Interference

1. A monochromatic light beam (5893 A^0) is reflected at normal incidence from a soap film of refractive index 1.42. What is the least thickness for which the film will appear bright and dark? **(Ans: For bright 1038 A^0 and for dark 2075 A^0)**
2. A parallel beam of light strikes an oil film (μ=1.4) floating on a surface of water (μ=1.33). When viewed at an angle of 30^0 from the normal 6^{th} dark fringe is seen. Find the thickness of the film for wavelength 5890 A^0. **(Ans: 1.35 μm)**
3. A sodium light (5890 A^0) strikes a film of oil (μ=1.46) floating on water. When viewed at an angle of 60^0 from the normal, 15^{th} dark ring is seen. What is the thickness of the film? **(Ans: 3.76μm)**
4. When light is reflected from an oil film of thickness 0.01 mm and refractive index 1.4 at an angle of 45^0 to the normal. If the reflected light falls on the slit of a spectrometer, calculate the number of dark bands seen between wavelengths 4000 A^0 and 5000 A^0. **(Ans: 12)**
5. MgF2 of refractive index 1.38 is coated on a glass plate in order to reduce the reflection from the glass surface using interference. How thick is the coating needed to produce a minimum reflection at centre of visible spectrum (λ= 5500 AU) **(Ans:9.96 μm)**
6. When white light fall normally on a soap film, whose thickness is $5x10^{-5}$ cm. And refractive index is 1.33; which wavelength in the visible region will be reflect most strongly.
7. An oil drop of volume 0.2 c.c is dropped on the surface of a tank of water of area 1 sq. meter.the thin film spread uniformly over the surface and white light which is incident normally is observed through spectrometer.the spectrum is seen to contain one dark band whose centre has wavelength $5.5x10^{-5}$ cm in air. Find the refractive index of oil.
8. White light is incident on a soap film at an angle sin^{-1} (4/5) and the reflected light is observed with a spectroscope. It is found that two consecutive dark bands correspond to wavelengths $6.1x10^{-5}$ and $6x10^{-5}$ cm. If the refractive index of the film be 4/3, calculate the thickness. (**Ans :- t=0.0017cm)**
9. A parallel beam of light of wavelength 5890 A^0 is incident on a glass plate having refractive index 1.5 such that the angle of refraction in the plate is 60^0 . Calculate the smallest thickness of glass plate which will appear dark by reflected light. **(Ans: 3927 A^0)**
10. A soap film of refractive indeed 1.33 is illuminated with white light of different wavelengths at an angle of 45^0. For the wavelength 5890 A^0, calculate the thickness at which minimum intensity would be observed. **(Ans: 2615 A^0)**
11. A soap film of refractive index 4/3 and thickness $1.5x10^{-4}$ cm is illuminated by white light incident at an angle of 45^0. The light reflected by it is examined by a spectroscope in which it is found a dark band corresponding to a wavelength $5x10^{-5}$cm.Calculate the order of interference band .**(Ans :- n=6)**
12. White light falls at an angle of 45^0. on a parallel soap film of refractive index 1.33. At what minimum thickness of the film will it appear bright yellow of wavelength 5900 A^0 in the reflected light? .**(Ans :- t=1309 A^0)**

13. A parallel beam of sodium light strikes a film of oil floating on water. When viewed at an angle 30^0 from the normal, eight dark bands seen .Determine the thickness of the film. Refractive index of the oil is 1.46. λ=5890 A^0 (**Ans :- t=1.7175x10^{-4}cm)**
14. Two plane glass surfaces in contact along one edge are separated at the opposite edge by a thin wire. If twenty interference fringes are observed (5893 A^0) between these edges in sodium light at normal incidence, what is the diameter of the wire? **(Ans: 5.89 µm)**
15. A wedge shaped film is illuminated by light of wavelength 4650 A^0. The angle of wedge is 40". Calculate the fringe separation between two consecutive fringes. **(Ans: 1.19 µm)**
16. A monochromatic light of wavelength 5.82x10^{-7} m falls normally on a glass wedge angle of 20sec of an arc. If the refractive index of glass in 1.5 find the number of dark interference fringes per cm of the wedge length. **(Ans :- fringe width = 0.2cm, no of dark fringes per cm= 5)**

