logo

**Birzeit University**

physics 211

**Experiment No.6**

**Torsional Torques and the Torsional Modulus**

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**-Abstract:**

\* The aim of the experiment:

To find the torsional modulus **k** , and to find the shear modulus **G**.

\* Tools :

A massive dumbbell shaped object is fixed to a thin metallic rod(aluminum or steel), the system is twisted and set in vibration, the period for small vibrations is measured and is related to the torsional constant, stopwatch, meterstick.

**- Theory :**

The period T for small oscillations is given by :

T=2π ------------------(1)

Where the **I** is moment of inertia of the system , and **k** is the torsional constant.

For elastic twisting of the rod, the torque τ is related to the twist angle θ by :

τ = -k θ-----------------(2)

Where k is related to the dimensions of the rod by the following relation:

k = G -----------------------(3)

where G is the shear modulus , d is the rod's diameter ,and L is its length .

- **Procedure :**

\*Step 1:Determine the moment of inertia :

1- one rod is being used ,the system through six different angles θ is twisted and calculated .

2- τ is calculated .

3- set the dumbbell object into oscillation by pulling it with the spring and releasing it.

4- the period T is measured, and I is determined.

\*Step2:log k vs. log L

**-Data:**

I = 0.00723

\*Table1:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| τ (N.m) | F(N) | r (m) | θ (rad) | θ (deg) |
| 0.057 | 0.38 | 0.15 | 0.175 | 10 |
| 0.087 | 0.58 | 0.15 | 0.349 | 20 |
| 0.126 | 0.84 | 0.15 | 0.524 | 30 |
| 0.161 | 1.07 | 0.15 | 0.698 | 40 |
| 0.165 | 1.10 | 0.15 | 0.872 | 50 |

T = 1.31 sec, Kavg.=0.166404 N.m/rad

\*Table 2:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Log L | Log k | k | L(cm) | T(sec) |
| -1.309 | -2.330 | 0.0974 | 27.0 | 1.712 |
| -0.973 | -2.738 | 0.0647 | 37.8 | 2.100 |
| -0.740 | -2.954 | 0.0521 | 47.7 | 2.341 |

d= constant = 2.85 mm

\*Table 3:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Log D | Log k | k | T(sec) | D(m) |
| -5.69 | -0.094 | 0.91 | 0.560 | 0.00337 |
| -6.10 | -1.3 | 0.27 | 1.024 | 0.00232 |

l= constant = 48.4 cm

**-Calculations:**

We can find I from :

T = 2π

I = = = 0.00723 this value is constant.

We can find k in table 2 by:

k = = = 0.0974 N.m/rad …….etc.

We can find k in table 3 by:

k = = = 0.91 N.m/rad ……..etc.

Slope = 0.166404 N.m/rad = k

Slope = -1.09668 = m

Intercept= -3.76556

Slope = 2.941463 = n

Intercept= 16.64293

**-Result and Conclusion :**

n= 3.0 ±0.1

m= -1.0 ±0.1

kavg = 0.0714 from table 2.

kavg = 0.59 from table 3.