THE UNITED REPUBLIC OF TANZANIA

NATIONAL EXAMINATIONS COUNCIL

CERTIFICATE OF SECONDARY EDUCATION EXAMINATION

031/2A **PHYSICS 2B**

ACTUAL PRACTICAL B

(For Both School and Private Candidates)

Time: 2:30 Hours **ANSWERS** **Year: 2012**

Instructions

1. This paper consists of two questions.

2. Answer all questions.

1. You are provided with a Pendulum bob, Stop watch/clock, Thread, Tape measure, Retort stand and clamp. Proceed as follows:

(a) Set the apparatus as shown in Figure 1.
The apparatus consists of a retort stand with a clamp holding a thread. A pendulum bob is attached at the end of the thread. The length from the clamp to the knot on the thread is X, and the length from the knot to the center of the bob is Y = 10 cm. The total effective length of the pendulum is therefore (X + Y). This setup allows the bob to swing freely when displaced and released.

(b) Measure X = 60 cm, then set the bob into oscillations by displacing it to a small angle and releasing it. Record the time (t) taken for 20 complete oscillations.
To perform this task, the bob is pulled slightly from its rest position so that it swings back and forth in a regular manner. Using a stopwatch, the time taken for 20 full oscillations is measured. This allows for a more accurate determination of the period of one oscillation by dividing the total time by 20.

(c) Repeat (b) above for the length of X = 50 cm, 40 cm, 30 cm, and 20 cm.
This step involves shortening the length of the thread X and repeating the oscillation and time measurement. Each time, 20 oscillations are timed and the period is calculated.

(d) Record your results in a suitable table including periodic time T and T^2.
The table will contain columns for X (cm), t (s), T = t ÷ 20, and T^2 = (T × T). Sample data is shown below:

X (cm)	t (s)	T (s)	T^2 (s^2)
60	31.0	1.55	2.4025
50	28.4	1.42	2.0164
40	25.4	1.27	1.6129
30	22.0	1.10	1.2100
20	18.4	0.92	0.8464

(e) Plot a graph of T^2 against X.
On the vertical axis, T^2 (s^2) is plotted, and on the horizontal axis, X (cm) is plotted. A straight line is expected, showing a linear relationship between the square of the period and the length.

(f) Calculate the slope (S) of your graph.
The slope S is found from the graph by choosing two points on the straight line and applying the formula:
S = (change in T^2) ÷ (change in X)
Using two points: (X_1 = 20 cm, T_1^2 = 0.8464), (X_2 = 60 cm, T_2^2 = 2.4025)
S = (2.4025 - 0.8464) ÷ (60 - 20) = 1.5561 ÷ 40 = 0.0389025 s^2/cm

(g) Read and record the T^2-intercept.
From the graph, the T^2-intercept is where the line crosses the T^2 axis (when X = 0). Estimated intercept is approximately 0.025 s^2.

(h) (i) Compute the value of $4\pi^2 \div S$.
$4\pi^2 = 39.4784$
Then, $4\pi^2 \div S = 39.4784 \div 0.0389025 = 1014.4$ cm/s^2

(ii) Comment on the value obtained in (h)(i).
The result 1014.4 cm/s^2 is close to the standard acceleration due to gravity which is 981 cm/s^2. The slight difference is likely due to experimental error in timing or length measurement.

(i) (i) Calculate the value of Z where $S = T^2 \div Z$.
Rewriting the formula gives $Z = T^2 \div S$. Using $T^2 = 2.4025$ and S = 0.0389025,
$Z = 2.4025 \div 0.0389025 = 61.75$ cm

(ii) How is Y related to Z?
Z represents the total effective length of the pendulum. Since X is the measured length of thread and Y is the distance from the knot to the bob (10 cm), the effective length is X + Y. Thus, Z = X + Y, showing that Y is a constant added to X in determining the actual pendulum length.

(j) State any two (2) sources of error.
One source of error is human reaction time when starting or stopping the stopwatch, which can lead to inaccurate measurement of oscillation time. Another source is air resistance, which can slow the bob slightly and cause a longer period, especially if the oscillation angle is too large.

(k) Suggest the aim of this experiment.
The aim of the experiment is to verify the relationship between the square of the period of a simple pendulum and its length, and to use this relationship to estimate the acceleration due to gravity.

2. You are provided with a rectangular glass block, optical pins, office pins, drawing board, a white sheet of paper and a protractor. Proceed as follows:

(a) Place a glass block on a white sheet of paper with its largest face upper most and trace its figure ABCD. Remove the block; mark the centre of the face AB as O.
This creates a reference rectangle on the paper for measuring angles and tracing the path of light through the glass. The point O at the middle of AB is where the incident ray will strike the glass.

(b) Draw a line at O making an angle of 30° to the normal 'N' which is representing the incident ray.
This means drawing a line from point O at 30° from a perpendicular (normal) to AB. This line simulates the incoming ray of light before it enters the glass block.

(c) Erect two pins P_1 and P_2 on the 30° line. Return the glass block on the rectangle ABCD.

These pins act as indicators for the direction of the incident ray. When the block is returned to its position, the ray continues through the glass.

(d) View P_1 and P_2 through face CD of the block and erect sighting pins Q_1 and Q_2 in line with the images P_1 and P_2 respectively. Remove the block and draw a line to the rectangle joining points Q_1 and Q_2 to represent an emergent ray. Finally draw a line joining point O and the point of contact E of line Q_1Q_2 with CD to represent refracted ray.
This process reconstructs the path of light through the glass. The emergent ray from Q_1Q_2 shows how light exits the block, while the line from O to E traces how light refracted within the block.

(e) Measure the angle of refraction, r, between the normal at O and OE.
Using a protractor, the angle between the refracted ray and the normal is measured and recorded as r.

(f) Draw the diagram for this experiment.
This diagram includes the incident ray, the refracted ray, the emergent ray, the glass block, and all the pin positions. It visually represents the light's path through the medium.

(g) Repeat the procedures in 2 (c), (d) and (e) for the angle of incidence of 40°, 50°, 60° and 70°
The same setup is used to trace the rays and measure the corresponding angles of refraction.

(h) Tabulate your results as follows:

Angle of incidence i°	Angle of refraction r°	Sin i°	Sin r°
30	20	0.5000	0.3420
40	26	0.6428	0.4384
50	31	0.7660	0.5150
60	36	0.8660	0.5878
70	40	0.9397	0.6428

(j) What is the nature of the graph?
The graph is a straight line passing through the origin, showing a linear relationship between Sin i° and Sin r°.

(k) Find the slope of the graph.
Using the first and last values:
Slope = (0.9397 - 0.5000) ÷ (0.6428 - 0.3420) = 0.4397 ÷ 0.3008 = 1.4618

(l) What does the slope of the graph represent?
The slope represents the refractive index of the glass. According to Snell's Law, n = Sin i ÷ Sin r.

(m) Read and record Sin i° intercept of the graph.
The graph passes through the origin, so the intercept is 0.

(n) State the relationship between Sin i° and Sin r°.
The relationship is Sin i° = n × Sin r°, where n is the refractive index. This shows direct proportionality.

(o) State a possible source of error in this experiment.
One possible source of error is incorrect alignment of pins or inaccurate drawing of ray lines, which may lead to wrong angle measurement.

(p) How can you minimize the error in 2 (o)?
To minimize error, use sharp pins, ensure they are placed vertically, sight along the pin line carefully, and repeat measurements for consistency.

(q) Suggest the aim of this experiment.
The aim of this experiment is to verify Snell's Law of refraction and determine the refractive index of a glass block by measuring angles of incidence and refraction.