three types of radiation. Most students responded reasonably well in terms of penetration and range but there was less clarity about the effect of magnetic fields. Many students wrote about being attracted to 'positive' or 'negative' sides without actually mentioning magnetic fields. Of those that did describe all the properties, most did well and got high marks. Over a third of the students gave a Level 3 answer.

9

Foundation

(a) Many students thought that an electromagnet could somehow be adjusted to pick up a variety of specific metals. It was also not uncommon to see students stating that the electromagnet could separate metals, failing to realise that they were comparing the electromagnet with a permanent magnet, which would also be able to separate metals.

(b) The vast majority of students attempted this question, but many struggled to describe how to put an electromagnet together, and in particular it was not uncommon for students to connect the ends of the nail to the power supply. There was also a small minority of students who tried to express the intention to strip the ends of the insulating wire and attach crocodile clips to this, but actually described stripping the entire insulating wire. A few students thought that the insulating wire was to keep their electromagnet thermally insulated. Of those who did manage to describe the construction of an electromagnet well, most could describe a test to see if their electromagnet was working, but many struggled to increase the strength of the electromagnet, with comments indicating that they should turn up the power on the power supply, rather than increasing p.d., current or number of turns on the coil. Just less than half of students accessed Levels 2 or 3.

Higher

(a) Nearly four fifths of students answered this question correctly. The most common reason for not answering correctly was for stating that the electromagnet could separate metals, failing to realise that they were comparing the electromagnet with a permanent magnet, which would also be able to separate metals.

(b) Many students struggled to describe how to construct an electromagnet; in particular it was not uncommon to see students connecting the ends of the nail to the power supply, or failing to make clear whether the insulating wire or the iron nail was connected to the power supply. Most students who managed to do this correctly went on to describe a test for the strength of the electromagnet, although a significant number of students merely tested whether the electromagnet could pick up paperclips, and did not count how many. A number of students were confused between changing the strength of the electromagnet and testing the strength of it; it was not uncommon to see students stating that an electromagnet could be tested by adding more turns to the coil on the nail. About a third of students gave Level 3 responses to this question. A common reason for a student reaching Level 2 but not getting into Level 3 was that they talked about increasing the power from the power supply, rather than increasing the current or potential difference. Just under a quarter of students gave Level 2 responses.

10

(a) Nearly all students selected the correct terms for parts (a) and (c). However, fewer were able to identify that the heaviest elements are formed only in a supernova, in part (b).

(b) Nearly all students selected the correct terms for parts (a) and (c). However, fewer were able to identify that the heaviest elements are formed only in a supernova, in part (b).

(c) Nearly all students selected the correct terms for parts (a) and (c). However, fewer were able to identify that the heaviest elements are formed only in a supernova, in part (b).

(d) This question carried four marks; the spread of marks was fairly even with around a fifth of students achieving zero marks, one-fifth gaining 1 mark, one-fifth gaining 2 marks and so on. Many were able to identify that nuclear fusion in stars was the mechanism by which different elements were formed. Also, many answers correctly identified the fusion of hydrogen to form helium. Thereafter, descriptions relating to the formation of heavier elements tended to be vague or confused, although a fair number correctly stated that elements heavier than iron were formed in a supernova.

11 (a) A number of students simply quoted the information from the table and included no new relevant information and so gained no credit for their answer. A few actually ignored the numerical data in the table and simply extolled the virtues of loft insulation or explained how double-glazing was able to insulate the house.

Some did go on to identify that loft insulation was the cheapest to install or that fitting an energy-efficient boiler gave the most money saved per year.

Calculations were presented by many students but the main difficulty was explaining the significance of these using clear statements. Few answers went further than calculating the four payback times (often inaccurately).

The least able calculated other sums of money because they misunderstood what was required e.g. multiplying the cost of installation by the annual saving. Some confused the amount saved as being the amount per month that had to be paid. Others thought that a really long pay-back time was a good idea because it gave you a long time to pay back the money.

Many answers failed to make any comparisons between the four options, even though there may have been payback times calculated. Terms such as ‘cost effective’ were not used by many students and payback time was often inadequately described.

Students needed to complete a calculation to be considered a Level 2 response, payback time or cost effectiveness over a period of time were commonly seen. Students also needed to make a clear comparison to gain 3 or 4 marks, perhaps referring to cost effectiveness or payback time.