17. Interference fringes are produced when monochromatic light is incident normally on a thin wedge shaped film of refractive index 1.5. If the distance between two consecutive fringes is 0.02 mm, find the angle of the film in degrees. **(Ans: 0.525^0)**
18. Light of wavelength 6000 A^0 falls normally on the wedge-shaped film of refractive index 1.4 forming fringes that are 2mm apart. Calculate the angle of the wedge. **(Ans: 1.071×10^{-4} rad).**
19. Light of wavelength 5500 A^0 falls normally on a thin wedge shaped of refractive index 1.4 forming fringes that are 2.5mm apart. Find the angle of wedge in seconds. .**(Ans :- θ=16.2 sec)**
20. In Newton's ring experiment (λ=5893 A^0), a thin convex lens of focal length 1.0 m (μ=1.5) is used instead of a plano-convex lens. What is the diameter of 7^{th} dark ring? **(Ans: 4.06 mm)**
21. In Newton's ring experiment the light used is of wavelengths λ_1= 6000A^0 and λ_2= 4800 A^0. The radius of curvature of plano-convex lens is 0.96 m. If n^{th} dark ring of λ_1 coincides with $(n+1)^{th}$ dark ring of λ_2, calculate n and diameter of n^{th} ring. **(Ans: 3.03 mm)**
22. In Newton's ring experiment, the monochromatic light used is of wavelength 5896 A^0. The radius of curvature of plano-convex lens is 1 m. The 16^{th} dark ring has a radius of 2.5 mm. Calculate refractive index of the medium **(Ans: 1.51)**
23. In a Newton's ring experiment the diameter of 5^{th} ring was 0.336cm and that of 15^{th} ring was 0.59cm. Find the radius of curvature of the plano convex lens if wavelength of the light is λ=5890 A^0 .**(Ans :- R=99.83cm)**
24. In Newton's ring experiment, light of wavelength 5896 A^0 is used. For a liquid medium, the radius of 7^{th} bright ring is found to be 0.15 cm. The radius of plano-convex lens is 1m. Calculate the speed of light in the liquid. **(Ans: 1.76 ×10^8 m/s)**
25. In Newton's ring experiment, the diameter of 7^{th} dark ring is 3.4 mm for a plano-convex lens of radius 1m. Calculate the diameter of 16^{th} dark ring. If liquid of refractive index 1.3 is filled between the lens and glass plate, calculate radius of 7^{th} and 16^{th} bright ring. **(Ans: 7^{th} - 1.4 mm and 16^{th} – 2.22 mm)**

26. In Newton's ring experiment the diameter of 4^{th} and 12^{th} dark rings are 0.400cm and 0.700cm respectively. Deduce the diameter of 20^{th} ring. **(Ans :- Diameter of 20th ring = 0.0906cm)**
27. A movable mirror of Michelson interferometer is moved through a distance 0.05 mm and 200 fringes are observed crossing the field of view. Calculate the wavelength. **(Ans:600 nm)**
28. In Michelson interferometer, introduction of a thin plate in the path of a beam (λ= 5896 A^0) causes 50 bands to shift the line of observation. If thickness of the plate is 0.034 mm, calculate the refractive index of the plate. **(Ans: 1.43)**
29. Calculate the distance between successive positions of Michelson's interferometer for maximum distinctness for wavelengths 5896 A^0 and 5890 A^0. **(0.289 mm)**
30. When a thin film of glass μ= 1.5 is interposed in the path of one the interfering beams of Michelson's interferometer a shift of 30 fringes of sodium light is observed across the field of view . If the thickness of the film is 0.018 mm, calculate the wavelength of the light used.**(Ans :- λ= 6000 A^0)**
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DIFFRACTION

1. In Fraunhofer diffraction at a single slit of width 0.2 mm, a screen is placed 1.2 m away from the slit. If the first minima lie at 3.7 mm on either side of the central maximum, find the wavelength of light. **(Ans: 616 nm)**
2. A light of wavelength 550 nm falls normally on a slit of width 2.2 µm. Determine the angular position of second and third minima. **(Ans: 2^{nd}- 30^0 and 3^{rd}- 48.6^0)**
3. A monochromatic beam of light of wavelength 5000 A^0 falls normally on a single slit. The central maximum fans out 30^0 on both sides of the direction of the incident light. Calculate the slit width. **(Ans: 1µm)**
4. For a diffraction grating, the angle of diffraction for second order maxima for wavelength 500 nm is 30^0. Calculate number of lines per cm. **(Ans: 5000 cm/s)**
5. A plane grating has 15000 lines per inch. Find the angle of separation of 5048 A^0 and 5016 A^0 lines of Helium in second order spectrum. **(Ans: 0.27^0)**
6. A plane grating produces an angular separation of 0.01 rad between two wavelengths observed at an angle of 30^0. The mean value of the wavelength is 5000 A^0. Calculate the difference in two wavelengths if the spectrum is observed in the second order. **(Ans: 86.6 ^{0})**
7. A grating has 2620 lines per inch. If a wavelength of 6000 A^0 is used, how many orders are observed for the grating? **(Ans: 16)**
8. A diffraction grating having 4000 lines per cm is illuminated normally by light of wavelength 5000 A^0. Calculate the dispersive power in the third order spectrum. **(Ans: 15×10^5 rad/m)**
9. Calculate the aperture of the objective of a telescope which may be used to resolve two stars separated by 2.44×10^{-6} rad for wavelength 600 nm. **(Ans: 0.3m)**
10. Calculate the minimum number of lines in grating which will first resolve the lines of wavelengths 5890 A^0 and 5896 A^0 in the first and second order. **(Ans: First order- 982; Second order-491)**
11. A collimated beam of microwaves impinges on a metal screen that contains a long horizontal slit that is 20 cm wide. A detector locates the first minimum of irradiance at an angle of 36.87^0 above the central axis. Determine the wavelength of radiation. **(Ans: 12 cm)**
12. Calculate the angles at which the first dark band and the next bright band are formed in Fraunhofer diffraction pattern of a slit of width 0.2mm, if λ= 5896 A^0 **(Ans: θ_1=10.12' θ_2=15.18')**
13. A single slit diffraction pattern is formed using white light .For what wavelength of light does the second minimum coincide with the third minimum for the wavelength 4000 A^0 **(Ans: λ=6000 Å)**
14. Light beam of wavelength 5.8×10^{-7} m is incident od a slit having a width of 0.3x10-3 m .The viewing screen is 2 m away from the slit. Find the angular position of 1^{st} dark fringes and the width of central bright fringe. What happens to the linear width if the slit

