Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2016

Centre Number

Candidate Number

Physics

Assessment Unit AS 3
assessing
Practical Techniques
Session 1

ML

[AY131]

WEDNESDAY 11 MAY, MORNING

TIME

1 hour 30 minutes, plus your additional time allowance.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
Turn to page 2 for further Instructions and Information.

Question Number	Marks	Remark
1		
2		
3		
4		
5		
Total Marks		

INSTRUCTIONS TO CANDIDATES

Answer **all** the questions in this booklet. Rough work and calculations must also be done in this booklet. Except where instructed, do **not** describe the apparatus or experimental procedures.
The Teacher/Supervisor will tell you the order in which you are to answer the questions.
One hour is to be spent on Section A and 30 minutes on Section B.
Section A consists of four short experimental tests. **You will have access to the apparatus for 13 minutes for each of the tests.** At the end of this 13-minute experimental period there is a 2-minute changeover to the area set aside for the next test. Any spare time before the start of the next test may be used to write up anything you have not yet completed.
At the end of your Section A work you will be told to move to the area set aside for Section B.
Section B consists of one question in which you will analyse a set of experimental results.

INFORMATION FOR CANDIDATES

The total mark for this paper is 40.
Section A and Section B carry 20 marks each.
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.

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(Questions start overleaf)

Section A

Examiner Only	
Marks	Remark

1 (a) (i) Place the straight edge of the semicircular transparent block on the long line XY. Do this on **Fig. 1.1**. The **centre** of the block's straight edge should be at the point where the line marked "normal" cuts XY. The curved edge of the block lies below **XY** as shown by the dashed line.

On **Fig. 1.1**, direct a ray of light along the line marked "ray 1". Mark the position of the refracted ray and complete **Fig. 1.1** by drawing the refracted ray.
On **Fig. 1.1**, mark the angle between the refracted ray and the normal and label it 'α'.

Measure the angle marked θ and the angle marked α and record their values below.

θ = _______________ °

α = _______________ ° [2]

(ii) Determine the refractive index, n, of the material from which the transparent block is made.

n = _______________ [1]

Examiner Only	
Marks	Remark

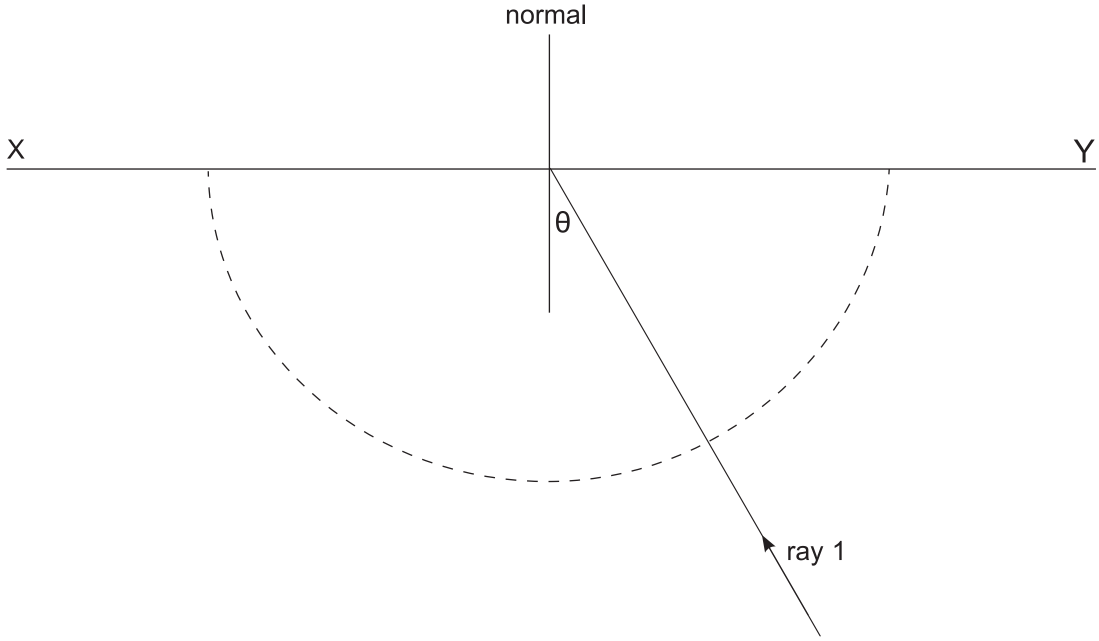

Fig. 1.1

(b) Replace the block exactly as in question **(a)(i)**.
Do this on **Fig. 1.2**.

