Q. 1. *What are Newton's ring ?*

Ans. When a plano-convex surface is placed on a glass plate, an air film of gradually increasing thickness is formed between the two. When monochromatic light is allowed to fall normally on film and viewed in reflected light, alternate dark and bright rings are observed. These are known as Newton's ring.

Q. 2. *Why are these rings circular ?*

Ans. These rings are foci of constant thickness of the air film and these foci being concentric circle; hence fringes are circular.

Q. 3. *Why do you use an extended source of light here ?*

Ans. To view the whole air film, an extended source is necessary.

Q. 4. *Why do the rings get closer as the order of the rings increases ?*

Ans. This is due to the fact that the radii of dark rings are propotional to square root of natural numbers while those of bright rings are proportional to square root of odd natural numbers.

Q. 5. *On what factors does the diameter of ring depend ?*

Ans. The diameter depends upon (i) wavelength of light used (ii) refractive index μ of enclosed film (iii) radius of curvature R of convex lens.

Q. 6. *Do you get rings in the transmitted light ?*

Ans. Yes, in this case the colour of rings is complimentary of the reflected light.

Q. 7. *Why is the centre of the ring dark ?*

Ans. Although at centre, the thickness of air film is zero but at the point of contact the two interfering rays are opposite in phase and produce zero intensity.

Q. 8. *Sometimes the centre is bright. Why ?*

Ans. This happens when a dust particle comes between the two surfaces at the point of contact.

Q. 9. *What will happen when the glass plate is silvered on its front surface ?*

Ans. In this case, the transmitted system of the fringes will be reflected and due to superposition of reflected and transmitted systems there will be uniform illumination.

Q. 10. *What will happen when sodium lamp is replaced by white light source ?*

Ans. Few coloured fringes will be observed near the centre.

Q. 11. *What will happen if a few drops of a transparent liquid are introduced between the lens and plate?*

Ans. The diameter of fringes is reduced by a factor of $\sqrt{\mu}$.

Q. 12. *Why do you make the light fall on the convex lens normally ? What will happen if the light incident obliquely ?*

Ans. The light is allowed to fall normally so that angles of incident and reflection may be zero so that $\cos \theta$ may be taken as unity. In case of oblique incidence, the diameter of rings will increase.

Q. 13. *How can you determine R ?*

Ans. This can be determined either by spherometer or by Boy's method.

Q. 1. *What is an ammeter ?*

Ans. It is an instrument designed to read current flowing in an electrical circuit. It is placed in series with the circuit.

Q. 2. *What will happen if it is connected in parallel to the circuit ?*

Ans. It will measure only the part of current flowing through it and not the total current.

Q. 3. *Why the resistance of an ammeter be kept low ?*

Ans. If the resistance of the ammeter is made high, it will change the value of the current in the circuit.

Q. 4. *How is the resistance made low ?*

Ans. It is done by connecting a low resistance (shunt) in parallel with galvanometer.

Q. 5. *What is the order of resistance of a moving coil ammeter ?*

Ans. It is of the order of .01 ohm.

Q. 6. *How do you convert a galvanometer into an ammeter ?*

Ans. After deciding the range of ammeter, we find the resistance of shunt. Then from resistance we find the length of shunt to be connected in parallel with the galvanometer.

Q. 7. *How can you change the range of ammeter ?*

Ans. By changing the resistance of shunt.

Q. 8. *Suppose we want to increase its range then what should we do ?*

Ans. The resistance of the shunt is to be decreased.

Q. 9. *Find the value of shunt resistance needed to increase the range of an ammeter of 1 amp, having resistance of 0.9 ohm, to 10 amp.*

Ans. $I_g = I \dfrac{S}{G+S}$ where $I_g = 1$ amp., $S = ?$, $G = 0.9$ ohms and $I = 10$ amp. Therefore

$$I = 10 \frac{S}{S+0.9}$$

or $$9S = 0.9$$

or $$S = 0.1$$

Thus resistance of the shunt is to be decreased to 0.1 ohm. from 0.9 ohm., if we want to extend the range from 1 ampere to 10 amperes.

Q. 10. *What is a milliammeter ?*

Ans. It is a low range ammeter.

Q. 11. *How will you change ammeter into milliammeter ?*

Ans. Resistance of milliammeter is more than the resistance of an ammeter. Therefore to convert an ammeter into a milliammeter, the resistance of the shunt is increased.

Q. 12. *Can you measure alternating current with this ammeter ?*

Ans. For it, a hot wire ammeter is needed.

Viva-Voce

Q. 1. ***What is a voltmeter ?***

Ans. It is an intstrument used to measure the potential difference between two points directly in volts, when connected *across* those ponts.

Q. 2. ***What should be the resistance of a voltmeter ?***

Ans. It should be high.

Q. 3. ***Why ?***

Ans. In order to read the actual potential difference between two points in a circuit, it is essential that on connecting the voltmeter this potential difference should not change. For this, the current drawn by the voltmeter should be very small. This requires that resistance of voltmeter be large.

