# PHYSICS PRACTICAL SHEETS

Date 02/03/2023 ..... KU ..... CAMPUS
Class ..... CE
Roll No. ..... 25
Shift ..... Morning
Object of the Experiment (Block Letter)

Experiment No. ..... 1
Group ..... T
Sub. ..... Physics
Set .....

## DETERMINATION OF THE ACCELERATION DUE TO GRAVITY USING A COMPOUND PENDULUM

**Apparatus Required:**

i) A compound pendulum
ii) A wedge
iii) Stopwatch
iv) Meter Rod

**Theory:**

The time period of a compound pendulum oscillating with a small amplitude is

$$T = 2\pi\sqrt{\frac{I}{mgl}}$$

where,

$I$ = moment of inertia of the pendulum bar about rotational axis
$l$ = distance between the center of suspension and centre of gravity.

By parallel axis theorem of moment of inertia,

$$I = I_0 + ml^2$$

or, $$I = mk^2 + ml^2$$

$I_0$ = moment of inertia about an axis through centre of mass
$k$ = radius of gyration

Now, the time period.

$$T = 2\pi\sqrt{\frac{mk^2+ml^2}{mgl}} = 2\pi\sqrt{\frac{l+\frac{k^2}{l}}{g}}$$

Let $L$ be the length of equivalent simple pendulum, having same time period. Then,

$$T = 2\pi\sqrt{\frac{L}{g}}$$

$$\therefore L = l + \frac{k^2}{l}$$

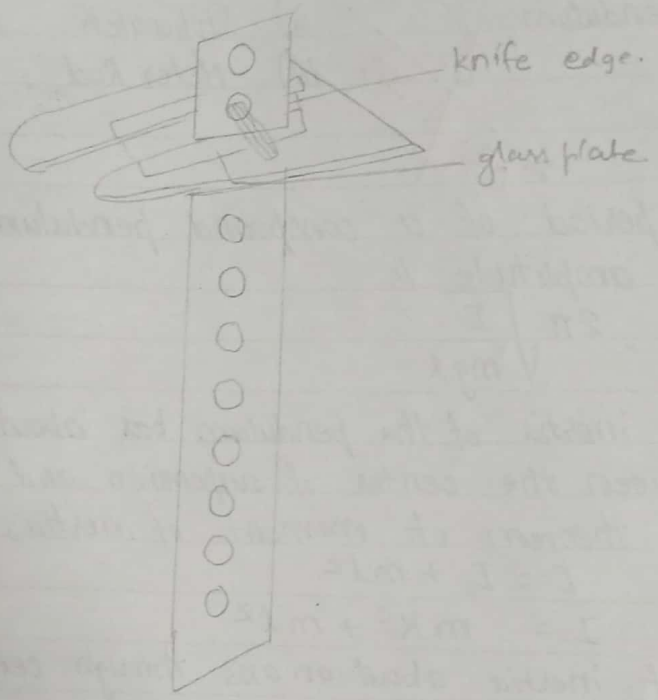


Fig: Schemmatic diagram of compound pendulum

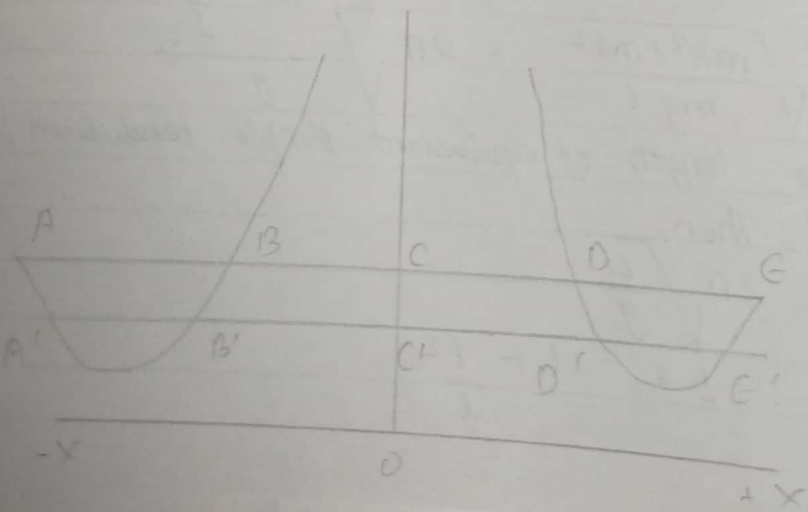


Fig: Time period vs Distance from CG

Along y-axis  Along x-axis

The point at a distance equal to the length of equivalent simple pendulum (L) from the center of suspension and in the line with the center of mass, is called the center of oscillation. The center of suspension and center of oscillation are interchangable.

