Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

Physics

Advanced
Paper 3: General and Practical Principles in Physics

Sample Assessment Materials for first teaching September 2015
Time: 2 hour 30 minutes

Paper Reference
9PH0/03

You may need the Formulae Sheet, a calculator, protractor and a ruler.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You may use a scientific calculator.

Information

- The total mark for this paper is 120.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an *****, marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- You are advised to show your working in calculations including units where appropriate.

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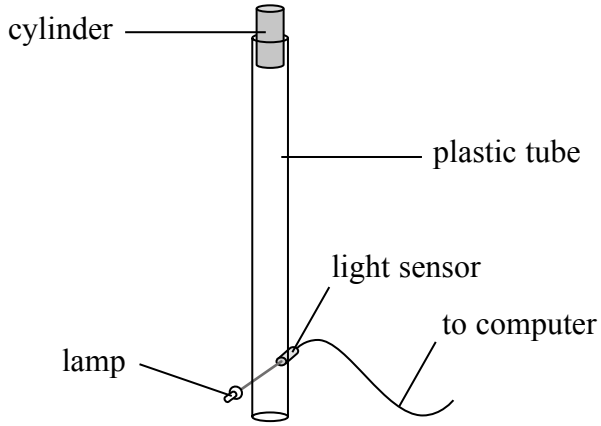
Answer ALL questions in the spaces provided.

1 A student uses a lamp and a light sensor as a light gate connected to a data logger and computer to determine the speed of a falling object. He drops a small cylinder through a clear plastic tube. The light gate and data logger measure the time of fall of the cylinder and the speed is calculated.



The student repeats the experiment five times and records the results in a table.

Speed/m s^{-1}	Mean speed/m s^{-1}
4.52 4.59 4.43 4.63 4.58	4.55

(a) The student incorrectly includes all the values when calculating the mean speed. A second student thinks that the true value of the mean speed is different.

Explain whether the second student is correct.

(2)

(b) Explain **one** advantage of using a light gate and data logger in this experiment.

(2)

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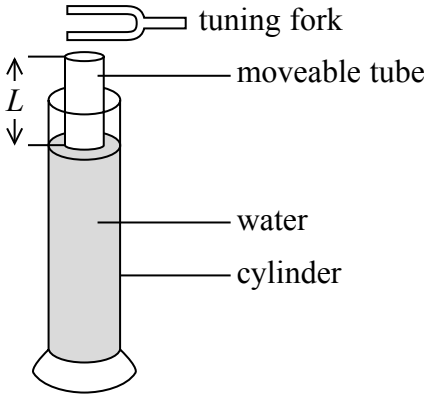
(Total for Question 1 = 4 marks)

2 A set of tuning forks is used to find a value for the speed of sound in air.
A tuning fork is struck and then held near to the end of an air column formed by a moveable tube. The moveable tube is used to adjust the length, L, of the air column until a standing wave is set up in the tube and the loudest sound is heard. The experiment is repeated for a number of different tuning forks.



The following results are obtained by a student.

Fork frequency/Hz	Length, L/cm	Speed of sound/m s^{-1}
256	31.9	327
320	25.6	328
512	16.1	330

Student A says "These results show that the speed of sound increases as the frequency of the sound increases".

Student B says "The speed of sound should be the same for each frequency".

By estimating the uncertainties in these results, conclude which of these statements is valid.

(Total for Question 2 = 4 marks)

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TURN OVER FOR QUESTION 3

3 Small electrical devices are often powered by electric cells; different devices use different types of cell.

(a) The cells normally used in a television remote control have an e.m.f. of 1.5 V.