Q. 4. *How can you convert a galvanometer into voltmeter ?*

Ans. After deciding about the range of voltmeter to be designed, we find the value of high resistance that is to be connected in series with galvanometer resistance. The combination will then act as voltmeter.

Q. 5. *How can you change the range of voltmeter ?*

Ans. We can increase its range by increasing its resistance. It can be done by connecting an additional resistance in series with it.

Q. 6. *How will you increase the range of a voltmeter of resistance 120 ohms. of 1 volt upto 3 volts ?*

Ans. Using the relation $R = \frac{V}{I_g} - G = \frac{3}{1/120} - 120 = 360 - 120$

$= 240$

That is, we shall put in its series an additional resistance of 240 ohms.

Q. 7. *What is a millivoltmeter ?*

Ans. It is a low range voltmeter.

Q. 8. *How can you change a voltmeter into millivoltmeter ?*

Ans. By decreasing its resistance because the resistance of millivoltmeter is much less than that of a voltmeter.

Q. 9. *Can you measure alternating potential difference with it ?*

Ans. For this, a hot wire instrument is needed.

Q. 10. *Can you change an ammeter into a voltmeter ?*

Ans. Yes, by putting a suitable high resistance in series with ammeter.

Q. 11. *Is voltmeter also convertible into an ammeter ?*

Ans. Yes, by shunting the voltmeter with a low resistance.

Q. 1. *What do you mean by refractive index ?*

Ans. The ratio of the sine of angle of incidence to the sine of angle of refraction is constant for any two media, *i.e.*,

$$\boxed{\frac{\sin i}{\sin r} = \mu}$$

This is constant known as refractive index.

Q. 2. *Is it essential in your experiment to place the prism in the minimum deviation position ? If so, why ?*

Ans. Yes. It is essential because we obtain a bright and distinct spectrum and magnification is unity *i.e.*, the distance of the object and image from the prism is same. The rays of different colours after refraction diverge from the same points for various colours.

Q. 3. *Will the angle of minimum deviation change, if the prism is immersed in water ?*

Ans. Yes. The refractive index of glass in water is less than air hence angle of minimum deviation becomes less.

Q. 4. ***Does the angle of minimum deviation vary with the colour of light ?***

Ans. Yes, it is minimum for red and maximum for violet colour.

Q. 5. ***Does not the deviation depend upon the length of the base of the prism ?***

Ans. No it is independent of the length of the base. By increasing the length of base, resolving power is increased.

Q. 6. ***What do you mean by pure spectrum ?***

Ans. A spectrum in which there is no overlapping of colours is known as pure spectrum. Each colour occupies a separate and distinct position.

Q. 7. ***Can you determine the refractive index of a liquid by this method ?***

Ans. Yes. The experimental liquid is filled in a hollow glass prism.

Q. 8. ***How μ vary with wavelengths ?***

Ans. Higher is the wavelength, smaller is the refractive index.

Q. 9. ***What is the relationship between deviation and wavelength ?***

Ans. Higher is deviation, smaller is wavelength *i.e.* deviation for violet colour is most but wavelength is least.

Q. 10. ***Which source of light are you using ? Is it a monochromatic source of light?***

Ans. Mercury lamp. It is not a monochromatic source of light. The monochromatic source contains only one wavelength.

Q. 11. ***Can not you use a monochromatic source (sodium lamp) ?***

Ans. Yes, we can use a sodium lamp but it will give only yellow lines and not the full spectrum.

Q. 12. ***What is construction of mercury lamp ?***

Ans. It consists of a long cylindrical tube which contains two electrodes. The tube contains some mercury and argon gas at a pressure of about 10 mm. of mercury. The cylindrical tube is enclosed in a vacuum jacket to reduce the loss of heat from it to surroundings.

Q. 13. ***Why is it that mercury lamp works at high pressure and sodium lamp works at low pressure ?***

Ans. In mercury lamp, the visible light results due to the transition of electron among higher orbits which are promoted at high pressure. In case of sodium, the transitions are due to electron jump from higher orbit to lower orbit which are promoted at low pressure.

Q. 14. ***Can a mercury lamp be run at low pressure ? What will happen in this case?***

Ans. The mercury lamp can run at low pressure but in this case the light emitted by the lamp will be in ultra-violet region of the spectrum.

Q. 15. ***After switching off mercury lamp, it can not be started again at once, why?***

Ans. The starting electrode does not function before the vapourised mercury has condensed.

Q. 16. ***What is the working temperature of this lamp ?***

Ans. The working temperature is about 600°C.

Q. 17. ***What is the type of your mercury lamp ?***

Ans. It is hot cathode positive column type.

Q. 1. *What are Newton's ring ?*

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Ans. The light is allowed to fall normally so that angles of incident and reflection may be zero so that $\cos \theta$ may be taken as unity. In case of oblique incidence, the diameter of rings will increase.

