Analysis and Evaluation Medium Demand

Name: ____________________

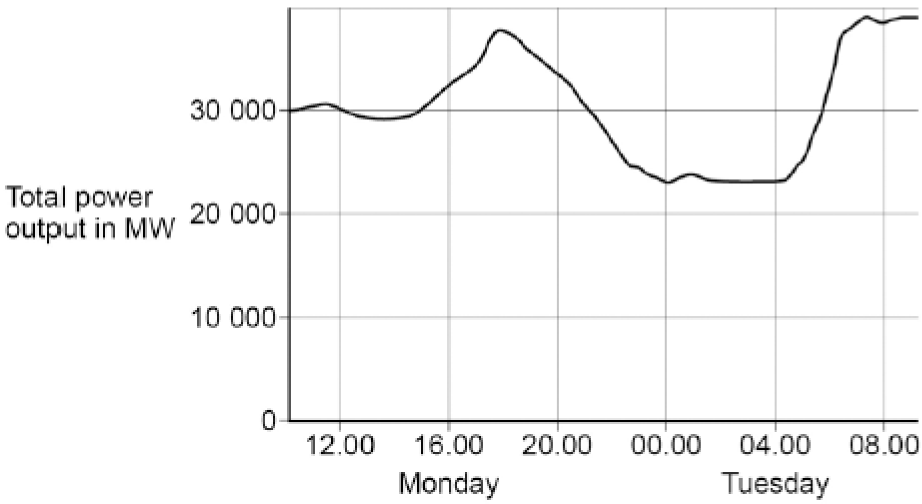
Class: ____________________

Date: ____________________

Time:	**365 minutes**
Marks:	**363 marks**
Comments:	

1 The National Grid ensures that the supply of electricity always meets the demand of the consumers.

The figure below shows how the output from fossil fuel power stations in the UK varied over a 24-hour period.



(a) Suggest **one** reason for the shape of the graph between 15.00 and 18.00 on Monday.

....

....

(1)

(b) Gas fired power stations reduce their output when demand for electricity is low.

Suggest **one** time on the figure above when the demand for electricity was low.

....

....

(1)

(c) The National Grid ensures that fossil fuel power stations in the UK only produce about 33% of the total electricity they could produce when operating at a maximum output.

Suggest **two** reasons why.

1 ....

....

2 ....

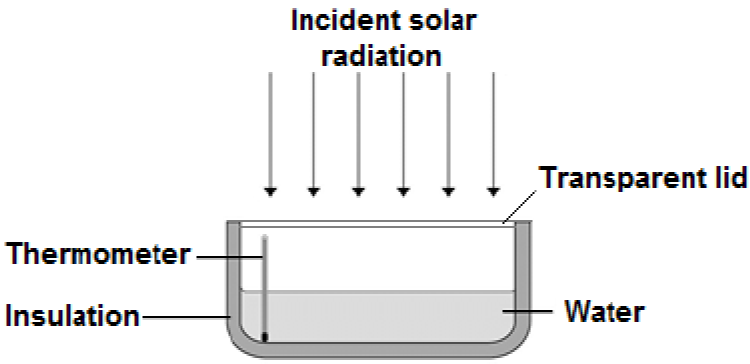
....

(2)
(Total 4 marks)

2 A student investigated how much energy from the Sun was incident on the Earth's surface at her location.

She put an insulated pan of water in direct sunlight and measured the time it took for the temperature of the water to increase by 0.6 °C.

The apparatus she used is shown in the figure below.



(a) Choose the most appropriate resolution for the thermometer used by the student.

Tick **one** box.

0.1 °C ☐

0.5 °C ☐

1.0 °C ☐

(1)

(b) The energy transferred to the water was 1050 J.

The time taken for the water temperature to increase by 0.6 °C was 5 minutes.

The specific heat capacity of water is 4200 J / kg °C.

Write down the equation which links energy transferred, power and time.

....

(1)

(c) Calculate the mean power supplied by the Sun to the water in the pan.

....

....

....

Average power = ... W

(2)

(d) Calculate the mass of water the student used in her investigation.

Use the correct equation from the Physics Equation Sheet.

....

....

....

Mass = ... kg

(3)

(e) The student's results can only be used as an estimate of the mean power at her location.

Give **one** reason why.

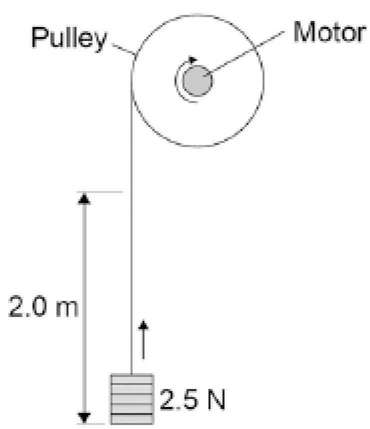
....

....

(1)
(Total 8 marks)

3 A student investigated the efficiency of a motor using the equipment in **Figure 1**.

Figure 1



He used the motor to lift a weight of 2.5 N a height of 2.0 m.

He measured the speed at which the weight was lifted and calculated the efficiency of the energy transfer.

He repeated the experiment to gain two sets of data.

(a) Give **one** variable that the student controlled in his investigation.

....

(1)

(b) Give **two** reasons for taking repeat readings in an investigation.

1 ....

....

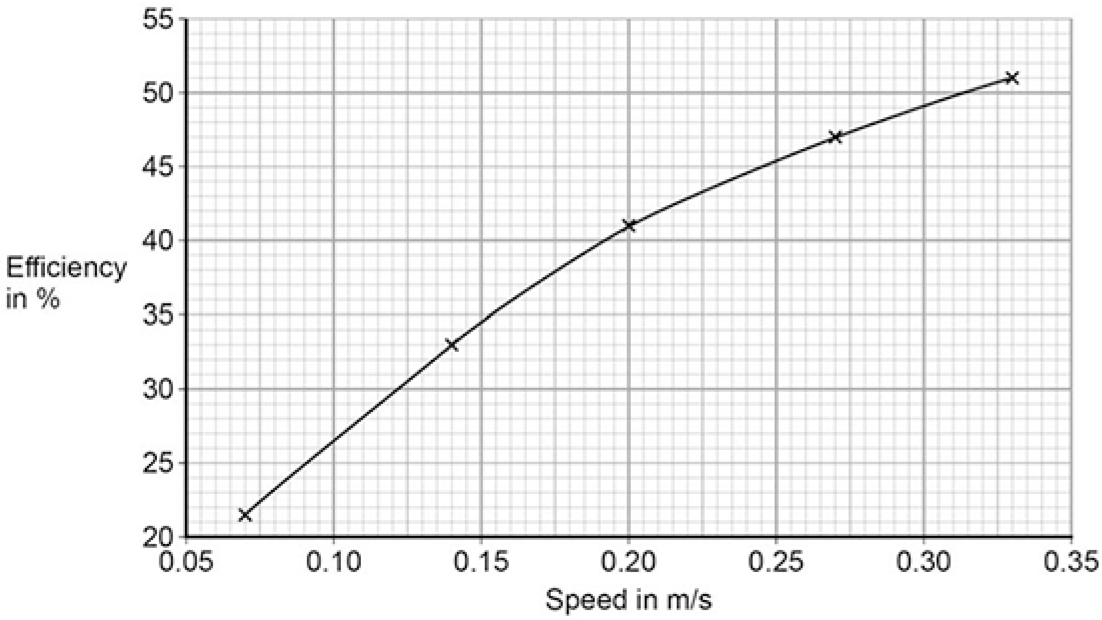
2 ....

....

(2)

(c) **Figure 2** shows a graph of the student's results.

Figure 2



Give **two** conclusions that could be made from the data in **Figure 2**.

....

....

....

....

(2)

(d) Give the main way that the motor is likely to waste energy.

....

....

(1)

(e) When the total power input to the motor was 5 W the motor could not lift the 2.5 N weight.

State the efficiency of the motor.

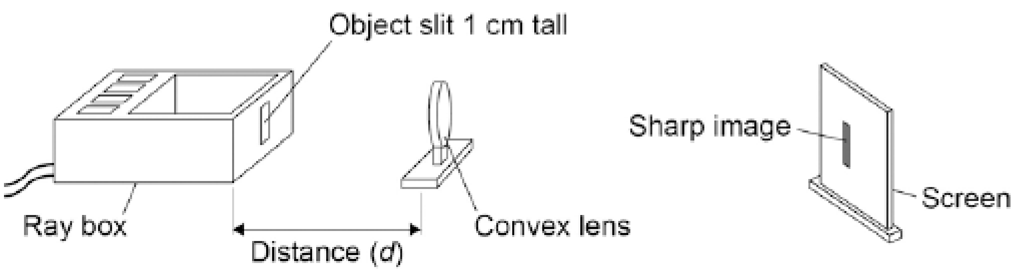
Efficiency = ... %

(1)
(Total 7 marks)

4 A student investigated how the magnification produced by a convex lens varies with the distance (*d*) between the object and the lens.

The student used the apparatus shown in **Figure 1**.

Figure 1



(a) The student measured the magnification produced by the lens by measuring the image height in centimetres.

Explain why the image height in centimetres was the same as the magnification.

....

....

....

....

(2)

(b) The data recorded by the student is given in **Table 1**.

Table 1

Distance between the object and the lens in cm	**Magnification**
25	4.0
30	2.0
40	1.0
50	0.7
60	0.5

It would be difficult to obtain accurate magnification values for distances greater than 60 cm.

Suggest **one** change that could be made so that accurate magnification values could be obtained for distances greater than 60 cm.

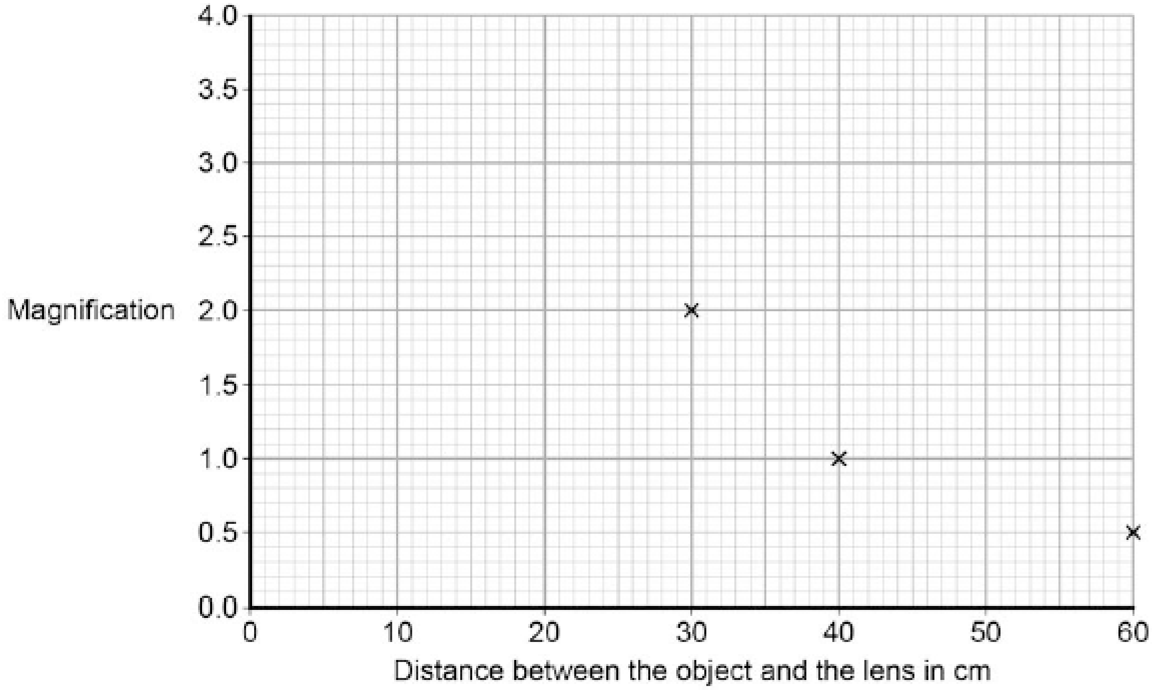
....

....

(1)

(c) The graph in **Figure 2** is incomplete.

Figure 2



Complete the graph in **Figure 2** by plotting the missing data and then drawing a line of best fit.

(2)

(d) How many times bigger is the image when the object is 35 cm from the lens compared to when the object is 55 cm from the lens?

....

....

....

(2)

(e) During the investigation the student also measured the distance between the lens and the image.

Table 2 gives both of the distances measured and the magnification.

Table 2

Distance between the lens and the image in cm	**Distance between the lens and the object in cm**	**Magnification**
100	25	4.0
60	30	2.0
40	40	1.0
33	50	0.7
30	60	0.5

Consider the data in **Table 2**.

Give a second way that the student could have determined the magnification of the object.

Justify your answer with a calculation.

....

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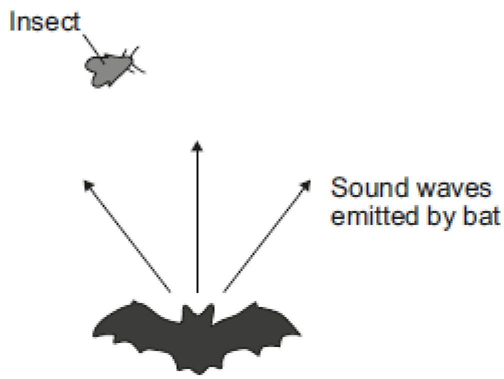
....

....

(2)
(Total 9 marks)

5 Bats use the reflection of high pitched sound waves to determine the position of objects. The image below shows a bat and an insect flying in front of the bat.



(a) What determines the pitch of a sound wave?

Tick (✓) **one** box.

	Tick (✓)
amplitude	
frequency	
speed	

(1)

(b) State the name given to reflected sound waves.

....

(1)

(c) The bat emits a sound wave with a frequency of 25.0 kHz and a wavelength of 0.0136 metres.

Calculate the speed of this sound wave.

....

....

....

Speed = ... m/s

(2)

(d) Sound waves are longitudinal. Describe a longitudinal sound wave.

....

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....

....

(2)
(Total 6 marks)

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

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

Figure 1 shows where these people live.

Figure 1

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

....

....

....

....

(1)

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

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

Figure 2

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

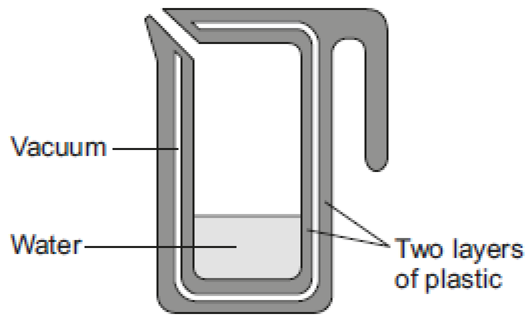
Compare the advantages and disadvantages of the two methods of generating electricity.

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

(6)
(Total 7 marks)

7 A new design for a kettle is made from two layers of plastic separated by a vacuum. After the water in the kettle has boiled, the water stays hot for at least 2 hours.

The new kettle is shown below.



(a) The energy transferred from the water in the kettle to the surroundings in 2 hours is 46 200 J.

The mass of water in the kettle is 0.50 kg.

The specific heat capacity of water is 4200 J/kg °C.

The initial temperature of the water is 100 °C.

Calculate the temperature of the water in the kettle after 2 hours.

....

....

....

....

Temperature after 2 hours = ... °C

(3)

(b) Calculate the average power output from the water in the kettle to the surroundings in 2 hours.

....

....

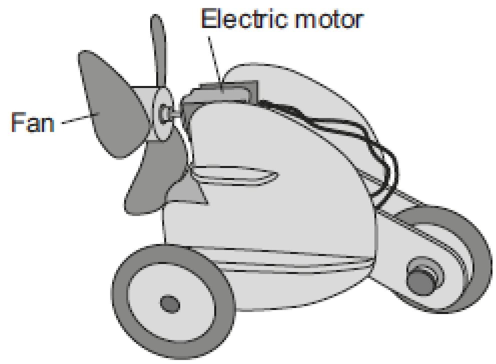
....

....

Average power output = ... W

(2)
(Total 5 marks)

8 The diagram shows an air-driven toy.
When the electric motor is switched on the fan rotates.
The fan pushes air backwards making the toy move forwards.



(a) (i) The toy has a mass of 0.15 kg and moves forward with a velocity of 0.08 m/s.

How is the momentum of the toy calculated?

Tick (✓) **one** box.

0.15 + 0.08 = 0.230	☐
0.15 ÷ 0.08 = 1.875	☐
0.15 × 0.08 = 0.012	☐

(1)

(ii) What is the unit of momentum?

Tick (✓) **one** box.

kg m/s ☐ m/s^2 ☐ kg/m/s ☐

(1)

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

less than	**equal to**	**more than**

The momentum of the air backwards is .... the momentum of the toy forwards.

(1)

(b) The electric motor can rotate the fan at two different speeds.

Explain why the toy moves faster when the fan rotates at the higher of the two speeds.

....

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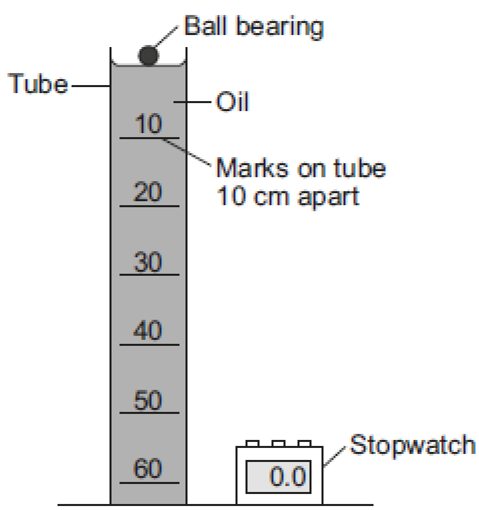
(2)
(Total 5 marks)

9 A student investigated how the speed of a ball bearing changes as the ball bearing falls through a tube of oil.
Figure 1 shows the equipment the student used.

Figure 1



The student measured the time taken for the ball bearing to fall different distances.
Each distance was measured from the top of the oil.

(a) What is likely to have been the main source of error in this investigation?

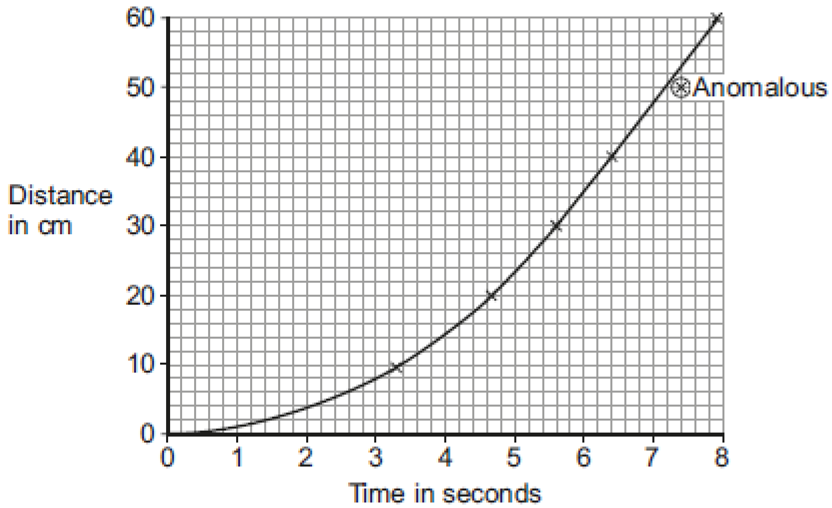
....

....

(1)

(b) **Figure 2** shows the student's results plotted as a graph.

Figure 2



(i) The student has identified one of the results as being anomalous.

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

after	**as**	**before**

The anomalous result was caused by the stopwatch being started

.... the ball bearing was released.

(1)

(ii) What can you conclude from the graph about the speed of the ball bearing during the first four seconds?

....

....

(1)

(iii) The graph shows that the ball bearing reached its terminal velocity.

Describe how the graph would be used to calculate the terminal velocity of the ball bearing.

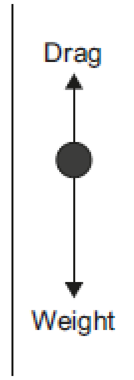
....

....

(1)

(iv) The directions of the two forces acting on the ball bearing as it falls through the oil are shown in **Figure 3**.

Figure 3



Explain, in terms of the forces shown in **Figure 3**, why the ball bearing reaches its terminal velocity.

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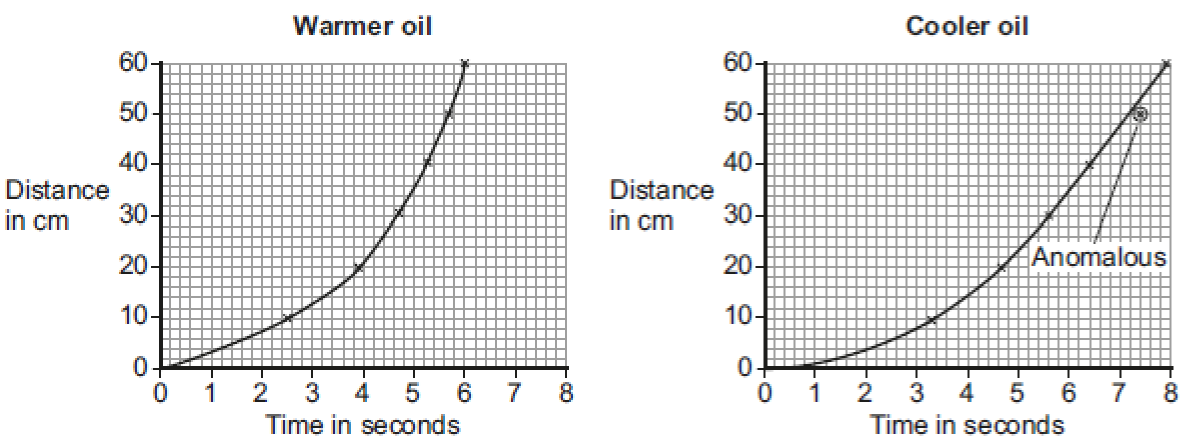
....