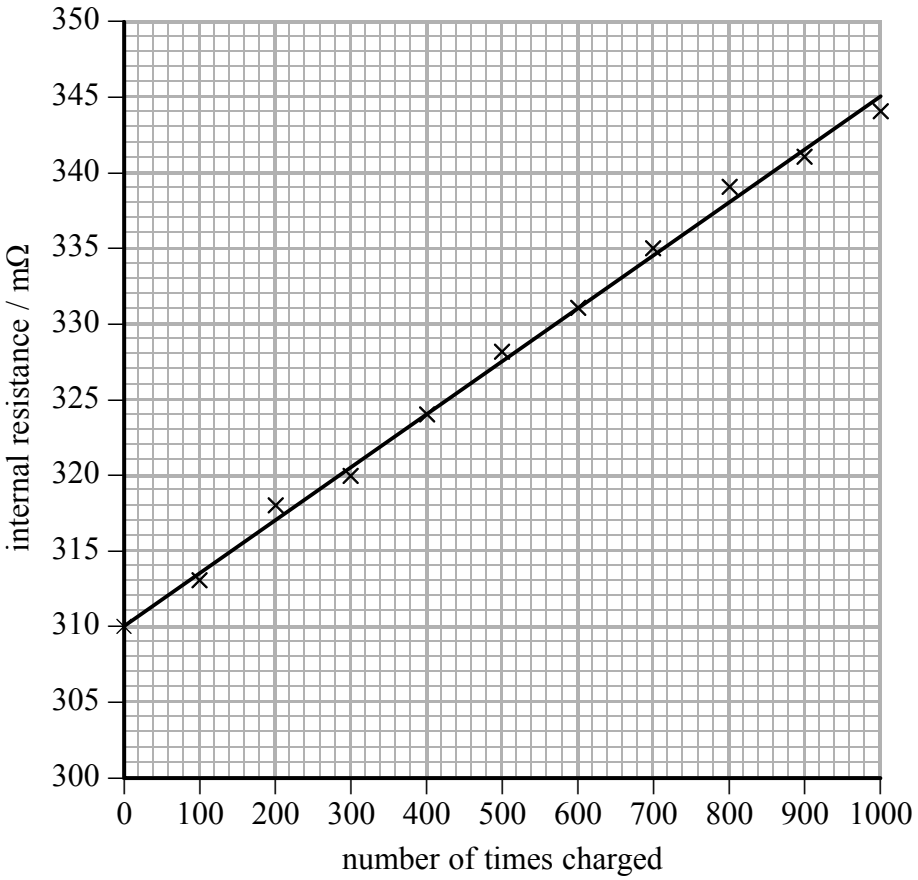
(i) Describe a procedure to determine the internal resistance and e.m.f. of an electrical cell. You should include a circuit diagram.

(3)

(ii) Describe how you would use your results to find a value for the e.m.f. and internal resistance of the cell.

(3)

(b) The cells used in a camera to charge the flash unit are 3.6 V lithium ion rechargeable cells. The data sheet supplied with such a cell includes a graph which shows how the internal resistance of the cell varies with the number of times it has been charged and discharged.



The cell is recommended for use in a camera flash charger which typically draws a supply current of 800 mA. The manufacturer claims that even after 500 charging cycles the cell terminal potential difference (p.d.) will be more than 99% of the terminal p.d. when new and supplying the same current.

Analyse the data from this graph to explain whether it supports the claim, supporting your answer with a calculation.

(4)

(Total for Question 3 = 10 marks)

4 A student carries out an experiment to investigate the stretching of a liquorice lace.

(a) The student fixes one end of the lace to a support and adds different masses to the end of it, measuring the extension each time with a metre rule. His results are shown in the table.

Mass/kg	Force/N	Extension/m
0.03	0.294	0.005
0.04	0.392	0.0075
0.06	0.589	0.011
0.07	0.687	0.012

Criticise the recording of these results.

(3)

(b) Describe how the student should measure the extension of the lace to make his results as accurate as possible.

(2)

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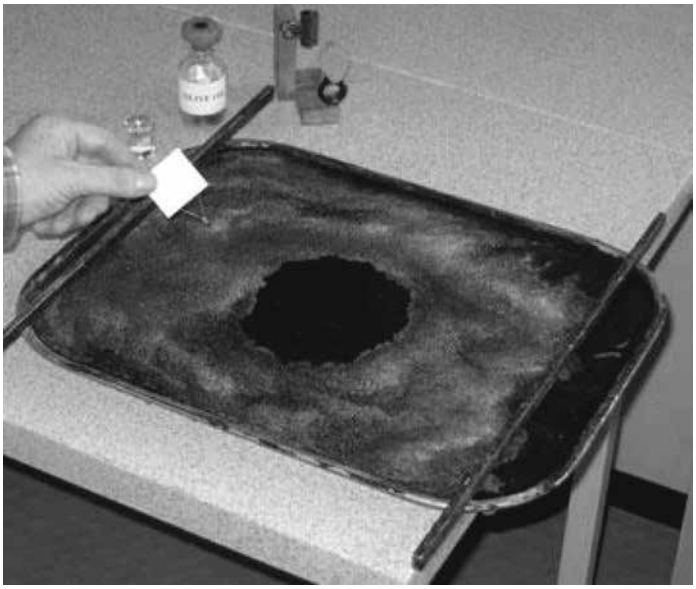
(Total for Question 4 = 5 marks)

5 When a drop of oil is placed on the surface of water it spreads out to form a thin film 1 molecule thick. A student uses this phenomenon to determine the size of an oil molecule.

