the other fingers at the top. The faces of the prism should be cleaned with a clean piece of fine linen, if necessary.

(vii) If an asbestos ring is used, it must be held in the non-lumimous part of the bunsen flame; should be supplied with fresh solution of common salt from time to time.

(viii) The width of the slit image should be as narrow as possible.

(ix) In taking reading care should be taken to ascertain whether the zero of the main circular scale has been crossed in going from one position to the other

EXPT 45. TO DETERMINE THE REFRACTIVE INDEX OF THE MATERIAL OF A PRISM.

Theory : If A be the angle of the prism and δ_m that of minimum deviation which light of a given colour undergoes by refraction through the prism in a principal section, then the refractive index of the material of the prism for light of the given colour *i.e.*, wavelength is given by the relation

$$\mu = \frac{\sin\frac{A+\delta_m}{2}}{\sin\frac{A}{2}}$$

The expression for μ can be deduced in the following manner.

Let a ray PQ (Fig.5.33) be incident on the first face of a prism and after passsing through the principal plane of the prism, finally emerge out through the other face in the direction RS. Let θ and φ be the respective angles of incidence and refraction at the first face of the prism and φ' and θ' the corresponding quantities for the second face. Now the deviation of the ray, given by the angle SOT, is equal to $(\theta-\varphi) + (\theta'-\varphi')$. But in the position of minimum deviation, the ray passes symmetrically through the prism so that $\theta=\theta'$ and $\varphi=\varphi'$.

Therefore the angle of minimum deviation,

$\delta_m = 2\,(\theta - \varphi)$ ... ... (1)

From the figure, it can be shown that the angle LMR (between the two normals at the two faces) is equal to the angle

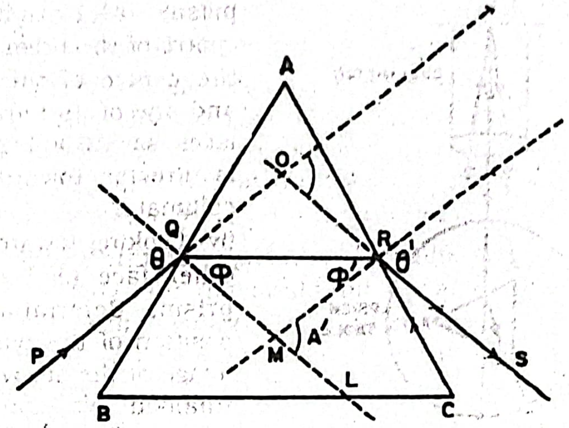

Fig. 5.33

(A) of the prism. But $\angle LMR$ is also equal to $(\varphi+\varphi')$. Therefore,

$$\angle LMR = \angle A = \varphi+\varphi' = 2\varphi \;\ldots\;\ldots\; (2)$$

$$(i.e.,\ \varphi = \frac{A}{2})$$

From (1) and (2) $\theta = \frac{A+\delta_m}{2}$ ... ... (3)

$$\text{Hence } \mu = \frac{\sin\theta}{\sin\varphi} = \frac{\sin\frac{A+\delta_m}{2}}{\sin\frac{A}{2}}$$

Apparatus : Spectrometer, sodium lamp, prism, spirit level, reading lens, etc.

Description of the apparatus : See spectrometer (Art.5.4).

Procedure : (i) Make all the necessary adjustments of the spectrometer including focussing for parallel rays by Schuster's method in the usual manner as described in Art. 5.4. Determine the vernier constants of both the verniers. Now place the prism on the prism table in such a way that the vertex of the prism coincides with the centre of the prism table.

(ii) Determine the angle of the prism in the manner described in expt 44.

