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Section	Mark
Section A Task 1 Q1	
Section A Task 1 Q2	
Section A Task 2 Q1	
Section B Q1	
Section B Q2	
Section B Q3	
TOTAL	



General Certificate of Education  
Advanced Level Examination  
June 2014

# Physics (Specifications A and B)

## PHA6/B6/X

**Unit 6 Investigative and Practical Skills in A2 Physics  
Route X Externally Marked Practical Assignment (EMPA)**

### Section B Written Test

<p><b>For this paper you must have:</b></p> <ul style="list-style-type: none"> <li>• your completed Section A Task 2 question paper / answer booklet.</li> <li>• a ruler</li> <li>• a pencil</li> <li>• a calculator.</li> </ul>	<p><b>Instructions</b></p> <ul style="list-style-type: none"> <li>• Use black ink or black ball-point pen.</li> <li>• Fill in the boxes at the top of this page.</li> <li>• Answer <b>all</b> questions.</li> <li>• You must answer the questions in the space provided. Do not write outside the box around each page or on blank pages.</li> <li>• Show all your working.</li> <li>• Do all rough work in this book. Cross through any work you do not want to be marked.</li> </ul>
<p><b>Time allowed</b></p> <ul style="list-style-type: none"> <li>• 1 hour 15 minutes</li> </ul>	<p><b>Information</b></p> <ul style="list-style-type: none"> <li>• The marks for questions are shown in brackets.</li> <li>• The maximum mark for this paper is 25.</li> </ul>
<p><b>Details of additional assistance (if any).</b> Did the candidate receive any help or information in the production of this work? If you answer yes, give the details below or on a separate page.</p> <p>Yes <input type="checkbox"/> No <input type="checkbox"/></p>	

<p><b>Practical Skills Verification</b> Teacher Declaration: I confirm that the candidate has met the requirement of the practical skills verification (PSV) in accordance with the instructions and criteria in section 3.8 of the specification.</p>	<p>Yes <input type="checkbox"/></p>
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Signature of teacher ..... Date .....

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## PHA6/B6/X

**Section B**

Answer **all** the questions in the spaces provided.

Time allowed 1 hour 15 minutes.

You will need to refer to the work you did in Section A Task 2 when answering these questions.

- 1 (a) (i)** Determine the gradient,  $G$ , of your graph (**Figure 6**) of  $(\sqrt{l+x} - \sqrt{l})$  against  $\frac{1}{T}$ .

**[2 marks]**

.....  
 .....

$$G = \dots\dots\dots$$

- 1 (a) (ii)** Evaluate  $\frac{G}{x}$ .

**[2 marks]**

.....  
 .....

$$\frac{G}{x} = \dots\dots\dots$$

- 1 (b)** **Figure 7** on page 3 shows a side view and a front view of the apparatus you used in Section A Task 2.

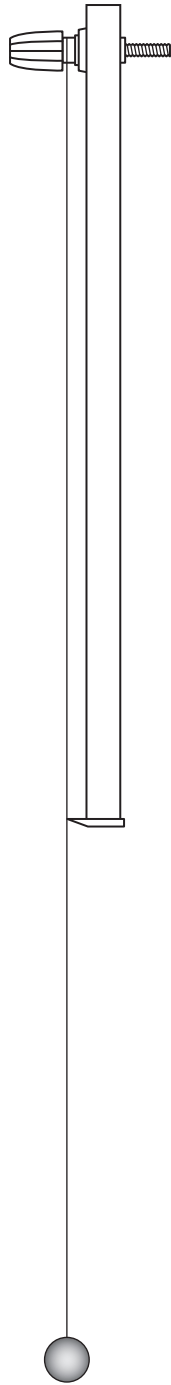
Add suitable annotation to either or both of these views to indicate:

- 1 (b) (i)** where you positioned the fiducial mark in order to measure  $T$   
**1 (b) (ii)** the position from which you viewed the oscillations of the pendulum.

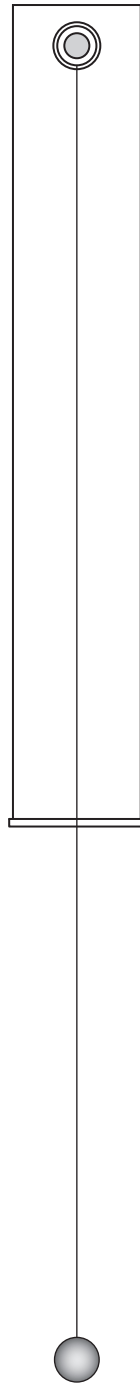
**[2 marks]**

Figure 7

side view



front view



Turn over ►

**1 (c)** Students A and B make systematic errors when carrying out the experiment.

Student A makes accurate measurements to determine  $l$  and  $T$  but records a value for  $x$  that is too large.