(2)

(c) The student repeated the investigation using warmer oil.

Figure 4 shows the set of results using the warmer oil **and** the set of results using the cooler oil.

Figure 4



Compare the two graphs in **Figure 4**.

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

less than	**equal to**	**greater than**

After falling 40 cm, the drag force on the ball bearing in the warmer oil is

.... the drag force on the ball bearing in the cooler oil.

Explain the reason for your answer.

....

....

....

....

(3)
(Total 9 marks)

10 X-rays and ultrasound can both be used for scanning internal organs.

(a) Ultrasound is used to scan unborn babies but X-rays are **not** used to scan unborn babies.

Explain why.

....

....

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....

....

....

(3)

(b) The behaviour of ultrasound waves when they meet a boundary between two different materials is used to produce an image.

Describe how.

....

....

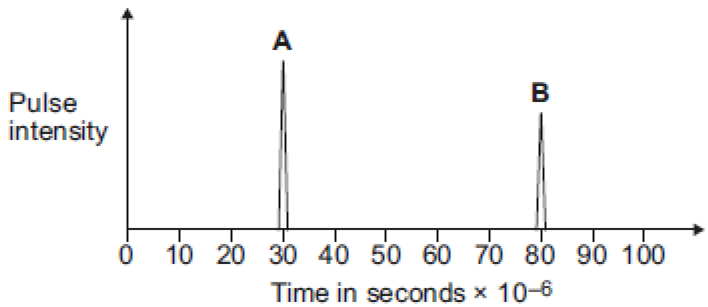
....

....

(2)

(c) **Figure 1** shows two pulses from a scan of an unborn baby. The emitted pulse is labelled **A**. The returning pulse picked up by the receiver is labelled **B**.

Figure 1



The closest distance between the unborn baby and the mother's skin is 4.0 cm.
Use information from **Figure 1** to calculate the average speed of the pulse.

....

....

....

....

....

....

Average speed = ... m/s

(3)

(d) **Figure 2** shows an X-ray of an arm with a broken bone.

Figure 2

© emmy-images/iStock

(i) Describe how X-rays are able to produce an image of bones.

....

....

....

....

....

....

(3)

(ii) Complete the following sentence.

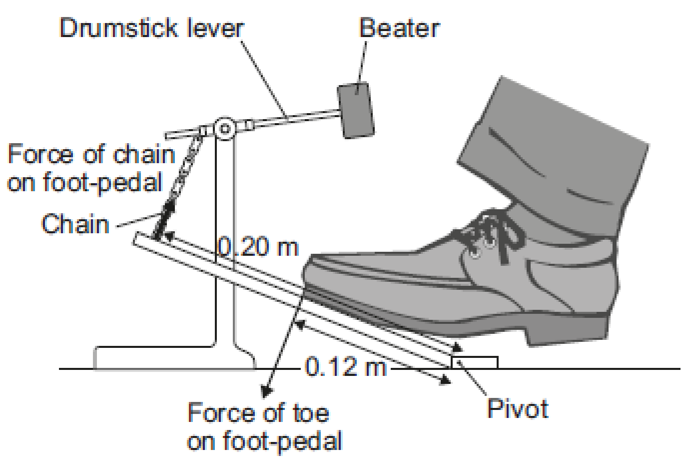
X-rays are able to produce detailed images because their wavelength

is very ....

(1)
(Total 12 marks)

11 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 in the **Figure 1**.

Figure 1



(a) When the toe is pushed down the force creates a moment on the foot-pedal.

(i) State what is meant by the moment of a force.

....

....

(1)

(ii) The foot-pedal is pushed halfway down and held stationary. The toe and the chain both exert a force on the foot-pedal.

Compare the sizes and directions of the moments caused by the force of the toe and the force of the chain on the foot-pedal.

....

....

(1)

(iii) The drummer’s toe pushes with a 1.5 N force on the foot-pedal.
The perpendicular distance from the pivot to the force is 0.12 m.
The perpendicular distance from the pivot to the chain is 0.20 m.

Calculate the force of the chain acting on the foot-pedal.

....

....

....

....

....

....

Force = ... N

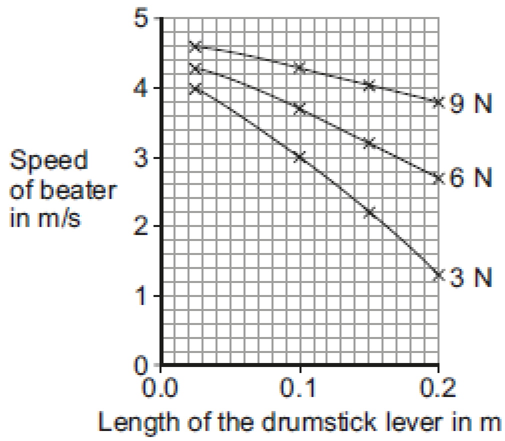
(3)

(b) The foot-pedal is pushed with different forces to make the beater move at different speeds.

The higher the speed at which the beater hits the drum, the louder the sound the drum makes.

Figure 2 shows how the length of the drumstick lever affects the speed of the beater for three different forces.

Figure 2



The drummer needs to be able to sometimes play the drum quietly and sometimes loudly.

How does the **length** of the drumstick lever affect the variation in loudness of the sound from the drum when applying:

a force of 3 N? ....

....

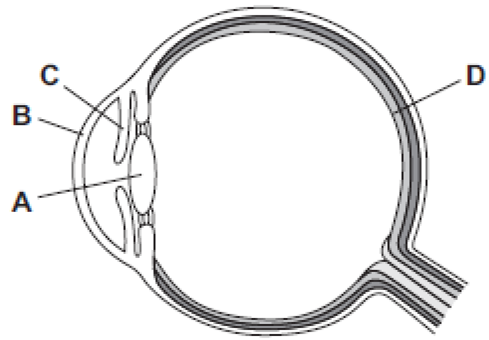
a range of forces from 3 N to 9 N? ....

....

(2)
(Total 7 marks)

12 (a) **Figure 1** shows a section through a human eye.

Figure 1



Write the correct letter, **A**, **B**, **C** or **D**, in each empty box to identify the parts of the eye labelled in **Figure 1**.

Part of the eye	**A, B, C or D**
Cornea	
Lens	
Retina	

(3)

(b) The table shows how the mass of 1 cm^3 of different materials varies with refractive index.

Material	**Refractive index**	**Mass in g**
Water	1.33	1.00
Glass **X**	1.52	2.54
Glass **Y**	1.70	2.93
Glass **Z**	1.81	3.37

(i) Describe the pattern shown in above table.

....

....

(1)

(ii) Lenses used for correcting visual defects often have a low refractive index.

State **one** advantage and **one** disadvantage of using lenses with a high refractive index for correcting visual defects.

Advantage ....

Disadvantage ....

(2)

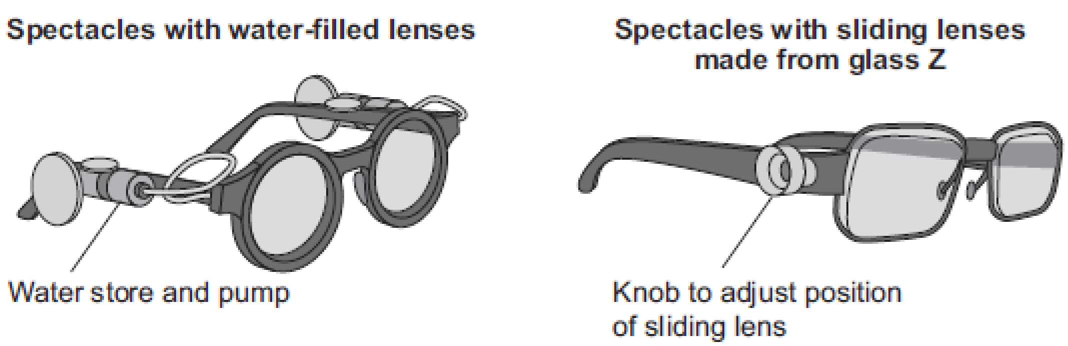
(iii) The eyesight of a person can change throughout their lifetime. Scientists have designed cheap spectacles that allow the wearer to change the focal length of the lenses as their eyesight changes.

Two designs are:

- using water-filled lenses where water is pumped in or out of the lens to change its shape
- using a pair of specially shaped lenses for each eye that are able to slide across each other.

Figure 2 shows these two designs.

Figure 2



Suggest **one** advantage and **one** disadvantage of each design.

....

....

....

....

....

....

....

....

....

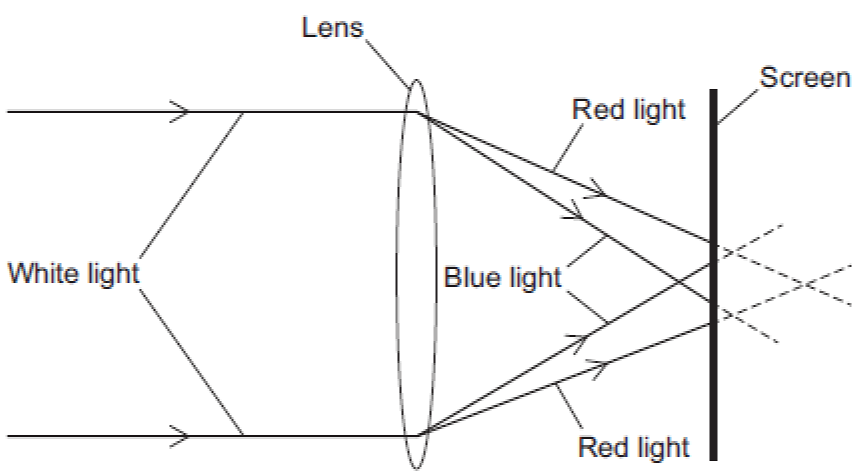
....

(4)

(c) **Figure 3** shows parallel rays of white light from a distant point being refracted towards a screen by a lens.

The lens is made from a glass with a much greater refractive index than glass normally used for correcting visual defects.

Figure 3



What would you notice about the image on the screen?

State **two** observations.

1 ....

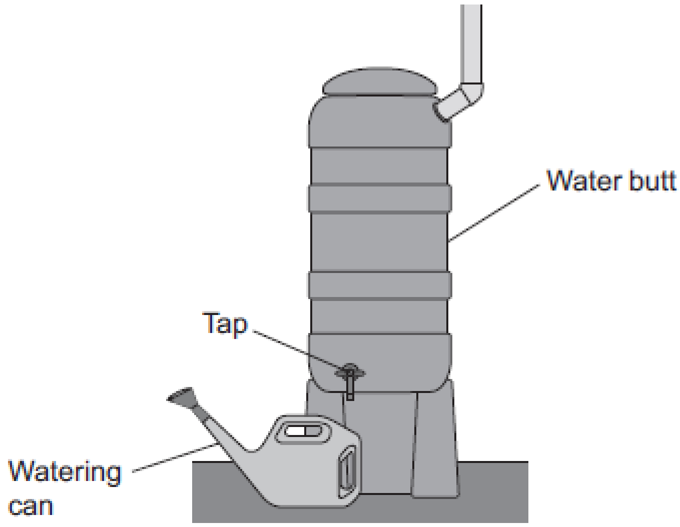
....

2 ....

....

(2)
(Total 12 marks)

13 The diagram shows a water butt used to collect rainwater.



A tap allows water to be collected from the water butt in a watering can.

(a) If the tap was placed higher up on the water butt, what difference would it make to the rate of flow of water from the tap?

Explain your answer.

....

....

....

....

(2)

(b) A hosepipe is now attached to the tap. The hosepipe takes water to where it is needed.

A gardener did an investigation to see how the rate of flow of water through a hosepipe, from a water butt, varies with the length of the hosepipe.

His results are shown in below table.

Length of hosepipe in metres	**Water collected in 10 seconds in cm^3**
2.0	500
3.0	500
4.0	500
5.0	500
10.0	250
15.0	170

(i) What conclusions can you make based on the results in the table above?

....

....

....

....

(2)

(ii) Suggest further readings that should be taken to improve the investigation.

Give reasons for your answers.

....

....

....

....

....

....

....

....

(4)

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

You are provided with a water butt and lengths of hosepipe of different diameter.

Describe how you would investigate how the rate of flow of water through a hosepipe varies with the diameter of the hosepipe.

In your description you should include:

- any additional equipment that you would use
- any measurements you would make using the equipmentz
- any variables that need to be controlled and how this would be achieved.

....

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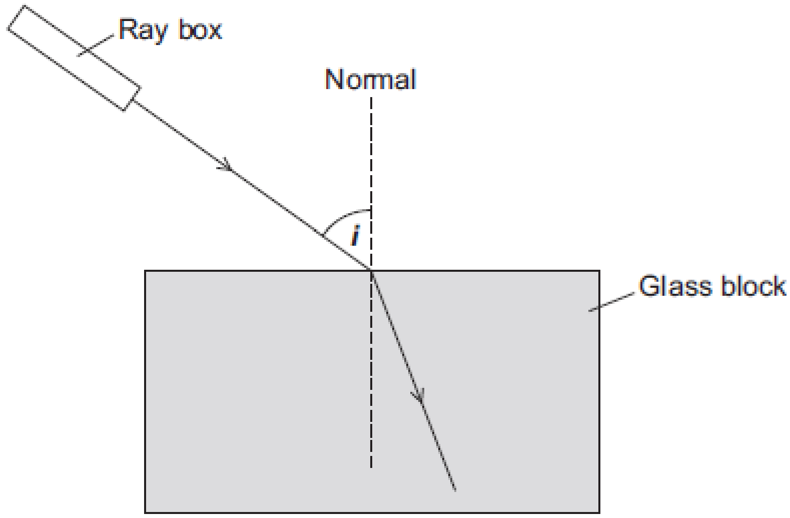
(6)
(Total 14 marks)

14 (a) **Figure 1** shows a ray of light entering a glass block.

Figure 1



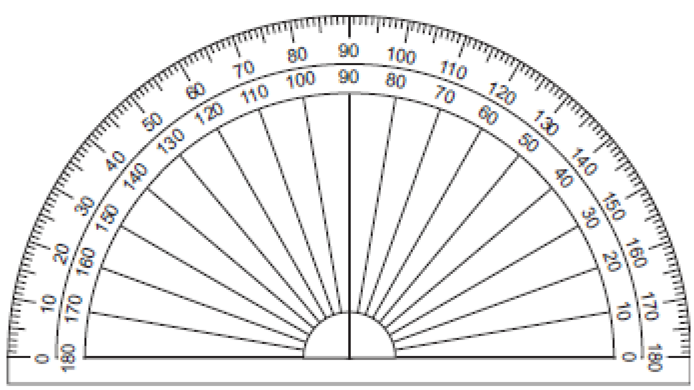
(i) The angle of incidence in **Figure 1** is labelled with the letter ***i***.

On **Figure 1**, use the letter ***r*** to label the angle of refraction.

(1)

(ii) **Figure 2** shows the protractor used to measure angles ***i*** and ***r***.

Figure 2



What is the resolution of the protractor?

Tick (✓) **one** box.

1 degree ☐ 5 degrees ☐ 10 degrees ☐

(1)

(iii) The table shows calculated values for angle ***i*** and angle ***r*** from an investigation.

Calculated values
sin ***i*** = 0.80
sin ***r*** = 0.50

Use the values from the table to calculate the refractive index of the glass.

....

....

....

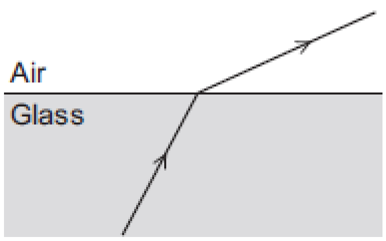
Refractive index = ...

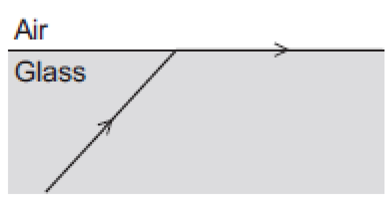
(2)

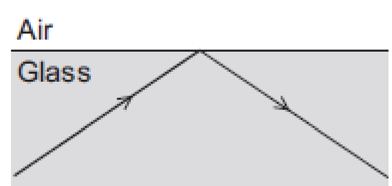
(b) The diagrams below show a ray of light moving through glass.

Which diagram correctly shows what happens when the ray of light strikes the surface of the glass at the critical angle?

Tick (✓) **one** box.







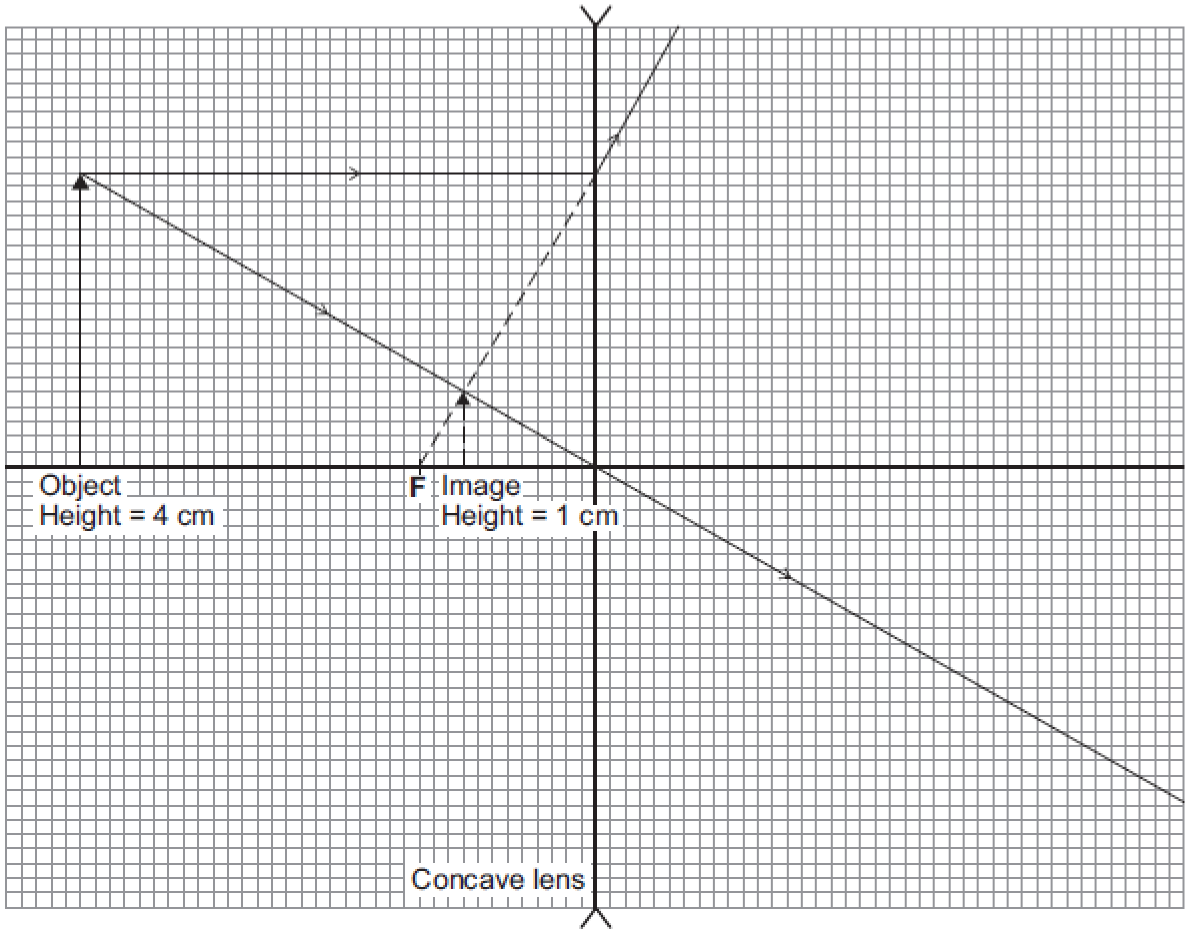
☐ ☐ ☐

(1)

(c) A concave (diverging) lens is fitted into a door to make a security spyhole.

Figure 3 shows how this lens produces an image.

Figure 3



(i) State **one** word to describe the nature of the image in **Figure 3**.

....

(1)

(ii) Use data from **Figure 3** to calculate the magnification of the image.

....

....

....

Magnification = ...

(2)

(iii) What is another use for a concave lens?

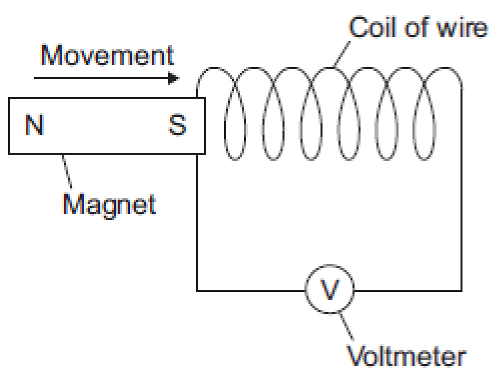
Tick (✓) **one** box.

A magnifying glass	☐
Correcting short sight	☐
To focus an image in a camera	☐

(1)
(Total 9 marks)

15 **Figure 1** shows a magnet moving into a coil of wire. This movement causes a reading on the voltmeter.

Figure 1



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

generated	**induced**	**produced**

Moving the magnet into the coil of wire causes a reading on the voltmeter because a

potential difference is .... across the ends of the wire.

