OCR
Oxford Cambridge and RSA

A Level Physics B (Advancing Physics)

H557/03 Practical skills in physics

Practice paper – Set 1

Time allowed: 1 hours 30 minutes

You must have:
- the Data, Formula and Relationships Booklet

You may use:
- a scientific calculator
- a ruler (cm/mm)

First name										
Last name										
Centre number						**Candidate number**				

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **18** pages.

SECTION A

Answer **all** the questions.

1 This question is about estimating small dimensions.

A stack of paper, shown in Fig. 1.1, forms a cube. It was measured, using a standard metre ruler, and found to have a side length of 7.60 ± 0.05 cm.

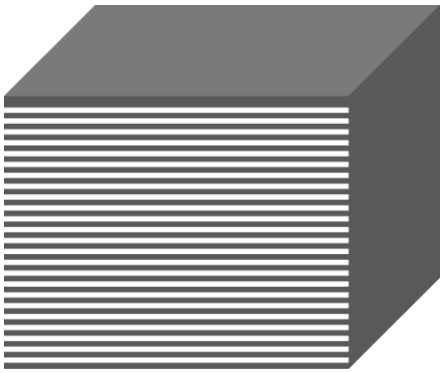


Fig. 1.1

(a) (i) Suggest why an uncertainty value of ± 0.05 cm is reasonable when using a standard metre ruler.

.....

..... **[1]**

(ii) Calculate the volume, *V,* of the stack of paper.

V = ... cm^3 **[1]**

(iii) Show that the percentage uncertainty in the volume of the pad is approximately 2%.

[2]

(b) The individual sheets from the pad were laid out, side by side, on a flat surface, to form a square. The length of the side of the resulting square was found to be 152.00 ± 0.05 cm.

(i) Explain why dividing the volume of the pad by the total area of sheets when laid out flat gives the thickness of a single sheet.

.....

.....

.....**[1]**

(ii) Calculate the thickness, *t*, of a single sheet of paper using this method and include the percentage uncertainty in your answer.

t = ...cm ± …… % **[3]**

(iii) Suggest an alternative method to find the paper thickness that reduces the uncertainty in the result.

.....

.....**[1]**

(c) An experiment to estimate the size of an oil molecule was first carried out in 1899 by Lord Rayleigh.

The diameter, *d*, of a small drop of oil held on a wire loop is measured using a hand lens and a millimetre scale as shown in Fig. 1.2

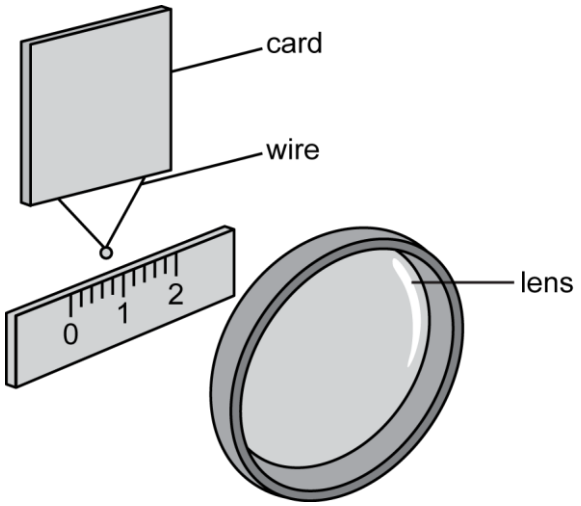


Fig. 1.2

The oil drop is placed on a clean water surface lightly dusted with talcum powder. The drop spreads over the surface, pushing back the talcum powder, producing an almost circular patch, diameter D, on the water surface as shown in Fig. 1.3

