Analysis and Evaluation Low Demand

Name:

Class:

Date:

Time:	**315 minutes**
Marks:	**313 marks**
Comments:	

1 Energy resources can be renewable or non-renewable.

(a) Coal is a non-renewable energy resource.

Name **two** other non-renewable energy resources.

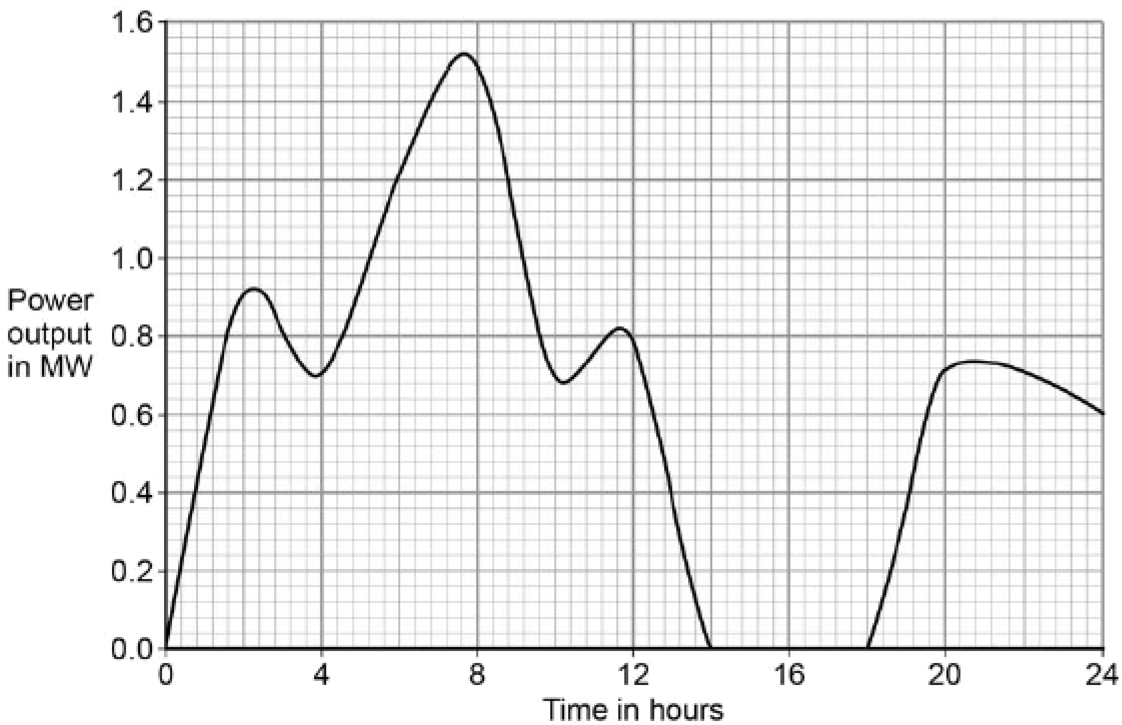
1 ....

2 ....

(2)

(b) Wind turbines are used to generate electricity.

The graph below shows how the power output of a wind turbine changes over one day.



A wind turbine does not generate electricity constantly.

For how many hours did the wind turbine generate no electricity?

....

Time = ... hours

(1)

(c) Electrical power is transferred from power stations to the National Grid.

What is the National Grid?

Tick **one** box.

a system of cables and pylons ☐

a system of cables and transformers ☐

a system of cables, transformers and power stations ☐

(1)

(d) An island has a large number of wind turbines and a coal-fired power station.

The island needs to use the electricity generated by the coal-fired power station at certain times.

Choose **one** reason why.

Tick **one** box.

Wind is a renewable energy resource. ☐

Wind turbine power output is constant. ☐

The power output of wind turbines is unpredictable. ☐

The fuel cost for wind turbines is very high. ☐

(1)

(e) A wind turbine has an average power output of 0.60 MW.

A coal-fired power station has a continuous power output of 1500 MW.

Calculate how many wind turbines would be needed to generate the same power output as one coal-fired power station.

....

....

Number of wind turbines = ...

(2)

(f) It is important that scientists develop new energy resources.

Choose **one** reason why.

Tick **one** box.

All energy resources are running out.	☐
All energy resources are used to generate electricity.	☐
Most energy resources have negative environmental effects.	☐

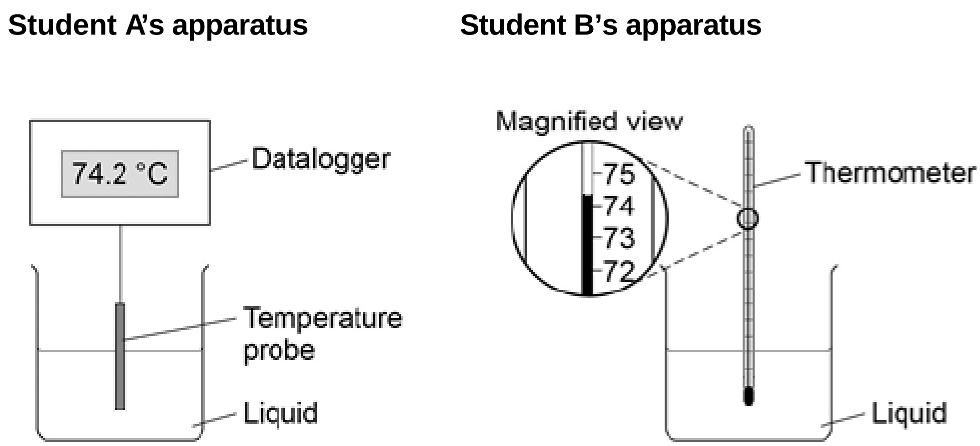
(1)
(Total 8 marks)

2 Two students investigated the change of state of stearic acid from liquid to solid.

They measured how the temperature of stearic acid changed over 5 minutes as it changed from liquid to solid.

Figure 1 shows the different apparatus the two students used.

Figure 1



(a) Choose **two** advantages of using student **A**'s apparatus.

Tick **two** boxes.

Student **A**'s apparatus made sure the test was fair. ☐

Student **B**'s apparatus only measured categoric variables. ☐

Student **A**'s measurements had a higher resolution. ☐

Student **B** was more likely to misread the temperature. ☐

(2)

(b) Student **B** removed the thermometer from the liquid each time he took a temperature reading.

What type of error would this cause?

Tick **one** box.

A systematic error ☐

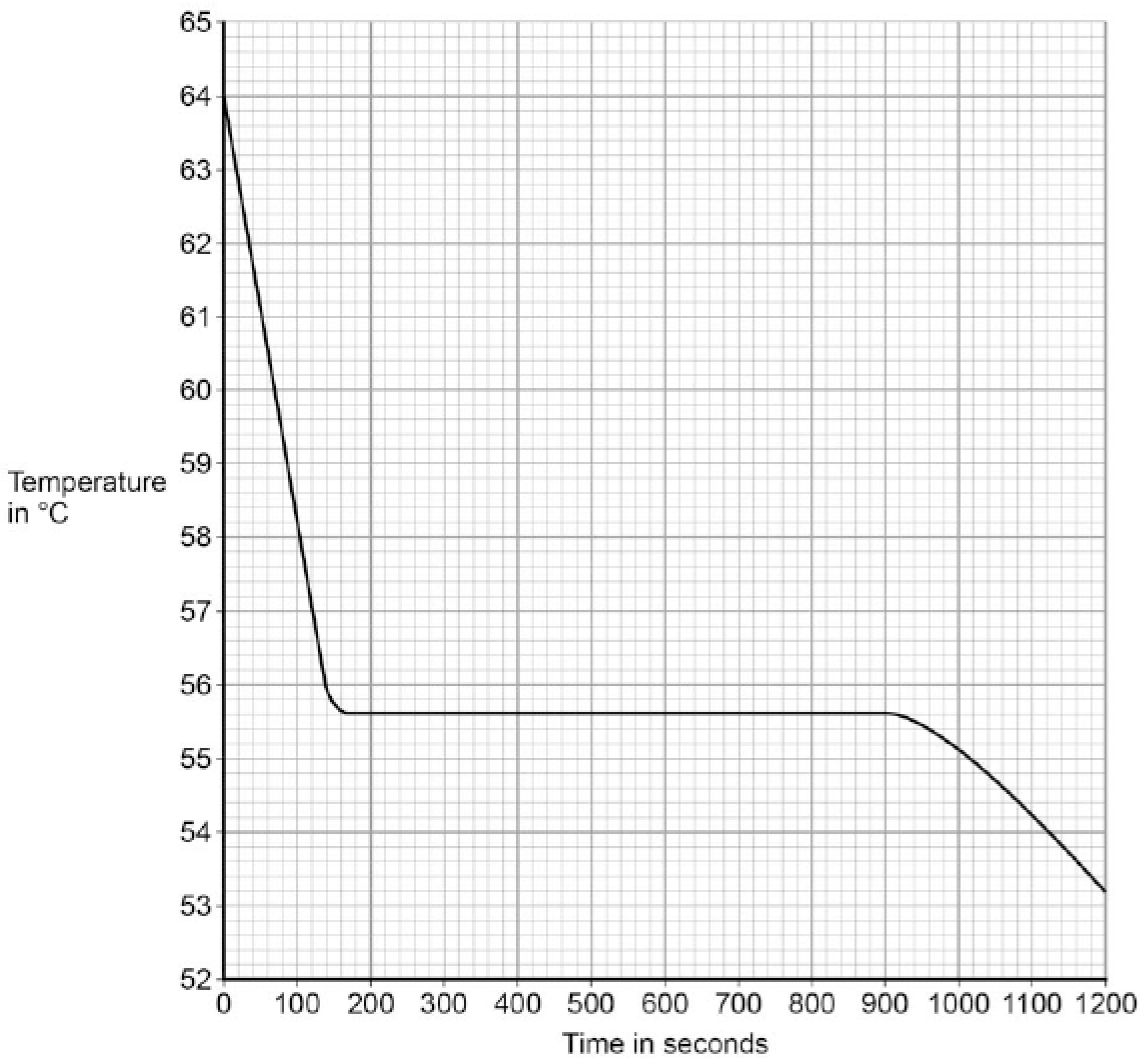
A random error ☐

A zero error ☐

(1)

(c) Student **A**'s results are shown in **Figure 2**.

Figure 2



What was the decrease in temperature between 0 and 160 seconds?

Tick **one** box.

8.2 °C ☐

8.4 °C ☐

53.2 °C ☐

55.6 °C ☐

(1)

(d) Use **Figure 2** to determine the time taken for the stearic acid to change from a liquid to a solid.

Time = ... seconds

(1)

(e) Calculate the energy transferred to the surroundings as 0.40 kg of stearic acid changed state from liquid to solid.

The specific latent heat of fusion of stearic acid is 199 000 J / kg.

Use the correct equation from the Physics Equations Sheet.

....

....

....

Energy = ... J

(2)

(f) After 1200 seconds the temperature of the stearic acid continued to decrease.

Explain why.

....

....

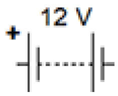
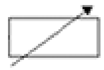
....

....

(2)
(Total 9 marks)

3 A student wants to investigate how the current through a filament lamp affects its resistance.

(a) Use the circuit symbols in the boxes to draw a circuit diagram that she could use.

12 V battery	**variable resistor**	**filament lamp**	**voltmeter**	**ammeter**
				

(2)

(b) Describe how the student could use her circuit to investigate how the current through a filament lamp affects its resistance.

....

....

....

....

....

....

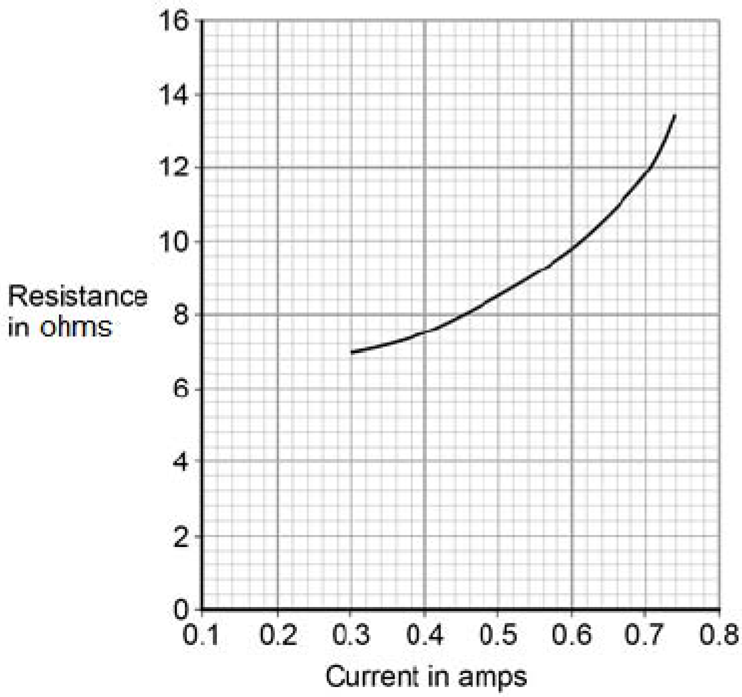
....

....

(4)

(c) The student's results are shown in **Figure 1**.

Figure 1



Describe how the resistance of the filament lamp changes as the current through it increases.

....

....

(1)

(d) Use **Figure 1** to estimate the resistance of the filament lamp when a current of 0.10 A passes through the lamp.

Resistance = ... Ω

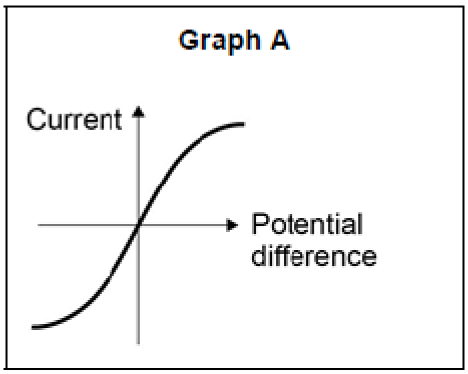
(1)

(e) The current-potential difference graphs of three components are shown in **Figure 2**.

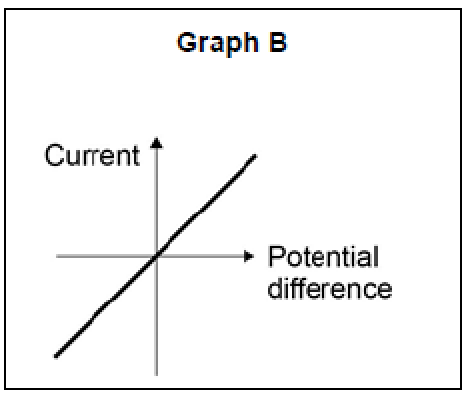
Use answers from the box to identify each component.

diode	**filament lamp**	**light dependent resistor**
resistor at constant temperature		**thermistor**

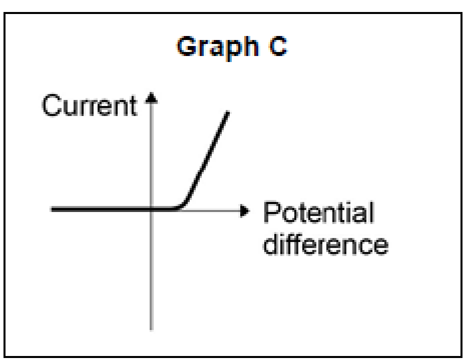
Figure 2



....



....



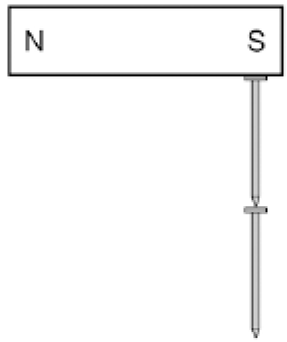
....

(3)
(Total 11 marks)

4 **Figure 1** shows two iron nails hanging from a bar magnet.

The iron nails which were unmagnetised are now magnetised.

Figure 1



(a) Complete the sentence.

Use a word from the box.

forced	**induced**	**permanent**

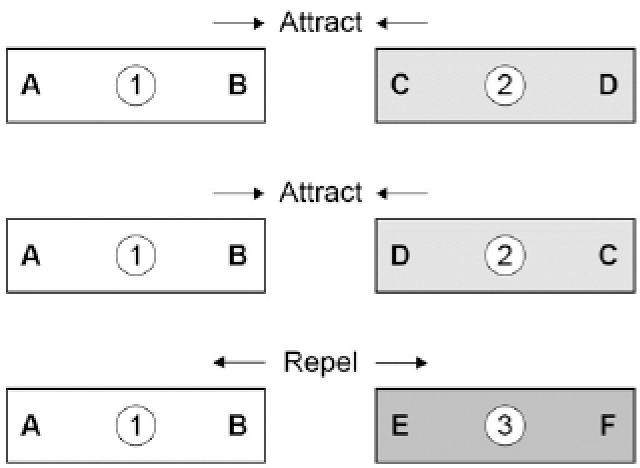
The iron nails have become .... magnets.

(1)

(b) Each of the three metal bars in **Figure 2** is either a bar magnet or a piece of unmagnetised iron.

The forces that act between the bars when different ends are placed close together are shown by the arrows.

Figure 2



Which **one** of the metal bars is a piece of unmagnetised iron?

Tick **one** box.

Bar 1 ☐

Bar 2 ☐

Bar 3 ☐

Give the reason for your answer.

....

....

(2)

(c) A student investigated the strength of different fridge magnets by putting small sheets of paper between each magnet and the fridge door.

The student measured the maximum number of sheets of paper that each magnet was able to hold in place.

Why was it important that each small sheet of paper had the same thickness?

....

....

....

(1)

(d) Before starting the investigation the student wrote the following hypothesis:

'The bigger the area of a fridge magnet the stronger the magnet will be.'

The student's results are given in the table below.

Fridge magnet	**Area of magnet in mm^2**	**Number of sheets of paper held**
A	40	20
B	110	16
C	250	6
D	340	8
E	1350	4

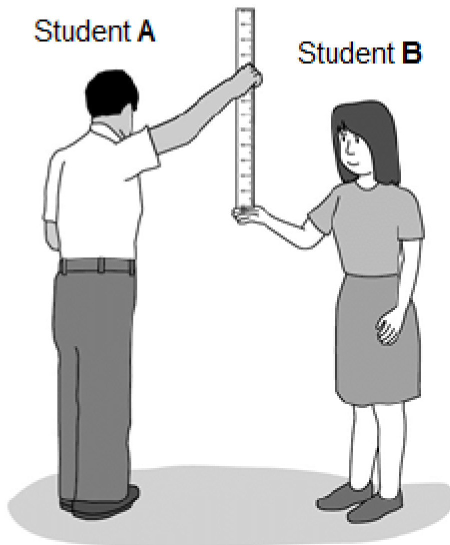
Give **one** reason why the results from the investigation **do not** support the student's hypothesis.

....

....

(1)
(Total 5 marks)

5 (a) The figure below shows two students investigating reaction time.



Student **A** lets the ruler go.

Student **B** closes her hand the moment she sees the ruler fall.

This investigation can be used to find out if listening to music changes the reaction times of a student.

Explain how.

....

....

....

....

....

....

....

....

....

(4)

(b) A second group of students used a stop clock and computer simulation test to measure their reaction times.

The table below shows their results.

Student	Reaction time in seconds		
	Test 1	**Test 2**	**Test 3**
X	0.44	0.40	0.34
Y	0.28	0.24	0.22
Z	0.36	0.33	0.47

Give **one** conclusion that can be made from the results for student **X** and student **Y**.

....

....

(1)

(c) Test **3** for student **Z** gave an anomalous result.

Suggest **two** possible reasons why this anomalous result occurred.

1 ....

....

2 ....

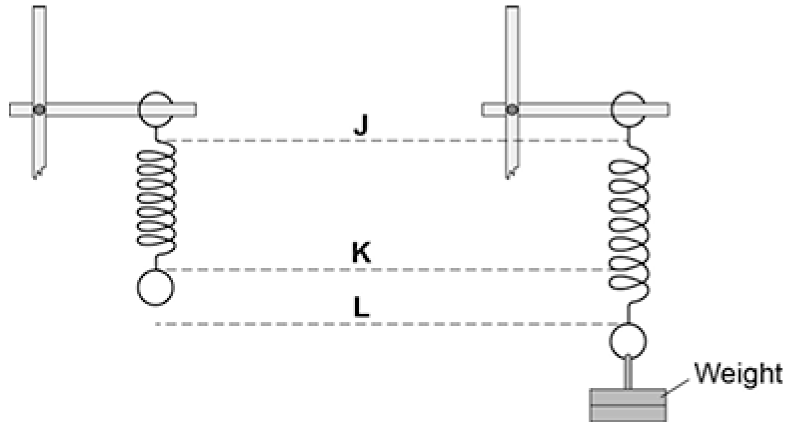
....

(2)
(Total 7 marks)

6 A student suspended a spring from a laboratory stand and then hung a weight from the spring.

Figure 1 shows the spring before and after the weight is added.

Figure 1



(a) Which distance gives the extension of the spring?

