7.3 Bar Pendulum

Apparatus:

A rectangular bar of uniform cross section, rigid support, meter scale, stop watch.

1) Examine the given rectangular uniform bar. There are uniformly spaced holes in the bar (How many?). Two knife edges are also given. Any one knife edge may be fixed to any hole and the bar may be suspended by placing the knife edge on a horizontal support.
2) Fix knife edge K_1 on hole no. 1 and the knife edge K_2 on the last hole (bottom hole). Suspend the bar by placing K_1 on the horizontal support. Set the bar into simple harmonic oscillations and find out the time period (T). Also note the distance from K_1 to K_2. Call this distance y. Do it twice and record your readings.
3) Bring K_1 down to the second hole while move K_2 up by one hole. Repeat the above process (i.e. measure the time taken for 20 oscillations and measure the distance y)
4) Keep on moving K_1 down and K_2 up till observations have been taken on all holes.
5) The time period T depends on y according to,

$$T = 2\pi\sqrt{\frac{x^2 + k^2}{x\,g}} \tag{7.8}$$

where $x = \frac{y}{2}$

$g =$ *acceleration due to gravity*

$k =$ *a constant* called *the radius of gyration of the bar*

6) Plot a graph of xT^2 as a function of x^2. This graph will be a straight line (Why?)
7) From the slope and intercept of the graph, calculate the value of g and k.
8) Can you check that the value of k obtained by you is correct?

The equation used:

The oscillations of the bar pendulum are governed by the equation,

$$I\frac{d^2\vartheta}{dt^2} = -Mgx\vartheta \tag{7.9}$$

where $PC = x$ (Fig 7.3)

and $I = I_c + Mx^2$ (by parallel axis theorem)

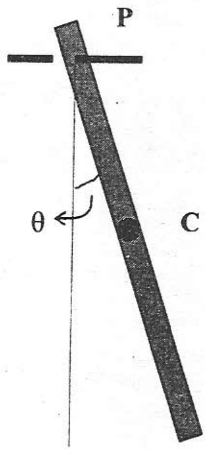


Figure 7.3 Bar Pendulum.

I = Moment of inertia of the bar pendulum about the horizontal axis through the point of suspension P (knife edge K_1 is at P)

M = Mass of the bar

From equation (7.9), time period is

$$T = 2\pi\sqrt{\frac{I_C + M\,x^2}{Mgx}} \tag{7.10}$$

where I_c = M.I. of bar about the horizontal axis through C

We define K such that $I_c = Mk^2$ then Equation. (7.10) leads to Equation (7.8)

Observations:

S.No.	y(cm)	Time of 20 oscillations		Time period $T = \frac{1}{20}\left(\frac{t_1 + t_2}{2}\right)$
		t_1 (sec)	t_2 (sec)	
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				

7.4 Kater's Pendulum-I

Appratus:

Kater's pendulum, weights (four No.), Two knife edges, Wedge, meter scale, stopwatch, thread.

Kater's pendulum depicts non uniform distribution of mass. Consider the following sequence of steps.

1) Kater's pendulum is also a compound pendulum. Examine it. How does it differ from a bar pendulum?
2) Kater's pendulum has two knife edges and cylindrically-shaped wooden and metallic weights whose positions may be varied.
3) To begin with, keep the weights and the two knife edges K_1 and K_2 any where and fix them.
4) Suspend the pendulum by placing K_1 on a horizontal support. Set the pendulum into simple harmonic motion. Find out the time period, call it T_1.
5) Without disturbing the positions of K_1 or K_2 or the weights, suspend the pendulum by placing K_2 on the horizontal support. Find the time period of oscillations, call it T_2.
6) Without disturbing the positions of K_1 or K_2 or the weights, balance the pendulum on edge. (You may use a wooden scale as an edge). Find out the position of the center of mass. (Mark it with a chalk). Measure the distance from K_2 to C. Call it L_2. Measure the distance from K_1 to C; call it L_1.
7) Be careful in measuring L_1 and L_2 in the above step. (If you like, you may mark the positions of edges K_1 or K_2 also by chalk, remove the knife edges as well as the weights from the rod and only then measure L_1 and L_2).
8) The value of g is given by

$$g = 4\pi^2 \frac{\left(L_1^2 - L_2^2\right)}{L_1T_1^2 - L_2T_2^2} \tag{7.11}$$

9) Repeat the above steps (3) to (7) for different configuration of positions of knife edges and the weights. Do this five times. From these five sets, calculate g individually for each set by using the above equation.

The equation used:

When the pendulum is suspended on the knife edge K_1, Eequation (7.8) of the last experiment is applicable with $x = L_1$, hence

$$T_1 = 2\pi\sqrt{\frac{L_1^2 + k^2}{L_1 g}} \tag{7.12}$$

Similarly, when the pendulum is suspended on the edge K_2, the time period T_2 is given by

$$T_2 = 2\pi\sqrt{\frac{L_2^2 + k^2}{L_2 g}} \tag{7.13}$$

Eliminating the unknown k we get equation (7.11).

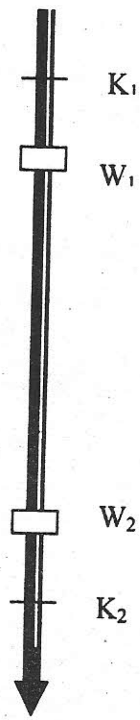


Figure7.4 Kater's Pendulum.

Observations:

S.No.	Time of 20 oscillations using Edge 1	$T_1 = \frac{1}{2}\left(\frac{t_{11} + t_{12}}{2}\right)$	Time of 20 oscillations using Edge 2	$T_2 = \frac{1}{2}\left(\frac{t_{21} + t_{22}}{2}\right)$	L_1	L_2
1.						
2.						
3.						
4.						
5.						