She dips a wire loop into the oil so that a small, spherical oil drop forms. She uses a millimetre scale to measure the diameter of this oil drop.

The student fills a tray with water and scatters a fine powder on the water surface. The oil drop is placed on the water surface and spreads out to form a thin film, approximately circular, as shown in the photograph.



The student uses a metre rule to measure the diameter of the circular thin film. She records the following measurements:

diameter of oil drop = 0.5 mm
diameter of thin film = 250 mm

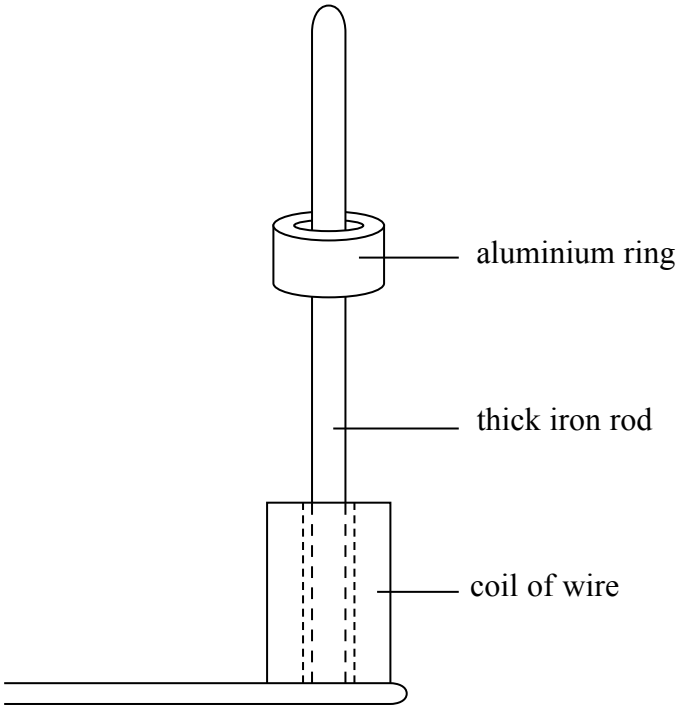
The student now equates the volume of oil as a drop to the volume of the film.

Evaluate the student's method and suggest refinements that would improve the accuracy of determining the size of the molecule.

(Total for Question 5 = 6 marks)

6 A coil of wire is placed around the lower end of an iron rod. The coil is supplied with an alternating current.

A thick aluminium ring is placed around the iron rod above the coil. The coil remains in the position shown.



(a) An alternating current is induced in the aluminium ring.

Explain, using Lenz's law, why the aluminium ring remains in the position shown.

(4)

(b) The current is switched off and the aluminium ring comes to rest on top of the coil. The supply to the coil is changed and a direct current (dc) is switched on. An upwards force F acts on the ring for 0.05 s accelerating it to a final speed, v. The ring then moves freely through a height of 30 cm.

Mean diameter of ring = 4.8 cm
Mass of ring = 0.019 kg
Magnetic field strength = 0.032 T

(i) Use conservation of energy to calculate the speed v of the ring after 0.05 s.

(2)

v = ...

(ii) Use the idea of impulse to calculate the magnitude of the mean force F acting on the ring and hence the mean current I in the ring.

(6)

F = ...

I = ...

(Total for Question 6 = 12 marks)

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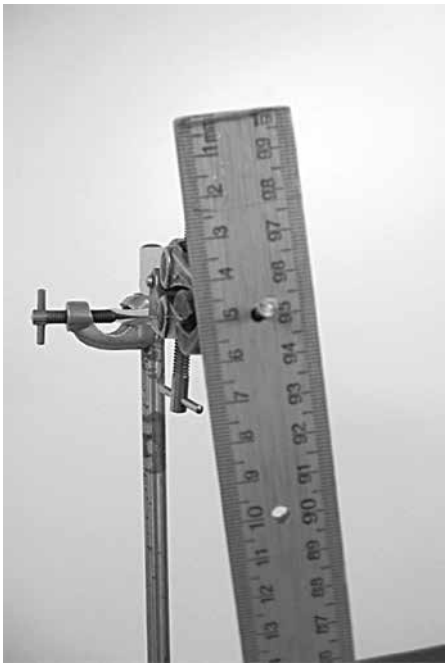
7 A metre rule has a small hole drilled at the 5 cm mark. The rule is hung on a horizontal pin passing through the hole.



