Acceleration due to gravity 'g' by Bar Pendulum

OBJECT: To determine the value of acceleration due to gravity and radius of gyration using bar pendulum.

Apparatus used: Bar pendulum, stop watch and meter scale.

Formula:

A. The general formula of the time period for bar pendulum is given by following equation:

$$T = 2\pi\sqrt{\frac{\frac{k^2}{l}+l}{g}} = 2\pi\sqrt{\frac{l_2+l_1}{g}}$$

$$\boxed{g = \frac{4\pi^2(l_1+l_2)}{T^2} = \frac{4\pi^2 L}{T^2}} \quad (1)$$

Where l: distance between C.G. and suspension point, L: distance between suspension and oscillation points, $L = l_1 + l_2 = l + \frac{k^2}{l}$, g: acceleration due to gravity, T: time period.

B. The time period is minimum when $l=\pm k$, in this situation the equation (1) becomes as:

$$T_{min} = 2\pi\sqrt{\frac{2k}{g}}$$

or $$\boxed{g = \frac{8\pi^2 k}{T_{min}^2}} \quad (2)$$

where, k: radius of gyration, T_{min}: minimum time period.

The value of 'g' can be calculated using equations (1) and (2).

The values of L, T, k and Tmin are obtained using graph between T and L for bar pendulum which is shown in following figure.

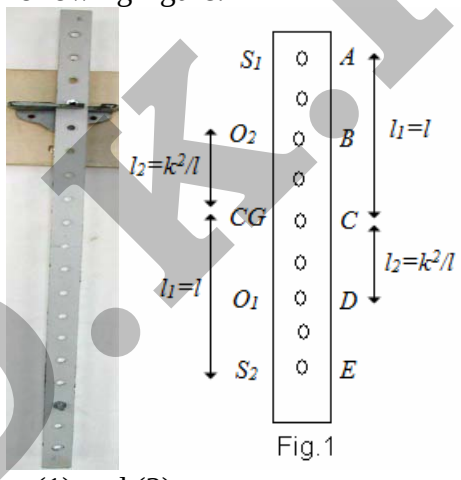

Fig.1

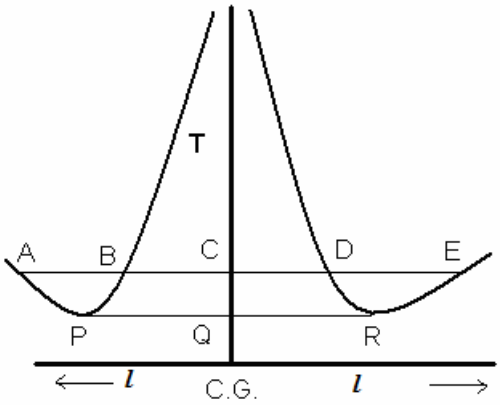

Fig. 2

From Figures (1) and (2),

(a) L_1=AC+CD, L_2=EC+CB and L=(L_1+L_2)/2, T=time at C

(b) k =(PQ+QR)/2 and T_{min}= time at Q

C. The radius of gyration can be obtained with following formula

$$\boxed{k = \sqrt{l_1 l_2}} \quad (3)$$

Where l_1=(AC+CE)/2, l_2=(BC+CD)/2

Procedure:

(1) Place the knife-edges at the first hole of the bar.
(2) Suspend the pendulum through rigid support with the knife-edge.
(3) Oscillate the pendulum for small amplitude ($\theta=3\sim4^0$).
(4) Note the time taken for 20 oscillations and measure the distance of the hole from the C.G. of the bar.
(5) Repeat the observations (2)-(4) for knife-edges at first half side holes of bar.
(6) Repeat the process (1)-(5) for the second half side of the bar.
(7) Plot the graph between T and L.

Observations:

1. Least count of the stop watch = ….. sec
2. Least count of the meter scale =…… cm
3. *Table for l and T*

S. No.	*l* (cm)	t (time taken for 20 oscillations)	T = t/20
For first half side of the bar			
1	45		
2	40		
3	35		
4	30		
5	25		
6	20		
7	15		
8	10		
9	5		
For second half side of the bar			
10	-5		
11	-10		
12	-15		
13	-20		
14	-25		
15	-30		
16	-35		
17	-40		
18	-45		

Calculations: *from graph,* $L=(AD+EB)/2=…$, $T=…sec$,
$k=PR/2=…$ $T_{min}=…sec$
$l_1=(AC+CE)/2=…$, $l_2=(BC+CD)/2$

1. $g_1=\frac{4\pi^2 L}{T^2}$ 2. $g_2=\frac{8\pi^2 k}{T_{min}^2}$ 3. $g=\frac{g_1+g_2}{2}$ 4. $k=\sqrt{l_1 l_2}$

Results: The acceleration due to gravity (g) = …….m/s^2
Radius of gyration (k) =……cm (from calculation)
=……cm (from graph)

Precautions:

1. The motion of the pendulum should be in a vertical plane. While taking the time, start taking observations after two oscillations to avoid any irregularity of motion.
2. The amplitude of oscillation should be small.