(iii) To determine the angle of minimum deviation, so

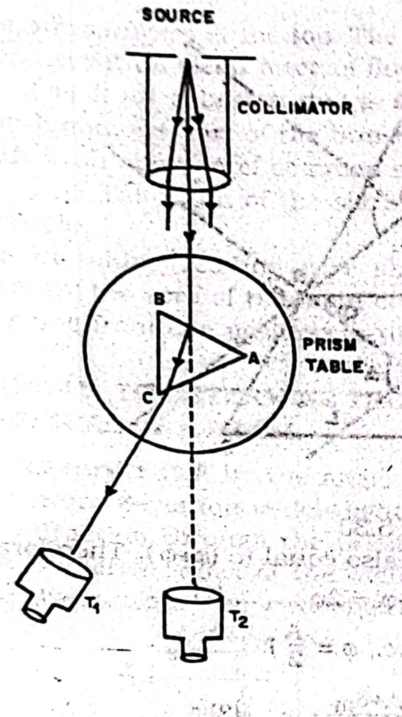

Fig.5.34

place the prism on the prism table that the centre of the prism is on the centre of the table and one of its refracting faces, say AB in Fig. 5.34 is directed towards the collimator.

(iv) Looking towards the other face (AC) of the prism, determine the position of the refracted image of the slit with an unaided eye. Turn the prism table so that the deviation gradually decreases. At the same time follow the image. Gradually the image will approach as near to the direct course of the rays from the collimator as possible. On further turning the table in the same direction, the image will be found to move back. *This point of turning back is the position of minimum deviation.*

(v) The telescope is now brought approximately to the position of minimum deviation of the image. If the image is not already in the field of view, a slight adjustment this way or that way will bring it in the field of view. Next by turning the prism table, set the image exactly at its position of minimum deviation. Rotate the telescope at the same time so that the image always remains near the intersection of the cross-wires. Once the position of minimum deviation of the image is determined, the intersection of the cross-wires is focussed on the image. The fine adjustments of the telescope at this stage should always be done by the tangent screw. Now read the two verniers attached to the telescope.

(vi) Repeat the adjustment for minimum deviation at least three times. Note the readings and take the mean separately for both the vernier readings.

(vii) Remove the prism and receive the direct light by the telescope. In doing so the image should be focussed on the intersection of the cross-wires. Note the readings on both the verniers. Repeat the operation three times and take the mean separately for both the verniers.

(viii) Determine separately the difference between the mean readings for the minimum deviated rays and direct rays for each vernier. This difference is the angle of minimum deviation (δ_m). Take the mean of the two vernier readings.

(ix) From known values of A and δ_m, calculate μ.

(a) Table for angle of minimum deviation (δm).

Vernier number	No. of observations	Reading for the minimum deviation position					Reading for the direct position.					Angle of minimum deviation (δm)	Mean δ_m
		Main scale reading (S)	Vernier scale divn. (V.D.)	Vernier scale reading V=V.D.×V.C.	Total reading M=S+V	Mean M	Main scale reading (S)	Vernier scale divn. (V.D.)	Vernier scale reading V=V.D.×V.C	Total reading N=S+V	Mean N		
I	1	---	---	---	---		---	---	---	---			
	2	---	---	---	---	---	---	---	---	---	---	---	
	3	---	---	---	---		---	---	---	---			
II	1	---	---	---	---								
	2					---					--	----	
	3												

Results :

(A) Vernier constants for vernier No. I and II.

Determine the vernier constants in the manner shown in expt. 35.

(B) Table for the angle of the prism (A).

Make a table similar to the one in expt.35 or 36.

(C) Table for angle of minimum deviation (δ_m).

(a) Table for angle of minimum deviation (δ_m).

$$\textbf{Calculation}: \mu = \frac{\sin\left(A+\frac{\delta m}{2}\right)}{\sin\frac{A}{2}} = \frac{\sin \ldots}{\sin \ldots} = \frac{\ldots}{-} = \ldots$$

Discussions : Same as in expt. 44

Oral questions and their Answers.