Tick **one** box.

from **J** to **K** ☐

from **K** to **L** ☐

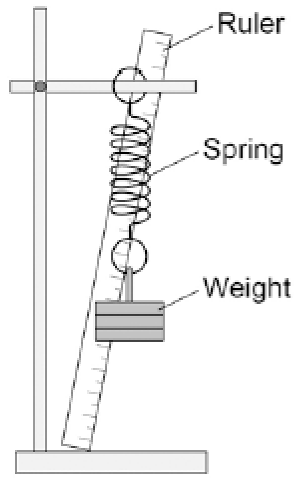
from **J** to **L** ☐

(1)

(b) The student used the spring, a set of weights and a ruler to investigate how the extension of the spring depended on the weight hanging from the spring.

Figure 2 shows that the ruler is in a tilted position and not upright as it should be.

Figure 2



How would leaving the ruler tilted affect the weight and extension data to be recorded by the student?

Use answers from the box to complete each sentence.

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

greater than	**the same as**	**smaller than**

The weight recorded by the student would be .... the actual weight.

The extension recorded by the student would be .... the actual weight.

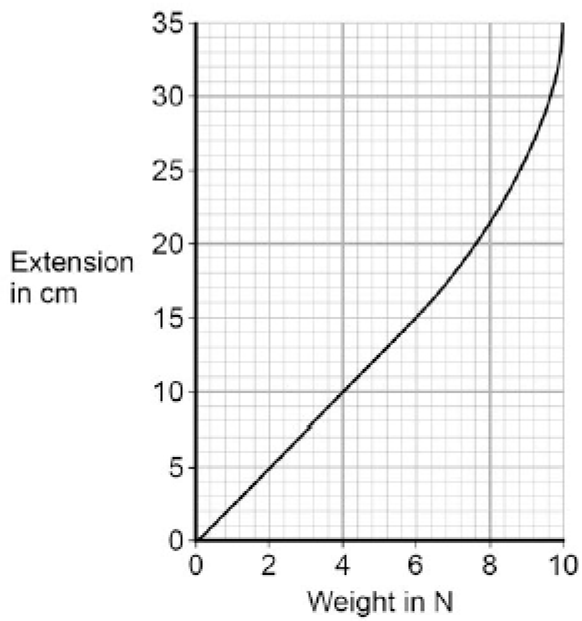
(2)

(c) The student moves the ruler so that it is upright and not tilted.

The student then completed the investigation and plotted the data taken in a graph.

The student's graph is shown in **Figure 3**.

Figure 3



Use **Figure 3** to determine the additional force needed to increase the extension of the spring from 5cm to 15cm.

Additional force = ... N

(1)

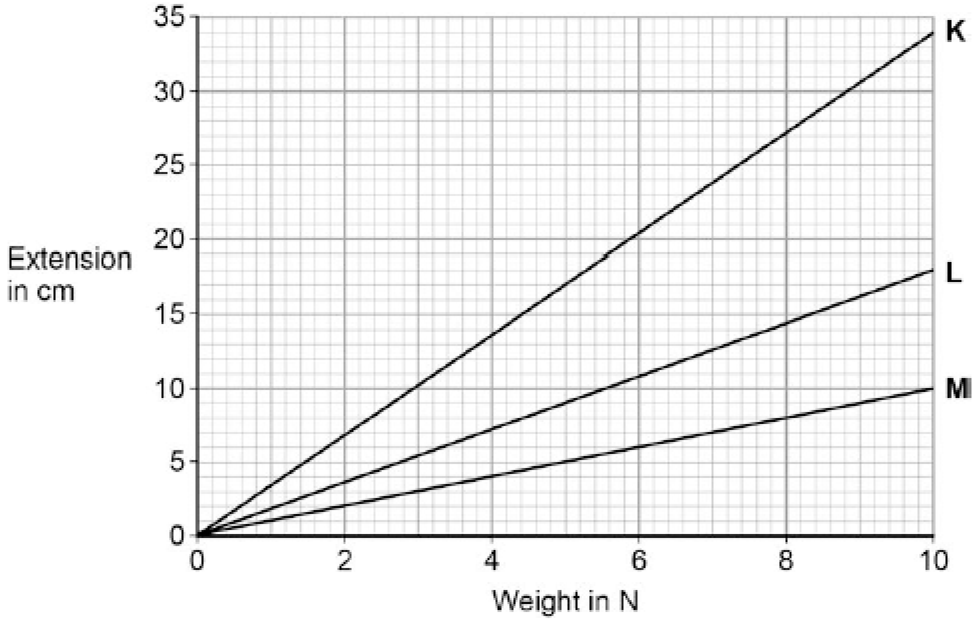
(d) What can you conclude from **Figure 3** about the limit of proportionality of the spring?

(1)

(e) The student repeated the investigation with three more springs, **K**, **L** and **M**.

The results for these springs are given in **Figure 4**.

Figure 4



All three springs show the same relationship between the weight and extension.

What is that relationship?

Tick **one** box.

The extension increases non-linearly with the increasing weight. ☐

The extension is inversely proportional to the weight. ☐

The extension is directly proportional to the weight. ☐

(1)

(f) Which statement, **A**, **B** or **C**, should be used to complete the sentence?

Write the correct letter, **A**, **B** or **C**, in the box below.

A a lower spring constant than

B the same spring constant as

C a greater spring constant than

From **Figure 4** it can be concluded that spring **M** has [ ] the other two springs.

(1)
(Total 7 marks)

7 Different energy sources are used to generate electricity.

(a) Use words from the box to match the correct energy source to each of the descriptions given in the table.

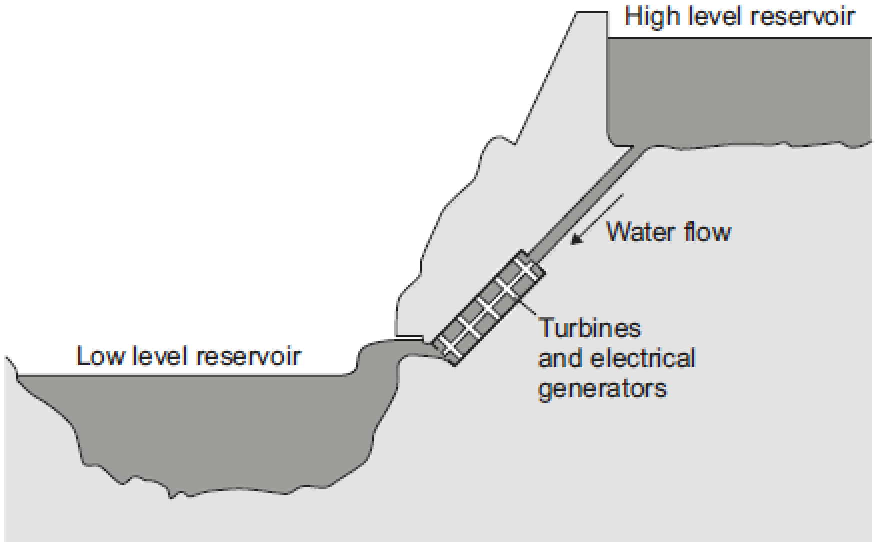
biofuel	**coal**	**geothermal**	**nuclear**	**waves**

Description	**Energy source**
Energy from the Earth’s core is used to heat water.	
Fission of uranium nuclei is used to heat water.	
Gases from rotting plant material are burned to heat water.	

(3)

(b) Energy can be stored in a pumped storage power station.

The figure shows a pumped storage power station.



When electricity is needed, the water in the high level reservoir is allowed to flow to the low level reservoir. The flowing water generates electricity.

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

electrical	**gravitational potential**	**kinetic**	**nuclear**	**sound**

The water in the high level reservoir stores .... energy.

The flowing water has .... energy.

The water turns the turbine which is connected to the generator.

The generator produces some ...., this is wasted energy.

(3)

(c) The total power input to a pumped storage power station is 600 MW.

The useful power output is 540 MW.

(i) Calculate the efficiency of this pumped storage power station.

....

....

....

Efficiency = ...

(2)

(ii) Calculate how much power is wasted by the pumped storage power station.

....

Power = ... MW

(1)

(iii) How is the temperature of the surroundings affected by the energy wasted by the pumped storage power station?

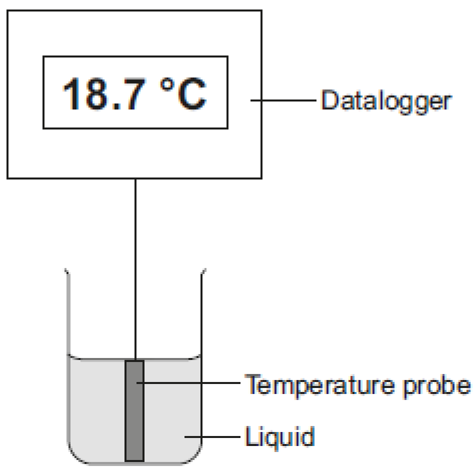
....

(1)
(Total 10 marks)

8 A student investigated the cooling effect of evaporation.

She used the equipment (datalogger and probe) shown in **Figure 1** to measure how the temperature of a liquid changed as the liquid evaporated.

Figure 1



(a) Which type of variable was the temperature in this investigation?

Tick (✓) **one** box.

	Tick (✓)
control	
dependent	
independent	

(1)

(b) Before the investigation started, the student checked the accuracy of three different temperature probes. The student put the probes in a beaker of boiling water that had a temperature of 100.0 °C.
The readings from the three temperature probes are shown in **Figure 2**.

Figure 2

Probe A	Probe B	Probe C
99.8	100.1	103.2

Which **one** of the temperature probes, **A**, **B** or **C**, was **least** accurate?

Write the correct answer in the box.

Give a reason for your answer.

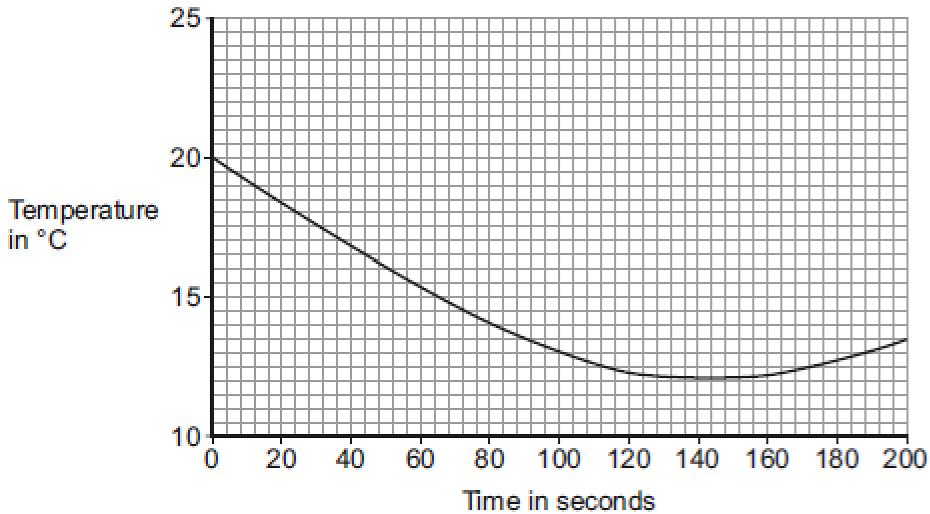
....

....

(2)

(c) **Figure 3** shows how the temperature recorded changed during the investigation.

Figure 3



(i) Use **Figure 3** to determine the lowest temperature recorded as the liquid evaporated.

Temperature = ... °C

(1)

(ii) Use **Figure 3** to determine how long it took for all the liquid to evaporate. Give a reason for your answer.

Time = ... seconds

Reason: ....

....

(2)

(iii) How would increasing the starting temperature of the liquid above 20 °C affect the rate of evaporation of the liquid?

....

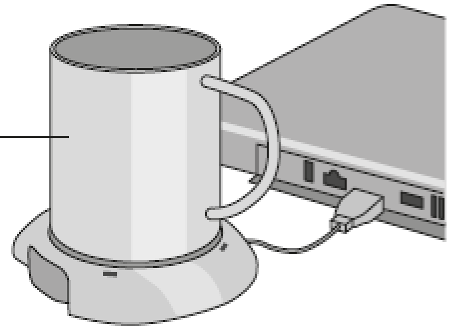
....

(1)
(Total 7 marks)

9

A heater uses energy from a laptop computer to keep a drink hot.

The image shows a metal mug on the heater.



(a) The laptop computer is operating on battery power.
How would connecting the heater affect the amount of time the laptop computer would operate for, before needing to be recharged?

Tick (✓) **one** box.

	Tick (✓)
it would decrease the time	
it would not affect the time	
it would increase the time	

(1)

(b) The power output from the heater is 12 W.

Calculate the energy transferred to the metal mug in 60 seconds.

....

....

....

Energy = ... joules

(2)

(c) The table lists changes that may affect the energy transfer per second from the heater to the liquid.

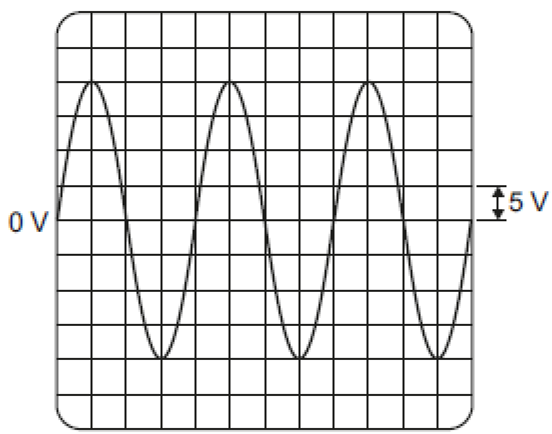
Tick (✓) **one** box to show the effect of each change.

Change	**Energy transfer per second to the liquid**		
	increases	**decreases**	**does not change**
use a mug with a smaller base			
use a lower power heater			
use a plastic mug instead of a metal mug			

(3)
(Total 6 marks)

10 (a) **Figure 1** shows the oscilloscope trace an alternating current (a.c.) electricity supply produces.

Figure 1



One vertical division on the oscilloscope screen represents 5 volts.

Calculate the peak potential difference of the electricity supply.

....

Peak potential difference = ... V

(1)

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

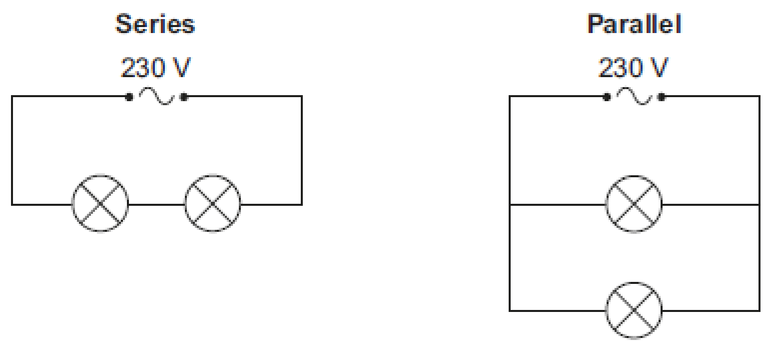
40	**50**	**60**

In the UK, the frequency of the a.c. mains electricity supply is .... hertz.

(1)

(c) **Figure 2** shows how two lamps may be connected in series or in parallel to the 230 volt mains electricity supply.

Figure 2



(i) Calculate the potential difference across each lamp when the lamps are connected in **series**.

The lamps are identical.

....

Potential difference when in series = ... V

(1)

(ii) What is the potential difference across each lamp when the lamps are connected in **parallel**?

Tick (✓) **one** box.

115 V ☐ 230 V ☐ 460 V ☐

(1)

(iii) Give **one** advantage of connecting the lamps in parallel instead of in series.

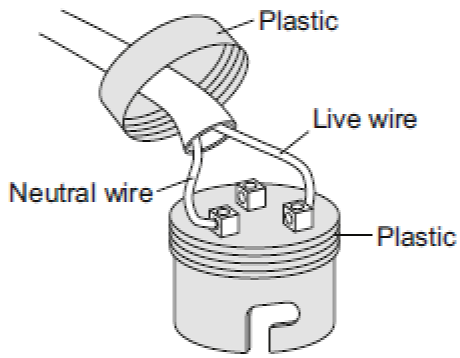
....

....

(1)

(d) **Figure 3** shows the light fitting used to connect a filament light bulb to the mains electricity supply.

Figure 3



The light fitting does **not** have an earth wire connected.

Explain why the light fitting is safe to use.

....

....

....

....

(2)

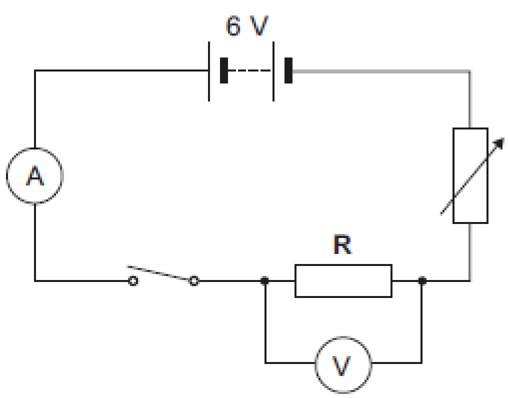
(e) A fuse can be used to protect an electrical circuit.

Name a different device that can also be used to protect an electrical circuit.

....

(1)
(Total 8 marks)

11 The diagram shows an electrical circuit.



(a) The 6 V battery shown in the diagram is made up of a number of identical 1.5 V cells.

Calculate the minimum number of cells needed to make the battery.

....

Number of cells =................................

(1)

(b) The switch in the diagram is shown in the open position. Closing the switch completes the circuit.

Charge flows through the completed circuit and a reading is shown on both the ammeter and the voltmeter.

(i) In 10 seconds, 20 coulombs of charge flows through the circuit.

Calculate the current reading shown on the ammeter.

....

....

Current = ... A

(2)

(ii) For 20 coulombs of charge to flow through the resistor R, 100 joules of work must be done.

Calculate the potential difference reading given by the voltmeter.

....

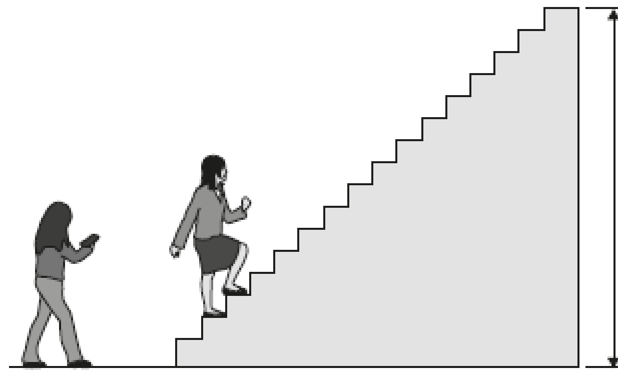
....

Potential difference = ... V

(2)
(Total 5 marks)

12 A student did an experiment to calculate her power.
The diagram below shows how she obtained the measurements needed.

The student first weighed herself and then ran up a flight of stairs. A second student timed how long it took her to go from the bottom to the top of the stairs. The height of the stairs was also measured.



(a) Complete the following sentence.

To run up the stairs the student must do work against

the force of ....

(1)

(b) The student did 2240 J of work going from the bottom of the stairs to the top of the stairs.

The student took 2.8 seconds to run up the stairs.

(i) Calculate the power the student developed when running up the stairs.

....

....

Power = ... W

(2)

(ii) How much gravitational potential energy did the student gain in going from the bottom to the top of the stairs?

Tick (✓) **one** box.

much more than 2240 J	☐
2240 J	☐
much less than 2240 J	☐

(1)

(c) Another four students did the same experiment.

The measurements taken and the calculated values for power are given in the table.

Student	**Weight in newtons**	**Time taken in seconds**	**Power in watts**
A	285	3.8	240
B	360	2.4	480
C	600	3.4	560
D	725	4.0	580

(i) To make a fair comparison of their powers the students kept **one** variable in the experiment constant.

What variable did the students keep constant?

....

(1)

(ii) From the data in the table a student wrote the following conclusion.

'The greater the weight of the student the greater the power developed.'

Suggest why this conclusion may **not** be true for a larger group of students.

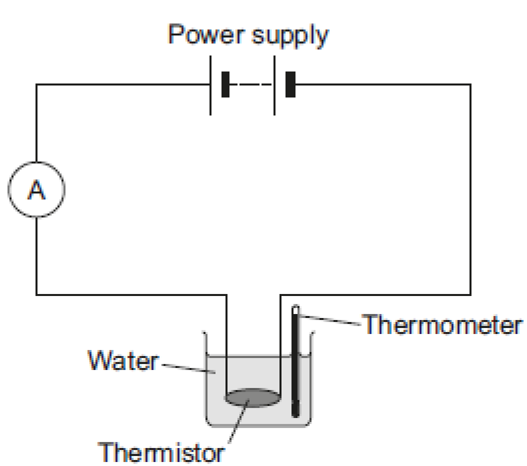
....

....

