



Rewarding Learning

ADVANCED
General Certificate of Education

Centre Number

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Candidate Number

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Physics

Assessment Unit A2 3B

assessing

Practical Techniques
and Data Analysis



[APH32]

APH32

Assessment

TIME

1 hour.

Assessment Level of Control:

Tick the relevant box (✓)

Controlled Conditions	
Other	

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer the questions in the spaces provided.

Do not write outside the boxed area on each page or on blank pages.

Complete in black ink only. **Do not write with a gel pen.**

Answer **all four** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 50.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

You may use an electronic calculator.



- 1 The apparatus shown in **Fig. 1.1** can be used to determine the specific heat capacity of aluminium.

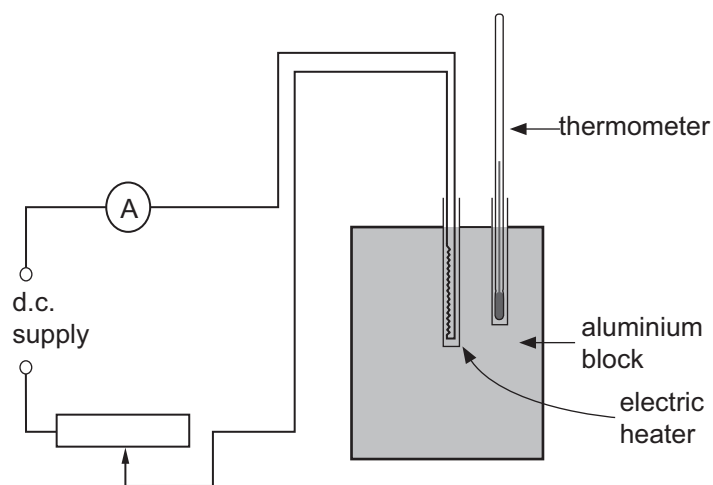


Fig. 1.1

The initial temperature of the aluminium block was recorded using the thermometer. The heater was then turned on for 20 minutes. The current remained almost constant for the duration of the experiment. Details of the measurements made during the experiment are recorded in **Table 1.1**.

Table 1.1

Measurement	Value	Unit
Mass of aluminium block, m	1020	g
Average current, I	2.02	A
Initial temperature, θ	23	$^{\circ}\text{C}$
Final temperature, θ	38	$^{\circ}\text{C}$
Time of heating, t	1200	s



(a) (i) The specific heat capacity of the aluminium can be determined from the results obtained.

Would you expect this experimental value to be higher or lower than the actual value for the specific heat capacity of aluminium? Explain your answer.

[2]

(ii) Explain how you would modify the apparatus in **Fig. 1.1** to obtain a more accurate value for the specific heat capacity of aluminium.

[1]

(iii) Explain why it is poor practice to record the final temperature of the aluminium block at the same time that the heater is switched off. State how you would obtain a more accurate value for the final temperature of the aluminium block.

[2]

[Turn over



- (b) The equipment used to measure each quantity and its associated uncertainty is stated in **Table 1.2**.

Table 1.2

Measurement	Equipment used	Uncertainty
Mass	Balance	± 1 g
Current	Ammeter	± 0.01 A
Temperature	Thermometer	± 1 °C
Time	Stopclock	± 1 s

The specific heat capacity c is given by **Equation 1.1**

$$c = \frac{I^2 R t}{m \Delta \theta} \quad \text{Equation 1.1}$$

Use **Equation 1.1** along with the information given in **Table 1.1** and **Table 1.2** to determine the percentage uncertainty in the value of the specific heat capacity of the aluminium.

Assume the uncertainty in the value of the resistance R of the electric heater is negligible.

Percentage uncertainty in $c =$ _____ %

[5]





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- 2 The viscosity η of a liquid can be determined by observing the motion of a sphere falling through the liquid.

In this experiment, a long graduated tube with equally spaced markers is filled with a liquid, glycerol, as shown in **Fig. 2.1**. A steel ball bearing, of diameter d , is released from rest at the surface of the glycerol. It initially accelerates before moving with a constant velocity known as its terminal velocity v_t .

The experiment is repeated for ball bearings of various diameters.

