η by Maxwell Needle

OBJECT: To determine the modulus of rigidity of material of given wire by dynamical method using Maxwell needle.

Apparatus used: Maxwell needle, stop watch, screw gauge, meter scale.

Formula: The following formula is used for the determination of modulus of rigidity (η).

$$\eta = \frac{2\pi l}{r^4}\frac{(m_s - m_H)L^2}{\left(T_1^2 - T_2^2\right)}$$

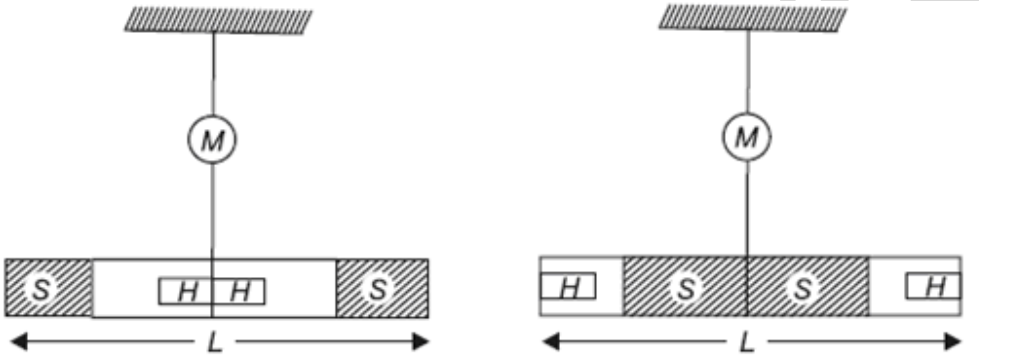
Where l: length of wire, L: length of Maxwell needle, r: radius of wire,

m_S: mean mass of solid cylinders, m_H; mean mass of hollow cylinders,

T_1: time period of oscillation when solid masses are out side,

T_2: time period of oscillation when solid cylinders are inside

Figure:



Arrangement 1: Solid cylinders at outside ***Arrangement 2:*** *Solid cylinders at inside*

Procedure:

(1) Measure the length of wire using meter scale through which the Maxwell needle is hanged. This will give you value of *l*.

(2) Measure the length of Maxwell needle using meter scale. This will give you value of L.

(3) Measure the mass of both solid cylinders using balance and do its half, this will provide the value of m_S.

(4) Measure the mass of the both hollow cylinders and do its half, this will provide the value of m_H.

(5) Find out the least count of screw gauge and zero error in it.

(6) Using screw gauge, measure the diameter of wire. Its half will provide the value of radius of wire.

(7) Find out the least count of stop watch.

(8) Now put the hollow cylinders at inside and solid cylinders at out side of the Maxwell needle. Oscillate it in horizontal plane about vertical axis. Note the time for 10, 20 and 30 oscillations. Divide the time with number of oscillations and find its mean. This will provide the value of T_1.

(9) Now place solid cylinders at inside and hollow cylinders at out side of the Maxwell needle. Oscillate it in horizontal plane about vertical axis. Note the time for 10, 20 and 30 oscillations. Divide the time with number of oscillations and find its mean. This will provide the value of T_2.

(10) Put all the value in given formula and solve it with log method.

Observations:

(1) Length of wire (l)=……..cm

(2) Length of Maxwell needle (L)=…….cm

(3) Mean mass of solid cylinders (m_S)=……..gm

(4) Mean mass of hollow cylinders (m_H)=……gm

(5) Least count of screw gauge= $\frac{pitch}{Number\ of\ \text{divisions on circular scale}}$ =……..cm

(6) Zero error in screw gauge=……..cm

(7) ***Table for diameter of wire***

Sr. no.	M.S. (cm)	C.S. (div)	un-corrected diameter (d= MS + CS x LC) (cm)	Mean un-corrected diameter (d: cm)	corrected diameter (D=d± zero error) (cm)
1.					
2.					
3.					
4.					
5.					
6.					

(8) *Radius of wire (r)=D/2=…..…..cm*

(9) Least count of stop watch=…….sec

(10) Table for T_1 and T_2:

Sr. no.	Number of oscillations (N)	For outside solid cylinders			For inside solid cylinders		
		t_1 (sec)	$T_1=t_1/N$ (sec)	MeanT_1 (sec)	t_2 (sec)	$T_2=t_2/N$ (sec)	MeanT_2 (sec)
1.	10						
2.	20						
3.	30						

Calculation: $\eta = \frac{2\pi l}{r^4}\frac{(m_s - m_H)L^2}{\left(T_1^2 - T_2^2\right)}$

(Put all the values in the above formula and solve it with log method)

Results: The modulus of rigidity of given wire material = …….N/m^2

Precautions:

1. There should be no kink in the wire.
2. The Maxwell needle should remain horizontal and should not vibrate up and down.
3. The amplitude of vibration/oscillation should be small so that wire is not twisted beyond the elastic limit.
4. To avoid the backless error, the circular scale of screw gauge should be moved in one direction.