



PHYSICS

BOOKS - MODERN PUBLICATION

DISPERSION

Example

1. A ray of light suffers minimum deviation, while passing through a prism of refractive index 1.5 and refracting angle 60°

,calculate the angle of deviation and angle of incidence.



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2. A thin prism of 5° angle gives a deviation of 3.2° . What is the value of refractive index of the material of the prism?



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3. A prism with a refracting angle of 60° gives angles of minimum deviation 53° , 51° and 52° for blue, red yellow light respectively. What is the dispersive power of the material of the prism?



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4. A combination of two prisms, one of flint and other of crown glass produces dispersion without deviation. The angle of the flint glass

prism is 15° . Calculate the angle of crown glass prism and the angular separation of the red and violet rays on emergence from the spectroscope. (μ for crown glass = 1.52, μ for flint glass = 1.65, ω for crown glass = 0.02, ω for flint glass = 0.03).



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5. A crown glass prism of refracting angle 6° is to be achromatised for red and blue light using a flint glass prism. Find the angle of the

second prism ang also the mean deiation from
the following data:

Refractive index for crown glass :

$$\mu_r = 1.520, \mu_b = 1.531$$

Refractive index for flint glass:

$$\mu_r = 1.662, \mu_b = 1.684.$$



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6. A ray of light incident at 49° on the face of
an equilateral prism passes

symmetrically. Calculate the refractive index of the material of the prism.



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7. A ray of light passes through an equilateral glass prism, such that angle of incidence is equal to the angle of emergence. If the angle of emergence is $\frac{3}{4}$ times the angle of prism, calculate the refractive index of the glass prism.



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8. A ray of light is incident normally on one of the faces of a prism of apex angle 30° and refractive index $\sqrt{2}$. Find the angle of deviation for the ray of light.



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9. A ray of light is incident on the face AB of a glass prism ABC having the vertex angle A equal to 30° . The face AC is silvered and a ray of light is incident on the face AB, such that it

etraces its path.If efractive index of the glass is $3\frac{1}{2}$,calculate the ngle of incidence on the face AB.



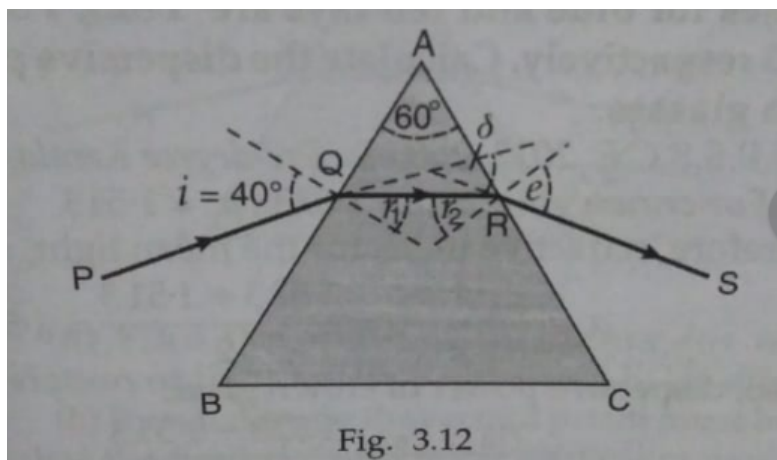
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10. Prism of refractive index 1.53 is placed in water of refractive index 1.33.If the angle of the prism is 60° ,calculate the angle of minimum deviation in water.



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11. An equilateral glass prism ($\mu = 1.6$) is immersed in water ($\mu = 1.33$). Calculate the angle of deviation produced for a ray of light incident at 40° on one face of the prism.



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12. Find the angle of dispersion between the red and violet colours produced by a flint glass prism of refracting angle 60° . Refractive indices of the prism for red and violet colours are 1.622 and 1.663 respectively.



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13. The refractive indices of crown and flint glasses for blue and red rays are 1.523, 1.513

and 1.773, 1.743 respectively. Calculate the dispersive powers of the two glasses.



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14. In a certain spectrum produced by a glass prism of dispersive power 0.031, it was found that the refractive index for the red ray is 1.645, whereas the refractive index for the blue ray is 1.665. What is the refractive index for the yellow ray?



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15. Determine the angle of flint glass prism, which should be combined with a crown glass prism of 5° so as to give dispersion but no deviation.