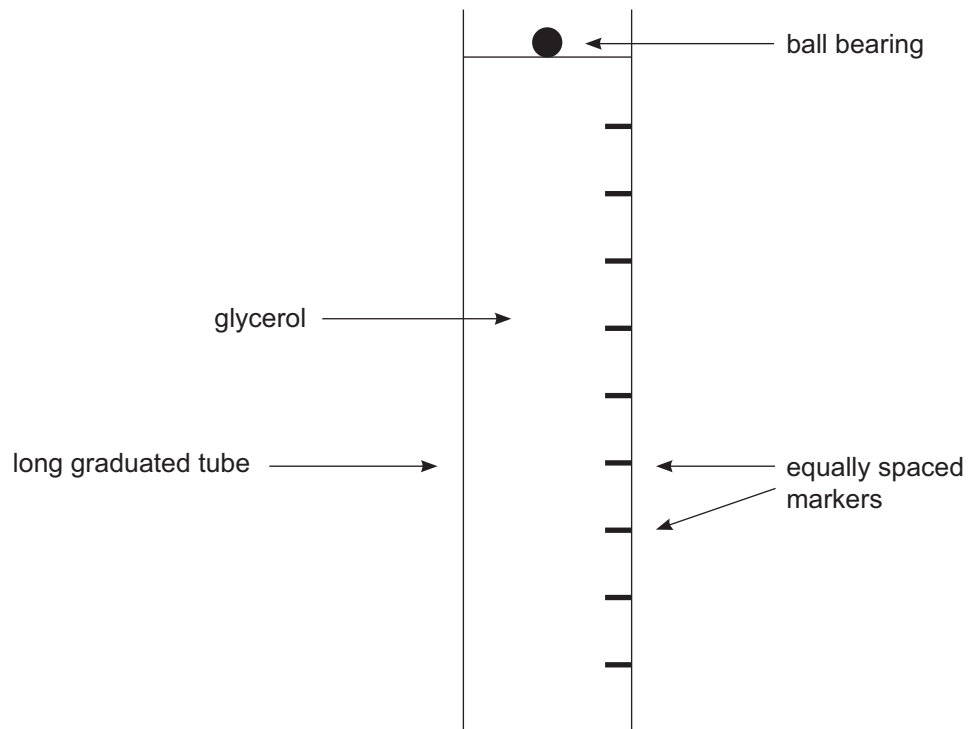


Fig. 2.1

The viscosity η is related to the diameter d of the ball bearing and its terminal velocity v_t according to **Equation 2.1**

$$\eta = \frac{Xd^2}{v_t} \quad \text{Equation 2.1}$$

where X is a known constant.



(a) The ball bearings to be used have diameters ranging from approximately 4 mm to 12 mm.

(i) Name the piece of apparatus you would use to measure the diameter of these ball bearings.

_____ [1]

(ii) Describe how this piece of apparatus is used to obtain as accurate a value of the diameter as possible.

_____ [2]

[Turn over



(b) A stopclock is started as the ball bearing is released at the surface.

The time that the ball bearing passes each marker in its descent is recorded.

(i) How can you tell when the ball bearing has reached its terminal velocity?

[1]

(ii) Explain how you would determine a reliable value for the terminal velocity.

[4]

(iii) Why is it best to adjust your position so that you view each marker at eye level?

[1]



(c) (i) The experiment is completed for all the ball bearings and the graph shown in Fig. 2.2 is obtained.

State how the value for the viscosity of the glycerol is obtained.

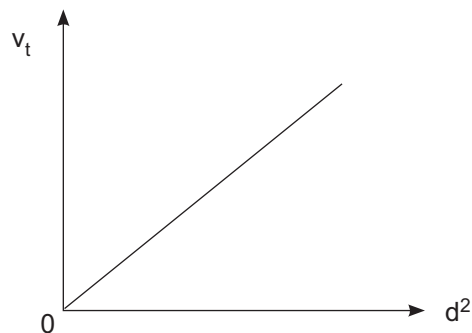


Fig. 2.2

[1]

(ii) Determine the SI unit for η .

The SI unit for X is $\text{kg m}^{-2} \text{s}^{-2}$.

Unit for η = _____ [2]



- 3 It was known that a frequency meter was not accurately recording the frequency produced by a signal generator. The output from the signal generator was set at a fixed value and connected across the y-input of a CRO to allow for a more accurate determination of the frequency.