Increase the angle of incidence, θ, in the block until the ray is **just** totally internally reflected.

Mark the position of the corresponding incident ray.

Remove the block and complete **Fig. 1.2** by drawing the incident ray and labelling the critical angle 'C'.

Measure angle C and record the value below.

C = _______________ ° [1]

Examiner Only	
Marks	Remark

The critical angle and refractive index are related by **Equation 1.1**

$$n \sin C = K \qquad \textbf{Equation 1.1}$$

where K is a constant.

(c) Determine the value of K.

K = _______________ [1]

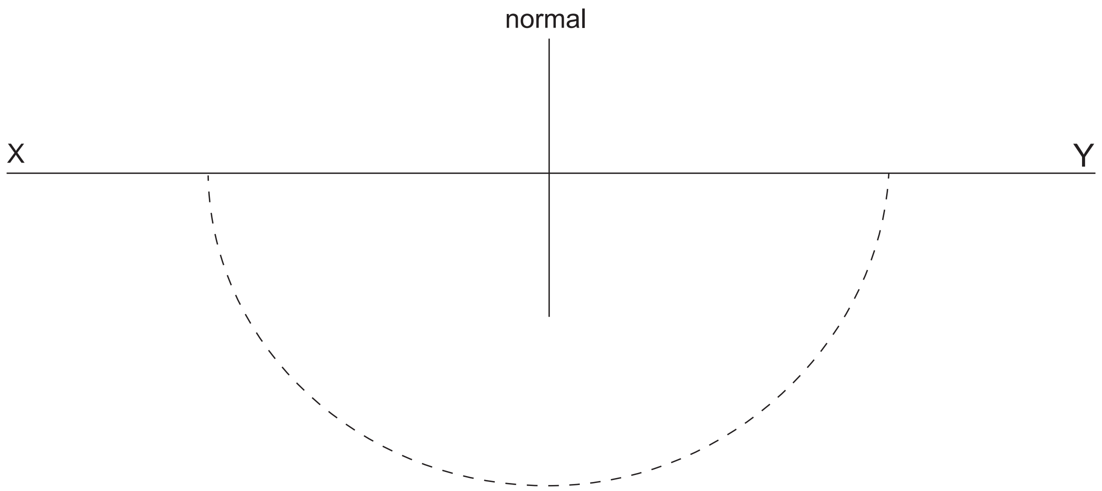

Fig. 1.2

Examiner Only

Marks	Remark

2 You are provided with the circuit shown in **Fig. 2.1**. The value of resistance R_1 is to be determined by taking measurements of the potential difference across the terminals of the variable power supply and across resistor R_1 for different values of R_2.

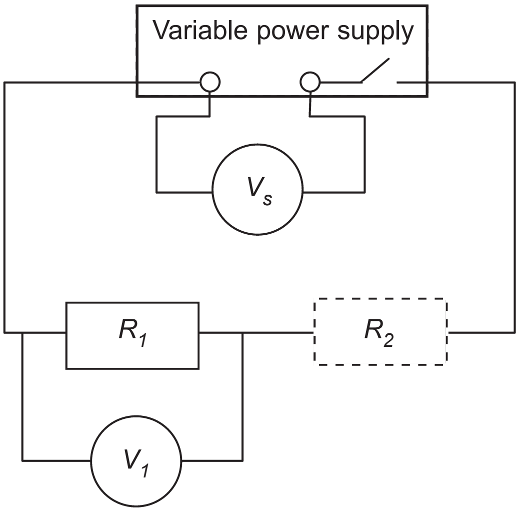

Fig. 2.1

(a) Use the ohmmeter to measure the resistance of the resistors labelled R_{2a}, R_{2b} and R_{2c}.
Record these values in **Table 2.1** in the column headed R_2/Ω. [1]

