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REGISTRATION CENTRE NUMBER	CENTRE NAME	
CANDIDATE'S FULL NAMES		
CANDIDATE IDENTIFICATION NUMBER	SUBJECT CODE 7155	PAPER NUMBER 3 (Group 1)
FOR OFFICIAL USE ONLY (Candidate Random CODE): ▶		

GENERAL CERTIFICATE OF EDUCATION BOARD
TECHNICAL AND VOCATIONAL EDUCATION EXAMINATION
ADVANCED LEVEL

SUBJECT TITLE	SUBJECT CODE	PAPER NUMBER
ENGINEERING SCIENCE	**7155**	**3 (Group 1)**
ALL INDUSTRIAL SPECIALTIES	EXAMINATION DATE: **JUNE 2021**	

TWO HOURS

Enter the information required in the shaded boxes above.
Do not write in pencil except for diagrams and graphs.

You are required to answer ALL questions.
Each candidate is expected to pass through two posts and one main stream experiment.

In all cases involving calculations, you are advised to show all the steps in your workings.
You are expected to spend 15 minutes at each post and 90 minutes at the mainstream.

If you have difficulty understanding the requirements of the question, or other problems you should ask the supervisor.
Your results must be recorded in the spaces provided in this question booklet.
Calculators and formulae booklets may be used.
Graph paper is provided at the back page of this booklet

In describing an experimental setup the candidate must be brief and clear in his/her method
Candidates are advised to draw diagram(s) of the setup, do relevant calculations and/or identification of device(s).
At the end of the examination, fasten all your work securely together.
You are reminded of the need for good English and orderly presentation in your answers.

The mark distribution is as follows:

Post 1 = 25 marks	Post 2 = 25 marks	Mainstream = 50 marks

TURN OVER

FOR EXAMINERS' USE ONLY		
Marked by:.....	*SCORE*	
Signature: ..... *Date:*	1	
	2	
Checked by:.....	Mainstream	
Signature: ..... *Date:*	Total	

TITRATION OF STRONG BASE AND WEAK ACID.

APPARATUS.

100 ml beaker, burette, retort stand and clamp,water, 50 cm^3 measuring cylinder, 0.50 mol/dm^3 sodium hydroxide, ($NaOH_{(aq)}$), ethanoic acid, ($CH_3COOH_{(aq)}$), phenolphthalein,

PROCEDURE.

1. Mount up the burette on the retort stand and clamp.
2. Fill the burette with 0.50 mol/dm^3 sodium hydroxide solution (titrant) and record the initial volume, V_1 in table 1 below.
3. Measure 10 ml of ethanoic acid using the measuring cylinder and pour into the beaker.
4. Add four (4) drops of phenolphthalein indicator into the beaker containing the acid and note the colour of the solution. Record the colour observed.
   Colour = ---------- **(1 mark)**
5. Open the burette clip and run the base into the acid slowly until the equivalence point of the titration is reached.
6. Measure and record the final volume of the base solution that reaches the equivalence point of the titration V_2. Record your value in table 1 below.
7. Note the colour of the solution at the equivalence point.. Record the colour observed.
   Colour = ---------- **(1 mark)**
8. Repeat the procedure twice and record the data in table 1 below.

OBSERVATION /DATA/CALCULATION

Table 1

Sodium hydroxide	Initial reading (V_1)	Final reading (V_2)	Volume of base delivered/cm^3	Mean value V/cm^3
Approximate				
Accurate 1				
Accurate 2				

(8 marks)

9. Write the balanced chemical reaction between ethanoic acid and sodium hydroxide ----------
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   ---------- **(2 marks)**

10. Explain the phrase titration reaction----------

---------- (2 marks)

11. What is the significance of the equivalence point in a titration reaction.

---------- (2 marks)

12. Calculate the concentration of the ethanoic acid ----------

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---------- (4 marks)

13. Sketch the titration curve of sodium hydroxide solution and ethanoic acid. The solutions are weak acid and strong base----------

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---------- (3marks)

14 State two precautions to minimise error in this experiment----------

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---------- (2 marks)

(Total = 25 marks)

POST 2

LOGIC DEVICES.

APPARATUS.

3 V battery, copper wire, LED, 4 crocodile clips.

PROCEDURE/OBSERVATION /CALCULATIONS.

Using the circuit diagram of figure 1 below and with the electrical components provided to you, connect the circuit and proceed with the experiment.

1. Connect the negative terminal of battery to one end of the crocodile clip with copper wire A_1.
2. Connect the positive terminal of battery to one end of the crocodile clip with copper wire A_2.
3. Connect one end of another crocodile clip B_2 with copper wire to the bulb terminal.
4. Connect one end of another crocodile clip B_1 with copper wire to the bulb terminal.
5. Join the two crocodile clips of B_1 and A_2 to form switch, S_1, and join the two crocodile clips of A_1 and B_2 to form switch, S_2,

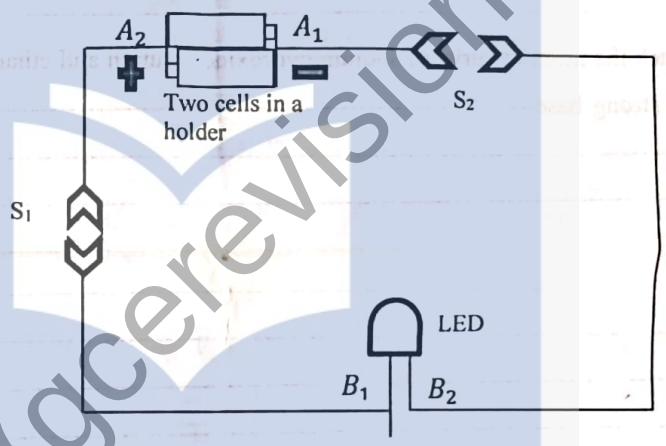

Figure 1

6. Close switch S_2 and open switch S_1, observe the LED and make your comments

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.....(1.5marks)

7. Close switch S_1 and open switch S_2, observe the bulb and make your comments.....

.....

