Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

5158683849

PHYSICS **9702/51**

Paper 5 Planning, Analysis and Evaluation **May/June 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **8** printed pages.

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CAMBRIDGE International Examinations

1 A student is investigating the force between two charged metal spheres S and T, as shown in Fig. 1.1.

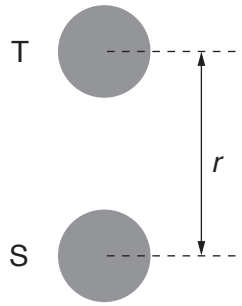

Fig. 1.1

Each sphere may be charged by connecting the positive lead from a power supply to the sphere and then removing the lead. The electromotive force (e.m.f.) of the power supply used to charge sphere T is V.

The force F between the two charged spheres may be determined by attaching sphere S to a top pan balance.

For a constant charge on sphere S, it is suggested that the relationship between F and V is

$$F = \frac{\alpha V}{r^2}$$

where r is the distance between the centres of the spheres and α is a constant.

Design a laboratory experiment to test the relationship between F and V.
Explain how your results could be used to determine a value for α.

You should draw a diagram, on page 3, showing the arrangement of your equipment. In your account you should pay particular attention to

- the procedure to be followed,
- the measurements to be taken,
- the control of variables,
- the analysis of the data,
- any safety precautions to be taken.

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Diagram

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2 A student is investigating monochromatic light passing through a diffraction grating. A series of maxima are produced on a screen, as shown in Fig. 2.1.

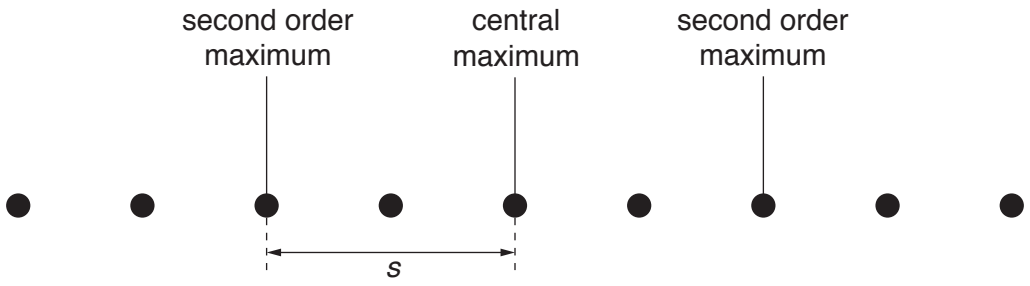

Fig. 2.1

The student measures the distance s between the central maximum and the second order maximum on the screen.

The experiment is repeated for different wavelengths of light.

It is suggested that s and the wavelength λ are related by the equation

$$\frac{s^2}{s^2 + D^2} = 4N^2\lambda^2$$

where D is the distance between the diffraction grating and the screen and N is the number of lines per unit length of the diffraction grating.

(a) A graph is plotted of $\frac{1}{s^2}$ on the y-axis against $\frac{1}{\lambda^2}$ on the x-axis.

Determine expressions for the gradient and y-intercept.

gradient = ...

y-intercept = ...

[1]

(b) Values of λ and s are given in Fig. 2.2.

$\lambda / 10^{-7}\,\text{m}$	s / m	$\frac{1}{\lambda^2} / 10^{12}\,\text{m}^{-2}$	$\frac{1}{s^2} / \text{m}^{-2}$
4.3	0.62 ± 0.02		
4.8	0.72 ± 0.02		
5.3	0.82 ± 0.02		
5.8	0.92 ± 0.02		
6.2	1.02 ± 0.02		
6.6	1.10 ± 0.02		

Fig. 2.2

Calculate and record values of $\frac{1}{\lambda^2} / 10^{12}\,\text{m}^{-2}$ and $\frac{1}{s^2} / \text{m}^{-2}$ in Fig. 2.2.

Include the absolute uncertainties in $\frac{1}{s^2}$. [2]

(c) (i) Plot a graph of $\frac{1}{s^2} / \text{m}^{-2}$ against $\frac{1}{\lambda^2} / 10^{12}\,\text{m}^{-2}$.