Q. 13. *How can you determine R ?*

Ans. This can be determined either by spherometer or by Boy's method.

Q. 1. *What is photo-electric effect ?*

Ans. When the light of very short wavelength is incident on certain metals e.g. sodium, potassium, the electrons are emitted. The process of emission of electrons is called photo electric effect. The electrons are called photo electrons.

Q. 2. *What are the laws of photoelectric emission ?*

Ans. (i) The number of photo electrons emitted depends upon the intensity of the incident light.

(ii) The velocity of the electrons emitted depends upon the frequency of the incident light and is independent of intensity of incident light.

Q. 3. *What is a photo cell ?*

Ans. It is a glass bulb enclosing a photo metal as cathode and another electrode as anode. They are of two types :

(i) Vacuum type

(ii) Gas filled type (*e.g.* Argon is filled at low pressure).

Gas filled type photocells give more current as compared to vacuum type.

Q. 4. *Write Einstein's photo electric equation and explain the terms used.*

Ans. $$h\nu - h\nu_0 = \tfrac{1}{2}.m\nu^2,$$

where $1/2.\ mv^2$ is kinetic energy of the ejected electron, ν is the frequency of light incident on photcmetal and ν_0 is the threshold frequency. h is Planck's constant.

Q. 5. *What is threshold frequency ?*

Ans. It is the minimum frequency of the incident light which is capable of ejecting photo-electrons. Light of frequency less than threshold frequency cannot eject an electron out of the metal, howsoever the intense light may be.

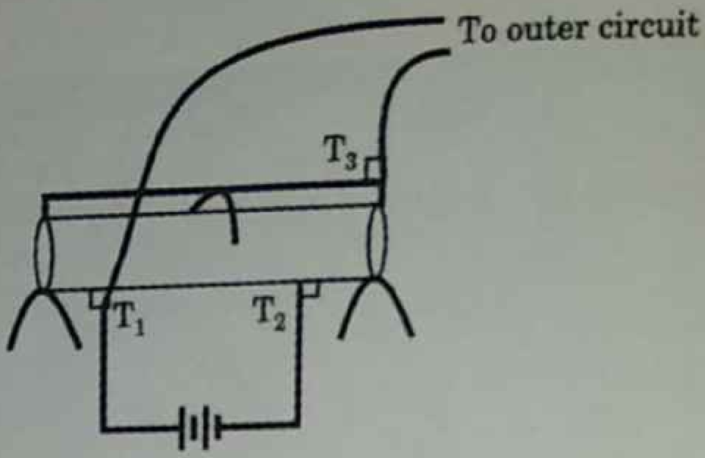

Fig. 12: Rheostat as a potential divider

(2) Resistance Box

Resistance box is a covered wooden box with thick metallic bars having some slots, for metallic keys (Fig. 13). Some resistance value (in ohms) is written against every slot. There are two connecting points in the resistance box by which it will be connected to the outer circuit. Below every slot, there is a coiled resistance connected across the two metallic blocks (Fig. 14).When all the keys are inserted in the slots, no resistance is applied, as the current will pass through the metallic bar and not through the resistance because metallic bar offers approximately no resistance to the current. But when any key is taken out, there is discontinuity in the metallic path so current is bound to pass through the resistance and that resistance will be applied in the circuit. No resistance is connected below the slot marked for infinite resistance and if the key is taken out from this slot then, there will be break in the circuit *i.e.* infinite resistance will be applied. The resistance wire inside the resistance box, is doubly wound to avoid inductive effect.

(1) Rheostat

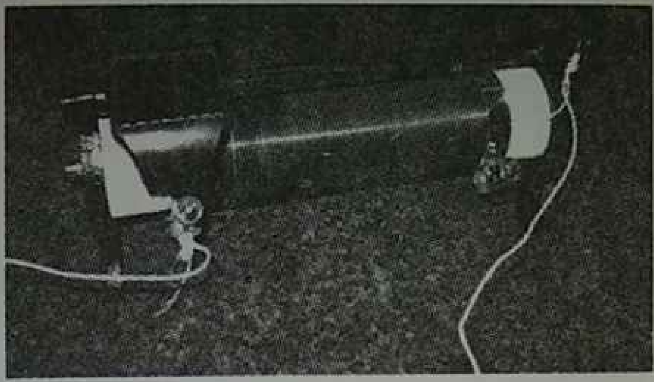

Fig. 9: Rheostat

Rheostat consists of a non conducting hollow cylinder on which wire is wound. There are three points for making connections (Fig. 9). Two points are the end points of the wire and third point is connected to a sliding key. The rheostat can be used as a fixed resistance, variable resistance and as a potential divider.

(1) *As a fixed resistance*: Connect the lower points T_1 and T_2 to the outer circuit. (Fig. 10).

(2) *As a variable resistance*: Connect first lower point and the top point to the outer circuit (Fig. 11).