Table 2.1

Resistor	R_2/Ω	V_s/V	V_1/V	R_1/Ω
R_{2a}				
R_{2b}				
R_{2c}				

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

(b) (i) Insert resistor R_{2a} into the circuit at position R_2 as shown in **Fig. 2.1**. Adjust the variable power supply so that V_s has a value between 4V and 5V and record the values for V_s and V_1 in **Table 2.1**.

(ii) Remove R_{2a} and replace it by resistor R_{2b}. Adjust the variable power supply so that V_s has a value between 7V and 8V and record the new values for V_s and V_1 in **Table 2.1**.

(iii) Remove R_{2b} and replace it by resistor R_{2c}. Adjust the variable power supply so that V_s has a value between 10V and 11V and record the new values for V_s and V_1 in **Table 2.1**.

[2]

(c) Theory states that the unknown resistance R_1 is linked to the other variables by **Equation 2.1**.

$$R_1 = \frac{V_1 R_2}{V_s - V_1} \qquad \textbf{Equation 2.1}$$

(i) Use **Equation 2.1** to calculate a value for R_1 for each value of R_2 and record the values in **Table 2.1**. [1]

(ii) Comment on the reliability of the R_1 values obtained and justify your comment.

____

____

____ [1]

Examiner Only	
Marks	Remark

3 In this question you are to obtain a value for the length of the metal wire from which a paper clip is made and to estimate the uncertainties in the length and cross-sectional area of the wire.

Carefully straighten the paper clip as best you can.

(a) **(i)** Use a ruler to measure **one** value for the length, L, of the straightened clip. Estimate the absolute uncertainty in your value for length, L. Record your answers, with the appropriate unit, in the spaces below.

$L =$ ______________ $\pm$ ______________ [1]

(ii) Explain how you got this value for the absolute uncertainty.

____

____

____ [1]

(b) Use a micrometer screw gauge to obtain a **reliable** value for the diameter, d.

$d =$ ______________ mm [1]

(c) The wire has a circular cross section. **Equation 3.1** states the relationship between the area, A, and diameter, d, of a circle.

$$A = \frac{\pi d^2}{4} \qquad \textbf{Equation 3.1}$$

Determine the percentage uncertainty, $\%U_A$, in the value for A, given that the absolute uncertainty in using the micrometer screw gauge is ± 0.01 mm.

$\%U_A =$ ____________________ [2]

Examiner Only	
Marks	Remark

4 A newtonmeter is attached to a wooden block using string, as shown in **Fig. 4.1**. The size of the frictional force between the wooden block and the bench is the value on the newtonmeter when the block is pulled so that it moves at a **steady speed**.

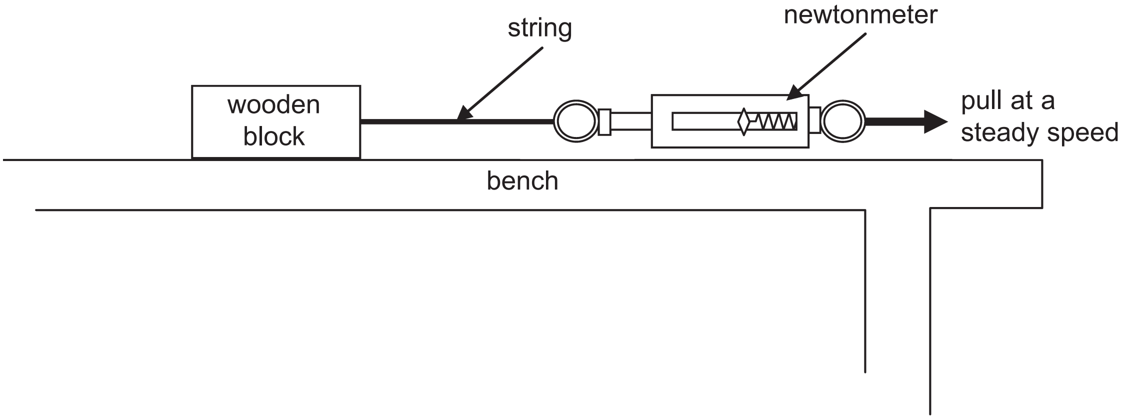

Fig. 4.1

(a) (i) Use the top pan balance to measure the mass of the wooden block. Record the value in the shaded cell in **Table 4.1**.