For a Level 3 response a minimum of 2 calculations were needed and some further detail (in addition to the Level 2 comparison). Statements referring to the fact that loft insulation would not pay for itself in your lifetime or a ranking of the installation order were needed also. The markscheme list possible responses but it is not an exhaustive list. Students who discussed the relative insulating properties of the methods gained no credit, but these responses were treated as neutral and ignored. The best answers were those that came to some conclusion about the relative merits of the four methods.

(b) (i) Very few students scored the mark in this question. Many students thought that the U-value was the selling price of the house. A substantial number answered in terms of energy transfer but had insufficient detail to gain the mark.

(ii) Most students appeared to have little idea what U-value is in both parts of this question. Many students made no attempt at this question, but of those who did, more thought that increasing the amount of insulation would increase the U-value rather than decrease it, probably in relation to their incorrect answer to (i).

12 (a) About one third of the students realised that a positive charge would be needed to make the atom neutral.

(b) (i) Unfortunately, this question provided few responses which achieved credit. Many responses simply described, in detail, knowledge of the three principal subatomic particles and our modern model of an atom with the space for alpha particles to pass through, rather than the significance of the unexpected degree of alpha scattering found by Rutherford and Marsden which resulted in the abandoning of the plum pudding model.

(ii) Less than one fifth of the students scored this mark. Most answers being given in terms of the whole experiment being repeated rather than the compilation of the vast number of individual readings.

(c) Most of the students were able to score some marks, although one fifth of the students scored zero and a further tenth did not attempt the question. The names of the three particles were usually given and often the polarity was known. Some students extended their answers and often said far too much about the electron arrangement, talking about covalent and ionic bonding. The basic idea of a nucleus and orbiting electrons was well known but few gave extra detail about size of the nucleus, balance of protons and neutrons etc. However some excellent answers were seen and the question was clearly accessible to most students. The meanings of the terms relative charge and relative mass were not well known.

13 (a) Many of the students did not attempt to write down the minimum frequency of ultrasound, and a lot of the students were not aware that the wavelength of an X-ray is similar to the diameter of an atom, leading to some interesting responses. Only a small proportion of the students scored both marks with a further third of the students scoring one mark.

(b) This question was attempted by the vast majority of students, most of whom wrote a reasonably lengthy answer. Almost half of the students scored at least 4 marks. Some students chose to write down everything they knew about X rays or ultrasound, including lots of details about how they work which was not asked for in the question. There was a common misconception that X-ray photography uses gamma rays to produce images, and also that X-rays are radioactive. A lot of students limited themselves to level 2 by failing to write about the precautions necessary when using X-rays. Most students (perhaps prompted by the photographs in the question) were aware that ultrasound is used for fetal scanning, but a fair number of students stated that it was just used for scanning for babies, failing to mention that the babies in question were still in the womb. A lot of students stated that ultrasound was used to look for babies in the mother's stomach, which was allowed here but raises some questions about their knowledge of biology. A number of students got mixed up between CT scans and MRI scans.

15

(a) (i) Around three-quarters of students correctly identified the defect as ‘short sight’. Many others attempted to explain the defect, without naming it.

(ii) This question was well answered with the majority of students answering correctly. A very small minority of students failed to include an answer. Students should be encouraged not to leave blank spaces where a choice of answers is listed.

(b) Almost all students answered this question correctly.

(c) The Quality of Communication question was very well answered, with almost all students scoring four or more marks out of the six available. A number of students answered in bullet point form, but failed to write in full sentences. The information at the beginning of the question reminds students that they will be assessed on using good English, amongst other criteria. A well thought-out answer including many salient points is preferable to an extended account where the same point is repeated several times.

(d) Around a fifth of responses scored one of the two marks for the suggestion of moving the lens, but failed to score the second mark by being vague about the direction of movement; ‘up’, ‘down’ ‘backwards’ and ‘forwards’ were often seen. There were also a number of answers relating to inserting a diverging lens in front of the camera lens, as in the correction of eye defects. The specification makes a distinction between the two methods of focusing for the eye and the camera.

16

(a) Three-quarters of students knew why an energy storage system would work if the road surface was black. Many answers stated that ‘black surfaces absorb heat’ rather than ‘absorb heat well’.

(b) (i) A quarter of students gave a correct definition of specific latent heat of fusion. However, many incorrect responses referred to melting rather than a change from solid to liquid.

(ii) Nearly all students correctly calculated the amount of energy required to melt the ice.

(c) (i) Two-thirds of students correctly stated that the variable to be controlled was mass of ice. The remainder stated that the mass of salt had to be controlled.