(3) *As a potential divider*: Connect the two lower points to a battery and first lower point and the top point to the outer circuit where we require a variable potential (Fig. 12).

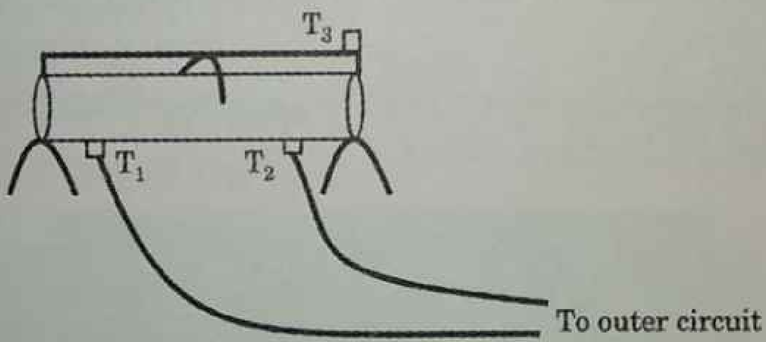

Fig. 10: Rheostat as a constant resistance

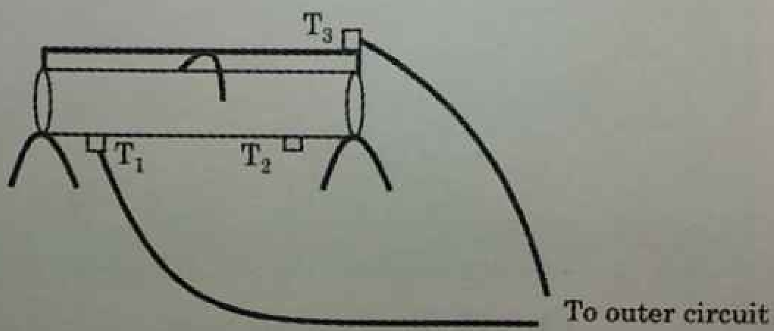

Fig. 11: Rheostat as a variable resistance

VIVA-VOCE

Q1: What are Newton's rings? Where are they formed?

Ans. When light is incident normally on a thin film of variable thickness, interference takes place between the two rays reflected from the upper and lower surfaces of the thin air film and interference pattern (concentric alternate bright and dark circular rings with center as dark) is obtained. These rings are known as Newton's rings. These rings are formed somewhere between the plano convex lens and glass plate.

Q2: Why Newton's rings are circular?

Ans. The path difference for the points, equal distance from the center, is same *i.e.* the locus of equal path difference is a circle so the bright or dark fringes (rings) are circular.

Q6: Why the centre of Newton's rings is dark?

Ans. At the centre of the air film, the plano convex lens and glass plate are in contact, so the thickness of the film is zero at the centre, and the effective path difference between the two interfering rays becomes $\frac{\lambda}{2}$, and the condition of minima is satisfied so centre of the Newton's ring is dark. This path difference $\frac{\lambda}{2}$ is due to the fact that the one of the interfering rays, is reflected from the lower surface of the air film (reflected from glass surface, an optically denser medium) and when a ray is reflected from an optically denser medium, it undergoes a phase change of π or a path difference of $\frac{\lambda}{2}$.

Q7: How can you make the centre of Newton's ring bright in reflected light?

Ans. We can make the centre of Newton's ring as bright in reflected light by introducing oil of sassafras ($\mu = 1.57$) between the glass lens L ($\mu = 1.5$) and glass plate P ($\mu = 1.65$). The refractive index of the oil of sassafras is between the refractive indices of the glass lens and the glass plate. So both interfering rays will now be reflected by an optically denser medium, and hence at the centre, the effective path difference will be zero as the thickness of air film is already zero at center, which is condition for maxima and hence center will be bright.

Q8: If plano convex lens is replaced by abi convex lens, will Newton's rings be still obtained?

Ans. Yes, Newton's rings will still be obtained, because there will be no change in the shape of the air film.

Q9: Why plano convex lens of large focal length is used in Newton's ring experiment?

Ans. The focal length of the plano convex lens is taken large so as to have the radius of curvature large [$\frac{1}{f} = (\mu - 1)(\frac{1}{R_1} - \frac{1}{R_2})$], so that the thickness of the air film should be small and hence, the wedge angle θ of the film should be kept small and negligible.

Q10: If the lower glass plate is replaced by a plane mirror, what ring pattern will be obtained?

Ans. The Newton's ring in reflected case and that of in transmitted case are complementary *i.e.* where we get a bright ring in reflected case, a dark ring is obtained in transmitted case at that position. So, when plane mirror is used in place of glass plate, the transmitted rings will also be seen along with reflected case so uniform illumination will be obtained in the field of view.

Q11: If this experiment is performed using white light, what ring pattern will be obtained?