1. What are the different parts of a spectrometer ? Briefly discuss their uses.

See spectrometer (Art.5.4)

2. Why the spectrometer should be levelled before its use?

Otherwise the position of the image will change with the position of the telescope *i.e.*, will be different for different positions of the telescope.

3. Why do you adjust the telescope and the collimator for parallel rays?

If the incident rays are not parallel *i.e.*, if they are either divergent or convergent, the distance of the image formed by the prism will be different for different positions of the prism (see theory of Schuster's method, Art. 5.4). As a result, the image which remains focussed for one position of the prism will go out of focus for another position of the prism. But if the incident rays are parallel *i.e.*, the object is at infinity, then the image, will also be formed at infinity. Hence if the telescope is once focussed for infinity then the 'image will remain so for every position of the prism. The collimator should be focussed for parallel rays, because the method of determining the angle of the prism described in expt 44 is applicable only for parallel rays. Also the effect of aberration will be minimised so that sharp images will be obtained.

4. Explain the theory of Schuster's method?

See theory of Schuster's method (expt. 43)

5. What do you mean by "eccentric error"? How this can be eliminated?

See spectrometer (Art.5.4)

6. Why are the straight lines and concentric circles marked on the prism table?

For optical levelling of the prism table it is necessary that the faces of the prism be vertical. This condition can be achieved with the help of the straight lines. The centre of the prism may be made to coincide with that of the prism table with the help of the circles.

7. What is a prism ? What do you mean by base, face, the edge, principal section and the angle of the prism?

See Art.5.4.

8. How would you place the prism on the prism table in order to measure its angle? Why is it so placed?

With its edge vertically over the centre of the table. It is so placed in order to minimise the error which would occur in the measurement of A when the incident rays are not perfectly parallel.

9. Will it do if the middle of the prism is placed on the centre of the prism table when the prism is a large one and the aperture of the telescope small?

No, for the telescope, though set in proper direction, may not receive the reflected ray from the edge of the prism.

10. What do you mean by monochromatic light? Is sodium light strictly monochromatic?

Light consisting of only one particular wavelength is known as monochromatic light.

No. Sodium light is not monochromatic. It contains light of two wavelengths of values 5890 A.U. and 5896 A.U.

11. Why do you take sodium light and not white light?

Because, it gives a single image of the slit and a single value of minimum deviation while white light gives a spectrum and the value of minimum deviation is different for light of different colours *i.e.*, wavelengths.

12. How does the deviation of a ray vary with its angle of incidence?

For a particular angle of incidence, the deviation becomes minimum. But the deviation will become greater if the angle of incidence either increases or decreases than this particular angle of incidence.

13. What is the condition for obtaining minimum deviation?

The angle of incidence must be equal to the angle of emergence.

14. How does the deviation change with the colour of light?

Deviation increases with shorter wavelengths e.g., it is greater for violet than for red light.

15. *Can you expect an emergent ray for any incident ray on the prism?*

No, for a prism of definite angle, there is a certain range of the anglas of incidence for which there will be a corresponding emergent ray.

16. *What are the factors on which refractive index μ depends?*

Refractive index depends, among others, on (a) material of the prism and (b) the colour of the light.

17. *What kind of an image is produced by the telescope?*

A virtual image at infinity is produced by the telescope. A real diminished image is produced by the objective of the telescope while the eye-piece produces a virtual magnified image.

18. *While taking readings, why is it necessary to make the centre of the cross-wire coincide with one edge of the image?*

This is necessary because the images of both the cross-wires and the slit have certain widths. Hence if the centre of the corss-wire is made to coincide with one particular edge of the slit image, then greater accuracy in the recording of scale readings can be obtained.

19. *What is the necessity of avoiding parallax between the images of the slit and the cross-wires?*

Otherwise the coincidence between the images of the slit and the cross-wires will change with the movement of the eye, thus introducing an error in the readings.