(a) The rule is rotated through a small angle and released. It then oscillates about the pin as a pendulum with a time period T.

(i) Describe how to use a stopwatch to determine a value for T.

(2)

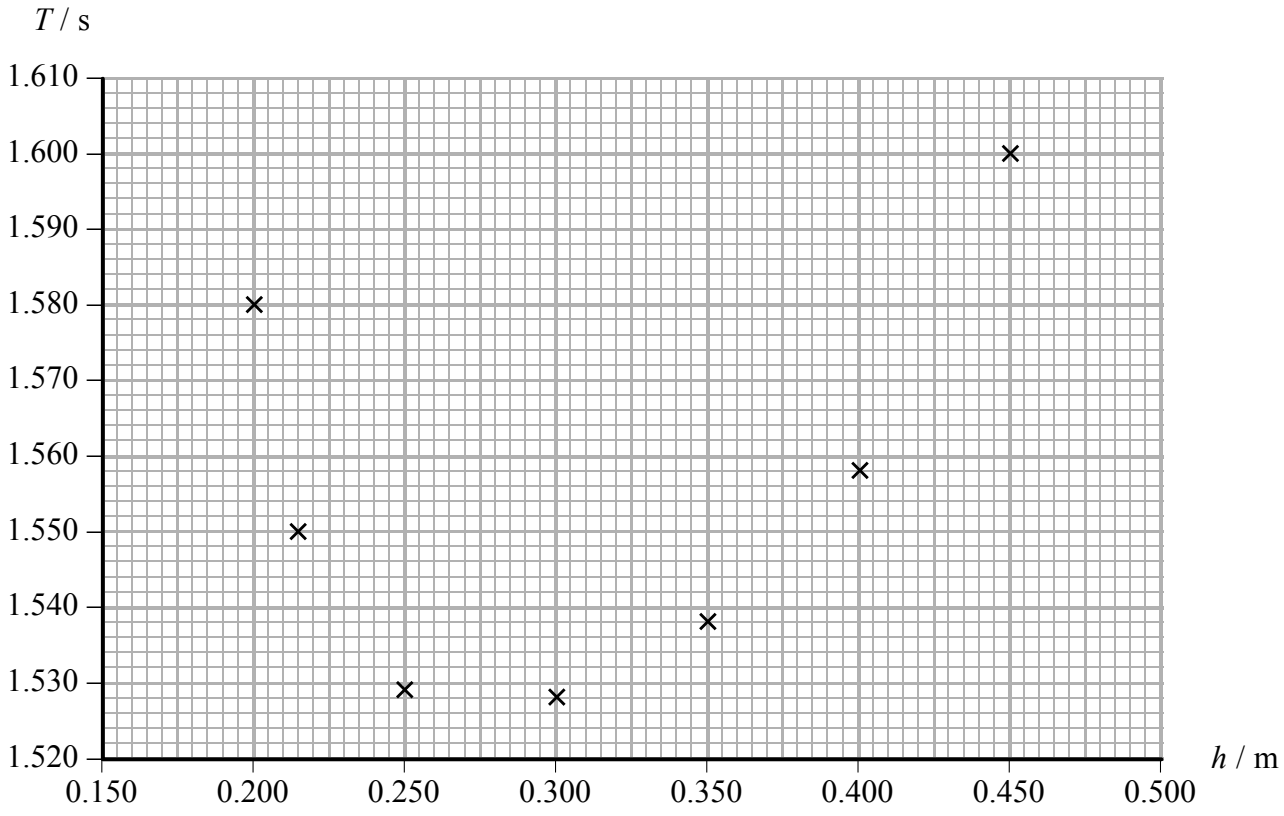
(ii) State **two** reasons why repeating the readings will improve the results for T.

(2)

(b) There are six more holes drilled at intervals down the rule. The rule is hung from each hole and the distance h from the pin to the 50 cm mark is recorded.