(1)
(Total 6 marks)

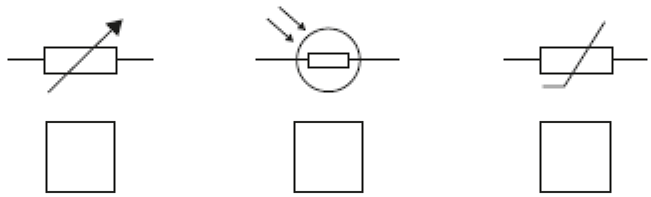
13 **Figure 1** shows the apparatus used to investigate how the current through a thermistor depends on the temperature of the thermistor.

Figure 1



(a) Which **one** of the following is the correct circuit symbol for a thermistor?

Tick (✓) **one** box.

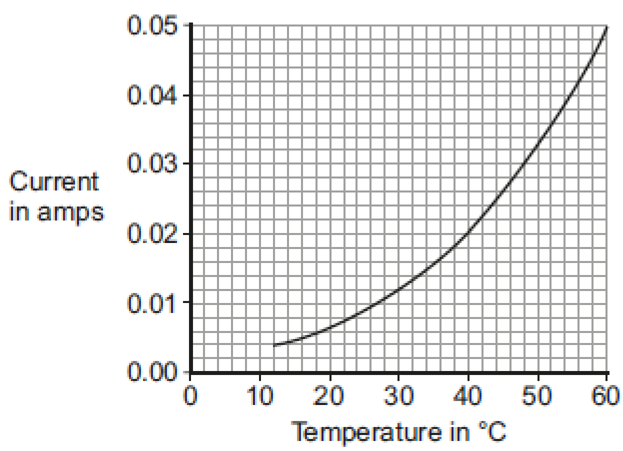


(1)

(b) To get a range of results, hot water at 60 °C was poured into the beaker.
The temperature of the water and current through the thermistor were then recorded as the water cooled.

The results of the investigation are shown in **Figure 2**.

Figure 2



(i) Suggest **one** way the investigation could have been changed to give a wider range of temperatures.

....

....

(1)

(ii) Describe how the current through the thermistor depends on the temperature of the thermistor.

....

....

(1)

(iii) Use **Figure 2** to determine the current through the thermistor at 40 °C.

Current at 40 °C = ... A

(1)

(iv) At 40 °C the thermistor has a resistance of 250 Ω.

Use your answer to part **(iii)** and the resistance of the thermistor to calculate the potential difference across the thermistor.

....

....

....

....

Potential difference = ... V

(2)

(v) The potential difference across the thermistor stays the same all through the investigation.

What conclusion can be made from the results in **Figure 2** about the resistance of the thermistor as the temperature of the thermistor **decreases?**

Tick (✓) **one** box.

the resistance increases	☐
the resistance does not change	☐
the resistance decreases	☐

(1)
(Total 7 marks)

14 **Figure 1** shows an X-ray of an arm with a broken bone.

Figure 1

© emmy-images/iStock

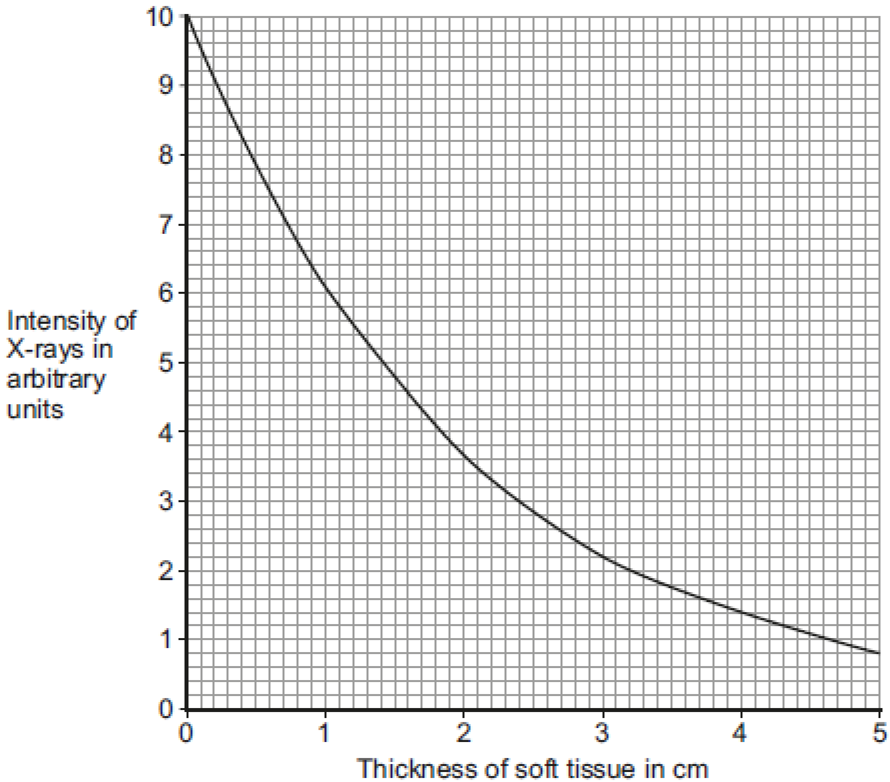
(a) Complete the following sentence.

X-rays are part of the .... spectrum.

(1)

(b) **Figure 2** shows how the intensity of the X-rays changes as they pass through soft tissue and reach a detector.

Figure 2



(i) Use **Figure 2** to determine the intensity of X-rays reaching the detector for a 3 cm thickness of soft tissue.

Intensity of X-rays = ... arbitrary units

(1)

(ii) Describe how the thickness of soft tissue affects the intensity of the X-rays.

....

....

....

....

(2)

(iii) The data in **Figure 2** are shown as a line graph and not as a bar chart.

Choose the reason why.

Tick (✓) **one** box.

Both variables are categoric	☐
Both variables are continuous	☐
One variable is continuous and one is categoric	☐

(1)

(c) What happens to X-rays when they enter a bone?

....

....

(1)

(d) How are images formed electronically in a modern X-ray machine?

Tick (✓) **one** box.

With a charge-coupled device (CCD)	☐
With an oscilloscope	☐
With photographic film	☐

(1)

(e) Radiographers who take X-ray photographs may be exposed to X-rays.

(i) X-rays can increase the risk of the radiographer getting cancer.

Why can X-rays increase the risk of getting cancer?

Tick (✓) **one** box.

X-rays travel at the speed of light	☐
X-rays can travel through a vacuum	☐
X-rays are ionising	☐

(1)

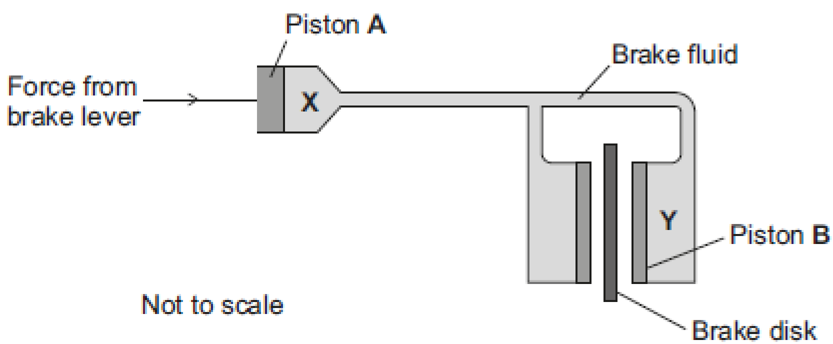
(ii) What should the radiographer do to reduce the risk from X-rays?

....

....

(1)
(Total 9 marks)

15 The figure below is a simplified diagram of a hydraulic brake system.



(a) Which is the correct statement about the pressure at **X** and the pressure at **Y**?

Tick (✓) **one** box.

The pressure at **X** is greater than at **Y**	☐
The pressure at **X** is the same as at **Y**	☐
The pressure at **X** is less than at **Y**	☐

(1)

(b) Piston **B** is larger than piston **A**.

How will this affect the size of the force on piston **B**?

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

smaller than	**the same as**	**larger than**

The force on piston **B** will be .... the force on piston **A**.

(1)

(c) (i) A force of 24 N acts on piston **A**. The cross-sectional area of piston **A** is 8 mm^2.

Calculate the pressure in N/mm^2 at position **X**.

....

....

....

....

Pressure = ... N/mm^2

(2)

(ii) The unit N/mm^2 is not often used to measure pressure.

Which unit is usually used to measure pressure?

Tick (✓) **one** box.

newton ☐

pascal ☐

watt ☐

(1)

(d) The liquid used in the hydraulic brake system freezes at –30 °C.

Suggest **one** effect a temperature below –30 °C would have on the brake system.

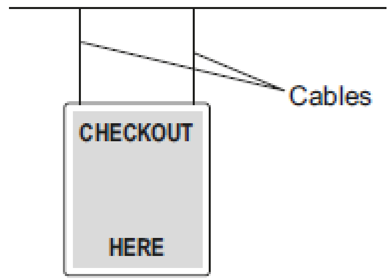
....

....

(1)
(Total 6 marks)

16 A sign hangs from the ceiling using two cables, as shown in **Figure 1**.

Figure 1



(a) On **Figure 1**, mark the centre of mass of the sign using an X.

(1)

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

concentrated	**greatest**	**pivoted**

The centre of mass of an object is the point where the mass appears

to be ....

(1)

(c) A breeze made the sign swing forwards and backwards like a pendulum.
The frequency of oscillations of the sign was 2 hertz.

Calculate the periodic time for the sign.

....

....

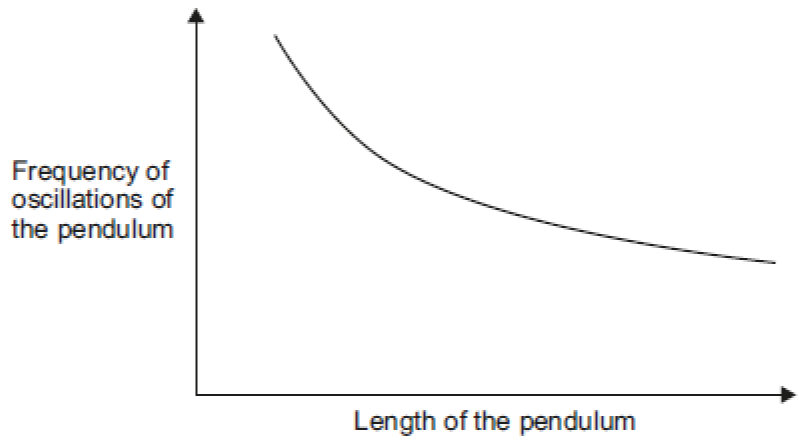
....

Periodic time = ... seconds

(2)

(d) **Figure 2** is a sketch graph showing how the frequency of the oscillations of a pendulum changes as the length of the pendulum is increased.

Figure 2



Give **one** way the sign could be made to swing with a lower frequency.

Use **only** the information in the sketch graph.

....

....

(1)
(Total 5 marks)

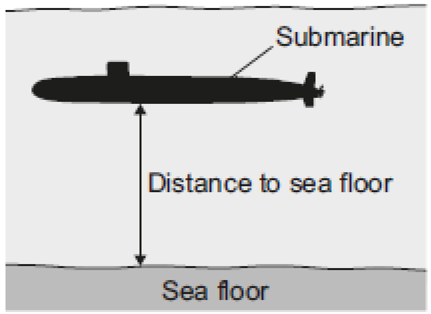
17 (a) Ultrasound is sound above the maximum frequency that humans can hear.

Tick (✓) **one** box.

20 Hz	☐
2000 Hz	☐
20 000 Hz	☐

(1)

(b) The image shows a submerged submarine.



Not to scale

The submarine sends a pulse of ultrasound to the sea floor.
The pulse takes 0.25 seconds to travel from the submarine to the sea floor.

The speed of sound in water is 1600 m/s.

Calculate the distance from the submarine to the sea floor.

....

....

....

....

Distance = ... m

(2)

(c) The ultrasound is reflected from the sea floor back to the submarine.
Use the correct answer from the box to complete the sentence.

half	**the same as**	**twice**

The total distance the ultrasound pulse travelled is .... the distance to the sea floor.

(1)

(d) The submarine moves through the sea and every few seconds sends a pulse of ultrasound to check the distance to the sea floor.

The table shows the time taken for five ultrasound pulses to travel from the submarine to the sea floor and back to the submarine.

Pulse number	Time for pulse to return in seconds
1	0.50
2	0.45
3	0.38
4	0.40
5	0.48

Describe how the distance from the submarine to the sea floor changed over these five pulses.

....

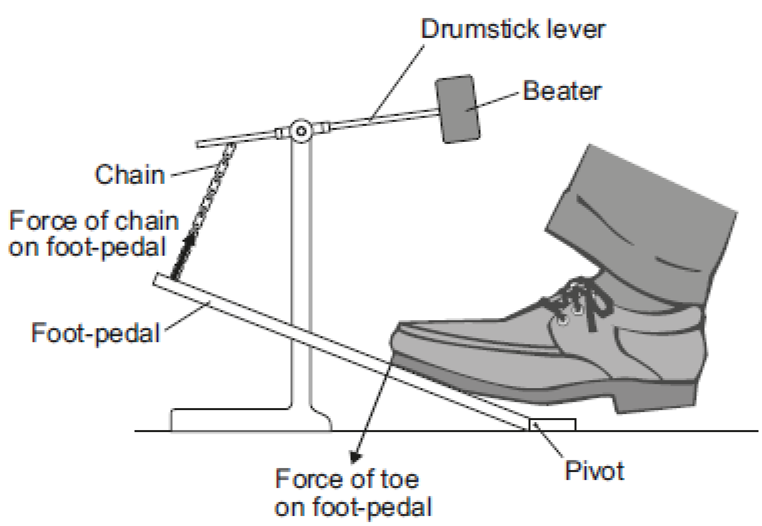
....

....

....

(2)
(Total 6 marks)

18 A drum is hit by a beater attached to a drumstick lever. The drumstick lever is attached to a foot-pedal by a chain, as shown below.



(a) State how the size of the force of the chain on the foot-pedal compares with the size of the force of the toe on the foot-pedal.

....

....

(1)

(b) The foot-pedal is pushed halfway down and held stationary.

The force of the toe and the force of the chain each create a moment which acts on the foot-pedal.

Compare the size and direction of the moments of the toe and the chain.

Tick (✓) **one** box.

Size	**Direction**	**Tick (✓)**
The moments are equal	same	
The moments are equal	opposite	
The moment of the force of the toe is greater	same	

(1)

(c) How can the drummer create a greater moment about the pivot without increasing the force he applies?

....

....

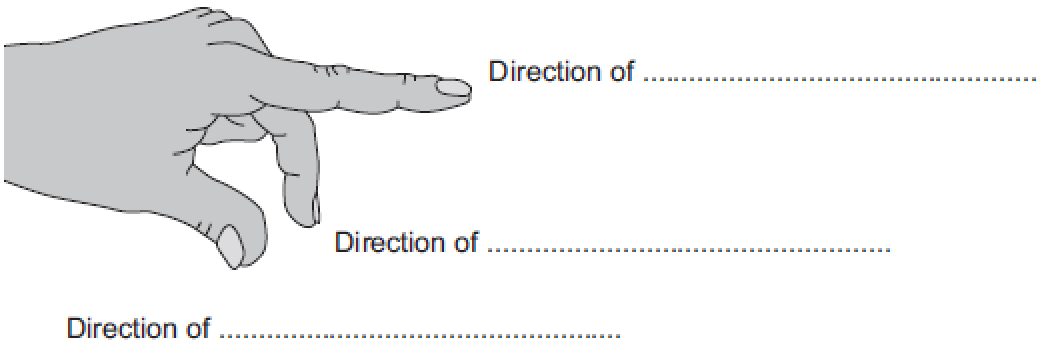
(1)
(Total 3 marks)

19 The left-hand rule can be used to identify the direction of the force acting on a current-carrying conductor in a magnetic field.

(a) Use words from the box to label **Figure 1**.

current	field	force	potential difference

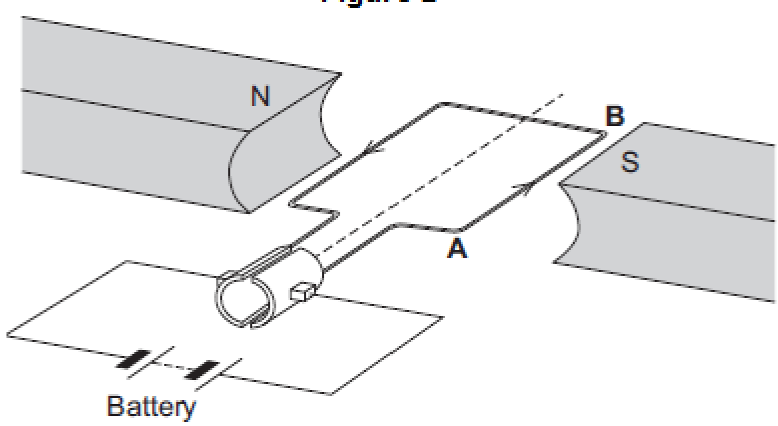
Figure 1



(3)

(b) **Figure 2** shows an electric motor.

Figure 2



(i) Draw an arrow on **Figure 2** to show the direction of the force acting on the wire **AB**.

(1)

(ii) Suggest **two** changes that would increase the force acting on the wire **AB**.

1...

2...

(2)

(iii) Suggest **two** changes that would reverse the direction of the force acting on the wire **AB**.

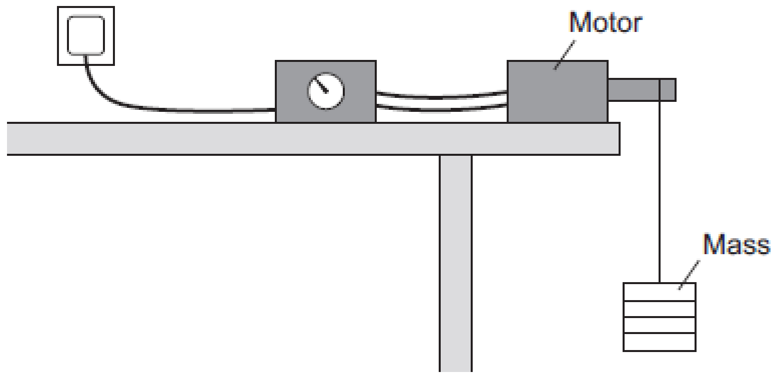
1...

2...

(2)

(c) A student used an electric motor to lift a mass. This is shown in **Figure 3**.

Figure 3



The student varied the electrical input power to the motor. For each different electrical input power, he recorded the time taken to lift the mass and calculated the output power of the motor.

The results are shown in the table.

Test	Electrical input power in watts	Work done lifting the mass in joules	Time taken to lift the mass in seconds	Output power in watts
A	20	24	2.4	10
B	40	24	1.2	20
C	60	24	0.8	30
D	80	24	0.2	120

The result for **Test D** is anomalous.

(i) Calculate the efficiency of the motor in **Test D**.

....

....

Efficiency = ...

(2)

(ii) Comment on your answer to part (c)(i).

....

....

(1)

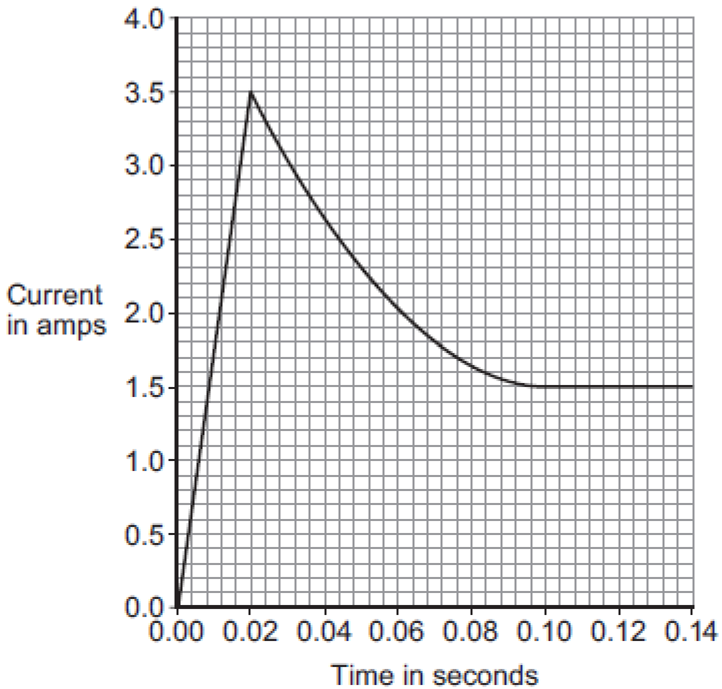
(iii) Suggest a reason for this anomalous result.

....

....

(1)
(Total 12 marks)

20 The graph shows how the current through a filament bulb changes after the bulb is switched on.



(a) What happens to the current through the bulb in the first 0.02 seconds after the bulb is switched on?

....

(1)

(b) Between 0.02 seconds and 0.08 seconds the current through the bulb decreases.

(i) What, if anything, happens to the **resistance** of the bulb between 0.02 seconds and 0.08 seconds?

Draw a ring around the correct answer.

decreases **does not change** **increases**

(1)

(ii) What, if anything, happens to the **temperature** of the bulb between 0.02 seconds and 0.08 seconds?

Draw a ring around the correct answer.

decreases **does not change** **increases**

(1)

(c) The bulb is connected to a 12 V power supply.