(ii) Two-thirds of students correctly ticked two boxes with suggestions as to why the student stirred the crushed ice.

(iii) Nearly all students could correctly describe the pattern of how mass of salt added to some crushed ice affected the melting point of the ice.

(d) Just under half of students scored full marks for a calculation of energy transferred given values of power and time in non-SI units. Conversion from: kW to W; and minutes to seconds, was required. The spread of marks demonstrated this, with a third of students dropping one mark.

(e) The Quality of Communication question brought together the elements of the entire question and asked for advantages and disadvantages of using energy storage, salt and undersoil heating for keeping a road free from ice in the winter. Most students used the available space and many used additional pages.

Three-quarters of students scored four marks or more. Some excellent work was seen, but many students wasted time by repeating much of what was in the question. Also they ended a very good account with an unnecessary summary. Some very well written work only addressed either an advantage or a disadvantage of each system.

17

A low proportion of students were able to make a relevant comment on the arrangements of particles in solids or gases.

Generally, most students made a good attempt at the question, with few students leaving it blank. Most were able to make sensible statements about the spacing and movement of particles in solids and gases, but rather fewer referred to the forces between the particles: fewer still attempted to use these statements to explain the properties given in the information box.

Too many students simply repeated the information given in the question and weaker students wrote all they knew, including about particles and their behaviour in a liquid The use of the term ‘kinetic theory’ in the question distracted some students into describing conduction and convection. Others became obsessed with the fact that free electrons make metals good conductors.

More able students could select the relevant property of particles to explain the macroscopic property of solids and gases.

18

(a) A very low proportion of students did not attempt this question. Out of those who did answer nearly one-quarter failed to score any marks; answers referring to burning fossil fuels, wind turbines, waves and tides were not uncommon. Some answers started correctly with water falling, but then reverted to the water being heated up. A significant number of students either failed to include the useful energy transfers taking place, or just referred to the kinetic energy of the moving water transferring to 'electricity'.

(b) The majority of students were able to gain at least one mark out of the three, with more than one-fifth giving good descriptions of the consequences of burning fossil fuels. Some missed the reference to 'better for the environment' and answered in terms of saving money on fuel bills.

(c) Slightly less than half of students scored the mark. Many demonstrated an understanding of legal power made by government, but few mentioned economic factors. Incorrect suggestions included 'letting the people decide' or concern about the disposal of appliances which did not comply with the suggested new rule.

19

(a) (i) Just over two thirds of the students scored this mark.

(ii) Nearly half of the students gave an acceptable answer to score this mark.

(iii) There was generally a lack of detail in the answers with most marks being achieved by a description of the velocity changes occurring with little reference to the forces involved. Popular misconceptions were that the graph represented a hill that the cyclist had to ascend or that the graph was a distance-time graph and the cyclist would become stationary at point Z. Many of the students described in great detail practical details of cycling and the fatigue of the cyclist without referring to the question asked. Many of the students used the term speed to refer to the constant force applied to the pedals resulting in answers such as 'he moves at constant speed causing velocity to increase'. A significant number of the students answered in terms of direction changing, many doing so at the same time as mentioning that the cyclist was on a straight road. Few of the students realised that the graph indicates that the acceleration was decreasing but that the velocity was still increasing but at a slower rate to become steady between Y and Z with the forces being balanced. Most students achieved Level 1 to score 1 or 2 marks.

(b) (i) The calculation was relatively straightforward with four fifths of the students arriving at a correct answer. However only a quarter of the students were able to give the correct unit.

(ii) Nearly three fifths of the students scored one mark, generally for identifying that the kinetic energy would decrease. Only a small proportion of the students scored both marks. A common incorrect answer to the second part was friction.

20

(a) Most of the students scored very well here, with nearly three quarters gaining both marks. ‘J’ was usually seen with ‘it is the smallest’. Some students tried to elaborate further and ended up by confusing their answer. Another popular answer was ‘(only) small stars become Black Dwarfs’.

(b) (i) Both ‘become a supernova’ and ‘it will explode’ were seen here although only one response was needed. About a quarter of the students scored zero and those that did often had either a subsequent incorrect stage written down or ‘it will implode’.

(ii) This was not done very well with over four fifths of the students scoring zero. Most of the students mentioned the lack of weighing machines or another method for measuring the mass. Another popular response was the idea that we cannot visit Betelgeuse.