(1)

(b) A student investigated how the number of turns on the coil of wire affects the maximum voltmeter reading. The student changed the number of turns on the coil of wire, then moved the magnet into the coil. The student recorded the maximum voltmeter reading.

To obtain valid data, suggest **two** variables that the student should control in this investigation.

1...

....

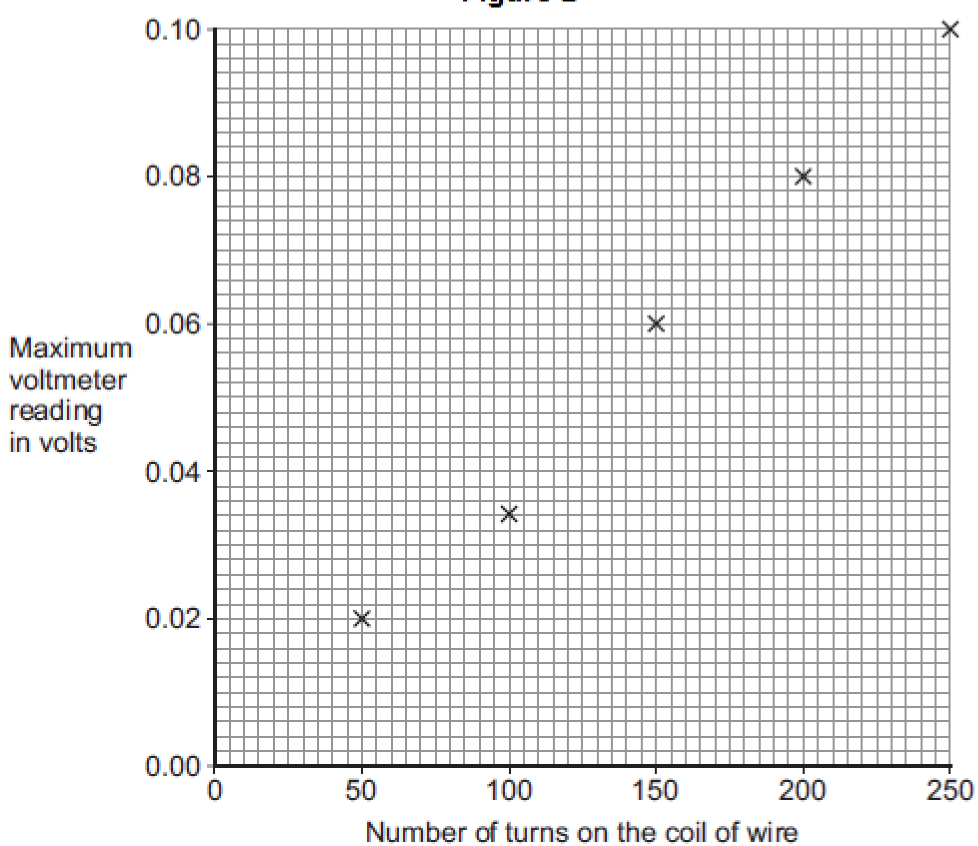
2...

....

(2)

(c) The student's results are shown in **Figure 2**.

Figure 2



(i) One of the results is anomalous.
Suggest a reason for the anomalous result.

....

(1)

(ii) Draw a line of best fit on **Figure 2**.

(1)

(d) A data-logger can automatically record and store data.

It may have been better for the student to have used a data-logger in his investigation rather than a voltmeter.

Suggest **one** reason why.

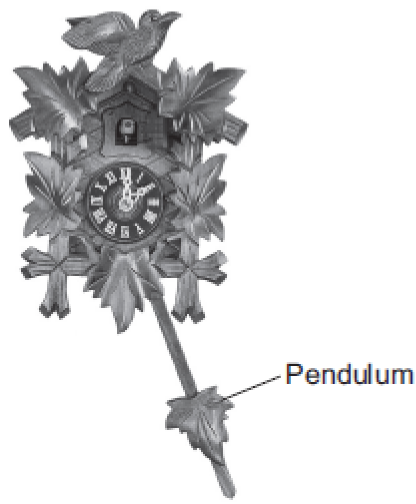
....

....

(1)
(Total 6 marks)

16 The clock shown in **Figure 1** uses a pendulum to keep time.

Figure 1



(a) The pendulum has a frequency of 0.80 Hz.

Calculate the periodic time of the pendulum.

....

....

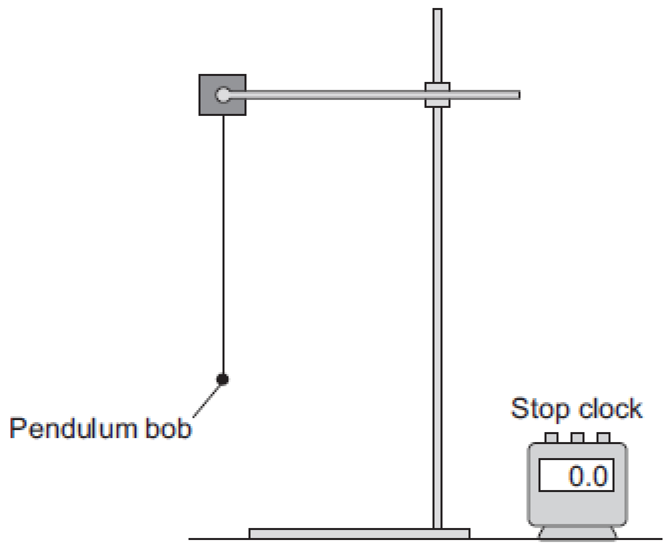
....

Periodic time = ... seconds

(2)

(b) A student investigated the factors affecting the oscillation of a pendulum. The student set up a pendulum as shown in **Figure 2**.

Figure 2



The student investigated how many complete oscillations the pendulum made for different lengths of the pendulum and different masses of the pendulum bob.

The results are shown in the table.

Length of the pendulum in millimetres	**Mass of the pendulum bob in grams**	**Number of complete oscillations made by the pendulum in 20 seconds**
200	100	22
200	200	22
400	100	15
400	200	15
600	50	13
600	100	13

(i) State **two** conclusions that the student should make from the results shown in the table.

1...

....

2...

....

(2)

(ii) The student wants to be more certain that her conclusions are correct.

Suggest **two** ways in which the investigation could be improved.

1. ....

....

2. ....

....

(2)
(Total 6 marks)

17 A student finds some information about energy-saving light bulbs.

(a) A 30W light bulb uses 600J of electrical energy in a certain period of time. In that time, it produces 450 J of light energy. The rest of the energy is wasted.

(i) Calculate the energy wasted by the light bulb in this period of time.

....

Wasted energy = ... J

(1)

(ii) What happens to the energy wasted by the light bulb?

....

....

(1)

(iii) Calculate the efficiency of this light bulb.

....

....

Efficiency = ...

(2)

(iv) Calculate the period of time, in seconds, during which the 600 J is provided to the 30 W light bulb.

....

....

Time = ... s

(2)

(b) A company that makes light bulbs provides information about some of their products.

The table shows some of this information.

	Power in watts	Lifetime in hours	Cost of bulb in £
Filament bulb	60	1250	2.00
LED bulb	12	50 000	16.00

(i) Suggest why it is important to confirm this information independently.

....

(1)

(ii) A homeowner is thinking about replacing his filament bulbs with LED bulbs.

A 12 W LED bulb gives the same light output as a 60 W filament bulb.

Suggest reasons why the homeowner is likely to choose LED bulbs.

Use the information given in the table.

....

....

....

....

(2)

(iii) State **one** factor, other than efficiency, that is important when considering the choice of a bulb for lighting in the home.

....

....

(1)
(Total 10 marks)

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

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

....

....

....

....

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....

(4)

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

....

....

....

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(2)

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

Calculate the amount of energy required for this change.

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

....

....

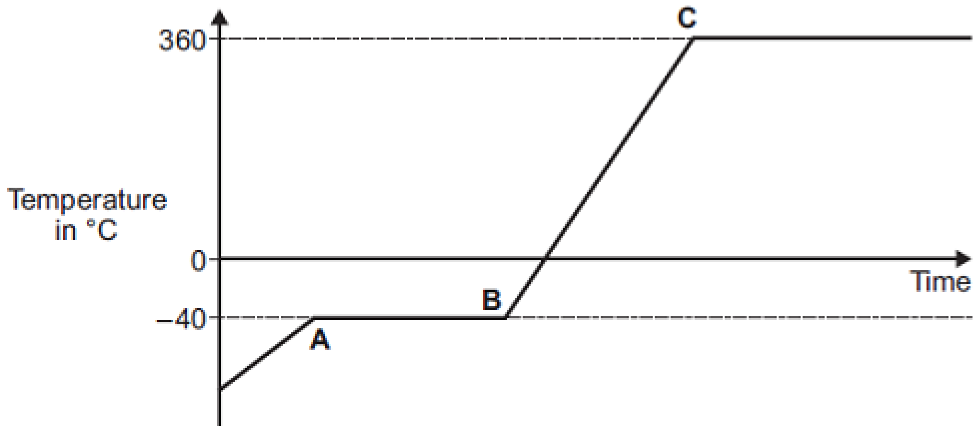
....

Energy required = ... J

(2)

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

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



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

Section **AB** ....

....

....

....

....

Section **BC** ....

....

....

....

....

(4)
(Total 12 marks)

19 An investigation was carried out to show how thinking distance, braking distance and stopping distance are affected by the speed of a car.

The results are shown in the table.

Speed in metres per second	**Thinking distance in metres**	**Braking distance in metres**	**Stopping distance in metres**
10	6	6	12
15	9	14	43
20	12	24	36
25	15	38	53
30	18	55	73

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

As speed increases, thinking distance
- decreases.
- increases.
- stays the same.

As speed increases, braking distance
- decreases.
- increases.
- stays the same.

(2)

(b) One of the values of stopping distance is incorrect.

Draw a ring around the incorrect value in the table.

Calculate the correct value of this stopping distance.

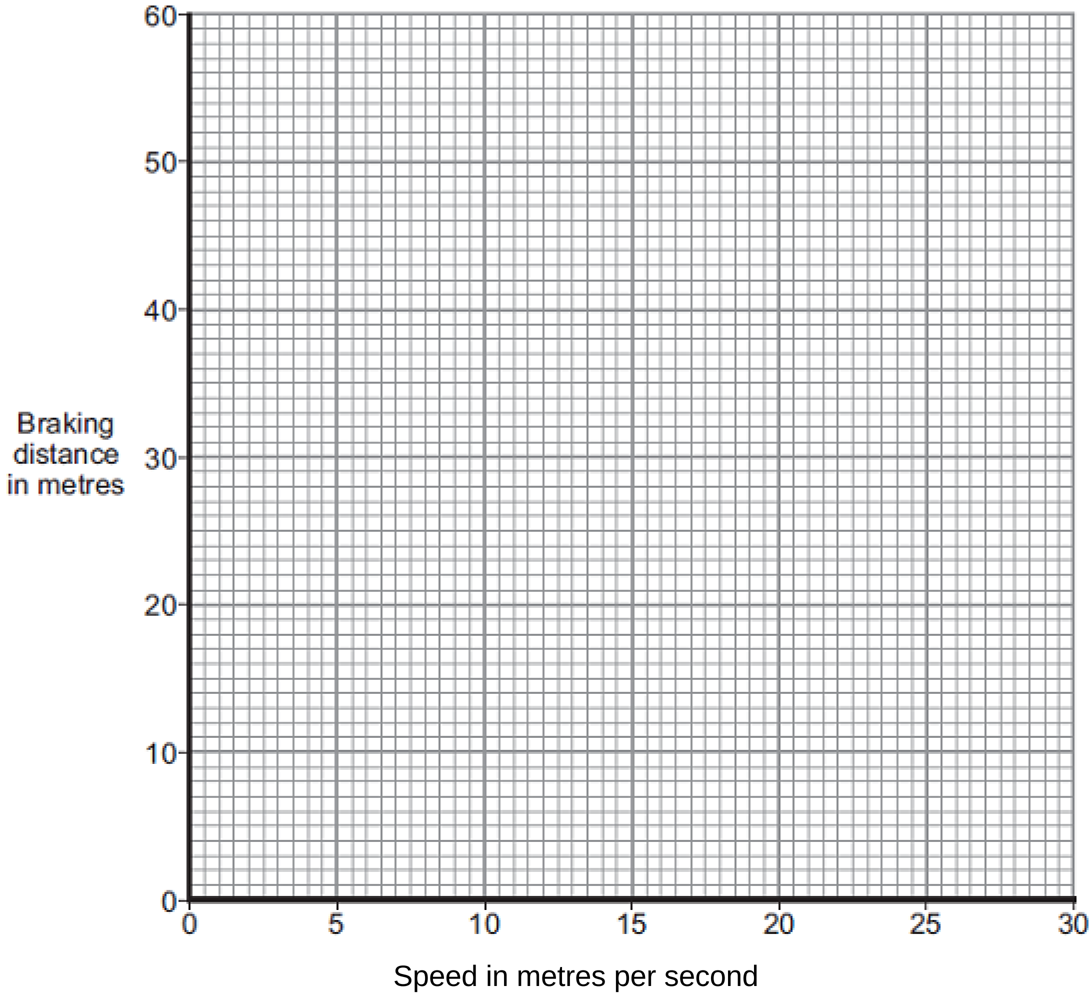
....

Stopping distance = ... m

(2)

(c) (i) Using the results from the table, plot a graph of braking distance against speed.

Draw a line of best fit through your points.



(3)

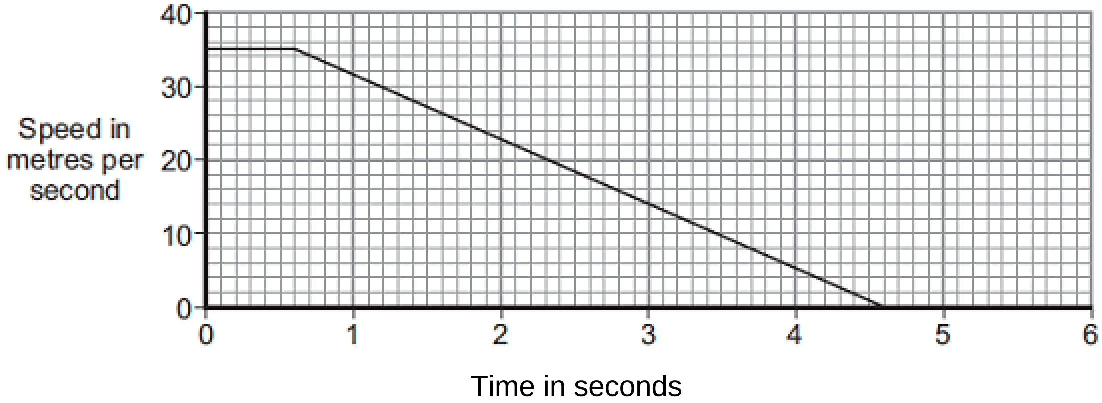
(ii) Use your graph to determine the braking distance, in metres, at a speed of 22 m / s.

Braking distance = ... m

(1)

(d) The speed–time graph for a car is shown below.

While travelling at a speed of 35 m / s, the driver sees an obstacle in the road at time t = 0. The driver reacts and brakes to a stop.



(i) Determine the braking distance.

....

....

....

....

Braking distance = ... m

(3)

(ii) If the driver was driving at 35 m / s on an icy road, the speed–time graph would be different.

Add another line to the speed–time graph above to show the effect of travelling at 35 m / s on an icy road and reacting to an obstacle in the road at time t = 0.

(3)

(e) A car of mass 1200 kg is travelling with a velocity of 35 m / s.

(i) Calculate the momentum of the car.

Give the unit.

....

....

....

Momentum = ...

(3)

(ii) The car stops in 4 seconds.

Calculate the average braking force acting on the car during the 4 seconds.

....

....

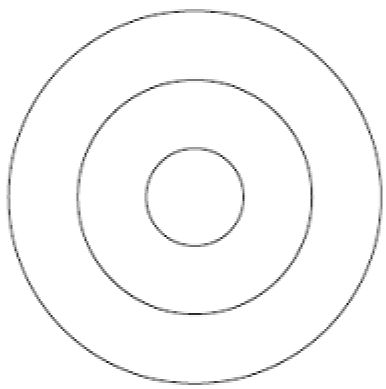
Force = ... N

(2)
(Total 19 marks)

20 A teacher demonstrates the production of circular waves in a ripple tank.

Diagram 1 shows the waves at an instant in time.

Diagram 1



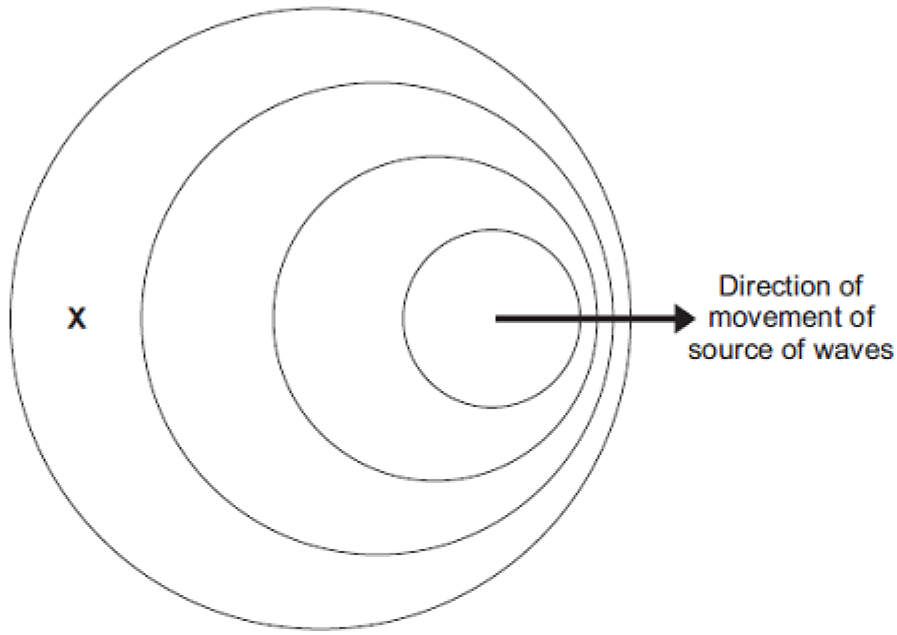
(a) Show on **Diagram 1** the wavelength of the waves.

(1)

(b) The teacher moves the source of the waves across the ripple tank.

Diagram 2 shows the waves at an instant in time.

Diagram 2
(Actual size)



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

decreased	**increased**	**stayed the same**

In **Diagram 2**, the observed wavelength of the waves at **X**

has ....

In **Diagram 2**, the frequency of the waves at **X**

has ....

(2)

(ii) Take measurements from **Diagram 2** to determine the wavelength of the waves received at **X**.

Give the unit.

....

....

Wavelength = ...

(3)

(c) The teacher uses the waves in the ripple tank to model the changes in the wavelengths of light observed from distant galaxies.

When observed from the Earth, there is an increase in the wavelength of light from distant galaxies.

(i) State the name of this effect.

....

(1)

(ii) What does this increase in wavelength tell us about the movement of most galaxies?

....

....

(1)

(iii) Explain how this observation supports the Big Bang theory of the formation of the Universe.

....

....

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....

....

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....

....

....

....

(4)

(iv) State **one** other piece of evidence that supports the Big Bang theory of the formation of the Universe.

....

....

(1)
(Total 13 marks)

21 (a) Radio waves, microwaves and visible light are all electromagnetic waves that are used for communication.

(i) Name another electromagnetic wave that is used for communication.

....

(1)

(ii) Name an electromagnetic wave which is **not** used for communication.

State a use for this electromagnetic wave.

Electromagnetic wave ....

Use ....

....

(2)

(b) The table below shows the wavelengths for some electromagnetic waves, **A**, **B**, **C** and **D**.

Wave	**Wavelength**
A	1000 m
B	100 m
C	10 m
D	3 cm

A teacher is going to demonstrate diffraction of waves through a gap. She will carry out the demonstration in a classroom.

The teacher is able to generate waves **A**, **B**, **C** and **D**.

Which wave, **A**, **B**, **C** or **D**, would she use? ☐

Explain your answer.

....

....

....

....

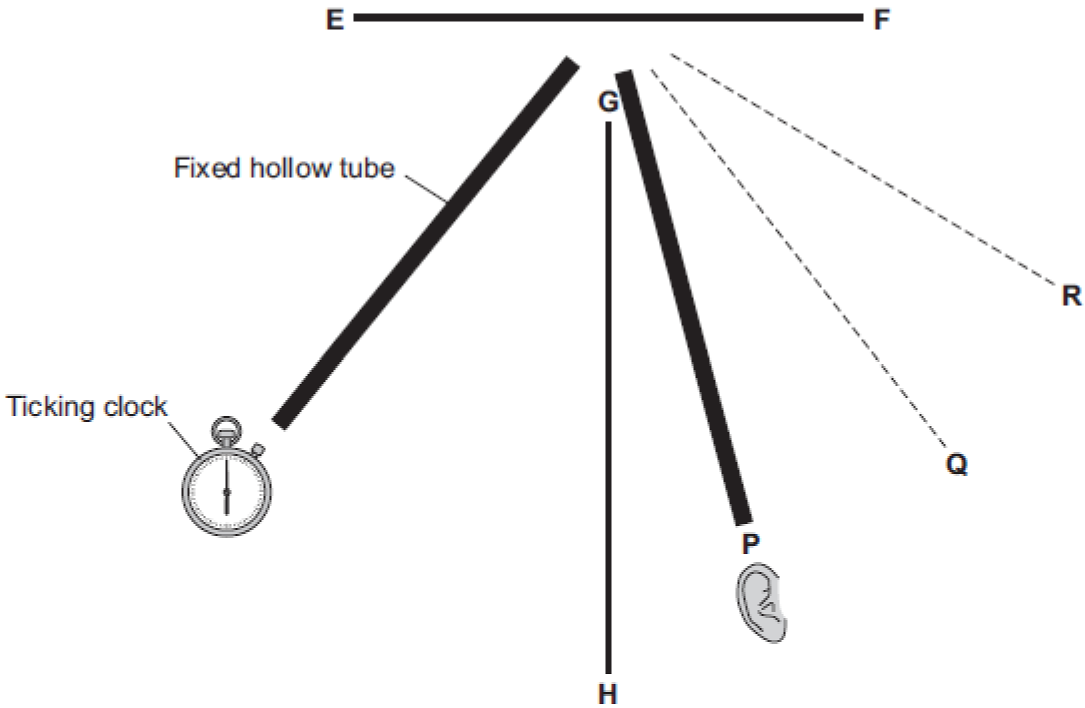
....