(ii) Pull the block of wood along the desk, for about a metre, at a steady speed and record the frictional force in **Table 4.1**. Repeat the procedure until you consider the results to be consistent.

Table 4.1

Total mass moved/g	Frictional Force/N	Mean frictional force/N

Examiner Only	
Marks	Remark

Examiner Only	
Marks	Remark

(iii) Next, add a 500 g mass to the top of the wooden block. Record the total mass in **Table 4.1**.

(iv) Pull the block of wood with 500 g on top along the desk for about a metre and record the frictional force in **Table 4.1**. Repeat the procedure until you consider the results to be consistent.

(v) Add a second 500 g mass and repeat the procedure, recording values in **Table 4.1**. [2]

(b) Determine the mean frictional force for each mass. Record your values of force in **Table 4.1**. [1]

(c) Below are three possible relationships between the frictional force, F, and the mass, m, of the object moved,

$F = \beta m^2$ **Equation 4.1**

$F = \beta m$ **Equation 4.2**

$F = \frac{\beta}{m}$ **Equation 4.3**

where β is a constant.

Select which relationship best fits the data you have recorded in **Table 4.1** and justify your choice.

Relationship = _______________

____

____

____ [2]

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Section B

5 An electric current flowing through a copper wire is due to the movement of electrons. The average speed, v, of the electrons (in m s^{-1}) moving towards the positive terminal of the power supply (the drift speed) is given by the relationship in **Equation 5.1**,

$$v = \frac{1}{5.33 \times 10^{10}\, d^2} \qquad \textbf{Equation 5.1}$$

where d is the diameter of the copper wire (in m).

(a) (i) Complete **Table 5.1** by calculating the electron drift speed, in m s^{-1}, for the following wire diameters. Give all drift speeds to 3 significant figures.

Table 5.1

***d*/mm**	***v*/m s^{-1}**
0.711	
0.559	
0.376	
0.234	
0.152	

[3]

(ii) It is possible to draw a **linear** graph to show the relationship between v and d. State what should be plotted on each axis and the numerical value for the gradient along with its unit.

y-axis = ________________

x-axis = ________________

Gradient = ________________ unit = ________________

[4]

(b) **Table 5.2** provides data showing the variation of drift speed, *v*, with current, I, through a wire of cross-sectional area $8.82 \times 10^{-7}\,m^2$.

Table 5.2

I/mA	v/μm s^{-1}
193	15.8
378	30.8
429	35.9
547	46.6
639	52.6

On the grid of **Fig. 5.1** draw a graph of I (*y*-axis) against *v* (*x*-axis).