Student B makes accurate measurements to determine  $l$  and  $x$  but (when measuring  $T$ ) consistently thinks that 20 oscillations are being counted but the time recorded is for only 19 oscillations.

Explain what effect these systematic errors have:

**1 (c) (i)** on the graph that student A plots

**[2 marks]**

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**1 (c) (ii)** on the graph that student B plots.

**[2 marks]**

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**1 (c) (iii)** The students are told that  $(\sqrt{l+x} - \sqrt{l})$  is directly proportional to  $\frac{1}{T}$ .

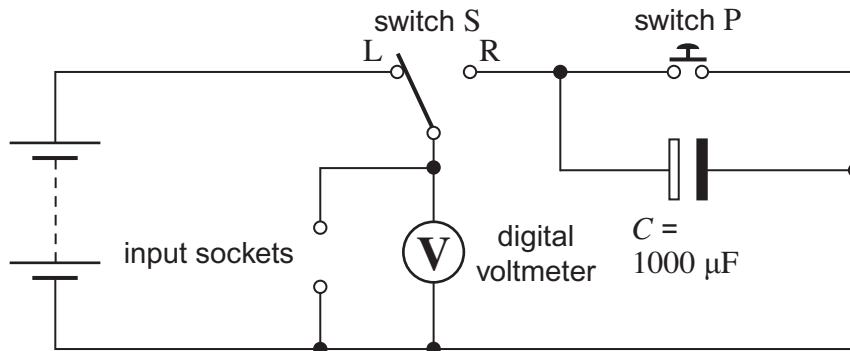
Suggest why the systematic error made by student A is easier to discover than that made by student B.

**[1 mark]**

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- 2 By modifying the circuit you used in Question 2 of Section A Task 1 a student designs a capacitance meter. The circuit used by the student is shown in **Figure 8**.

**Figure 8**



A capacitor of unknown capacitance is connected to the input sockets. Switch S is moved to position L and switch P is briefly pressed, then the voltmeter reading,  $V_0$ , is recorded. When switch S is moved to position R the voltmeter reading falls to a new value,  $V$ .

The capacitance of the unknown capacitor, is given by  $C_U = \frac{C \times V}{V_0 - V}$  where  $C = 1000 \mu\text{F}$  for the circuit in **Figure 8**.

- 2 (a) Suggest why a digital voltmeter (rather than an analogue voltmeter) should be used. **[1 mark]**

.....

.....

- 2 (b) The  $1000 \mu\text{F}$  capacitor may differ by up to 20% from its stated value. For a certain unknown capacitance,  $C_U$ ,  $V_0$  is  $6.0 \text{ V} \pm 0.1 \text{ V}$  and  $V$  is  $2.3 \text{ V} \pm 0.1 \text{ V}$ .

Determine the largest possible capacitance,  $C_U$ .

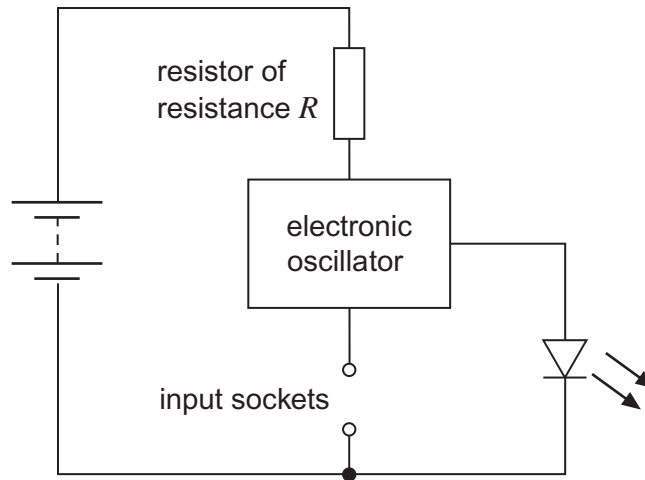
**[2 marks]**

largest possible capacitance,  $C_U = \dots\dots\dots$

Turn over ►

2 (c) **Figure 9** shows a circuit that can be used to determine the capacitance of an unknown capacitor.