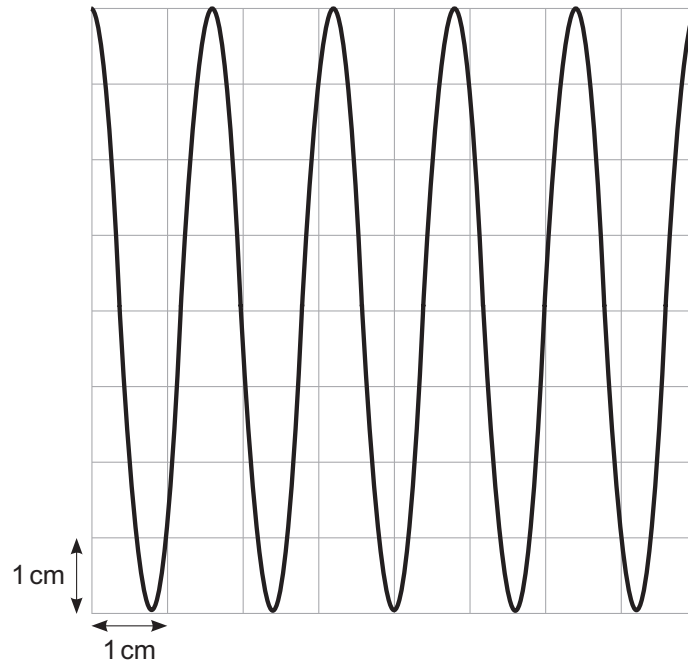


Fig. 3.1



(a) The trace observed on the CRO is shown on **Fig. 3.1**.

Determine the frequency of the fixed value of the signal generator if the timebase is set to 20 ms cm^{-1} .

Frequency = _____ Hz [4]

(b) Assume the value for the frequency determined using the CRO and calculated in (a) is accurate. The value of this frequency using the frequency meter has a percentage error of 7.7% compared to the value from the CRO. Determine the frequency shown on the frequency meter if the meter reads to 0.1 Hz and is reading less than the accurate value obtained using the CRO.

Frequency shown on meter _____ Hz [2]

[Turn over



- 4 A radioactive source was placed a fixed distance from a Geiger-Muller tube and the count rate was measured three times. A lead plate of thickness 5 mm was placed between the source and the counter as illustrated in **Fig. 4.1** and the count rate per minute was once again measured three times. The experiment was repeated for a maximum of 4 lead plates, each of thickness 5 mm.

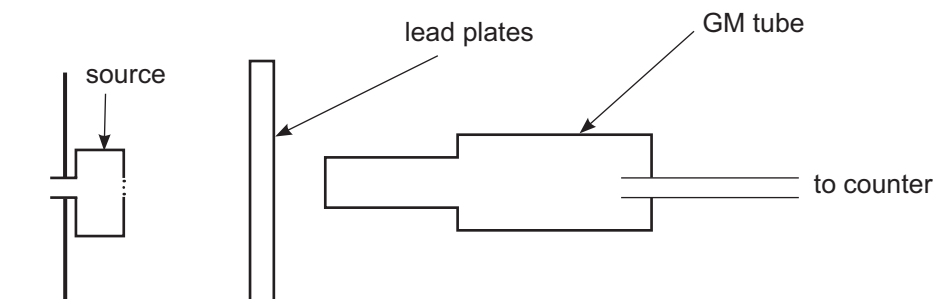


Fig. 4.1

The results of the experiment are shown in **Table 4.1**.

Table 4.1

Number of lead plates P	Count rate C / min ⁻¹				Corrected count rate C / min ⁻¹
	1	2	3	Average	
0	2191	2190	2189		
1	1315	1945	1317		
2	773	771	775		
3	473	480	468		
4	280	272	270		

- (a) What type of radiation is being detected?

_____ [1]



(b) (i) Calculate the average values for the counts per minute and insert them into **Table 4.1**. [2]

(ii) Initial observations showed that the background count rate was 40 counts per minute.

Calculate the corrected count rate C for each plate and insert your values into **Table 4.1**. [1]

(c) The corrected count rate C is related to the number of lead plates P between the source and the Geiger counter according to **Equation 4.1**

$$C = C_0 e^{-\mu P} \quad \text{Equation 4.1}$$

where C_0 is the corrected count rate with no plate present and μ is a constant.

(i) A graph of the corrected count rate C against the number of lead plates P can be plotted and used to determine a value for the constant μ .

Plot this graph on the grid of **Fig. 4.2**. The horizontal axis has been labelled and scaled for you. Scale the vertical axis appropriately, plot the points and draw the best-fit curve for the points plotted. [4]

[Turn over



The constant μ is related to the number of plates required to reduce the count rate per minute to half of its initial value. This number of plates is called the half-value plate number $P_{\frac{1}{2}}$.