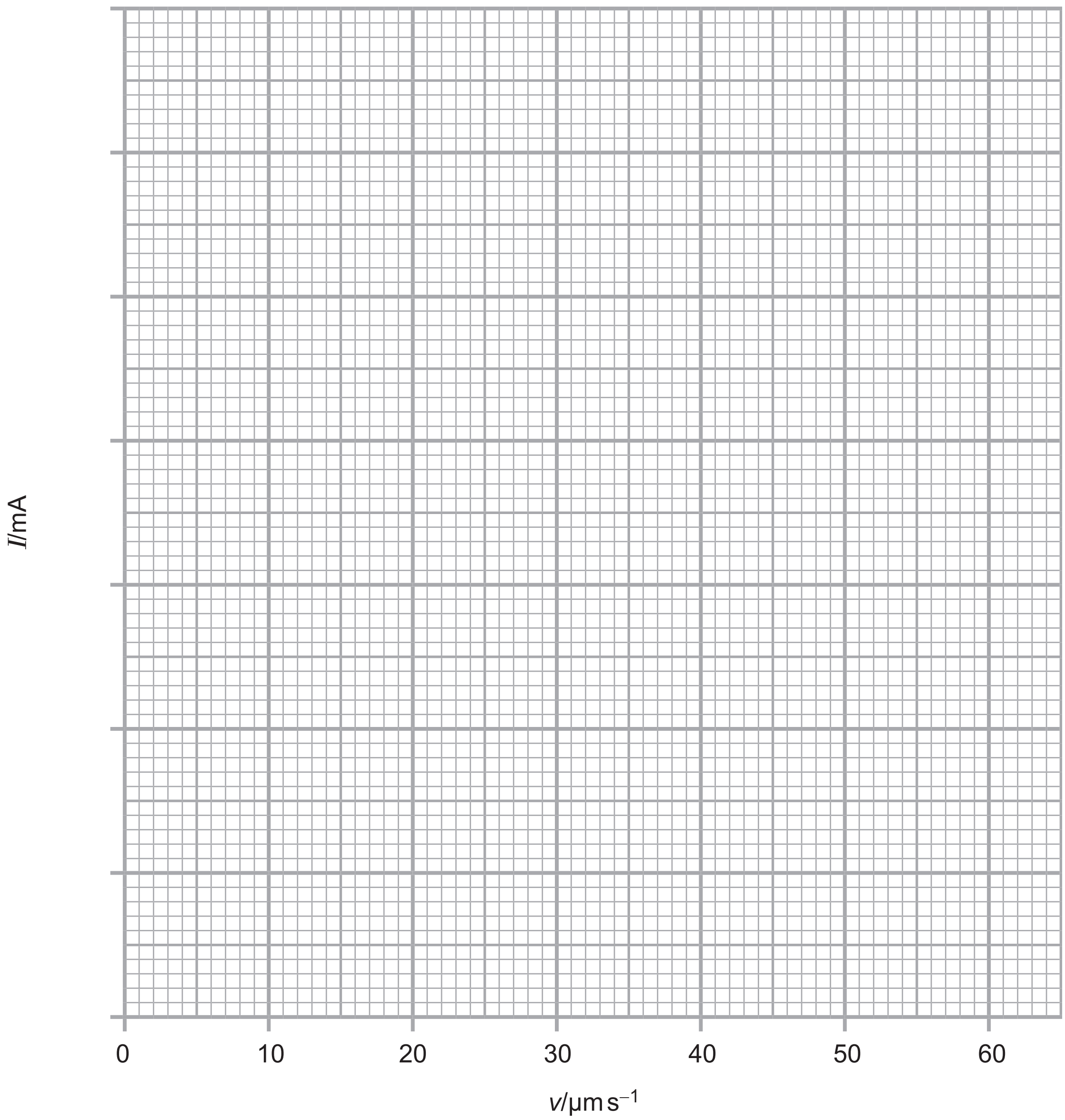

Fig. 5.1

[4]

Examiner Only

Marks	Remark

(c) (i) Determine the gradient of the graph drawn in **Fig. 5.1** and state the unit in which it is measured.

Gradient = _______________ unit = _______________

[4]

The gradient, m, of the graph in **Fig. 5.1** is related to the number of free electrons, n, in a cubic metre of copper by **Equation 5.2**,

$$m = nAe \qquad \textbf{Equation 5.2}$$

where A is the cross-sectional area of the wire ($8.82 \times 10^{-7}\,\text{m}^2$) and e is the electronic charge (1.60×10^{-19} C).

(ii) Determine the number of free electrons that exist in a cubic metre of copper.

Number = _______________ [2]

(iii) Determine the density of copper, in $\text{kg}\,\text{m}^{-3}$, if each atom contributes a single free electron, and 6.02×10^{23} copper atoms have a mass of 63.6 g.

Density = _______________ $\text{kg}\,\text{m}^{-3}$ [3]

THIS IS THE END OF THE QUESTION PAPER

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