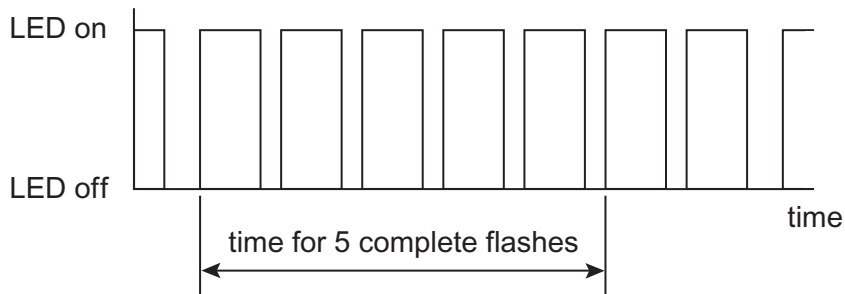
**Figure 9**



When a capacitor of capacitance  $C$  is connected to the input sockets, the LED flashes at a steady frequency,  $f$ , which depends on  $C$  and  $R$ . If  $R$  is known and  $f$  is measured,  $C$  can be found using the chart in **Figure 11**: instructions on the use of this chart are given at the bottom of page 7.

The student makes three measurements of the time for 5 flashes of the LED when  $R = 5.0 \text{ k}\Omega$ .

**Figure 10**



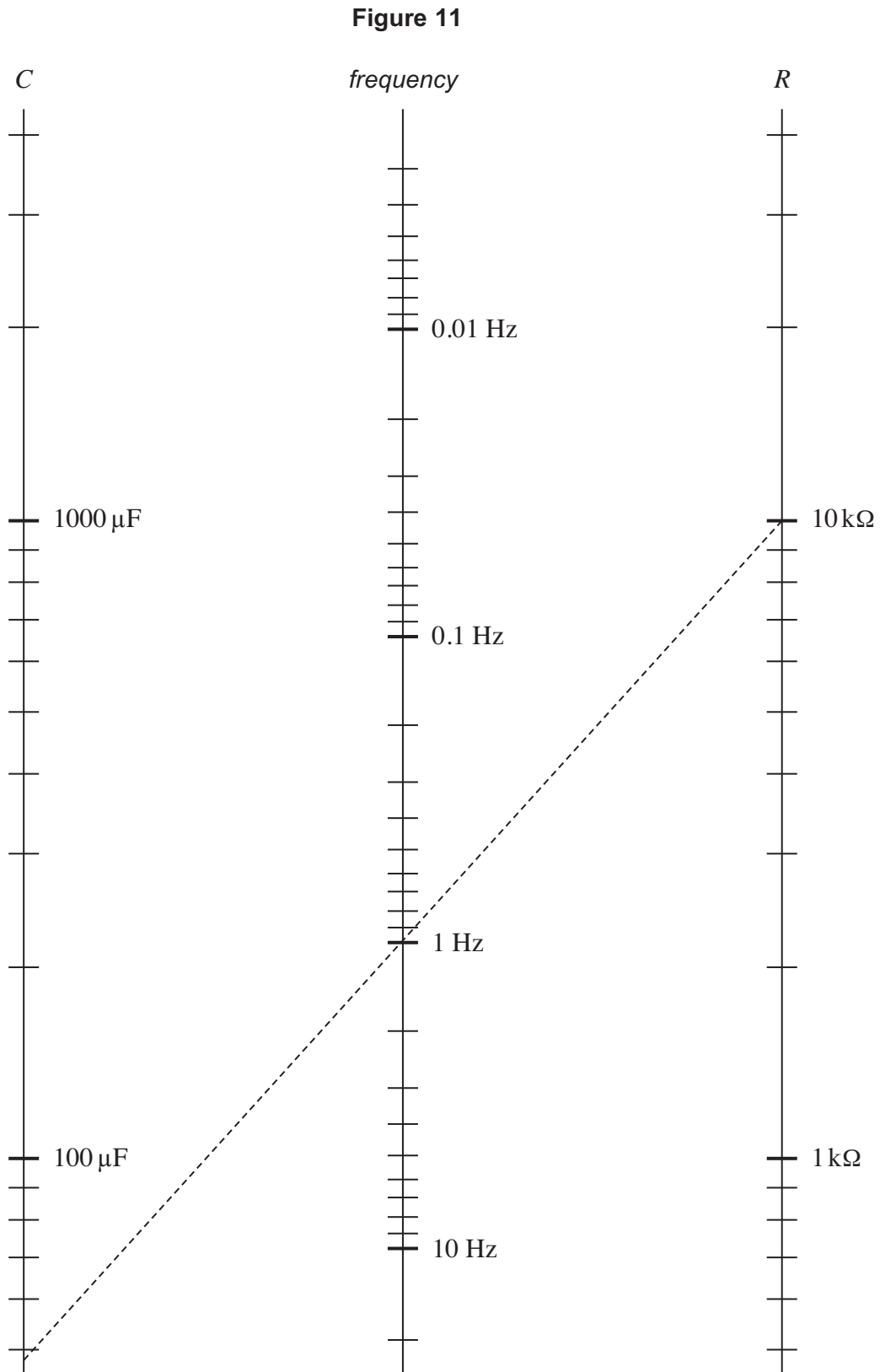
time for 5 flashes of the LED/s		
47.6	46.4	46.7

Use the student's measurements to determine  $C$ , showing clearly on **Figure 11** how you arrived at your result.

