UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education Advanced Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

6226761837

PHYSICS **9702/51**

Paper 5 Planning, Analysis and Evaluation **May/June 2011**

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 a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
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.

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1	
2	
Total	

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1 When light is incident on the front of a photocell, an e.m.f. is generated in the photocell.

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A student wishes to investigate the effect of adding various thicknesses of glass in front of a photocell. This may be carried out in the laboratory by varying the number of identical thin glass sheets between a light source and the front of the photocell.

It is suggested that the e.m.f. V is related to the number n of glass sheets by the equation

$$V = V_0 e^{-\alpha n t}$$

where t is the thickness of one sheet, α is the absorption coefficient of glass and V_0 is the e.m.f. for $n = 0$.

Design a laboratory experiment to determine the absorption coefficient of glass. You should draw a diagram, on page 3, showing the arrangement of your equipment. In your account you should pay particular attention to

(a) the procedure to be followed,

(b) the measurements to be taken,

(c) the control of variables,

(d) the analysis of the data,

(e) the safety precautions to be taken.

[15]

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Diagram

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For Examiner's Use

For Examiner's Use	Defining the problem	Methods of data collection	Method of analysis	Safety considerations	Additional detail

2 A student is investigating how a volume of nitrogen gas is affected by the pressure exerted on it.

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A sample of nitrogen gas is trapped in a vertical tube of uniform cross-sectional area by a small volume of oil. Pressure is applied by a pump. The applied pressure is measured on a gauge, as shown in Fig. 2.1.

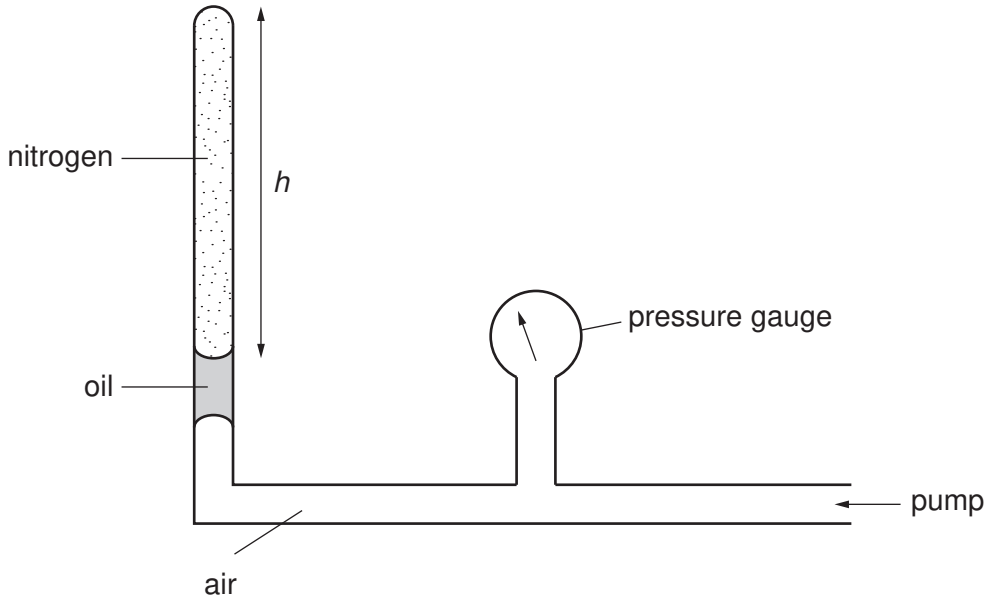

Fig. 2.1

The temperature T of the nitrogen is 290 K.

An experiment is carried out to investigate how the height h of nitrogen trapped in the tube varies with the pressure p.

Question 2 continues on the next page.

It is suggested that p and h are related by the equation

$$pAh = NkT$$

where A is the cross-sectional area of the tube, k is the Boltzmann constant and N is the number of molecules of nitrogen gas.

(a) A graph is plotted of p on the y-axis against $\frac{1}{h}$ on the x-axis. Express the gradient in terms of N.

gradient = ...[1]

(b) Values of p and h are given in Fig. 2.2.

$p/10^5$ Pa	$h/10^{-3}$ m	
1.10	400 ± 5	
1.22	360 ± 5	
1.38	320 ± 5	
1.57	280 ± 5	
1.83	240 ± 5	
2.09	210 ± 5	

Fig. 2.2

Calculate and record values of $\frac{1}{h}$ in Fig. 2.2. Include the absolute uncertainties in $\frac{1}{h}$.