T is determined for each value of h and a graph of T against h is plotted.

h/m	T/s
0.450	1.601
0.400	1.558
0.350	1.538
0.300	1.528
0.250	1.529
0.215	1.550
0.200	1.580



(i) Draw a line of best fit on the graph.

(1)

(ii) Use your line to determine the value of h that would produce the smallest value of T.

Record these values.

(2)

h = ... T = ...

(c) The graph of T against h does **not** produce a straight line.

The variables T and h are related by

$$T^2 h = 4\pi^2 h^2/g + C$$

where C is a constant.

Describe a graphical method to determine a value for C and state the unit for C.

(3)

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(Total for Question 7 = 10 marks)

8 Photograph 1 shows a toy known as a popper. It is a hollow hemisphere made of rubber.

Photograph 1

When the top of the popper is pushed down, it changes shape as in Photograph 2.

Photograph 2

It remains in this shape for two to three seconds. It then returns to its original shape and is launched from the surface, rising nearly a metre.

(a) A student concludes that the material of the popper should be classed as a plastic material rather than an elastic material because it remains inverted.

Explain whether you think this conclusion is correct.

(3)

(b) The initial speed of the popper can be determined using only a metre rule to measure the maximum height reached by the popper.

(i) Describe how the maximum height measurement can be used to determine the launch speed.

(3)

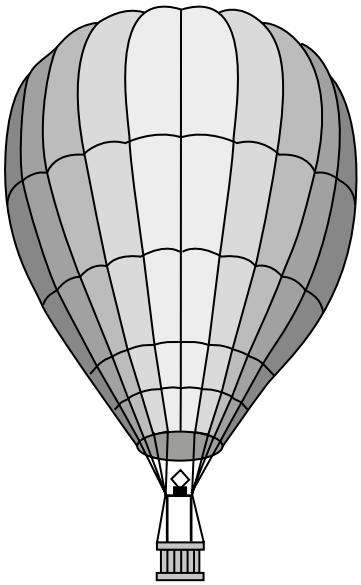
(ii) Comment on using the maximum height measurement as a means of determining an accurate value for the launch speed.

(3)

(Total for Question 8 = 9 marks)

9 Newton's laws relate the changes in motion of an object to the forces acting on the object.

(a) A hot-air balloon is made of an envelope, containing hot air, with a wicker basket suspended from it. The balloon rises upwards because the heated air in the envelope is less dense than the surrounding air.



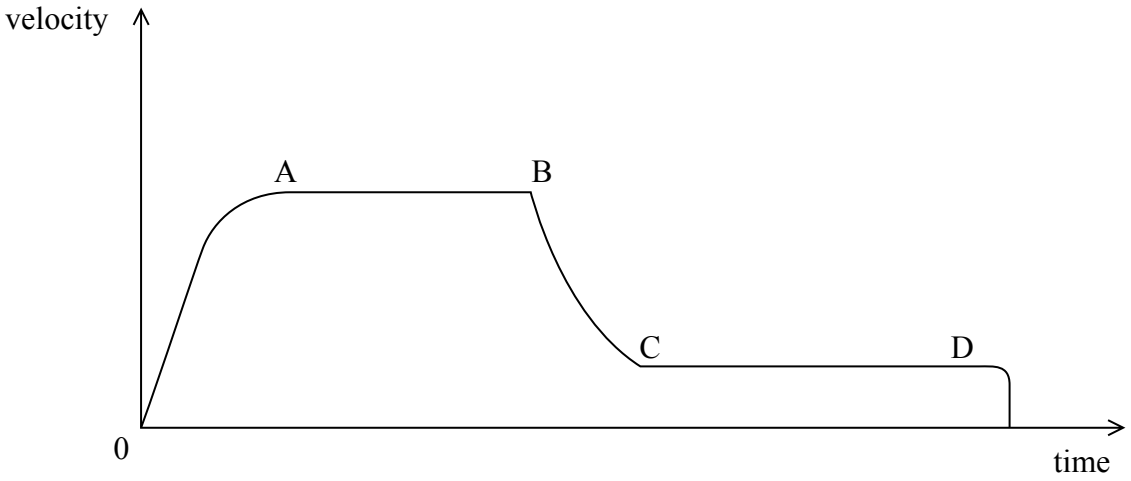
The total volume of the hot-air balloon is 2880 m^3. The total mass of the hot-air balloon, including the envelope, is 3400 kg. The density of the surrounding air is 1.20 kg m^{-3}.