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 .....

$C =$  .....

[3 marks]

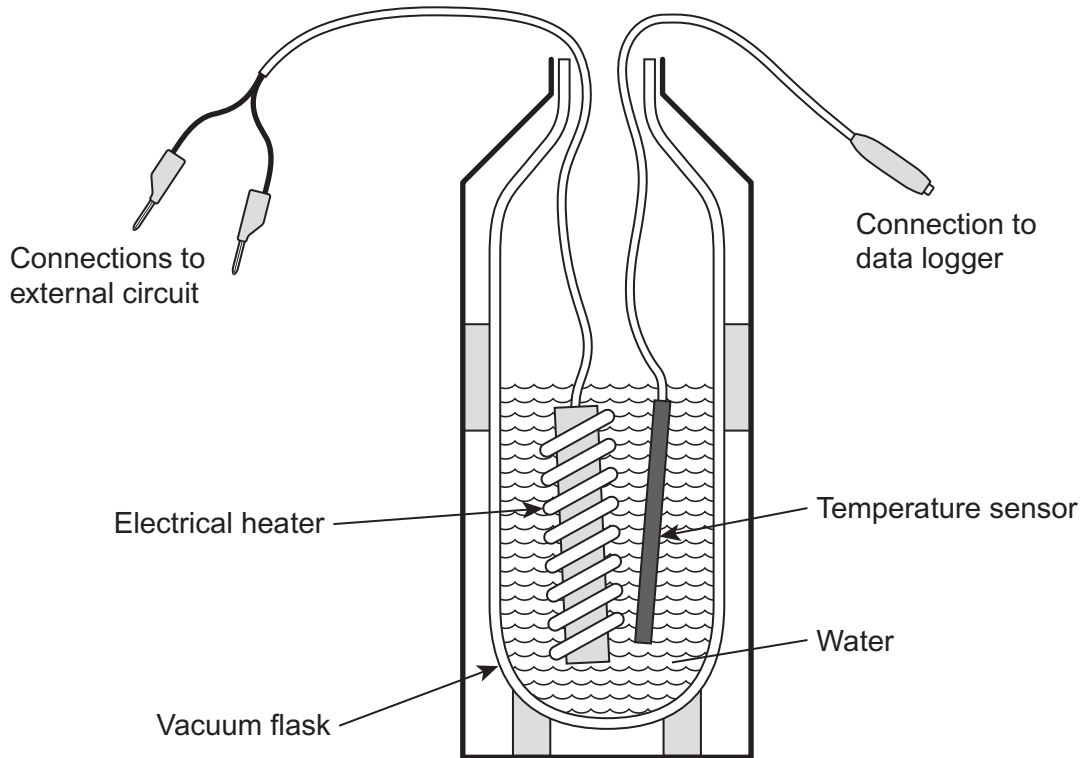


The dotted line joining the three scales in **Figure 11** shows the capacitance that can be found when the values of  $R$  and  $f$  are known, eg when  $R$  is  $10\ \text{k}\Omega$  and  $f$  is  $1.0\ \text{Hz}$ , the capacitance is just less than  $50\ \mu\text{F}$ .

Turn over ►

- 3 An experiment is carried out to determine the specific heat capacity of water using the apparatus shown in **Figure 12**.

**Figure 12**



Energy is supplied to the water using an electrical heater.  
Heat loss to the surroundings is minimised by placing the water in a vacuum flask.  
The temperature of the water is determined using a temperature sensor connected to a data logger.

The procedure is as follows.

- The mass of the water is determined using a balance.
- The heater is connected to a circuit that allows measurements to be made so that the mean power supplied to the heater can be calculated.
- Data logging starts as the heater is switched on.
- The heater is switched off after 500 s.
- Data logging ends after 800 s.

- 3 (a) If the sample rate of the data logger = 0.05 Hz, how many samples are recorded while data are being sent to the data logger?

**[1 mark]**

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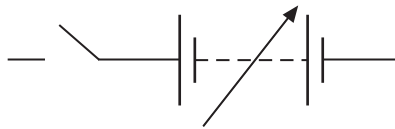
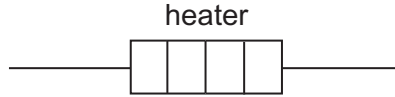
number of samples = .....