7.5 Kater's Pendulum-II (use of graph)

Apparatus:

Kater's pendulum, weights (four No.), Two knife edges, Wedge, meter scale, stopwatch, thread.

1) Keep the knife edges as distant from one another far as possible. Keep one metallic weight W_2 near K_2 and another W_1 nearly midway between K_1 and K_2. Remove all other weights altogether.
2) Measure T_1 and T_2 as in the last experiment. Also measure L_1 and L_2 (but without removing the weights.) This is your first set of readings.
3) Move W_1 and W_2 in the same direction by a small distance (say 5 cms). Do not disturb K_1 and K_2. Measure T_1, T_2, L_1 and L_2 again. This is your second set of observations.
4) Repeat the above process as many times as possible.
5) Plot a graph of $(L_1T_1^2 - L_2T_2^2)$ as a function of $(L_1 - L_2)$. The graph will be a straight line (why?)
6) Slope of the above graph is $4\pi^2\frac{L}{g}$; where L is the distance between K_1 and K_2 (why?)
7) From the slope of the graph, calculate the value of "g".
8) Check the value of 'g' by using the least squares fit technique.

Observations:

S. No.	Time of 20 oscillations using Edge 1	$T_1 = \frac{1}{2}\left(\frac{t_{11}+t_{12}}{2}\right)$	Time of 20 oscillations using Edge 2	$T_2 = \frac{1}{2}\left(\frac{t_{21}+t_{22}}{2}\right)$	L_1	L_2
1.						
2.						
3.						
4.						
5.						
6						
7.						
8.						

7.6 Use of moment of inertia (M.I.) table to find the moment of inertia of a given object

Apparatus:

Moment of inertia table, spirit level, stop watch, cylinders, rectangular solid, cone, wooden scale, Vernier Callipers.

1) A M.I table may be set into angular oscillations. What should be the maximum angular amplitude? Should the oscillating disk be horizontal? Check that it is horizontal by using a spirit level.
2) The time period of angular oscillations of the circular disk is given by

$$T_0 = 2\pi\sqrt{\frac{I_0}{C}} \tag{7.14}$$

because $$I_0\frac{d^2\vartheta}{dt^2} = -C\vartheta \tag{7.15}$$

where I_0 is the moment of inertia of the disk about the suspension wire. What is C? Does it depend on the amplitude of oscillations?

3) To begin with, make the disk horizontal. Set it into oscillation. Find the time period T by finding the time taken by 5 oscillations (and by dividing 5).
4) Now place a heavy cylinder in the center of the disk. The disc should remains horizontal. The moment of inertia of the system has now increased and is $(I_0 + I_1)$

where $I_1 = \frac{1}{2}MR^2$ is the moment of inertia of cylinder alone (Calculate the value of I_1 by measuring the values of M and R).

5) Set the disc (with cylinder on it) into oscillation. Measure the time period T_1. It is given by

$$T_1 = 2\pi\sqrt{\frac{I_0 + I_1}{C}} \tag{7.16}$$

6) Remove the cylinder and place a rectangular or conical solid in its place now and measure the time period T_2

$$T_2 = 2\pi\sqrt{\frac{I_0 + I_2}{C}} \tag{7.17}$$

I_2 is the M.I. of the rectangular or conical solid placed now.

7) The above step should be carried out for a rectangular solid as well as conical solid.

8) Measure the dimensions of these solids and record their masses. Calculate their moments of inertia from their dimensions.

9) The above equations are of the form

$$T = 2\pi\sqrt{\frac{I_0 + I_s}{C}} \tag{7.18}$$

where I_s is the moment of inertia of a particular solid (a cylinder, a cone or a rectangular solid)

or, $$T^2 = \left(\frac{4\pi^2}{C}\right)I_s + \frac{4\pi^2}{C}I_0 \tag{7.19}$$

10) Plot a graph of T^2 as a function of I_s, where I_s for each solid has been calculated in step (8).

Calculate C and I_0 from the graph.

Remember the following

The angular amplitude should be normally less than 90^0

You can check that the disc is horizontal by using spirit level.

I is the M.I. about the suspension wire.

C does not depend on the amplitude.

C is torque per unit angular twist.

Observations:

a) M.I. Table alone

S.No.	Time of 5 oscillations (sec)			Time period $T_0 = \frac{1}{5}\frac{(t_1 + t_2 + t_3)}{3}$
	t_1	t_2	t_3	

cylinder M =
D =

b) M.I. Table + a solid object (~~whose M.I. is known~~)

S.No.	Time of 5 oscillations (sec)			Time period $T_s = \frac{1}{5}\frac{(t_1 + t_2 + t_3)}{3}$
	t_1	t_2	t_3	

M = , a = , b =

Rectangular solid

c) M.I. Table + a solid object (~~whose M.I. is o be known~~)

S.No.	Time of 5 oscillations (sec)			Time period $T_{us} = \frac{1}{5}\frac{(t_1 + t_2 + t_3)}{3}$
	t_1	t_2	t_3	

(T_{us} is time period of unknown solid)

d) M. I. Table + Cone (M =
D =

7.7 Verification of parallel axis theorm.

Apparatus:

Moment of inertia table, spirit level, stop watch, two cylinders, wooden scale, Vernier Callipers.