Calculate the power of the bulb when the current through the bulb is 1.5 A.

Choose the unit from the list below.

coulomb **joule** **watt**

....

....

Power = ... unit ....

(3)
(Total 6 marks)

21 Light changes direction as it passes from one medium to another.

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

diffraction	**reflection**	**refraction**

The change of direction when light passes from one medium to another is

called ....

(1)

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

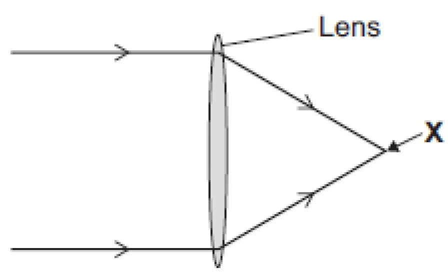
When light passes from air into a glass block, it changes

direction	away from the normal. towards the normal. to always travel along the normal.

(1)

(c) **Diagram 1** shows light rays entering and passing through a lens.

Diagram 1



(i) Which type of lens is shown in **Diagram 1**?

Draw a ring around the correct answer.

concave **convex** **diverging**

(1)

(ii) In **Diagram 1**, what is the point **X** called?

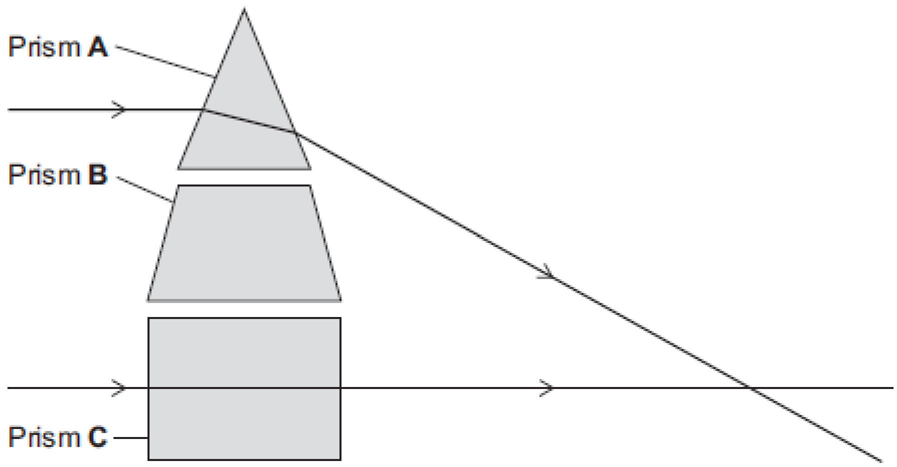
....

(1)

(d) A lens acts like a number of prisms.

Diagram 2 shows two parallel rays of light entering and passing through prism **A** and prism **C**.

Diagram 2



Draw a third parallel ray entering and passing through prism **B**.

(4)

(e) What **two** factors determine the focal length of a lens?

1 ....

2 ....

(2)
(Total 10 marks)

22 On 14 October 2012, a skydiver set a world record for the highest free fall from an aircraft.

After falling from the aircraft, he reached a maximum steady velocity of 373 m / s after 632 seconds.

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

This maximum steady velocity is called the [frictional / initial / terminal] velocity.

(1)

(b) The skydiver wore a chest pack containing monitoring and tracking equipment.
The weight of the chest pack was 54 N.

The gravitational field strength is 10 N / kg.

Calculate the mass of the chest pack.

....

....

Mass of chest pack = ... kg

(2)

(c) During his fall, the skydiver's acceleration was not uniform.

Immediately after leaving the aircraft, the skydiver's acceleration was 10 m / s ^{2}.

(i) Without any calculation, estimate his acceleration a few seconds after leaving the aircraft.

Explain your value of acceleration in terms of forces.

Estimate ....

Explanation ....

....

....

....

....

....

(3)

(ii) Without any calculation, estimate his acceleration 632 seconds after leaving the aircraft.

Explain your value of acceleration in terms of forces.

Estimate ....

Explanation ....

....

....

....

....

....

(3)
(Total 9 marks)

23 (a) **Diagram 1** shows a magnetic closure box when open and shut. It is a box that stays shut, when it is closed, due to the force between two small magnets.

These boxes are often used for jewellery.

Diagram 1

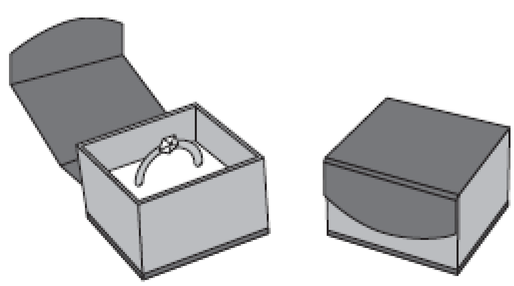
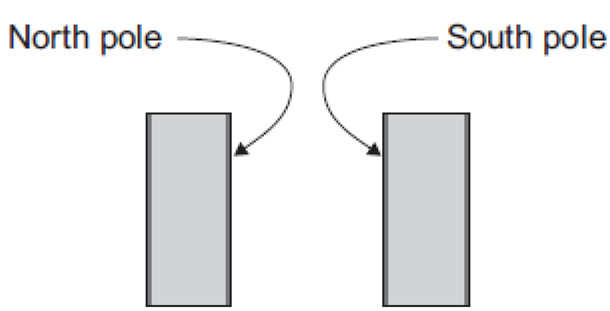


Diagram 2 shows the two magnets. The poles of the magnets are on the longer faces.

Diagram 2



(i) Draw, on **Diagram 2**, the magnetic field pattern between the two facing poles.

(2)

(ii) The magnets in the magnetic closure box must **not** have two North poles facing each other.

Explain why.

....

....

....

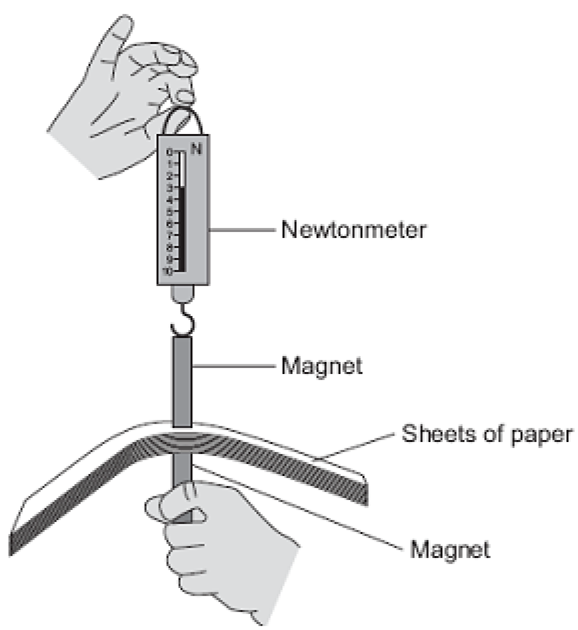
....

(2)

(b) A student is investigating how the force of attraction between two bar magnets depends on their separation.

She uses the apparatus shown in **Diagram 3**.

Diagram 3



She uses the following procedure:

- ensures that the newtonmeter does not have a zero error
- holds one of the magnets
- puts sheets of paper on top of the magnet
- places the other magnet, with the newtonmeter magnetically attached, close to the first magnet
- pulls the magnets apart
- notes the reading on the newtonmeter as the magnets separate
- repeats with different numbers of sheets of paper between the magnets.

The results are shown in the table.

Number of sheets of paper between the magnets	10	20	30	40	50	60	70	80	120
Newtonmeter reading as the magnets separate	3.1	2.6	2.1	1.5	1.1	1.1	1.1	1.1	1.1

(i) Describe the pattern of her results.

....

....

....

....

(2)

(ii) No matter how many sheets of paper the student puts between the magnets, the force shown on the newtonmeter never reaches zero.

Why?

....

....

(1)

(iii) The student is unable to experiment with fewer than 10 sheets of paper without glueing the magnet to the newtonmeter.

Suggest why.

....

....

....

....

(2)

(iv) Suggest **three** improvements to the procedure that would allow the student to gain more accurate results.

....

....

....

....

....

....

....

....

(3)

(v) The thickness of one sheet of paper is 0.1 mm.

What is the separation of the magnets when the force required to separate them is 2.1 N?

....

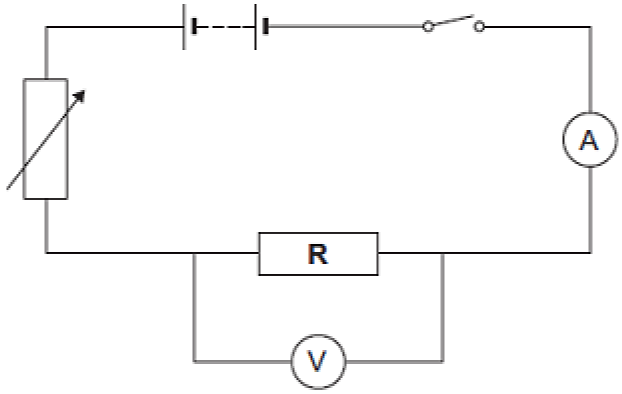
....

....

Separation of magnets = ... mm

(3)
(Total 15 marks)

24 (a) A resistor is a component that is used in an electric circuit.



(i) Describe how a student would use the circuit to take the readings necessary to determine the resistance of resistor **R**.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

(6)

(ii) Explain why the student should open the switch after each reading.

....

....

....

....

(2)

(iii) In an experiment using this circuit, an ammeter reading was 0.75 A.
The calculated value of the resistance of resistor **R** was 16 Ω.

What is the voltmeter reading?

....

....

Voltmeter reading = ... V

(2)

(iv) The student told his teacher that the resistance of resistor **R** was 16 Ω.

The teacher explained that the resistors used could only have one of the following values of resistance.

10 Ω **12 Ω** **15 Ω** **18 Ω** **22 Ω**

Suggest which of these resistors the student had used in his experiment.

Give a reason for your answer.

....

....

....

....

(2)

(b) The diagram shows a fuse.

Describe the action of the fuse in a circuit.

....

....

....

....

....

....

....

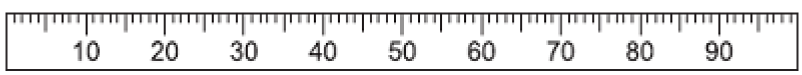
....

(3)
(Total 15 marks)

25 A student carries out an investigation using a metre rule as a pendulum.

(a) **Diagram 1** shows a metre rule.

Diagram 1



(i) Draw, on **Diagram 1**, an **X** to show the position of the centre of mass of the rule.

(1)

(ii) State what is meant by the 'centre of mass of an object'.

....

....

(1)

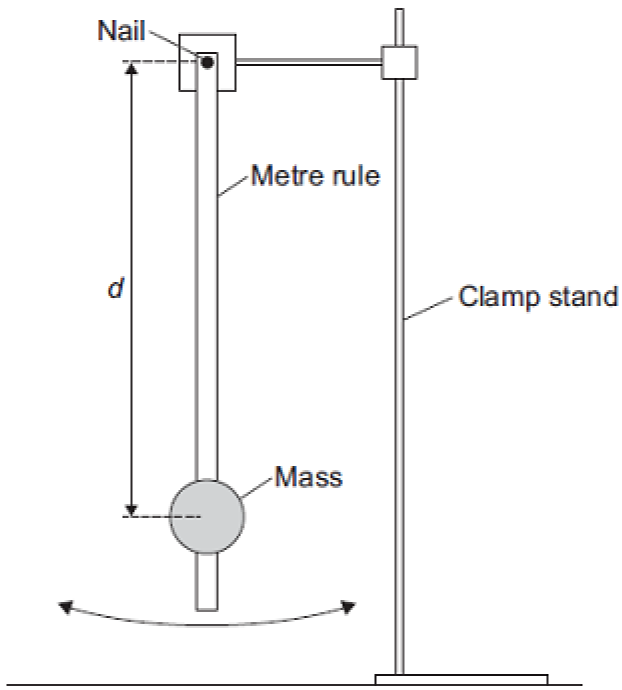
(b) The student taped a 100 g mass to a metre rule.

She set up the apparatus as shown in **Diagram 2**.

She suspended the metre rule from a nail through a hole close to one end, so she could use the metre rule as a pendulum.

The distance d is the distance between the nail and the 100 g mass.

Diagram 2



(i) Draw, on **Diagram 2**, a **Y** to show a possible position of the centre of mass of the pendulum.

(1)

(ii) The student carried out an investigation to find out how the time period of the pendulum varies with *d*.

Some of her results are shown in the table.

	Time for 10 swings in seconds				
***d* in cm**	**First test**	**Second test**	**Third test**	**Mean value**	**Mean time for 1 swing in seconds**
10.0	15.3	15.4	15.5	15.4	1.54
30.0	14.7	14.6	14.7	14.7	1.47
50.0	15.3	15.6	15.4	15.4	1.54
70.0	16.5	16.6	16.5		

Complete the table.

You may use the space below to show your working.

....

....

(3)

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

Describe how the student would carry out the investigation to get the results in the table in part (ii).

You should include:

- any other apparatus required
- how she should use the apparatus
- how she could make it a fair test
- a risk assessment
- how she could make her results as accurate as possible.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

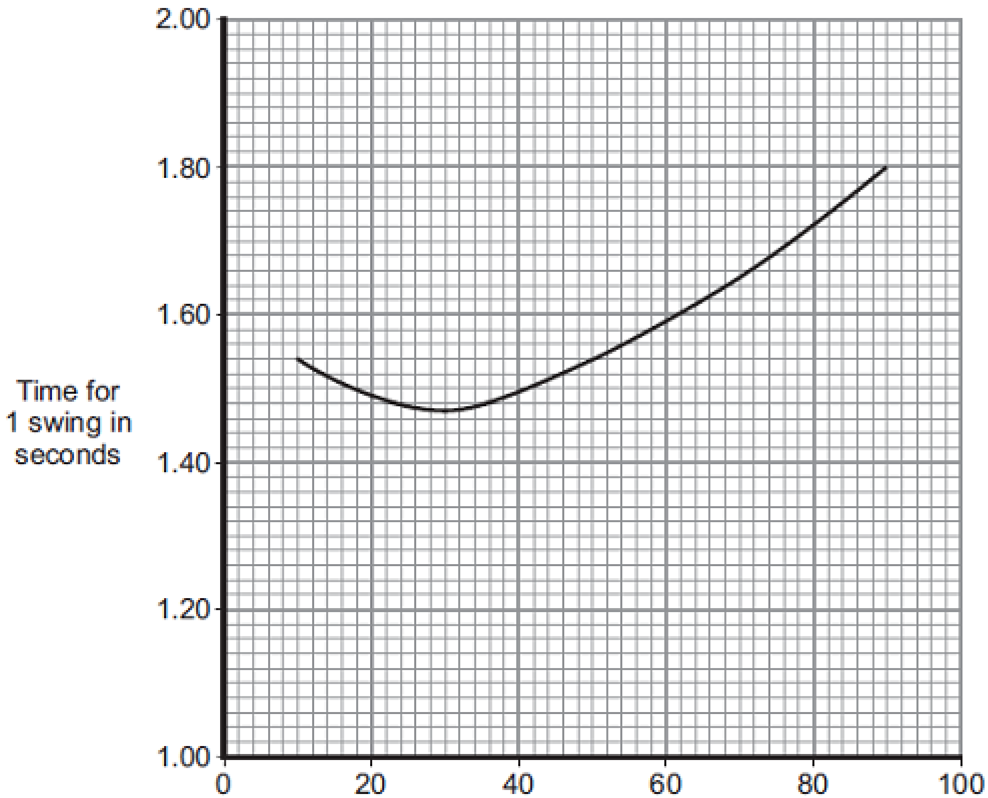
....

....

....

(6)

(c) A graph of the student's results is shown below.



(i) Describe the pattern shown by the graph.

....

....

....

....

(2)

(ii) The student thinks that the measurements of time for *d* = 10 cm might be anomalous, so she takes a fourth measurement.

Her four measurements are shown below.

15.3 s **15.4 s** **15.5 s** **15.3 s**

State whether you consider any of these measurements to be anomalous.

Justify your answer.

....

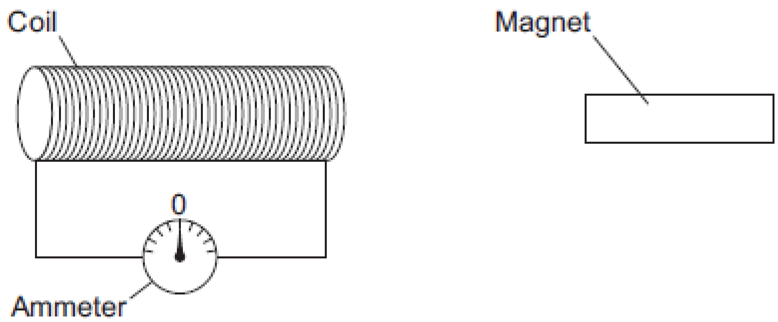
....

....

....

(2)
(Total 16 marks)

26 The figure below shows a coil and a magnet. An ammeter is connected to the coil.



The ammeter has a centre zero scale, so that values of current going in either direction through the coil can be measured.

(a) A teacher moves the magnet slowly towards the coil.

Explain why there is a reading on the ammeter.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

(6)

(b) The table below shows some other actions taken by the teacher.

Complete the table to show the effect of each action on the ammeter reading.

Action taken by teacher	**What happens to the ammeter reading?**
Holds the magnet stationary and moves the coil slowly towards the magnet	
Holds the magnet stationary within the coil	
Moves the magnet quickly towards the coil	
Reverses the magnet and moves it slowly towards the coil	

(4)

(c) The magnet moves so that there is a steady reading of 0.05 A on the ammeter for 6 seconds.

Calculate the charge that flows through the coil during the 6 seconds.

Give the unit.

....

....

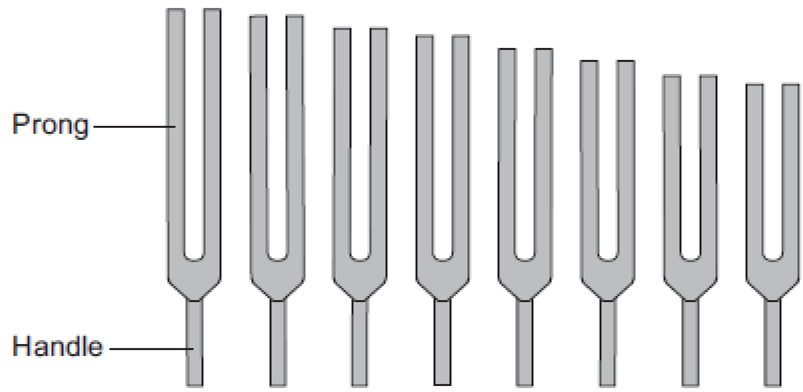
....

Charge = ...

(3)
(Total 13 marks)

27 **Figure 1** shows a set of tuning forks.

Figure 1



A tuning fork has a handle and two prongs. It is made from metal.

When the prongs are struck on a hard object, the tuning fork makes a sound wave with a single frequency. The frequency depends on the length of the prongs.

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

direction	**loudness**	**pitch**	**speed**

The frequency of a sound wave determines its ....

The amplitude of a sound wave determines its ....

(2)

(b) Each tuning fork has its frequency engraved on it. A student measured the length of the prongs for each tuning fork.

Some of her data is shown in the table.

Frequency in hertz	**Length of prongs in cm**
320	9.5
384	8.7
480	7.8
512	7.5

(i) Describe the pattern shown in the table.

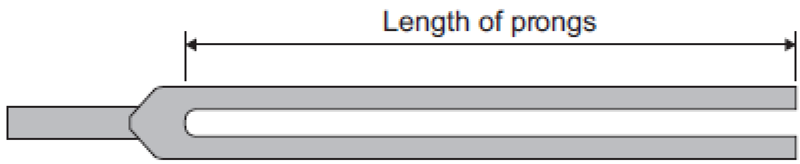
....

....

(1)

(ii) **Figure 2** shows a full-size drawing of a tuning fork.

Figure 2



Measure and record the length of the prongs.

Length of prongs = ... cm

(1)

Use the data in the table above to estimate the frequency of the tuning fork in **Figure 2**.

Explain your answer.

....

....

....

....

....

Estimated frequency = ... Hz

(3)

(c) Ultrasound waves are used in hospitals.

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

electronic	**hydraulic**	**radioactive**

Ultrasound waves can be produced by .... systems.

(1)

(ii) The frequency of an ultrasound wave used in a hospital is 2×10^6 Hz.

It is **not** possible to produce ultrasound waves of this frequency using a tuning fork.

Explain why.

....

....

