OBJECT :- To determine the value of 'g' by kater's pendulum.

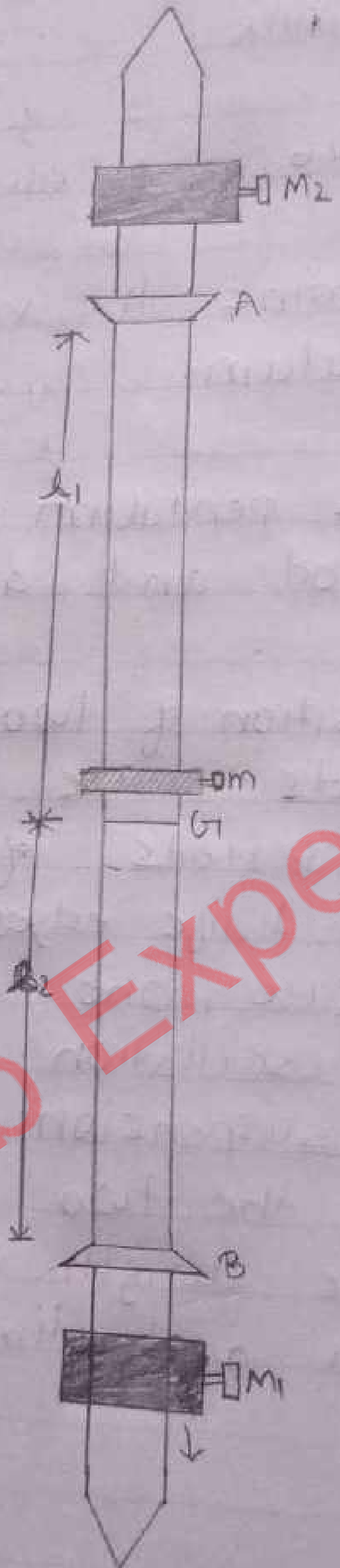
Apparatus :- kater's pendulum, stop watch, telescope, meter rod and a rigid support.

Theory :- The position of two knife edges and the weights are so adjusted that the time periods of the pendulum about the two knife edges are equal. In such a case, one knife edges is at the center of oscillation while the other at center of suspension. In this position, the distance b/w the two knife edges AB is equal to the length of the equivalent simple pendulum and time period of the pendulum.

Formula :-

Time period

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


M2
A
l1
m
G
l2
B
M1

Where g is the acceleration due to gravity.

If T_1 and T_2 are time periods about the two knife-edges A and B respectively and L_1 and L_2 are the distance from G upto the edges A and B, then

$$T_1 = 2\pi\sqrt{\frac{L_1^2+K^2}{L_1 g}} \quad \text{and} \quad T_2 = 2\pi\sqrt{\frac{L_2^2+K^2}{L_2 g}}$$

$$\frac{T_1^2 L_1 g}{4\pi^2} = L_1^2+K^2 \quad \text{and} \quad \frac{T_2^2 L_2 g}{4\pi^2} = L_2^2+K^2$$

$$\frac{g}{4\pi^2}(T_1^2 L_1 - T_2^2 L_2) = L_1^2 - L_2^2$$

or $$\frac{4\pi^2}{g} = \frac{T_1^2 L_1 - T_2^2 L_2}{L_1^2 - L_2^2}$$

$$g = \frac{8\pi^2}{\frac{T_1^2+T_2^2}{L_1+L_2} + \frac{T_1^2-T_2^2}{L_1-L_2}}$$

If T_1 and T_2 are very small equal and L_1 and L_2 differ by a friendly large amount second term in the tenominator will be very small.

Observation Table:-

	Distance of knife edge from end	Knife edge K_1 on top time for 10 oscillations $t_1(s)$ (i)	$t_2(s)$ (ii)	mean(t_1)	Time Period $T_1 = \frac{t_1}{10}$	Knife edge K_2 on top Time for 10 oscillations $t_1'(s)$ (i)	$t_2'(s)$ (ii)	mean (t_2)	Time Period $T_2 = \frac{t_2}{10}$	$\lvert T_1 - T_2 \rvert$
1.	10	20.27	20.23	20.23	2.023	20.33	20.17	20.17	2.033	0.015
2.	12	19.54	19.50	19.52	1.952	19.43	19.43	19.43	1.94	0.009
3.	14	19.42	19.48	19.45	1.945	19.60	19.53	1.943	1.95	0.008
4.	16	18.30	18.14	18.22	1.842	18.14	18.15	1.953	1.85	0.007
5.	18	18.27	18.25	18.26	1.826	18.35	18.34	1.815	1.83	0.008

Final Arrangement

Distance of knife edge K	Knife edge K_1 on top Time for 50 oscillation t_1 (i)	t_2 (ii)	mean (t_1) s	Time Period $T_1 = \frac{t_1}{50}$ s	Knife edge K_2 on top Time for 50 oscillation t_2'	t_1'	Mean t_2 (s)	Time Period $T_2 = \frac{t_2}{50}$ s
12 Cm	96.572	98.431	96.501	1.930	96.768	96646	96.707	1.934

Calculations →

When knife edge is 12cm. from end.

$T_1 = 1.930$ sec $T_2 = 1.934$ sec

$L_1 = 66.87$ cm. $L_2 = 29.13$ cm.

$$g = \frac{8\pi^2}{\frac{T_1^2+T_2^2}{L_1+L_2} + \frac{T_1^2-T_2^2}{L_1-L_2}} = \frac{8\pi^2}{\frac{(1.930)^2+(1.934)^2}{66.87+29.13} + \frac{(1.930)^2-(1.934)^2}{66.87-29.13}}$$

$$\boxed{g = 986.87 \text{ cm/s}^2}$$

Result :-

The acceleration due to gravity

$g = 986.87 \text{ cm/s}^2$

Actual value $= 980 \text{ cm/s}^2$

(i) The knibe edges should be sharp, horizontal and parralled to each other.

(ii) The amplitude of vibration should be small so that $\sin\theta \simeq \theta$

(iii). The support on which the pendulum vibrates should be rigid and should not move on the pendulum vibrates.

(iv). For final observations the time of at least 100 vibrations must be taken with an accurate stop watch.

(v). To avoid any irregularity of motion in the begining, the time period should be noted after the pendulum has made a few vibrations.