1) Read the statement of parallel axis theorem. Prove it yourself.
2) For verifying this theorem, you will use the M.I. table. You will also need two identical metallic cylinders (100 gm each in weight) and a wooden scale.
3) Place the scale on the disc of M.I. table. Center of scale should coincide with the center of the disc. Now place the two cylinders on the scale at equal distance from the center of scale. Measure the distance between center of the scale and center of a cylinder. Call it x.
4) Set the disc (on which scale and cylinders has been placed) into oscillation. Measure the time period T (by measuring time taken by five oscillations).
5) Change x. Measure T again. Do it at least seven times.
6) Plot a graph of T^2 as a function of x^2. It is a straight line.
7) T^2 depends on x^2 in accordance with the equation

$$T^2 = A x^2 + B \tag{7.20}$$

where $$A = 8\pi^2 \frac{m}{C}$$

and m is the mass of one cylinder. (7.21)

8) Calculate the value of A and B from the graph. Can you check whether these values are correct ?

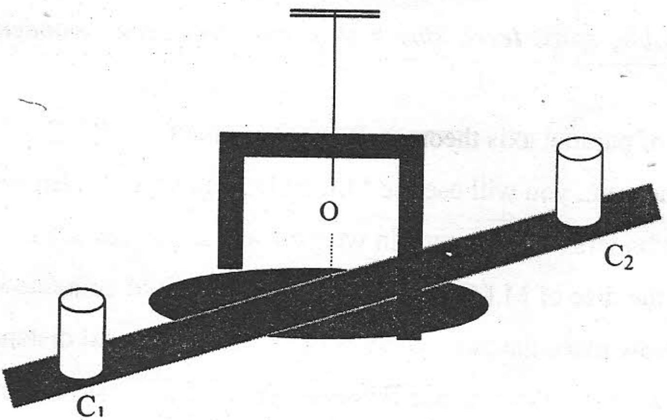


Figure 7.4 Moment of inertia table.

The equation used:

The M.I. of the system is

$$I = I_0 + I_{sc} + 2\,(M.I.\,of\ one\ cylinder) \tag{7.22}$$

where I_0 is the moment of inertia of the disk and I_{sc} is the moment of inertia of the scale (placed on the disk).

By parallel axis theorem, M.I. of the cylinder $= \frac{1}{2}mr^2 + mx^2$

Eqn. 7.23 becomes

$$I = I_0 + I_{sc} + mr^2 + 2\,mx^2 \tag{7.23}$$

The time period is

$$T = 2\pi\sqrt{\frac{I}{C}},$$

Hence

$$T^2 = \frac{4\pi^2}{C}I$$

Using (7.23), this becomes

$$T^2 = \frac{4\pi^2}{C}(I_0 + I_{sc} + mr^2) + \frac{8\pi^2 m}{C}x^2$$

or $T^2 = B + Ax^2$

where $A = \frac{8\pi^2 m}{C}$

and $B = \frac{4\pi^2}{C}(I_0 + I_{sc} + mr^2)$

Moment of inertia of the scale is given by

$$I_{sc} = \frac{M_{sc}}{12}(a^2 + b^2)$$

where

M_{sc}= mass of the scale

a = length of the scale

and b = breadth of the scale

Observations

S.No.	x	Time of 5 oscillations (sec)			Time period $T = \frac{1}{5}\frac{(t_1 + t_2 + t_3)}{3}$
		t_1	t_2	t_3	
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					

7.8 Fly wheel

a) To determine the moment of inertia of the given fly wheel by measuring time interval.

Apparatus:

Flywheel, thread, slotted weights, scale, stopwatch, Vernier Callipers.

1) Examine the fly wheel. Note that it rotates freely. Pay particular attention to the "counter" which records the number of rotations made by the wheel. What is the least count of the counter ?
2) Wind a thread, N_1 times on the axleis of the wheel. Attach a mass M to one end of the thread and let the mass fall. As it falls down, the wheel start rotating.
3) The angular velocity of the wheel will go on increasing till N_1 revolutions have been completed. At that instant, the thread will leave the axle of the wheel completely. From now on the angular speed of the wheel will start decreasing (because of friction)
4) Thus the wheel will attain its maximum angular velocity just after completing N_1 revolutions (or just as the thread leaves the axle). This maximum angular velocity is called ω.
5) The wheel will continue to rotate and will make (say) N_2 revolutions more and will eventually stop.

   What does N_2 depends on ?
6) Let the later N_2 revolution be made in time t_2 then it can be shown that

$$\omega = \frac{4\pi N_2}{t_2} \qquad \text{(show it)}$$

7) If the earlier N_1 revolutions are made in time t_1 it can be shown that

$$\omega = \frac{4\pi N_1}{t_1} \qquad \text{(show it)}$$

8) Let ω be determined by one of the above equations. (better use both). Which one will give more accurate value of ω ?

   Using energy conservation law one can write that

$$MgL = \frac{1}{2}I\omega^2 + \frac{1}{2}Mv^2 + N_1\,\xi$$

where $L = 2\pi\, rN_1$

I = M.I. of the wheel

r = radius of the axle of the wheel

$v = r\omega$

ξ = energy loss per revolution due to frictional force

Again from energy conservation law

$$\frac{1}{2}I\omega^2 = N_2\,\xi \qquad (7.25)$$

(prove the above equations)

9) Keep M fixed. Repeat the measurements of ω for six different values of N_1.

Equation above may be written as

$$\omega^2 = \frac{2(-\xi + 2\,\pi\, r\, M\, g)}{I + M\, r^2}N_1 \qquad (7.26)$$

10) Plot a graph of ω^2 as a function of N_1.

According to above equation, it should be a straight line. Find the slope of line.

11) Plot a graph of ω^2 as a function of N_2. Use Equation (7.25) above, Find the slope.

Calculate I and ξ from the slopes of the two graphs.