Art.5.5 Interference of light

Let two beams of light cross each other at a certain point. Then according to Young's principle of superposition, the resultant intensity at the point of cross-over will be either greater or less than that which would be given by one beam alone. This modification of intensity due to superposition of two or more beams of light is known as *interference of light.* The interference is said to be *constructive* when the resultant intensity is more or *destructive* when the resultant intensity is less than that given by *any beam alone.*

Let us refer to the arrangement shown in Fig.5.35. S_1 and S_2 are two narrow parallel slits on a perpendicular opaque

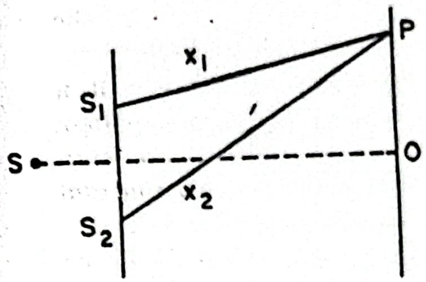

Fig.5.35

screen illuminated by two sources of light. Let a screen be placed at a certain distance towards the right of S_1 and S_2. Light passing through S_1 and S_2 will interfere at a certain point, say P, on the screen. If the geometrical distance of P from S_1 and S_2 are x_1 and x_2 respectively, then constructive interference will take place at P when the path difference $x_2 - x_1 = n\lambda$ wher $n = 0,1,2,3...$ while destructive interference will take place when $x_2 - x_1 = (2n-1)\frac{\lambda}{2}$ where $n = 1,2,3,....$. Thus one would expect a pattern of alternate bright and dark lines on the screen. Whether this pattern will be permanent will depend on whether the path difference of a point from the sources remains constant. The path difference $x_2 - x_1$ refers to the geometrical path difference and this, of course, remains constant so long as the experimental set up is not disturbed. However, there is involved another path difference due to the initial phase difference of the light sources (path diff. $= \frac{\lambda}{2\pi} \times$ phase diff).

The total path difference of a point on the screen from the sources is made up of both these constituents. So long as the experimental arrangement is no disturbed, the total path difference of a point on the screen depends on the phase difference of the light sources. The initial phase between two idependent sources of light changes very rapidly-about a billion times per second. Thus if S_1 and S_2 are illuminated by two independent sources of light, the total path difference will go on changing along with the change in phase between the two sources. A point on the screen, therefore, alternates between brightness and darkness a billion times every second. As a result, instead of observing a pattern of alternate bright and dark lines on the screen, we see the whole of the screen to be illuminated—the intensity of illumination being the average of maximum and minimum intensity. Thus, although interference is taking place all the time when the slits S_1 and S_2 are illuminated by two independent sources of light, we do not quite call it interference. *By interference we mean a permanent pattern of alternate points of maximum and minimum intensity, which will not be disturbed so long as the experimental arrangement is not disturbed.*

Let us place another narrow perpendicular slit S to the left of S_1 and S_2 so that $SS_1=SS_2$. Instead of illuminating S_1 and S_2 with two independent sources, let us illuminate S with a monochromatic source of light. Light coming out of the slits falls on S_1 and S_2. According to Huygen's principle of secondary waves, S_1 and S_2 now become two secondary sources of light. Secondary waves spread out from S_1 and S_2 and interfere with each other. Since S_1 and S_2 are equidistant from S, they are on the same wavefront, *i.e.*, their phase difference is zero.Even if they are not on the same wavefront, they will always have a constant phase difference since both of them are derived from the same original source S. Thus the total path difference of a point on the screen from the two sources S_1 and S_2 will remain constant. Moreover, since the amplitude of the wave from S_1 and S_2 are same, the points of destructive interference will be completely dark. Therefore, we now have a pattern of alternate bright and dark lines on the screen. As long as the experimental arrangement is not disturbed, the pattern will remain stationary or we now have a permanent interference pattern. The bright or dark lines are referred to as *fringes.*

From the discussion above it is clear that to produce an interference pattern, we must have two sources which have a *point-to-point* phase relationship so that they always have a constant phase difference. These sources are called *coherent sources*. It is further clear that two sources can be coherent only when they become sources of light under the influence of the same source. A real source *and its virtual image, two virtual sources formed due to a single source are examples of coherent sources.*

Conditions necessary for permanent interference :

Some important conditions that must be satisfied in order to produce a *permanent* or *stationary* interference pattern are

(1) The two beams of light which interfere must be coherent ,*i.e.*, must originate from the same source of light.