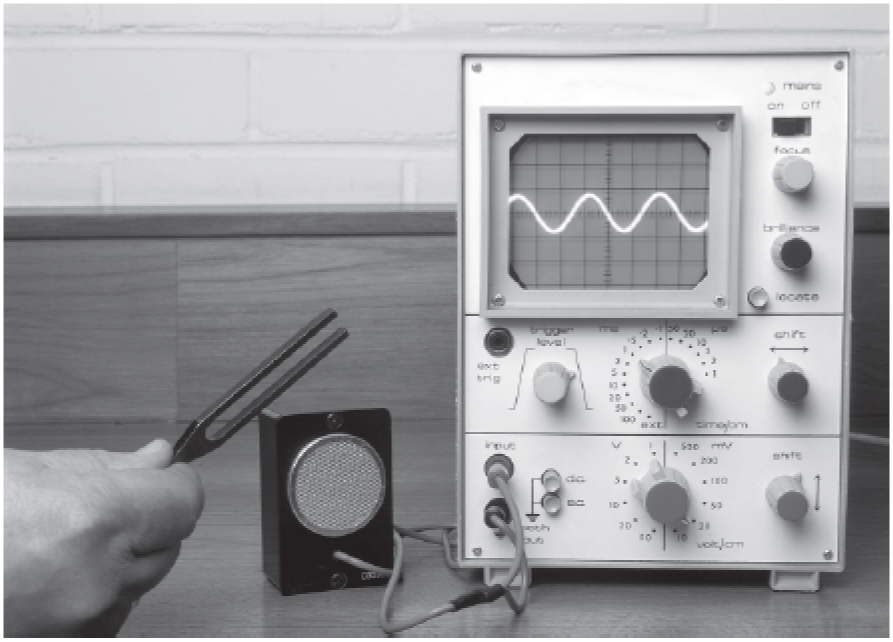
....

....

(2)

(d) **Figure 3** shows a tuning fork and a microphone. The microphone is connected to an oscilloscope.

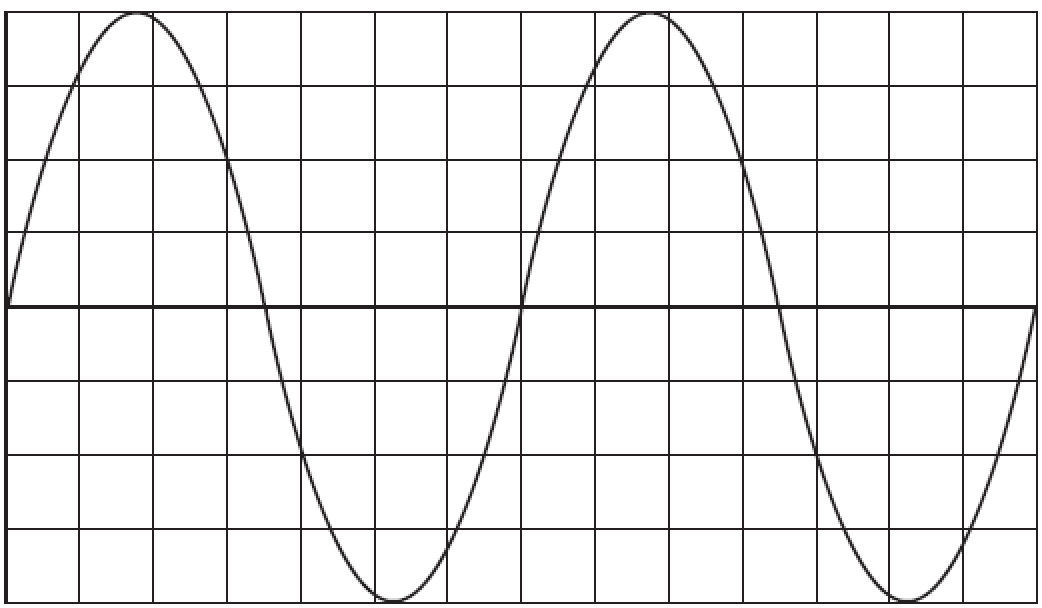
Figure 3



When the tuning fork is struck and then placed in front of the microphone, a trace appears on the oscilloscope screen.

Figure 4 shows part of the trace on the screen.

Figure 4



Each horizontal division in **Figure 4** represents a time of 0.0005 s.

What is the frequency of the tuning fork?

....

....

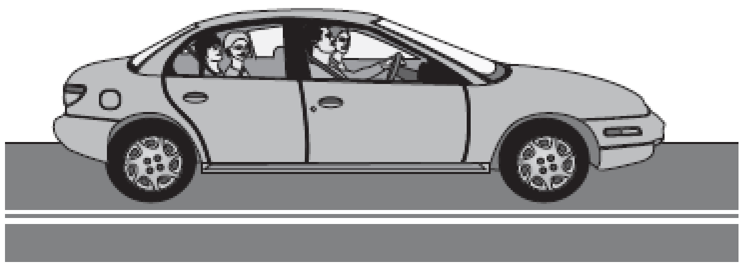
....

Frequency = ... Hz

(3)
(Total 13 marks)

28 The figure below shows a car with an electric motor.

The car is moving along a flat road.



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

light	**electrical**	**kinetic**	**potential**	**sound**

The car's motor transfers .... energy

into useful .... energy as the car moves.

Some energy is wasted as .... energy.

(3)

(ii) What happens to the wasted energy?

....

....

(1)

(b) The electric motor has an input energy of 50 000 joules each second.

The motor transfers 35 000 joules of useful energy each second.

Calculate the efficiency of the electric motor.

....

....

....

Efficiency = ...

(2)
(Total 6 marks)

29 Energy can be transferred through some materials by convection.

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

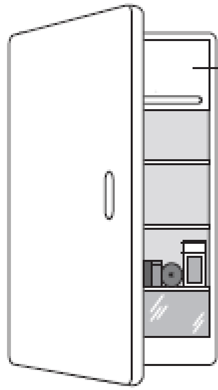
gas	**liquid**	**solid**

Energy **cannot** be transferred by convection through a ....

(1)

(b) The figure below shows a fridge with a freezer compartment.

The temperature of the air inside the freezer compartment is –5 °C.



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

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

decreased	**unchanged**	**increased**

When the air near the freezer compartment is cooled, the energy of the air particles is ....

The spaces between the air particles are ....

The density of the air is ....

(3)

(c) The table below shows some information about three fridges, **A**, **B** and **C**.

The efficiency of each fridge is the same.

Fridge	Volume in litres	Energy used in one year in kWh
A	232	292
B	382	409
C	622	524

(i) Which fridge, **A**, **B** or **C**, would cost the least to use for 1 year? ☐

Give **one** reason for your answer.

....

....

(2)

(ii) A householder looks at the data in the table above.

What should she conclude about the pattern linking the volume of the fridge and the energy it uses in one year?

....

....

(1)

(iii) The householder could not be certain that her conclusion is correct for all fridges.

Suggest **one** reason why not.

....

....

(1)
(Total 8 marks)

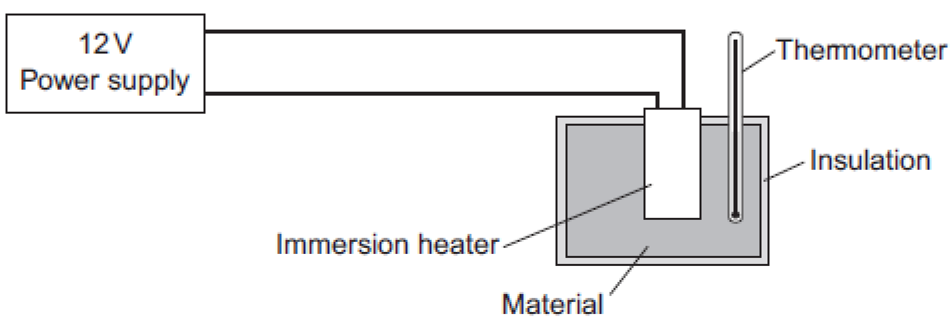
30 A student used the apparatus in **Figure 1** to compare the energy needed to heat blocks of different materials.

Each block had the same mass.

Each block had holes for the thermometer and the immersion heater.

Each block had a starting temperature of 20 °C.

Figure 1



The student measured the time taken to increase the temperature of each material by 5 °C.

(a) (i) State **two** variables the student controlled.

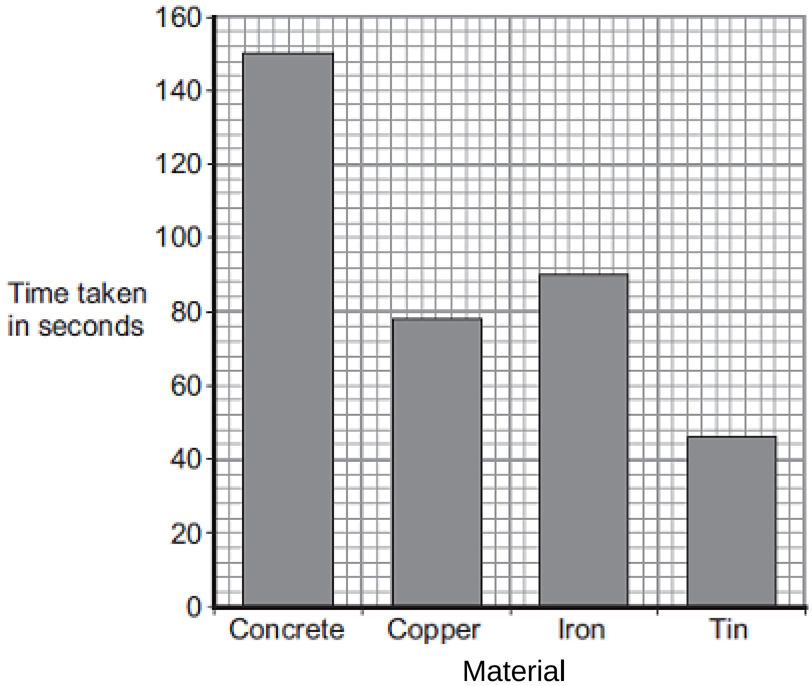
1 ....

2 ....

(2)

Figure 2 shows the student's results.

Figure 2



(ii) Why was a bar chart drawn rather than a line graph?

....

....

(1)

(iii) Which material was supplied with the most energy?

....

Give the reason for your answer.

....

....

(2)

(iv) The iron block had a mass of 2 kg.

Calculate the energy transferred by the heater to increase the temperature of the iron block by 5 °C.

The specific heat capacity of iron is 450 J / kg °C.

....

....

....

Energy transferred = ... J

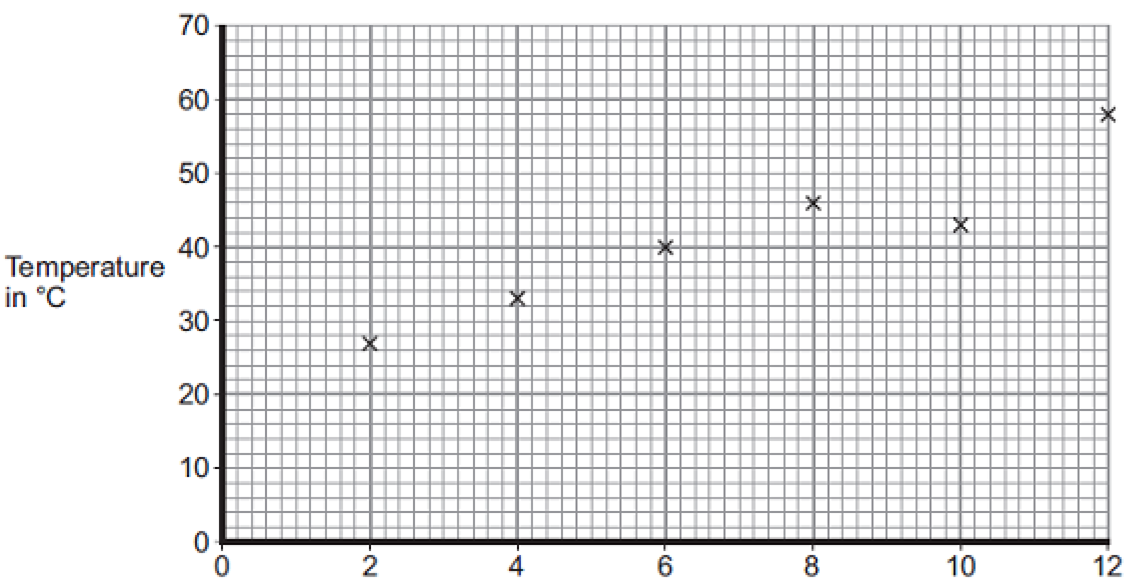
(2)

(b) The student used the same apparatus to heat a 1 kg block of aluminium.

He recorded the temperature of the block as it was heated from room temperature.

The results are shown in **Figure 3**.

Figure 3



(i) One of the student's results is anomalous.

Draw a ring around the anomalous result.

(1)

(ii) Draw the line of best fit for the points plotted in **Figure 3**.

(1)

(iii) What was the temperature of the room?

Temperature = ... °C

(1)

(iv) What was the interval of the time values used by the student?

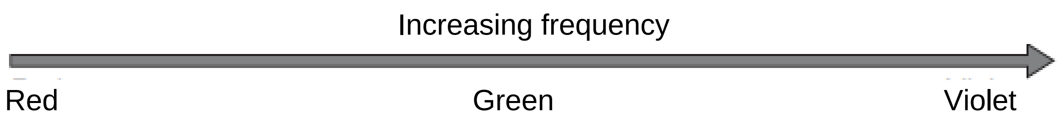
Interval = ... minutes

(1)
(Total 11 marks)

31 (a) The visible light spectrum has a range of frequencies.

Figure 1 shows that the frequency increases from red light to violet light.

Figure 1



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

decreases	**stays the same**	**increases**

As the frequency of the light waves increases, the wavelength

of the light waves .... and

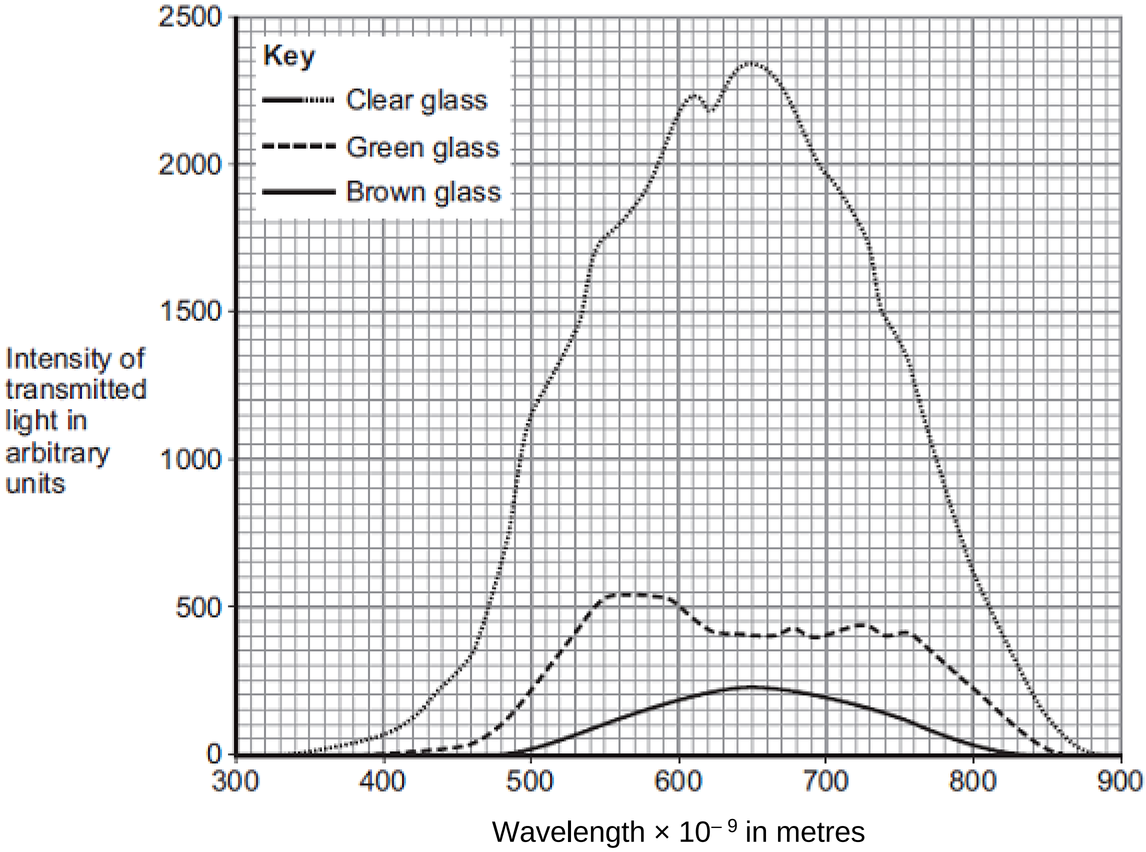
the energy of the light waves ....

(2)

(b) Bottled beer will spoil if the intensity of the light passing through the glass bottle into the beer is too high.

Figure 3 shows the intensity of the light that is transmitted through three different pieces of glass.

Figure 3



(i) The pieces of glass all had the same thickness.

Suggest why.

....

....

(1)

(ii) Bottles made of brown glass are suitable for storing beer.

Suggest why.

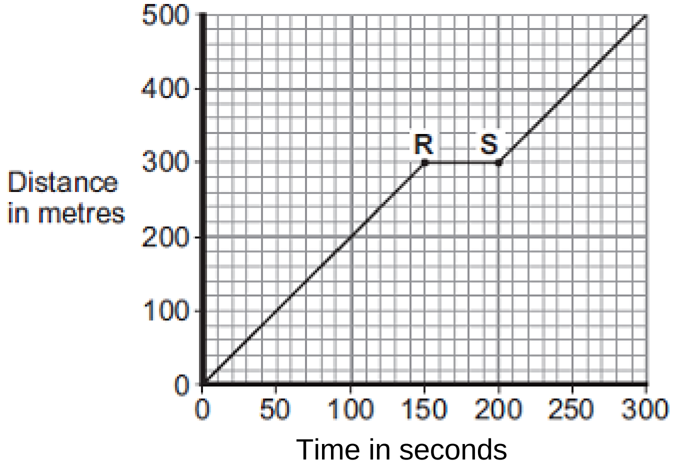
....

....

(1)
(Total 4 marks)

32 (a) **Figure 1** shows the distance–time graph for a person walking to a bus stop.

Figure 1



(i) Which **one** of the following statements describes the motion of the person between points **R** and **S** on the graph?

Tick (✓) **one** box.

Not moving ☐

Moving at constant speed ☐

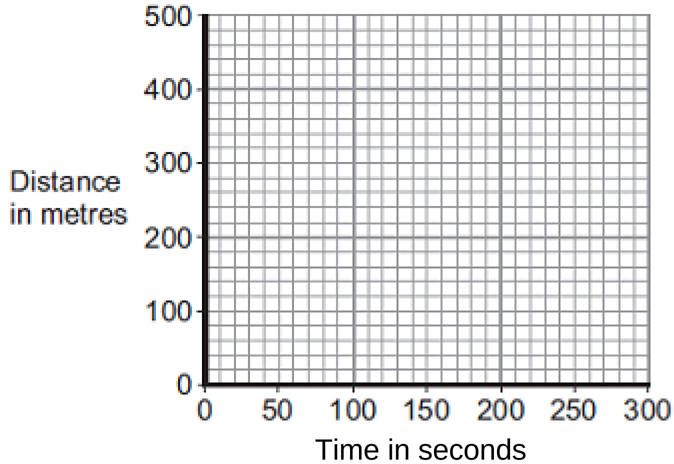
Moving with increasing speed ☐

(1)

(ii) Another person, walking at constant speed, travels the same distance to the bus stop in 200 seconds.

Complete **Figure 2** to show a distance–time graph for this person.

Figure 2



(1)

(b) A bus accelerates away from the bus stop at 2.5 m/s^2.

The total mass of the bus and passengers is 14 000 kg.

Calculate the resultant force needed to accelerate the bus and passengers.

....

....

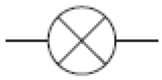
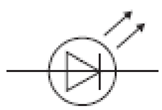
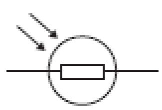
....

Resultant force = ... N

(2)

(Total 4 marks)

33 (a) Draw **one** line from each circuit symbol to its correct name.

Circuit symbol	**Name**
	Diode
	
	Light-dependent resistor (LDR)
	
	Lamp
	
	Light-emitting diode (LED)

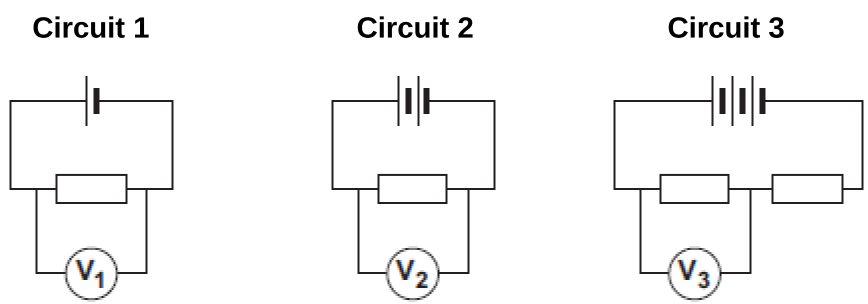
(3)

(b) **Figure 1** shows three circuits.

The resistors in the circuits are identical.

Each of the cells has a potential difference of 1.5 volts.