Ans. The centre will be dark as the thickness of film is zero for all wavelength at the centre and hence minima for all the wavelengths. But the surrounding rings will be coloured as different positions different colours will have their condition for maxima satisfied.

Q12: Why the traveling microscope should be moved only in one direction?

Ans. Traveling microscope is moved only in one direction to avoid the backlash error in the instrument.

Q13: Why an extended source of light is used?

Ans. The extended source of light is used to observe the entire interference pattern from one position.

Q14: How the radius of curvature of the plano convex lens is calculated?

Ans. There are two methods

(i) By optical method (using Boy's method)

(ii) By spherometer

Q15: Define interference, coherence and phase.

Ans. Interference is defined as the modification (variation) in the intensity of two or more waves, obtained by their superposition. Two sources are said to be coherent if they have constant or zero phase difference between them. Phase is the angular address or position of a particle executing SHM.

Q16: Can two independent sources work as coherent sources?

Ans. No, two independent sources can never have constant phase relation. So they can never work as coherent sources.

Q17. What is the division of amplitude and the division of wave front?

Ans. The interference is of two kinds. Actually these are the methods to create coherent sources.

(i) *Division of amplitude*: In this type of interference the coherent sources are created by dividing the amplitude by method of reflection and refraction. Examples are Interference in thin films, Newton's rings etc

(ii) *Division of wave front*: In this type of interference the coherent sources are created by dividing the wavefront. Examples are Young's double slit experiment, Biprism, Lloyd mirrors etc.

Q18: How is the Newton's rings pattern observed in transmitted light?

Ans. Newton's rings in transmitted light is complementary to that of reflected case. The centre of the Newton's rings in transmitted case is bright whereas centre is dark in the reflected case (Figs. 2.4 & 2.5).

Q19: How can refractive index of a liquid be calculated with help of Newton's rings?

Ans. First the experiment is performed for air film and the average value of $(D_{n+p}^2 - D_n^2)_{air\ film}$ for air film is calculated. Now introduce liquid between lens and glass plate and the same experiment is performed and the average value $(D'^2_{n+p} - D'^2_{n})_{liquid\ film}$ for liquid film is calculated. The refractive index of the liquid is given by

$$\mu = \frac{(D_{n+p}^2 - D_n^2)_{air\ film}}{(D'^2_{n+p} - D'^2_{n})_{liquid\ film}}$$

Q20: Why microscope is used in this experiment and not the telescope?

Ans. The fringes are formed near the air film not at infinity so to see the fringes we require a microscope and not a telescope.

Q21: What are fringes of equal thickness and fringes of equal inclination?

Ans. The fringes formed by the loci of equal thickness of the film, are called fringes of equal thickness. Newton's rings, wedge shaped film, Michelson interferometer fringes with inclined mirrors are the examples of such type of fringes.

The fringes formed by the loci of equal inclination (path difference is proportional to the angle of inclination), are called fringes of equal inclination (also called as Haidinger's fringes). Michelson interferometer fringes with parallel mirrors, parallel air film, and Lummer and Gehrecke plates are examples of such type of fringes.

Q22: On what factors does the diameter of the Newton's rings depend?

Ans. For n^{th} dark ring, the diameter can be given as

$$D_n^2 = \frac{4n\lambda R}{\mu}$$

So the diameter depends upon wavelength, radius of curvature of the plano convex lens, refractive index of the material of the thin film and order of the ring. If oil (μ>1) is introduced between the plate and the lens then the diameter of the rings will decrease.

VIVA-VOCE

Q1: What source is used in this experiment - ac or dc?

Ans. In this experiment dc source is used.

Q2: When there is a gap between the two plates of capacitor *i.e.* circuit is broken then how current is flowing?

Ans. Charging of capacitor with direct current is a transient phenomenon *i.e.* the current flows for a short period till the capacitor is fully charged. But in alternating current the current flows in the capacitor continuously. The flow of current in capacitor can be understood by the concept of displacement current proposed by Max well.

Q3: During charging/discharging why we get saturation curve.

Ans. The voltage reaches to its maximum value then saturation is achieved, and no current flows any further.

Q4: Explain working of voltmeter/ammeter.

Ans. Voltmeter/ammeter is basically galvanometer. Galvanometer consists of a coil fixed between the two poles pieces. When current is passed through the coil it is rotated and a pointer is attached with it. The pointer will show the deflection when current is passed through the galvanometer.

Q5: What is time constant?

Ans. Time constant (or relaxation time) is defined as the time in which the voltage reaches to $(1-\frac{1}{e})$ or 0.632 times the maximum value of voltage during charging. Time constant is also defined as the time in which the voltage decays to $\frac{1}{e}$ or 0.368 times the maximum value of voltage during discharging.

Q6: What is role of capacitor in ac and in dc circuits?

Ans. In dc circuits, only transient current flows in the circuit containing capacitor whereas ac circuit with capacitor, the current flows continuously as ac changing its direction alternatively.

