The following question given below consist of an "Assertion" (A) and "Reason" (R) Type questions. Use the following Key to choose the appropriate answer.

(A) If both (A) and (R) are true, and (R) is the correct explanation of (A).

(B) If both (A) and (R) are true but (R) is not the correct explanation of (A).

(C) If (A) is true but (R) is false.

(D) If (A) is false but (R) is true.

Q.1 **Assertion : -** When a ray of white light passes through a prism then red light gets deviated less than the violet light.

Reason : - A beam of white light when passed through a hollow prism gives spectrum. **[C]**

Sol. Assertion is correct but reason is false. For hollow prism, refractive index of an inside and outside is same hence no refraction and so no deviation.

Q.2 **Assertion** : For total internal reflection, angle of incident in denser medium must be greater than critical angle for the pair of media in contact.

Reason : $\mu = \frac{1}{\sin C}$, where the symbols have their standard meaning **[B]**

Q.3 **Assertion** : The images formed by total internal reflections are much brighter than those formed by mirrors or lenses.

Reason : There is no loss of intensity in total internal reflection. **[A]**

Q.4 **Assertion** : Different colours travel with different speed in vacuum.

Reason : Wavelength of light depends on refractive index of medium. **[D]**

Q.5 **Assertion** : The prism formula indicates that refractive index of material of a prism depends on angle of prism A and angle of minimum deviation δ_m as $\mu = \frac{\sin(A+\delta_m)/2}{\sin A/2}$

Reason : At minimum deviation $i_1 = i_2$ **[D]**

Q.6 **Assertion :** The behavior of any lens depend on the surrounding medium.

Reason : A lens can be looked upon as a collection of small prism with varying prism angle. **[B]**

Q.7 **Statement - I :** Red and violet rays are incident colinearly over a point on a glass prism kept in air then it can give zero deviation.

Statement - II : Zero deviation cannot be produced by a single prism. **[D]**

Q.8 **Assertion (A) :** Monochromatic light is incident on a prism at an angle of incidence 60°. Refracting angle of prism is 60° and its refractive index for given light 1.732. In this situation, deviation suffered by light will be minimum.

Reason (R) : Deviation continuously decreases as the angle of incidence is continuously increased. **[C]**

Q.9 **Statement-I :** For a prism of refracting angle 60° and refractive index $\sqrt{2}$ minimum deviation is 30°

Statement-II : At minimum deviation,

$r_1 = r_2 = \frac{A}{2} = 30°$

Sol.[B] $A = 60°$ $\mu = \sqrt{2}$

$i = \frac{A+\delta_m}{2} = \frac{60+30}{2} = 45°$

$r_2 = \frac{A}{2} = 30°$

$\frac{\sin i}{\sin r} = \frac{\sin 45°}{\sin 30°} = \frac{1/\sqrt{2}}{1/2} = \sqrt{2}$

Both Statement-I and Statement-II are true but Statement-II is not the correct explanation of Statement-I.

Q.10 **Assertion :** There exist two angles of incidence for the same magnitude of deviation (except minimum deviation) by a prism kept in air.

Reason : In a prism kept in air, a ray is incident on first surface and emerges out of second

surface (of prism) along the previous emergent ray, then this ray emerges out of first surface along the previous incident ray. This principle is called principle of reversibility of light.

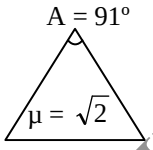
Sol. **[A]**

Both (A) & (R) are true and (R) is correct explanation of (A).

Passage # 6

A prism (triangular) is an optical device which is used to deviate or disperse light passing through it. Any of the two adjacent surfaces can be used for refracting the light ray and angle between them is termed as refracting angle or angle of prism. Angle of deviation depends on angle of incidence of light ray. For minimum deviation angle of incidence is equal to angle of emergence.

Q.11 Consider a prism made of material of RI $\sqrt{2}$ and prism angle 91º. The angle at which light incident at first refracting surface will not emerge at second refracting surface is :

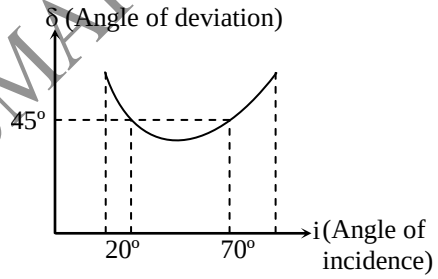


(A) 45º (B) 60º

(C) 30º (D) All of these

Sol.[D] No light ray will emerge if $A > 2i_c$

Q.12 Consider a graph between angle of deviation (δ) and angle of incidence for a particular prism. The prism angle is



(A) 45º (B) 60º (C) 90º (D) 30º

Sol.[A] $i + e - A = \delta$

or $A = i + e - \delta$

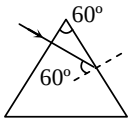
$= 20 + 70 - 45^\circ = 45^\circ$

Q.13 A light ray is incident normally at one face of an equilateral prism. The ray will emerge at the other face only if :

(A) $\mu < \frac{\sqrt{3}}{2}$ (B) $\mu > \frac{2}{\sqrt{3}}$

(C) $\mu < \frac{2}{\sqrt{3}}$ (D) All of these

Sol.[C]



Light ray will emerge only if

$60^\circ < i_c$

$\sin 60^\circ < \sin i_c$

or $\mu < \frac{2}{\sqrt{3}}$

Q.1 **Match the following :**

Column - I	**Column-II**
(A) Inverted crown-flint glass prism combination	(P) Deviation $\propto \frac{1}{\text{dispersive power}}$
(B) Achromatism	(Q) Deviation without dispersion
(C) Hollow prism	(R) Absence of chromatic aberration
(D) Glass slab	(S) Dispersion without Deviation

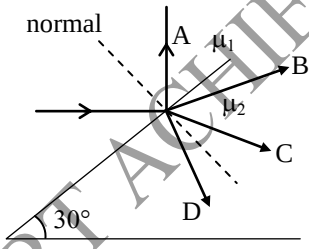
(A) → ALL ; (B) → Q, R ; C) → R ;(D) → R

Q.2 **Match the following :**

Column - I (property of Prism)	**Column-II (Depends on)**
(A) Dispersive power for white light	(P) Material of prism
(B) Prism angle	(Q) Geometry of prism
(C) Angular dispersion	(R) Light passing from prism
(D) Minimum deviation	(S) Surrounding medium of prism

(A) → S ; (B) → R, P ; (C) → Q ; (D) → Q

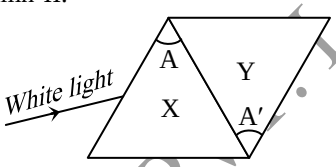
Q.3 For the situation shown in given figure match the column I with column II.



Column-I	**Column-II**
(A) Which ray is not possible	(P) A
(B) $\frac{\mu_1}{\mu_2} > \frac{2}{\sqrt{3}}$	(Q) B
(C) $\frac{\mu_1}{\mu_2} \le 1$	(R) C
(D) $\frac{\mu_1}{\mu_2} \ge 1$	(S) D

(A) → S ; (B) → P ; (C) → R (D) → P,Q

Q.4 A prism 'X' and another 'Y' are kept in contact with their refracting angles placed opposite to each other as shown in figure. White light is incident on the combination from the left. Column-I describes some situations. Match Column-I with the possible outcomes given in Column-II.



Column I	**Column II**
(A) The prisms are made of same without material and their refractingangles are equal, i.e., A = A′.The combination will cause	(P)Dispersion deviation
(B) The prisms are made of same material and their refracting angles are not equal, i.e., A ≠ A′. The combination will cause	(Q) No deviation
(C) The prisms are made of different materials and their refracting angles are equal, i.e., A = A′. Also the quantity $\mu_V - \mu_R$ has different values for the two prisms. Here μ_V and μ_R are the refractive indices for violet and red colours. The combination will cause	(R) No dispersion
(D) The prisms are made of different material and their refracting angles are unequal, i.e., A ≠ A′. Also $\frac{A}{A'} = -\frac{(\mu'-1)}{(\mu-1)}$, where μ is the refractive index for the mean wavelength (yellow) for the prism X while μ′ is the corresponding value for prism Y. The combination will cause	(S) Both deviation and dispersion

A → Q,R ; B → S ; C → S ; D → P,Q

Q.5

Column I (Property of prism)	**Column II (Depends on)**
(A) Dispersive power for white light	(P) Material of prism
(B) Prism angle	(Q) Geometry of prism
(C) Angular dispersion	(R) Light passing from prism
(D) Minimum deviation	(S) Surrounding medium of prism

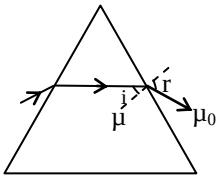
A→ P,S ; B → Q ; C→ P,Q,R,S ; D → P,Q,R,S

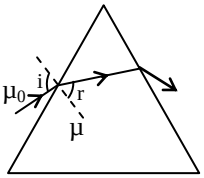
Q.6 As white light passes through a prism, it undergoes dispersion. In regard to this phenomenon. Match column I with column II -

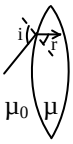
Column-I	**Column-II**
(A) The colour that travels slowest in the prism	(P) Different for different colours.
(B) Frequency	(Q) Shortest wavelength
(C) Angle of deviation	(R) Depends on angle of incidence (i), angle of emergence (e) and angle of prism (A). For minimum deviation i = e.
(D) Angle of minimum deviation	(S) undergoes maximum deviation.