....

(3)

(c) In another demonstration, a teacher used a loud ticking clock as a source of sound, two hollow tubes and two smooth surfaces, **EF** and **GH**.

The figure below shows one of the hollow tubes fixed in position with a ticking clock at one end.



A student placed his ear at one end of the other hollow tube in position **P**. He moved this hollow tube, in turn, to positions **Q** and **R**.

(i) At which position, **P**, **Q** or **R**, did he hear the loudest sound? ☐

(1)

(ii) Explain your answer to part **(i)**.

....

....

....

....

....

....

(3)

(iii) Suggest why smooth surface **GH** in the figure above was needed.

....

....

(1)

(iv) The frequency of a sound wave is 15 Hz.

The speed of sound is 330 m / s.

Calculate the wavelength of the sound wave.

....

....

Wavelength = ... m

(2)

(v) Give a reason why it would **not** be possible to do the demonstration in the figure above using sound waves with a frequency of 15 Hz.

....

....

(1)
(Total 14 marks)

22 Different radioactive isotopes have different values of half-life.

(a) What is meant by the 'half-life' of a radioactive isotope?

....

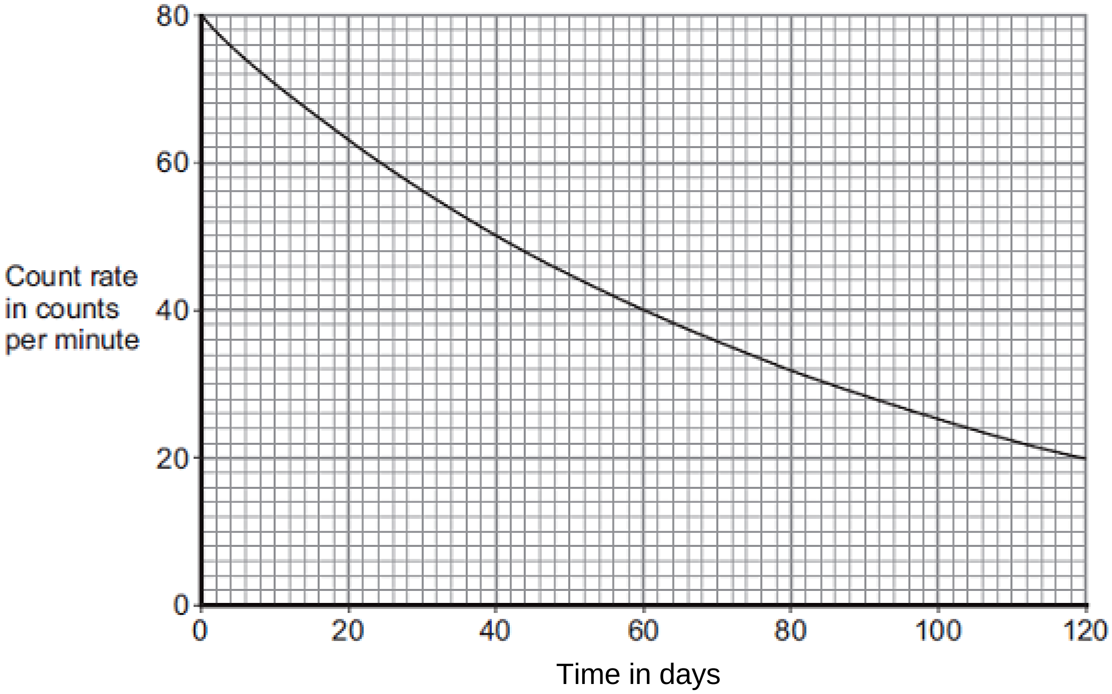
....

....

(1)

(b) **Figure 1** shows how the count rate from a sample of a radioactive isotope varies with time.

Figure 1



Use information from **Figure 1** to calculate the half-life of the radioactive isotope.

Show clearly on **Figure 1** how you obtain your answer.

Half-life = ... days

(2)

(c) The table below shows data for some radioactive isotopes that are used in schools.

Radioactive isotope	**Type of radiation emitted**	**Half-life in years**
Americium-241	Alpha and gamma	460
Cobalt-60	Gamma	5
Radium-226	Alpha, beta and gamma	1600
Strontium-90	Beta	28
Thorium-232	Alpha and beta	1.4×10^{10}

(i) State which radioactive isotope in the table above emits only radiation that is **not** deflected by a magnetic field.

Give a reason for your choice.

....

....

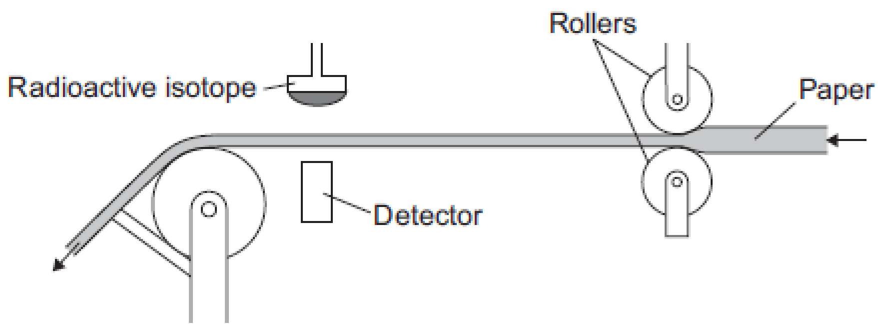
....

....

(2)

(ii) **Figure 2** shows a radioactive isotope being used to monitor the thickness of paper during production.

Figure 2



State which radioactive isotope in the table should be used to monitor the thickness of the paper.

Explain your choice.

....

....

....

....

....

(3)

All the radioactive isotopes in the table have practical uses.

State which source in the table would need replacing most often.

Explain your choice.

....

....

....

....

....

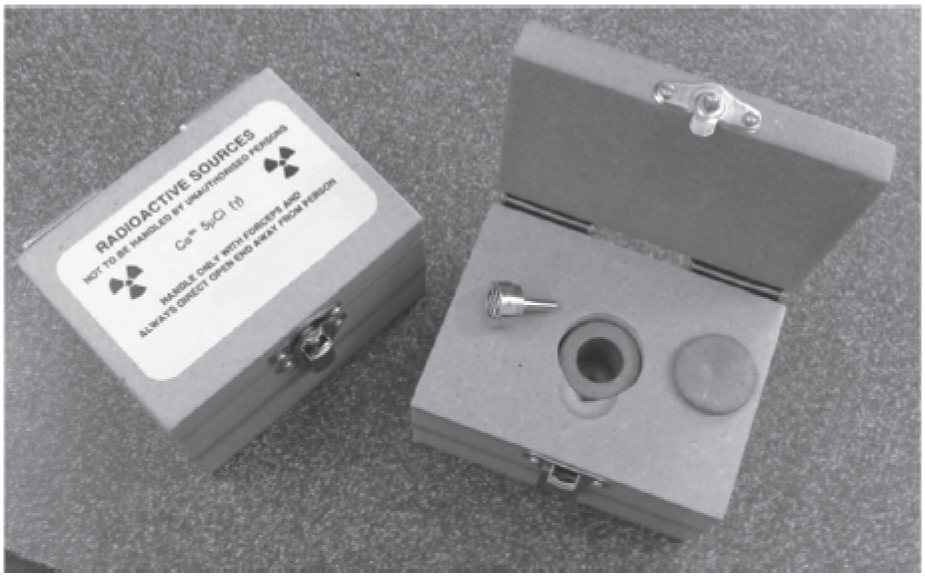
(3)

(iii) When the radioactive isotopes are not in use, they are stored in lead-lined wooden boxes.

The boxes reduce the level of radiation that reaches the surroundings.

Figure 3 shows two of these boxes.

Figure 3



State **one** source from the table which emits radiation that could penetrate the box.

Explain your answer.

....

....

....

....

....

....

(3)
(Total 14 marks)

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

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

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

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

Suggest why.

....

....

(1)

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

....

....

....

....

(2)

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

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

....

....

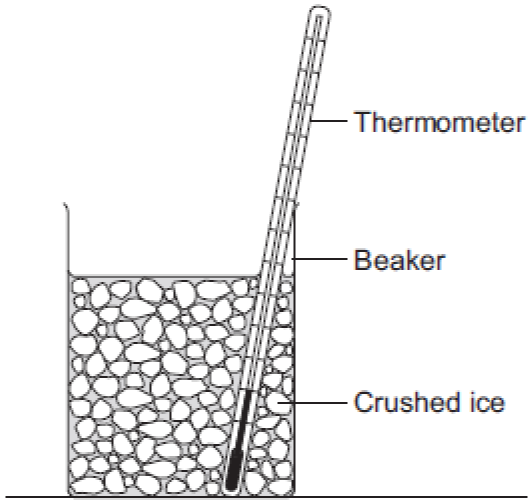
Energy = ... J

(2)

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

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

The figure below shows the equipment that she used.



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

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

....

....

(1)

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

Suggest **two** reasons why.

Tick (✓) **two** boxes.

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

(2)

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

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

Describe the pattern shown in the table.

....

....

(1)

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

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

Calculate the energy transferred in 2 minutes.

....

....

....

Energy transferred = ... J

(3)

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

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

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

- energy storage
- salt
- undersoil electrical heating.

....

....

....

....

....

....

....

....

....

....

....

....

Extra space ....

....

....

....

....

....

....

(6)
(Total 18 marks)

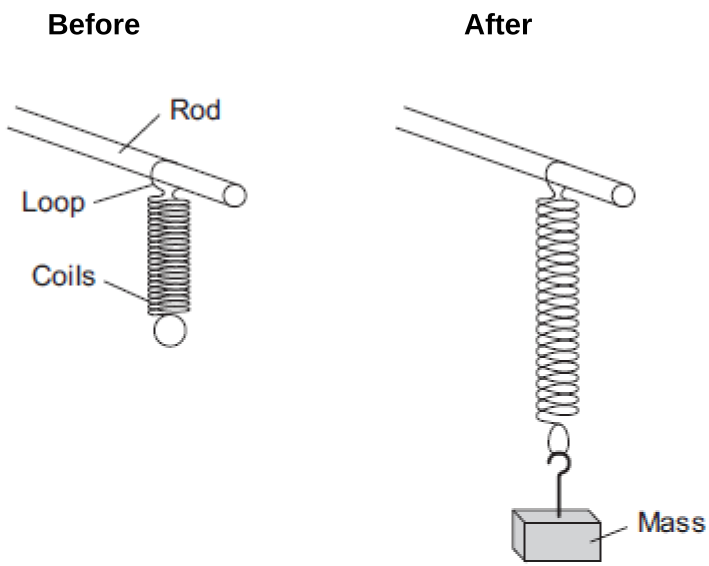
24 A student investigated the behaviour of springs. She had a box of identical springs.

(a) When a force acts on a spring, the shape of the spring changes.

The student suspended a spring from a rod by one of its loops. A force was applied to the spring by suspending a mass from it.

Figure 1 shows a spring before and after a mass had been suspended from it.

Figure 1



(i) State **two** ways in which the shape of the spring has changed.

1 ....

2 ....

(2)

(ii) No other masses were provided.

Explain how the student could test if the spring was behaving elastically.

....

....

....

....

(2)

(b) In a second investigation, a student took a set of measurements of force and extension.

Her results are shown in **Table 1** .

Table 1

Force in newtons	0.0	1.0	2.0	3.0	4.0	5.0	6.0
Extension in cm	0.0	4.0		12.0	16.0	22.0	31.0

(i) Add the missing value to **Table 1**.

Explain why you chose this value.

....

....

....

....

(3)

(ii) During this investigation the spring exceeded its limit of proportionality.

Suggest a value of force at which this happened.

Give a reason for your answer.

Force = ... N

Reason ....

....

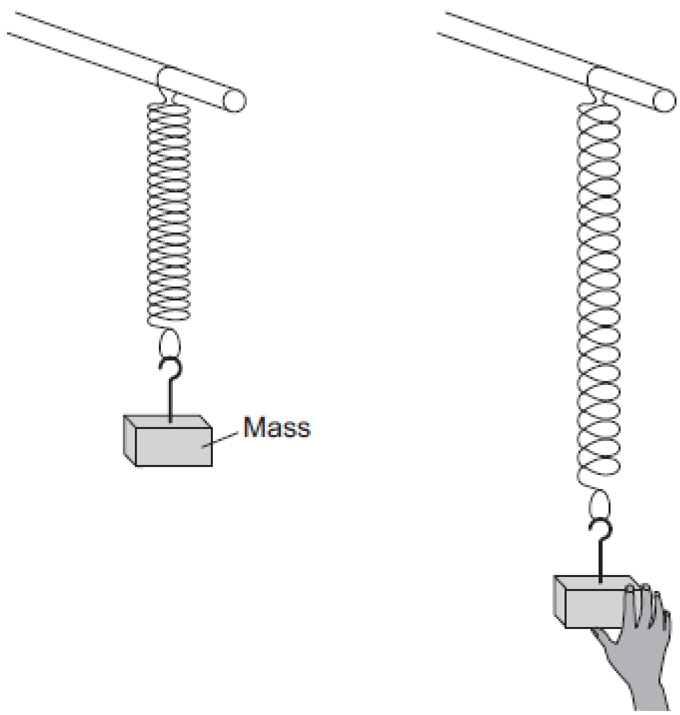
....

(2)

(c) In a third investigation the student:

- suspended a 100 g mass from a spring
- pulled the mass down as shown in **Figure 2**
- released the mass so that it oscillated up and down
- measured the time for 10 complete oscillations of the mass
- repeated for masses of 200 g, 300 g and 400 g.

Figure 2



Her results are shown in **Table 2**.

Table 2

	Time for 10 complete oscillations in seconds			
Mass in g	**Test 1**	**Test 2**	**Test 3**	**Mean**
100	4.34	5.20	4.32	4.6
200	5.93	5.99	5.86	5.9
300	7.01	7.12	7.08	7.1
400	8.23	8.22	8.25	8.2

(i) Before the mass is released, the spring stores energy.

What type of energy does the spring store?

Tick (✓) **one** box.

	Tick (✓)
Elastic potential energy	
Gravitational potential energy	
Kinetic energy	

(1)

(ii) The value of time for the 100 g mass in **Test 2** is anomalous.

Suggest **two** likely causes of this anomalous result.

Tick (✓) **two** boxes.

	Tick (✓)
Misread stopwatch	
Pulled the mass down too far	
Timed half oscillations, not complete oscillations	
Timed too few complete oscillations	
Timed too many complete oscillations	

(2)

(iii) Calculate the correct mean value of time for the 100 g mass in **Table 2**.

....

....

Mean value = ... s

(1)

(iv) Although the raw data in **Table 2** is given to 3 significant figures, the mean values are correctly given to 2 significant figures.

Suggest why.

....

....

....

....

(2)

(v) The student wanted to plot her results on a graph. She thought that four sets of results were not enough.

What extra equipment would she need to get more results?

....

....

....

....

(2)

(Total 17 marks)

25 Electricity can be generated using various energy sources.

(a) Give **one** advantage and **one** disadvantage of using nuclear power stations rather than gas-fired power stations to generate electricity.

Advantage ....

....

Disadvantage ....

....

(2)

(b) (i) A single wind turbine has a maximum power output of 2 000 000 W.

The wind turbine operated continuously at maximum power for 6 hours.

Calculate the energy output in kilowatt-hours of the wind turbine.

....

....

....

Energy output = ... kWh

(2)

(ii) Why, on average, do wind turbines operate at maximum power output for only 30% of the time?

....

....

(1)

(c) An on-shore wind farm is made up of many individual wind turbines.

They are connected to the National Grid using underground power cables.

Give **one** advantage of using underground power cables rather than overhead power cables.

....

....

(1)
(Total 6 marks)

26 A note was played on an electric keyboard.

The frequency of the note was 440 Hz.

(a) (i) What does a frequency of 440 Hz mean?

....

....

(1)

(ii) The sound waves produced by the keyboard travel at a speed of 340 m / s.

Calculate the wavelength of the note.

Give your answer to **three** significant figures.

....

....

....

Wavelength = ... metres

(3)

(b) **Figure 1** shows a microphone connected to a cathode ray oscilloscope (CRO) being used to detect the note produced by the keyboard.

Figure 1

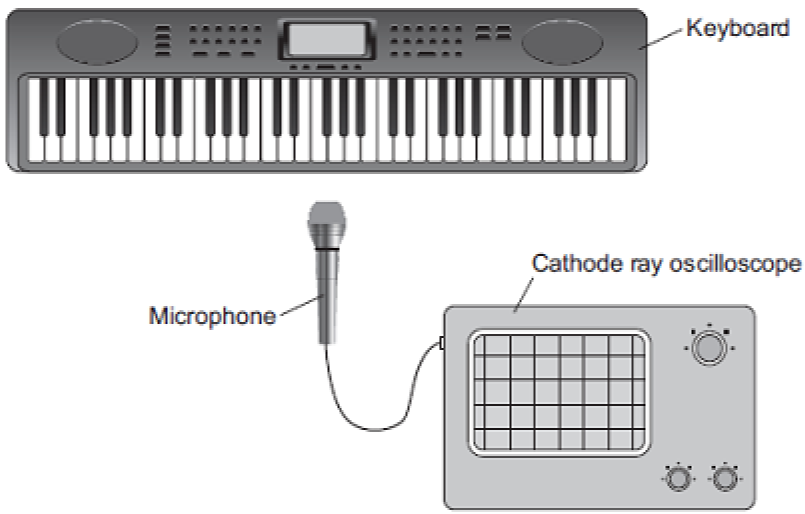
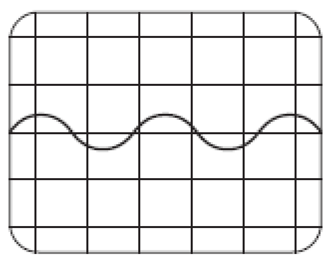


Figure 2 shows the trace produced by the sound wave on the CRO.

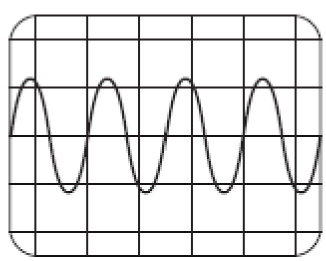
Figure 2



A second note, of different wavelength, was played on the keyboard.

Figure 3 shows the trace produced by the sound wave of the second note on the CRO.

Figure 3



The settings on the CRO were unchanged.

What **two** conclusions should be made about the **second** sound wave produced by the keyboard compared with the **first** sound wave?

Give a reason for each conclusion.

Conclusion 1 ....

....

Reason ....

....

Conclusion 2 ....

....

Reason ....

....

(4)
(Total 8 marks)

27 The figure below shows a slide in a children's playground.

(a) A child of mass 18 kilograms goes down the slide.

The vertical distance from the top to the bottom of the slide is 2.5 metres.

Calculate the decrease in gravitational potential energy of the child sliding from the top to the bottom of the slide.

Gravitational field strength = 10 N / kg

....

....

....

Decrease in gravitational potential energy = ... J

(2)

(b) The slide is made of plastic.

(i) The child becomes electrically charged when he goes down the slide.

Explain why.

....

....

....

....

(2)

(ii) Going down the slide causes the child's hair to stand on end.

What conclusion about the electrical charge on the child's hair can be made from this observation?

....

....

Give a reason for your answer.

....

....

(2)

(iii) Why would the child **not** become electrically charged if the slide was made from metal?

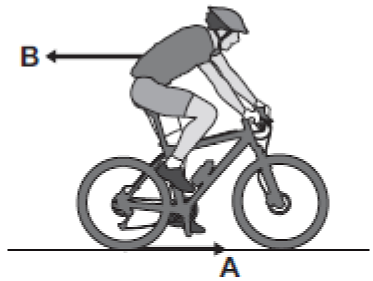
....

....

(1)
(Total 7 marks)

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

Figure 1



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

Draw a ring around the correct answer.

friction **gravity** **weight**

(1)

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

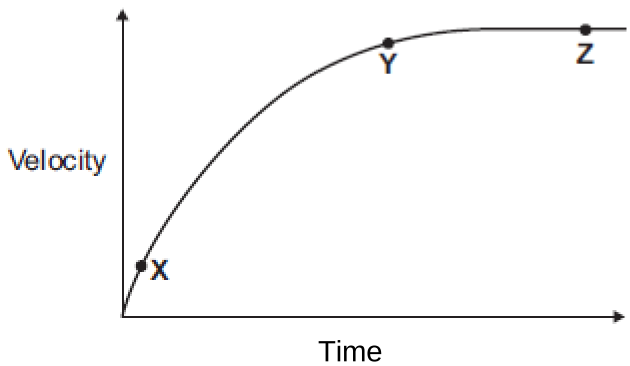
....

(1)

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

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

Figure 2



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

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

....

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....

....

Extra space ....

....

....

....

....

....

....

....

....

....

....

....

(6)

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

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

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

....

....

....