Q7: How can you slow down the charging rate of the capacitor?

Ans. The time constant is given by the formula $\tau = RC$. To increase the time constant *i.e.* to slow down the charging we can increase the value of resistance or capacitance.

Q8: What is meant by phase between current and voltage?

Ans. In pure resistive circuit, the voltage and current reach to their respective maximum value simultaneously and there is no time lag between the current and voltage. This time lag represented in term of angle and is called as phase.

In pure capacitive circuit, current leads from the voltage by T/4 or 90°.

In pure inductive circuit, current lags behind the voltage by T/4 or 90°.

Q9: What is impedance?

Ans. The resistance offered by inductor, capacitor and resistance to alternating current individually is called as reactance. Resistance offered by a combination of any two is known as impedance.

Reactance of capacitor, $X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$

Reactance of inductor, $X_L = \omega L = 2\pi f L$

Where C is the capacitance of capacitor (unit Farad).

L is the inductance of inductor (unit Henry).

f is the frequency of the alternating current.

Q10: What is meant by oscillations in electrical circuit?

Ans. When alternating current is applied across an LCR circuit, the electrostatic energy is stored in capacitor and electromagnetic energy is stored in inductor. Now if source is removed the conversion of electrostatic energy into electromagnetic energy and vice versa with a certain frequency is known as electrical oscillations. The frequency of electrical oscillations is given by

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}$$

Object : To determine the dispersive power of the material of the prism for violet and yellow colours of mercury light with the help of a spectrometer.

Apparatus required : Spectrometer, prism, mercury source and reading lens.

Formula used :

The dispersive power, ω, of the material of the prism is given by the formula

$$\boxed{\omega = \frac{\mu_v - \mu_y}{\mu - 1}}$$

where μ_v = refractive index of the material of the prism for violet colour,

μ_y = refractive index of the material of the prism for yellow colour,

and $\mu = \frac{\mu_v + \mu_y}{2}$

The refractive index of the prism is given by

$$\boxed{\mu = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}}$$

where A = Angle of the prism,

δ_m = Angle of minimum deviation.

Procedure : The procedure is as follows :

(i) Adjustment of the spectrometer.

(ii) Measurement of angle of prism A.

(iii) Measurement of angle of minimum deviation δ_m for violet and yellow colours.

For details see Experiment No. 1.

Observations : Make the tables, similar to those in Experiment No. 1.

Calculations :

Find out the value of μ_v and μ_y using the relation,

$$\mu = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

μ_v = ...

μ_y = ...

$$\mu = \frac{\mu_v + \mu_y}{2} = \dots$$

and

$$\omega = \frac{\mu_v - \mu_y}{\mu - 1}$$

Result : The dispersive power of the given prism,

$= \dots\dots$

Precautions and Sources of error :

Same as in the experiment No. 1.

Viva-Voce

Q. 1. ***What do you mean by dispersive power ? Define it.***

Ans. The dispersive power of a material is its ability to disperse the various components of the incident light. For any two colours, it is defined as the ratio of angular dispersion to the mean deviation, *i.e.*

$$\omega = \frac{\delta_v - \delta_r}{\delta_y}$$

Q. 2. ***On what factors, the dispersive power depends ?***

Ans. It depends upon (i) material, and (ii) wavelength of colours.

Q. 3. ***Out of the prism of flint and crown glasses, which one will you prefer to use?***

Ans. We shall prefer a prism of flint glass because it gives greater dispersion.

Q. 4. ***What is a normal spectrum ?***

Ans. A spectrum in which angular separation between two wavelengths is directly proportional to difference of the wavelengths is called a normal spectrum.

Q. 5. ***Do you think that a prismatic spectrum is a normal one ?***

Ans. No.

Q. 6. ***Can you find out the dispersive power of a prism with sodium light ?***

Ans. No. This is a monochromatic source of light.

Q. 7. ***How many types of spectra you know ?***

Ans. There are two main types of spectra (i) emission spectra and (ii) absorption spectra.

Q. 8. ***What type of spectra do you expect to get from (i) an incandescent filament lamp (ii) sun light (iii) mercury lamp ?***

Ans. (i) continuous spectrum, (ii) band spectrum, and (iii) line spectrum.

Q. 9. ***How do you classify emission spectrum ?***

Ans. (i) Continuous spectrum, given by a candle or electric bulb.

(ii) Band spectrum, given by elements of compound in molecular state.

(iii) Line spectrum, given by sodium or mercury spectrum.

Q. 10. ***What is difference between a telescope and a microscope ?***

Ans. Telescope is used to see the magnified image of a distinct object. Its objective has large aperture and large focal-length. The microscope is used to see the magnified image of very near object. Its objective has small focal-length and aperture.

Q. 11. ***Without touching can you differentiate between microscope and telescope ?***

Ans. The objective of microscope has small aperture while the telescope has a large aperture.