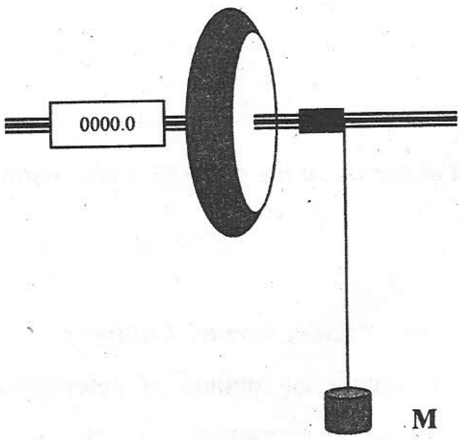


Figure 7.5 Fly wheel.

Observations

S. No.	Mass attached M (gm)	Counter reading C_0	Reading C_1	Time interval t_1 (sec.)	Reading C_2	Time interval t_2 (sec.)
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

In the above table

C_0 = counter reading before beginning the winding of the thread on the axle.

C_1 = reading when the thread has been wound N_1 times on the axle.

C_2 = reading when the flywheel ultimately stops rotating

t_1 = interval of time from the moment the mass is released to the moment when the thread is completely unwound.

t_2 = Interval of times from the moment the thread is completely unwound to the moment the flywheel ultimately stops rotating.

$$N_1 = |C_1 - C_0|$$

$$N_2 = |C_2 - C_0|$$

b) To determine the moment of inertia of the given fly wheel without measuring time interval.

Apparatus:

Flywheel, thread, weights, meter scale, Vernier Callipers.

An interesting and unconventional method of determining the moment of inertia of a fly wheel is not to use the stopwatch at all . the steps are as follows.

i) A thread is wound on the axle of the flywheel N_1 times and a mass M is attached to the free end of the thread. The mass M is now released and it starts descending, as the thread gets unwound. The counter reading is noted, before releasing the mass M. Let the reading be C_1.

ii) The mass M falls on the ground, when the thread is completely unwound. The flywheel continues to rotate, till it ultimately stops due to friction. Let the final counter reading be C_2.

The difference $|C_2 - C_1|$ is equal to the total number of rotations made by the fly wheel. As before we denote by N_2, the number of rotations made by the flywheel after the thread has been completely unwound. Thus

$$N_1 + N_2 = |C_2 - C_1|$$

This equation can be used to determine N_2.

Observations:

S. No.	Mass attached M (gm)	N_1	Counter reading C_1	Counter reading C_2	N_2
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					

Calculation:

Energy conservation implies that

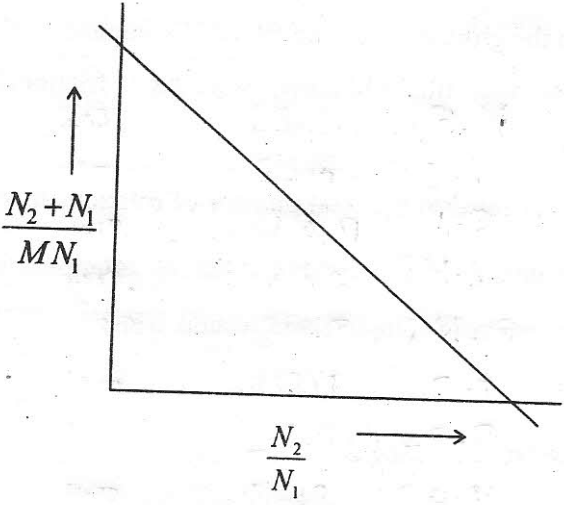
$$Mg\,(2\pi\, rN_{1)} = \frac{1}{2} I\omega^2 + \frac{1}{2} Mr^2\omega^2 + N_1\,\xi$$

also $\frac{1}{2} I\omega^2 = N_2\,\xi$

Eliminating ω^2 from the above two equations, one gets

$$\frac{N_1 + N_2}{M N_1} = \frac{2\pi rg}{\xi} - \frac{r^2}{I} \cdot \frac{N_2}{N_1}$$

This suggests the following straight line graph:



Magnitude of slope $= \frac{r^2}{I}$

and Intercept $\frac{2\pi rg}{\xi}$

Hence I and ξ can be calculated.

7.9 Spring

To determine the spring constant K of a given spring by static method.

Apparatus:

Helical spring, pin, stand, slotted weights of 10 gm each, meter scale, thread.

1) A spring is given. Lay it on a horizontal table. Measure its length (use a thread)
2) Suspend the spring vertically. Measure its length. Does the length differ from the previous measurement ? Account for the difference.
3) Mount a scale on a vertical stand. Suspend the spring vertically parallel to the scale. Attach a pointer (a pin) to the lower end of spring. Let the spring attain equilibrium. Read the pointer position.
4) Attach a mass of 20 gm to the lower end of spring. Let the spring again attains equilibrium. Read the pointer position again.
5) Go on increasing the mass attached in steps of 20 gm till you reach a mass of 160 gm. Note the pointer position each time.
6) Now decrease the mass in steps of 20 gm, reading the pointer positions at each step, till all the masses have been removed.
7) Now you have a record of pointer positions (x) and the corresponding values of (m) suspended mass. Plot a graph of x as a function of m . It is a straight line. From the slope, calculate the spring constant.
8) Use least squares fit (LSF) method also; to calculate the slope and therefore the spring constant (K)

Observations:

S.No.	Mass suspended M (gm)	Pointer position		Average pointer position $y = \frac{1}{2}(y_1 + y_2)$ (cm)
		Mass increasing y_1 (cm)	Mass decreasing y_2 (cm)	
1.	20	23.3	23.4	
2.	40	23.6	23.7	
3.	60	24.0	24.0	
4.	80.	24.3	24.3	
5.	100	24.8	24.9	
6.	120	25.3	25.3	
7.	140	25.7	25.8	
8.	160	26.2	26.1	
9.	180	26.7	26.7	
10.				