Figure 1



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

half	**twice**	**the same as**

The resistance of **circuit 1** is .... the resistance of **circuit 3**.

(1)

(ii) Calculate the reading on voltmeter $\mathbf{V_2}$.

....

Voltmeter reading $\mathbf{V_2}$ = ... V

(1)

(iii) Which voltmeter, $\mathbf{V_1}$, $\mathbf{V_2}$ or $\mathbf{V_3}$, will give the lowest reading?

Draw a ring around the correct answer.

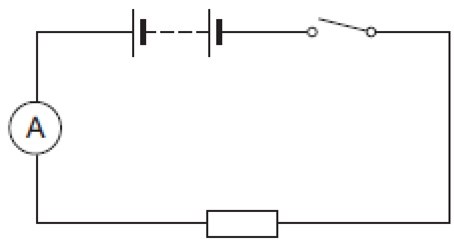
$\mathbf{V_1}$ $\mathbf{V_2}$ $\mathbf{V_3}$

(1)

(c) A student wanted to find out how the number of resistors affects the current in a series circuit.

Figure 2 shows the circuit used by the student.

Figure 2



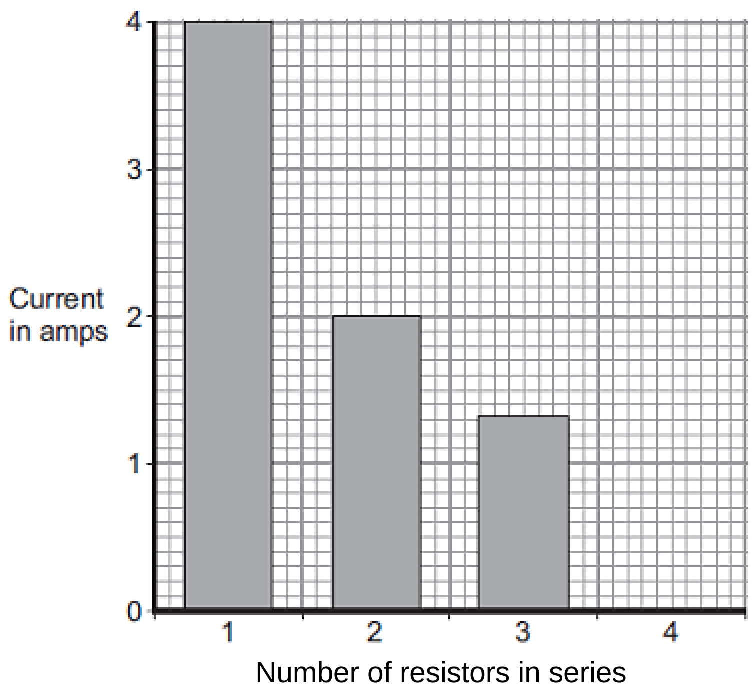
The student started with one resistor and then added more identical resistors to the circuit.

Each time a resistor was added, the student closed the switch and took the ammeter reading.

The student used a total of 4 resistors.

Figure 3 shows three of the results obtained by the student.

Figure 3



(i) To get valid results, the student kept one variable the same throughout the experiment.

Which variable did the student keep the same?

....

(1)

(ii) The bar chart in **Figure 3** is not complete. The result using 4 resistors is not shown.

Complete the bar chart to show the current in the circuit when 4 resistors were used.

(2)

(iii) What conclusion should the student make from the bar chart?

....

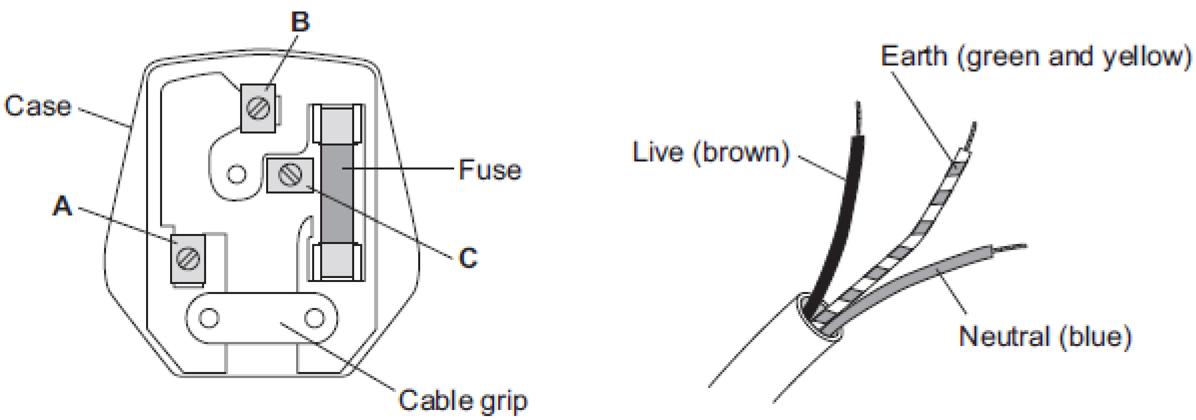
....

(1)
(Total 10 marks)

34 (a) **Figure 1** shows the inside of a three-pin plug and a length of three-core cable.

The cable is to be connected to the plug.

Figure 1



(i) Complete **Table 1** to show which plug terminal, **A**, **B** or **C**, connects to each of the wires inside the cable.

Table 1

Wire	**Plug terminal**
Live	
Neutral	
Earth	

(2)

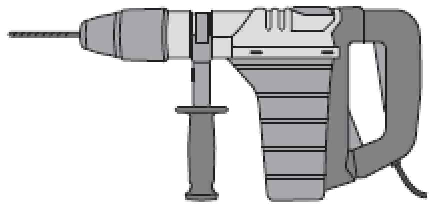
(ii) Name a material that could be used to make the case of the plug.

....

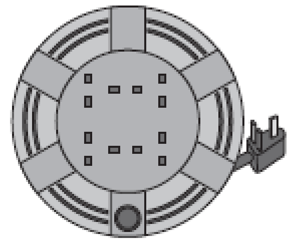
(1)

(b) **Figure 2** shows an electric drill and an extension lead. The drill is used with the extension lead.

Figure 2



Electric drill



Extension lead

(i) The drill is used for 50 seconds.

In this time, 30 000 joules of energy are transferred from the mains electricity supply to the drill.

Calculate the power of the drill.

....

....

....

Power = ... W

(2)

(ii) A second drill is used with the extension lead. The power of this drill is 1200 W.

The instructions for using the extension lead include the following information.

When in use the lead may get hot: **DO NOT go over the maximum power** • lead wound inside the case: 820 watts • lead fully unwound outside the case: 3100 watts

It would **not** be safe to use this drill with the extension lead if the lead was left wound inside the plastic case.

Explain why.

....

....

....

....

....

....

(3)

(c) **Table 2** gives information about three different electric drills.

Table 2

Drill	Power input in watts	Power output in watts
X	640	500
Y	710	500
Z	800	500

A person is going to buy **one** of the drills, **X**, **Y** or **Z**. The drills cost the same to buy.

Use only the information in the table to decide which **one** of the drills, **X**, **Y** or **Z**, the person should buy.

Write your answer in the box. ☐

Give a reason for your answer.

....

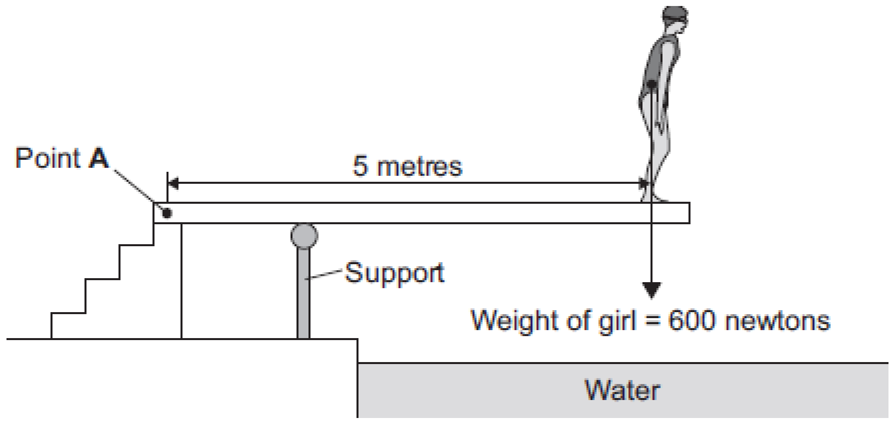
....

....

(1)
(Total 9 marks)

35 **Figure 1** shows a girl standing on a diving board.

Figure 1



(a) Calculate the moment of the girl's weight about Point **A**.

....

....

....

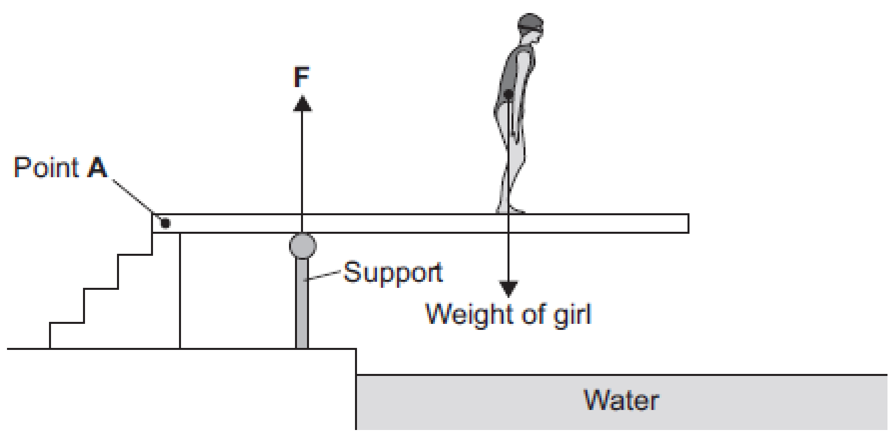
Moment = ... newton metres

(2)

(b) **Figure 2** shows the girl standing at a different place on the diving board.

The support provides an upward force **F** to keep the diving board balanced.

Figure 2



Complete the following sentence.

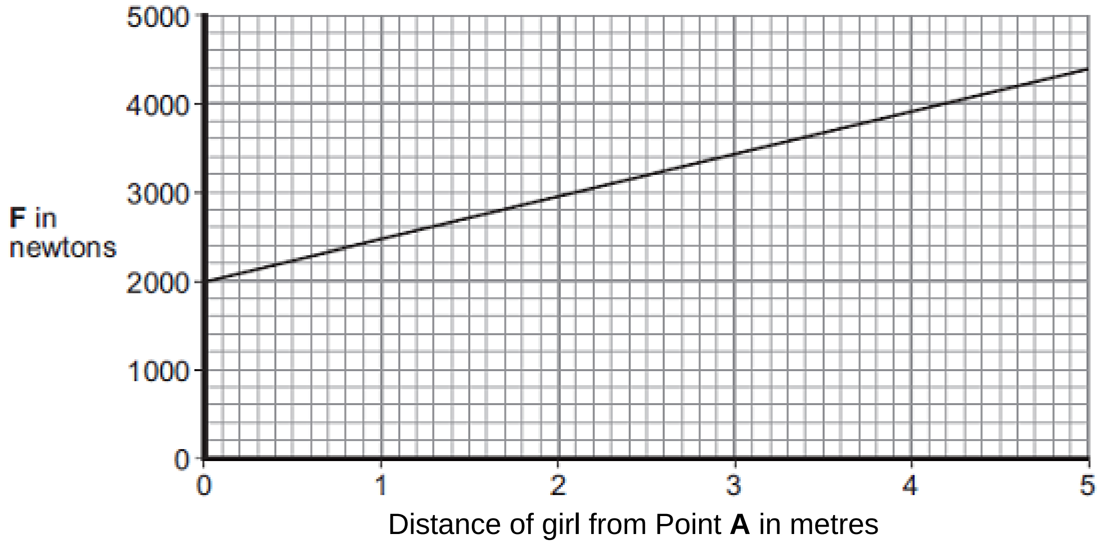
The diving board is not turning. The total clockwise moment is balanced

by the total ....

(1)

(c) **Figure 3** shows how the upward force **F** varies with the distance of the girl from Point **A**.

Figure 3



(i) Use **Figure 3** to determine the upward force **F** when the girl is standing at a distance of 3 metres from point **A**.

Upward force **F** = ... newtons

(1)

(ii) What conclusion should be made from **Figure 3**?

....

....

....

(1)
(Total 5 marks)

36 (a) Some humans are short-sighted.

Complete the following sentence.

Short sight can be caused by the eyeball being too ....

(1)

(b) Spectacles can be worn to correct short sight.

The table below gives information about three different lenses that can be used in spectacles.

	Lens feature		
	Material	**Mass in grams**	**Type**
Lens A	Plastic	5.0	Concave (diverging)
Lens B	Glass	6.0	Convex (converging)
Lens C	Glass	5.5	Convex (converging)

Which lens from **Table 2** would be used to correct short sight?

Draw a ring around the correct answer.

Lens A **Lens B** **Lens C**

Give the reason for your answer.

....

....

(2)

(c) Every lens has a focal length.

Which factor affects the focal length of a lens?

Tick (✓) **one** box.

The colour of the lens ☐

The refractive index of the lens material ☐

The size of the object being viewed ☐

(1)

(d) A lens has a focal length of 0.25 metres.

Calculate the power of the lens.

....

....

....

Power of lens = ... dioptres

(2)

(e) Laser eye surgery can correct some types of eye defect.

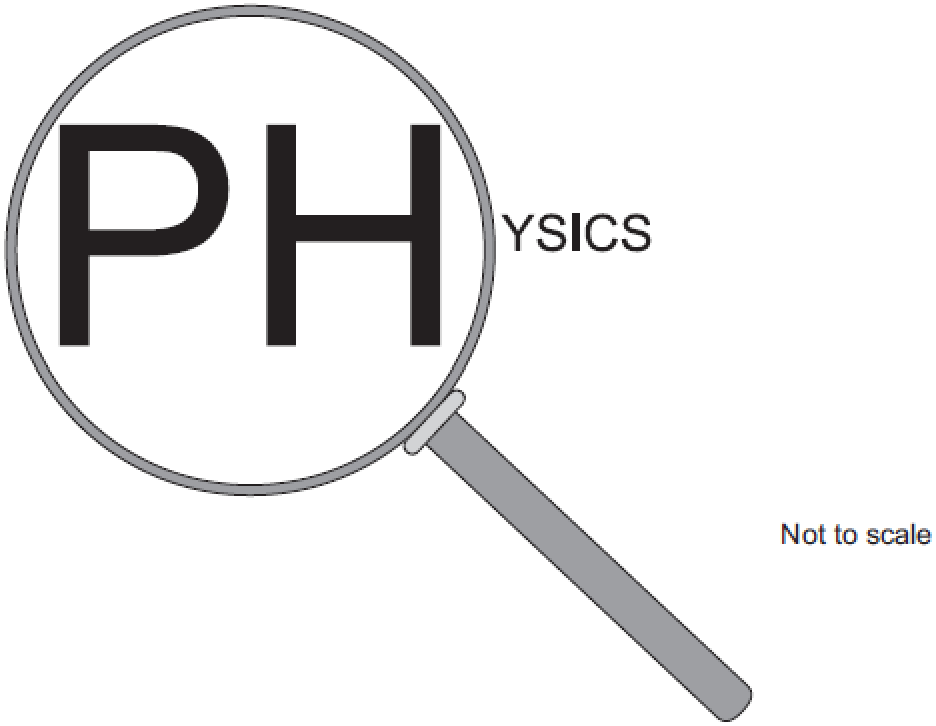
Which of the following is another medical use for a laser?

Tick (✓) **one** box.

Cauterising open blood vessels	☐
Detecting broken bones	☐
Imaging the lungs	☐

(1)

(f) The figure shows a convex lens being used as a magnifying glass.



An object of height 14 mm is viewed through a magnifying glass.

The image height is 70 mm.

Calculate the magnification produced by the lens in the magnifying glass.

....

....

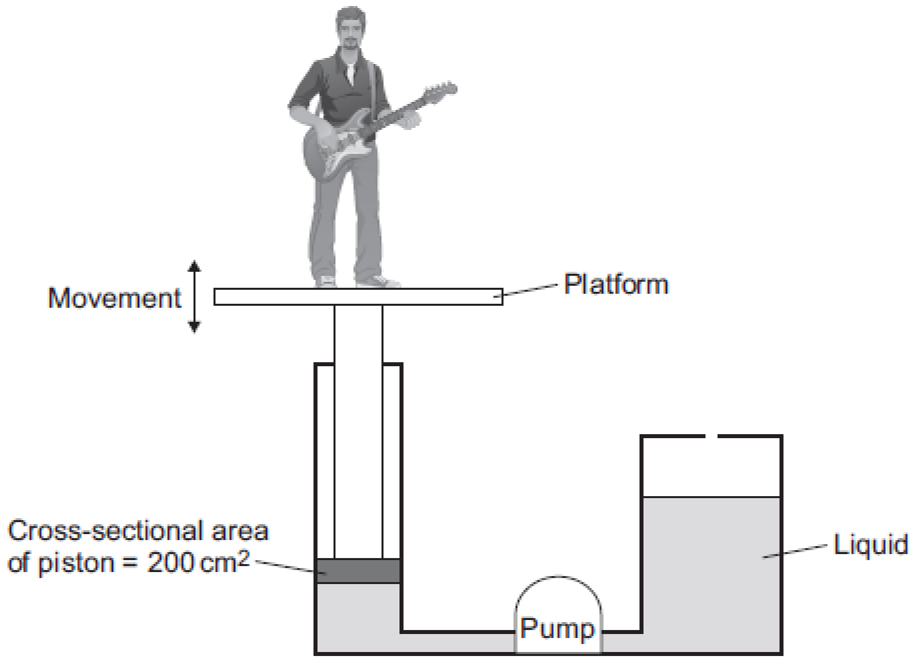
....

Magnification = ...

(2)
(Total 9 marks)

37 Musicians sometimes perform on a moving platform.

The figure below shows the parts of the lifting machine used to move the platform up and down.



(a) What name is given to a system that uses liquids to transmit forces?

Draw a ring around the correct answer.

electromagnetic **hydraulic** **ionising**

(1)

(b) To move the platform upwards, the liquid must cause a force of 1800 N to act on the piston.

The cross-sectional area of the piston is 200 cm^2.

Calculate the pressure in the liquid, in N / cm^2, when the platform moves.

....

....

....

Pressure = ... N / cm^2

(2)

(c) A new development is to use oil from plants as the liquid in the machine.

Growing plants and extracting the oil requires **less energy** than producing the liquid usually used in the machine.

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

Using the oil from the plants gives	an environmental an ethical a social	advantage over the liquid

usually used.

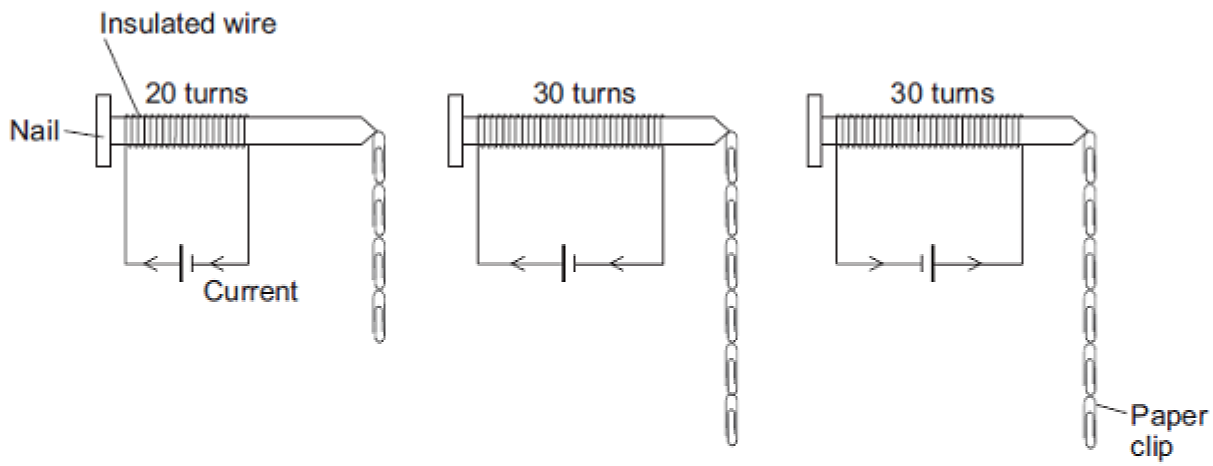
(1)
(Total 4 marks)

38 A student is investigating the strength of electromagnets.

Figure 1 shows three electromagnets.

The student hung a line of paper clips from each electromagnet.

Figure 1



Electromagnet **A** Electromagnet **B** Electromagnet **C**

No more paper clips can be hung from the bottom of each line of paper clips.

(a) (i) Complete the conclusion that the student should make from this investigation.

Increasing the number of turns of wire wrapped around the nail will ....

the strength of the electromagnet.

(1)

(ii) Which **two** pairs of electromagnets should be compared to make this conclusion?

Pair 1: Electromagnets .... and ....

Pair 2: Electromagnets .... and ....