(2) The two interfering waves must have the *same amplitude*, otherwise the intensity will not be zero at the regions of destructive interference.

(3) The original source must be *monochromatic*. Otherwise it may so happen that a particular point will satisfy the condition of constructive interference for a particular wavelength while satisfying the condition of destructive interference for some other wavelength present in the source. Thus the interference pattern, instead of consisting of alternate bright and dark lines, will be coloured.

Note : *The path difference of the point on the screen equidistant from the two sources is zero (n=o). Hence this point will be a point of constructive interference for all wavelengths. Thus, if white light is used as a source, all the wavelengths will be superposed on one another at this point. Consequently the fringe at this point, also known as the central fringe, will be white. All other fringes will be coloured for reason stated in condition (3) above.*

4. The two coherent sources must be close to each other, otherwise the fringes will be excessively and indistinguishably close to each other.

Production of coherent sources :

It is clear that for the production of permanent interference, the two sources of light must be coherent. There are different methods of producing two coherent sources; but al these methods may be conveniently classified under the following two main heads :

(a) Division of wavefront : In this method a wavefront is divided laterally into two parts by utilizing the phenomenon of reflection, or refraction, or diffraction in such a manner that the direction of the two divided parts are changed. Since they are derived from the same wavefront, they will always have a point-to-point phase relationship, *i.e.*, they are coherent. The formation of interference fringes by (i) Fresnel bi-prism, (ii) Lloyd's single mirror, (iii) Fresnel's double mirror, (iv) Rayleigh's interferometer, etc., belong to this category.

(b) Division of amplitude : In this method, the wavefront is also divided into two parts by a combination of both reflection and refraction. Since the resulting wavefronts are derived from the same source, they satisfy the condition of coherence. Examples of this class are the interference effects observed in (i) thin films, (ii) Newton's rings (iii) Michelson interferometer, (iv) Fabry-Perot interferometer, etc.

EXPT. 46. TO DETERMINE THE RADIUS OF CURVATURE OF A LENS BY NEWTON'S RINGS.

Theory : Newton's rings is a noteworthy illustration of the interference of light waves reflected from the *opposite surfaces of a thin film of variable thickness.* When a plano-convex or bi-conves lenx L of large radius of curvature is placed on a glass plate P, a thin air film of progressively increasing thickness in all directions from the point of contact between the lens and the glas plate is very easily formed (Fig. 5. 36). The air film thus possesses a radial symmetry about the point of contact. When it is illuminated normally with monochromatic light, an

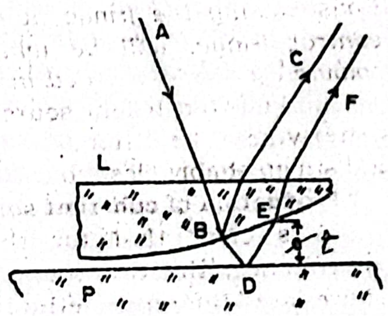

Fig. 5.36

interference pattern consisting of a series of alternate dark and bright circular rings, concentric with the point of contact is observed (Fig. 5.37). *The fringes are the loci of points of equal optical film thickness* and gradually become narrower as their radii increase until the eye or the magnifying instrument can no longer separate them.