(iii) This was generally done very well with half of the students giving one of the responses involving advances in measuring, scientific knowledge, or technology. Unfortunately a few of the students continued with the idea of technology extending to the building of spaceships enabling people to visit Betelgeuse.

(c) This was usually done well, with two fifths of the students scoring 3 or more marks. Some of the students were very unsure of the different stages and just wrote down Red Giant and White Dwarf and this enabled them to obtain two marks. The last stage was a little confusing to some of the students as they wrote about the star losing all of its energy or running out of energy rather than the star stopping emitting energy.

21

(a) In describing the difference between longitudinal and transverse waves less than one-fifth of students gave a clear description referring to the directions of oscillations and energy transfer. A vague statement correctly referring to ‘parallel’ and ‘perpendicular’ was awarded one mark, but statements such as ‘in a transverse wave the wave moves perpendicular to the waves’ were often seen.

(b) Hardly any students scored full marks for a description of how radio waves and sound waves differed. Many students thought that sound waves travelled faster and had greater frequencies. Most students knew that sound waves cannot travel through a vacuum.

22

(a) (i) Nearly all students knew that nuclear fission takes place within a reactor and that nuclear fusion takes place within a star.

(ii) Less than half of the students could state a way in which fusion differs from fission. Many statements referred to atoms or elements instead of nuclei.

(b) (i) A nuclear equation representing fission was given and students were asked to use the information in the equation to describe the process of fission.

This was well answered, with just under half of the students gaining all four marks. Many statements relating to fission were seen which ignored the given equation. For example ‘two or three neutrons are released’ when the equation clearly showed three.

(ii) Only a quarter of students could complete a nuclear equation depicting beta minus emission by adding subscripts for atomic number and a correct symbol for a beta particle.

Many students are unclear concerning the symbol, subscript and superscript for a beta particle.

23 (a) Nearly all students knew that when the resistance of a circuit increases the current in it decreases.

(b) Nearly three-quarters of the students recognised the description of a filament bulb and a LED.

(c) The Quality of Communication question was a description of an experiment where the change in resistance of metal with temperature was investigated.

Many students wasted time, and used a substantial fraction of the answer lines, describing the electrical circuit provided. Just under half of the students scored four marks out of six for an adequate account that could be repeated to give sufficient data.

Students who scored more than four marks often included a graph of resistance against temperature or some detail such as removing the Bunsen burner and stirring the water before taking readings.

Those who scored three marks or less often did not state how resistance could be calculated from the meter readings, or did not state that the meters had to be read at all but that ‘resistance had to be recorded’ at each temperature.

(d) (i) Almost all students could relate a range of resistance values in a table to those represented on a graph.

(ii) Almost all students were able to circle an anomalous value on the graph.

(iii) Surprisingly, less than half the students were able to suggest a reason for the anomalous results such as misreading the thermometer or meters or incorrectly calculating resistance.

(iv) About a third of students were able to suggest a disadvantage of a resistance thermometer compared to a liquid-in-glass thermometer. About one tenth could suggest two, including the need for an electrical supply and that temperature could not be read directly.

24

(a) This question incorporated the assessment of the Quality of Written Communication. The responses were, on the whole, disappointing. Many tried to answer this item without even mentioning conduction, convection or radiation. A sizeable minority simply listed the labelled parts of the diagram and after each stated that they stopped heat movement without stating what method of heat transfer was being affected or what it was about the component that was useful in this regard. It was obvious that many did not know what a vacuum was.

(b) Only half of the students scored any marks on this question. Many appeared to know what was going on here but could not make their ideas clear enough to gain marks. “Surface area” was often missed out. Other students suggested that it was “cold” that was moving rather than “energy” or “heat”. Common errors included “small ears made covering by fur easier”, “small ears wouldn't flap and cool down the fox” and “small ears enabled the fox to hold them close to their body for warmth”.

25

(a) (i) This was very poorly answered with few students realising what the function of ‘J’ was in the circuit. A significant number of students did identify ‘J’ as a variable resistor but did not go on to say what it does.

(ii) Again very poorly answered with only a very small minority of students understanding that the resistance increases as the temperature of the bulb increases.

(iii) Again the calculation was well done with nearly three quarters of students giving the correct numerical answer. However the unit was not well known with only just over one fifth of students giving the correct one.