width is increased? **(Ans: θ_1=0.100,linear width of central maximum=0.77cm, linear width decreases)**

15. Find the half angular width and total angular width of the central maximum in Fraunhofer diffraction pattern of a slit of width $12x10^{-5}$ cm, when illuminated by light of wavelength 6000 Å. **(Ans: Half angular width=30^0 and Total angular width =60^0)**
16. In Fraunhofer diffraction at a single slit of width 1.2x 10^{-6}m, find the half angular width of the central maximum if the slit is illuminated by light of wavelength 5890 A^0 **(Ans: Half angular width=29.41^0)**
17. How many lines/ cm are ther in a plane transmission grating which gives 1st order of light of wavelength 6000 A^0 at angle of diffraction 3**0^0. (Ans: 8333 lines/cm)**
18. Monochromatic light of wavelength 6500 Å falls normally on a grating 2cm wide. The first order spectrum is produced at an angle 150 from the normal .What is the total number of lines on the grating? **(Ans: Total number of lines on the grating =7962)**
19. Monochromatic light of wavelength 6560 A^0 falls normally on a grating 2cm wide .The first order spectrum is produced at an angle of $18^0$14' from the normal. Calculate the **T**otal number of lines on the grating. **(Ans: Total number of lines on the grating =9522)**
20. The wavelengths of visible spectrum are approximately 4000 A^0 to 7000 A^0 .Find the angular breadth of the first order visible spectrum produced by a plane grating having 6000 lines per cm, when light is incident normally on the grating. **(Ans: Angular breadth = $10^0$57')**
21. A plane transmission grating having 6000 lines/cm is used to obtain a spectrum of light from a sodium lamp in the second order .Calculate the angular separation between the two sodium lines whose wavelengths are 5890A^0 to 5896 A^0 **(Ans: Angular separation =0.06^0)**
22. How many orders will be visible if the wavelength of the incident radiation is 5000 A^0 and the number of lines on the grating is 2620 in one inch? **(Ans: 19)**
23. What is the highest order spectrum which may be seen with monochromatic light of wavelength 5000 A^0 by means of diffraction grating with 5000 lines/cm? **(Ans: 4)**
24. In a grating spectrum, which spectral line in 4th order will overlap with 3rd order line of 5461 A^0? **(Ans: 4096** A^0**)**
25. Find the total number of lines on grating and maximum value of the resolving power of a diffraction grating 3cm wide having 5000 lines/inch. If the wavelength of light used is 5890 A^0. **(Ans: Total no of lines =15000 and R.P. $_{MAX}$= 45000)**
26. Find the minimum number of lines that a diffraction grating would need to have in order to resolve in first order the red doublet given by a mixture of hydrogen and deuterium. The wavelength difference is 1.8 A^0 at 6553 A^0 **(Ans: 3641)**
27. A diffraction grating having 15000 lines to an inch is used to photograph a spectrum. Calculate the angular dispersion in the second order spectrum of wavelength region $5.9x10^{-5}$ cm. **(Ans: angular dispersion= 16339 rad/cm)**
28. Find the separation of 2 points on the moon that can be resolved by 500 cm telescope .The distance of the moon is 3.8x105 km. The eye is most sensitive to light of wavelength 5500 A^0 **(Ans: 50.996m)**