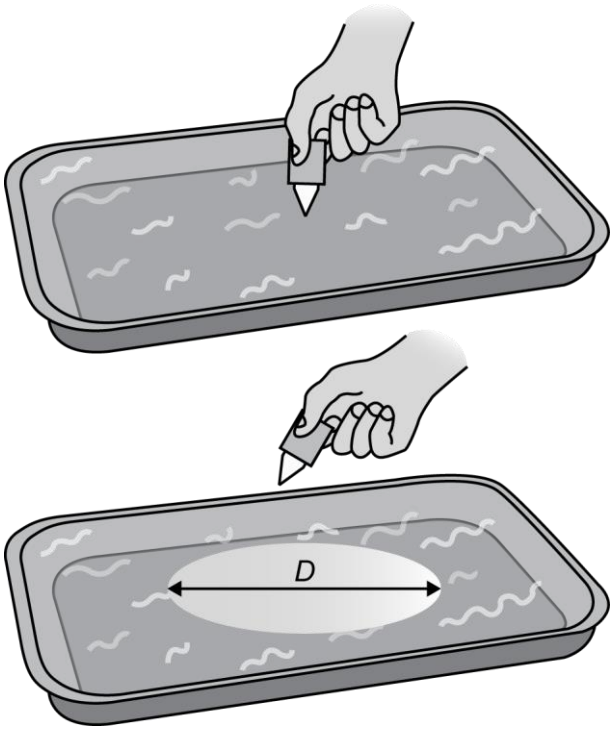


Fig. 1.3

(i) Show that the thickness of the oil film, *t*, is given by

$$t = \frac{2d^3}{3D^2}$$

[1]

(ii) Rayleigh suggested that the oil would spread over the water surface until the patch was one molecule thick. The thickness of the patch is therefore an estimate of the size of an oil molecule.

Suggest how the uncertainty in the values of *d* and *D* might be minimized and explain why this is essential if the uncertainty in *t* is to be reasonably small.

.....

.....

.....

.....

.....

.....**[3]**

2 Fig. 2.1 shows the layout of the apparatus required to observe the superposition of light from two sources.

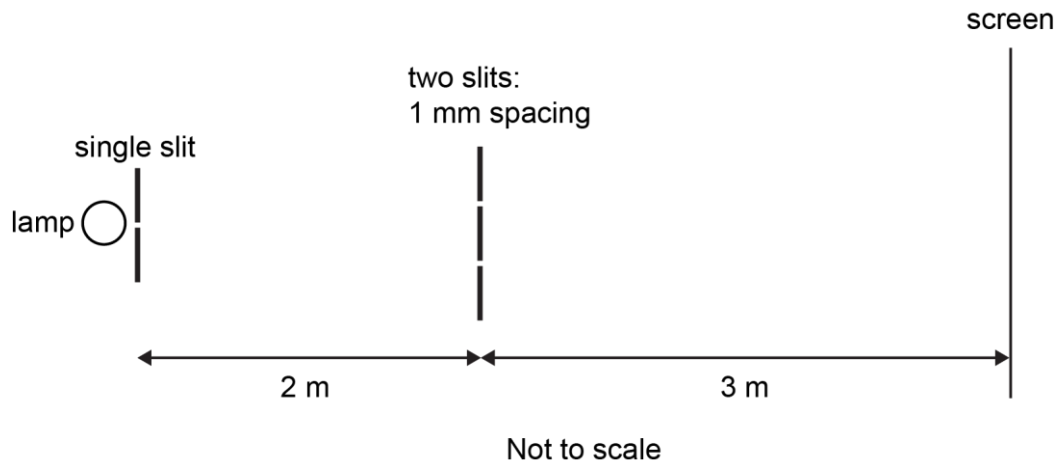


Fig. 2.1

(a) In a laboratory experiment a vertical filament optics lamp and single slit were used as the light source placed 2 m away from a pair of slits. The slits were produced by painting a glass slide black and then scraping two lines in the paint using a pin.

(i) Suggest how the double slit spacing could be determined.

.....

.....

.....

.....**[1]**

(ii) Explain why it is necessary to have a small slit spacing.

.....

.....

.....

.....**[2]**

(b) Fig. 2.2 shows the arrangement used to create the interference pattern on the screen. The slit separation is *d* and the distance from the slits to the screen is *L*. Point **O** shows the position of the central maximum and the distance to the adjacent maximum at point **P** is *x*.