Let us consider a ray of monochromatic light AB from an extended source to be incident at the point B on the upper surface of the film (Fig. 5. 36). One portion of the ray is reflected from point B on the glass air boundary and goes upwards along BC. The other part refracts into the air film along BD. At point D, a part of light is


Fig.5.37

again reflected along DEF. The two reflected waves BC and BDEF are derived from the same source and are *coherent*. They will produce constructive or destructive interference depending on their path difference. Let e be the thickness of the film at the point E. Then the optical path difference between the two rays is given by $2\mu e \cos(\theta+r)$ where θ is the angle which the tangent to the convex surface at the point E makes with the horizontal, r is the angle of refraction at the point B and μ is the refractive index of the film with respect to air.

From an analytical treatment by Stokes, based on the principle of *optical reversibility*, and Lloyd's single mirror experiment, it was established that *an abrupt phase change of π occurs when light is reflected from a surface backed by a denser medium, while no such phase change occurs when the point is backed by a rarer medium.* In Fig. 5.36 the point B is backed by a rarer medium (air) while the point D is backed by a denser medium (glass). Thus there will be an additional path difference of $\frac{\lambda}{2}$ between the rays BC and BDEF corresponding to this phase difference of π. Then the total optical path difference between the two rays is

$$2\mu e \cos(\theta+r) \pm \frac{\lambda}{2}$$

The two rays will interfere constructively when

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5. *What is the physical significance of the moment inertia?*
Moment of inertia plays the same part in rotating bodies as mass plays when bodies move in straight line.

6. *What is the unit of moment of inertia?*
In C.G.S system it is gm. cm^2

EXPT. 13. TO DETERMINE THE VALUE OF g, ACCELERATION DUE TO GRAVITY, BY MEANS OF A COMPOUND PENDULUM

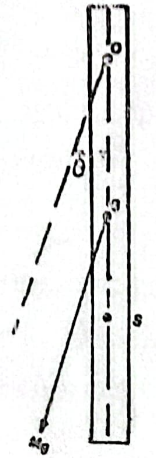

Fig.2.22a

Theory : Compound pendulum is a rigid body of any shape free to turn about a horizontal axis. In Fig. 2.22a, G is the centre of gravity of the pendulum of mass M, which performs oscillations about a horizontal axis through O. When the pendulum is at an angle θ to the vertical, the equation of motion of the pendulum is Iw = Mglsinθ where w is the angular acceleration produced, l is the distance OG and I is the moment of inertia of the pendulum about the axis of oscillations. For small amplitude of vibrations, sinθ = θ, so that

Iw = Mglθ

Hence the motion is simple harmonic, with period of vibrations,

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

If K is the radius of gyration of the pendulum about an axis through G parallel to the axis of oscillation through O, from the Parallel Axes Theorem,

$I = M(K^2+l^2)$, and so

$$T = 2\pi\sqrt{\frac{k^2+l^2}{gl}} = 2\pi\sqrt{\frac{\frac{k^2+l^2}{l}}{g}} \qquad (1)$$

Since the periodic time of a simple pendulum is given by

$T = 2\pi\sqrt{\frac{L}{g}}$, the period of the rigid body (compound pendulum) is the same as that of a simple pendulum of length

$$L = \frac{k^2+l^2}{l} \qquad (2)$$

This length L is known as the length of the simple equivalent pendulum. The expression for L can be written as a quadratic in (l). Thus from (2)

$$l^2 - lL + k^2 = 0 \qquad (3)$$

This gives two values of l (l_1 and l_2) for which the body has equal times of vibration. From the theory of quadratic equations,

$$l_1 + l_2 = L \text{ and } l_1 l_2 = k^2$$

As the sum and products of two roots are positive, the two roots are both positiue. This means that there are two positions of the centre of suspension on the same side of C.G. about which the periods (T) would be same. Similarly there will be two more points of suspension on the other side of the C. G., about which the time periods (T) will again be the same. Thus, there are altogether *four* points, *two* on either side of the C.G., about which the time periods of the pendulum are the same (T). The distance between two such points, assymetrically situated on either side of the C. G., will be the length (L) of the simple equivalent pendulum. If the length OG in Fig. 2.22a is l_1 and we measure the length $GS = \frac{k^2}{l_1}$ along OG produced, then obviously $\frac{k^2}{l_1} = l_2$ Or, OS = OG + GS = $l_1 + l_2$ = L. The period of oscillation about either O or S is the same.