Given, for crown glass:

$\mu_v = 1.523$, $\mu_r = 1.515$, for flint glass:

$\mu_v = 1.688$, $\mu_r = 1.650$.



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16. Find the angle for a prism of dispersive power 0.021 and refractive index 1.53 to form an achromatic combination with prism of angle 4.2° and dispersive power 0.045 having refractive index 1.65. Find the resultant deviation.



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17. The dispersive powers of crown and flint glasses are 0.03 and 0.05 respectively. If

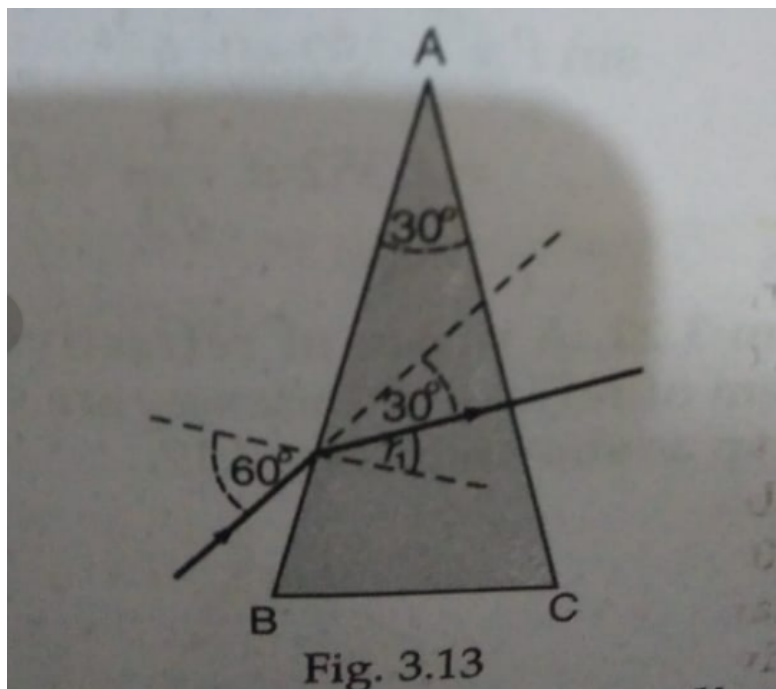
difference in the refractive indices for blue and red colour is 0.015 for crown glass and 0.022 for flint glass, calculate the angles of the two prisms for a deviation of 2° without dispersion.



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18. A ray of light is incident at an angle of 60° on the first face of a prism of an angle 30° . The ray emerging out of the prism makes an angle of 30° with the incident ray as shown in

Fig.3.13.



calculate the refractive index of the material of the prism.



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19. A glass prism of angle 72° and refractive index 1.66 is immersed in water of refractive index 1.33. Find the angle of minimum deviation for a parallel beam of light passing through the prism.

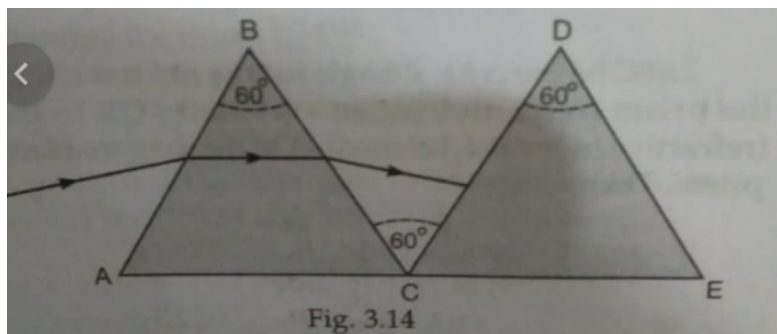


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20. A ray of light is incident on a prism ABC of refractive index $\sqrt{3}$ as shown in Fig.3.14.

Find the angle of incidence for which the

deviation of light ray by the prism ABC is minimum.

