**Instructions to candidates**

1. Write your **Name, Index Number**, school and date in the spaces provided above.
2. **Sign** and **write** the date of examination in the spaces provided above.
3. Answer **ALL** the questions in the spaces provided.
4. All writing **MUST** be clearly shown in the spaces provided.

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**For Examiner’s use only**

<table>
<thead>
<tr>
<th>Question</th>
<th>1 (e)</th>
<th>1 (f)</th>
<th>1 (g)</th>
<th>1 (h)</th>
<th>2 (b)</th>
<th>2 (d)</th>
<th>2 (e)</th>
<th>2 (f)</th>
<th>2 (g)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum score</td>
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<td>5</td>
<td>3</td>
<td>6</td>
<td>1</td>
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<td>3</td>
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<td>Candidates score</td>
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PART A

You are provided with the following:

- A white screen with cross wires labelled O
- A lens and a lens holder
- A white screen labelled S
- A meter rule
- A candle

Proceed as follows:

(a) Set up the apparatus as shown in fig. 1

(b) Position the lens so that the object distance \( u = 20 \text{cm} \)

(c) Adjust the screen S so that a sharp image of the cross wires is formed on the screen S. Measure the image distance \( v \). Record the value of \( u \) and the corresponding value of \( v \) in table 1.

(d) Repeat (b) and (c) above for value of \( u = 20 \text{cm}, 25 \text{cm}, 30 \text{cm}, 35 \text{cm}, 40 \text{cm}, 45 \text{cm} \).

(e) Complete table 1.

<table>
<thead>
<tr>
<th>( u ) (cm)</th>
<th>20</th>
<th>25</th>
<th>30</th>
<th>35</th>
<th>40</th>
<th>45</th>
</tr>
</thead>
<tbody>
<tr>
<td>( v ) (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( u + v ) (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>( uv ) (cm(^2))</td>
<td></td>
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</table>

Table 1. (6 marks)

(f) On the grid provided plot a graph of \( uv \) (y axis) against \( u + v \) (5 marks)
Determine the slope of the graph. (3 marks)

PART B

You are provided with the following:
- A boiling tube
- Some dry sand
- A liquid in a measuring cylinder labelled L
- Half-meter rule
- A vernier calipers (to be shared)
- A weighing machine (one per room)
- Tissue paper

Proceed as follows:

(i) Measure the length of the boiling tube

\[ h = \quad \text{______________________________ cm} \quad (1/2 \text{ marks}) \]

(ii) Put a little amount of sand in the boiling tube and place it in the measuring cylinder which is almost filled with a liquid labelled L. Add sand, little by little until the tube floats upright as shown in figure 2.

![Figure 2](image-url)
Measure the length, \( d \), of the boiling tube which is above the liquid

\[ d = \underline{\underline{\phantom{00000}}} \text{ cm} \quad (\frac{1}{2} \text{ marks}) \]

(iii) Determine the length, \( t \), of the boiling tube which is immersed in the liquid.

\[ t = \underline{\underline{\phantom{00000}}} \text{ cm} \quad (\frac{1}{2} \text{ marks}) \]

(iv) Remove the boiling tube from the measuring cylinder, wipe it dry (on the outside) and weigh its mass, \( m \), including the sand inside.

\[ m = \underline{\underline{\phantom{00000}}} \text{ cm} \quad (\frac{1}{2} \text{ marks}) \]

(v) Measure the external diameter, \( D \), of the boiling tube.

\[ D = \underline{\underline{\phantom{00000}}} \text{ cm} \quad (\frac{1}{2} \text{ marks}) \]

(vi) Determine external radius, \( R \).

\[ R = \underline{\underline{\phantom{00000}}} \text{ cm} \quad (\frac{1}{2} \text{ marks}) \]

(vii) Using the formula

\[ m = \rho \times (\pi R^2) \], determine \( \rho \) for the liquid.

\[ \rho = \underline{\underline{\phantom{00000}}} \quad (3 \text{ marks}) \]

2. You are provided with the following:
   - 2 dry cells
   - A cell holder
   - A nichrome wire mounted on a metre rule
   - An ammeter, \( A \)
   - A voltmeter, \( V \)
   - A jockey \( J \)
   - A switch \( S \)
   - 8 connecting wires.
Proceed as follows:

(a) Set up the apparatus as shown in fig. 3.

(b) With the switch open, record the reading \( E \) of the voltmeter.

\[
E = \underline{\text{__________________________}} \quad (3 \ \text{marks})
\]

(c) Place the jockey, \( J \), on the nichrome wire at 100\text{cm} mark. Close the switch, read and record the values of \( I \) (ammeter reading) and the corresponding values of \( V \) (voltmeter reading) in table 2.

(d) Repeat (c) above for length, \( L = 70\text{cm}, 60\text{cm}, 50\text{cm}, 40\text{cm} \) and 20\text{cm}.

Complete table 2.

\[
\begin{array}{|c|c|c|c|c|c|c|}
\hline
L(\text{cm}) & 100 & 70 & 60 & 50 & 40 & 20 \\
\hline
I(A) & & & & & & \\
V(V) & & & & & & \\
E - V(V) & & & & & & \\
\hline
\end{array}
\]

Table 2 \quad (7 \ \text{marks})

(e) Plot a graph of \((E - V)\) (y axis) against \( I \). \quad (5 \ \text{marks})
(f) Determine the slope of the graph. (3 marks)

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(g) Given that $E = V + Ir$, from the graph determine

(i) The internal resistance, $r$, of the battery. (2 marks)
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_________________________________________________________________

(ii) $V$ when $I$ is 0.3A. (2 marks)
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