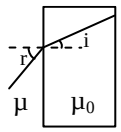
Sol. A → Q, S B → P C → P, R D → P,R

Q.1 For which of the following cases, (sin i/sinr) is equal to (μ/μ_0) –

(A) 

(B) 

(C) 

(D) 

[B,C,D]

Q.2 By properly combining two prisms made of different materials, it is possible to -

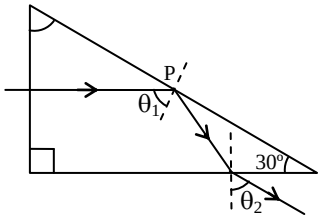
(A) have dispersion without average deviation

(B) have deviation without dispersion

(C) have both dispersion and average deviation

(D) have neither dispersion nor average deviation **[A,B,C]**

Q.3 A ray of light is incident normally on one face of 30º – 60º – 90º prism of refractive index $\frac{5}{3}$, immersed in water of refractive index $\frac{4}{3}$ as shown in the figure –



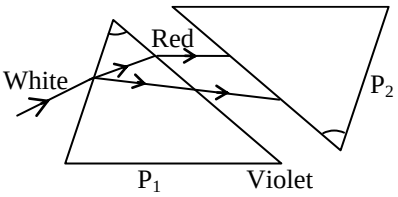
(A) The exit angle θ_2 of the ray is $\sin^{-1}\left(\frac{5}{8}\right)$

(B) The exit angle θ_2 of the ray is $\sin^{-1}\left(\frac{5}{4\sqrt{3}}\right)$

(C) Total internal reflection at point P just ceases if the refractive index of water is increased to $\frac{5}{2\sqrt{3}}$ by dissolving some substance

(D) Total internal reflection at point P just ceases if the refractive index of water is increased to $\frac{5}{6}$ by dissolving some substance **[A,C]**

Q.4 P_1 and P_2 are identical prisms arranged as shown in figure. A ray of white light incident on one face of P_1 undergoes dispersion and falls on one face of P_2. Then –



(A) Light emerging from P_2 will be white

(B) In the light emerging from P_2, dispersion will be greater

(C) The direction of light emerging from P_2 will be parallel to the direction of ray incident on P_1

(D) The ray emerging from P_2 will be white even if prisms P_1 and P_2 have identical geometry but different materials.

Q.5 In dispersion without deviation -

(A) the deviation produced by one is crossed by the other prism

(B) the dispersion produced by one prism is crossed by the other prism

(C) the resultant deviation is zero

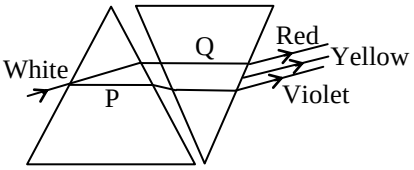
(D) None of the above **[A,C]**

Q.6 A thin prism P_1 with angle 4º and made from glass of refractive index 1.54 is combined with another thin prism P_2 made from glass of refractive index 1.72 to produce dispersion without deviation. The angle of the prism P_2 is -

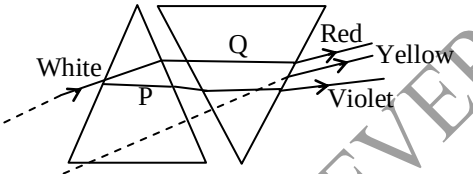
(A) 5.33º (B) 4º

(C) 3º (D) 2.6º **[C]**

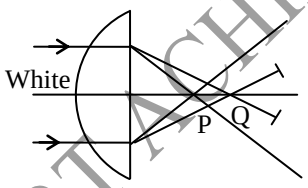
Q.7



(i)



(ii)



(iii)

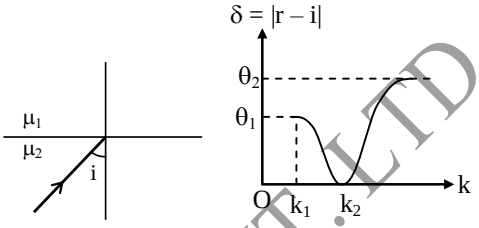
(A) Figure (i) shows deviation without dispersion

(B) Figure (ii) is for showing dispersion without deviation

(C) In figure (i) prism P is of flint glass and Q of crown glass (if these two are the only options)

(D) In figure (iii) a transverse screen at P would show violet at centre, red outside **[A,B,D]**

Q.8 The figure given below shows a ray incident at angle i = $\frac{\pi}{3}$. If the graph drawn shown the variation of |r – i| versus $\frac{\mu_1}{\mu_2}$ = k, (r = angle of refraction), then correct option are :



(A) the value of k_1 is $\frac{2}{\sqrt{3}}$

(B) the value of $\theta_1 = \frac{\pi}{6}$

(C) the value of $\theta_2 = \frac{\pi}{3}$

(D) the value of k_2 is 1 **[B,C,D]**

Q.9 Out of the following, select the correct statements -

(A) refractive index, frequency and deviation are maximum for red colour

(B) if there were no atmosphere, the length of the day on the earth would increase

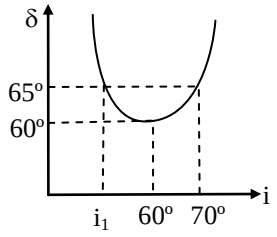
(C) for greater value of μ, the angle of deviation increases

(D) if the critical angle for the medium of a prism is θ_C and the angle of prism is A, there will be no emergent ray when $A > 2\theta_C$

[C, D]

Q.10 The angle of deviation (δ) vs angle of incidence (i) is plotted for a prism.

Pick up the correct statements



(A) The angle of prism is 60º

(B) the refractive index of the prism is n = $\sqrt{3}$

(C) For deviation to be 65º the angle of incidence i_1 = 55º

(D) The curve of 'δ' vs 'i' is parabolic.

Sol. **[A,B,C]**

$\delta = i + e - A$ (for minimum deviation i = e)

$\therefore$ minimum deviation = 2i – A

$60^o = 2 \times 60^o - A \Rightarrow \because A = 60^o$

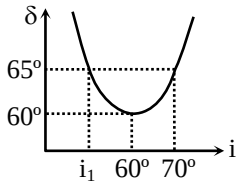
$$\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)} = \frac{\sin\left(\frac{60^o+60^o}{2}\right)}{\sin\left(\frac{60^o}{2}\right)} = \sqrt{3}$$

$\delta_1 = i_1 + e - A$

$65^o = i_1 + 70^o - 60^o$ or $i_1 = 55^o$

the δ versus i curve is not parabolic

Q.11 The angle of deviation (δ) vs angle of incidence (i) is plotter for a prism. Pick up the correct statements -



(A) The angle of prism is 60°

(B) The refractive index of the prism is $n = \sqrt{3}$

(C) For deviation to be 65° the angle of incidence $i_1 = 55^o$

(D) The curve of 'δ' vs 'i' is parabolic

[A,B,C]

Sol. $\delta = i + e - A$ (for minimum deviation i = e)

$\therefore$ minimum deviation = 2i – A

$60^o = 2 \times 60^o - A \Rightarrow A = 60^o$

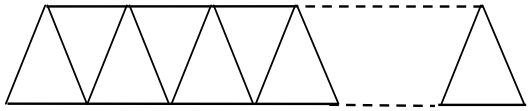
$$n = \frac{\sin\left[\frac{A+\delta_m}{2}\right]}{\sin\left[\frac{A}{2}\right]} = \frac{\sin\left[\frac{60^o+60^o}{2}\right]}{\sin\left[\frac{60^o}{2}\right]} = \sqrt{3}$$

$\delta_1 = i_1 + e - A$

$65^o = i_1 + 70^o - 60^o$ or $i_1 = 55^o$

The δ versus i curve is not parabolic.

Q.12 n number of identical equilateral prism are kept in contact as shown in figure. If deviation through a single prism is δ. Then - (n, m are integers)



(A) If n = 2m, deviation through n prism is zero

(B) If n = 2m + 1, deviation through system of n prism is δ

(C) If n = 2m, deviation through system of n prism is δ

(D) If n = 2m + 1, deviation through system of n prism is zero

Sol.[A,B]

Q.13 Refractive index of an equilateral prism is $\sqrt{2}$ -

(A) minimum deviation from this prism can be 30°

(B) minimum deviation from this prism can be 45°

(C) at angle of incidence = 45°, deviation is minimum

(D) at angle of incidence = 60°, deviation is minimum

Sol. **[A,C]**

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

$\delta m = 30^o$ for $\mu = \sqrt{2}$ & $A = 60^o$

At minimum deviation

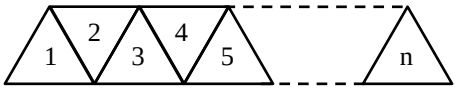
$r_1 = r_2 = \frac{A}{2} = 30^o$

$\sin i_1 = \mu \sin r_1$

$= \sqrt{2} \sin(30^o)$

$= \frac{1}{\sqrt{2}} \Rightarrow i_1 = 45^o$

Q.14 n number of identical equilateral prisms are kept in contact as shown in figure. If deviation through a single prism is δ. Then (n, m are integers) -



(A) if n = 2 m, deviation through n prism is zero

(B) if n = 2m + 1, deviation through system of n prisms is δ

(C) if n = 2m, deviation through system of n prisms is δ

(D) if n = 2m + 1, deviation through system of n prisms is zero

Sol. **[A,B]**

In case of even no. of prism, deviation of prism get cancelled. However in case of odd no. of prism, deviation of one prism remain while others get cancelled.