The point S is called the centre of oscillation. The points O and S are interchangeable *i.e.*, when the body oscillates about O or S, the time period is the same. If this period of oscillation is T, then from the expression $T = 2\pi\sqrt{\frac{L}{g}}$ we get

$$g = 4\pi^2 . \frac{L}{T^2}$$

By finding L graphically, and determining the value of the period T, the acceleration due to gravity (g) at the place of the experiment can be determined.

Apparatus : A bar pendulum, a small metal wedge, a beam compass, a spirit level, a telescope with cross-wires in the eye-piece, stop-watch, and a wooden prism with metal edge.

Description of the apparatus : The apparatus ordinarily used in the laboratory is a rectangular bar AB of brass about 1 meter long. A series of holes is drilled along the bar at intervals of 2-3 cm (Fig.2.22b). By inserting the metal wedge S in one of the holes and placing the wedge on the support S_1S_2, the bar may be made to oscillate.

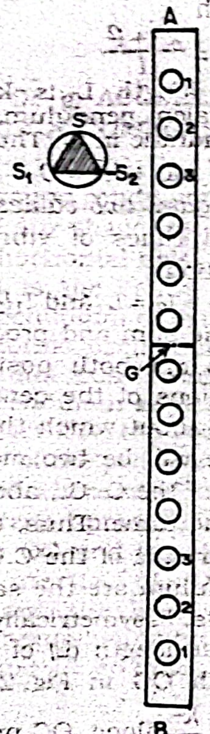

Fig.2.22b.

Procedure : (i) Find out the centre of gravity G of the bar by balancing it on the wooden prism.

(ii) Put a chalk mark on the line AB of the bar. Insert the metal wedge in the first hole in the bar towards A, and place the wedge on the support S_1S_2 so that the bar can turn round S.

(iii) Place a telescope at a distance of about a metre from the bar and focus the cross-wires and rotate the collar of the tube till the cross-wires form a distinct cross. Next focus the telescope on the bar and see that the point of inter-section of the cross-wires coincides with the chalk mark along the line AB of the bar.

(iv) Set the bar to oscillate taking care to see that the amplitude of oscillations is not more than 5^0. Note the time for 50 oscillations by counting the oscillations when the line AB passes the inter-section of the cross-wires in the same direction.

(v) Measure the length from the end A of the bar to the top of the first hole *i.e.*, upto the point of suspension of the pendulum.

(vi) In the same way, suspend the bar at holes 2,3,............and each time note times for 50 oscillations. Also measure distances from the end A for each hole.

(vii) When the middle point of the bar is passed, it will turn round so that the end B is now on the top. But continue measuring distances from the point of suspension to the end A

(viii) Now calculate the time-period T from the time recorded for 50 oscillations.

(ix) On a nice and large graph paper, plot a curve with length as abscissa and period T as ordinate with the origin at the middle of the paper along the abscissa. (Fig.2.22c).

(x) Through the point on the graph paper corresponding to the centre of gravity of the bar, draw a vertical line. Draw a second line ABCD along the abscissa. AC or BD is the length of the equivalent simple pendulum *i.e.*, $L = l_1 + \frac{k^2}{l_1}$. AG $= l_1$ and

$GC = \frac{k^2}{l_1} = l_2$, C being the centre of oscillation.

Similarly GD $= l_1$ and $GB = \frac{k^2}{l_1} = l_2$. B being the centre of oscillation. From this, $g = 4\pi^2 \frac{L}{T^2}$ can be calculated.

