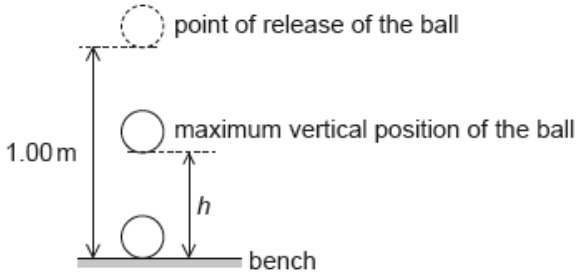
HL Paper 2

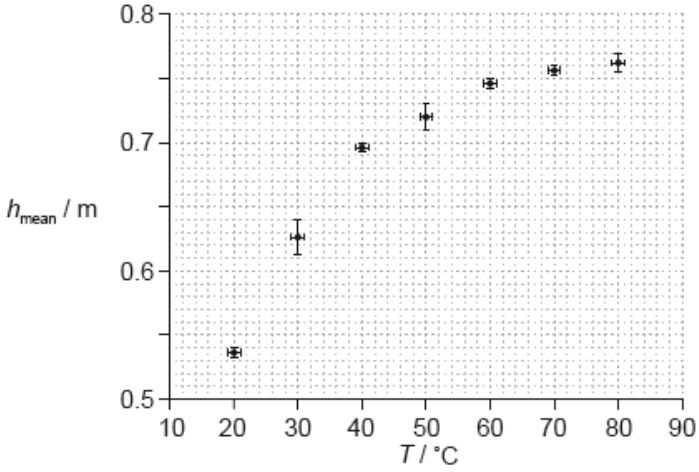
Data analysis question.

An experiment is undertaken to investigate the relationship between the temperature of a ball and the height of its first bounce.

A ball is placed in a beaker of water until the ball and the water are at the same temperature. The ball is released from a height of 1.00 m above a bench. The maximum vertical height h from the bottom of the ball above the bench is measured for the first bounce. This procedure is repeated twice and an average h_{mean} is calculated from the three measurements.



The procedure is repeated for a range of temperatures. The graph shows the variation of h_{mean} with temperature T.



A student hypothesizes that h_{mean} is proportional to T^2.

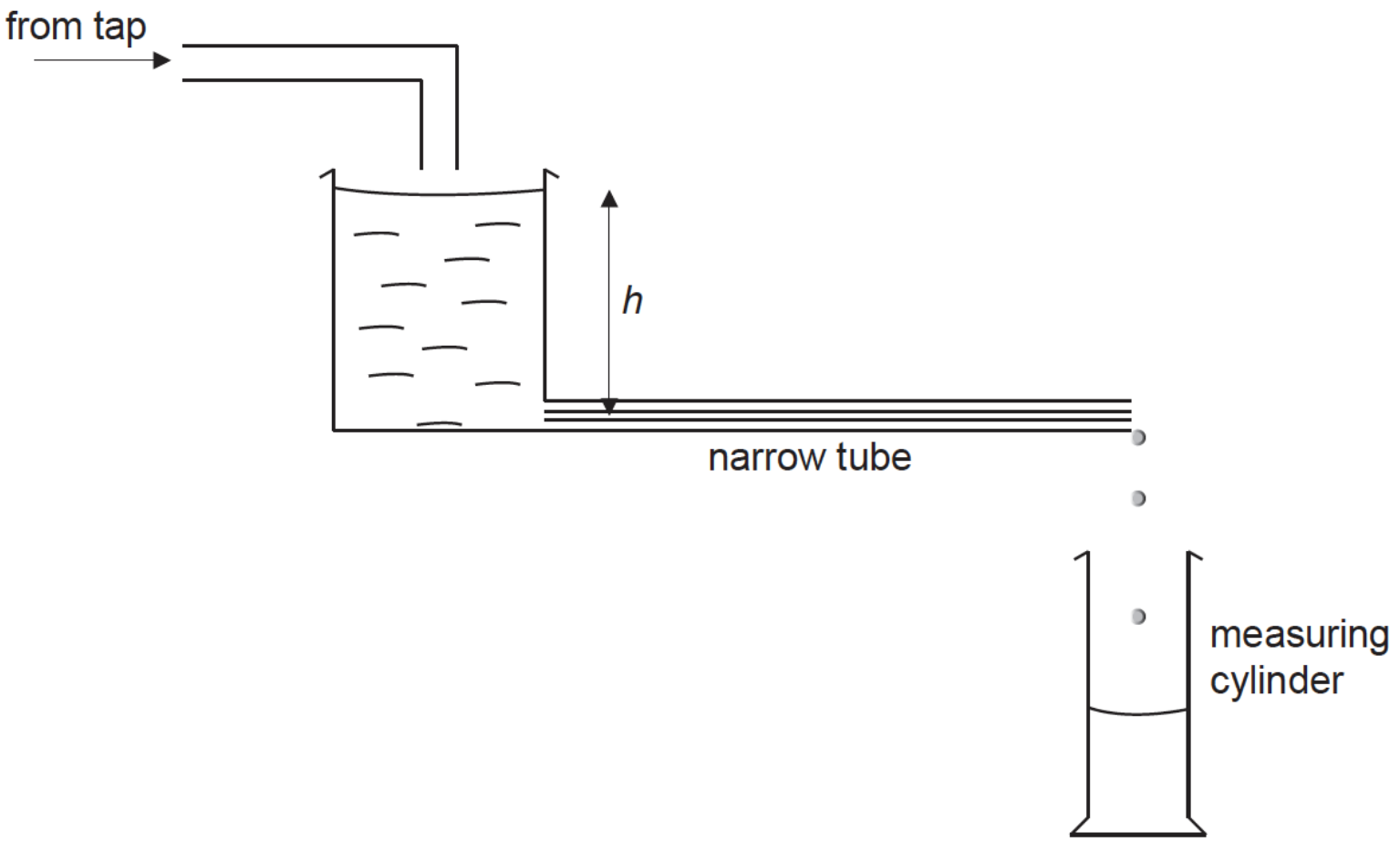
b.i. Comment, using **two** points on your line of best-fit, whether or not this is a valid hypothesis. [3]