Calculate the initial upward acceleration of the balloon.

(4)

Initial acceleration = ...

*(b) The graph shows the velocity of a skydiver from the moment that she begins her freefall jump, until she lands on the ground.

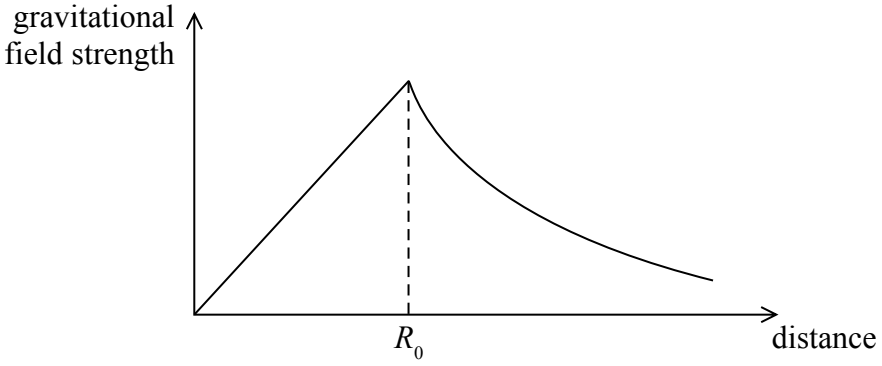


Explain, in terms of the force acting, the shape of the graph from the point when the parachute opens until point D.

(6)

(Total for Question 9 = 10 marks)

10 The graph shows the variation of the gravitational field strength with distance from the centre of the Earth. R_0 is the radius of the Earth.



(a) Describe how gravitational field strength varies with distance from the centre of the Earth

- for distances between 0 and R_0
- for distances greater than R_0

(3)

(b) A scientist suggests the following:

> "If a tunnel were made through the centre of the Earth, an object dropped at one end would accelerate downwards until it reached the centre. It would then decrease in speed until it reached the other end of the tunnel with a speed of zero. The object would then return the other way, undergoing simple harmonic motion."

Using the graph between 0 and R_0, determine whether simple harmonic motion would occur.

(4)

(c) The scientist also suggests that the period of oscillation for a body dropped through the tunnel would be the same as the orbital period for a body orbiting just above the surface of the Earth. Its radius of orbit is assumed to be R_0.

(i) Derive an expression for the period of oscillation of the body dropped through the tunnel.

(4)

(ii) Derive an expression for the orbital period for a body that is orbiting the Earth with radius R_0.

(3)

(Total for Question 10 = 14 marks)

11 A physicist investigates how light intensity varies with distance from a light bulb. She sets up the apparatus as shown.

(a) Explain why the resistance R of the LDR will increase as it gets further away from the bulb.

(2)

(b) The relationship between R and d is given by

$$R = \mathrm{k}\, d^{\,\mathrm{p}}$$

where k and p are constants.

Explain why a graph of ln R against ln d should give a straight line.