Q.15 For refraction through a small angled prism, the angle of minimum direction -

(A) increases with the increase in RI of the prism

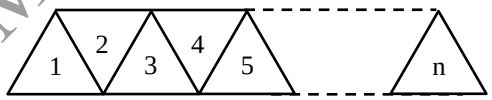
(B) will be 2D for a ray of RI 2.4,. if it is D for a ray of RI 1.2

(C) is directly proportional to the angle of prism

(D) will decrease with the increase in RI of the prism

Sol. **[A,C]** $\delta = (\mu - 1) A$

Q.16 n number of identical small angled prisms are kept in contact as shown in figure. If deviation through a single prism is δ for given incident ray. Then (n, m are integers)



(A) if n = 2m, deviation through n prism is zero

(B) if n = 2m + 1, deviation through system of n prism is δ

(C) if n = 2m, deviation through system of n prism is δ

(D) if n = 2m + 1, deviation through system of n prisms is zero

Sol.[A, B] In case of even no. of prism deviation of prism get cancelled, however in case of odd no. of prism, deviation of one prism remain while others get can celled

Q.17 For refraction through a small angle prism, the angle of minimum deviation.

(A) increases with the increase in R.I. of the prism

(B) will be 2 D for a ray of R.I. 2.4, if it is D for a ray of R.I. 1.2

(C) is directly proportional to the angle of prism

(D) will decrease with the increase in R.I. of the prism

Sol. **[A,C]**

Q.18 For the refraction of light through a prism :

(A) For every angle of deviation there are two angles of incidence

(B) The light travelling inside an equilateral prism is necessarily parallel to the base when prism is set for minimum deviation

(C) There are two angles of incidence for minimum deviation

(D) Angle of minimum deviation will increase if refractive index of prism is increased keeping the outside medium unchanged and if $\mu_p > \mu_s$

Sol. **[B,D]**

Q.19 White light is incident on a equilateral prism. In case of minimum deviation of a particular colour-

(A) Angle of incidence will be maximum for violet colour

(B) Angle of incidence will be minimum for violet colour

(C) Angle of refraction will be equal for all colours

(D) Angle of emergence will be minimum for red colour

Sol.[A,C,D] $r_1 = r_2 = \frac{A}{2}$ in case of minimum deviation.

and $\frac{\sin i}{\sin r_1} = \mu \Rightarrow \sin i = \mu \sin\left(\frac{A}{2}\right)$

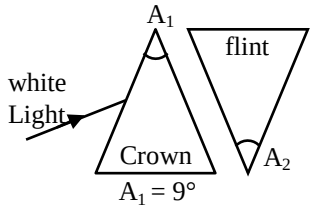
μ_v is maximum

so i for violet will be maximum

μ_R is minimum

So e = i. i.e. e will be minimum for red.

Q.20 Two prisms one made of crown glass (μ_{v_1} = 1.58, μ_{R_1} = 1.52) and second made of flint glass (μ_{v_2} = 1.48, μ_{R_2} = 1.42) are arranged as shown. Angle of prism for crown glass prism is given 9°. Now choose the incorrect statements :



(A) For zero deviation of light ray A_2 should be equal to 11° (Approx)

(B) For zero dispersion of light ray A_2 should be equal to 9° (Approx)

(C) For zero deviation of light ray A_2 should be equal to 9° (Approx)

(D) For zero dispersion A_2 should be equal to 11° (Approx).

Sol.[C,D] For zero deviation.

$A_1 (\mu_{y_1} - 1) = A_2 (\mu_{y_2} - 1)$

$9 (1.55 - 1) = A_2 (1. 45 - 1)$

$9 \times 0.55 = A_2 \times 0.45$

$A_2 = 11°$

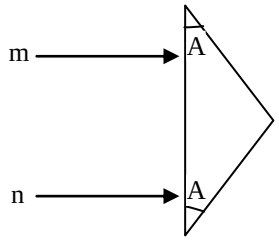
For zero dispersión.

$A_1 (\mu_{v_1} - \mu_{R_1}) = A_2 (\mu_{v_2} - \mu_{R_2})$

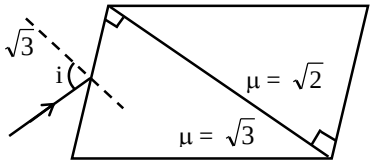
$9 (0.06) = A_2 (0.06)$

$A_2 = 9°$

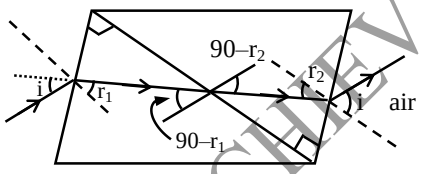
Q.1 The prism shown in figure has a refractive index $\mu_g = \sqrt{3}$ and the angles A are 30°. Two light rays m and n are parallel as they enter the prism. Angle between them after they emerge (in degrees) is – **[0060]**



Q.2 A ray of light from a liquid ($\mu = \sqrt{3}$) is incident on a system of two right angled prism of refractive indices $\sqrt{3}$ & $\sqrt{2}$ as shown. The ray suffers zero deviation when emerges into air from CD. The angle of incidence i is …. × 9º.



Sol.[5]



$\sqrt{3}\ \sin i = \sqrt{3}\ \sin r_1$ …(1)

$\sqrt{3}\ \sin(90 - r_1) = \sqrt{2}\ \sin(90 - r_2)$

$\sqrt{3}\ \cos r_1 = \sqrt{2}\ \cos r_2$ …(2)

$\sin i = \sqrt{2}\ \sin r_2$ …(3)

$i = r_1$

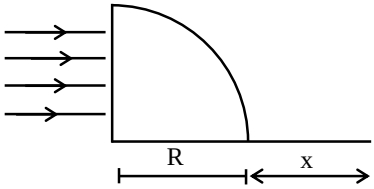
$3\cos^2 r_1 + \sin^2 i = 2$

$2\cos^2 r_1 + \cos^2 r_1 + \sin^2 r_1 = 2$

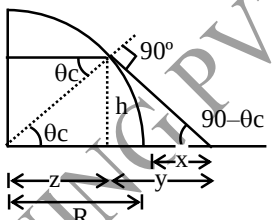
$\cos^2 r_1 = \frac{1}{2}$

$r_1 = 45^\circ \therefore i = 45^\circ$

Q.3 A uniform horizontal beam of light is incident upon a prism as shown. The prism is in the shape of a quarter cylinder of radius R = 5 cm and has index of refraction μ = 1.5. A patch on the table top for a distance x from the cylinder is unilluminated. The value of x in cm is.



Sol. [1]



$x = (y + z) - R$

$y = h \tan\theta_c$

$z = h \cot\theta c$

$x = h[\tan\theta c + \cot\theta c] - R$

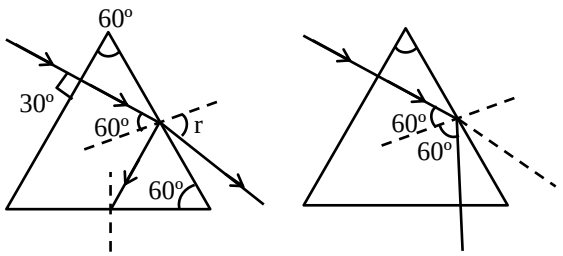
$\sin\theta_c = \frac{h}{R} = \frac{1}{1.5} = \frac{2}{3} \Rightarrow h = \frac{2R}{3}$

$x = \frac{2R}{3}\left[\frac{2}{\sqrt{5}} + \frac{\sqrt{5}}{2}\right] - R$

= 1.71 cm

Q.4 Cross section of a glass prism has the form of an equilateral triangle. A ray is incident onto one of the faces perpendicular to it. Angle ϕ between the incident ray and the ray that leaves the prism in degree is ……× 60º. The refraction index of glass is 1.5.

Sol.[2]



$1.5 \times \sin 60^\circ = 1 \times \sin r$

$1.5 \times \frac{\sqrt{3}}{2} = \sin r$

$\frac{15}{10} \times \frac{\sqrt{3}}{2} = \sin r$

$\frac{3\sqrt{3}}{4} = \sin r$

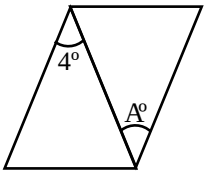
$\sin r > 1$

$\therefore$ T/R will take place

angle = 120º

Q.5 A thin prism P_1 with angle 4º and made from glass of refractive index 1.54 is combined with another thin prism P_2 made from glass of refractive index 1.72 to produce dispersion without deviation. What is the angle of prism in degree ?