(b) Most students managed to score some marks on this question with the majority of students at level 2 and gaining 3 or 4 marks. Comparison of the cost aspect was done best by students, with many correctly calculating the need for 18 halogen bulbs to last as long as 1 LED and the higher associated costs. Very few students made a comment on efficiency beyond the fact that LEDs were more efficient. A lot could have been written about energy efficiency such as less waste energy, less heat produced, lower power input and lower running costs for the LED bulb. Even a simple statement of not having to change the LED bulb as often as the halogen bulb was not common. There were a small number of students who believed that you could increase the efficiency by adding more bulbs. So for example if you had 4 halogen bulbs at 10% efficiency then this would give you 40% efficiency. This led to erroneous conclusions that you could make halogen bulbs more efficient than an LED bulb. There were also a small number of students who believed that the higher the number for efficiency the more energy was wasted and so a higher efficiency was undesirable. A large number of students wasted time, and a considerable amount of the answer space, just rewriting the information in the table without any comparison other than to quote the numbers given. Specialist terms were usually limited to those given in the question. There was a considerable variation in the ability to use good English; some excellent sentences and clear writing, and at the other extreme an inability even to use capital letters and full stops, and copy correct spellings from words given in the question.

26

(a) Very few candidates obtained level 3 (5 or 6 marks), about half obtained level 1 (1 or 2 marks). In general, the responses regarding X-rays were answered in more detail than ultrasound. Many candidates were able to describe what the wave did, but failed to give accurate or detailed descriptions of the waves. Wavelength and frequency descriptions were often muddled. In many wrong responses, candidates failed to answer the question posed, often just appearing to write down any facts they had learned.

(b) Almost half of the candidates failed to gain any mark on this question. Often wrong responses detailed how X-rays affected the human body, organs or tissues; rather than damage at a cellular level.

(c) Less than one third of candidates could give a medical treatment using ultrasound. The most common correct response related to the treatment or removal of kidney stones. Many candidates with incorrect responses failed to note that the question asked for ‘other than imaging’ and stated scans of a fetus as their answer.

27

(a) Two thirds of the students failed to score any marks on this question. Many students failed to gain marks due to the idea that this was the first day of generating electricity and nuclear needed a long start-up time so gas would be used until nuclear was ready. This misconception gave students little chance to gain any credit. Those who did score credit usually recognised the idea that gas could be turned on quickly and / or could be used to supply at peak demands. Many students thought that the gas power station provided gas to the home.

(b) Nearly all students attempted this question and most got some credit, usually for comparing the costs of the two methods. Many students gave vague statements where the science was weak and incomplete. Some of these students were the more able who wrote eloquently but failed to gain credit because of phrases such as “eco-friendly”, “environmentally friendly” or made statements which did not go far enough such as “cause pollution”, “harmful”. Many students wrote about visual pollution, noise, harming birds, smells on the farm, etc. In the future, they need to elaborate ideas, giving more exact details. Most students made a choice and gave sensible reasons for that choice. The more able students were able to compare the advantages and disadvantages of both systems, and provide an overall conclusion at the end. Many students simply listed advantages and disadvantages of the two methods and did not attempt to fully answer the question by making a clear conclusion – as the question asked. Some students thought that the animal waste was dead animals or animals that need to be killed as the energy source. Other misconceptions included methane being non-renewable, the production of carbon dioxide being an advantage (helping the farmer's plants grow better) and that the major disadvantage of biogas was the smell. It was pleasing to see that more students were planning their answer before starting it.

28

(a) Few students scored marks here; there seems to be a general ignorance of the function of transformers in the National Grid. Many students stated that its purpose was to make the electricity travel faster along the cables.

(b) This six-mark question included assessment of the Quality of Written Communication. Very few students scored more than half marks.

(c) Students seemed very confused by this question, and only the better students scored any marks. Many students thought that the magnetic field was a way of transmitting electricity over a distance. Many others misread the label on the x-axis and thought that it referred to the length of the cable rather than the distance from the cable.

29

(a) (i) Few students appear to understand what geothermal energy is. Just over a tenth of students did not attempt this question.

(ii) Most students that attempted this question simply described a hydroelectric system, missing the point about this being a pumped storage hydroelectric system. Many students thought that it was the energy or the electricity that was being pumped; others thought that it was the pump that stored the energy. Almost a quarter of students did not attempt this question.

(b) This was the 6-mark Quality of Written Communication (QWC) question in which students had to discuss the advantages and disadvantages of two proposals: building off-shore wind turbines or laying a cable to connect to renewable resources in Iceland. The best responses came from those who spent a couple of minutes making a grid to show the pros and cons of each in note form. They then used these notes to construct a full response. Most students could provide advantages and disadvantages for the wind turbines, but rather fewer responses successfully referred to the link to Iceland. Some students had clearly not read the question properly, and had failed to notice that the wind turbines were off-shore. Their answers therefore related to the countryside being ruined and land taken up with thousands of large turbines. There were many objections to the underwater cable on the grounds that ‘electricity and water don’t mix’. Just under a tenth of students failed to make an attempt at this question, however the majority wrote at length.