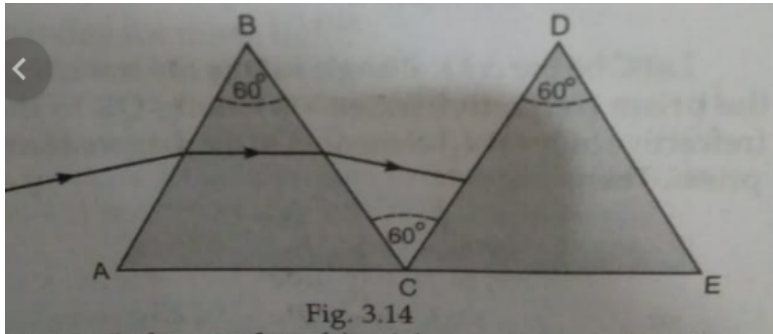


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21. A ray of light is incident on a prism ABC of refractive index $\sqrt{3}$ as shown in Fig.3.14.

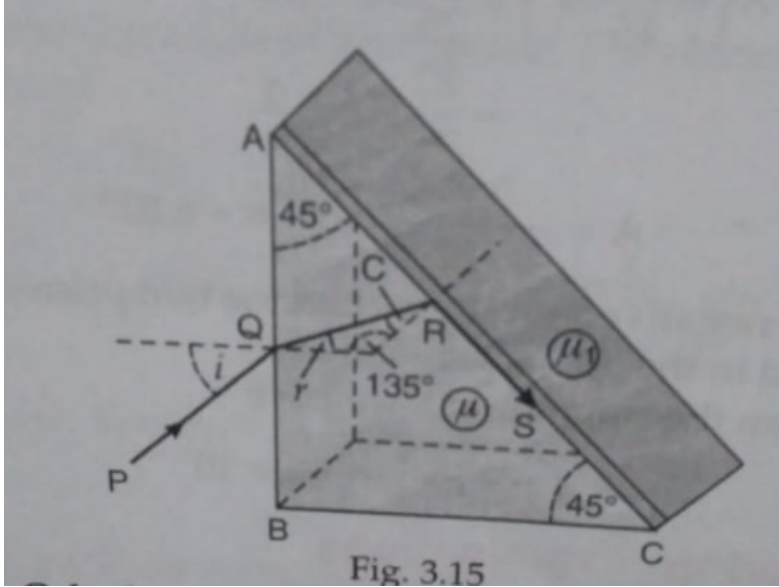
By what angle the second prism must be rotated, so that the final ray suffers net

minimum deviation.



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22. A right angle prism ($45^\circ - 90^\circ - 45^\circ$) of refractive index μ has a plate of refractive index μ_1 (μ_1 lower than μ) cemented to its diagonal face. The assembly is in air. A ray is incident at face AB as shown in Fig. 3.15

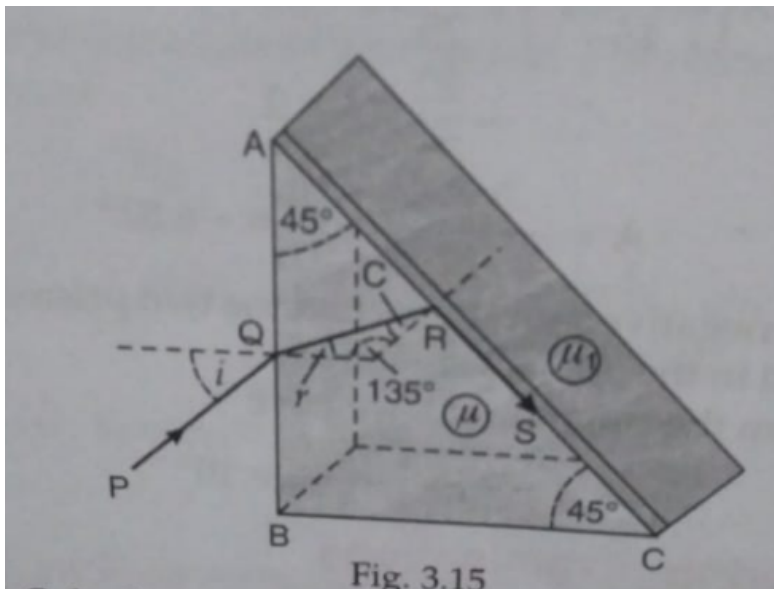


Calculate the angle of incidence at face AB for which the ray strikes the diagonal face at critical angle.