(1)

(iii) Suggest **two** variables that the student should control in this investigation.

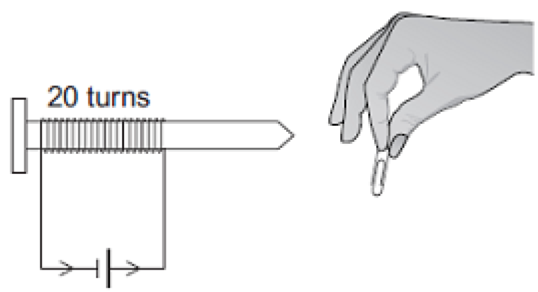
1 ....

2 ....

(2)

(b) The cell in electromagnet **A** is swapped around to make the current flow in the opposite direction. This is shown in **Figure 2**.

Figure 2



What is the maximum number of paper clips that can now be hung in a line from this electromagnet?

Draw a ring around the correct answer.

fewer than 4 **4** **more than 4**

Give **one** reason for your answer.

....

....

....

(2)

(c) Electromagnet **A** is changed to have only 10 turns of wire wrapped around the nail.

Suggest the maximum number of paper clips that could be hung in a line from the end of this electromagnet.

Maximum number of paper clips = ...

(1)
(Total 7 marks)

Mark schemes

1 (a) any **two** from:

- nuclear
- oil
- (natural) gas

2

(b) 4 (hours)

1

(c) a system of cables and transformers

1

(d) The power output of wind turbines is unpredictable

1

(e) 1500 / 0.6

1

2500 (wind turbines)

1

*allow 2500 with no working shown for **2** marks*

(f) Most energy resources have negative environmental effects.

1

[8]

2 (a) Student A's measurements had a higher resolution

1

Student B was more likely to misread the temperature

1

(b) a random error

1

(c) 8.4 °C

1

(d) 740 (seconds)

allow answers in the range 730 – 780

1

(e) 0.40 × 199 000

1

79 600 (J)

1

*accept 79 600 (J) with no working shown for **2** marks*

(f) stearic acid has a higher temperature than the surroundings

accept stearic acid is hotter than the surroundings

1

temperature will decrease until stearic acid is the same as the room temperature / surroundings

1

[9]

3 (a) battery, lamp and ammeter connected in series with variable resistor

1

voltmeter in parallel with (filament) lamp

1

(b) **Level 2 (3–4 marks):**
A detailed and coherent description of a plan covering all the major steps is provided. The steps are set out in a logical manner that could be followed by another person to obtain valid results.

Level 1 (1–2 marks):
Simple statements relating to relevant apparatus or steps are made but they may not be in a logical order. The plan would not allow another person to obtain valid results.

0 marks:
No relevant content

Indicative content

- ammeter used to measure current
- voltmeter used to measure potential difference
- resistance of variable resistor altered to change current in circuit **or** change potential difference (across filament lamp)
- resistance (of filament lamp) calculated **or** R=V / I statement
- resistance calculated for a large enough range of different currents that would allow a valid conclusion about the relationship to be made

4

(c) (as current increases) resistance increases (at an increasing rate)

1

(d) any value between 6.3 and 6.9 (Ω)

1

(e) **A**: Filament lamp

1

B: Resistor at constant temperature

1

C: Diode

1

[11]

4 (a) induced

1

(b) bar 2

1

(the same end) of bar 1 attracts both ends of bar 2

or

only two magnets can repel so cannot be bar 1 or bar 3

1

(c) so the results for each magnet can be compared

or

so there is only one independent variable

fair test is insufficient

allow different thickness of paper would affect number of sheets each magnet could hold

accept it is a control variable

1

(d) because the magnet with the biggest area was not the strongest

accept any correct reason that confirms the hypothesis is wrong eg smallest magnet holds more sheets than the largest

1

[5]

5 (a) **Level 2 (3–4 marks):**
A detailed and coherent description of a plan covering all the major steps is provided. The steps are set out in a logical manner that could be followed by another person to obtain valid results.

Level 1 (1–2 marks):
Simple statements relating to relevant apparatus or steps are made but they may not be in a logical order. The plan would not allow another person to obtain valid results.

0 marks:
No relevant content.

Indicative content

- measure the distance the ruler falls before being stopped
- the greater this distance the greater the reaction time
- repeat measurements and calculate a mean
- repeat several times with the student listening to music (through earphones). Calculate a mean.
- a (significant) difference between the two means would show that music affects reaction time.

4

(b) reaction time decreases with practice

allow Y has a shorter reaction time

1

allow Y has faster reaction times (than X)

(c) the stop clock was started before the computer test started

1

the student was distracted

1

[7]

6 (a) from K to L

1

correct order only

1

smaller than

1

(c) 4 N

1

(d) the limit of proportionality is reached when a weight of 7N is added to the spring

accept any number from 6.8 to 7.2 inclusive

1

(e) the extension is directly proportional to the weight.

1

(f) C

1

[7]

7 (a) geothermal

1

nuclear

1

biofuel

1

(b) gravitational (potential)

1

kinetic

1

sound

1

(c) (i) 90% or 0.9(0)

*an answer of 0.9(0) with a unit gains **1** mark*

2

(ii) 60 (MW)

allow 10<u>%</u>

1

(iii) increased

1

[10]

8 (a) dependent

1

(b) (probe) C

allow 103.2

1

largest difference between reading and actual temperature

reason only scores if C chosen

accept larger

it is 3.2 greater is insufficient

comparing C with only one other probe is insufficient

1

(c) (i) 12(°C)

accept a value between 12.0 and 12.2 inclusive

1

(ii) 140 (seconds)

accept an answer between 130 and 150 inclusive

1

temperature starts to rise

only scores if time mark awarded

accept the temperature was lowest (at this time)

1

(iii) increase

accept faster (rate)

1

[7]

9 (a) it would decrease the time

1

(b) 720 (J)

allow ***1*** *mark for correct substitution ie 12 × 60 provided no subsequent step*

2

(c) decreases

1

decreases

1

decreases

1

more than one tick in any row negates the mark

[6]

10 (a) 20

1

(b) 50

1

(c) (i) 115

1

(ii) 230

1

(iii) if one goes out the other still works
or
brighter

accept power (output) is greater

can be switched on/off independently is insufficient

1

(d) the outside/casing is plastic

there is plastic around the wires is insufficient

it is plastic is insufficient

1

and plastic is an insulator

an answer the light fitting is double insulated gains both marks

1

(e) (residual current) circuit breaker

accept RCCB

accept RCBO

accept RCCD

accept RCB

accept miniature circuit breaker / MCB

trip switch is insufficient

breaker is insufficient

do not accept earth wire

1

[8]

11 (a) 4

1

(b) (i) 2

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

$I = \frac{100}{20}$

provided no subsequent step

2

(ii) 5

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

$V = \frac{100}{20}$

provided no subsequent step

2

[5]

12 (a) gravity

accept weight for gravity

air resistance is insufficient

1

(b) (i) 800

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

$P = \frac{2240}{2.8}$

provided no subsequent step

2

(ii) 2240 J

1

(c) (i) (vertical) height

accept (height of) stairs

1

(ii) a fast / short time (for a lighter student) may give the greatest power

accept time is a factor

or

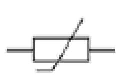
a slow / long time (for a heavy student) may give the least power

fitness is insufficient

1

[6]

13 (a) last box ticked



1

(b) (i) use hotter water (than 60 °C)

accept use boiling water

accept use water at any stated temperature above 60 °C

or

add ice cubes

accept add water at any stated temperature below 12 °C

use different temperatures is insufficient

1

(ii) the current increases as the temperature increases

1

(iii) 0.02 (A)

1

(iv) 5 (V)

or

their **(b)(iii)** × 250 correctly calculated

*allow **1** mark for correct substitution ie V = 0.02 × 250*

or

*V = their **(b)(iii)** × 250*

2

(v) the resistance increases

1

[7]

14 (a) electromagnetic

accept e.m.

1

(b) (i) 2.2 (arbitrary units)

allow an answer between 2.1 and 2.3

1

(ii) the thicker the tissue the lower the intensity

accept more intensity is needed to pass through thicker tissue

1

the relationship is not linear

accept the line is not straight

*allow for **1** mark*

it still goes through with thicker tissue

or

intensity does not reach zero

or

at 5 cm X rays still pass through

1

(iii) Both variables are continuous

1

(c) (they are) absorbed

accept (they are) stopped

1

(d) With a charge-coupled device (CCD).

1

(e) (i) X-rays are ionising

1

(ii) stand behind a (protective) screen

accept leave the room

accept wear a lead apron

1

[9]

15 (a) The pressure at X is the same as at Y

1

(b) larger than

1

(c) (i) 3 (N/mm^2)

accept 3 000 000 Pa (correct unit must be given)

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

$$\frac{24}{8}$$

provided no subsequent step

2

(ii) pascal

1

(d) the brakes would not work

allow the vehicle (car/bike etc) would not stop

accept they would freeze solid ***or*** *seize up*

1

[6]

16 (a) X marked in the centre of the sign

Check position by eye

1

(b) concentrated

1

(c) 0.5 (s)

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

$\frac{1}{2}$

provided no subsequent step

2

(d) make the cables longer

accept pendulum / sign for cables

1

[5]

17 (a) 20 000 Hz

1

(b) 400 (m)

*allow **1** mark for correct substitution ie 1600 × 0.25*

provided no subsequent steps shown

*an answer of 200 (m) gains **1** mark*

2

(c) twice

1

(d) From pulse 1 to pulse 3 the distance (to the sea floor) decreased

accept the sea got shallower

or

the submarine went deeper for the distance decreased

1

then (after pulse 3) the distance (to the sea floor) increased

accept the sea got deeper

or

the submarine rose for the distance increased

*An answer of the distance decreased then increased gains **1** mark*

1

[6]

18 (a) (force on the chain is) smaller (than the force of the toe)

1

(b) Tick in middle box

The moments are equal and opposite

1

(c) move the toe (up the pedal) away from the pivot

1

[3]

19 (a) field

correct order only

1

current

1

force

accept motion

accept thrust

1

(b) (i) arrow pointing vertically downwards

1

(ii) increase current / p.d.

accept voltage for p.d.

1

increase strength of magnetic field

accept move poles closer together

1

(iii) reverse (poles of) magnets

1

reverse battery / current

1

(c) (i) 1.5 or 150%

efficiency = 120 / 80 (× 100)

*gains **1** mark*

an answer of 1.5 % or 150

*gains **1** mark*

2

(ii) efficiency greater than 100%

or

output is greater than input

or

output should be 40 (W)

1

(iii) recorded time much shorter than actual time

accept timer started too late

accept timer stopped too soon

1

[12]

20 (a) increases

accept reaches highest value

*do **not** accept increases and decreases*

1

(b) (i) increases

1

(ii) increases

1

(c) 18

*allow **1** mark for correct substitution i.e. 12 × 1.5 provided no subsequent step*

2

watt

accept W

answer may be indicated in the list

1

[6]

21 (a) refraction

1

(b) towards the normal

1

(c) (i) convex

1

(ii) principal focus

accept focal point

1

(d) parallel on left

1

refracted towards the normal at first surface

1

refraction away from normal at second surface

1

passes through or heads towards principal focus

1

(e) refractive index

accept material from which it is made

1

(radius of) curvature (of the sides)

accept shape / radius

*do **not** accept power of lens*

ignore thickness / length

1

[10]

22 (a) terminal

1

(b) 5.4 (kg)

*correct substitution of 54 = m × 10 gains **1** mark*

2

(c) (i) 0< a <10

1

some upward force

accept some drag / air resistance

1

reduced resultant force

1

(ii) 0

1

upward force = weight (gravity)

1

resultant force zero

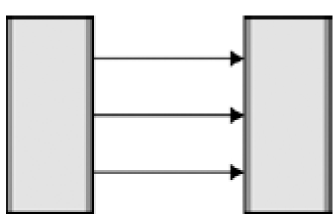
1

[9]

23 (a) (i) field pattern shows:
some straight lines in the gap

1

direction N to S



1

(ii) north poles repel

1

(so) box will not close

1

(b) (i) as paper increases (rapid) decrease in force needed

1

force levels off (after 50 sheets)

1

(ii) the newtonmeter will show the weight of the top magnet

1

(iii) (top) magnet and newtonmeter separate before magnets separate

accept reverse argument

1

(because) force between magnets is greater than force between magnet and hook of newtonmeter

1

(iv) any **three** from:

- means of reading value of force at instant the magnets are pulled apart
- increase the pulling force gently
  or
  use a mechanical device to apply the pulling force
- clamp the bottom magnet
- use smaller sheets of paper
- fewer sheets of papers between readings (smaller intervals)
- ensure magnets remain vertical
- ensure ends of magnet completely overlap
- repeat the procedure several times for each number of sheets and take a mean
- make sure all sheets of paper are the same thickness

3

(v) 3 (mm)

*30 × 0.1 ecf gains **2** marks*

*2.1 N corresponds to 30 sheets gains **1** mark*

3

[15]

24 (a) (i) any **six** from:

- switch on
- read both ammeter and voltmeter
  allow read the meters
- adjust variable resistor to change the current
- take further readings
- draw graph
- (of) V against I
  allow take mean
- R = V / I
  allow take the gradient of the graph

6

(ii) resistor would get hot if current left on

1

so its resistance would increase

1

(iii) 12 (V)

*0.75 × 16 gains **1** mark*

2

(iv) 15 (Ω)

1

16 is nearer to that value than any other

1

(b) if current is above 5 A / value of fuse

1

fuse melts

allow blows / breaks

*do **not** accept exploded*

1

breaks circuit

1

[15]

25 (a) (i) **X** placed at 50 cm mark

1

(ii) <u>point</u> at which mass of object may be (thought to be) concentrated

1

(b) (i) **Y** placed between the centre of the rule and the upper part of mass

1

(ii) 16.5

*allow for **1** mark*
(16.5 + 16.6 +16.5) / 3

2

1.65

value consistent with mean value given

only penalise significant figures once

1

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

0 marks
No relevant content

Level 1 (1 – 2 marks)
A description of a method which would provide results which may not be valid

Level 2 (3 – 4 marks)
A clear description of a method enabling some valid results to be obtained. A safety factor is mentioned

Level 3 (5 – 6 marks)
A clear and detailed description of experiment. A safety factor is mentioned. Uncertainty is mentioned

examples of the physics points made in the response:

additional apparatus

- stopwatch

use of apparatus

- measure from hole to centre of the mass
- pull rule to one side, release
- time for 10 swings and repeat
- divide mean by 10
- change position of mass and repeat

fair test

- keep other factors constant
- time to same point on swing

risk assessment

- injury from sharp nail
- stand topple over
- rule hit someone

accuracy

- take more than 4 values of *d*
- estimate position of centre of slotted mass
- small amplitudes
- discard anomalous results
- use of fiducial marker

6

(c) (i) initial reduction in *T* (reaching minimum value) as *d* increases

1

after 30 cm *T* increases for higher value of *d*

1

(ii) (no)

any **two** from:

- fourth reading is close to mean
- range of data 0.2 s / very small
- variation in data is expected

2

[16]

26 (a) *there is a* magnetic field *(around the magnet)*

1

(this magnetic field) changes / moves

1

and cuts through coil

accept links with coil

1

so a p.d. *induced* across coil

1

the coil forms *a* complete circuit

1

so a current (*is* induced)

1

(b) ammeter reading does not change

must be in this order

accept ammeter has a small reading / shows a current

1

zero

1

greater than before

accept a large(r) reading

1

same as originally but in the opposite direction

accept a small reading in the opposite direction

1

(c) 0.30

*allow **1** mark for correct substitution, ie 0.05 = Q / 6*

2

C / coulomb

allow A s

1

[13]

27 (a) pitch

1

loudness

1

(b) (i) as length (of prongs) decreases frequency / pitch increases

accept converse

accept negative correlation

ignore inversely proportional

1

(ii) 8.3 (cm)

accept 8.3 ± 0.1 cm

1

(iii) (8.3 cm is) between 7.8 (cm) and 8.7 (cm)

*ecf from part **(ii)***

1

(so *f* must be) between 384 (Hz) and 480 (Hz)

1

410 (Hz) ≤ *f* ≤ 450 (Hz)

*if only the estimated frequency given, accept for **1** mark an answer within the range*

1

(c) (i) electronic

1

(ii) frequency is (very) high

accept frequency above

*20 000 (Hz) **or** audible range*

1

so tuning fork ***or*** length of prongs would be very small (1.2 mm)

1

(d) 285.7 (Hz)

accept any correct rounding 286, 290, 300

*allow **2** marks for 285*

*allow **2** marks for correct substitution 0.0035 = 1 / f*

*allow **1** mark for T = 0.0035 s*

*allow **1** mark for an answer of 2000*

3

[13]

28 (a) (i) electrical

correct order only

1

kinetic

1

sound

1

(ii) transferred into surroundings / atmosphere

accept warms the surroundings

allow released into the environment

becomes heat or sound is insufficient

1

(b) 0.7 / 70 %

an answer of 70 without % or with the wrong unit ***or*** *0.7 with a unit gains* ***1*** *mark*

2

[6]

29 (a) solid

1

(b) decreased

correct order only

1

decreased

1

increased

1

(c) (i) A

reason only scores if A chosen

1

uses least / less energy (in 1 year)

a comparison is required

accept uses least power

accept uses least kWh

1

(ii) greater the volume the greater the energy it uses (in 1 year)

1

(iii) a very small number sampled

accept only tested 3

accept insufficient evidence / data

allow not all fridges have the same efficiency ***or*** *a correct description implying different efficiencies*

only tested each fridge once is insufficient

there are lots of different makes is insufficient

1

[8]

30 (a) (i) any **two** from:

- mass (of block)

  accept weight for mass
- starting temperature
- final / increase in temperature

  temperature is insufficient
- voltage / p.d.

  same power supply insufficient
- power (supplied to each block)
- type / thickness of insulation

  same insulation insufficient

2

(ii) one of variables is categoric

or

(type of) material is categoric

accept the data is categoric

accept a description of categoric

do ***not*** *accept temp rise is categoric*

1

(iii) concrete

reason only scores if concrete chosen

1

(heater on for) longest / longer time

a long time or quoting a time is insufficient

do ***not*** *accept it is the highest bar*

1

(iv) 4500 (J)

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

$2 \times 450 \times 5$ provided no subsequent step shown

2

(b) (i) point at 10 minutes identified

1

(ii) line through all points except anomalous

line must go from at least first to last point

1

(iii) 20 (°C)

if 20°C is given, award the mark.

If an answer other than 20°C is given, look at the graph. If the graph shows a correct extrapolation of the candidate's best-fit line and the intercept value has been correctly stated, allow 1 mark.

1

(iv) 2 (minutes)

1

[11]

31 (a) decreases

correct order only

1

increases

1

(b) (i) intensity (of transmitted light) depends on thickness

or

to enable a valid comparison

or

it is a control variable

accept absorption depends on thickness

it would affect the results is insufficient

fair test is insufficient

1

(ii) transmits the least light

or

absorbs the most light

accept very little light is transmitted

*do **not** accept transmits none of the light*

*do **not** accept absorbs all of the light*

any reference to heat negates this mark

1

[4]

32 (a) (i) not moving

1

(ii) straight line from origin to (200,500)

ignore a horizontal line after (200,500)

1

(b) 35 000

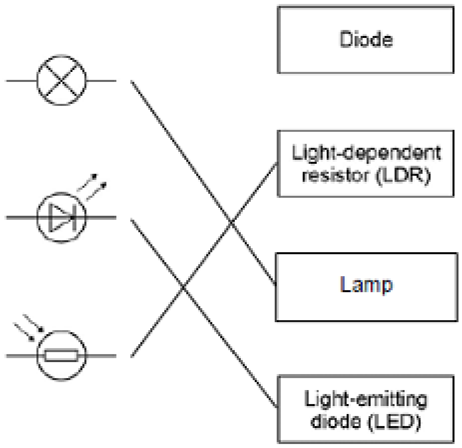
*allow **1** mark for correct substitution, ie 14 000 × 2.5 provided no subsequent step*

an answer of 87 500 indicates acceleration (2.5) has been squared and so scores zero

2

[4]

33 (a)



*allow **1** mark for each correct line if more than one line is drawn from any symbol then all of those lines are wrong*

3

(b) (i) half

1

(ii) 3(V)

1

(iii) V_1

1

(c) (i) potential difference / voltage of the power supply

accept the power supply

accept the voltage / volts

accept number of cells / batteries

accept (same) cells / batteries

do not accept same ammeter / switch / wires

1

(ii) bar drawn – height 1.(00)A

ignore width of bar

*allow **1** mark for bar shorter than 3rd bar*

2

(iii) as the number of resistors increases the current decreases

1

[10]

34 (a) (i)

Wire	Plug terminal
Live	C
Neutral	A
Earth	B

*all 3 correct for **2** marks*

*allow **1** mark for 1 correct*

2

(ii) plastic
or
rubber

accept:

ABS
UF / urea formaldehyde
nylon
PVC

1

(b) (i) 600

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

ie $P = \frac{30\,000}{50}$

provided no subsequent step

2

(ii) power is greater than 820 (W)

power is 1200 W is insufficient

1

the lead /cable / wire <u>will</u> overheat / get (too) hot

accept lead / cable will melt

may overheat / get hot is insufficient

1

so there is a risk of fire

accept causing a fire

1

(c) X

any **one** from:

- most / more efficient
- smallest energy input (per second)
- cheapest to operate

mark only scores if X is chosen

mark is for the reason

accept smallest input (power) for same output (power)

accept wastes least energy

smallest (power) input is insufficient

uses least electricity is insufficient

1

[9]

35 (a) 3000

*allow **1** mark for correct substitution, ie 600 × 5 provided no subsequent step*

2

(b) anticlockwise moment

must be both words

1

(c) (i) 3400

allow 3.4 kilo (newtons)

1

(ii) as the distance (of the girl from point A) increases, force F increases

allow gets bigger for increases

force is (directly) proportional to distance will negate any correct response

1

[5]

36 (a) long

1

(b) lens A

1

it is a concave / diverging lens

this mark is only gained if lens A is stated

any reference to lens material or mass of lens negates this mark

allow it will focus light onto the retina

1

(c) The refractive index of the lens material

1

(d) 4

ignore any signs

allow ***1*** *mark for correct substitution, ie* $\frac{1}{0.25}$ *provided no subsequent step*

2

(e) Cauterising open blood vessels

1

(f) 5

allow ***1*** *mark for correct substitution, ie* $\frac{70}{14}$ *provided no subsequent step*

2

[9]

37 (a) hydraulic

1

(b) 9

allow ***1*** *mark for a correct substitution, ie* $\frac{1800}{200}$ *provided no subsequent step*

2

(c) an environmental

1

[4]

38 (a) (i) increase

1

(ii) A and B
and
B and C

both required for the mark

either order

1

(iii) any **two** from:

- size of nail
  or
  nail material
  allow (same) nail
- current
  allow (same) cell
  allow p.d.
  same amount of electricity is insufficient
- (size of) paper clip
- length of wire
  accept type / thickness of wire

2

(b) 4

1

B picks up the same number as C, so this electromagnet would pick up the same number as A
or
direction of current does not affect the strength of the electromagnet

allow it has got the same number of turns as A

1

(c) 2

allow 1 or 3

1

[7]

Examiner reports

7

(a) Just over half the students scored all 3 marks, the most common mistake was to mix up geothermal and nuclear.