Include error bars for $\frac{1}{s^2}$. [2]

(ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Both lines should be clearly labelled. [2]

(iii) Determine the gradient of the line of best fit. Include the absolute uncertainty in your answer.

gradient = ... [2]

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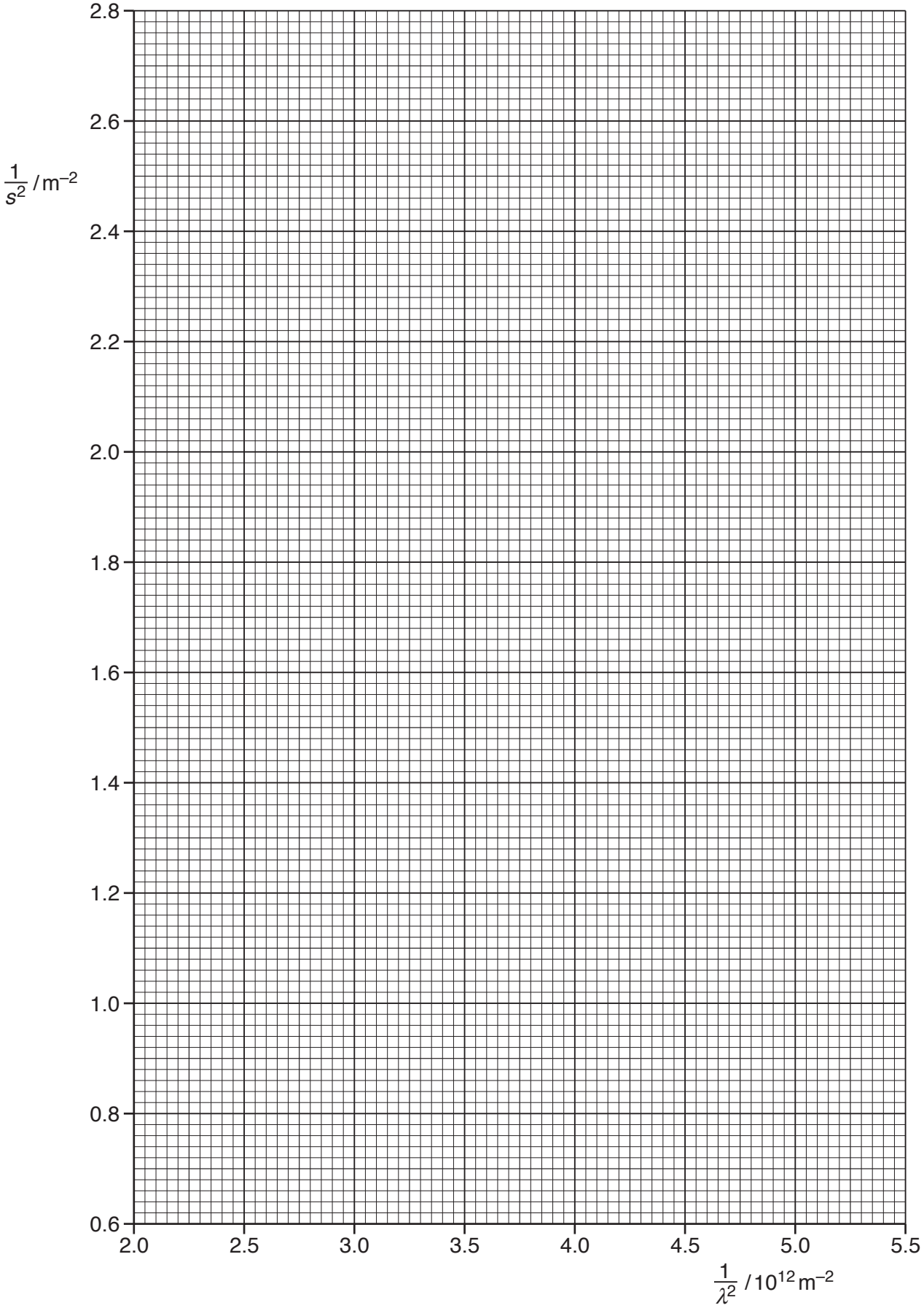

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[Turn over

(iv) Determine the *y*-intercept of the line of best fit. Include the absolute uncertainty in your answer.

y-intercept = ... [2]

(d) (i) Using your answers to **(a)**, **(c)(iii)** and **(c)(iv)**, determine the values of *D* and *N*. Include appropriate units.

D = ...

N = ...
[3]

(ii) Determine the percentage uncertainty in *N*.

percentage uncertainty in *N* = ... % [1]

[Total: 15]

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