POLARIZATION

1. The refractive index of glass is 1.5. Calculate Brewster's angle for it. Also calculate the angle of refraction. **(Ans:33.69^0)**
2. The refractive indices of glass and water are 1.54 and 1.33 respectively. Calculate the polarizing angle for beam passing from glass to water and from water to glass. **(Ans: Glass to water- 40.82^0 and water to glass- 49.18^0)**
3. Two polarizing sheets placed one on the top of other are exposed to unpolarized light. What must be the angle between the characteristic directions of sheets if the intensity of transmitted light is (a)1/3 of maximum intensity of the transmitted beam from the first sheet (b) 1/3 of the intensity of the incident beam. **(Ans: (a) 54.76^0 or 125.24^0 (b) 35.31^0 or 144.69^0)**
4. Two Nicol prisms are arranged such that the amount of light transmitted through them is maximum. What will be the percentage reduction in the intensity of the incident light on the first prism when the analyser is rotated through 30^0? **(Ans: 62.5 %)**
5. Two polaroids are adjusted to obtain maximum intensity. Through what angle should one polaroid be rotated to reduce the intensity (a) 1/2 (b) 1/4? **(Ans: (a) 45^0 or 135^0 (b) 60^0 or 120^0)**
6. Calculate thickness of a half wave plate of quartz for a wavelength 4000 A^0. (μ_e=1.553 and μ_o=1.544) **(Ans: 0.22 μm)**
7. Calculate thickness of a quarter wave plate for light of wavelength 5893 A^0, given refractive indices for E-wave and O-wave as 1.554 and 1.533 respectively. **(Ans: 7.02 μm)**
8. Calculate thickness of calcite plate which would convert plane polarized light into circularly polarized light of wavelength 5890 A^0. (μ_e=1.658 and μ_o=1.486) **(Ans: 0.856 μm)**
9. Plane polarized light of wavelength 5000 A^0 passes through a quartz plate (μ_e=1.553 and μ_o=1.544) with its optic axis parallel to the faces. Calculate the least thickness of the plate for which the emergent beam will be plane polarized. **(Ans: 0.275 μm)**
10. For wavelength of 6000 A^0 and μ_e=1.553 and μ_o=1.544, calculate thickness of (a) quarter wave plate (b) half wave plate. **(Ans:(a)0.167 μm (b) 0.333μm)**
11. The value of μe and μo for quartz are 1.5508 and 1.5418 respectively. Calculate the phase retardation for λ=5000Å when the plate thickness is 0.032mm. **(Ans: Phase retardation= 3.617 radian)**
12. At what angle of incidence should a beam of sodium light be directed upon the surface of diamond to produce most complete polarization? **Critical angle for diamond 24.5^0 (Ans: 67^0 28')**
13. A polarizer and analyzer are oriented so that the amount of light transmitted is maximum. To what fraction of its maximum value is intensity of transmission light reduced when the analyzer is rotated through 1) 45^0 and 2)90^0 **(Ans: 1) 0.5 2)0)**
14. A glass plate of refractive index 1.5 is to be used as polarizer. What is the angle of polarization angle of refraction **(Ans: 33^0 69')**
15. Calculate the thickness of quarter wave plate of wavelength 5890 Å (μ_e=1.50 and μ_o=1.55) **(Ans: t=2.945 μm)**

16. Calculate the thickness of quarter wave plate of wavelength 5890 Å (μ_e=1.57 and μ_o=1.55) **(Ans: t=7.36 μm)**
17. Calculate the thickness of a calcite plate which would convert plane polarized light into circularly polarized light .The principal refractive indices are μ_e=1.486 and μ_o=1.658 at the wavelength 5890 Å of light used. **(Ans: t=8.56x10^{-7}m)**
18. Plane polarized light passes through a quartz plate with its optic axis parallel to the faces. Calculate the least thickness of the plate for which the emergent beam will be plane polarized. (μ_e=1.5533 and μ_o=1.5442 and λ=5x10^{-5} m **(Ans: t=1.37x10^{-5}m)**
19. Find the thickness of a quarter wave plate when the wavelength of light is equal to 5890 Å, given μ_e=1.54 and μ_o=1.55 **(Ans: t=1.47x10^{-5}m)**
20. Quartz has refractive indices 1.553 and 1.544. Calculate the thickness of the quarter wave plate for sodium light of wavelength 5890 Å **(Ans: t=1.63x10^{-5}m)**
21. Plane polarized light is incident on a plate of quartz cut with faces parallel to optic axis .Calculate the thickness for which the phase difference between the two rays is 60^0 where (μ_e=1.5583 and μ_o=1.5442 and λ=5000 Å **(Ans: t=0.00091cm)**