Q. 12. ***What is that which you are adjusting in focussing the collimator and telescope for parallel rays ?***

Ans. In case of collimator, we adjust the distance between collimating lens and slit while in case of telescope the distance between cross wires from the objective lens is adjusted.

Q. 13. ***What are these distances equal to when both the adjustments are complete?***

Ans. The slit becomes at the focus of collimating lens in collimator and cross wires become at the focus of objective lens in telescope.

Q. 14. *How can telescope and collimator be adjusted together ?*

Ans. (i) The prism is set in minimum deviation for yellow colour.

(ii) Prism is rotated towards telescope and telescope is adjusted to get a well defined spectrum.

(iii) Now the prism is rotated towards collimator and the collimator is adjusted to get well defined spectrum.

(iv) The process is repeated till the spectrum is well focussed. This is known as Schuster's method.

Description of the apparatus :

Spectrometer : The spectrometer consists of the following parts :

(i) the Collimator C,

(ii) the prism table P, and

(iii) the Telescope T.

(i) The Collimator : The collimator C consists of two hollow concentric metal tubes, one being longer than the cther. The longer tube carries an achromatic lens L at one end and the smaller tube on the other end. The smaller tube is provided with a slit at the outer end (width of the slit can be adjusted with the help of a screw attached to it) and can be moved in or out the longer tube with the help of rack and pinion arrangement. The slit is adjusted in the focal plane of the lens L to obtain a pencil of parallel rays from the collimator when light is allowed to be incident upon slit. The collimator is also provided with two screws for adjusting the inclination of the axis of the collimator. This is rigidly fixed to the main part of the apparatus.

(ii) The Prism Table : It is a circular table supported horizontally in the centre of the instrument and the position can be read with the help of two verniers attached to it and moving over a graduated circular scale carried by the telescope. The levelling of the prism table is made with the help of three screws provided at the lower surface. The table can be raised or lowered and clamped in any desired position with the help of a screw. The prism table is also provided with a tangent screw for a slow motion. There are

Fig. (1)

concentric circles and straight lines parallel to the line joining two of the levelling screws on the prism table.

(iii) The Telescope : The telescope consists of similar tubes as in case of collimator carrying achormatic objective lens O at one end and Ramsdon eyepiece E on the another side end. The eyepiece tube can be taken in or out with the help of rack and pinion arrangement. Two crosswires are focussed on the focus of the eyepiece. The telescope can be clamped to the main body of the instrument and can be moved slightly by tangent screw. The telescope is attached to the main scale and when it rotates, the graduated scale rotates with it. The inclination of telescope is adjusted by two screws provided at the lower surface.

Adjustments :

Before using the spectrometer, the following adjustments must be made.

(a) The axis of the telescope and that of the collimator must intersect the principal vertical axis of rotation of the telescope.

This adjustment is done by the manufacturer and can only be tested in the laboratory. For this purpose a pin is mounted vertically in the centre of prism table and observing its image in the telescope tube without eyepiece and for a wide slit in the collimator. If the image appears in the middle, then the adjustment is perfect otherwise the image is made in the centre by using the screws supporting the telescope and collimator till the pin appears in the middle.

(b) Prism table should be levelled.

(i) The prism table is levelled with the help of three screws supporting the prism table. A spirit level is placed along a line joining the screws and the two screws are moved till the air bubble appears in the middle. Now place the spirit level along a line perpendicular to the previous line and adjust the third screw such that again the air bubble appears in the middle. Here one thing should be remembered that the first two screws should not be touched this time. The prism table is now levelled.

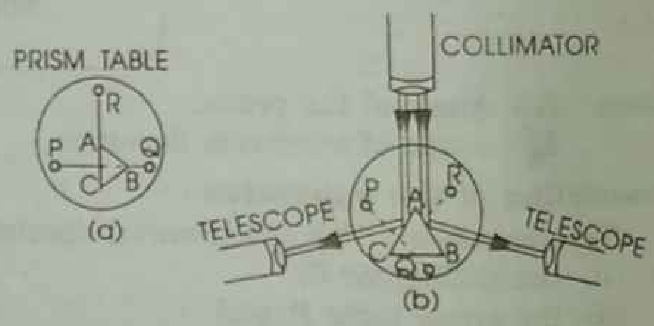

Fig. (2)

(ii) The second method (which is generally used in optical levelling of the prism table) : In this method the prism is placed on the prism table with its refracting edge at the centre of the prism table and one of its polished surface perpendicular to the line joining the two levelling screws P and Q as shown in fig. (2)a.

Now rotate the prism table in such a way that refracting edges AB and AC face towards the collimator and light falling on the prism is usually reflected on both the sides as shown in fig. (2) b.

The telescope is moved to one side to receive the light reflected from the face AB and the levelling screws P and Q are adjusted to obtain the image in the centre of the field of view.

Again the telescope is moved to the other side to receive the light reflected from the face AC and the remaining third screw R is adjusted till the image becomes in the central field of view of the telescope.