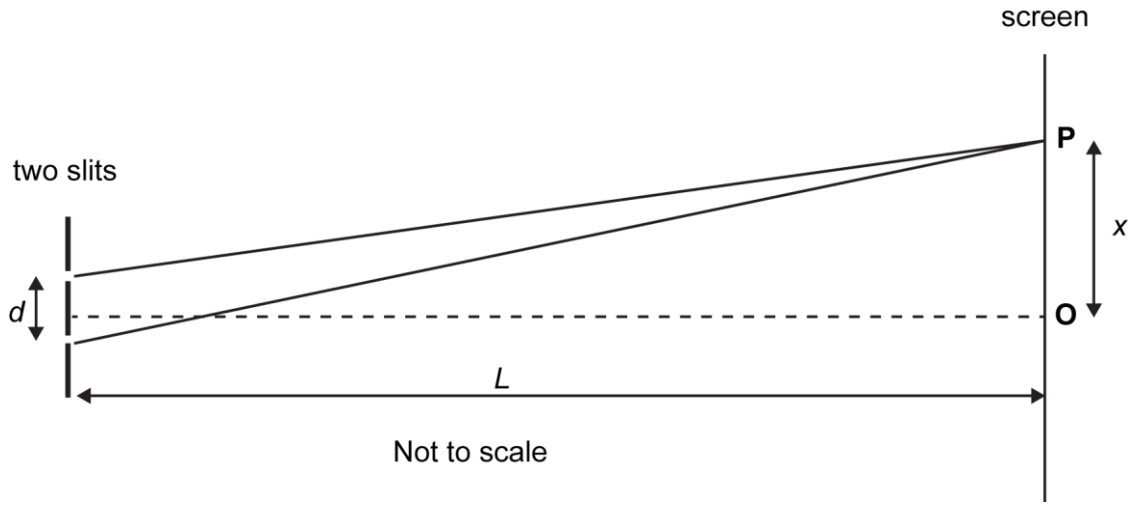


Fig. 2.2

Use the diagram to explain why

$$\lambda \approx \frac{xd}{L}.$$

[2]

(c) Fig. 2.3 shows the pattern of light observed on the screen placed 3 m away from a pair of slits spaced 1 mm apart. The total width of the pattern shown was measured to be 1.3 cm.

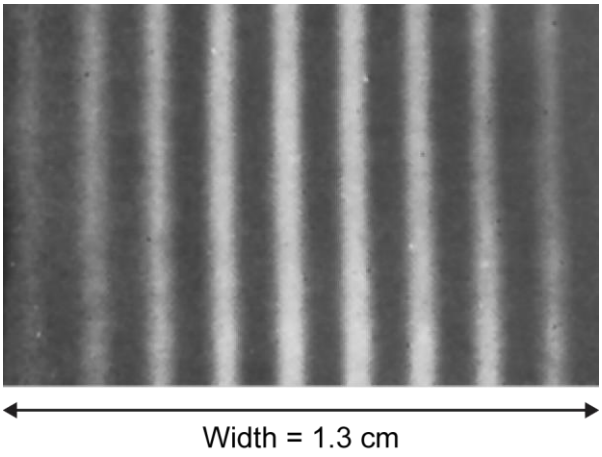


Fig. 2.3

Use data from Fig. 2.3 to estimate the wavelength, λ, of the light used in this experiment.

λ = ... m **[3]**

(d)* Some changes were suggested to improve the experiment:

Increase the distance between the slits and the screen to increase the fringe spacing.

Increase the slit width to increase the intensity of light reaching the screen.

Reduce the distance between the light source and the slits to increase the intensity of the fringes.

Use coloured filters to enable the wavelengths of specific colours to be measured.

Comment on each of the proposals, pointing out any difficulties that may result from the changes mentioned.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

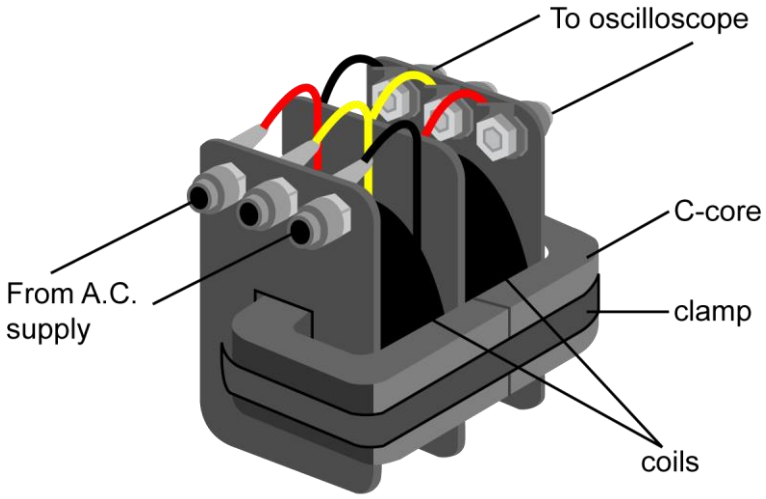
.....

.....