Work done = ...

(3)

(ii) Complete the following sentences.

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

bicycle ....

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

(2)

(Total 13 marks)

29 (a) What is ultrasound?

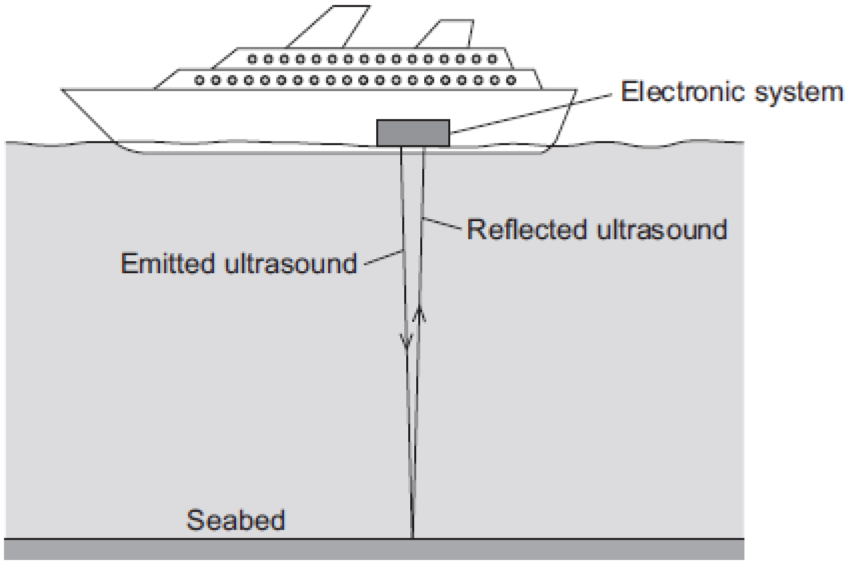
....

....

(1)

(b) **Figure 1** shows how ultrasound is used to measure the depth of water below a ship.

Figure 1



A pulse of ultrasound is sent out from an electronic system on-board the ship.

It takes 0.80 seconds for the emitted ultrasound to be received back at the ship.

Calculate the depth of the water.

Speed of ultrasound in water = 1600 m / s

....

....

....

....

Depth of water = ... metres

(3)

(c) Ultrasound can be used in medicine for scanning.

State **one** medical use of ultrasound scanning.

....

(1)

(d) Images of the inside of the human body can be made using a Computerised Tomography (CT) scanner. The CT scanner in **Figure 2** uses X-rays to produce these images.

Figure 2

monkeybusinessimages/iStock/Thinkstock

State **one** advantage and **one** disadvantage of using a CT scanner, compared with ultrasound scanning, for forming images of the inside of the human body.

Advantage of CT scanning ....

....

....

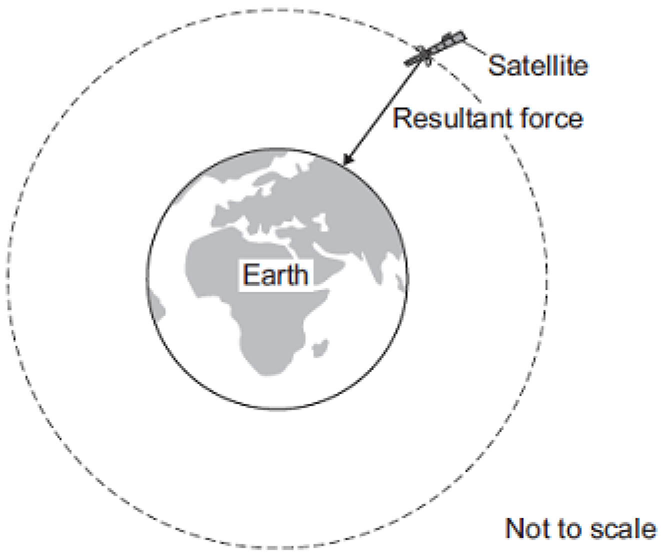
Disadvantage of CT scanning ....

....

....

(2)
(Total 7 marks)

30 Man-made satellites can orbit the Earth, as shown in the figure below.



The satellite experiences a resultant force directed towards the centre of the orbit.

The resultant force is called the centripetal force

(a) What provides the centripetal force on the satellite?

....

(1)

(b) State **two** factors that determine the size of the centripetal force on the satellite.

1 ....

2 ....

(2)

(c) The table below gives data for five different satellites orbiting the Earth.

Satellite	Average height above Earth's surface in kilometres	Time taken to orbit Earth once in minutes	Mass of satellite in kilograms
A	370	93	419 000
B	697	99	280
C	827	103	630
D	5 900	228	400
E	35 800	1440	2 030

(i) State the relationship, if any, between the height of the satellite above the Earth's surface and the time taken for the satellite to orbit the Earth once.

....

....

(1)

(ii) State the relationship, if any, between the time taken for the satellite to orbit the Earth once and the satellite's mass.

....

....

(1)

(d) Over 300 years ago, the famous scientist Isaac Newton proposed, with a 'thought experiment', the idea of satellites.

Newton suggested that if an object was fired at the right speed from the top of a high mountain, it would circle the Earth.

Why did many people accept Isaac Newton's idea as being possible?

Tick (✓) **one** box.

Isaac Newton was a respected scientist who had made new discoveries before. ☐

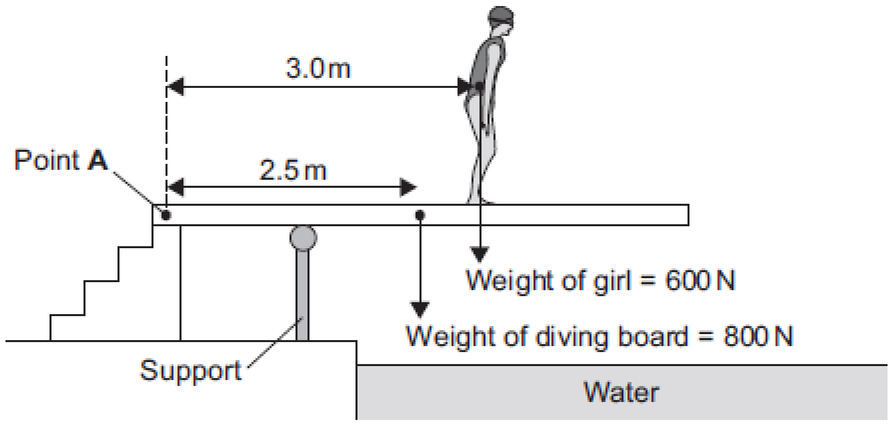
Isaac Newton went to university. ☐

It was a new idea that nobody else had thought of before. ☐

(1)
(Total 6 marks)

31 (a) **Figure 1** shows a girl standing on a diving board.

Figure 1



Calculate the total clockwise moment of the weight of the diving board and the weight of the girl about Point **A**. Give the unit.

....

....

....

....

....

....

....

Total clockwise moment about Point **A** = ...

(4)

(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

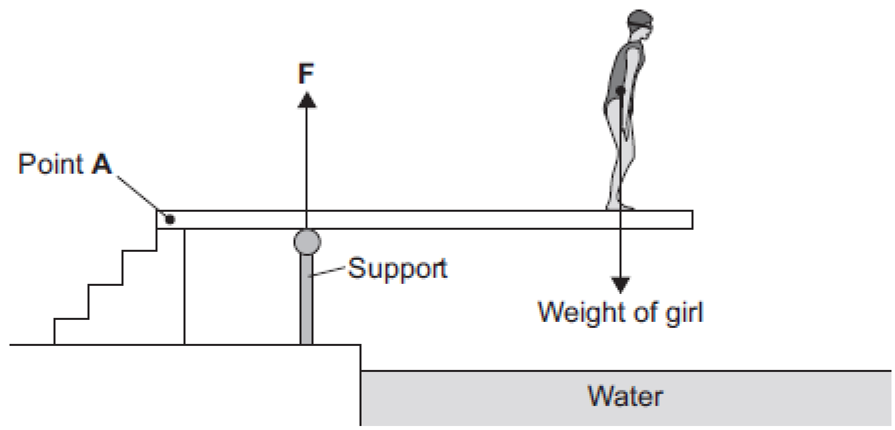
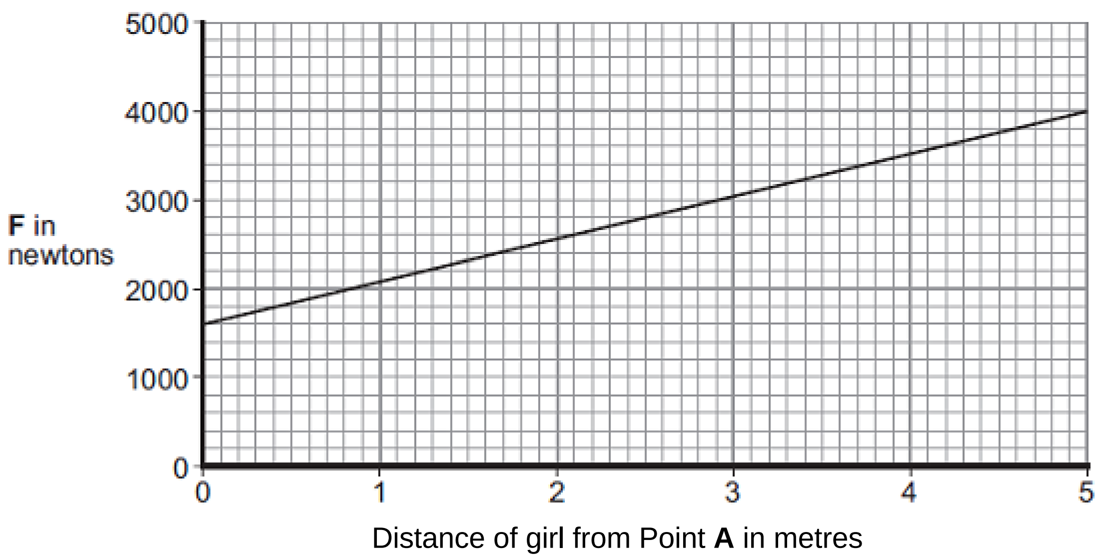


Figure 3 shows how the upward force **F** varies with the distance of the girl from Point **A**.

Figure 3



Explain, in terms of clockwise and anticlockwise moments, why the upward force **F** increases as shown in **Figure 3**.

....

....

....

....

....

....

....

....

(3)
(Total 7 marks)

32 (a) Human ears can detect a range of sound frequencies.

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

2	**20**	**200**	**2000**	**20 000**

The range of human hearing is from about .... Hz to .... Hz.

(2)

(ii) What is ultrasound?

....

....

(1)

(iii) Ultrasound can be used to find the speed of blood flow in an artery.

State **one** other medical use of ultrasound.

....

(1)

(b) The speed of an ultrasound wave in soft tissue in the human body is 1.5×10^3 m / s and the frequency of the wave is 2.0×10^6 Hz.

Calculate the wavelength of the ultrasound wave.

....

....

Wavelength = ... m

(2)

(c) When ultrasound is used to find the speed of blood flow in an artery:

- an ultrasound transducer is placed on a person's arm
- ultrasound is emitted by the transducer
- the ultrasound is reflected from blood cells moving **away** from the transducer
- the reflected ultrasound is detected at the transducer.

Describe the differences between the ultrasound waves emitted by the transducer and the reflected waves detected at the transducer.

....

....

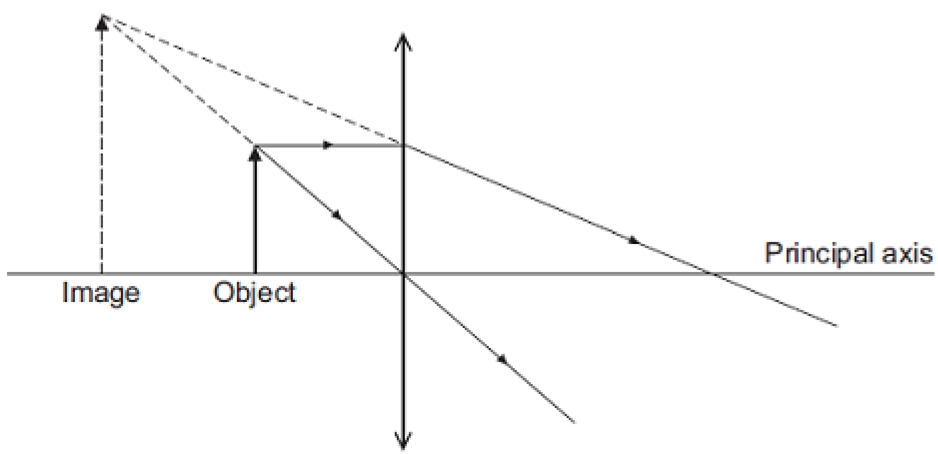
....

....

(2)
(Total 8 marks)

33 (a) The diagram shows how a convex lens forms an image of an object.

This diagram is **not** drawn to scale.



(i) Which **two** words describe the image?

Draw a ring around each correct answer.

diminished **inverted** **magnified** **real** **upright**

(2)

(ii) The object is 4 cm from the lens. The lens has a focal length of 12 cm.

Calculate the image distance.

....

....

....

Image distance = ... cm

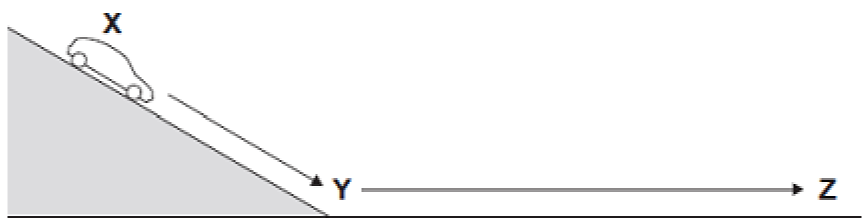
(3)

(b) What does a minus sign for an image distance tell us about the nature of the image?

....

(1)
(Total 6 marks)

34 (a) The diagram shows a car at position **X**.



The handbrake is released and the car rolls down the slope to **Y**.
The car continues to roll along a horizontal surface before stopping at **Z**.
The brakes have **not** been used during this time.

(i) What type of energy does the car have at **X**?

....

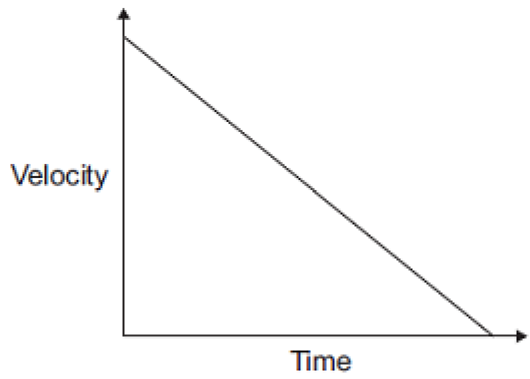
(1)

(ii) What type of energy does the car have at **Y**?

....

(1)

(b) The graph shows how the velocity of the car changes with time between **Y** and **Z**.



(i) Which feature of the graph represents the negative acceleration between **Y** and **Z**?

....

(1)

(ii) Which feature of the graph represents the distance travelled between **Y** and **Z**?

....

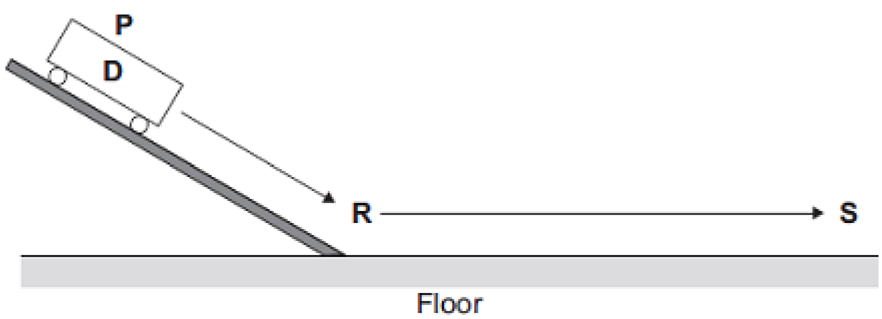
(1)

(iii) The car starts again at position **X** and rolls down the slope as before.
This time the brakes are applied lightly at **Y** until the car stops.

Draw on the graph another straight line to show the motion of the car between **Y** and **Z**.

(2)

(c) Three students carry out an investigation. The students put trolley **D** at position **P** on a slope. They release the trolley. The trolley rolls down the slope and along the floor as shown in the diagram.



The students measure the distance from **R** at the bottom of the slope to **S** where the trolley stops. They also measure the time taken for the trolley to travel the distance **RS**.
They repeat the investigation with another trolley, **E**.

Their results are shown in the table.

Trolley	Distance RS in centimetres	Time taken in seconds	Average velocity in centimetres per second
D	65	2.1	
E	80	2.6	

(i) Calculate the average velocity, in centimetres per second, between **R** and **S** for trolleys **D** and **E**. Write your answers in the table.

....

....

....

(3)

(ii) Before the investigation, each student made a prediction.

- Student **1** predicted that the two trolleys would travel the same distance.
- Student **2** predicted that the average velocity of the two trolleys would be the same.
- Student **3** predicted that the negative acceleration of the two trolleys would be the same.

Is each prediction correct?

Justify your answers.

....

....

....

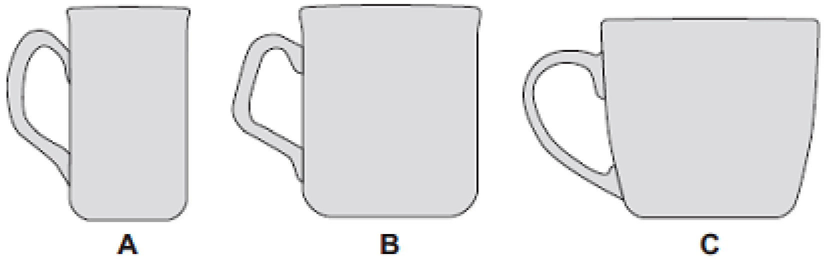
....

....

....

(3)
(Total 12 marks)

35 The diagram shows three cups **A**, **B** and **C**.



Energy is transferred from hot water in the cups to the surroundings.

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

condensation	**conduction**	**convection**

Energy is transferred through the walls of the cup by ....

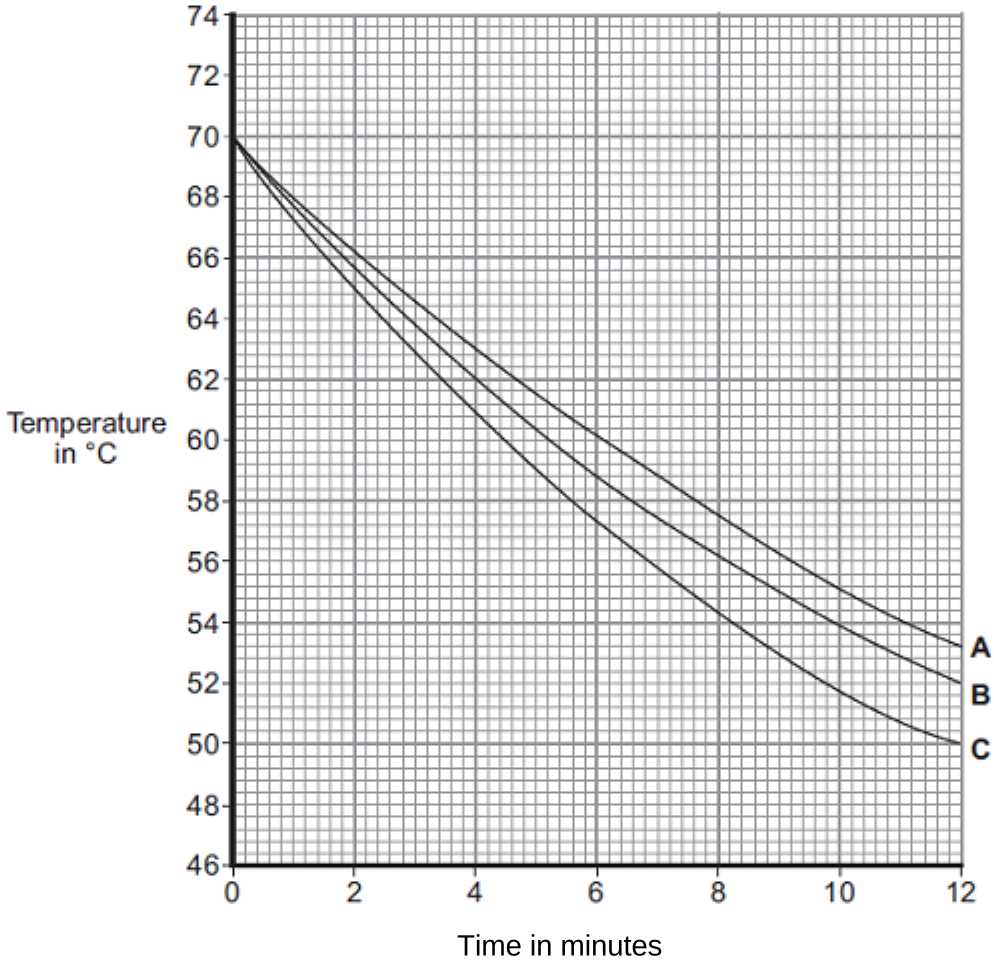
In the air around the cup, energy is transferred by ....

(2)

(b) Some students investigated how the rate of cooling of water in a cup depends on the surface area of the water in contact with the air.

They used cups **A**, **B** and **C**. They poured the same volume of hot water into each cup and recorded the temperature of the water at regular time intervals.

The results are shown on the graph.



(i) What was the starting temperature of the water for each cup?

Starting temperature = ... °C

(1)

(ii) Calculate the temperature fall of the water in cup **B** in the first 9 minutes.

....