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23. A right angle prism ($45^\circ - 90^\circ - 45^\circ$) of refractive index μ has a plate of refractive index μ_1 (μ_1 lower than μ) cemented to its diagonal face. The assembly is in air. A ray is incident at face AB as shown in Fig.3.15



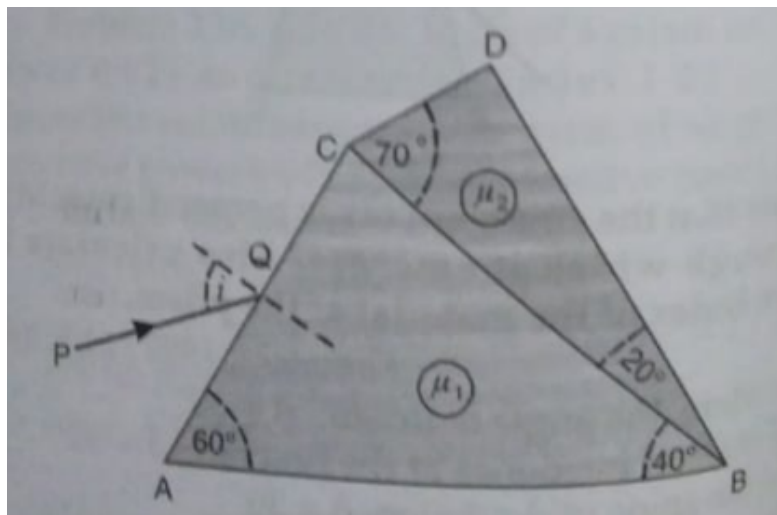
Assuming $\mu = 1.352$, calculate the angle of incidence at face AB for which the refracted

ray passes through the diagonal face undeviated.



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24. A prism of refractive index μ_1 and another prism of refractive index μ_2 are struck together without a gap as shown in Fig.3.17.



The angles of the prisms are shown. μ_1 and μ_2 depend on δ , the wavelength of light according to

$$\mu_1 = 1.20 + \frac{10.8 \times 10^4}{\delta^2} \quad \text{and}$$

$$\mu_2 = 1.45 + \frac{1.8 \times 10^4}{\delta^2},$$

where δ is in nm.

Calculate the wavelength δ_0 for which rays incident at any angle on the interface BC pass through without bending at that interface.



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25. The refractive indices of the crown glass for blue and red light are 1.51 and 1.49 respectively and those of the flint glass are 1.77 and 1.73 respectively. An isosceles prism of angle 6° is made of crown glass. A beam of white light is incident at a small angle on this prism. The other flint glass isosceles prism is combined with the crown glass prism such that there is no deviation of the incident light. Determine the angle of the flint glass prism. Calculate the net dispersion of the combined system.



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26. Draw a ray diagram to show refraction of a ray of monochromatic light passing through a glass prism.



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27. How does the angle of minimum deviation of a glass prism vary, if the incident violet light is replaced by red light? Give reason.





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28. Derive the relation for refractive index of the material of prism when the prism is placed in minimum deviation position.



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29. A glass prism is held in water. How is its angle of minimum deviation affected?



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30. Plot a graph to show the variation of the angle of deviation as a function of angle of incidence for light rays passing through a prism.



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31. What is dispersion of light?



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32. Out of blue and red, which light has larger wavelength?



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33. Out of red and blue lights, for which colour is the refractive index of glass greater?



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34. For which colour, the refractive index of the material of prism is maximum and minimum?



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35. Which photon is more energetic, red or violet one and why?



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36. Refractive indices of glass for lights of yellow, green and red colours are μ_y , μ_g and μ_r respectively. Rearrange these symbols in an increasing order of values.



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37. Define dispersive power of a prism.



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38. Define dispersive power of a prism.



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39. Define dispersive power of a prism.



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40. On what factors does the angular dispersion of a prism depend?



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41. On what factors does the dispersive power of the material of a prism depend?



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42. What is significance of dispersive power of a prism?



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43. On what factors does the dispersive power of the material of a prism depend?



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44. Why do we wear light coloured clothes in summer?



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45. Explain, why one prefers even in summer a black umbrella to a white one.



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46. Why is a rainbow formed in teh sky?



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47. What is the essential condition for observing a rainbow?



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48. A ray of light, incident on an equilateral glass prism ($\mu_g = \sqrt{3}$) moves parallel to the base line of the prism inside it. Find the angle of incidence for this ray.



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49. Derive the relation for refractive index of the material of prism when the prism is placed

in minimum deviation position.



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50. The following table gives the value of the angle of minimum deviation for different values of the angle of incidence for a triangular prism.