7.10. Spring

To determine the spring constant K of a given spring by dynamic method

Apparatus:

Helical spring, pin, stand, slotted weights of 10 gm each, meter scale, thread, stopwatch.

1) Suspend the spring vertically. Attach a mass of 10 gm to the lower end and let the mass oscillate up and down simple harmonically.
2) Find the time period of SHM. Measure the time of 20 oscillations; thrice.
3) Increase the suspended mass by 10 gm. Find the time period again.
4) Repeat this process till you reach a mass of 100 gm. Do not increase the mass further.
5) Plot a graph of T^2 as a functionof M (suspended mass)
6) The graph is a straight line. From its slope, calculate the spring constant.
7) From the intercept of the above graph, find the effective mass of spring.
8) Use least squares fit method also, to calculate the spring constant and the effective mass.
9) The time period is given by the equation

$$T = 2\pi\sqrt{\frac{M + m_{eff}}{K}} \qquad (7.28)$$

where M = suspended mass

m_{eff} = effective mass of the spring

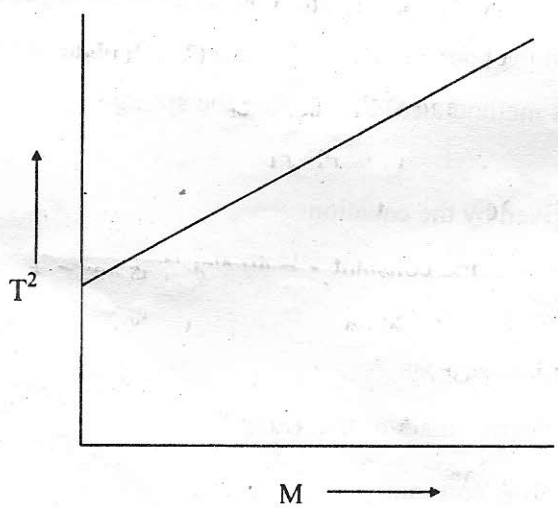
K = spring constant

m_{eff} is the effective mass of spring such that

$\frac{1}{2}m_{eff}v^2$ = contribution of the spring to the kinetic energy of the system. Under simple assumptions, m_{eff} turns out to be one third of the actual mass of the spring.

Observations:

S.No.	Mass suspended M (gm)	Time of 20 oscillations t (sec)			Time period $T = \frac{1}{20}\frac{(t_1+t_2+t_3)}{3}$
		t_1	t_2	t_3	
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					



8.3 Conversion of Galvanometer into Voltmeter

Appratus:

Galvanometer, resistance boxes, keys, dry cell, rheostat, voltmeter, connecting wires.

1) Suppose a given resistance S is combined in series with a moving coil galvanometer of known resistance G. The combination will act as a voltmeter. What is the maximum voltage it can measure ?

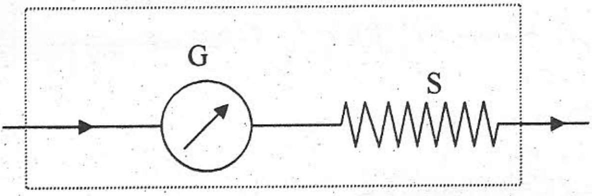


Figure 8.4

2) Conversely suppose we want to make a voltmeter which may measure up to 250 mV. What is the value of S needed? Calculate it. (Use the equation $V_{max} = I_g(G+S)$ and justify this equation)

3) We set up a circuit in which the potential difference across two points in the circuit is approximately 250 mV or less. Use the voltmeter prepared above and an ordinary voltmeter (available in the laboratory) to measure this potential difference.

4) Take ten corresponding readings in the two voltmeters and plot a graph between them.

5) Calculate the slope of this graph. Does it agree with what you expect ?