Sol. **[3]**



deviation = 0

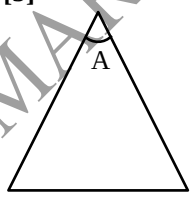
$(\mu_1 - 1)\,4 - (\mu_2 - 1)A = 0$

$(1.54 - 1)\,4 - (1.72 - 1)\,A = 0$

$A = \frac{0.54 \times 4}{0.72} = 3^\circ$

Q.6 A certain thin prism is found to produce a minimum deviation of 40º and produces a deviation of 44º when the angle of incidence is either 42º or 62º. The angle of incidence when light undergoes minimum deviation in degree …. × 10 degree.

Sol. **[5]**



$\delta = i + e - A$

$44° = 42° + 62° - A$

$44° = 104° - A$

$A = 104° - 44° = 60^\circ$

when deviation is minimum

$D = 40°$

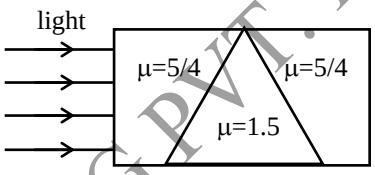
$D = i + e - A$

$38° = 2i - 60°$

$100° = 2i$

$i = 50°$

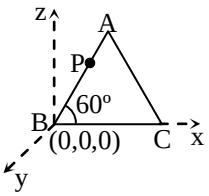
Q.7 A thin isosceles prism with angle 4º and refractive index 1.5 is placed inside a transparent tube with water (refractive index = $\frac{5}{4}$) as shown. The deviation of light whether upward or downward due to prism will be in degree is ….. × 10^{-1}.



Sol. **[8]**

Deviation by prism = $\left(\frac{1.5 \times 4}{5} - 1\right) \times 4 = 0.8^\circ$

Q.8 An equilateral prism ABC is placed in air with its base side C lying horizontally along x-axis as shown the figure. A ray given by $\sqrt{3}\,z + x = 10$ is incident at a point P on face AB of prism.



(a) Find the value of μ for which the ray grazes the faces AC.

(b) Find direction of the finally refracted ray if μ = 3/2

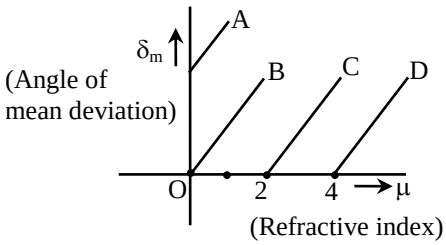
(c) Find the equation of ray coming out of prism if bottom BC is silvered ?

Sol. (a) $\mu = 2/\sqrt{3}$, (b) Parallel to z-axis,

(c) $\sqrt{3}\,z + x = 10$

PHYSICS

Q.1 A student gets four different graphs when he does experiment with the prism at different value of angle of incidence. Which is correct –



(A) A , B, C (B) B, C, D

(C) C, B (D) only C **[D]**

Sol. A, B is not possible similarly for D μ is more than 4, which is not possible

Q.2 For a prism, its refractive index is cot A/2. Then minimum angle of deviation is -

(A) 180° – A (B) 180° – 2A

(C) 90° – A (D) A/2 **[B]**

Sol. $\cot A/2 = \dfrac{\sin\left(\dfrac{A+\delta_m}{2}\right)}{\sin A/2}$

$\dfrac{\cos A/2}{\sin A/2} = \dfrac{\sin\left(\dfrac{A+\delta_m}{2}\right)}{\sin A/2}$

$\sin(90 - A/2) = \sin\left(\dfrac{A+\delta_m}{2}\right)$

so $\delta_m = 180° - 2A$

Q.3 A glass prism has μ = 1.5 and the refracting angle is 90° . If a ray falls on it at angle of incidence of 30° then what will be the angle of emergence:

(A) 60°

(B) 30°

(C) 45°

(D) The ray will not come out of this prism

[D]

Q.4 The cross-section of a prism (μ = 1.5) in an equilateral triangle. A ray of light is incident perpendicular on one of the faces. The angle of deviation of the ray is –

(A) 60º (B) 120º

(C) 90º (D) none of these

[A]

Q.5 A prism has a refracting angle of 60°, any ray falling on one face of the prism will not emerge from the other face if its refractive index exceeds :

(A) 1.414 (B) 1.500

(C) 1.732 (D) 2.000 **[C]**

Q.6 If the refracting angle of a prism is 60º and minimum deviation is 30º, the angle of incidence is -

(A) 30º (B) 45º (C) 60º (D) 90º

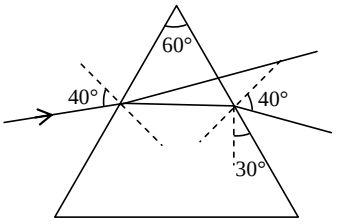
Sol. **[B]** $i = \dfrac{\delta_m + A}{2} = \dfrac{30º+60º}{2} = 45º$

Q.7 A ray of light is incident on a face of equilateral triangular prism at an incident angle 40°. At this angle, minimum deviation occurs. The value of this deviation is –

(A) 60° (B) 10°

(C) 20° (D) 40° **[C]**

Sol.



At δ_{min}

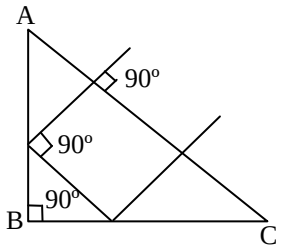
$i = e$

$\delta_{min} = i + e - A$

$= 40 + 40 - 60$

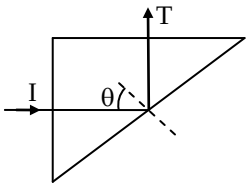
$= 20°$

Q.8 A ray of light is incident on a prism ABC(AB = BC) and travels as shown in figure. The refractive index of the prism material should be at least-



(A) 4/3 (B) √2 (C) 1.5 (D) √3 **[B]**

Q.9 A triangular prism of glass is shown in figure. A ray incident normal to one face is totally reflected.If θ is 45°, then index of refraction of the glass is-



(A) less than 1.41 (B) equal to 1.41

(C) greater then 1.41 (D) None of these **[C]**

Q.10 Find the angle of a prism of dispersive power 0.021 and refractive index 1.52 to form an achromatic combination with a prism of angle 4.2° and dispersive power 0.045 having refractive index 1.65.

(A) 11.25° (B) 12° (C) 11° (D) 11.5°

[A]

Q.11 The dispersive powers of flint glass and crown glass are 0.053 and 0.034 respectively and their mean refractive indices are 1.68 and 1.53 for white light. Calculate the angle of the flint glass prism required to form an achromatic combination with a crown glass prism of refracting angle 4°

(A) 2° (B) 4° (C) 5° (D) 6°

[A]

Q.12 Calculate the dispersive power for crown glass from the given data $\mu_v = .5230$, $\mu_r = 1.5145$

(A) 2° (B) 3°

(C) 0.0163° (D) 2.5° **[C]**

Q.13 Angle of minimum deviation for a prism of refractive index 1.5 is equal to the angle of prism. The angle of prism is - (cos 41° = 0.75)

(A) 62° (B) 41° (C) 82° (D) 31°

Sol. [C] $\mu = 1.5$, $\delta_m = A$, Given cos 41° = 0.75

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

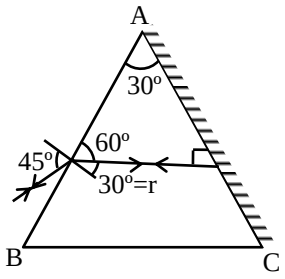
$$= \frac{2\sin\frac{A}{2}\cos\frac{A}{2}}{\sin\frac{A}{2}}$$

$$\mu = 2\cos\frac{A}{2}$$

$$\frac{3}{2} = 2\cos\frac{A}{2} \Rightarrow \cos\frac{A}{2} = 0.75 = \cos 41^\circ$$

$$\frac{A}{2} = 41^\circ \ \therefore \ \boxed{A = 82^\circ}$$

Q.14 The face AC of a prism ABC of refracting angle 30° is silvered. A ray is incident on face AB at an angle of 45° as shown in figure. The refracted ray undergoes reflection at face AC and retraces its path. The refractive index of the prism is-



(A) $\sqrt{2}$ (B) $\sqrt{\frac{3}{2}}$

(C) $\frac{3}{2}$ (D) $\frac{4}{3}$ **[A]**

Q.15 In a thin prism of glass (refractive index 1.5), which of the following relations between the angle of minimum deviations δ_m and angle of refraction r will be correct ?

(A) $\delta_m = r$ (B) $\delta_m = 1.5r$

(C) $\delta_m = 2r$ (D) $\delta_m = \frac{r}{2}$ **[A]**

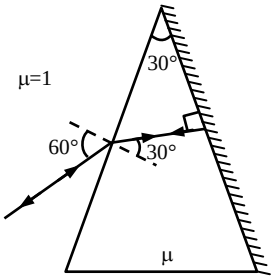
Sol. For minimum deviation $r = \frac{A}{2} \Rightarrow A = 2r$

$\delta_m = (\mu - 1)A = (1.5 - 1) \times 2r \ \therefore \boxed{\delta_m = r}$

Q.16 One of the refracting surfaces of a prism of angle 30° is silvered. A ray of light incident at an angle of 60° retraces its path . The refractive index of the material of the prism is -

(A) $\sqrt{2}$ (B) $\sqrt{3}$ (C) 3/2 (D) 2 **[B]**

Sol.