.....(1.5 marks)

8. Close switch S_2, and switch S_1, observe the bulb and make your comments

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.....(1.5 marks)

9. Open switch S_1 and switch S_2, observe the LED and make your observation.

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.....(1.5 marks)

10. From your observations in 6, 7 , 8 and 9 above, identify the logic gate produced.

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..... (2 marks)

11. Draw the symbol of your logic gate identified in question 10 above.

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.....(3 marks)

12. Explain the word 'gate' as applied to logic devices.

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.....(2 marks)

13. Draw the truth table of your logic gate identified in question 10 above.

--- (4 marks)

14. Draw a labeled circuit diagram of your experiment to indicate the inputs, output, and power source. Insert the milliammeter and millivoltmeter into your circuit in positions that could measure the current and voltage respectively for the load.

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..... (6 marks)

15. Give one precaution taken during the experiment to minimize error

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(2 marks)

(TOTAL = 25 marks)

MAINSTREAM

EXPERIMENT TO DETERMINE THE PERIOD OF OSCILLATION.

APPARATUS

A metre rule, one 50 g mass, cellotape, a stop watch, protractor, two inextensible threads (120 cm and 20 cm).

PROCEDURE

1. Tie the 50 g mass using the 20 cm thread to one end.
2. Measure 10 cm length from the 50 g mass and attach it to the centre of the 120 cm thread to form a knot.
3. Clamp the metre rule between two stands.
4. Attach one end of thread of length l_1 = 50 cm from the knot to 10 cm mark on the metre rule.
5. Attach the other end of the thread l_1 = 50 cm from the knot to 90 cm mark on the metre rule such that the distance between the marks X is 80 cm as shown on Figure 2.
6. Suspend the 50 g mass pendulum so that the centre of gravity is 10 cm below the suspension knot.

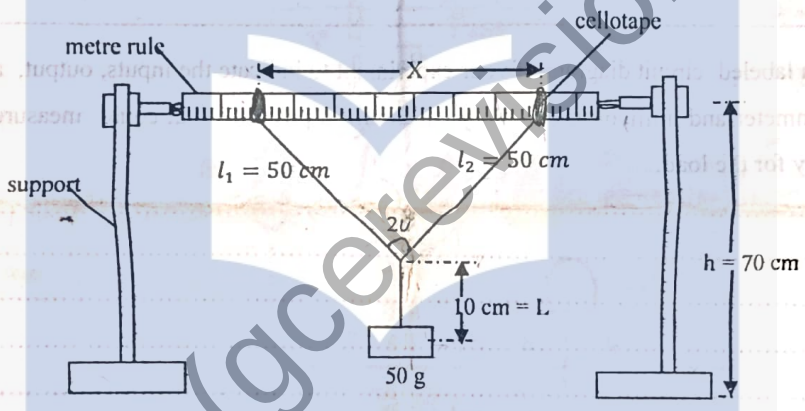

Figure 2

L1 = 40° L2 = 40°

7. Measure the angle between the threads l_1 and l_2 with a protractor (2θ). Record the value in the table 2 below. 120°
8. Pull the 50 g pendulum horizontally by a small angle towards yourself and then release. Measure the time (t) for 20 oscillations and record in table 1.
9. Remove the cellotape and adjust the distance X, by 5 cm inward from both marks on the metre rule to obtain X_2, X_3, X_4 and X_5.
10. Repeat step 8 for the other distances (X), and record the time (t) for 20 oscillations and corresponding angle(2θ) and complete table 2 below.

OBSERVATION/DATA/CALCULATION

Table 2

Length (X/cm)	Time (t/s)) for 20 oscillations	Period (T/s)	T^2 (s^2)	20^0	θ^0	$cos\theta$
X_1=80	25.63	1.2815	1.5×10^{-3}	120	60	0.5
X_2	27.01		1.3×10^{-3}	100	50	0.64
X_3	28.16		1.2×10^{-3}	80	40	0.76
X_4	29.19		1.1×10^{-3}	40	20	0.93
X_5	30.65		1.0×10^{-3}	20	10	0.98

(18 marks)

11. Plot a graph of $T^2(s^2)$ against $\cos\theta$ (9 marks)

12. Find the slope "S" of the graph

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.....(7 marks)

13. The graph plotted above actually uses the oscillation of T, given by $T = \sqrt{\frac{l\cos\theta}{g}}$

where $l_1 = l_2 = l$. Determine the value of g.

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..... (6 marks)

14. Using the value of g obtained in question 13, find the period at X_3= 60 cm. Compare it with the corresponding T on table 2 above.

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.....(7marks)

15. Outline any TWO precautions you took to obtain better results.

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.....(3 marks)

(Total: 50 marks)