Temperature fall = ... °C

(2)

(iii) Which cup, **A**, **B** or **C**, has the greatest rate of cooling?

Using the graph, give a reason for your answer.

....

.... **(2)**

(iv) The investigation was repeated using the bowl shown in the diagram.

The same starting temperature and volume of water were used.

Draw on the graph in part **(b)** another line to show the expected result. **(1)**

(v) After 4 hours, the temperature of the water in each of the cups and the bowl was 20°C.

Suggest why the temperature does **not** fall below 20°C.

.... **(1)**

(c) (i) The mass of water in each cup is 200 g.

Calculate the energy, in joules, transferred from the water in a cup when the temperature of the water falls by 8°C.

Specific heat capacity of water = 4200 J / kg°C.

....

....

....

Energy transferred = ... J **(3)**

(ii) Explain, in terms of particles, how evaporation causes the cooling of water.

....

....

....

....

....

....

....

....

(4)
(Total 16 marks)

36 Electrical circuits have resistance.

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

When the resistance of a circuit increases, the current in the circuit	decreases. increases. stays the same.

(1)

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

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

An electrical component which has a resistance that increases as the

temperature increases is ....

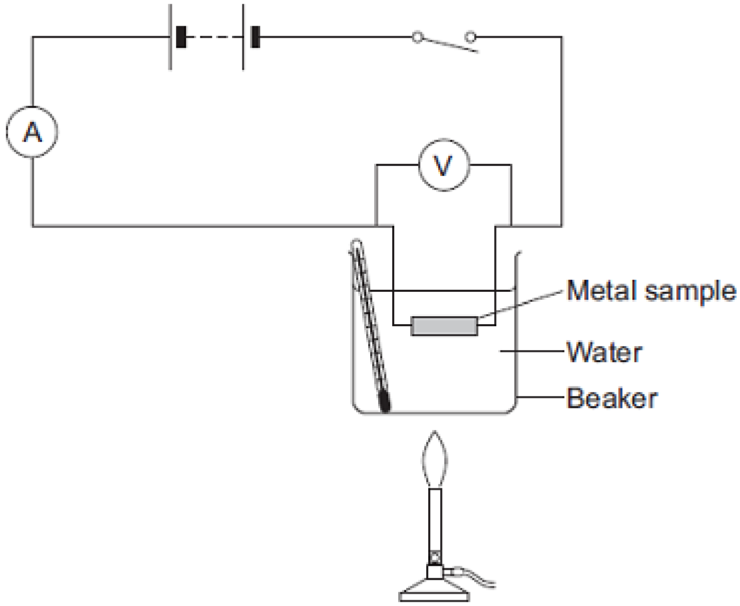
An electrical component which emits light only when a current flows through it

in the forward direction is ....

(2)

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

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



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

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

Include in your answer:

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

....

....

....

....

....

....

....

....

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....

....

....

....

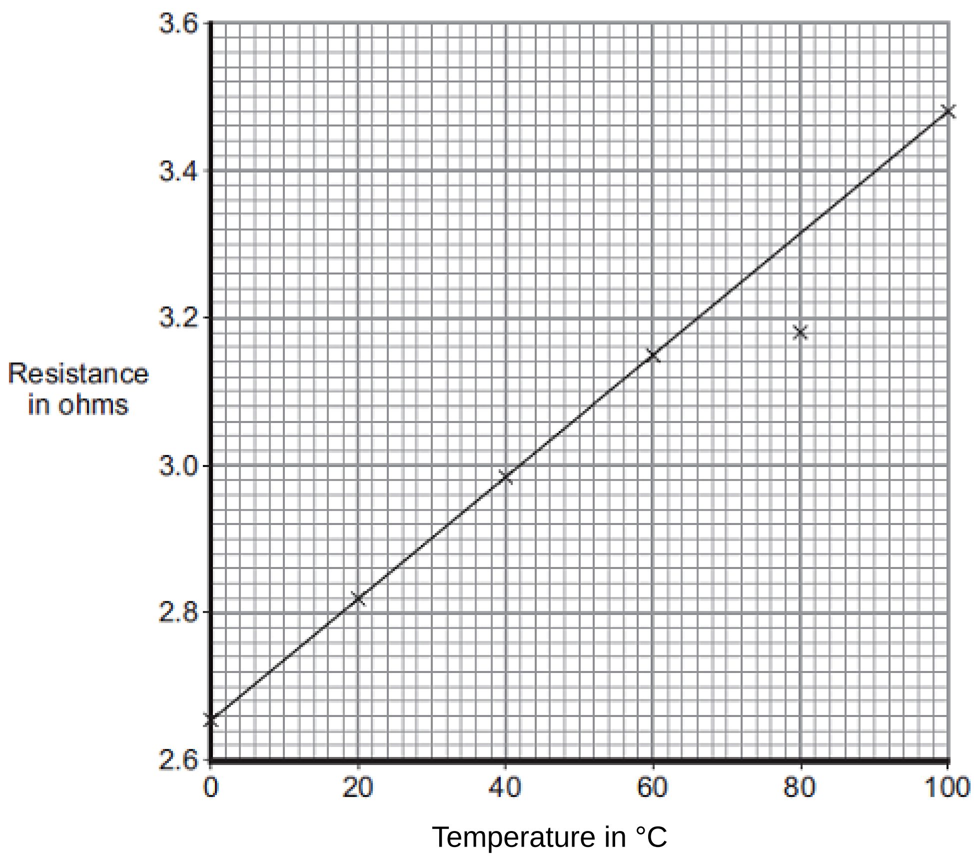
(6)

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

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

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

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



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

(1)

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

(1)

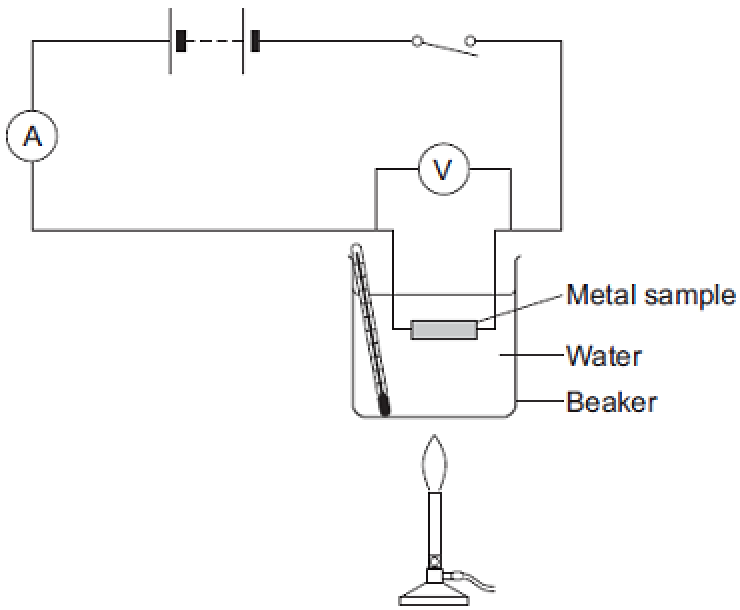
(iii) Suggest a reason for the anomalous result.

....

....

(1)

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



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

1 ....

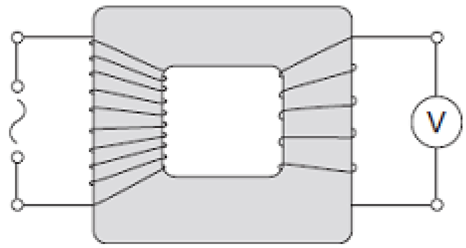
....

2 ....

....

(2)
(Total 14 marks)

37 The diagram shows a transformer with a 50 Hz (a.c.) supply connected to 10 turns of insulated wire wrapped around one side of the iron core.
A voltmeter is connected to 5 turns wrapped around the other side of the iron core.



(a) What type of transformer is shown in the diagram?

Draw a ring around the correct answer.

step-down **step-up** **switch mode**

(1)

(b) The table shows values for the potential difference (p.d.) of the supply and the voltmeter reading.

p.d. of the supply in volts	**Voltmeter reading in volts**
6.4	3.2
3.2	
	6.4

(i) Complete the table.

(2)

(ii) Transformers are used as part of the National Grid.

How are the values of p.d. in the table different to the values produced by the National Grid?

....

....

(1)

(c) Transformers will work with an alternating current (a.c.) supply but will **not** work with a direct current (d.c.) supply.

(i) Describe the difference between a.c. and d.c.

....

....

....

....

(2)

(ii) Explain how a transformer works.

....

....

....

....

....

....

....

....

(4)
(Total 10 marks)

Mark schemes

1 (a) power output increases (to meet demand) due to people returning home from work / school

accept many electrical appliances are switched on (which increases demand)

1

accept other sensible suggestions

(b) 00.00

accept midnight

1

allow answers between 00.00 and 04.00

(c) any **two** from:

- conserves fuel reserves
- spare capacity to compensate for unreliable renewable resources
- provides spare capacity in case of power station emergency shut-down
- so as to not make unnecessary environmental impact

2

[4]

2 (a) 0.1 (°C)

1

(b) power = energy transferred / time

allow P = E / t

1

allow E = P × t

(c) 1050 / 300

1

3.5 (W)

1

accept 3.5 (W) with no working shown for ***2*** *marks*

(d) 1050 = m × 4200 × 0.6

1

m = 1050 / (4200 × 0.6)

1

m = 0.417 (kg)

1

*accept 0.417 (kg) with no working shown for **3** marks*

(e) any **one** from:

- energy used to heat metal pan (as well as the water)
- energy transfer to the surroundings (through the insulation)
- angle of solar radiation will have changed during investigation
- intensity of solar radiation may have varied during investigation

1

[8]

3 (a) weight (lifted)

or

height (lifted)

1

(b) any **two** from:

- calculate a mean
- spot anomalies
- reduce the effect of random errors

2

(c) as speed increases, the efficiency increases

1

(but) graph tends towards a constant value

or

appears to reach a limit

accept efficiency cannot be greater than 100%

1

(d) heating the surroundings

1

(e) 0 (%)

1

[7]

4 (a) magnification = $\frac{\text{image height}}{\text{object height}}$

1

dividing by an object height of 1 cm gives the same (numerical) value

1

(b) accept anything practical that would work eg:

use a taller object

use a (travelling) microscope

attach a scale to the screen and use a magnifying glass

1

(c) both points plotted correctly

1

correct line of best fit drawn

a curve passing through all points (within ½ square), judge by eye

1

(d) values of 1.4 and 0.6 extracted from the graph

1

2.33 times bigger

accept any number between 2.3 and 2.5 inclusive

1

(e) by dividing the distance between the lens and the image by the distance between the lens and the object

1

at least one correct calculation and comparison eg 100÷25 = 4 which is the same as the measured magnification

1

[9]

5 (a) frequency

1

(b) echo(es)

1

(c) 340 (m/s)

*allow **1** mark for correct substitution ie 25 000 × 0.0136 provided no subsequent step*

or

*allow **1** mark for a correct calculation showing an incorrect value from conversion to hertz × 0.0136*

*an answer of 0.34 gains **1** mark*

2

(d) (a wave where the) oscillations are parallel to the direction of energy transfer

both marking points may appear as labels on a diagram

accept vibrations for oscillations
accept in same direction as for parallel to
allow direction of wave (motion) for direction of energy transfer

*allow **1** mark for a correct calculation showing an incorrect value from conversion to hertz × 0.0136*

1

causing (areas of) compression and rarefaction

accept correct description in terms of particles

mechanical wave is insufficient
needs a medium to travel through is insufficient

1

[6]

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

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

allow not enough (surplus) electricity would be generated

1

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

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

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

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

Level 0 (0 marks):
No relevant information

examples of physics points made in the response

Advantages of both methods:

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

accept carbon neutral

accept no greenhouse gases

accept doesn't contribute to global warming

Advantages of wind:

- higher average power output

produces more energy is insufficient

Advantages of hydroelectric:

- constant / reliable power (output)
- lower (installation) cost

Disadvantages of wind:

- higher (installation) cost
- variable / unreliable power output
- (may) kill birds / bats

Disadvantages of hydroelectric:

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

Disadvantages of both methods:

- (may be) noisy
- visual pollution

ignore payback time unless no other relevant points made

ignore time to build for both

6

[7]

7 (a) 78 (°C)

*allow **2** marks for correct temperature change ie 22 °C*

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

ie 46 200 = 0.5 × 4200 x θ

or

$$\frac{46200}{0.5 \times 4200} = \theta$$

3

(b) 6.4 (W)

*allow **2** marks for an answer that rounds to 6.4*

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

ie 46 200 = P × 7200

an answer of 23 000 or 23 100 or 385 gains 1 mark

2

[5]

8 (a) (i) 0.15 × 0.08 = 0.012

1

(ii) kg m/s

1

(iii) equal to

1

(b) momentum of the air increases
or
force backwards increases

accept air moves faster

accept momentum backwards increases

accept pushes more air back(wards)

1

so momentum of the toy must increase
or
the force forwards (on the toy) increases

accept momentum forwards must increase

it = toy

1

[5]

9 (a) starting / stopping the stopwatch

human error is insufficient

reaction time is insufficient

or
timing over the smaller distances

accept not timing accurately

do not accept references to measuring distance incorrectly

1

(b) (i) before

1

(ii) increasing

accept accelerating

it is not constant is insufficient

it is less than after four seconds is insufficient

it reaches a constant speed negates

1

(iii) calculate the gradient of the straight/steepest/constant section

accept gradient of any section after 5.5 seconds/30 cm

1

(iv) drag (force) increases (as the ball bearing gets faster)

accept frictional/upward force for drag

1

(until) drag (force) = weight
or
(until) resultant force is zero

accept upward force = downward force

accept till forces are balanced

1

(c) less than

1

ball bearing increases speed at a greater rate

accept it travels the same distance in less time

or
ball bearing has a greater acceleration

accept the ball bearing is going faster

or
terminal velocity has not been reached

1

so resultant force must be greater
or
as weight is the same (the drag must be less)

accept warmer oil has a lower density/viscosity for 1 mark if neither of the two reason marks score

1

[9]

10 (a) ultrasound is not ionising

allow ultrasound does not harm the (unborn) baby

1

but X-rays are ionising

1

so X-rays increase the health risk to the (unborn) baby

accept specific examples of health risks, eg cancer, stunted growth, impaired brain function etc

X-rays are dangerous is insufficient

1

(b) ultrasound/waves are partially <u>reflected</u>

(when they meet a boundary) (between two different media / substances / tissues)

must be clear that not all of the wave is reflected

1

the time taken is measured (and is used to determine distances)

1

(c) 1600 (m/s)

*800 (m/s) gains **2** marks*

*160 000 (m/s) gains **2** marks*

*0.0016 (m/s) gains **2** marks*

*allow **2** marks for*

$$\frac{0.04}{25 \times 10^{-6}}$$

or

$$\frac{0.08}{50 \times 10^{-6}}$$

*80 000 (m/s) gains **1** mark*

*0.0008 (m/s) gains **1** mark*

*allow **1** mark for*

$$\frac{0.04}{25}$$

or

$$\frac{0.08}{50}$$

*allow **1** mark for evidence of doubling the distance or halving the time*

3

(d) (i) they are absorbed by bone

allow stopped for absorbed

X-rays are reflected negates this mark

1

they are transmitted by soft tissue

allow pass through for transmitted

allow flesh / muscle / fat

accept less (optically) dense material for soft tissue

1

(the transmitted) X-rays are detected

1

(ii) short

accept small

1

[12]

11 (a) (i) turning effect

accept force multiplied by perpendicular distance from the line of action of the force to the pivot

1

(ii) moments are equal (in size) and opposite (in direction)

both parts are required

allow clockwise moment = anticlockwise moment

1

(iii) 0.9 (N)

*allow **2** marks for F = 0.18 ÷ 0.2 provided no subsequent steps*

*allow **1** mark for (anticlockwise moment) = 0.18 (Nm)*

*allow **1** mark for correct substitution i.e. 1.5 × 0.12 = F × 0.20*

3

(b) a longer drumstick lever gives a quieter sound
a longer drumstick lever allows
a greater range of volumes

a greater force gives a louder sound is insufficient

1

[7]

12 (a) B

must be in correct order

1

A

1

D

1

(b) (i) mass increases as refractive index increases

accept weight / density increases as refractive index increases

1

(ii) thinner

accept thin

1

heavier

accept heavy

1

(iii) maximum one advantage and one disadvantage of each design

water-filled

advantages:

- lenses are light
- wide range of focal length
- allows fine adjustment
- allows lenses to be altered independently.

1

disadvantages:

- unattractive
- lens might burst
- lens might leak
- uncomfortable.

1

sliding lenses

advantages:

- hard-wearing
- look like conventional glasses
- easy to adjust
- allows lenses to be altered independently.

1

disadvantages:

- heavy
- might slide out of position
- might get dirt between the lenses.

1

(c) any two from:

the image is

- blurred
- coloured
- inverted
- diminished.

accept not focussed

1

1

[12]

13 (a) rate of flow of water less

1

because pressure is less
or
because force acting is less
or
because height of water above tap is less

1

(b) (i) at short lengths water collected is the same

accept rate of flow for water collected

1

at longer lengths water collected decreases as the length of pipe increases

*if no other mark gained allow as the length increases the flow decreases for **1** mark*

1

(ii) **max 4 marks**

take more readings to calculate a mean (1)

take more readings is insufficient

to reduce effect of random errors (1)
or
take more readings between 5.0 m and 10.0 m (1)
see where the change occurs (1)
or
take more readings above 15.0 m (1)

accept take more readings at longer lengths

to see if trend continues (1)

*maximum of **2** marks for more readings and max **2** for reasons*

4

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

0 marks
No relevant content

Level 1 (1−2 marks)
There is a basic description of the measurement of time **or** volume **or** diameter of pipe

Level 2 (3−4 marks)
There is a description of the measurement of the time taken to collect a fixed volume
or the volume collected in a fixed time
and a description of an additional control variable

Level 3 (5−6 marks)
There is a description of the measurement of the time taken to collect a fixed volume
or the volume collected in a fixed time
and a description of an additional control variable
and a description of appropriate equipment

examples of the points made in the response
equipment

- tape measure or rule
- stopwatch
- container for collecting water
- measuring cylinder.

measurements

- diameter of hosepipe
- length of hosepipe
- volume of water collected
- time taken for collecting water
- repeat for different diameters.

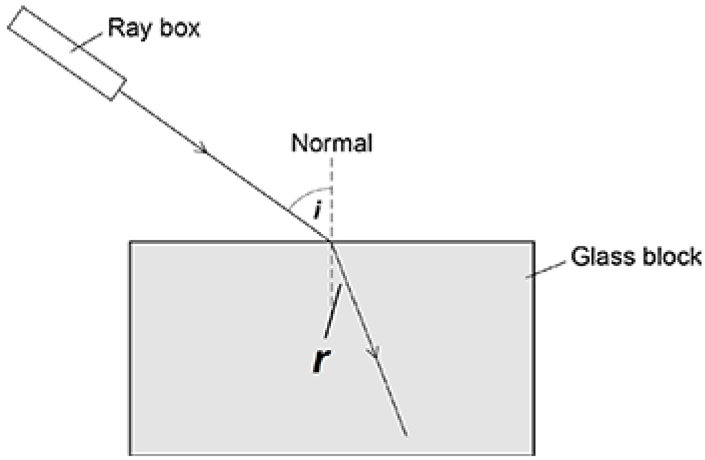
control factors

- height of water in water butt (achieved by using a tap)
- length of hosepipe and how it is achieved by measuring and cutting.