The relationship between μ and $P_{\frac{1}{2}}$ is given by **Equation 4.2**

$$\mu = \frac{\ln 2}{P_{\frac{1}{2}}} \quad \text{Equation 4.2}$$

- (ii) Use your graph to determine an accurate value for $P_{\frac{1}{2}}$ and hence the value of the constant μ .

$$P_{\frac{1}{2}} = \underline{\hspace{10cm}}$$

$$\mu = \underline{\hspace{10cm}}$$

[5]

- (iii) Calculate the thickness of lead plates required to reduce the initial count rate per minute by half.

$$\text{Thickness} = \underline{\hspace{10cm}} \text{ mm}$$

[1]



C / min⁻¹

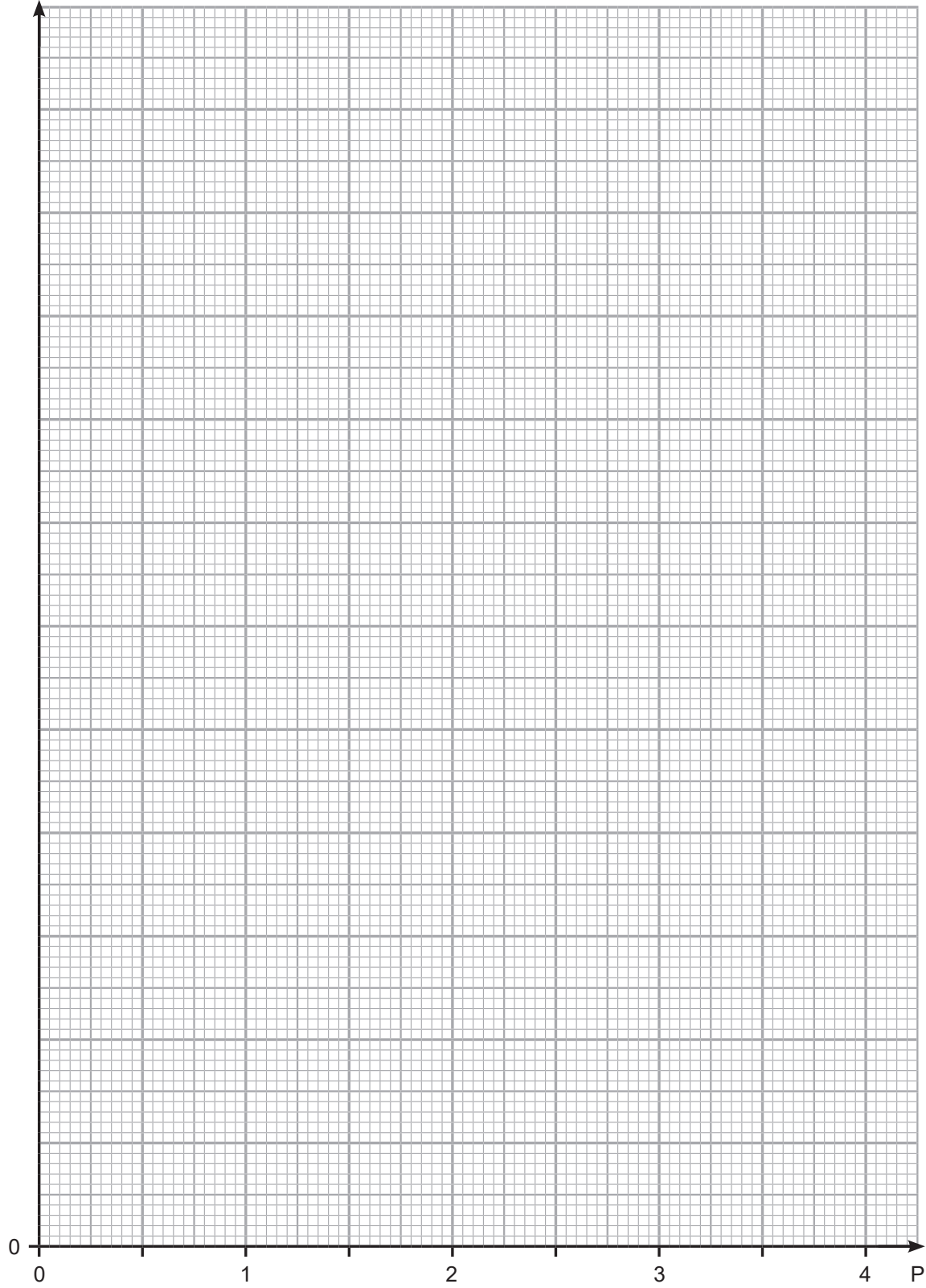


Fig. 4.2

[Turn over

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- (d) (i) By taking the natural log (\ln) of both sides of **Equation 4.1**, a more accurate value of μ can be obtained by drawing a linear graph. State what variables would be plotted on each axis to obtain this linear graph.

Vertical axis _____

Horizontal axis _____

[3]

- (ii) State how you would determine the value of the constant μ from the graph.

_____ [2]

- (iii) If the count rate values had not been adjusted for the background count, state how, if at all, the intercept of your graph would be affected.

_____ [1]



(iv) State two safety precautions that should be employed when handling radioactive sources.

[2]

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Question Number	Marks
1	
2	
3	
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Total Marks	
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Examiner Number

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