If a graph is plotted between the distance of the center of suspension from the center of gravity taken along the X-axis and the corresponding time period T taken along Y-axis for the bar pendulum, then the graph is as shown in figure.

If a horizontal line ABCDE is drawn, it cuts the graph at the points A, B, D, E about which the time period is the same. The points A and D or B and E lie on the opposite sides of the center of gravity at unequal distances such that the time period about these points is the same. Hence, one of these corresponds to the center of suspension and the other to the center of oscillation. The distance AD or BE gives the length of equivalent simple pendulum.

Observations:

| No. of obs | Side A: Time for 20 oscillat. 1 | 2 | Mean | Time period | Dist. from CG | No. of obs | Side B: Time for 20 oscilla. 1 | 2 | Mean | Time period | Distance from CG. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 32.3 | 31.85 | 32.075 | 1.60 | 49 | 1 | 32.29 | 32.65 | 32.47 | 1.62 | 48.5 |
| 2 | 31.28 | 31.46 | 31.37 | 1.57 | 42.1 | 2 | 31.50 | 31.69 | 31.60 | 1.58 | 42.0 |
| 3 | 30.87 | 30.90 | 30.885 | 1.54 | 37.9 | 3 | 30.91 | 30.97 | 30.94 | 1.55 | 38.3 |
| 4 | 30.56 | 29.90 | 30.23 | 1.51 | 34 | 4 | 30.91 | 30.53 | 30.72 | 1.54 | 35.4 |

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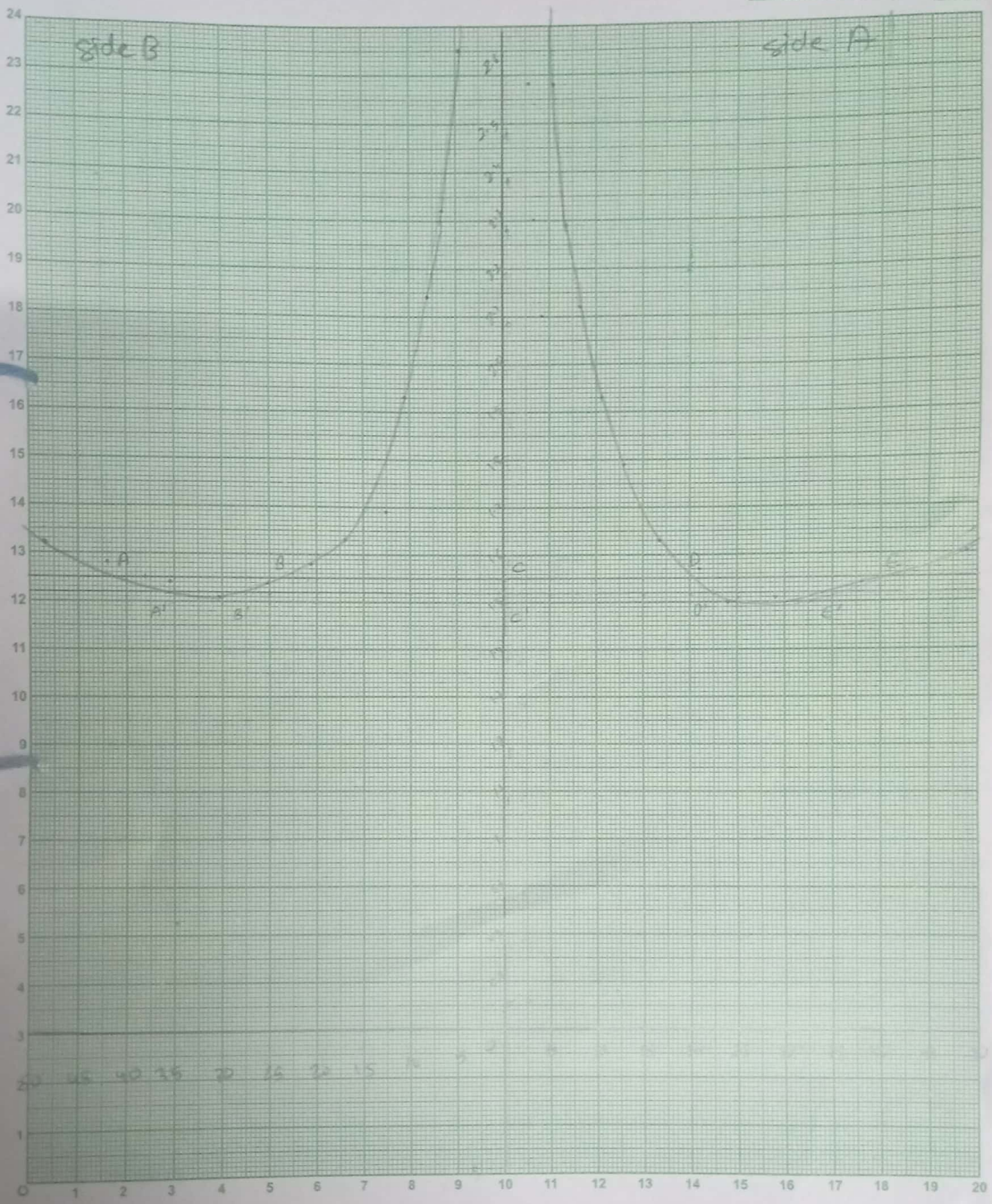
Along y-axis
10 small boxes = 0.1 T