[3]

(c) **(i)** Plot a graph of $p/10^5$ Pa against $\frac{1}{h}/\text{m}^{-1}$. Include error bars for $\frac{1}{h}$. [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 uncertainty in your answer.

gradient = ...[2]

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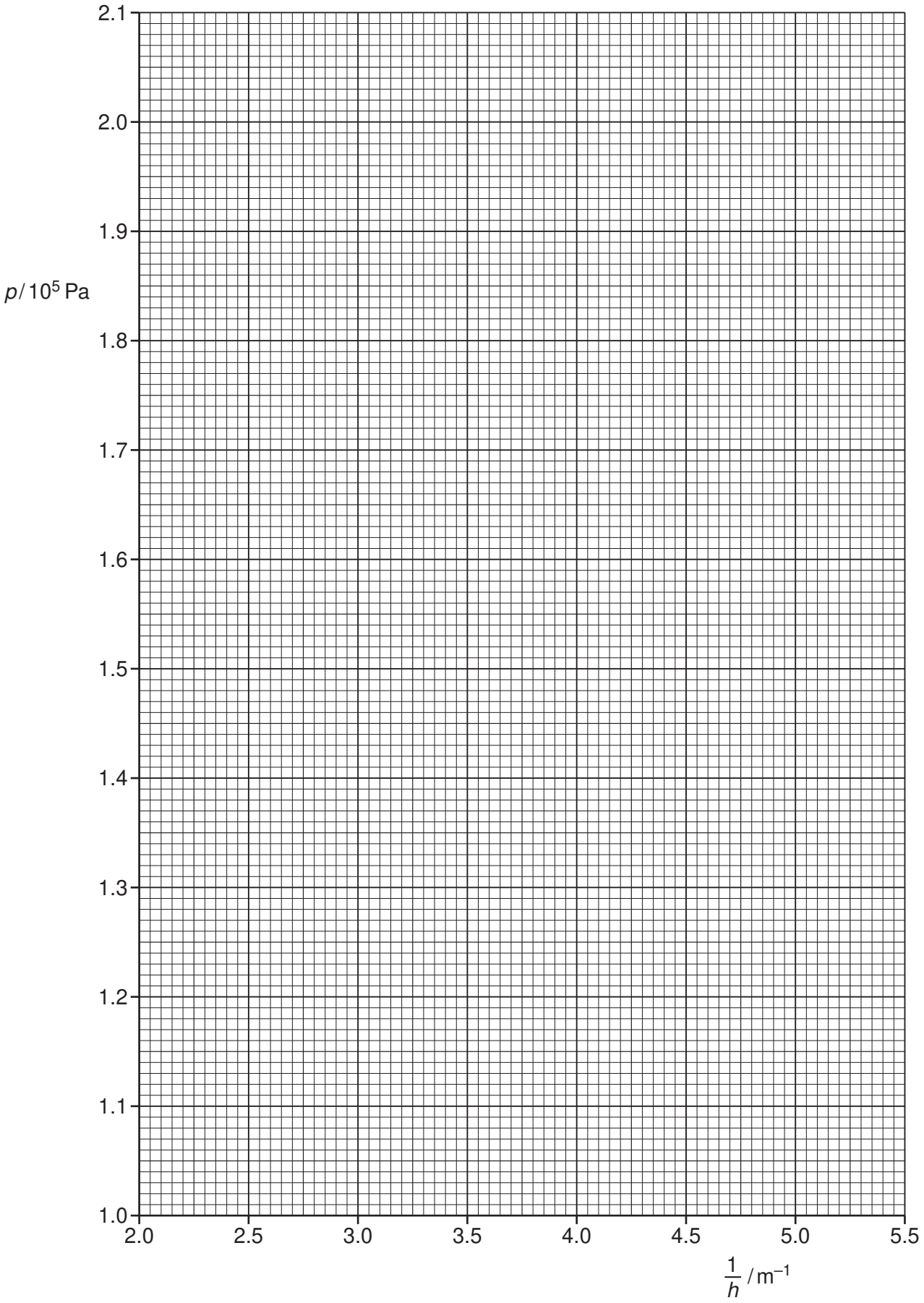

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(d) In this experiment, $A = 3.14 \times 10^{-6}\,m^2$ and $k = 1.38 \times 10^{-23}\,J\,K^{-1}$. Using your answer in **(c)(iii)**, determine the value of N. Include the absolute uncertainty in your value.

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N = ...[2]

(e) **(i)** The pressure is reduced so that $p = 1.10 \times 10^5$ Pa and the temperature decreases by 12 ±1 K.

Determine h using the relationship given and your answer in **(d)**.

h = ...[2]

(ii) Determine the percentage uncertainty in your value of h.

percentage uncertainty = ... % [1]

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