.....**[6]**

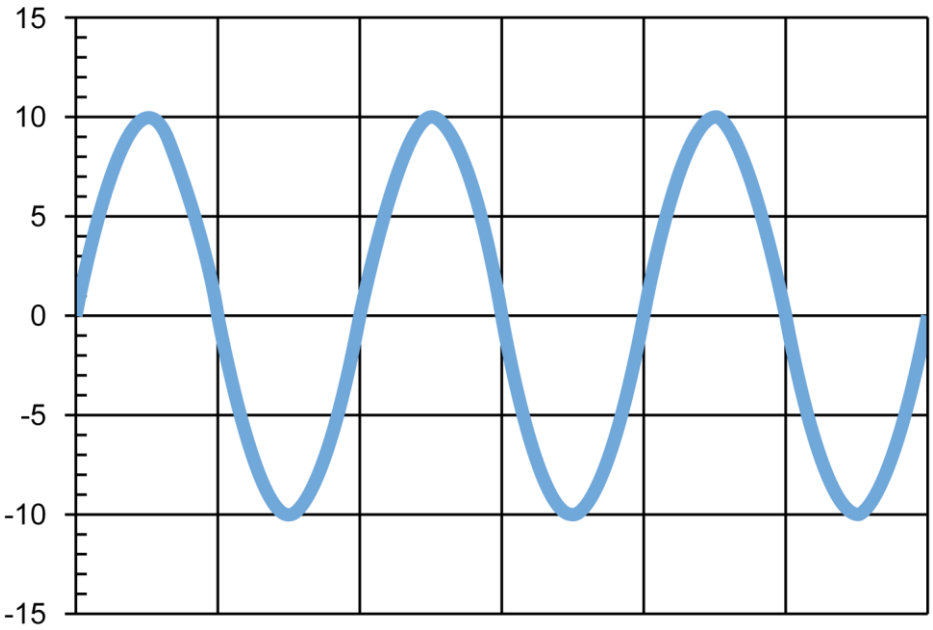
3 This question is about the behaviour of transformers.

In an experiment to verify the relationship between the primary and secondary voltage and the number of turns on the primary and secondary windings, some pre-wound coils were assembled onto a laminated iron C-core as shown below.



(a) The voltages were measured using an oscilloscope. The y axis was set to 5 volts per division and the x axis to 10 milliseconds per division. The voltage gain and time base settings remained constant throughout the experiment.

The trace shown below was obtained with a secondary coil of 300 turns.



(i) Mark with an **X** three points on the trace where the flux in the transformer core is zero.

[1]

(ii) Show that the maximum rate of change of flux in the core is about 3×10^{-2} Wb s^{-1}.

[1]

(iii) Explain why the peak flux in the core is unlikely to exceed 0.17 mWb.

.....

.....

.....

.....**[2]**

(b)* Describe the experiments, using the same apparatus, which would need to be performed in order to verify the equation that links the primary and secondary voltages with the numbers of turns on the primary and secondary coils for an ideal transformer. Include how the data gathered would be analysed in order to see if it was consistent with the equation.

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

....

.... **[6]**

SECTION B

Answer **all** the questions.

4 This question is about an experiment investigating the relationship between volume of a gas, V, and temperature, T, at constant pressure. Fig 4.1 shows measurements taken by a student.

T / °C ±1 °C	V / mm^3 ±5 mm^3
1	115
6	117
10	119
15	122
20	124
25	127
30	130

Fig 4.1

Fig. 4.2 shows the graph for five of the data points.

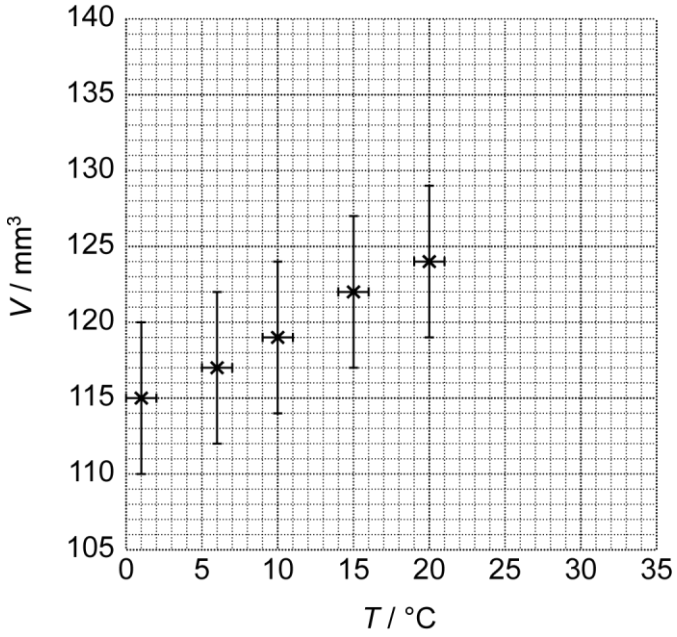


Fig. 4.2

(a) (i) Add the **two** remaining data points to the graph. Include uncertainty bars for the points and an appropriate line of best fit.