Along x-axis
10 small boxes =



| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 30·34 | 30·10 | 30·22 | 1·51 | 28·9 | 5 | 30·43 | 28·84 | 29·64 | 1·51 | 30·3 |
| 6 | 29·54 | 30·46 | 30 | 1·50 | 24 | 6 | 30·68 | 30·96 | 30·32 | 1·54 | 25·3 |
| 7 | 31·44 | 31·32 | 31·38 | 1·57 | 21 | 7 | 31·56 | 31·65 | 31·61 | 1·58 | 20·5 |
| 8 | 33·09 | 32·03 | 32·56 | 1·63 | 16·8 | 8 | 32·97 | 33·25 | 33·01 | 1·63 | 16·9 |
| 9 | 35·94 | 35·69 | 35·82 | 1·79 | 13 | 9 | 35·81 | 35·78 | 35·25 | 1·79 | 12·4 |
| 10 | 38·78 | 38·57 | 38·68 | 1·93 | 10·9 | 10 | 38·79 | 38·34 | 38·57 | 1·93 | 10·4 |
| 11 | 42·94 | 42·03 | 42·49 | 2·12 | 8·4 | 11 | 42·91 | 42·82 | 42·89 | 2·14 | 8 |
| 12 | 46·03 | 45·75 | 45·89 | 2·29 | 6·8 | 12 | 46·31 | 46·93 | 46·42 | 2·32 | 6·5 |
| 13 | 51·46 | 51·93 | 51·70 | 2·58 | 5·5 | 13 | 52·34 | 53·46 | 52·75 | 2·64 | 4·9 |

From the graph

| No. of obs | Length of simple pendulum | | | Time period. | $4/T^2$ |
|---|---|---|---|---|---|
| | I | II | Mean L | ~~1·55~~ | |
| 1 | AD = 63 | BE = 63·8 | 63·4 | 1·55 | 25·39 |
| 2 | A'D' = 59·5 | B'E' = 61·7 | 60·6 | 1·52 | 25·23 |

Mean $4/T^2 = 25·31$

Then,

$g = 4\pi^2 L/T^2 = 999·20$

$\therefore$ % error = $\left| \frac{999·20 - 980}{980} \right| \times 100\% = 1·95\%$.

Precautions:

i) The knife edge should be horizontal and the bar pendulum parallel to the wall.

ii) the amplitude of oscillation must be small

iii) Distance should be measured from knife edge.

iv) Graph should be free hand curve.