b.ii. Suggest why using two points cannot confirm that h_{mean} is proportional to T^2. [2]

c.ii. The temperature is measured using a liquid in glass thermometer. Explain why it is likely that the uncertainty in T is constant. [2]

This question is about the flow of liquids.

A student carries out an experiment to investigate how the rate of flow *R* of water through a narrow tube varies with the pressure difference across the tube. The pressure difference is proportional to the height *h* shown in the diagram. The student measures *h* in cm with a metre ruler. *R* is obtained by measuring the volume of water collected in a measuring cylinder in a time of 100s.



c. The equation of the trend line shown in (b) is given by [4]

$$R = -0.0005h^2 + 0.0843h - 1.5632.$$

(i) Calculate the value of R for $h = 0$.

(ii) State why this value of R is not physically possible.

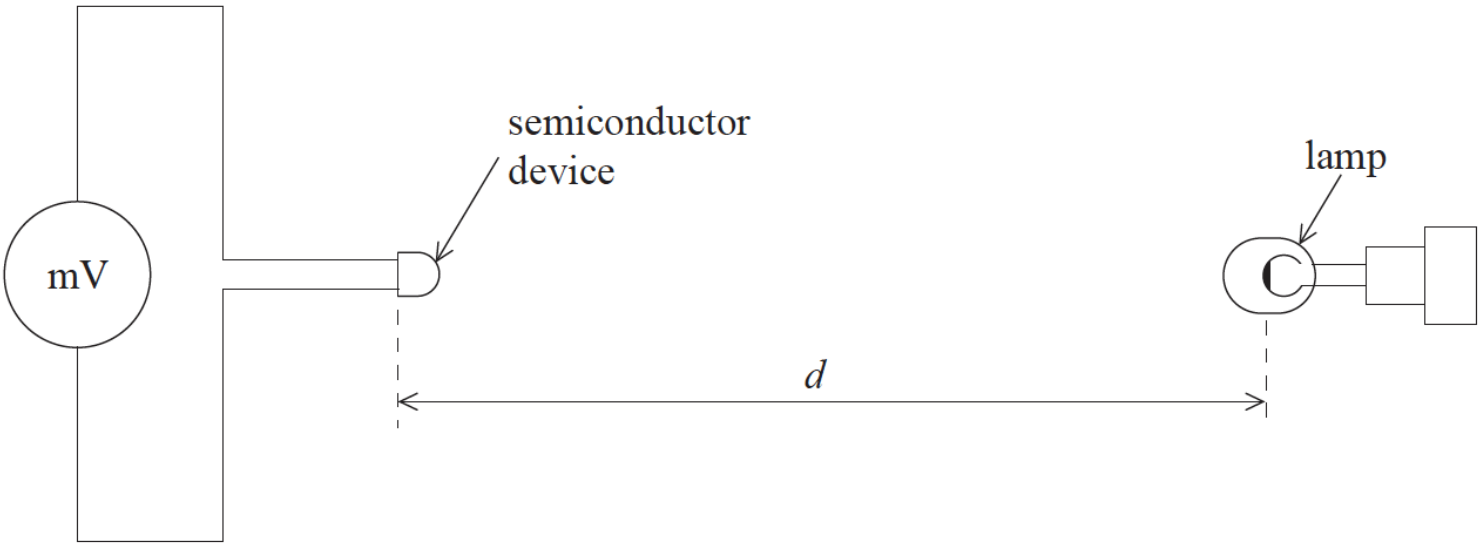
(iii) State the number of significant figures that you have used for your value in (c)(i).