   Note that

   Maximum voltage $= I_g\ (G+S)$

   Expected slope $= \dfrac{I_g}{N}(G+S)$

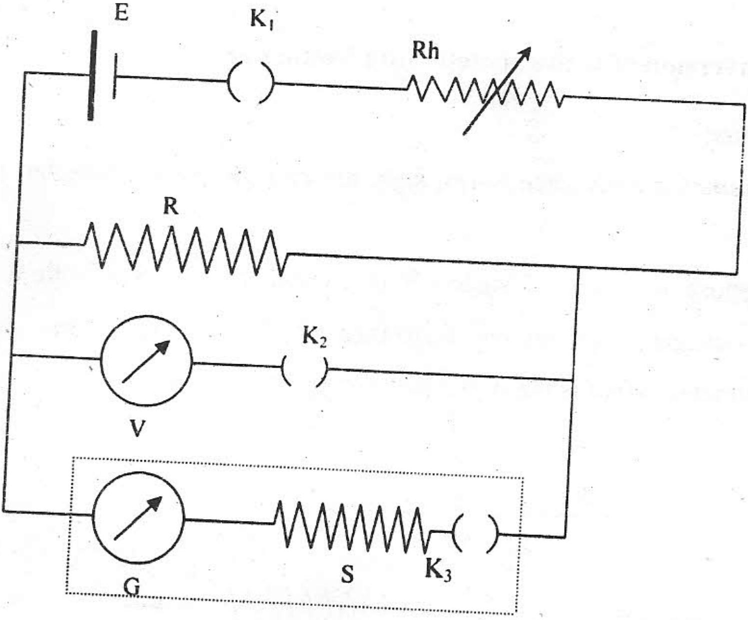


Figure 8.5

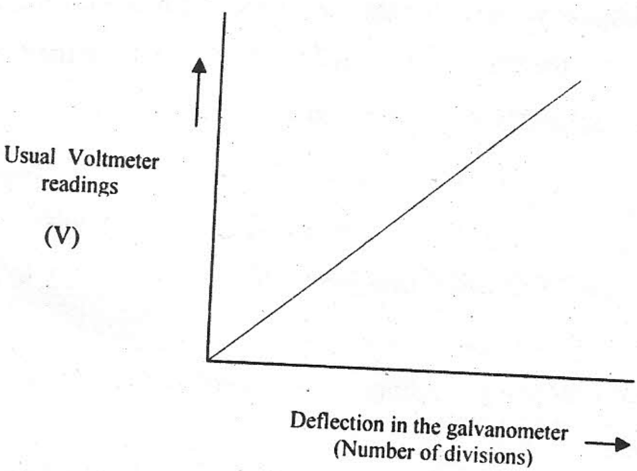


Figure 8.6

Observations:

S.No.	Galvanometer reading (divisions)	Voltmeter reading (mV)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

8.4 V-I Characteristics of Semiconductor diode

(a) Forward Characteristics

1) Set up the circuit as shown in Fig 8.7 a.
2) Vary the voltage in small steps and measure the current.
3) Sketch VI characteristics and extend the linear portion of the curve downwards to obtain the cut-in voltage V_c. The slope of the linear portion gives the dynamic r_d resistance of the diode.

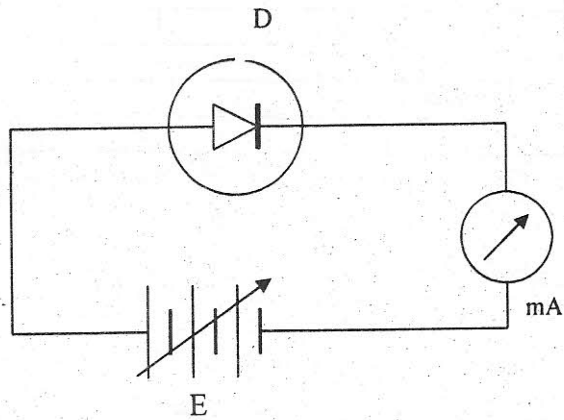


Figure. 8.7 Diode (D) Forward biased.

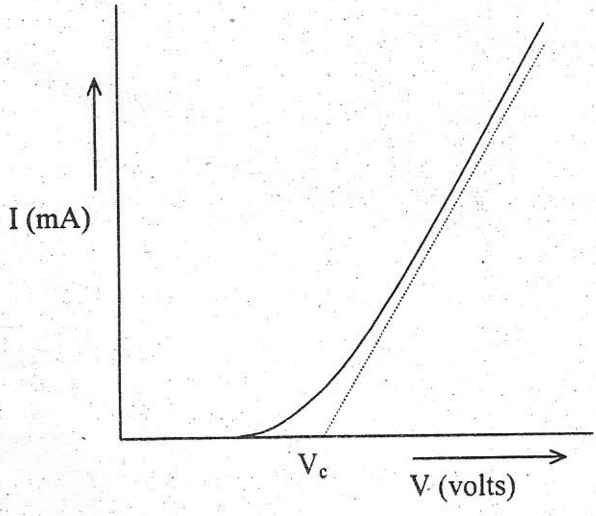


Figure 8.8 Forward biased characteristics.

(b) Reverse Characteristics

a) Set up the circuit as shown (in reverse bias)

b) Vary the voltage in step of 1 V and measure the current. Tabulate the readings.

c) Plot the characteristics and calculate the reverse saturation current

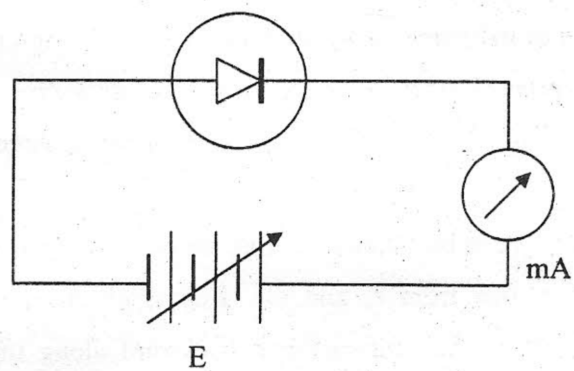


Figure 8.9 Reversed biased .

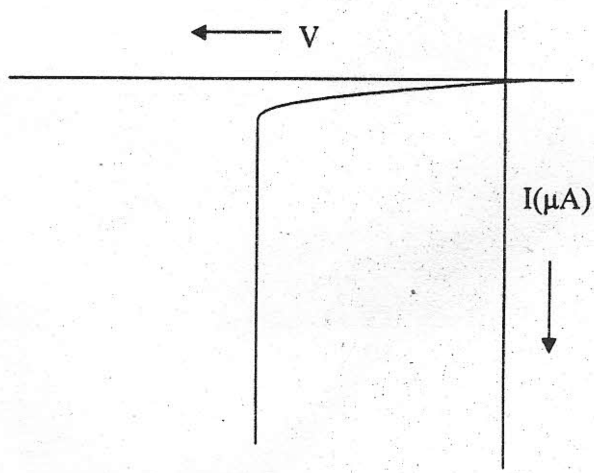


Figure 8.10 Reversed biased characteristics

8.5 To compare the e.m.f. of two primary cells by using a potentiometer.

Apparatus:

Potentimeter, wet cells, eliminator, resistance boxes, keys, two way keys, rheostat, connecting wires, joykey.