Angle of incidence	33°	38°	42°	52°	60°	71°
Angle of deviation	60°	50°	46°	40°	43°	50°

For what value of the angle of incidence, is the angle of emergence likely to be equal to the angle of incidence?



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51. Name the factors on which the deviation produced in the path of a ray of light by a prism depends.



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52. Derive the relation for refractive index of the material of prism when the prism is placed in minimum deviation position.





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53. Out of blue and red light, which is deviated more by a prism? Give reasons.



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54. Violet colour is seen at the bottom of the spectrum, when white light is dispersed by a prism. Why?



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55. Rays of red and blue light are incident on a given prism. Explain, which will have the larger value of δ_m the angle of minimum deviation.



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56. Draw a properly labelled graph between the angle of incidence and the angle of deviation for a prism and show the point of minimum deviation.



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57. Plot a graph to show the variation of the angle of deviation as a function of angle of incidence for light rays passing through a prism.



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58. How does the angle of deviation vary with the angle of incidence in case of a prism ?
What is the angle fo minimum deviation?



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59. A monochromatic ray of light is made to fall on a normal 60° prism under minimum deviation condition. What is the relation between the angle of incidence and the angle of emergence?



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60. When does a ray incident on a prism deviate away from the base?



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61. A glass prism has a minimum angle of deviation δ_m in air. State with reason, how the angle of minimum deviation will change, if the prism is immersed in a liquid of refractive index greater than 1.



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62. Define dispersive power of a prism.



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63. Explain why white light is dispersed when passing through a prism.



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64. A ray of white light shows no dispersion on emerging from a glass plate (slab). Is there no dispersion inside the glass plate as well?



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65. Why does the sky appear blue? What will it look like on moon?



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66. The bluish colour predominates in a clear sky. Why?



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67. Why does the sky appear blue? What will it look like on moon?



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68. The sun appears red at sun rise or sunset, why?



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69. Why does the sun appear reddish in the morning (as well as in evening)?



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70. Why are danger signals red in colour? Give reason.



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71. Eye is more sensitive to yellow colour. Why are then the danger signals red?



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72. What does a welder protect against when he bears a mask?



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73. Do materials always have the same colour, whether viewed by reflected light or through transmitted light?



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74. How would a blue object appear under sodium lamp light?



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75. What colour do you observe, when white light passes through a blue and yellow filter?



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76. Why are 'haloes' (rings) observed sometimes round the sun or moon?



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77. State the reason for the following observations recorded from the surface of moon.

sky appears dark and



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78. State the reason for the following observations recorded from the surface of moon.

rainbow is never formed.





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79. Show that the limiting value of the angle of prism is twice its critical angle.



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80. The refracting angle of a prism is A and the refractive index of its material is $\cot A/2$. For a ray of light incident on the prism, find the angle of minimum deviation in terms of A .

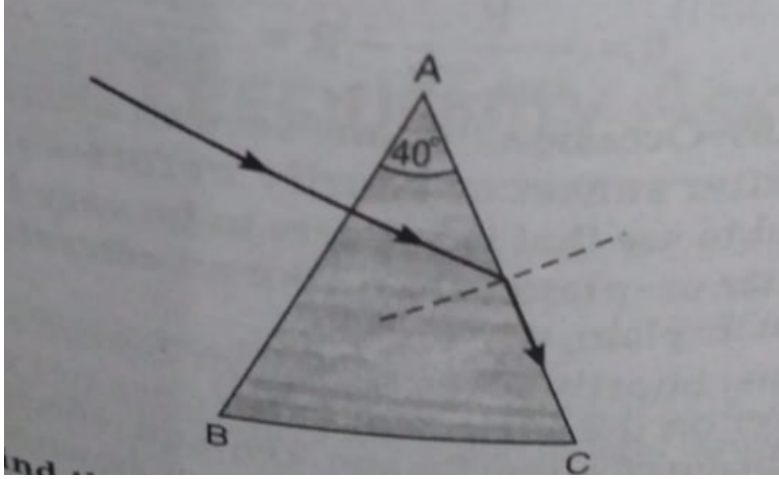


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81. The refracting angle of a prism is 40° and the refractive index of its material is given by

$$\mu = 1.25 + \frac{b}{\delta^2}$$

When a ray of light is incident normally on the face AB of the prism, after refraction through the prism, the ray of light just grazes along the face AC as shown in Fig.3.20.