3 (b) (i) Complete the diagram in **Figure 13** to show the circuit that should be connected to the heater.

[1 mark]

**Figure 13**



3 (b) (ii) During the experiment it is noticed that the measurements being made to determine power are not steady.  
Explain how the mean power transformed in the heater should be determined.

[1 mark]

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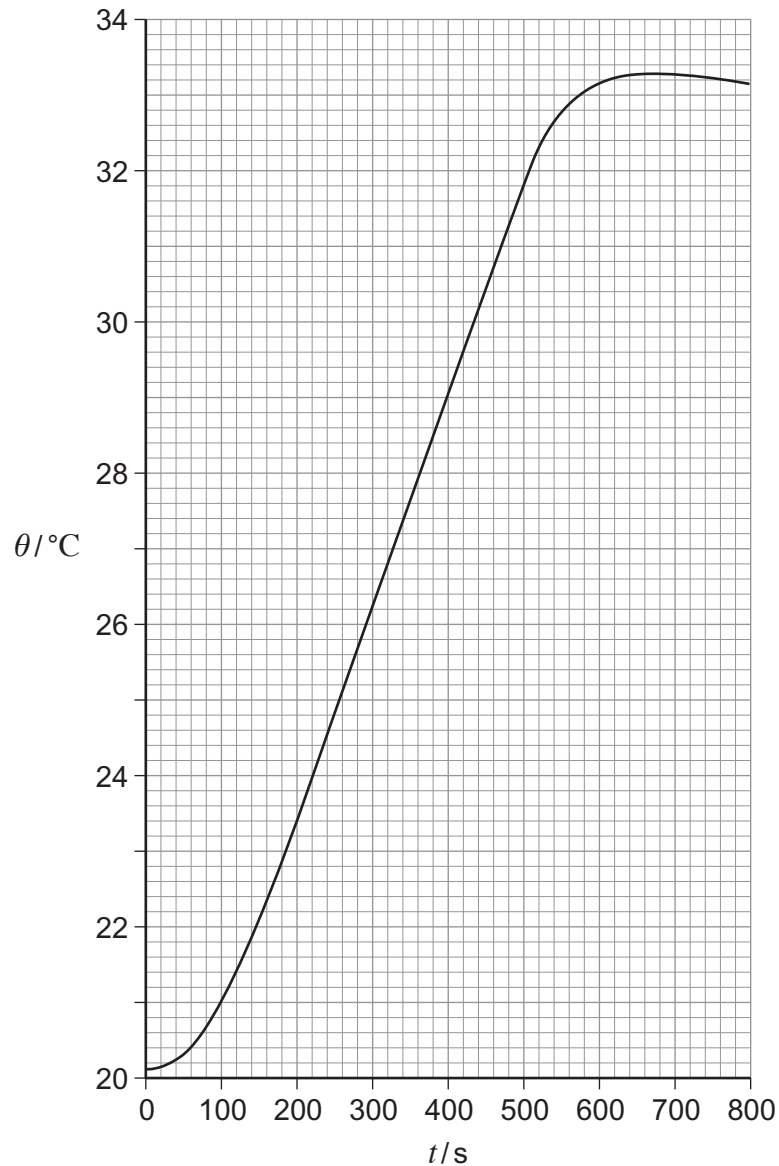
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- 3 (c) The data collected in the experiment are displayed on the graph of temperature,  $\theta$ , against time,  $t$ , shown in **Figure 14**.

**Figure 14**



- 3 (c) (i) Why does the temperature indicated by the temperature sensor continue to increase after the heater is switched off at  $t = 500$ s?

[1 mark]

.....

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.....

**3 (c) (ii)** In the experiment represented in **Figure 14**

the mass of water in the flask = 119 g  
the mean power supplied to the heater = 15.2 W.

Use this information together with **Figure 14** to determine the specific heat capacity of the water.

You may wish to use the equation  $Q = mc\Delta\theta$ .

Note that the graph in **Figure 14** is linear between  $t = 180$  s and  $t = 400$  s.

**[3 marks]**

specific heat capacity = .....  $\text{J kg}^{-1} \text{K}^{-1}$

**3 (c) (iii)** Comment on any discrepancy between your result for the specific heat capacity of water and the accepted value of  $4180 \text{ J kg}^{-1} \text{K}^{-1}$ .

**[1 mark]**

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**END OF QUESTIONS**

**There are no questions printed on this page**

**DO NOT WRITE ON THIS PAGE  
ANSWER IN THE SPACES PROVIDED**