Draw a circuit diagram and set up the arrangement as shown. E should be always greater than ε_1 and ε_2. First put one of the cells, say ε_1 in the circuit by inserting the plug in the gap and taking out a resistance 1000 ohms from the resistance box and then press the jockey at one end of the wire. Note the direction of deflection in the galvanometer. Now repeat the same process with the jockey near the other end of the wire and note the direction of deflection. If the deflections are in opposite directions, the connectins rae correct.

In case they are in the same direction, check your connections, as the current from E should be more than from ε_1 and ε_2 . Repeat till the deflections are in opposite directions. Move the jockey forward and backward along the wire and obtained the balance point where on pressing the jockey there is no deflection in the galvanometer. Plug in the resistance 1000 ohm in the resistance box to get the accurate position of null point. Note the length of wire; let it be l_1 .

Next obtained the balance point for the cell ε_2 and note the length l_2. Repeat the process by changing the resistance. Calculate $\frac{l_1}{l_2}$ for the whole set of readings and obtained their mean. This gives the value of $\frac{\varepsilon_1}{\varepsilon_2}$

Observation Table:

S. No.	Balance point when ε_1 is on; l_1 (cm)	Balance point when ε_2 is on; l_2 (cm)	$\frac{\varepsilon_1}{\varepsilon_2} = \frac{l_1}{l_2}$
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

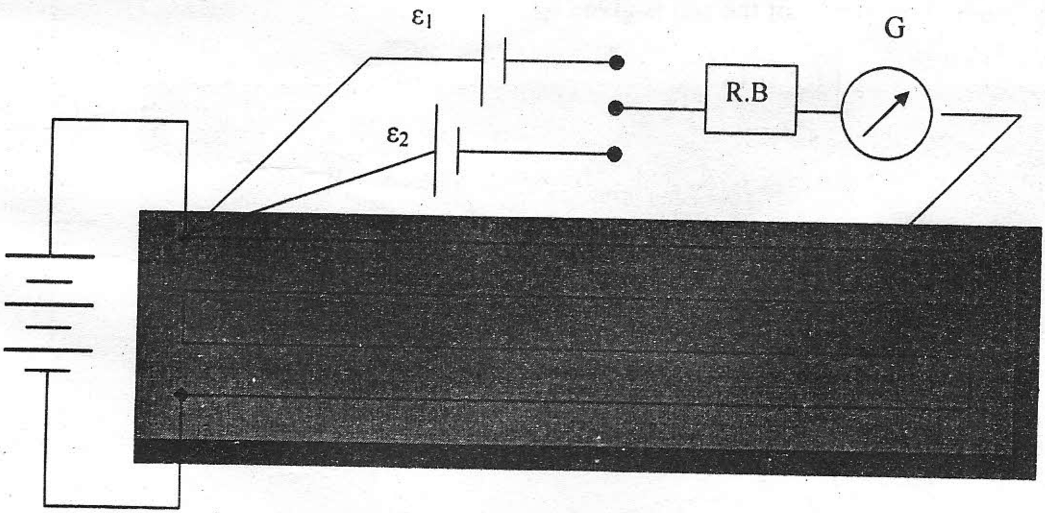


Figure 8.11

8.6. To determine the internal resistance of a cell by using a potentiometer.

Apparatus:

Potentimeter, dry cell, eliminator, resistance boxes, keys, rheostat, connecting wires, joykey.

Draw a circuit diagram and join the circuit as shown in Fig 8.12. Take out the plug of 1000 ohm from R_2 insert the plugs in key K_1 and K_2 and move the jockey near the end and press it there and note the the direction of deflection. If the two deflections are in opposite directions, the connections are correct.

Now take out resistance of 1000 ohms resistance from the resistance box R_2 joined along with galvanometer. Measure the balancing length ; call it l_1 . (K_2 closed; and K_1 open).

Again take out resistance from R_2. Now insert both the the keys. Remove a small resistance (2-10 ohm) from the box R_1 and now find the null point. Let the new balancing length be l_2.

To be sure; measure balancing length l_1 and l_2 at least two times and then take their mean. Now switch off the potentiometer, remove keys; wait for some time, then repeat the process, at least five times, by introducing different values of resistance R_1.

The internal resistance of the cell is given by

$$r = \left(\frac{l_1 - l_2}{l_2}\right) R_1$$

Plot a graph between $(l_1 - l_2)R_1$ and l_2; from its slope calculate r .

Observation Table:

S. No.	R_1 (Ω)	Balance length l_1 (cm)	Balancing length l_2 (cm)	r
1.				
2.				
3.				
4.				
5.				

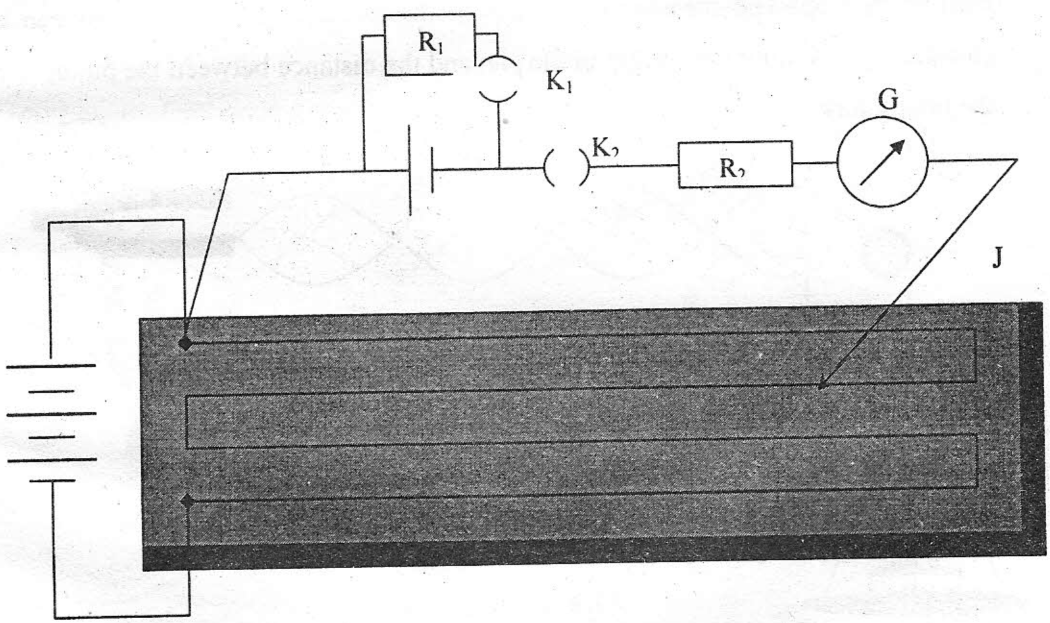


Figure 8.12

8.7. To determine the frequency of an electrically maintained tuning fork by Melde's method.

Apparatus:
Tuning fork, Melde's arrangement, thread, pan, slotted weights.

(a)- Transverse arrangement

Fix a thread to one of the prongs of the fork, with the help of a screw supplied for this purpose. Stretch the thread in a line with the prong of the fork and pass is over a ball bearing pully clamped to a stand. At its other end tie a small pan for the purpose of putting weights.

Place suitable weights in the pan. Adjust the gap between the platinum contacts and make the fork vibrate. The vibrations of the prong are at right angles to the line of stretched thread. The arrangement is shown in the figure Fig 8.13. Note the number of loops and measure the length of thread. The number of loops can be changed by changing the weight in the pan and the distance between the pulley and the tuning fork.

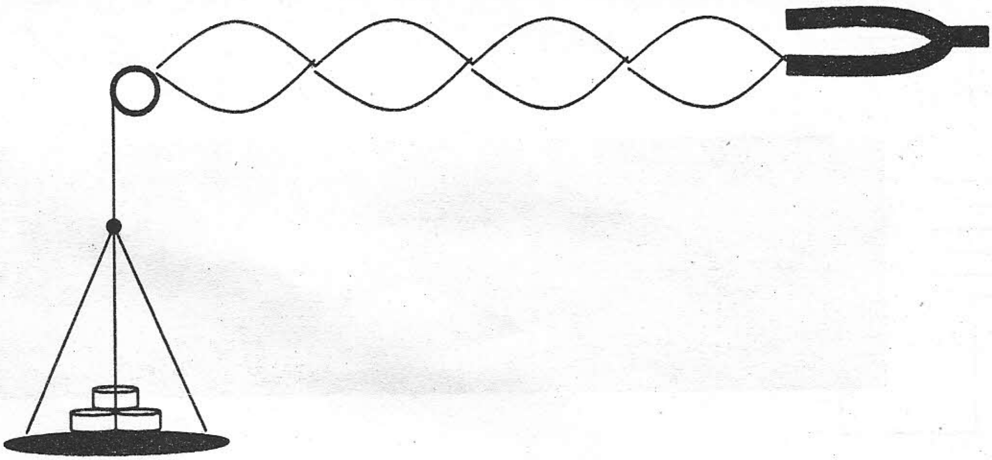


Figure 8.13

The frequency of the fork is given by

$$f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$$

where l is the length of one loop,

$T = mg$; Tension

μ = mass of the thread per unit length

Observation Table:

S.No.	$T = mg$	Number of loops p	Total length of thread L	$l = \frac{L}{p}$	$f = \frac{1}{2l}\sqrt{\frac{T}{m}}$
1.					
2.					
3.					
4.					
5.					

(b) Longitudinal arrangement

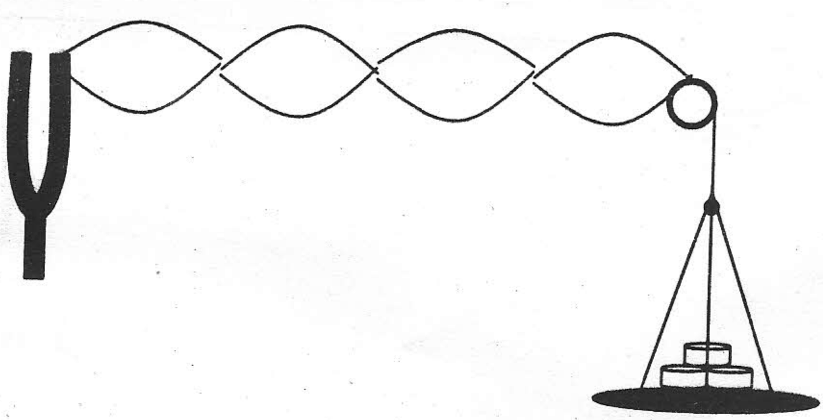


Figure 8.14

Tie one end of the thread to one of the prongs of the fork, with the help of a screw fixed to the prong of the fork. Stretch the thread in a line with the prong of the fork and pass it over a ball bearing pully clamped to a stand. At its end tie a small pan for the purpose of putting weights.

Place suitable weights in the pan. Adjust the gap between the platinum contacts and make the fork vibrate.. The vibration of the prongs are parallel to the line of stretched thread.

The frequency of the fork is given by

$$f = \frac{1}{l}\sqrt{\frac{T}{\mu}}$$

where l is the length of one loop,

$T = mg$ =Tension

μ = mass of the thread per unit length gm/cm.

Observation Table:

S.No.	$T = mg$	Number of loops p	Total length of thread L	$l = \frac{L}{p}$	$f = \frac{1}{l}\sqrt{\frac{T}{m}}$
1.					
2.					
3.					
4.					
5.					