Find the critical angle for the material of the prism.

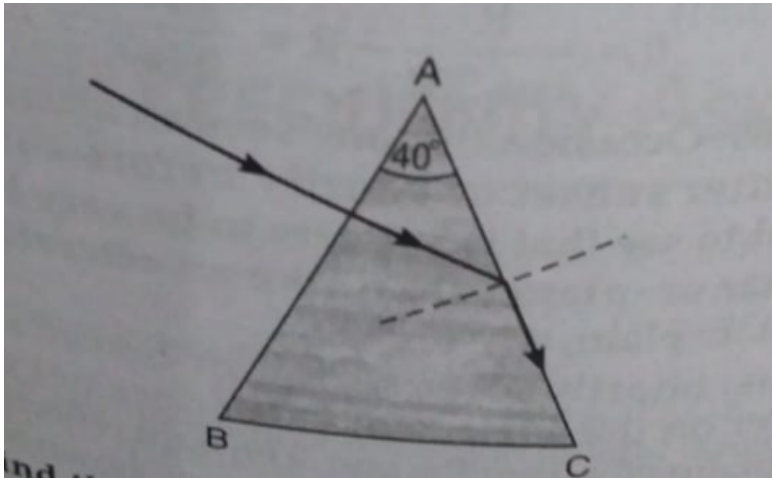


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82. The refracting angle of a prism is 40° and the refractive index of its material is given by

$$\mu = 1.25 + \frac{b}{\delta^2}$$

When a ray of light is incident normally on the face AB of the prism, after refraction through the prism, the ray of light just grazes along the face AC as shown in Fig.3.20.

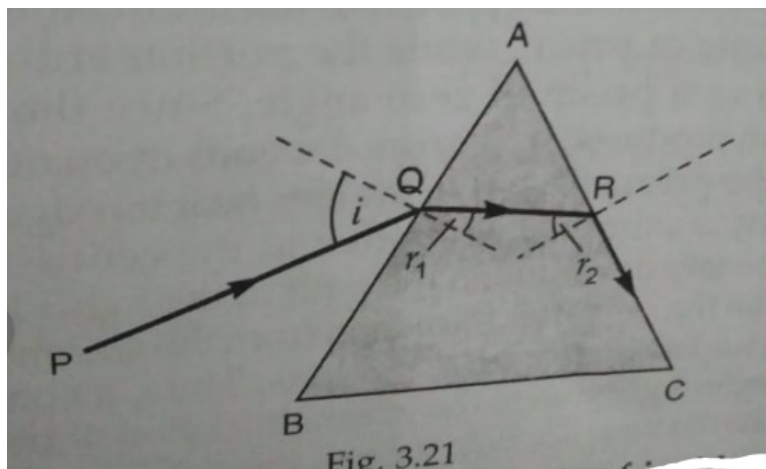


If the wavelength of the incident light is 440 nm, find the value of b .



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83. The refracting angle of a prism is A and the refractive index of its material is μ . When a ray of light is incident on the face AB of the prism, after refraction through the prism, the ray of light just grazes along the face AC as shown in Fig. 3.21.



Determine the value of the angle of incidence in terms of A and μ .



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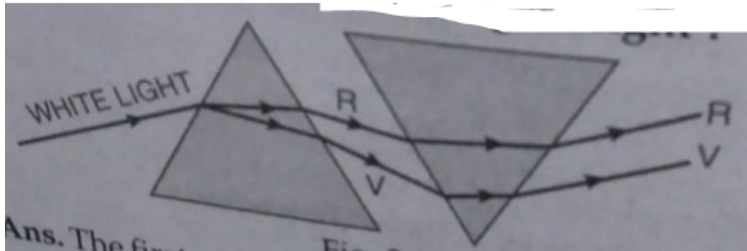
84. Explain the prismatic action of a convex lens.



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85. Two identical prisms are placed in the path of white light, such that their bases are parallel [Fig.3.23]. What will be the nature of

the emergent light?



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86. A beam of white light passing through a hollow prism gives no spectrum. Explain.



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87. Occasionally one sees an aircraft in the sky shortly after sunset or shortly before sunrise and is surprised to see that it appears to be very bright, more like a star or planet than like an aircraft as seen in daylight. Explain, why.