30

The mechanism of conduction appeared to be only loosely understood by many students. Unfortunately, unclear or incorrect statements such as 'the particles start to vibrate' were often seen. About half of the answers referred to the metal having free electrons, but descriptions of how these played a part in conduction were often hazy, if not wrong.

31

(a) Most students achieved two marks by calculating the correct numerical value. Less than a fifth of students scored the third mark by stating the correct unit; the most common error was to state that the weight was measured in kilograms.

(b) This was the Quality of Written Communication (QWC) question on the paper which required the students to demonstrate their ability to use good English, organise their information clearly and use specialist terms where appropriate. Many students were able to supply some basic information as physics points, but often their responses lacked either the structure and organisation or the logical sequencing to achieve Level 2 and score three or four marks.

(c) (i) This question was answered well. The main errors were the height at which the parachute was dropped (which was in the stem of the question,) or to state the dependent variable.

(ii) Of the three parachutes illustrated, the correct choice of parachute C was made by the vast majority of students, but there was less success in giving the reason in terms of a comparison of the relative surface areas and relative rates of descent.

32

(a) (i)(ii) It was a common erroneous statement that the core of a transformer conducts electricity.
Many candidates, in their responses to (a)(ii), failed to include any reference to the changing or alternating nature of the input, of the magnetic field or of the output.
Few candidates explained why the coils are made of insulated wire.

(b) Most candidates gained both marks.

33

Foundation Tier

The responses in part (a) was mostly worthy of credit.

(b) There were abundant clues in both the stem of the question and the labels on the diagram to start candidates on the correct sequence. However, rather too many candidates started their answers with the iron bolt moving upwards with the result that they were unable to logically explain the working of the circuit breaker.

Higher Tier

This question was particularly well answered by most candidates.

(a) Most candidates gained both marks in this part but some gave heat insulation and failed to mention electrical insulation.

(b) There were some excellent answers to this part but a minority of candidates were unable to explain how this type of circuit breaker works.

34

Only a small minority were able to give the correct position of the centre of mass. Usually positions in the body of the lifebelt either above or below the hook were suggested and very few earned any marks in part (ii). Incorrect responses to part (i) made a rational explanation more difficult in part (ii) but responses which could still gain credit, such as ‘below the point of suspension’ and ‘the lifebelt is symmetrical’, were only given by a minority of candidates.

Susan’s moment was usually numerically correct but the unit was often omitted or incorrect.

In part (c) it was rare for candidates to gain more than one mark. Where credit was gained it was usually for ‘low centre of mass’, ‘less likely to fall over’ or ‘easier to hold’. Very few made correct statements in relation to the moments involved and the communications mark, which was given for the correct use of terms, was rarely awarded.

35

The weaker candidates found difficulty in gaining marks, their writing was not coherent and lacking in relevant detail. Of the more able candidates a surprisingly large number had clearly studied the diagram, worked out how it worked and then offered reasonably precise answers to gain three or four of the marks.

36 This question produced few really competent answers. Most candidates gave vague (e.g. cheap, dangerous) or incorrect advantages and disadvantages, or, in some cases, answers relating to coal-fired stations. Those candidates who could clearly identify specific advantages and disadvantages of nuclear power stations scored well. Perhaps more practice in selecting the really important factors and stating them clearly would be useful.

37

Foundation Tier

Most candidates gained some credit on this question, with the better candidates producing very good descriptions. Some chose simply to describe what they could see in the two diagrams rather than describe the sequence of events that would cause the circuit to break. Incorrect ideas that were frequently seen were that, ‘the coils heat up’, ‘the springs pass the current’ or ‘the button must be pressed to switch off the electricity’. Very few candidates understood that as a consequence of an increased current the electromagnetic attraction increases and attracts the iron bolt.

Higher Tier

Most candidates gained credit on this question, with the better candidates producing very good, detailed descriptions. Some weaker candidates chose simply to describe what they could see in the two diagrams rather than describe the sequence of events that would cause the circuit to break. There were, however, only a few candidates who understood that as a consequence of an increased current, the electromagnetic attraction increases and attracts the iron bolt.