$1 \sin 60° = \mu \sin 30°$

$\therefore \mu = \sqrt{3}$

Q.17 A parallel beam of monochromatic light is incident on one face of an equilateral prism, the angle of incidence being 55°. The angle of emergence of the beam from the other face is 46° .The angle of minimum deviation is -

(A) less than 41º

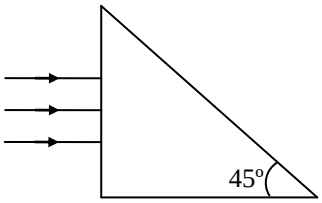
(B) equal to 41º

(C) greater than 41º

(D) greater than of equal to41º

[A]

Q.18 A beam of light consisting of red, green and blue colours is incident on an isosceles right angled prism as shown in the figure .The refractive indices of the material of the prism for red, green and blue colours are 1.39,1.43 and 1.47 respectively. The prism will –



A) separate red colour from green and blue colours.

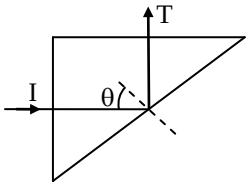
(B) separate blue colour from red and green colours

(C) separate green colour from, red and blue colours.

(D) separate all the three colours from one another

[A]

Q.19 A triangular prism of glass is shown in figure. A ray incident normal to one face is totally reflected.If θ is 45°, then index of refraction of the glass is-



(A) less than 1.41 (B) equal to 1.41

(C) greater then 1.41 (D) None of these

[C]

Q.20 The critical angle of a prism is 36º. The maximum angle of prism for which an emergent ray is possible is-

(A) 72º (B) 54º (C) 36º (D) 16º

Sol. **[A]**

For an emergent ray, $A \le 2\, i_c$

$\therefore A \le 2 \times 36º$

$\therefore A \le 72º$

Q.21 If the refracting angle of a prism is 60º and minimum deviation 30º, the angle of incidence will be :

(A) 30º (B) 45º

(C) 60º (D) 90º **[B]**

Q.22 A ray of light passes through an equilateral glass prism in such a manner that the angle of incidence is equal to the angle of emergence and each of these angles is equal to (3/4) of the angle of prism .The angle of deviation is :

(A) 40º (B) 70º

(C) 39º (D) 30º **[D]**

Q.23 When a beam of white light passes through a prism it splits up into different colours, violet is bent most because :

(A) μ of glass for violet rays is smaller than for other rays

(B) μ of glass for violet rays is greater than for other rays

(C) μ is same for all colours but violet rays have smaller wavelength

(D) μ is same for all colours but violet rays have longer wavelength **[B]**

Q.24 The deviation produced by a prism is :

(A) Same for all wavelengths

(B) Greatest for red and least for violet

(C) Greatest for violet and least for red

(D) The prism produces no deviation **[C]**

Q.25 Yellow light is refracted through a prism producing minimum deviation. If i_1 and i_2 denote the angle of incidence and emergence for the light then :

(A) $i_1 = i_2$ (B) $i_1 > i_2$

(C) $i_1 < i_2$ (D) $i_1 + i_2 = 90°$ **[A]**

Q.26 A small angle prism has a prism angle |A| = 4° and refractive index = 1.5.It is placed with its base horizontal in front of a vertical mirror. A horizontal ray of light passes through the prism and is reflected back from the mirror. By what angle the mirror should be rotated so that the reflected ray becomes horizontal ?

(A) 1º (B) 3º (C) 6º (D) 9º

[A]

Q.27 A ray is incident at an angle of incidence i on one face of a prism of small angle A and emerges normally from the opposite surface. If the refractive index of the material of the prism is μ, the angle of incidence i is nearly equal to :

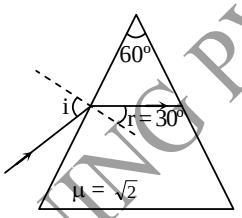
(A) A/μ (B) A/2μ (C) μA D)μA/2

[C]

Q.28 Refractive index of prism material is $\sqrt{2}$ and angle of prism is 60º. The angle of incidence for minimum deviation is -

(A) 30º (B) 45º (C) 60º (D) 90º

Sol.[B]

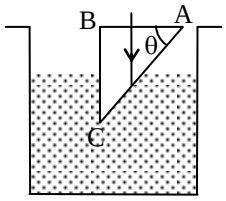


$r = \frac{A}{2} = 30º$

$\sin i = \sqrt{2} \sin 30º$

$\therefore \quad i = 45º$

Q.29 A glass prism of refractive index 1.5 is immersed in water (μ = 4/3). Light beam incident normally on the face AB is totally reflected to reach the face BC if :



(A) $\sin\theta > 8/9$ (B) $2/3 < \sin\theta < 8/9$

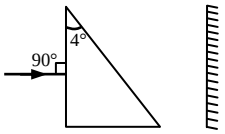
(C) $\sin\theta \le 2/3$ (D) $\cos\theta \ge 8/9$ **[A]**

Q.30 Deviation δ produced by a prism of refractive index μ and small angle A is given by :

(A) $\delta = (\mu - 1) A$ (B) $\delta = (\mu + 1) A$

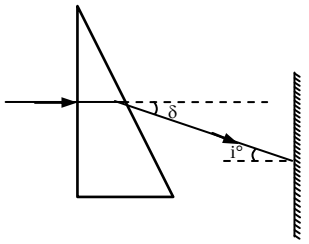
(C) $\delta = (A - 1) \mu$ (D) $\delta = (A + 1) \mu$ **[A]**

Q.31 A prism having an apex angle 4° and refractive index 1.5 is located in front of a vertical plane mirror as shown in figure. Through what total angle is the ray deviated after reflection from the mirror ?



(A) 176° (B) 4° (C) 178° (D) 2° **[C]**

Sol.



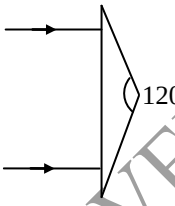
$\delta = (\mu - 1)\, A = (1.5 - 1)\, 4 = 2°$

Deviation by mirror = $180 - \angle i = 176°$

$\therefore$ Total deviation = 2 + 176

= 178°

Q.32 An isosceles prism of prism angle 120º has a refractive index of 1.44. Two parallel monochromatic rays enter the prism parallel to each other in air as shown in figure. The rays emerging from the opposite face **[IIT-JEE 95]**



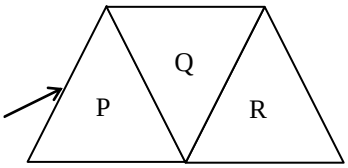
(A) Are parallel to each other

(B) Are diverging

(C) Make an angle $2 \sin^{-1}(0.72)$ with each other

(D) Make an angle $2[\sin^{-1}(0.72) - 30º]$ with each other **[D]**

Q.33 A given ray of light suffers minimum deviation in an equilateral prism P. Additional prisms Q and R of identical shape and of the same material as P are now added as shown in the figure. The ray will now suffer **[IIT-JEE 2001]**



(A) greater deviation

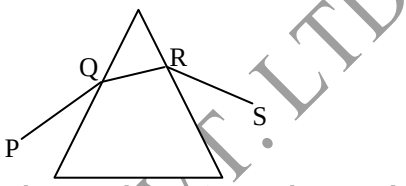
(B) no deviation

(C) same deviation as before

(D) total internal reflection **[C]**

Q.34 A light ray PQRS is passed through an equilateral prism then in case of minimum deviation.

[IIT Scr. - 2004]



(A) PQ is horizontal (B) QR is horizontal

(C) RS is horizontal (D) none of these **[B]**

Q.35 Two beams of red and violet colours are made to pass separately through a prism (angle of the prism is 60°). In the position of minimum deviation, the angle of refraction will be –

[IIT-JEE 2008]

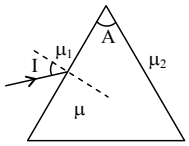
(A) 30° for both the colours

(B) greater for the violet colour

(C) greater for the red colour

(D) equal but not 30° for both the colours **[A]**

Q.36 A thin prism has different medium on its either side. A light ray is incident almost normally on the first face. What is the angle of deviation if all the angles are very small –



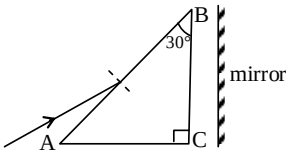
(A) $I\left(1-\frac{\mu_1}{\mu_2}\right)-A\left(1-\frac{\mu}{\mu_2}\right)$

(B) $I\left(1-\frac{\mu_1}{\mu_2}\right)+A\left(1-\frac{\mu}{\mu_2}\right)$

(C) $I\left(1+\frac{\mu_1}{\mu_2}\right)-A\left(1-\frac{\mu}{\mu_2}\right)$

(D) None of these **[C]**

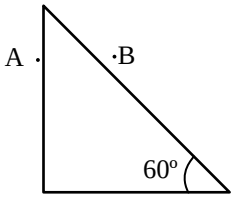
Q.37 Figure shows a right angled prism with refractive index $\frac{2}{\sqrt{3}}$. A light ray is incident at almost 90° on the inclined face. Find the deviation suffered by after it passes through prisms for the second time.