[4]

(ii) Calculate the percentage uncertainty for the values of V and T at point (30, 130).

Percentage uncertainty in V = ... %

Percentage uncertainty in T = ... %

[2]

(iii) The sample contains 4.5 μmol of particles. Use data from the graph to calculate the pressure of the gas, P.

P = ... Pa

[4]

(b) Fig. 4.3 shows the same data set plotted on different axes. The uncertainties in *T* and *V* are too small to be shown on this graph.

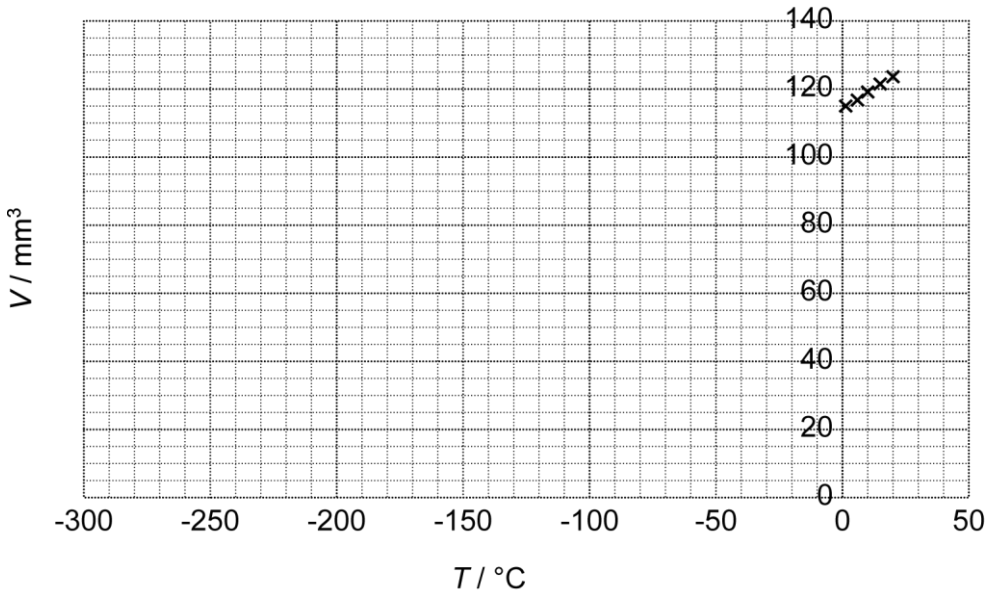


Fig. 4.3

(i) Add a line of best fit to the data points and extrapolate the line so that it intercepts the *x*-axis.

State the value of the *x*-intercept from the graph.

x-intercept = ...**[1]**

(ii) Describe and explain how the motion of the particles in an ideal gas changes as the gas approaches and reaches the temperature given in **b(i)**. Compare and explain any differences in the behaviour of a real gas such as nitrogen as it reaches the temperature given **b(i)**.

.....

.....

.....

.....

.....

.....

.....**[4]**

(iii) The accepted value of the *x*-intercept is – 273 °C. Use your answer from **b(i)** to determine the percentage difference between the experimental and accepted value.

..... % **[1]**

(iv) The uncertainty in the *x*-intercept is found to be 7%. Use this and your answer to **b(iii)** to discuss the accuracy of the investigation.

.....

.....**[2]**

(v) State and explain whether the gas in the investigation can be treated as an ideal gas in the temperature range used.

.....

.....

.....**[1]**

(vi) The molar mass of N_2 is 28 g mol^{-1}.

Treating nitrogen as an ideal gas, calculate the ratio of the r.m.s speed of the gas molecules between *T*= 20 °C and *T*= -196 °C.

Number of particles in one mole = 6.0 x 10^{23} mol^{-1}

[4]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).