(b) Just over a third of students scored 3 marks on this question, with just under a third scoring 1 mark. The remaining third either scored 2 or 0 marks. Students found this question quite difficult, many believing that the water stored electrical energy.

(c) (i) Just under a third of students scored both marks for this question, a third of students scored 1 mark for this question. The most common mistake was to either omit the % symbol or add an incorrect one, MW, for example.

(ii) Almost two thirds of students scored this mark. Common incorrect responses included multiplying or dividing the power input and output for the power station. An answer of 10% was creditworthy, provided the % sign was given.

(iii) Two fifths of students scored this mark. Common incorrect responses seen included global warming and pollution. The 'turbine overheating' was insufficient for the mark.

8

(a) Just over a third of students scored this mark. The most common incorrect answer was control.

(b) Almost three quarters of students scored the mark for choosing probe C, a lot of students found it difficult to articulate their ideas to explain their choice. A common incorrect answer was that C was an anomaly, or was inaccurate because it was above 100^{0}C and the temperature should have been going down, not up. Just over a third of students scored both marks.

(c) (i) Just over half of students scored this mark. Some students incorrectly read the scale and were outside the tolerance; others misunderstood the graph and stated 20 °C or 13.5 °C.

(ii) A quarter of students scored only 1 mark by stating the correct time, but a fifth of students scored both marks.

(iii) Half of students scored this mark, most incorrect responses stated the opposite effect, that rate of evaporation would be lower.

9

(a) Three quarters of students scored this mark.

(b) Three quarters of students scored both marks for this question, although the lack of a calculator was evident by the long multiplication calculations seen.

(c) This question discriminated well with almost all students scoring 1 mark, but there was evidence that students hadn't read the instruction that each response may be used once, more than once or not at all. Two fifths of students scored 2 marks.

10

(a) Only about one third of the students scored this mark. A common incorrect answer was '40'.

(b) Again only about one third of the students scored this mark. The most common answer was '60'.

(c) (i) A significant number of the students did not attempt this question. About one third of the students scored the mark.

(ii) About a third of the students knew the potential difference would equal that of the supply and so scored the mark.

(iii) There were relatively few students who answered in terms of independent circuits i.e. if one bulb goes out the other is unaffected. Those students who mentioned increased brightness or increased power were successful. The majority of students attempted to answer in terms of increased p.d. or current; or referred to p.d. or current being the same for each bulb. Those who stated that both bulbs had the same brightness failed to appreciate that this would also be true in a series circuit. Few students scored this mark.

(d) Over half of the students scored zero. There were too many students thinking that a light fitting without an earth wire is safe because of the perceived dangers caused by an earth wire. Others suggested that the neutral wire acted as an earth wire in this instance. Many students had the idea of plastic being an insulator, although a surprising number stated it is a conductor. It was relatively rare to see an unambiguous statement that the outside case of the fitting is made of plastic. Some students were distracted by the insulation on the individual wires.

(e) A significant number of students did not attempt this question. Of those that did, few scored the mark; the reference to a circuit breaker was rarely seen. A large number of the students failed to read the question and gave 'fuse' as their answer. Other common incorrect answers were insulation tape, plastic sockets, crocodile clips and plastic-covered wires.

11

(a) Just over half of the students scored this mark. A common incorrect answer was 9, arrived at by multiplying 6 by 1.5.

(b) (i) This question was answered well with the majority of the students scoring both marks. The most usual incorrect answer was where students had multiplied the two numerical values instead of dividing them.

(ii) Just over half of the students scored these two marks. The most common errors were multiplying the work done by the charge flowing or dividing the charge by the work done.

12

(a) The majority of the students scored this mark.

(b) (i) This was well answered by the majority of the students. Those who attempted it and failed to score a mark usually multiplied the numbers rather than dividing.

(ii) The vast majority of the students thought that the g.p.e. gained would be 'much more' or 'much less' than 2240J and so did not score the mark.

(c) (i) About half of the students scored this mark, with most referring to the number, size or height of the stairs.

(ii) Very few of the students scored this mark. Few appreciated that the power developed depends upon both weight and time taken. Some students hinted at this by referring to fitness or muscle development but a clear statement referring to time taken was needed. Those few who referred to the pattern sometimes failed to gain a mark by referring to heavy students running up in a short time. This would have given them a high power output which fits the pattern of the four students in the question.

13

(a) Under half of the students could identify the circuit symbol for a thermistor.

(b) (i) About a quarter of the students scored this mark. The main errors were either the students realising that different temperatures would increase the range but not stating that the additional temperatures should be outside the range shown on the graph line, or, more regrettably, responding in terms which indicated that they thought the component was some type of immersion heater and that more current inputted would increase the range.

(ii) This question produced surprisingly few correct answers with many students being unable to identify the positive correlation between the temperature change and the current. A significant number of the students did not attempt this question.

(iii) Most students were able to use the graph to give the correct current.

(iv) Again many students did not attempt this question. Of those that did over a half scored both marks by using their answer from [b][iii] to correctly multiply the current by the resistance to find the potential difference across the thermistor. However, many of the students either multiplied or divided a combination of the figures available, ie. the current, temperature and resistance.

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

14

(a) Nearly two thirds of students gained this mark. A common (incorrect) response was for students to call it the light spectrum rather than the electromagnetic spectrum.

(b) (i) The vast majority of students were able to read the correct value from the graph.

(ii) Over half of the students were able to describe the basic trend shown in the graph, but very few students could explain this to gain the second mark.

(iii) Just under two thirds of students identified the reason for using a line graph.

(c) Around a third of students gained this mark. There was a reasonably common misconception that X-rays are reflected by bone. A number of students linked the question to the properties of X-rays such as their ionising ability.

(d) Just under half the students gained this mark, most incorrect responses were 'with photographic film'.

(e) (i) The vast majority of students gained this mark.

(ii) Just over half of students gained this mark. Many students who did not score here wrote answers which were along the right lines, such as wear an apron, or wear a film badge.

15

(a) Around one third of students gained this mark. Most students seemed unaware that the pressure in a hydraulic system is the same at all points.

(b) Just over half of students scored this mark.

(c) (i) This calculation was done well, with nearly all students gaining both marks. Some were confused by mm2 causing them to incorrectly use 8x8 in the calculation.

(ii) Over half of students knew the correct unit for pressure.

(d) Just under half the students gained this mark. Of those who did not, many were along the right lines, suggesting that the brakes would still work to some extent although might be harder to apply them.

16

(a) Just under a fifth of students did not attempt this question, suggesting that they had not read the question and were just looking for answer lines. Just under half answered this correctly.

(b) Just over half of the students gained this mark.

(c) The vast majority of students were successfully able to identify and correctly use the equation and gained both marks here.

(d) Almost two thirds of students were able to state how the sign could be made to swing with a lower frequency.

17

(a) Just under two thirds scored this mark for identifying the maximum frequency of human hearing.

(b) The vast majority of students gained both marks for calculating the distance.

(c) Just over two thirds answered this correctly.

(d) A large number of students did not understand that the trend shown in the table needed to be identified. Only about a quarter of students gained both marks on this question. Under one fifth of students gained one mark, which was most commonly for realising that the distance decreased and increased again. A significant number of students talked about the time decreasing and increasing, without linking this to the distance between the submarine and the sea floor. A common response was to merely quote figures from the table, giving their answer in terms of time.

18

(a) Despite the length of the arrows on the diagram giving a clue to this answer, only about a quarter of students answered this question correctly.

(b) Just under half of students correctly identified the moments as equal and opposite.

(c) This question proved to be challenging for students with nearly a fifth gaining the mark. A significant minority of students confused the moment of a force with the pressure created by a force, and referred to putting a larger area of the foot on the pedal. Most recognized that the distance of the force from the pivot needed to be increased. A very common response, that gained no credit, was to say that the length of the chain could be changed.

19

(a) Three quarters of students gained all three marks on this question for correctly matching the field, current and force to the three digits of Fleming's left hand.

(b) (i) Half of the students failed to score the mark here for showing the direction of the force on the wire in the field. Among the various incorrect responses were: arrows pointing up, not down; curved arrows; arrows pointing towards the axis and those who did not read the question and put an arrow somewhere else and not on, or even close to, the wire AB.

(ii) Three quarters of the students scored both marks here for correctly suggesting an increase in the current and an increase in the magnetic field strength would increase the force acting on the wire. Suggestions that using a coil or using bigger magnets were not acceptable. Some students did not give comparative answers, eg changing the field or current, and did not score.

(iii) Three quarters of the students scored two marks, probably following on from their knowledge that allowed them to get 2 marks from ii. In many cases instead of 'reverse' they would use 'swap' or 'switch' and many wanted to say how they would reverse the magnetic field or current rather than simply saying that it needed to be reversed. Only a small number wanted to include an iron core. Some lost marks by being too imprecise with their answers such as 'move the magnets around' while others got confused about the split ring commutator.

(c) (i) Three-quarters of students gained full marks on this question with a common error being omitting the % from the 150 for the final answer. 150% was more commonly presented than 1.5. In some instances students selected the correct equation and wrote it out but failed to substitute correct numbers in the equation or showed no working and thus the origins of some answers couldn't be scrutinised. The number 24 cropped up in calculations a few times either subtracting from the power or substituting in place of output power; these students were clearly confused as to what work done was.

(ii) Most students realised that the efficiency couldn't be >100% or that output (energy or power) was greater than input. Where this wasn't achieved it was for saying that it was an anomaly without any further detail; saying it was different from the other; or just saying that it was impossible without further explanation.

(iii) This question was not well answered with most students scoring zero. The common themes for the incorrect answers were suggestions that the power was incorrectly calculated (output / input power or the output and input power were transposed), the stopwatch was misread or that there was a timing error, rather than identifying that the recorded time was too short.

20 (a) Nearly three quarters of the students were able to identify that the current increased during the first 0.02 seconds from the graph. Incorrect responses were mainly in terms of descriptions of the currents value after the specified time frame.

(b) (i) Surprisingly only one third of the students knew that the resistance would increase.

(ii) Slightly more of the students knew that the temperature would increase.

(c) Just over half of the students used the correct equation and applied the values given to calculate the power of the bulb. Almost half of the students were also able to give the correct unit.

26 (a) This question was quite well done, with some almost ‘text-book’ answers. Although only a small minority scored all six marks, around three-quarters of students scored at least two marks, usually for mentioning the ‘magnetic field’ and the ‘current produced’. There were, however, a small number of confused answers relating to the motor effect. Having answered the question, a significant number of students went on to explain what would happen if the magnet were withdrawn / moved faster / moved slower etc.

(b) Half of the students scored at least two of the four marks. A common mistake was not relating the actions to the original movement of the magnet, so that comparisons of size and direction of current were not made.

(c) This was answered well, with nearly all students achieving both marks for the calculation, and nearly two-thirds scoring the mark for the correct unit.

27 (a) Nearly all students knew that frequency determines the pitch of a sound and that amplitude determines the loudness of a sound.

(b) (i) Nearly all students correctly described the trend shown in the table of length of tuning fork prong and frequency.

(ii) Nearly all students correctly measured the length of a tuning fork prong.

(iii) Over half of the students were able to correctly estimate the frequency of the tuning fork measured in part (i) from a table listing prong lengths and frequency. Some students mistakenly assumed a relationship of direct proportionality between prong length and frequency.

(c) (i) Nearly all students knew that ultrasound waves were produced by electronic systems.

(ii) Less than half of the students could explain that ultrasound waves could not be produced by a tuning fork because the very high frequency would require an extremely small fork according to the evidence given. Many wrote that ‘tuning forks can only produce frequencies within the human audible range’ so scored neither mark.

(d) Just under half of the students scored full marks for correctly determining a frequency from a trace on an oscilloscope screen. Many calculated frequency from 1 / 0.0005 instead of from 1 / (7 × 0.0005).

28 (a) (i) Just over a half of all students correctly identified the energy transfers for an electric car.

(ii) Just under two fifths of the students were able to state that waste energy is transferred into the surroundings. Weaker students forgot that the question was about an electric car and confused the wasted energy with exhaust gases. Others thought the waste energy is recycled and used again.

(b) The majority of students were able to substitute the energy values given in the question into a correct equation. Most tried to express the answer as a percentage, but about one third of students failed to gain maximum marks because they either neglected to insert the % sign after the number 70 or they quoted the efficiency as 0.7 but then put either a % sign or a unit after the number.

29 (a) Two thirds of the students could identify that convection cannot take place in a solid.

(b) A small proportion of the students correctly identified the changes in energy, spacing and density of air when it is cooled.

(c) (i) The majority of students were able to identify fridge A as costing the least to use and also stated it uses less energy. Students would benefit from remembering to use words which imply that a comparison with the fridges which were not chosen.

(ii) Just under a half of the students correctly stated that as the volume of the fridge increased the energy used in one year also increased. A common incorrect response was to state that the volume in litres was always less than the energy used in kWh, a little like comparing apples to oranges.

(iii) A small proportion of students appreciated that three fridges is too small a sample from which to draw conclusions for all other fridges.

30 (a) (i) About one third of the students correctly chose two control variables, a further quarter were able to identify one control variable. A common reason for not gaining marks was not being specific with their answers, e.g. simply saying ‘temperature’ rather than ‘starting temperature’.

When a control variable is asked for, credit is not normally given for saying that the same equipment should be used, e.g. ‘use the same thermometer each time’.

(ii) A low proportion of students appreciated that bar graphs are used when one of the sets of data is categoric. Most simply referred to the ease of comparing results or the ease of drawing bar graphs.

(iii) About half of the students identified that concrete needed the most energy to increase its temperature by 5°C. The majority of these recognised this was because the heater had been on for longer. Students were expected to compare the time for heating concrete with the times for the other materials and not simply state that the bar was higher or that it took a long time.

(iv) Three quarters of the students could correctly substitute into the appropriate equation and calculate the correct energy transfer.

(b) (i) Four fifths of the students correctly identified the anomalous result as the one after 10 minutes.

(ii) Many students did not appreciate that when a line of best fit is required any anomalous results are ignored. A line of best fit should have as many points below the line as above the line. Just over a half of students drew an acceptable line of best fit.

(iii) A third of the students appreciated that the block was at room temperature when the heater was switched on and were able to extrapolate their line of best fit back to the temperature axis and correctly record the intercept. Common incorrect responses were the lowest and highest plotted temperatures plotted on the graph.

(iv) About three fifths of the students knew that the interval is the time between each reading.

31 (a) About a third of the students correctly identified the change in the wavelength and energy of a light wave when its frequency is increased.

(b) (i) The majority of students failed to go further than stating the thickness was kept constant to make the test fair. A low proportion of students were able to state that the intensity of transmitted light depended on the thickness of glass and therefore needed to be controlled.

(ii) Many students were distracted by the fact that brown colours are good absorbers of thermal energy. About two fifths of the students correctly stated that brown glass had the smallest intensity of transmitted light.

32 (a) (i) Just over three quarters of the students scored this mark. The most common error was to give the answer 'Moving at constant speed'.

(ii) Just over two fifths of the students were able to draw the correct line. The most common errors were; to join the line for the fullest extent available from (0,0) to (300,500); draw their line from (0,0) to (200,400) or to add a horizontal step to the line. A small proportion of students made no attempt at all.

(b) The correct answer was given by nearly four fifths of the students. Unfortunately, a number of students did not understand that it is the unit of acceleration that includes a square and not the numerical value that needs to be squared. These students wrote out the correct numerical equation included the units, then went on to square the numerical value for acceleration.

33 (a) This was well answered with three fifths of the students scoring all three marks. There seemed no real pattern to the errors that were made.

(b) (i) Just over three fifths of the students scored this mark.

(ii) Only just over half of the students were able to correctly add the potential differences of the two cells. Many of the incorrect answers resulted from the students multiplying the potential differences together.

(iii) Nearly three fifths of the students scored this mark.

(c) (i) Only about a third of the students scored this mark. Many students failed to realise that the bar graph indicated both the number of resistors and current had changed and gave either of these quantities as the answer. Using the same ammeter was another common incorrect answer. A minority of students stated that the control variable does not change without actually identifying a control variable.

(ii) A majority of the students could see the pattern of reducing current and scored one mark for drawing a bar of reduced height. About a fifth of the students were able to score the second mark by accurately drawing this bar at the value of 1.0 amps.

(iii) Over four fifths of the students were able to express an answer in terms of 'as the number of resistors increases, the current decreases'. Common errors were to have the two functions both increasing or both decreasing. Other unacceptable answers were that the number of resistors changed or affected the current without writing in which direction the change would be.

34

(a) (i) Most students could correctly identify one of the plug terminals but surprisingly, fewer than half of the students could correctly identify all three.

(ii) Virtually all of the students were aware that a suitable insulating material was needed for the casing of a three-pin plug. Most students gave the answer 'plastic' or an acceptable named plastic.

(b) (i) About four fifths of the students were able to substitute into the correct equation chosen from the Physics Equation Sheet and to calculate the power of the drill.

(ii) Very few of the students scored all of the three marks available. Many of the students were able to deduce from the information provided about the 1200W drill that it would cause the cable inside the casing to be overloaded but fewer of the students stated that this would definitely result in heating with the possibility of a fire developing. Some students thought that the extension cable provided the power and so the 1200W drill would not work. A significant number of students answered in terms of fuses blowing and there are still many students that state that anything electrical will blow up if there is a problem of any kind.

(c) Although many of the students correctly identified X as the best drill, under half of the students were able to give the reason for their choice in terms of the increased efficiency or smallest energy input or least money to operate.

35

(a) Students were able to select and use the correct equation successfully and scored both marks for this calculation.

(b) Just over a quarter of the students correctly stated anti-clockwise moment.

(c) (i) Three quarters of the students accurately determined the force from the graph.

(ii) Only a tenth of the students failed to state the correct conclusion from the graph.

36

(a) This was poorly answered with very few students able to identify that short-sight can be caused by the eyeball being too long.

(b) Over half of the students failed to identify lens A, and so scored zero. Of those students that did select lens A, only half stated the correct reason. Some students referred to the properties of the material rather than the optics here.

(c) Over two thirds of the students gained the mark.

(d) Most students gained both marks in this calculation.

(e) Only a fifth of the students failed to gain the mark.

(f) The majority of students were able to select and apply the correct equation but then inverted the calculation when using the calculator, ie 14 / 70.

37

(a) The vast majority of students could identify the system as hydraulic.

(b) The majority of students scored both marks for the calculation.

(c) Most students correctly identified the advantage as environmental.

38

(a) (i) The vast majority of students correctly completed the conclusion.

(ii) A third of the students correctly identified the two pairs of electromagnets.

(iii) Most students were able to identify at least one of the variables that needed to be kept the same. However, some quoted the dependent variables, others gave vague responses of power / electricity rather than p.d. or current.

(b) Half of the students scored both marks for identifying the number of paperclips and a correct reason.

(c) Almost every student scored the mark.