(A) 60° (B) 30°

(C) 90° (D) 180° **[C]**

Q.38 A right angled prism is placed on a printed page as shown in figure. observer A look through the vertical face while the observer B looks through the inclined face. Identify the correct statement.



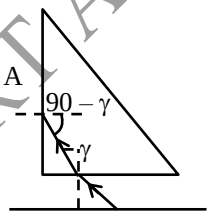
(A) If A is able to see the letters on the page then B will also see the letter

(B) If B is able to see the letters then A will also see letter.

(C) Both can see if the prism is made of glass $\mu = 1.5$

(D) Both can see whatever the refractive index of prism is

Sol. **[A]**



A can not see if ray will go for total internal reflection at vertical face.

$\therefore (90 - \gamma)_{minmum} > \theta_c$

$(90 - \gamma)_{min}$: $90 - \gamma_{max}$

$90 - \gamma_{max} > \theta_c$

$90 - \theta_c > \theta_c$

$45 > \theta_c$

$\text{Sin } 45 > \text{Sin } \theta_c = \mu > \sqrt{2}$

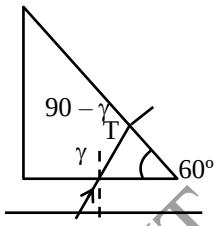
A can not see if $\mu > \sqrt{2}$

For B if he can not see then $60 - \gamma_{max} > \theta_c$

$60 - \theta_c > \theta_c$

$30 > \theta_c$

$\frac{1}{2} > \frac{1}{\mu}$



$\mu > 2$

B can not see if $\mu > 2$

Q.39 A beam of white light after passing through a prism produces a spectrum with seven colours. This is because:

(A) the prism converts white light into the light of seven colours

(B) the prism disperses white light into constituent components

(C) the colours are produced by the screen

(D) none of these **[B]**

Q.40 Minimum deviation suffered by red, yellow and violet beams passing through an equilateral transparent prism are 38.4°, 38.7° and 39.2° respectively. Calculate the dispersive power of the medium.

(A) 0.0206 (B) 0.00765

(C) 0.0130 (D) 0.206

Sol. **[A]**

$$\omega = \frac{\delta_V - \delta_R}{\delta_Y} = \frac{39.2° - 38.4°}{38.7°} = 0.0206$$

Q.41 In the position of minimum deviation, angle of emergence is:

(A) equal to the angle of incidence

(B) lesser than the angle of incidence

(C) greater than the angle of incidence

(D) equal to the angle of prism and the angle of incidence **[A]**

Q.42 If the refracting angle of a prism is 60° and minimum deviation 30°, the angle of incidence will be:

(A) 30° (B) 45°

(C) 60° (D) 90° **[B]**

Q.43 For a prism having prism angle 60° and $\mu = \sqrt{2}$, the angle of minimum deviation is:

(A) 30° (B) 45°

(C) 60° (D) 90° **[A]**

Q.44 A beam of monochromatic light is incident on one face of an equilateral prism, the angle of incidence being 55º. If the angle of emergence is 46º then the angle of minimum deviation is –

(A) 41° (B) < 41º (C) > 41º (D) ≥ 41º

Sol. **[B]**

$A = 60^\circ$; $i = 55^\circ$; $e = 46^\circ$

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

$55^\circ + 46^\circ = 60^\circ + \delta$

$\Rightarrow \quad \delta = 41^\circ \qquad \delta_{min} < \delta$

Q.45 A ray is incident at an angle of incidence i on one face of a prism of small angle A and emerges normally from the opposite surface. If the refractive index of the material of the prism is μ, the angle of incidence i is nearly equal to:

(A) A/μ (B) A/2μ

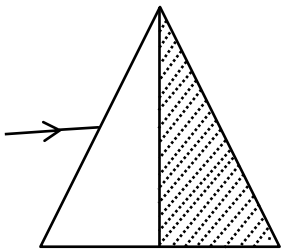
(C) μA (D) μA/2 **[C]**

Q.46 Angle of a prism is A and its one surface is silvered. Light rays falling at an angle of incidence 2A on the first surface return back through the same path after suffering reflection at the second silvered surface. Refractive index of the material is:

(A) 2 sin A (B) 2 cos A

(C) (1/2) cosA (D) tanA **[B]**

Q.47 A ray of light when incident upon a prism suffers a minimum deviation of 39°. If the shaded half portion of the prism is removed, then the same ray will -



(A) suffer a deviation of 19.5°

(B) suffer a deviation of 39°

(C) not suffer any deviation

(D) will be totally internally reflected **[A]**

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

$\delta \propto A$

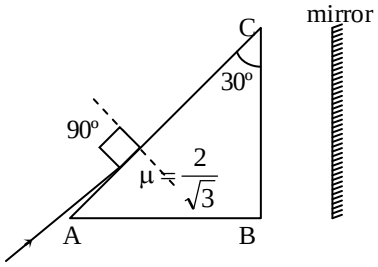
$\therefore \quad \dfrac{\delta_2}{\delta_1} = \dfrac{A_2}{A_1}$

$\therefore \quad \dfrac{\delta_2}{\delta_1} = \dfrac{A/2}{A} = \dfrac{1}{2}$

$\therefore \delta_2 = \dfrac{\delta_1}{2}$

$\delta_2 = \dfrac{39}{2} = 19.5^\circ$

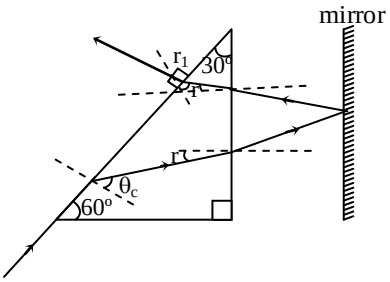
Q.48 A light ray is incident at almost 90º on the inclined face. Find the deviation suffered by after it passes through prisms for second time –



(A) 60º (B) 30º

(C) 90º (D) 180º **[C]**

Sol.



$$\sin 90^o = \frac{2}{\sqrt{3}} \sin \theta_c$$

$$\sin \theta_c = \frac{\sqrt{3}}{2} \quad \Rightarrow \ \theta_c = 60^o$$

$$30^o + 90^o - \theta_c + 90^o + r = 180^o$$

$$r = \theta_c - 30^o = 30^o$$

$$\therefore r_1 = 30^o - r = 0^o$$

so light will emerge out normally

Q.49 A crown glass prism of refracting angle 6º is to be used for deviation without dispersion with a flint glass of angle of prism α. Given: for crown glass μ_r = 1.513 and μ_v = 1.523, for flint glass μ_r = 1.645 and μ_v = 1.665. Find α.

(A) 3º (B) 4º

(C) 4.5º (D) 5º **[A]**

Sol. $(\mu_{V_1} - \mu_{r_1})\,\alpha_1 = (\mu_{v_2} - \mu_{r_2})\,\alpha_2$

$$\text{or } \alpha_2 = \frac{(1.523 - 1.513)}{(1.665 - 1.645)}\, 6^o = 3^o.$$

Q.50 A horizontal ray of light passes through a prism of index 1.50 and apex angle 4º and then strikes a vertical mirror, as shown in the figure (a). Through what angle must the mirror be rotated if after reflection the ray is to be horizontal?

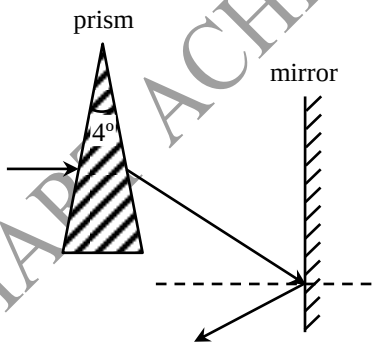


Fig. (a)

(A) 1º (B) 2º

(C) 2.5º (D) 1.5º **[A]**

Sol. As the apex angle is very small (α = 4º), the angle of deviation & can be obtained approximately:

$\delta = (n - 1)\alpha = (1.5 - 1) \times 4^o = 2^o$.

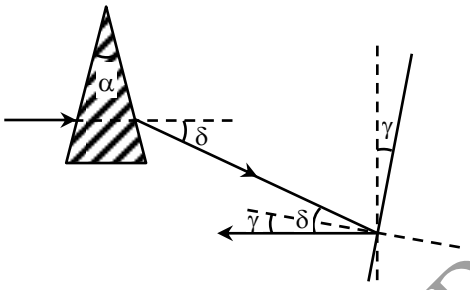


Fig. (b)

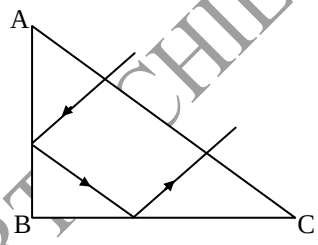
From Fig. (b) we see that if the reflected ray is to be horizontal, the mirror must be rotated clockwise through an angle γ given by

$$\gamma = \frac{\delta}{2} = 1^o$$

Q.1 A prism made of glass of refractive index 1.5 has a refracting angle of 50º, the other angles are equal. Light is incident normally on one of the face which encloses the refracting angle and then falls on the other face enclosing the same angle. Trace the path of light through the prism and calculate the angle of deviation. **[87º51]**

Q.2 (a) At what values of the refractive index of a rectangular prism can a ray travel as shown in Fig. The section of the prism is an isosceles triangle and the ray is normally incident onto the face AC.