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Exercise

1. For a prism prove that

$$A + \delta = i + e$$



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2. How does the angle of deviation vary with the angle of incidence in case of a prism ?

What is the angle fo minimum deviation?



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3. Derive the relation for refractive index of the material of prism when the prism is placed in minimum deviation position.



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4. Draw a ray diagram to show the refraction of light through a glass prism. Hence obtain the relation for the angle of deviation in terms of the angle of incidence, angle of emergence and the angle of the prism.





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5. Plot a graph to show the variation of the angle of deviation as a function of angle of incidence for light rays passing through a prism.



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6. Derive the relation, $\mu = \frac{\sin(A + \delta_m) / 2}{\sin A / 2}$

when refraction of light takes place through a

glass prism. here every letter has its usual meaning.



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7. Show that $\delta = (\mu - 1)A,$ (when symbols have their usual meanings.) for prism of small angle.



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8. Discuss the phenomenon of refraction through a prism. Prove the formula:

$$\delta = A(\mu - 1).$$



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9. Derive an expression for the angle of deviation of a small prism in terms of the refractive index and the angle of the prism.



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10. What is dispersion of light? Explain it with a diagram. Also explain the cause of dispersion.



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11. Write expression for the angular dispersion produced by a prism.



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12. Define dispersive power of a prism.



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13. Define dispersive power of a prism.



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14. What is dispersion of light? Explain it with a diagram. Also explain the cause of dispersion.



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15. Write expression for the angular dispersion produced by a prism.



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16. Define the term dispersion by a prism and give the reason for its occurrence .Write the formula for

refractive index of the material of a prism in terms of the angle of minimum deviation.



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17. Write expression for the angular dispersion produced by a prism.



Watch Video Solution

18. What is meant by the terms dispersion?



Watch Video Solution

19. Define dispersive power of a prism.



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20. A combination of two prisms, one of flint and other of crown glass produces dispersion without deviation. The angle of the flint glass prism is 15° . Calculate the angle of crown glass prism and the angular separation of the red and violet rays on emergence from the

spectroscope .(μ for crown glass = 1.52, μ for flint glass = 1.65 , ω for crown glass 0.02 , ω for flint glass = 0.03).



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21. What do you understand by deviation without dispersion? Obtain the condition for it.



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22. Explain in brief the formation of primary and secondary rainbows.



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23. Write a short note on rainbow.



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24. Write expression for the angular dispersion produced by a prism.



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25. State and prove prism formula.



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26. Discuss the phenomenon of refraction of light through a glass prism. Derive the relation: $A + \delta = i + e$, where the symbols have their usual meanings.



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27. Derive the relation for refractive index of the material of prism when the prism is placed in minimum deviation position.



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28. Discuss the phenomenon of refraction through a prism and prove that for a prism:

$$\mu = \frac{\sin(A + \delta_m) / 2}{\sin A / 2}, \text{ where } A \text{ is angle of prism,}$$

μ is refractive index of the material of prism

and δ_m is the angle of minimum deviation.



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29. Derive the relation, $\mu = \frac{\sin(A + \delta_m) / 2}{\sin A / 2}$

when refraction of light takes place through a glass prism. here every letter has its usual meaning.



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30. Derive the relation for refractive index of the material of prism when the prism is placed

in minimum deviation position.



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31. Derive the relation for refractive index of the material of prism when the prism is placed in minimum deviation position.



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32. Derive the relation for refractive index of the material of prism when the prism is placed

in minimum deviation position.



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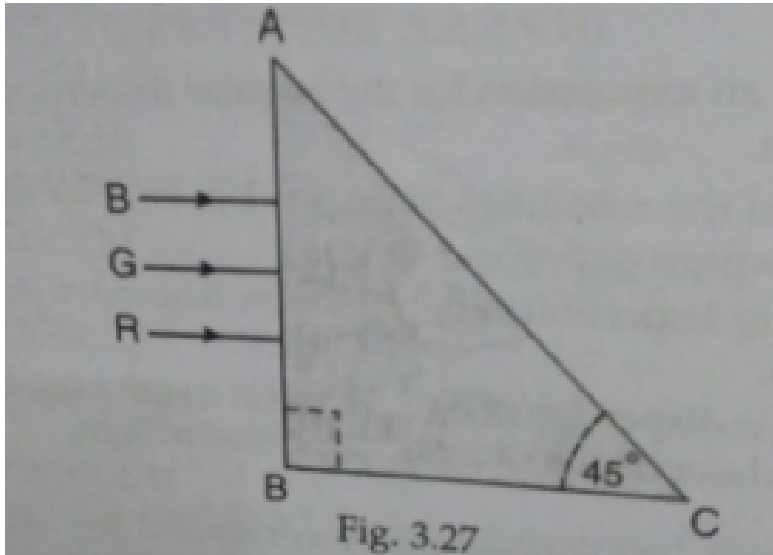
33. Show that $\delta = (\mu - 1)A$, (when symbols have their usual meanings.) for prism of small angle.