The procedure is repeated till the two images from both the reflecting faces are seen in the central field of view of the telescope. The prism table is now levelled.

(c) Telescope and collimator are adjusted for parallel light by Schuster's method.

First of all the prism is placed on the prism table and then adjusted approximately for minimum deviation position. The spectrum is now seen through the telescope. The prism table is rotated slightly away from this position towards collimator and the telescope is brought in view. The collimator is well focussed on the spectrum. Again rotate the prism table on the other side of minimum deviation position, *i.e.*, towards telescope and focus the telescope for the best image of the spectrum. The process of focussing the collimator and telescope is continued till the slight rotation of the prism table does not make the image to go out of focus. This means that both collimator and telescope are now individually set for parallel rays.

Procedure :

(A) Measurement of the angle of the prism.

(i) Determine the least count of the spectrometer.

(ii) Place the prism on the prism table with its refracting angle A towards the collimator and with its refracting edge A at the centre as shown in the fig. (3). In this case some of the light falling on each face will be reflected and can be received with the help of the telescope.

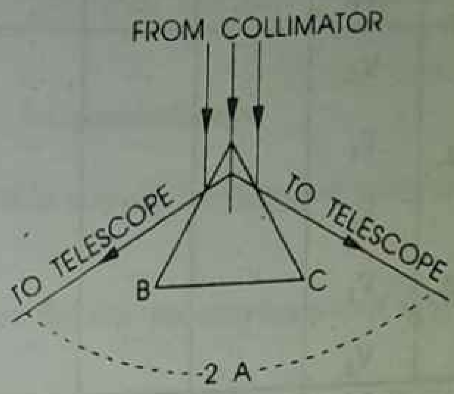

Fig. (3)

(iii) The telescope is moved to one side to receive the light reflected from the face AB and the crosswires are focssed on the image of the slit. The reading of the two verniers are taken.

(iv) The telescope is moved in other side to receive the light reflected from the face AC and again the crosswires are focussed on the image of the slit. The readings of two verniers are noted.

(v) The angle through which the telescope is moved or the difference in the two positions gives twice the refracting angle A of the prism. Therefore, half of this angle gives the refracting angle of the prism.

(B) Measurement of the angle of minimum deviation :

(i) Place the prism so that its centre coincides with the centre of the prism table and light falls on one of the polished faces and emerges out of the other polished face, after refraction. In this position the spectrum of light is obtained.

(ii) The spectrum is seen through the telescope and the telescope is adjusted for minimum deviation position for a particular colour (wavelength) in the following way :

Set up telescope at a particular colour and rotate the prism table in one direction, of course the telescope should be moved in such way to keep the spectral line in view. By doing so a position will come where the spectral line recede in the opposite direction although the rotation of the table is continued in the same direction. The particular position where the spectral line begins to recede in opposite direction is the minimum deviation position for that colour. Note the readings of two verniers.

(iii) Remove the prism table and bring the telescope in the line of the collimator. See the slit directly through telescope and coincide the image of slit with vertical crosswire. Note the readings of two verniers.

(iv) The difference in minimum deviation position and direct slit position gives the angle of minimum deviation for that colour.

(v) The same procedure is repeated to obtain the angles of minimum deviation for other colours.

Observations :

(i) Value of the one division of the main scale = 0·5 deg.
Total number of vernier divisions = 30
Least count of the vernier = 0·5/30 = 1 minute

(ii) Table for the angle (A) of the prism :

S. No.	Vernier	Telescope reading for reflection from first face			Telescope reading for reflection from second face			Difference a ~ b = 2A deg.	Mean value of 2A deg.	A deg.	Mean A deg.
		M.S. reading	V.S. reading	Total (a) deg.	M.S. reading	V.S. reading	Total (b) deg.				
1.	V_1	...	...	...	...	...	...	...	...	...	
	V_2	...	...	...	...	...	...	...			
2.	V_1	...	...	...	...	...	...	...	...	...	...
	V_2	...	...	...	...	...	...	...			
3.	V_1	...	...	...	...	...	...	...	...	...	
	V_2	...	...	...	...	...	...	...			

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

S. No.	Colour	Vernier	Dispersed image. Telescope in minimum deviation position			Telescope reading for direct image			Difference a ~ b deg.	Mean deviation δ_m deg.
			M.S. reading	V.S. reading	Total a deg.	M.S. reading	V.S. reading	Total b deg.		
1.	Violet	V_1	...	...	...	...	...	...	...	...
		V_2	...	...	...	...	...	...	...	
2.	Blue	V_1	...	...	...	...	...	...	...	...
		V_2	...	...	...	...	...	...	...	
3.	Green	V_1	...	...	...	...	...	...	...	...
		V_2	...	...	...	...	...	...	...	
4.	Yellow	V_1	...	...	...	...	...	...	...	...
		V_2	...	...	...	...	...	...	...	