(b) A right angled prism ABC has angle BAC equal to angle ACB and each 45º. It is made of glass of refractive index 1.60. A ray of light is incident upon the hypotenuse AC so that after refraction it strikes face AB and emerges at minimum deviation. What is the angle of incidence on AC ? What is the smallest angle of incidence on AC for which the ray can still emerge at AB ? If the angle of incidence upon AC is made zero, what will be the total deviation of the ray ?



[(a) $\mu > \sqrt{2}$ (b) 37º45′, 10º8′, 180º]

Q.3 The path of a ray of light passing through an equilateral glass prism ABC is shown in Fig.

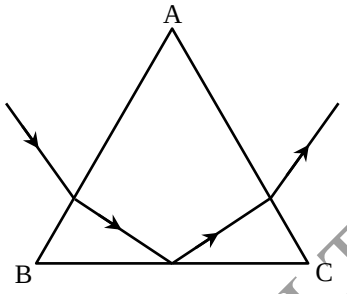


Fig. (a)

The ray of light is incident on face BC at the critical angle for just total internal reflection. The total angle of deviation after the refraction at face AC is 108º. Calculate the refractive index of the glass.

Sol. In the figure shown,

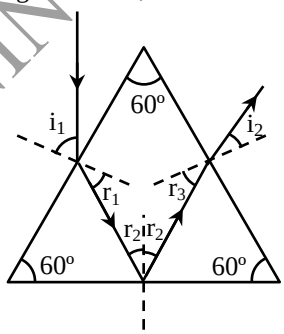


Fig. (b)

$r_2 = C$

$r_1 = 60 - r_2 = 60 - C$

$r_3 = 60 - r_2 = 60 - C$

$r_1 = r_3 = r$ (say)

$i_1 = i_2 = i$ (say)

Net deviation, $\delta = (i - r) + (180 - 2r_2) + (i - r)$

$= 180º$

or $r_2 + r - i = 36º$

or $C + 60 - C - i = 36º$

or $i = 24º$, $\sin 24º \simeq 0.40$

From Snell's law, we have

$\text{Sin } 24º = \mu \sin r$

or $0.4 = \mu \sin (60º - C)$

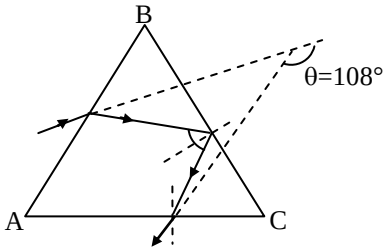
or $0.4 = \mu \left[\frac{\sqrt{3}}{2} \cos C - \frac{1}{2\mu} \right]$

or $0.8 = \sqrt{3}\mu \sqrt{1 - \frac{1}{\mu^2}} - 1$

or $\mu^2 - 1 = 1.08$

or $\mu = 1.447$

Q.4 The path of a ray of light passing through an equilateral glass prism ABC is shown in the figure. The ray of light is incident on face BC at the critical angle for just total internal reflection. The total angle of deviation after the refraction at face AC is 108º. Calculate the refractive index of the glass.



[1.45]

Q.5 Two prisms of identical geometrical shape are combined with their refracting angles oppositely directed. The materials of the prisms have refractive indices 1.52 and 1.62 for violet light. A violet ray is deviated by 1.0º when passes symmetrically through this combination. What is the angle of the prisms ? **[10º]**

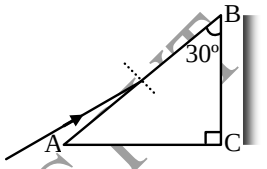
Q.6 The dispersive power of crown and flint glasses are 0.03 and 0.05 respectively. The refractive indices for yellow light for these glasses are 1.517 and 1.621 respectively. It is desired to form an achromatic combination of prisms of crown and flint glasses which can produce a deviation of 1º in the yellow ray. Find the refracting angles of the two prisms needed.

[A_{crown} = 4.8º, A_{flint} = 2.4º]

Q.7 A thin prism of angle 6.0º, $\omega = 0.07$ and $\mu_y = 1.50$ is combined with another thin prism having $\omega = 0.08$ and $\mu_y = 1.60$. The combination produces no deviation in the mean ray. (a) Find the angle of the second prism. (b) Find the net angular dispersion produced by the combination when a beam of white light passes through it. (c) If the prisms are similarly directed, what will be the deviation in the mean ray ? (d) Find the angular dispersion in the situation described in (c).

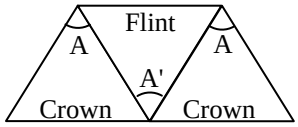
[(a) 5º (b) 0.03º (c) 6º (d) 0.45º]

Q.8 Figure shows a right angled prism with refractive index $\frac{2}{\sqrt{3}}$. A light ray is incident at almost 90º on the inclined face. Find the deviation suffered by after it passes through prisms for the second time.



Sol. 90º

Q.9 Three thin prisms are combined as shown in figure. The refractive indices of the crown glass for red, yellow and violet rays are μ_r, μ_y and μ_υ respectively and those for the flint glass are μ'_r, μ'_y and μ'_υ respectively. Find the ratio A'/A for which (a) there is no net angular dispersion, and (b) there is no net deviation in the yellow ray.



[(a) $\frac{2(\mu_V - \mu_r)}{\mu_v - \mu_r}$ (b) $\frac{2(\mu_y - 1)}{\mu_y - 1}$]

Q.10 The refractive index of the material of a prism has values μ_1, μ_2 and μ_3 respectively for light of three different wavelengths. If δ_1, δ_2 and δ_3 are the corresponding angles of minimum deviation for a given prism, and these angles are in arithmetical progression, prove that

$$\frac{\mu_1 + \mu_3}{\mu_2} = \frac{\sin\frac{\delta_1}{2} + \sin\frac{\delta_3}{2}}{\sin\frac{\delta_2}{2}}$$

Sol. For minimum deviation,

$$\mu_1 = \frac{\sin\frac{A + \delta_1}{2}}{\sin\frac{A}{2}}$$

$$\mu_2 = \frac{\sin\frac{A+\delta_2}{2}}{\sin\frac{A}{2}}$$

$$\mu_3 = \frac{\sin\frac{A+\delta_3}{2}}{\sin\frac{A}{2}}$$

$$\therefore \frac{\mu_1+\mu_3}{\mu_2} = \frac{\sin\frac{A+\delta_1}{2}+\sin\frac{A+\delta_3}{2}}{\sin\frac{A+\delta_2}{2}}$$

$$= \frac{2\sin\frac{2A+\delta_1+\delta_3}{4}\cos\frac{\delta_1-\delta_3}{4}}{\sin\frac{A+\delta_2}{2}}$$

Since δ_1, δ_2 and δ_3 are in A.P.

$\therefore 2\delta_2 = \delta_1 + \delta_3$

$$\therefore \frac{\mu_1+\mu_3}{\mu_2} = \frac{2\sin\frac{2A+\delta_2}{2}\cos\frac{\delta_1-\delta_3}{2}}{\sin\frac{A+\delta_2}{2}} = \quad 2\cos\frac{\delta_1-\delta_3}{4}$$

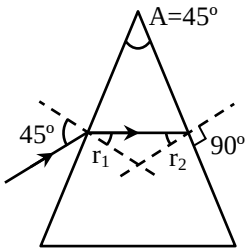
Multiplying and dividing by $\sin\frac{\delta_1+\delta_3}{4}$, we get

$$\frac{\mu_1+\mu_3}{\mu_2} = \frac{2\sin\frac{\delta_1+\delta_3}{4}\cos\frac{\delta_1-\delta_3}{4}}{\sin\frac{\delta_1+\delta_2}{4}} = \frac{\sin\frac{\delta_1}{2}+\sin\frac{\delta_3}{2}}{\sin\frac{\delta_2}{2}}$$

Q.11 The refracting angle of a prism is equal to $\pi/2$. It is given that γ is the angle of minimum deviation and β is the deviation of the ray at grazing incidence. Prove that $\sin\gamma = \sin^2\beta$ and $\cos\gamma = \mu\cos\beta$

Sol. $\left[\alpha = r_1 + r_2 = \sin^{-1}\frac{\sin 2\alpha}{n} + \sin^{-1}\frac{\sin\alpha}{n}\right]$

Q.12 In an isosceles prism of angle 45º, it is found that when the angle of incidence is same as the prism angle, the emergent ray grazes the emergent surface. Find the refractive index of the material of the prism. For what angle of incidence, the angle of deviation will be minimum?