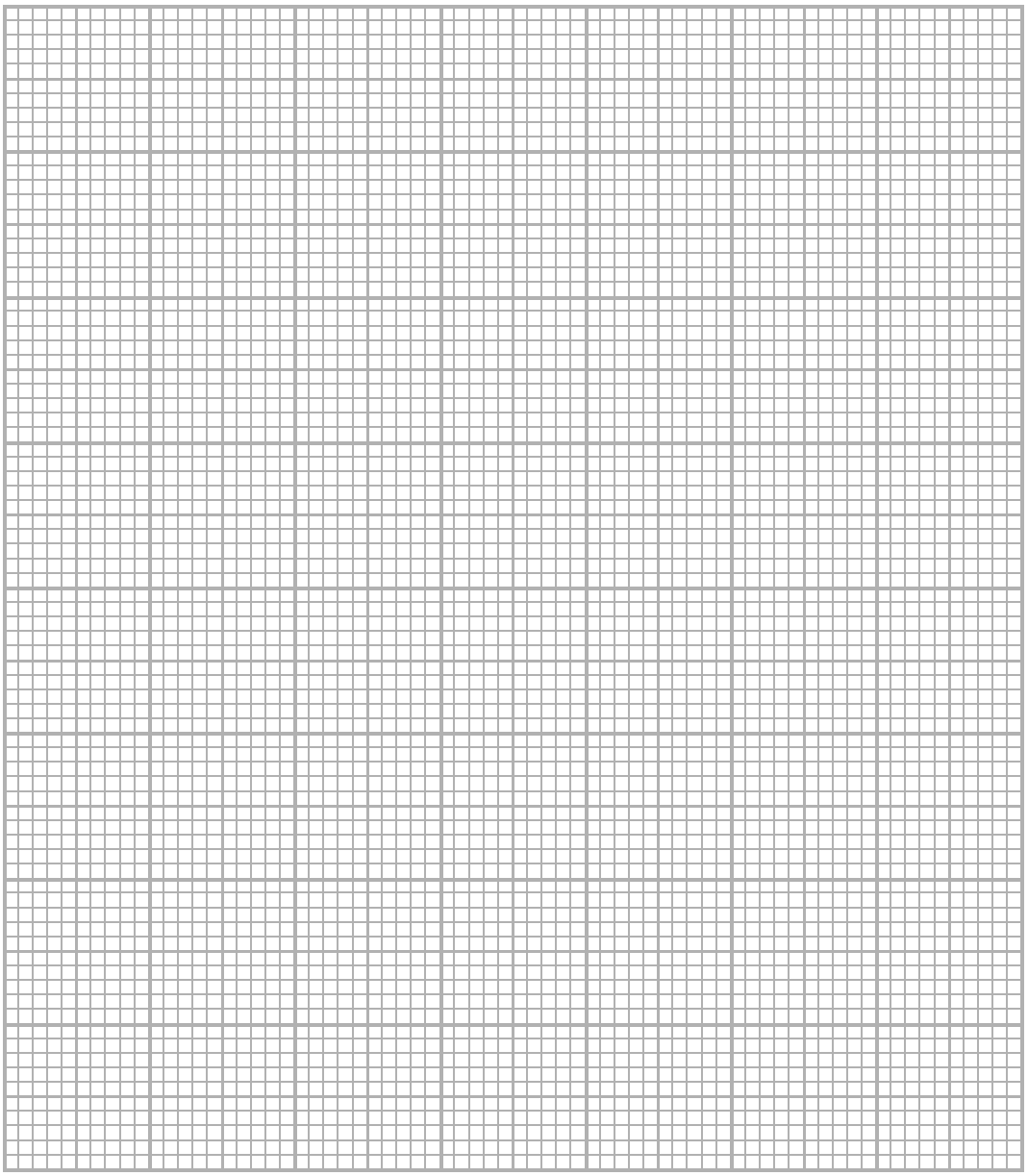
(2)

(c) She measures R for different values of d and records the following results.

d/m	R/kΩ		
1.00	1.79		
1.20	2.24		
1.60	3.32		
2.00	4.04		
2.60	5.50		

(i) Plot a graph of ln R against ln d. Use the columns provided to show any processed data.

(5)



(ii) Determine the mathematical relationship between R and d.

(4)

(Total for Question 11 = 13 marks)

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TURN OVER FOR QUESTION 12

12 A simple model of the hydrogen atom consists of an electron moving in a circular path around a proton.

(a) (i) In this simple model it is the electrostatic force, rather than the gravitational force, that is responsible for keeping the electron in a circular path.

By means of calculations justify this statement.

radius r of the hydrogen atom = 5.3×10^{-11} m

(4)

(ii) Ignoring the gravitational force, calculate the velocity of the electron in this simple model of the hydrogen atom.

(3)

Velocity = ...

(b) In another model it is assumed that the electron behaves like a wave with a de Broglie wavelength λ. The wave associated with the electron forms a standing wave whose wavelength is equal to the circumference of the circular path.

Calculate the velocity of the electron based on this model.

(3)

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Velocity = ...

(Total for Question 12 = 10 marks)

13 The photograph shows a tea cup on a saucer.

A student notices that walking with this sort of tea cup when it is filled with tea is particularly difficult to do without spilling it.

While walking, the tea starts to oscillate from side to side in the cup, rapidly increasing in amplitude and spilling over the edge.

The student develops the hypothesis that spillage occurs most when the frequency of the steps taken by a person matches the natural frequency of oscillation of tea in the cup.

(a) Explain whether the student's hypothesis is supported by relevant physics.

(4)

*(b) (i) Devise an experiment to investigate the hypothesis.

(6)

(ii) Describe how the measurements taken will be used to come to a conclusion.

(3)

(Total for Question 13 = 13 marks)

TOTAL FOR PAPER = 120 MARKS

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