(iv) Comment, with reference to the experimental data, on the number of significant figures that you have used for your value in (c)(i).

d. The student estimates that the uncertainty in timing 100s is ±1s. Using the data on the graph, deduce the absolute uncertainty in the volume of water collected when $R = 2.1$ units. [4]

Data analysis question.

A particular semiconductor device generates an emf, which varies with light intensity. The diagram shows the experimental arrangement which a student used to investigate the variation with distance d of the emf ε. The power output of the lamp was constant. (The power supply for the lamp is not shown.)



The table shows how ε varied with d.

d / cm	ε / mV
19.1	5.5
18.0	6.0
16.0	8.6
14.0	11.9
12.0	19.7
10.0	37.5

The student hypothesises that there may be an exponential relationship between ε and d of the form shown below, where a and k are constants.

$$\varepsilon = ae^{-kd}$$

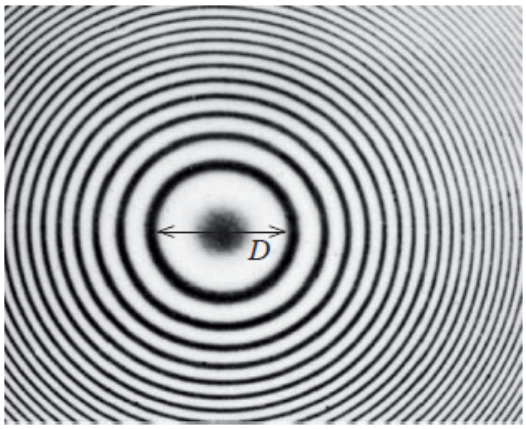
(i) Deduce a suitable unit for k.

(ii) Suggest the graph that the student should plot in order to get a straight-line graph if the hypothesis is valid.

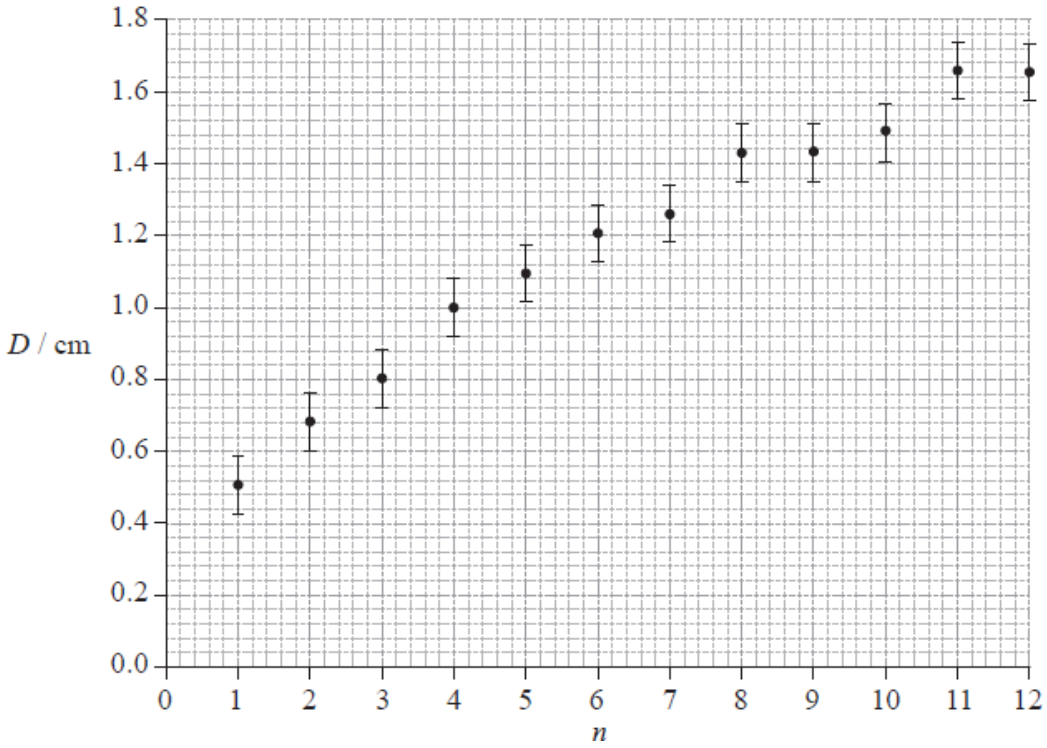
(iii) Explain how k can be obtained from the graph in (d)(ii).

Data analysis question.

The photograph below shows a magnified image of a dark central disc surrounded by concentric dark rings. These rings were produced as a result of interference of monochromatic light.



The graph below shows how the ring diameter D varies with the ring number n. The innermost ring corresponds to $n = 1$. The corresponding diameter is labelled in the photograph. Error bars for the diameter D are shown.



It is suggested that the relationship between D and n is of the form

$$D = cn^p$$

where c and p are constants.
Explain what graph you would plot in order to determine the value of p.