(xi) By drawing another line A'B'C'D' calculate another value of g

Alternate method of measuring the length of the pendulum.

Instead of measuring length from the end A to the point of suspension, length can also be measured from the point of suspension to the centre of gravity G of the bar (see Fig. 2.22b). In that case also there will be two sets of readings-one with the end A at the top and again with the end B at the top. Calculate the period T with 50 oscillations at each suspension. Now draw a graph with the centre of gravity of the bar at the origin which is put at the middle of the paper along the abscissa. Put the length measured towards the end A to the left and that measured towards the end B to the right of the origin (see Fig.2.22c). A line ABCD drawn parallel to the abscissa intersects the two curves at A B C and D.

Here also the length AC or BD is the length of the equivalent simple pendulum.

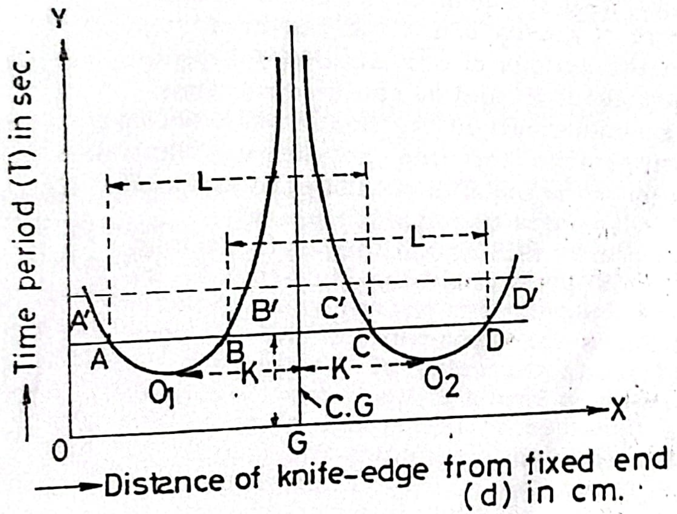

Fig. 2.22c

Results:

(A) Observation for the time period T and the distance of the point of suspension from the end A.

At the top	Hole no.	Distance from A	Time for 50 oscillations	Mean Time	Mean Period T
End A	1	=c m	(i) ....sec (ii) ...sec (iii) ...sec		
	2	= ... cm	(i) ....sec (ii) ...sec (iii) ...sec		
	3	= ... cm	(i) (ii) (iii) etc		
End B	1 2 3	etc		etc	

(B) Alternate method of measuring length.

Use the above table only changing the third column by "Distance from G",the centre of gravity.

(From graph)

Length AC=.....cm. Length BD =...cm.

Mean length $L = \frac{AC+BD}{2}$ =...cm

Corresponding time-period from the graph.

T =...sec. $g = \frac{4\pi^2 L}{T^2}$ =......cm. per sec^2

Discussions: (i) Distances are to be measured from the end A or the point G, preferably from A.

(ii) In measuring time an accurate stop-watch should be used.

(iii) Oscillations should be counted whenever the line of the bar crosses the intersecting point of the cross- wires, in the same direction.

(iv) Graph paper used should have sharp lines and accurate squares and should be sufficiently large to draw smooth and large curves.

(v) Amplitude of oscillations must not be more than 5°

(vi) Error due to the yielding of support, air resistance, and irregular knife-edge should be avoided.

(vii) Determination of the position of G only helps us to understand that $AG = l_1$ and $GC = \frac{K^2}{l_1} = l_2$ and is not necessary for determining the value of 'g'

(viii) For the lengths corresponding to the points A,B, C and D the period is the same.

(ix) At the lowest points of the curves P_1 and P_2 the centre of suspension and the centre of oscillation coincide.

It is really difficult to locate the points P_1 and P_2 in the graph and so K is calculated from the relation

$$K = \sqrt{GA.GB} = \sqrt{GB.GC}.$$