6

[14]

14 (a) (i)



1

(ii) 1 degree

1

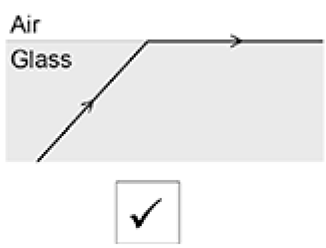
(iii) 1.6

*allow **1** mark for correct substitution, ie 0.80 / 0.5 provided no subsequent step shown*

working showing 1.59(9…..) scores zero

2

(b) 2nd diagram ticked



1

(c) (i) any **one** correct description:

- upright
- virtual
- diminished.

treat multiple words as a list

1

(ii) 0.25

*allow **1** mark for correct substitution, ie 1 / 4 or 5 / 20 provided no subsequent step shown*

ignore any unit

2

(iii) Correcting short sight

1

[9]

15 (a) induced

1

(b) any **two** from:

- use the same (strength) magnet

  same size magnet is insufficient
- the speed that the magnet is moved

  accept movement of the magnet
- the area of the turns

  same type / length of wire is insufficient
- the magnetic pole being moved towards the coil (of wire).

  use the same voltmeter is insufficient

2

(c) (i) voltmeter misread

or

number of turns miscounted

result misread is insufficient

human error is insufficient

allow the magnet was moved at a (slightly) different speed (into the coil) than for the other readings

allow spacing between the turns had changed

1

(ii) line of best fit passing through all points except (100, 0.034)

line does not need to go back to origin

1

(d) any **one** from:

- can re-check data / readings.

  accept can go back to data
- can take more readings (in a given time)

  can store data is insufficient
- easier to identify maximum value.

  automatically records data is insufficient

  accept is more accurate

  accept eliminates human error

1

[6]

16 (a) 1.25

*accept 1.3 for **2** marks*

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

ie $\frac{1}{0.8}$

provided no subsequent step shown

2

(b) (i) increasing the length (of the pendulum) decreases the number of oscillations / swings made (in 20 seconds)

accept increasing the length (of the pendulum) increases the time (of 1 oscillation / swing)

accept increasing the length (of the pendulum) decreases the speed / frequency (of 1 oscillation / swing)

answers must refer to the effect of increasing / decreasing length

ignore references to time being proportional to length

1

changing the mass (of the pendulum bob) does not change the number of oscillations / swings made (in 20 seconds)

accept changing the mass does not change the time / speed / frequency / results

accept weight for mass

1

(ii) any **two** suitable improvements:

- measure (the number of swings) over a wider range of (pendulum) lengths
- measure (the number of swings) over a wider range of (bob) masses
- measure the number of swings made over a greater period of time
- repeat each measurement & calculate mean / average (number of oscillations in 20 seconds)

  accept repeat measurements & discard anomalous measurements

  repeat measurements is insufficient
- measure (the total number of swings &) the fraction of swings made
- start the swings at the same height.

use a computer / datalogger to make measurement (of number of oscillations) is insufficient

measuring time period is insufficient

using a stop clock with greater resolution is insufficient

2

[6]

17 (a) (i) 150

1

(ii) transferred to the surroundings by heating

reference to sound negates mark

1

(iii) 0.75

*450 / 600 gains **1** mark*

*accept 75% for **2** marks*

*maximum of **1** mark awarded if a unit is given*

2

(iv) 20 (s)

*correct answer with or without working gains **2** marks*

*correct substitution of 600 / 30 gains **1** mark*

2

(b) (i) to avoid bias

1

(ii) use less power and last longer

1

1 LED costs £16, 40 filament bulbs cost £80

or

filament costs (5 times) more in energy consumption

1

(iii) any **one** from:

- availability of bulbs
- colour output
- temperature of bulb surface

1

[10]

18 (a) **solid**

<u>particles</u> vibrate about fixed positions

1

closely packed

accept regular

1

gas

<u>particles</u> move randomly

accept particles move faster

accept freely for randomly

1

far apart

1

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

1

unit mass / 1 kg

dependent on first marking point

1

(c) 41000 **or** 4.1×10^4 (J)

accept

41400 or 4.14×10^4

correct substitution of

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

2

(d) **AB**
changing state from solid to liquid / melting

1

at steady temperature

*dependent on first **AB** mark*

1

BC
temperature of liquid rises

1

until it reaches boiling point

*dependent on first **BC** mark*

1

[12]

19 (a) increases

1

increases

1

(b) 23 (m)

*accept 43 circled for **1** mark*

*accept 9 + 14 for **1** mark*

2

(c) (i) all points correctly plotted

all to ± ½ small square

*one error = **1** mark*

*two or more errors = **0** marks*

2

line of best fit

1

(ii) correct value from their graph (± ½ small square)

1

(d) (i) 70

*½ × 35 × 4 gains **2** marks*

*attempt to estimate area under the graph for **1** mark*

3

(ii) line from (0.6,35)

1

sloping downwards with a less steep line than the first line

1

cutting time axis at time > 4.6 s

accept cutting x-axis at 6

1

(e) (i) 42 000

*1200 × 35 gains **1** mark*

2

kgm / s

Ns

1

(ii) 10 500 (N)

*42 000 / 4 gains **1** mark*

alternatively:

$a = 35 / 4 = 8.75$ m / s^2

$F = 1200 \times 8.75$

2

[19]

20 (a) wavelength correctly shown

1

(b) (i) increased

1

decreased

1

(ii) 17-18 inclusive

1

evidence of measurement divided by 3 or mean of 3 separate measurements

1

mm

accept cm if consistent with answer

1

(c) (i) red shift

1

(ii) moving away

1

(iii) the furthest galaxies show the biggest red shift

1

(meaning that) the furthest galaxies are moving fastest

1

(so the) Universe is expanding

1

(extrapolating backwards this suggests that) the Universe started from an initial point

1

(iv) cosmic microwave background radiation

allow CMBR

1

[13]

21 (a) (i) infrared / *IR*

1

(ii) *UV / X-rays / gamma rays*

1

appropriate use corresponding with given wave:

dependent on first marking point

- UV: security marking ***or*** *tanning*
- X-rays: medical imaging ***or*** *checking baggage*
- gamma rays: sterilising surgical instruments ***or*** killing harmful bacteria in food

accept any sensible alternative uses

1

(b) D

1

gap must be comparable to wavelength

accept converse

1

can create gap of that size in classroom

dependent on first marking point

1

(c) (i) Q

1

(ii) sound waves reflected

accept 'it' for sound waves

ignore bounce

1

at EF

1

angle of incidence equal to angle of reflection

1

(iii) stop sound going direct from clock to ear

1

(iv) 22 (m)

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

*330 = 15 × λ scores **1** mark*

2

(v) outside audible range

1

[14]

22 (a) (average) time taken for the amount / number of nuclei / atoms (of the isotope in a sample) to halve

or

time taken for the count rate (from a sample containing the isotope) to fall to half

accept (radio)activity for count rate

1

(b) *60* ±*3* (days)

1

indication on graph how value was obtained

1

(c) (i) cobalt(-60)

1

gamma not deflected by a magnetic field

or

gamma have no charge

dependent on first marking point

accept (only) emits gamma

gamma has no mass is insufficient

*do **not** accept any reference to half-life*

1

(ii) strontium(-90)

1

any **two** from:

- *only* has beta
- alpha would be absorbed
- gamma unaffected
- *beta penetration / absorption depends on thickness of paper*

*if thorium(-232) or radium(-226) given, max **2** marks can be awarded*

2

(iii) cobalt(-60)

1

shortest half-life

accept half-life is 5 years

dependent on first marking point

1

so activity / count rate will decrease quickest

1

(iv) *americium(-241) / cobalt(-60) / radium(-226)*

1

gamma emitter

1

(only gamma) can penetrate lead *(of this box)*

do not allow lead fully absorbs gamma

1

[14]

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

1

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

melt is insufficient

1

unit mass / 1kg

1

(ii) 5.1×10^6 (J)

accept 5×10^6

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

2

(c) (i) mass of <u>*ice*</u>

allow volume / weight / amount / quantity of <u>ice</u>

1

(ii) to distribute the salt throughout the ice

1

to keep all the ice at the same temperature

1

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

allow concentration for mass

accept negative correlation

do ***not*** *accept inversely proportional*

1

(d) 60 000 (J)

accept 60 KJ

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

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

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

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

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

3

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

0 marks
No relevant content

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

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

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

examples of the points made in the response

extra information

energy storage

advantages:

- no fuel costs
- no environmental effects

disadvantages:

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

salt spreading

advantages:

- easily available
- cheap

disadvantages:

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

undersoil heating

advantages:

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

disadvantages:

- costly
- bad for environment

6

[18]

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

- length of coils increased
- coils have tilted
- length of loop(s) increased
- increased gap between coils
- *spring has stretched / got longer*
- *spring has got thinner*

2

(ii) remove mass

accept remove force / weight

1

observe if the spring returns to its original length / shape *(then* it is behaving elastically)

1

(b) (i) 8.0 (cm)

1

extension is directly proportional to force *(up to 4 N)*

for every 1.0 N extension increases by 4.0 cm (up to 4 N)

evidence of processing figures eg 8.0 *cm* is half way between 4.0 *cm* and 12.0 *cm*

1

allow spring constant (k) goes from to $\frac{1}{4}$ to $\frac{5}{22}$

1

(ii) any value greater than 4.0 N and less than or equal to 5.0 N

1

the increase in extension is greater than 4 cm per 1.0 N (of force) added

dependent on first mark

1

(c) (i) elastic potential energy

1

(ii) misread stopwatch

1

timed too many complete oscillations

1

(iii) 4.3 (s)

accept 4.33 (s)

1

(iv) stopwatch reads to 0.01 s

1

reaction time is about 0.2 s
or
reaction time is less precise than stopwatch

1

(v) use more masses

1

smaller masses eg 50 g

not exceeding limit of proportionality

1

[17]

25 (a) advantage

any **one** from:

- produce no / little greenhouse gases / carbon dioxide
  allow produces no / little polluting gases
  allow doesn't contribute to global warming / climate change
  allow produce no acid rain / sulphur dioxide
  reference to atmospheric pollution is insufficient
  produce no harmful gases is insufficient
- high(er) energy density in fuel
  accept one nuclear power station produces as much power as several gas power stations
  nuclear power stations can supply a lot of or more energy is insufficient
- long(er) operating life
  allow saves using reserves of fossil fuels or gas

1

disadvantage

any **one** from:

- produce (long term) radioactive waste
  accept waste is toxic
  accept nuclear for radioactive
- accidents at nuclear power stations may have far reaching or long term consequences
- high(er) decommissioning costs
  accept high(er) building costs
- long(er) start up time

1

(b) (i) 12 000 (kWh)

*allow **1** mark for correct substitution eg*

2000 × 6

or

2 000 000 × 6

or

$$\frac{12\,000\,000}{1000}$$

*an answer of 12 000 000 scores **1** mark*

2

(ii) any idea of unreliability, eg

- wind is unreliable

  reference to weather alone is insufficient
- shut down if wind too strong / weak
- wind is variable

1

(c) any **one** from:

- cannot be seen
- no hazard to (low flying) aircraft / helicopters
- unlikely to be or not damaged / affected by (severe) weather

  unlikely to be damaged is insufficient
- (normally) no / reduced shock hazard

  safer is insufficient

  less maintenance is insufficient

  installed in urban areas is insufficient

1

[6]

26 (a) (i) 440 (sound) waves produced in one second

accept vibrations / oscillations for waves

1

(ii) 0.773 (metres)

*allow **2** marks for an answer that rounds to 0.773*

*allow **2** marks for an answer of* $0.\dot{7}\dot{2}$

*allow **2** marks for an answer of 0.772*

*allow **1** mark for correct substitution ie 340 = 440 × λ*

3

(b) (sound is) louder

*do **not** accept the converse*

1

as amplitude is larger

waves are taller is insufficient

1

higher pitch / frequency

1

as more waves are seen

reference to wavelengths alone is insufficient

waves are closer together is insufficient

1

[8]

27 (a) 450

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

ie 18 × 10 × 2.5 provided no subsequent step shown

2

(b) (i) friction between child ('s clothing) and slide

accept friction between two insulators

accept child rubs against the slide

accept when two insulators rub (together)

1

causes electron / charge transfer (between child and slide)

accept specific reference, eg electrons move onto / off the child / slide

reference to positive electrons / protons / positive charge / atoms transfer negates this mark

answers in terms of the slide being initially charged score zero

1

(ii) all the charges (on the hair) are the same (polarity)

accept (all) the charge/hair is negative / positive

accept it is positive/negative

1

charges / hairs are repelling

both parts should be marked together

1

(iii) charge would pass through the metal (to earth)

accept metal is a conductor

accept metal is not an insulator

accept there is no charge / electron transfer

accept the slide is earthed

accept metals contain free electrons

1

[7]

28 (a) (i) friction

1

(ii) air resistance

accept drag

friction is insufficient

1

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

0 marks
No relevant content.

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

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

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

examples of the points made in the response

extra information

X to Y

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

Y to Z

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

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

accept speed for velocity throughout

6

(b) (i) 3360

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

ie 140 × 24 provided no subsequent step

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

2

joule / J

*do **not** accept j*

*do **not** accept Nm*

1

(ii) decreases

accept an alternative word / description for decrease

do not accept slows down

1

temperature

accept thermal energy

accept heat

1

[13]

29 (a) (sound waves) which have a frequency higher than the upper limit of hearing for humans
or
a (sound) wave (of frequency) above 20 000 Hz

sound waves that cannot be heard is insufficient

a wave of frequency 20 000 Hz is insufficient

1

(b) 640

*an answer of 1280 gains **2** marks*

*allow **2** marks for the correct substitution*

ie 1600 × 0.40 provided no subsequent step

*allow **2** marks for the substitution* $\frac{1600 \times 0.80}{2}$
provided no subsequent step

*allow **1** mark for the substitution 1600 × 0.80 provided no subsequent step*

*allow **1** mark for the identification that time (boat to bed) is 0.4*

3

(c) any **one** from:

- pre-natal scanning / imaging
- imaging of a named organ (that is not surrounded by bone), eg stomach, bladder, testicles

  accept heart

  *do **not** allow brain **or** lungs (either of these negates a correct answer)*
- Doppler scanning blood flow

1

(d) advantage

any **one** from:

- (images are) high quality or detailed or high resolution

  clearer / better image is sufficient
- (scan) produces a slice through the body
- image can be viewed from any direction

  allow images are (always) 3D / 360°
- an image can be made of <u>any</u> part (inside the body)

  allow whole body can be scanned
- easier to diagnose **or** see a problem (on the image)

1

disadvantage

any **one** from:

- (the X-rays used **or** scans) are <u>ionising</u>

  allow a description of what ionising is
- mutate cells **or** cause mutations **or** increase chances of mutations

  allow for cells:

  DNA / genes / chromosomes / nucleus / tissue

- turn cells cancerous **or** produce abnormal growths **or** produce rapidly growing cells
- kill cells

    damage cells is insufficient
- shielding is needed

    can be dangerous (to human health) unqualified, is insufficient

1

[7]

30 (a) gravitational attraction (between the satellite and the Earth)

allow gravity

allow weight of the satellite

1

(b) any **two** from:

- mass of satellite
- speed / velocity (of satellite)
- radius of orbit / circle

    allow height above the Earth

    radius / height alone is insufficient

2

(c) (i) increasing the height (above the Earth's surface) increases the time (for one orbit)

allow a positive correlation

allow as one gets bigger, the other gets bigger, or vice versa

ignore they are directly proportional

1

(ii) there is no relationship / correlation

1

(d) Isaac Newton was a respected scientist who had made new discoveries before

1

[6]

31 (a) 3800

*allow **1** mark for 2000*

*allow **1** mark for 1800*

*if neither of above scored, allow correct substitution for **1** mark (800 × 2.5) + (600 × 3)*

if moments have been calculated incorrectly, allow 1 mark for adding their two moment values correctly

3

newton metres **or** Nm

*do **not** allow nm **or** NM*

1

(b) as the girl increases her distance (from the pivot) the clockwise moment increases

1

(F must increase) as the anticlockwise moment must increase

1

so (the anticlockwise moment) is equalled / balanced by the clockwise moment
or
so resultant / overall moment (on the board) is zero

accept to balance / equal the moments

to balance the board is insufficient

1

[7]

32 (a) (i) 20

1

20 000

either order

accept ringed answers in box

1

(ii) (frequency) above human range

accept pitch for frequency

or

(frequency) above 20 000 (Hz)

*do **not** accept outside human range*

*allow ecf from incorrect value in **(a)(i)***

1

(iii) any **one** from:

- pre-natal scanning

  accept any other appropriate scanning use

  *do **not** accept pregnancy testing*
- removal / destruction of kidney / gall stones
- repair of damaged tissue / muscle

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

  accept physiotherapy

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

  cleaning teeth is insufficient

1

(b) 7.5×10^{-4} (m)

*$1.5 \times 10^3 = 2.0 \times 10^6 \times \lambda$ gains **1** mark*

2

(c) for reflected waves

must be clear whether referring to emitted or detected / reflected waves

if not specified assume it refers to reflected wave

any **two** from:

- frequency decreased
- wavelength increased
- intensity has decreased

  allow amplitude / energy has decreased
  allow the beam is weaker

2

[8]

33 (a) (i) magnified

1

upright

1

(ii) v = −6(cm)

*max **2** marks if no minus sign*

*6(cm) gains **2** marks*

$1/v = 1/12 - 1/4 = -1/6$
*gains **2** marks*

$1/12 = 1/4 + 1/v$
*gains **1** mark*

−5.99(cm)
*using decimals gains **3** marks*

3

(b) it is <u>virtual</u>

1

[6]

34 (a) (i) <u>gravitational potential</u> (energy)

1

(ii) <u>kinetic</u> (energy)

1

(b) (i) slope or gradient

1

(ii) <u>area</u> (under graph)

*do **not** accept region*

1

(iii) starts at same y−intercept

1

steeper slope than original and cuts time axis before original

the entire line must be below the given line

allow curve

1

(c) (i) 31

and

31

*correct answers to 2 significant figures gains **3** marks even if no working shown*

*both values to more than 2 significant figures gains **2** marks:*
30.952……
30.769….

65 / 2.1 and / or
*80 / 2.6 gains **1** mark*

*if incorrect answers given but if both are to 2 significant figures allow **1** mark*

3

(ii) student 1 incorrect because 80 ≠ 65

1

student 2 correct because average velocities similar

*ecf from **(c)(i)***

1

student 3 incorrect because times are different

1

[12]

35 (a) conduction

must be in correct order

1

convection

1

(b) (i) 70

accept ± half a square
(69.8 to 70.2)

1

(ii) 15

*accept 14.6 to 15.4 for **2** marks*

*allow for **1** mark 70 − 55*

ecf from (b)(i) ± half a square

2

(iii) C

1

biggest drop in temperature during a given time

accept it has the steepest gradient this is a dependent

1

(iv) starting at 70 °C and below graph for C
must be a curve up to at least 8 minutes

1

(v) because 20 °C is room temperature

accept same temperature as surroundings

1

(c) (i) 6720

*correct answer with or without working gains **3** marks*

*6 720 000 gains **2** marks*

*correct substitution of E = 0.2 × 4200 × 8 gains **2** marks*

*correct substitution of E = 200 × 4200 × 8 gains **1** mark*

3

(ii) the fastest particles have enough energy

accept molecules for particles

1

to escape from the surface of the water

1

therefore the mean energy of the remaining particles decreases

accept speed for energy

1

the lower the mean energy of particles the lower the temperature (of the water)

accept speed for energy

1

[16]

36 (a) decreases

1

(b) a filament bulb

allow bulb

1

an LED

1

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

0 marks
No relevant content.

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

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

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

examples of the physics points made in the response:

- read V and I
- read temperature
- apply heat

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

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

6

(d) (i) Q

1

(ii) (80, 3.18)

1

(iii) any **one** from:

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

allow misread meter

ignore any references to an error that is systematic

1

(iv) any **two** from:

- not portable

allow requires a lot of equipment allow takes time to set up

- needs an electrical supply
- cannot be read directly

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

2

[14]

37 (a) step-down

1

(b) (i) 1.6

correct order only

1

12.8

1

(ii) values of p.d. are smaller than 230 V

1

(c) (i) a.c. is constantly changing direction

accept a.c. flows in two / both directions

accept a.c. changes direction(s)

a.c. travels in different directions is insufficient

1

d.c. flows in one direction only

1

(ii) an alternating current / p.d. in the primary creates a <u>changing / alternating magnetic</u> field

1

(magnetic field) in the (iron) <u>core</u>

current in the core negates this mark

accept voltage for p.d.

1

(and so) an <u>alternating</u> p.d.

1

(p.d.) is induced across secondary coil

1

[10]

Examiner reports

5

Foundation

(a) Two fifths of students scored this mark.

(b) Less than a fifth of students scored a mark for this question. Many incorrect responses stated 'longitudinal', or another wave property like 'refraction' of 'diffraction.'

(c) Almost four fifths of students scored 1 mark for the answer of '0.34' failing to convert 25.0 kHz into Hz. If a conversion was attempted it needed to be seen before the calculation otherwise it counted as a subsequent (incorrect) step, which means they scored zero.

(d) Four fifths of students scored 0 marks for this question, most students believing that a longitudinal sound wave is a long sound wave. Most responses referred to amplitude, wavelength or frequency.

Higher

(a) Three quarters of students scored a mark for this question.

(b) Just under half the students scored a mark for this question. Many students, however, were baffled and gave an assortment of answers that ranged from wave behaviour (e.g. refraction) to wave properties (e.g. wavelength).

(c) The vast majority of students scored 1 mark for the answer of ‘0.34’. Some students incorrectly rearranged the equation and scored zero. A few students realised that the frequency needed converting, but didn’t do this correctly, but scored 1 mark for their final answer. One fifth of students scored 2 marks for the correct answer.

(d) Lots of partial descriptions of ‘waves parallel to energy transfer’, without stating what was parallel, the word oscillation (or vibration) was needed for this mark. Compressions and rarefactions was more likely to be credited. A third of students scored 1 mark, but less than a tenth of students scored 2 marks.

6

Foundation

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

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

Higher

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

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

7

(a) This question discriminated well, a third of students scored all 3 marks. A third of students scored 2 marks for calculating the temperature change of 22°C. Surprisingly, many students thought the final temperature would be 122°C having added the 22°C to the initial temperature. These students still scored 2 marks for their calculation of temperature change provided working was shown. A surprising number of students failed to correctly subtract 22 from 100, believing the answer to be 88°C.

A number of students selected an incorrect equation. Some students scored 1 mark for the substitution only and then incorrectly rearranged to achieve an incorrect final answer. Students should be reminded that the substitution gains 1 mark, not the subsequent rearrangement.

(b) Only one tenth of students scored 2 marks for the answer of 6.4 (W). Half the students scored 1 mark, with the most commonly seen answer of 23 100, which was achieved by dividing 46 200 by 2 (hours). A number of students attempted the conversion, but only got as far as minutes and ended with an answer of 385, which also scored 1 mark.

8

(a) (i) This was well answered with most students making the correct choice to calculate the momentum.

(ii) Just under half of the students correctly identified the unit of momentum.

(iii) Surprisingly few students understood that the backward and forward momentum would be the same.

(b) Most students scored zero with very few scoring both marks. The main problem was students not identifying either the directions of forces or the increased magnitude of the forces. Those who mentioned momentum often neglected to identify if it was the air or the toy they were referring to or the fact that it had increased. The most common point that gained credit was the air moving quicker or more air being forced backwards by the fan. Many of the students simply repeated information from the stem of the question stating that the toy went faster.

9 Foundation

(a) Many students were distracted by the markings on the tube and answered in terms of the marks not being the stated distance apart or by the fact that each individual centimetre was not marked. Other common errors were the weight of the ball bearing or the opacity of the oil. Too many students were happy with a one word answer such as 'stopwatch'. To score the mark the students needed to state what it was about the use of the stopwatch that led to an error being made.

