**Experiment 3: DYNAMICS LAB**

**ACCELERATION DUE TO GRAVITY: THE COMPOUND PENDULUM**

**BACKGROUND:** A pendulum is a weight suspended from a pivot so that it can swing freely. When a pendulum is displaced sideways from its resting, equilibrium position, it is subject to a restoring force due to gravity that will accelerate it back toward the equilibrium position. When released, the restoring force acting on the pendulum's mass causes it to oscillate about the equilibrium position, swinging back and forth. The time for one complete cycle, a left swing and a right swing, is called the period. The period depends on the length of the pendulum and also to a slight degree on the amplitude, the width of the pendulum's swing.

**History:** From the first scientific investigations of the pendulum around 1602 by Galileo Galilei, the regular motion of pendulums was used for timekeeping, and was the world's most accurate timekeeping technology until the 1930s. The pendulum clock invented by Christian Huygens in 1658 became the world's standard timekeeper, used in homes and offices for 270 years, and achieved accuracy of about one second per year before it was superseded as a time standard by the quartz clock in the 1930s. Pendulums are also used in scientific instruments such as accelerometers and seismometers. Historically they were used as gravimeters to measure the acceleration of gravity in geophysical surveys, and even as a standard of length. The word "pendulum" is new Latin, from the Latin pendulus, meaning 'hanging'.

**AIM OF STUDY:** To estimate the acceleration due to gravity g and the radius of gyration k of the compound pendulum.

**LABORATORY EQUIPMENT:** The Compound pendulum has the form of a bar with seven holes. It is supported on a knife edge. The compound pendulum carries a mass. The location of the bar is adjustable.

**EXPERIMENTAL PROCEDURE:** The end of the bar containing the extreme hole is marked O, the other end of the bar is marked E, the holes are marked Pi where i = 1, 2, 3, ... 7, the location of the mass is marked M and location of center of gravity (C.G), located by balancing on the fixed knife edge support, is marked G, then OE = 91.5cm, OM = 55.4cm and OG = 50.7cm. Displacing the pendulum slightly, the stop watch is measured for the duration of 30 swings T30swings of the compound pendulum.

**RESULTS AND CALCULATIONS:** OM = C.G = 55.4cm, OE = 91.5cm and OG = 50.7cm

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| *Τ*30 swings [sec] | *T* [sec] | *T2* [s2] | *dT2* [cms2] | OPi [cm] | *d* = OG – OPi [cm] | *d*2 [cm2] |
| 46.19 | 1.5397 | 2.3707 | 119.2462 | 0.4 | 50.3 | 2530.09 |
| 44.52 | 1.4840 | 2.2023 | 99.76419 | 5.4 | 45.3 | 2052.09 |
| 42.90 | 1.4300 | 2.1404 | 86.24812 | 10.4 | 40.3 | 1624.09 |
| 41.22 | 1.3740 | 1.8879 | 66.64287 | 15.4 | 35.3 | 1246.09 |
| 40.19 | 1.3397 | 1.7948 | 54.38244 | 20.4 | 30.3 | 918.09 |
| 39.35 | 1.3117 | 1.7206 | 43.53118 | 25.4 | 25.3 | 640.09 |
| 38.80 | 1.2933 | 1.6726 | 33.95378 | 30.4 | 20.3 | 412.09 |

From the graph, Slope S = 0.0404s2 and Intercept I = 17.534cms2

Gravity

Radius of Gyration

Min. Period

|  |  |  |  |
| --- | --- | --- | --- |
| *Tpractical* [sec] | *Ttheoretical* [sec] | %Error[%] | %[%] |
| 1.5397 | 1.4253 | -8.026 | 8.026 |
| 1.4840 | 1.3526 | -9.715 | 9.715 |
| 1.4630 | 1.2758 | -14.673 | 14.673 |
| 1.3740 | 1.1940 | -15.075 | 15.075 |
| 1.3397 | 1.1063 | -21.097 | 21.097 |
| 1.3117 | 1.0109 | -29.756 | 29.756 |
| 1.2933 | 0.9055 | -42.827 | 42.827 |
|  | Mean= | -20.167 | 20.167 |

**OBSERVATIONS:**

The period of a pendulum gets longer as the amplitude *θ0* (width of swing) increases.

**PRECAUTIONS:**

1. I ensured that the holes on the bar are equally displaced from the other.
2. I avoided error due to parallax while taking my readings with the meter rule.
3. I ensured the bar is balanced on the fixed knife edge support before marking my center of gravity.
4. I avoided zero error while using my stopwatch.
5. I avoided dangling of the oscillating bar while performing the experiment.
6. I ensured that the mass is firmly fitted on the bar.

**CONCLUSION**