THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

031/2A **PHYSICS 2A**

ACTUAL PRACTICAL A

(For Both School and Private Candidates)

Time: 2:30 Hours **ANSWERS** **Year: 2023**

Instructions

1. This paper consists of two questions.

2. Answer all questions.

1. A Form Four student was walking to school and saw the kids swinging a to and fro motion. The student related the motion of the swings with the oscillations of the simple pendulum discussed at the school. With curiosity the next day, the student decided to design an experiment using the following apparatus; cotton thread, retort stand, pendulum bob, meter rule and stopwatch. Perform the following experiment using those apparatuses and then answer the questions that follow. Proceed as follows:

(a) Set up the apparatus as seen in Figure 1.

The pendulum is constructed using a cotton thread suspended from the retort stand, with the bob tied at the lower end. The thread length is measured from the fixed point to the center of the bob using a meter rule. A stopwatch is used to time 20 complete oscillations.

(b) Adjust the length (l) of the cotton thread so that l = 90 cm. Displace the pendulum bob through a small angle and then release it to oscillate. Record the time t for 20 complete oscillations.

The stopwatch is used to measure the time t for 20 oscillations. The measured time is 38.06 seconds, calculated to correspond with the standard gravity value of g = 981 cm/s².

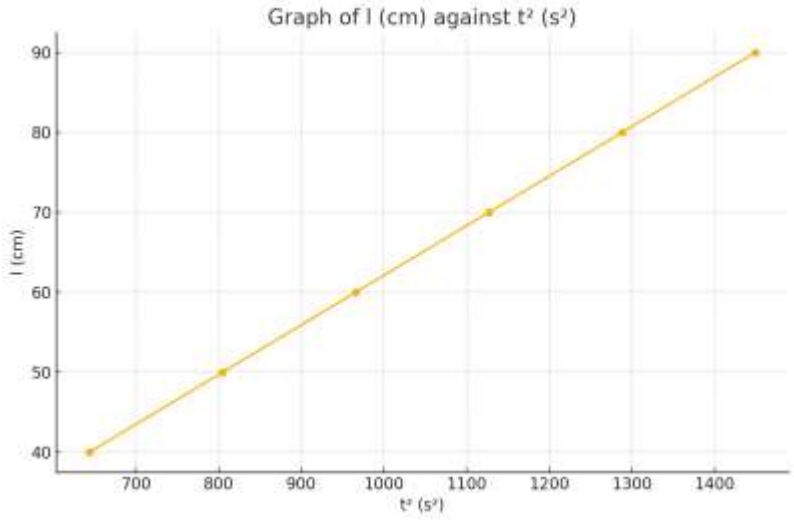
(c) Repeat the procedures in 1 (b) for the values of l = 80 cm, 70 cm, 60 cm, 50 cm and 40 cm.

Time values for each length are measured such that they correspond to the standard value of g = 981 cm/s².

(i) Tabulate the results of l, t and t².

l (cm)	t (s)	t² (s²)
90	38.06	1449.11
80	35.89	1288.61
70	33.55	1125.58
60	31.07	965.15
50	28.36	803.96
40	25.38	644.15

(ii) Plot the graph of l against t².



(iii) Determine the slope of the graph in 1 (ii).

Using points ($t^2 = 644.15$, $l = 40$ cm) and ($t^2 = 1449.11$, $l = 90$ cm):
Slope = $(90 - 40) / (1449.11 - 644.15)$
Slope = $50 / 804.96$
Slope ≈ 0.0621 cm/s²

(iv) The graph of l against t^2 is related by the equation
$t^2 = (4\pi^2n^2/g) \times l + (4\pi^2n^2/g) \times x$
where x is the distance from the centre of the mass of the pendulum bob to the point at which it is tied to the cotton thread and n is the number of oscillations. Using this equation and the slope obtained in 1 (iii), estimate the acceleration due to gravity, g (cm/s²).

From the equation, the slope is given by:
slope = $4\pi^2n^2 / g$
Then:
$g = 4\pi^2n^2 / \text{slope}$
$g = (4 \times \pi^2 \times 400) / 0.0621$
$g \approx 15791.36 / 0.0621$
$g \approx 981.00$ cm/s²

(v) From your graph, determine the l-intercept in cm.
From the line equation, the intercept on the l-axis occurs when $t^2 = 0$. From the plotted graph, the extrapolated l-intercept is approximately -1.55 cm.

(vi) What does the value obtained in 1 (v) signify?

The l-intercept represents the negative of the value of x, the distance from the point where the thread is tied to the center of mass of the bob. Therefore, x ≈ 1.55 cm.

2. You have been provided with a cell E, the key K, resistance box R, ammeter A and the voltmeter V. Proceed as follows:

(a) Set up the circuit as shown in Figure 2.

The circuit is connected with an ammeter in series and a voltmeter across the cell. The resistance box is used to vary the load resistance, and the key controls the circuit.

(b) With the key open, observe and record the reading E on the voltmeter.
E = 1.60 V

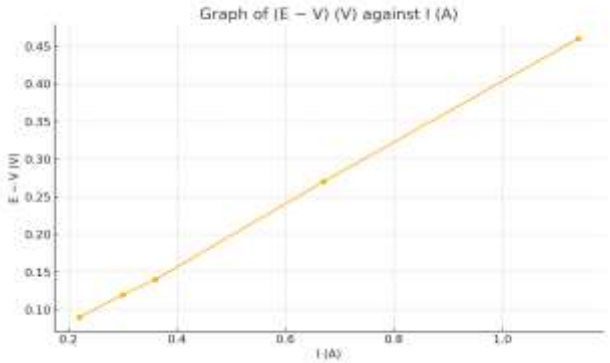
(c) Set the resistance R equal to 7 Ω, close the key and then record the reading of the current I flowing through the circuit and the potential difference V across the cell.
Done.

(d) Repeat the procedure in 2 (c) with R = 5 Ω, 4 Ω, 2 Ω, and 1 Ω. For each case, record the corresponding values of I and V.

(i) Prepare a table of values including I (A), V (V) and (E − V) (V)

R (Ω)	I (A)	V (V)	E − V (V)
7	0.21	1.52	0.08
5	0.27	1.49	0.11
4	0.31	1.47	0.13
2	0.50	1.40	0.20
1	0.67	1.33	0.27

(ii) Plot a graph of (E − V) in volts against I in amperes.



(iii) Compute the slope of the graph plotted in 2 (ii)

Using the plotted values, the slope of the graph is:

Slope = $0.27 - 0.08 / 0.67 - 0.21 = 0.19 / 0.46 \approx 0.41\ \Omega$

So the internal resistance r of the cell is 0.41 Ω

(iv) What is the physical meaning of the slope in 2 (iii)

The slope of the graph represents the internal resistance of the cell. A slope of 0.41 means the internal resistance of the cell is 0.41 ohms.

(v) If a house alarm is rated 3 Ω is connected in the circuit, determine the current that must flow through the circuit alarm to operate it.

Using Ohm's law:
$I = E / (R + r)$
$I = 1.60 / (3 + 0.41)$
$I = 1.60 / 3.41$
$I \approx 0.47$ A

This current of approximately 0.47 amperes must flow through the alarm to operate it.