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34. Three rays of light -red(R),green(G) and blue(B)-are incident on the face AB of a righth-

angled prism ABC as shown in Fig.3.27.



The refractive indices of the material of the prism for red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively.

Trace the path of the rays through the prism. How will the situation change, if these rays were incident normally on one of the faces of an equilateral prism?



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35. What is rainbow? Differentiate between a primary rainbow and secondary rainbow with a diagram. Why do two observers do not see the same rainbow?



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36. Explain formation of rainbow.



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37. Explain formation of rainbow.



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38. A ray of light is inclined to one face of the prism at an angle of 50° . If the angle of the prism is 60° and the ray is deviated through an angle of 42° , find the angle which the emergent ray makes with the second face of the prism.



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39. Calculate the refractive index of a prism, if the angle of the prism is 60° and the angle of minimum deviation is 30° .



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40. A ray of light incident on an equilateral glass prism shows minimum deviation of 30° . Calculate speed of light through the glass prism.



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41. A ray of light passing through an equilateral triangular glass prism from air undergoes minimum deviation, when angle of incidence is $\frac{3}{4}$ of the angle of prism. Calculate the speed of light in the prism.



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42. The refracting angle of a prism is 60° and the refractive index of the material of the

prism is 1.732. Calculate the angle of minimum deviation.



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43. A ray of light suffers minimum deviation, while passing through a prism of refractive index 1.5 and refracting angle 60° , calculate the angle of deviation and angle of incidence.



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44. A ray of light is incident on the face of a prism placed in minimum deviation position. If the angle of prism is 60° and deviation produced is 34° , find the angle of incidence and refractive index.



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45. What should be the refracting angle of a prism of refractive index 1.5 in order that the ray incident on the face at an angle of 50° may suffer minimum deviation.



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46. A ray of light is incident on the glass prism at an angle of 40° . Find the angle of emergence, if the angle of prism is 60° and refractive index.



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47. A ray of light passes through an equilateral glass prism, such that angle of incidence is

equal to the angle of emergence. If the angle of emergence is $\frac{3}{4}$ times the angle of prism, calculate the refractive index of the glass prism.



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48. How does the angle of minimum deviation of a glass prism of refractive index 1.5 change, if it is immersed in a liquid of refractive index 1.3?



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49. A glass prism of angle 72° and refractive index 1.66 is immersed in water of refractive index 1.33. Find the angle of minimum deviation for a parallel beam of light passing through the prism.



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50. A narrow beam of light is incident normally on one face of a glass prism having refractive index 1.48. Find the angle of prism if the ray

makes a grazing emergence along the other face. Draw a diagram showing the path of rays.



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51. An equilateral prism of refractive index 1.45 is surrounded by water of refractive index 1.33. A narrow beam of light is incident normally on one face of the prism. Find the direction of the emergent ray.



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52. White light is passed through a glass prism of angle 5° . If the refractive indices for red and blue colours are 1.641 and 1.659 respectively, calculate the angle of dispersion between these colours.



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53. A crown glass prism of refracting angle 6° is to be achromatised for red and blue light using a flint glass prism. Find the angle of the second prism and also the mean deviation from

the following data:

Refractive index for crown glass :

$$\mu_r = 1.520, \mu_b = 1.531$$

Refractive index for flint glass:

$$\mu_r = 1.662, \mu_b = 1.684.$$



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54. The dispersive powers of crown and flint glasses are 0.03 and 0.05 respectively. If difference in the refractive indices for blue and red colour is 0.015 for crown glass and 0.022

for flint glass, calculate the angles of the two prisms for a deviation of 2° without dispersion.



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