Sol. As the ray of light grazes the second surface, r_2 is the critical angle,

i.e., $\sin r_2 = \frac{1}{\mu}$

$r_2 = (45^\circ - r_1)$

and $\sin r_1 = \frac{\sin 45^\circ}{\mu} = \frac{1}{\sqrt{2}\mu}$

$\sin r_2 = \sin(45^\circ - r_1)$

$= \frac{1}{\sqrt{2}}[\cos r_1 - \sin r_1]$

$$\frac{1}{\mu} = \frac{1}{\sqrt{2}}\left[\sqrt{1-\frac{1}{2\mu^2}} - \frac{1}{\sqrt{2}\mu}\right]$$

or $$\frac{1}{\mu} = \frac{1}{\sqrt{2}}\left[\frac{\sqrt{2\mu^2-1}}{\sqrt{2}\mu} - \frac{1}{\sqrt{2}\mu}\right]$$

or $2 = \sqrt{2\mu^2-1} - 1$

or $2\mu^2 - 1 = 9$

$2\mu^2 = 10$

$\mu^2 = 5$ or $\mu = \sqrt{5}$

At minimum deviation,

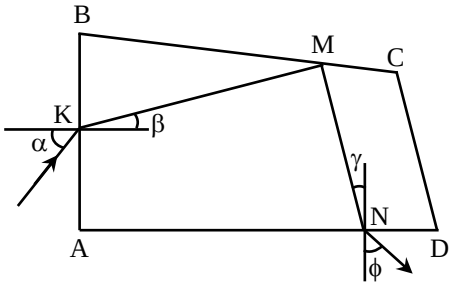
$r_1 = r_2 = \frac{45^\circ}{2} = 22.5^\circ$

$\mu = \frac{\sin i_1}{\sin r_1} \Rightarrow \sin i_1 = (\sqrt{5})\sin(22.5^\circ)$

$\therefore i_1 = 58.8^\circ$

Q.13 The faces of prism ABCD made of glass with a refraction index **n** form dihedral angles: $\angle A = 90^\circ$, $\angle B = 75^\circ$, $\angle C = 135^\circ$ and $\angle D = 60^\circ$ (the Abbe prism). A beam of light falls on face AB and after complete internal reflection from face BC escapes through face AD. Find the angle of incidence α of the beam onto face AB if a beam that has passed through the prism is perpendicular to the incident beam.

Sol. According to the initial condition, the incident beam and the beam that has passed through the prism are mutually perpendicular. Therefore, $\angle\phi = \angle\alpha$ and also $\angle\gamma = \angle\beta$ (Fig.).



The sum of the angles of the quadrangle AKMN is 360º. Therefore, ∠KMN = 90º and beam KM is incident on to face BC at an angle of 45º. If we know the angles of triangle KBM, it is easy to find that β = 30º. In conformity with the law of refraction, $\frac{\sin\alpha}{\sin\beta} = n$.

Hence, sin α = 0.5n andarc sin 0.5n
Since full internal reflection at an angle of 45º is observed only when $n \geq \sqrt{2}$, the angle α is within 45º ≤ α ≤ 90º.

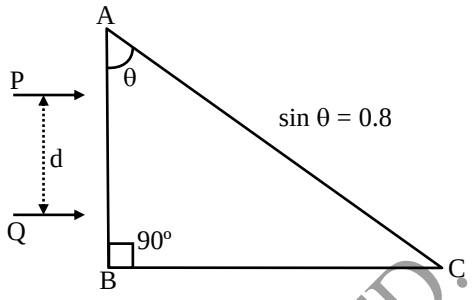
Q.14 A ray of light passes through a prism such that its deviation is equal to the angle of incidence which again is equal to 2α. It is given that α is the angle of prism. Show that $\cos^2\alpha = \frac{\mu^2 - 1}{8}$, where μ is the refractive index of the material of prism.

[3.024×10^{-4} radi]

Q.15 Two parallel beams of light P and Q (separation d) containing radiations of wavelengths 4000 Å and 5000 Å (which are mutually coherent in each wavelength separately) are incident normally on a prism as shown in Fig. The refractive index of the prism as a function of wavelength is given by the relation

$$\mu(\lambda) = 1.20 + \frac{b}{\lambda^2}$$

where λ is in Å and b is a positive constant. The value of b is such that the condition for total reflection at the face AC is just satisfied for one wavelength and is not satisfied for the other.

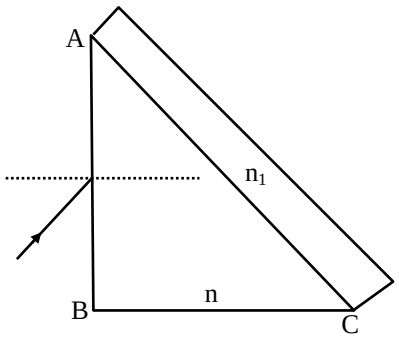


(a) Find the value of b.

(b) Find the deviation of the beams transmitted through the face AC. **[IIT-JEE 91]**

[(a) 0.8×10^6 Å^2 (b) $\sin^{-1}(0.9856) - \sin^{-1}(0.8) \approx 27^\circ$]

Q.16 A right angle prism (45º – 90º – 45º) of refractive index n has a plate of refractive index n_1 ($n_1 < n$) cemented to its diagonal face. The assembly is in air. A ray is incident on AB (Fig.).



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

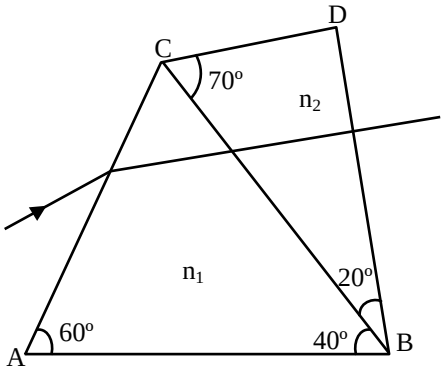
(b) Assuming n = 1.352, calculate the angle of incidence at AB for which the refracted ray passes through the diagonal face undeviated. **[IIT-JEE 96]**

[(i) $i = \sin^{-1}\left[n\sin\left(45^\circ - \sin^{-1}\frac{n_1}{n}\right)\right]$

(ii) $i = \sin^{-1}(0.9562) = 72.9^\circ$]

Q.17 A prism of refractive index n_1 and another prism of refractive index n_2 are stuck together without a gap as shown in fig. The angles of the prisms are as shown, n_1 and n_2 depend on λ, the wavelength of light according $n_1 = 1.20 + (10.8 \times 10^4/\lambda^2)$

and $n_2 = 1.45 + (1.80 \times 10^4/\lambda^2)$, where λ is in nm.



(a) Calculate the wavelength λ_0, for which rays incident at any angle on the interface BC pass through without bending at that interface.

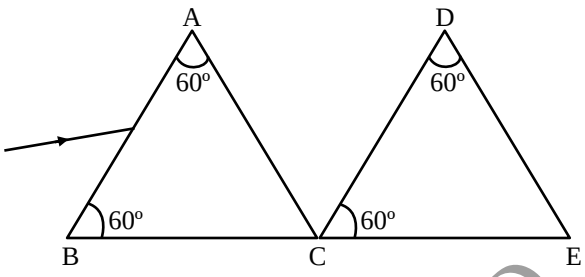
(b) For light of wavelength λ_0, find the angle of incidence i on the face AC such that the deviation produced by the combination of prisms is minimum. **[IIT-JEE 98]**

[(i) λ_0 = 600 nm (ii) i = $\sin^{-1}$ (3/4) = 48.6°]

Q.18 The refractive indices of the crown glass for blue and red lights 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. **[IIT-2001]**

[4°, –0.039°]

Q.19 Two equilateral prisms of refractive index $\sqrt{3}$ are kept side by side as shown in figure A light ray strikes the first prism at face AB. Find



(a) The angle of incident for the minimum deviation of emergent ray from the first prism

(b)By what angle the prism DCE should be rotated about C to get the minimum deviation of final emergent ray from the face DE.

[IIT-JEE 2005]

Sol. (a) i = 60°

(b)For minimum deviation, if the prism is rotated by an angle 60° to the anticlockwise, then both the prism will act as a glass slab and the deviation will be zero.]

Q.20 The refracting angle of a prism is A and it produces a minimum deviation of **180 – 4A**. Show that the refracting index of the material of prism is given by

$$\mu = \left[\frac{1-3\tan^2\frac{A}{2}}{\tan\frac{A}{2}+\tan^3\frac{A}{2}}\right]$$

Sol. We know that in minimum deviation, refractive index is given by

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

As, $\delta_m = 180 - 4A$

$\therefore \mu$

$$= \frac{\sin\left(\frac{180+3A}{2}\right)}{\sin\frac{A}{2}} = \frac{\sin\left(90-\frac{3A}{2}\right)}{\sin\frac{A}{2}} = \frac{\cos\frac{3A}{2}}{\sin\frac{A}{2}} =$$

$$\left[\frac{4\cos^3\frac{A}{2}-3\cos\frac{A}{2}}{\sin\frac{A}{2}}\right]$$

$$= \frac{\left(4\cos^2\frac{A}{2}-3\right)}{\tan\frac{A}{2}} =$$

$$\frac{\left[4\cos^2\frac{A}{2}-3\left(\sin^2\frac{A}{2}+\cos^2\frac{A}{2}\right)\right]}{\tan\frac{A}{2}}$$

$$= \left(\frac{\cos^2\frac{A}{2}-3\sin^2\frac{A}{2}}{\tan\frac{A}{2}}\right) = \left(\frac{1-3\tan^2\frac{A}{2}}{\sec^2\frac{A}{2}\tan\frac{A}{2}}\right) =$$

$$\left(\frac{1-3\tan^2\frac{A}{2}}{\tan\frac{A}{2}+\tan^3\frac{A}{2}}\right)$$