(b) (i) The majority of the students gave an incorrect answer, 'after' being the most popular choice.

(ii) Many of the students answered this in terms of describing how the distance varied with time during the first 4 seconds. Only about one third of the students scored the mark.

(iii) A substantial number of students did not attempt this question. Virtually none of the students who did attempt the question gave a correct answer. The most common error was not identifying that the terminal velocity was shown by the straight part of the graph. Even the very few who mentioned gradient or steepness failed to identify which part of the graph had to be used. The most common answer was simply to quote distance/time.

(iv) A small number of students received partial credit for this question, mostly through realising that the force of drag would become equal to the force due to the weight. However few articulated that the drag would increase. As in previous papers, there is still a common misconception that when forces on a moving object become balanced, the object become stationary.

(c) Many of the students did pick the correct answer from the three options but made no attempt at an explanation. Of those who did try it was pleasing to see that the majority had recognised that the ball bearing took less time to fall a particular distance in the warmer oil and this meant there was less drag. It was rare to see any reference to resultant force or to the weight of the ball being constant.

Higher

(a) This was answered well with about half of the students understanding that the error would be in the timing. Some students misunderstood the experimental set-up and thought the tube had been labelled incorrectly and should have had 10 at the bottom and 60 at the top like a measuring cylinder.

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

(ii) Most of the students' answers used phrases that were implied variations of the wording on the mark scheme. The most common being 'it is getting faster'. A significant minority did not read the question about 'during the first four seconds' and mentioned constant speed/terminal velocity. Many students said, as the distance increased, so did the time so the response was not sufficiently unambiguous to score the mark.

(iii) Very few students scored this mark. Many students had the right idea but missed gaining the mark by writing either 'work out the gradient', or 'use the straight line part', but not putting both ideas together. Most students who used specific values were working out average velocity, from (0,0) choosing coordinates after the velocity had become constant, but not appreciating that it needed change in y/change in x, all on the constant gradient section.

(iv) Around one fifth of the students scored both marks with a further two fifths scoring one mark. Many of the students did understand the idea of upward force balancing downward force although the phrase 'resultant force = 0' was rarely seen. Drag = weight was the most common answer with a wide variety of phrases describing 'balance'. The idea that the drag force increases was seen less often. Too many students were unspecific about how the weight and the drag force become equal. Unfortunately many students were confused about resultant force and said that ‘the resultant force was equal’ when they meant that the resultant force was 0 (the forces were balanced).

(c) Very few of the students scored 3 marks, although nearly two thirds of the students scored 2 marks, not always having accessed the mark for ‘less than’. Answers 'equal to' were rare and usually failed to score any further marks. The most usual reasons were 'ball going faster' and about travelling the same distance in less time. Few students gained the mark for recognising that the weight was the same or that the resultant force must be greater, although the former was the more frequent of the two. Quite a few answers described the weight changing. A few students mentioned the viscosity of the oil. There was still the misconception that a particle expanding was the reason for decreasing density. Some students mistakenly thought that the line of the ball in warmer oil had become straight towards the end.

10 (a) The vast majority of students gained at least one mark, but less than half went on to give a complete answer including a reference to the ionising properties of X-rays.

(b) Just under half of students gained marks on this question. Many students understood that the sound reflected, but did not add that it was only partial reflection. The notion of time being recorded and used to calculate distance was only expressed by about one tenth of students.

(c) This calculation caused problems for students with only a tiny minority managing to obtain the correct final answer. The majority of students neglected to either halve the time or double the distance from the mother's skin to the fetus.

(d) (i) A common misconception here was that bone reflected X-rays and the reflected X-rays were then detected. It was also not uncommon to see students stating that X-rays contained gamma rays or alpha particles. Many students who gained two marks neglected to mention that the X-rays passing through are detected. Around a quarter of students gained three marks.

(ii) This question was well answered with just over three quarters of students identifying why X-rays are able to produce detailed images.

11 (a) (i) A large majority of students were unable to define the moment of a force. This gap in their knowledge then caused them further difficulties as the question progressed.

(ii) Just over one tenth of students answered this question correctly, with a majority comparing the size and direction of forces, rather than the moments of the forces.

(iii) Approximately half of students failed to score any marks on this question. About one tenth correctly calculated the moment caused by the drummer's toe, but then could not complete the calculation. Just under half of students gained three marks.

(b) Just under half of students gained the first mark on this question. The most common error was to describe how length would affect the speed of the drumstick, but not link this with the loudness of the sound. Very few students identified that the range of volumes that could be produced got larger as the length increased.

12 (a) More than four-fifths of students correctly identified the three parts of the eye, thus gaining three marks. A further one-fifth achieved two marks, a smaller number gaining one mark and only a very few students failing to identify any part correctly.

(b) (i) Almost all students correctly described the pattern of data in one way or another.

(ii) It appeared that many students did not link the information given in (i) to this part of the question. Only one-tenth gained both marks, and around half gained one mark, usually for identifying that the lenses may be heavy. This meant that more than one-third failed to score any marks; a common answer was to say that the lenses would be able to correct visual defects, ie just repeating the information given in the question.

(iii) Many students adopted a logical approach to this question, dealing with one type of spectacle first and giving an advantage and a disadvantage, then moving on to the second type of spectacle. Many answers were seen relating to cost, for which no information had been provided, but better answers focused on the materials used, as well as design and function. Although only a small number of students achieved all four marks, around three-fifths were able to gain two or more marks.

(c) Two-fifths of students gained both marks, with a further two-fifths gaining one mark. Few students recognised that the image would be inverted and diminished. Many recognised that the image would be coloured in some way. Quite a few responses included ‘virtual’ when the question clearly stated that the image is projected on to the screen.

13 (a) Three-fifths of students scored both marks here, with a further fifth scoring one mark. The most common misunderstanding noted was that pressure was the same in all directions in water and so the height of the tap made no difference to flow rate.

Some students thought that the higher the tap, the greater the gravitational PE and so the faster the water would flow into the bucket.

A small minority suggested that pressure higher up the water butt was greater.
Most realised the correct answer to this and expressed it clearly, some referred to slower flow as opposed to rate of flow. A significant number of students expressed the reverse argument here that at depth there was more pressure.

A link (positive correlation) between distance to travel and rate of flow was a common incorrect answer, sometimes linked with speed = distance over time and possibly referring to some sort of idea about acceleration under gravity.

(b) (i) Most students gained at least one mark on this section and nearly half scored both marks; only a very few scored no marks at all. The common mistake was to only look at the two end values and therefore talk about the flow rate or water collected as decreasing as the pipe gets longer without mentioning the initial section where the amount stays constant. Some students only referred to one section of the results, for instance by saying that 'from 10 m the rate of flow decreases' but not including reference to before 10 m.

Some students only quoted figures from the table, without recognising any relationships.

(ii) More than half of the students scored two or more marks but very few scored all four.

The reason for finding the mean was often incorrectly stated as to find anomalies rather than to reduce the effects of random errors.

Other reasons for not gaining marks included describing extensions to the experiment such as changing the diameter of the pipes, or for describing control measures that should be used in the experiment.

(c) The QWC question was well answered by students with most achieving Level 3 and gaining five or six marks for identifying the variables, suggesting suitable controls, and describing the equipment they would use in a clear, logical plan of the experimental procedure required. Where students did not gain marks it was usually by not including in the description the requirements bullet-pointed in the question. Some students did not include the additional equipment needed, in particular a stopwatch / timer and something in which to measure the volume of liquid collected, such as a large measuring cylinder. Sometimes descriptions of equipment used were vague but recognisable and did get the idea across of how the water could be collected and measured. Students who scored low marks did not include a control either of the length of the hosepipe or the initial amount of water in the butt. Some students did not say that they were measuring the water collected in a fixed time, or timing how long it took to collect a fixed volume.

14 (a) (i) This question was well answered with three quarters of the students scoring the mark.

(ii) Slightly less than half of the students scored this mark, the most popular choice was 10 degrees.

(iii) About two thirds of the students scored both marks. The most common error was from students who failed to realise that sin *i* and sin *r* had already been calculated for them. These students then calculated sin (sin *i*) / sin (sin *r*) which gave a numerical answer almost equal to the correct answer, however this mistake meant that they scored zero.

(b) Surprisingly, fewer than one fifth of the students scored this mark.

(c) (i) More than two thirds of the students scored this mark.

(ii) Almost all of the students scored both marks on this calculation.

(iii) More than half of the students scored this mark.

15 (a) Only just over one third of the students scored this mark.

(b) A small minority of the students scored both marks but just over half of the students scored one mark. Many students suggested changes in material or thickness of the wire. It was also common to see students controlling the size of the magnet, but not the strength of it. A fair proportion of students' answers suggested that using the same voltmeter should be a control variable. Some students did not appreciate that the number of turns on the coil was the independent variable, despite this being clearly stated in the question.

(c) (i) Nearly one third of the students scored this mark. Many students did not give enough detail in their answer, referring to human error but not stating what that human error was. A number of students did not read the question properly and either gave a definition of the term anomaly or indicated which the anomalous point was.

(ii) This question was generally answered well, with most of the students drawing the line well. A larger proportion of students did not attempt this question compared to questions which involved ticking a box or writing on a line, suggesting that these students did not read the question.

(d) Just under two thirds of the students scored the mark, with the majority of the correct answers mentioning the improved accuracy of using a data-logger in this situation. A fair number of students suggested that a data logger would eliminate anomalies, failing to realise that anomalies in this investigation could be caused by a change in speed of the movement of the magnet as well as human errors in mis-reading the voltmeter or miscounting the coils.

16 (a) This question was answered well, with nearly all of the students scoring both marks.

(b) (i) About half of the students scored both marks, with more than a third of the students scoring one mark. The most common reason for this was students who correctly wrote that mass did not affect the frequency of the pendulum, but then went on to write that length did affect the frequency of the pendulum without specifying how.

(ii) Just under a quarter of the students scored both marks with a further third of the students scoring one mark. It was quite common to see students repeating the experiment and expecting to gain marks for this without including the idea of averaging or checking for anomalies.

21 (a) (i) This question was answered well with over three-quarters of students scoring the mark.

(ii) This question was answered well with most students scoring both marks.

(b) Whilst around three-quarters of students correctly chose wave **D**, less than a third were able to link the choice to the size of the gap needed for diffraction. A common incorrect response was that the wavelength itself was too long to fit in a classroom.

(c) (i) Around three-quarters of students correctly chose position **Q**.

(ii) Most students were able to gain one mark for the sound wave reflecting however, less than a fifth scored all three marks.

(iii) Less than half of responses were correct. There was evidence that students had not looked at the diagram in detail, and answered in terms of surface **EF** rather than **GH**.

(iv) Nearly all students correctly calculated the wavelength and scored both marks.

(v) Over two-thirds of students correctly linked the given frequency with the range of human hearing.

22

(a) Just over half of the students gave a correct definition of half-life.

(b) The vast majority of students were able to obtain a value of half-life from a graph of count rate against time.

(c) Parts (i), (ii), (iii) and (iv) required students to look at the type of radiation emitted and the half-life of five radioactive isotopes shown in the table, and select one for a particular task or set of circumstances. Marks were often dropped by students not naming the source.

(i) Over three-quarters of students knew the source that emits radiation that is not deflected by a magnetic field.

(ii) The majority of students were able to score at least one mark. Less than a quarter of students could explain which source should be used for monitoring the thickness of paper during production.

(iii) Over three-quarters of students knew which source would have to be replaced most often, but very few could give a full explanation.

(iv) Half of the students knew which of the sources emitted radiation that could penetrate the box and a further third of students gave an adequate explanation.

23

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

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

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

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

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

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

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

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

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

24 (a) (i) Over three-quarters of students correctly described two ways in which a spring changed shape when a mass was suspended from it. Some stated the same thing twice with ‘got longer’ and ‘extended’ or ‘bigger distance between the loops’.

(ii) Nearly three-quarters of students correctly described how the spring could be tested to see if it behaved elastically.

(b) (i) Nearly all students were able to score at least two out of three marks for completing **Table 1** with a value of extension and explaining their value.

(ii) Just less than half of the students correctly suggested a value of force at which the spring exceeded its limit of proportionality and gave a reason.

(c) (i) Nearly all students knew that the type of energy stored in the loaded spring was elastic potential energy.

(ii) Less than a third of students gave the correct two reasons out of five stating why a value in **Table 2** was anomalous.

(iii) Over four-fifths of students calculated the correct mean value of time in **Table 2** leaving out the anomalous value.

(iv) Hardly any students scored a mark where they were asked why raw values of time were given to three significant figures and mean values given to two significant figures. Instead of referring to the precision of a stopwatch and comparing this with human reaction time, they thought that it was something to do with making the plotting of a graph easier.

(v) Just under three-quarters of students correctly suggested that extra masses would be needed to get more results, but relatively few stated that that they should be smaller masses eg 50 g. Many of those who scored both marks also correctly referred to the value of force beyond which the spring may no longer behave elastically.

25

(a) A low proportion of students could give an advantage and a disadvantage of a nuclear power station compared with a gas-fired power station. A further quarter could give either an advantage or a disadvantage. Too many answers were vague and referred simply to pollution, rather than naming a gas. A common misunderstanding was to say that nuclear power stations give out carbon dioxide gas. A common misreading of the question was to give an advantage for a nuclear power station and a disadvantage for a gas-fired power station.

(b) (i) Nearly two thirds of the students were able to substitute a power and time value into the correct equation. A low proportion of students were able to convert the given power into kilowatts.

(ii) Just over a half of students were able to state that the wind is a variable and unreliable source of energy. The figure of 30% proved a distractor for weaker students who often quoted that 70% of the energy was wasted. Those students who mentioned that the output was weather-dependent were not given credit. The key aspect is variation in wind speed or power. Some students appear to believe that wind turbines are operated by supplying them with electrical energy, and are shut down to conserve energy.

(c) Two fifths of the students were able to give an advantage of underground cables compared with overhead cables. Too many statements were vague, students were expected to give some detail of why underground cables are less likely to be damaged. There are still a large number of students who believe that birds will be electrocuted if they land on overhead power cables.

26

(a) (i) This was a standard demand question. Around a third of students correctly answered the question asked. Many students answered the question ‘what does frequency mean?’

(ii) This was a high demand question. Around one-quarter of students achieved all three marks. Nearly two-thirds were able to carry out the calculation correctly, but either failed to see the instruction to give their answer to three significant figures, or did not understand what this meant.

(b) This was a standard demand question. Although around a half of students scored one or two marks out of the four available, very few achieved all four. Many students seemed confused as to what the question was asking, and stated a fact about the first wave for ‘Conclusion 1’ and a fact about the second wave for ‘Conclusion 2’. It was common to see ‘a louder sound’ linked to ‘increased wavelength’. Whilst many correctly identified the second wave as having a greater frequency, the reason often referred to a shorter wavelength, instead of more waves in the same time. Students need to recall that the horizontal axis on a CRO represents time.

27 (a) This was well answered with just over four fifths of the students scoring both marks. A small number of students used the correct equation but changed the mass into grams. Some of the students were unsure of the positioning of the decimal point after their multiplication of the values provided.

(b) (i) Less than half of the students indicated that the electrical charge was due to the friction between the slide and the child. There were few answers indicating that this charge would be transferred between the child and the slide. Unfortunately many answers were in terms of positive charge movement or ‘positive electrons’.

(ii) This part question provided few answers which deserved any marks, the majority of the students writing that the child's hair stood on end due to attractive forces or repulsion from the slide.

(iii) Again poorly answered with only a quarter of the students scoring the mark. Some of the students realised that a metal slide would result in the charges going to earth, but most of the students scored the mark for simply stating that metal is a conductor of electricity.

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

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

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

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

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

29 (a) Many students attempted to describe how ultrasound is used rather than defining it. Other answers were vague, eg ‘cannot be heard’ but without further qualification. Some thought ultrasound was an electromagnetic wave and some thought ultrasound was the gel applied when a scan is carried out.

(b) Few students gained all 3 marks for this calculation. Over two thirds of the students failed to take the echo into account and so scored 2 marks. About one student in ten failed to gain any marks.

(c) Just under two thirds of the students stated a correct medical use of ultrasound scanning. Many students who did not gain the mark were often not specific enough in their answer; ‘baby scanning’ was a common response that was not sufficient.

(d) Many students did not read the question carefully, so the advantages and disadvantages given were not comparative. Many responses were about patient perceptions or cost. A number of students reversed their responses giving the advantages as disadvantages.

30 (a) Two thirds of the students identified that gravity provided the centripetal force on the satellite.

(b) A few students correctly stated two factors that affected the size of the centripetal force on the satellite, with just over a third identifying one factor correctly. Answers that failed to score lacked sufficient detail e.g. ‘mass’ or ‘radius’, which could equally apply to the Earth as well as the satellite, so were not sufficient to gain marks.

(c) (i) Very few students failed to correctly state the correct relationship.

(ii) About two thirds of the students correctly identified that there was no relationship between the mass of a satellite and its orbital period.

(d) Most students identified that Isaac Newton was a respected scientist who had made new discoveries before.

31 (a) Almost two thirds of the students correctly calculated the total moment. Some added the weights and distances prior to multiplying them. Only half of the students who correctly calculated the moment could correctly state the unit. A number of students lost the unit mark by mixing upper and lower case letters.

(b) Many students failed to follow the instruction in the question that clockwise and anticlockwise moments are needed in the explanation, with a third of students scoring zero. A further third scored one mark. Many students referred to forces rather than moments, or simply used the word ‘balanced’ without relating it to the moments.

32 (a) (i) Three-quarters of the students knew the frequency range of human hearing.

(ii) Three-quarters of students knew what ultrasound is.

(iii) Nearly all students could state a medical use of ultrasound. Most referred to viewing a fetus but other statements such as ‘pregnancy testing’ and ‘looking at babies’ did not score the mark.

(b) The calculation which involved rearranging the wave equation and using data given in standard form was very well answered by the vast majority of students.

(c) Ultrasound waves were emitted and the reflected waves from an object, moving away, were detected. Less than one-fifth of the students could correctly describe the differences between the emitted and reflected waves because it was often not clear which wave was being referred to in the answers.

33 (a) (i) Less than three-quarters of students identified the image in the ray diagram as being magnified and upright.

(ii) More than half of the students gained full marks for a calculation using the lens formula that required a minus sign in the answer. Most of the remaining students forgot to invert the value for the final answer.

(b) Most students knew that a minus sign meant that the image was virtual.

34 (a) (i) Three-quarters of students knew that the energy possessed by a car at the top of a slope is gravitational potential.

(ii) Nearly all students knew that the energy the car possessed after rolling down the slope was kinetic.

(b) (i) Just over half of the students knew that the acceleration on a velocity-time graph of the car slowing down on a horizontal surface, was represented by its slope. There were many vague statements like ‘the line’.

(ii) Three quarters of students knew that the distance travelled on a velocity-time graph was represented by the area under the graph.

(iii) Students were asked to draw a second line on the velocity-time graph to show the motion of the car if its brakes had been lightly applied when it reached the bottom of the slope. This was very well answered with three-quarters of the students gaining full marks.

(c) (i) Students had to calculate two values of average speed for two trolleys from two sets of values of distance and time.

Three-quarters of the students were able to calculate the average speeds, but only a fifth of them gave the answers to two significant figures. In such situations students, are expected to give the answers to a suitable number of significant figures to match the other data in the table.

(ii) Students had to state and justify whether the distances, velocities and accelerations for the two trolleys were the same.

The distances were not the same because two different values had been given.

The speeds were the same to two significant figures. Because students usually had correct values of 31.0 and 30.8 for the velocities, they often argued that these values were not the same. In future, students will be expected to exercise better judgment in experimental situations and consider whether values are, more than, for example, 5% apart.

Despite the trolleys slowing down from the same initial velocity in different times and distances, many students stated that there was not enough evidence to judge whether the negative accelerations were the same.

Despite that, a third of the students did score full marks.

35

(a) Nearly all students recognised two situations that represented conduction and convection.

(b) (i) Almost all students were able to read the starting value of temperature from a cooling curve.

(ii) Nearly all students correctly calculated the temperature fall from the cooling curve. Those who got it wrong gave the value of the temperature reached rather than the change in temperature.

(iii) The given graph showed the cooling curves for three cups of different cross-sectional areas. Students were asked which cup showed the greatest rate of cooling. Only half of the students were able to give a reason because they did not refer to temperature drop in a given time.

(iv) A diagram of a fourth container was given and students had to draw the expected cooling curve on the same axes. This was well done with four-fifths of students scoring full marks.

(v) Nearly all students recognised that the lowest temperature reached after four hours was also room temperature.

(c) (i) The calculation of energy transferred from the water, where the mass of water was given in grams, was correctly done by two-thirds of the students.

(ii) The explanation of evaporation causing the cooling of water was very poorly answered with half of the students scoring zero marks. Many students described convection and very few referred to the reduction in the mean energy of the particles when the most energetic had escaped from the surface of the water. Only a tenth of students scored three or four marks.

36

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

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

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

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

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

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

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

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

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

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

37

(a) Most students recognised the transformer illustrated as being a step-down transformer.

(b) (i) Most students were able to complete a table with values of potential difference from the input and output of the transformer.

(ii) Most students knew that the values of potential difference produced by the National Grid were larger than those given in the question.

(c) (i) Only half of the students gave an adequate description of the difference between a.c and d.c., for example, 'a.c. flows in two directions whereas d.c. only flows in one direction'. A quarter of students scored zero. Their explanations often used 'ways' instead of 'directions' and referred to 'positive' and 'negative'.

(ii) The explanation of how a transformer works was poorly answered with more than a third of students scoring zero out of four.

Many answers only referred to the number of turns on each coil. Very few students mentioned the changing magnetic field in the primary coil and others stated that there was a current in the core.