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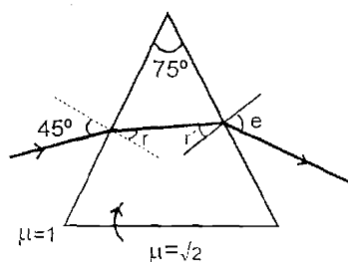
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Q 1. Find the value of  $\angle r$  for the case shown in figure



- (a)  $\sin^{-1}(0.5)$       (b)  $75^\circ - \sin^{-1}(0.5)$   
 (c)  $90^\circ$               (d)  $60^\circ$

Q 2. A ray of light is normally incident on one face of an equilateral glass prism ( $\mu = \sqrt{2}$ ). What is the angle of refraction from the first face of the prism ?

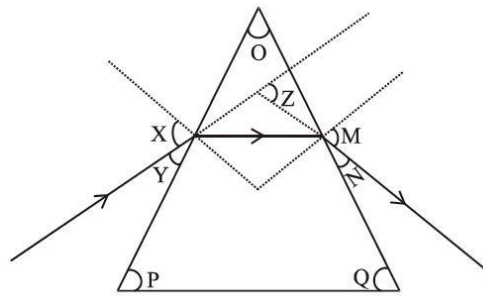
- (a)  $0^\circ$                       (b)  $30^\circ$   
 (c)  $45^\circ$                     (d)  $90^\circ$

Q 3. The critical angle between an equilateral prism and air is  $45^\circ$ . If the incident ray is perpendicular to the refracting surface, then

- (a) After deviation it will emerge from the second refracting surface  
 (b) It is totally reflected on the second surface and emerges out perpendicularly from third surface in air  
 (c) It is totally reflected from the second and third refracting surfaces and finally emerges out from the first surface  
 (d) It is totally reflected from all the three sides of prism and never emerges out

Q 4. The path of a ray of light passing through a glass prism is shown below :

In this diagram the angle of prism, angle of incidence, angle of emergence and angle of deviation respectively have been represented by:



- (a) O, Y, Z and N
- (b) P, Y, M and Z
- (c) O, X, M and Z
- (d) P, X, Z and N

Q 5. For glass prism ( $\mu = \sqrt{3}$ ), the angle of minimum deviation is equal to the angle of prism. The angle of prism is:

- (a)  $30^\circ$
- (b)  $45^\circ$
- (c)  $60^\circ$
- (d)  $90^\circ$

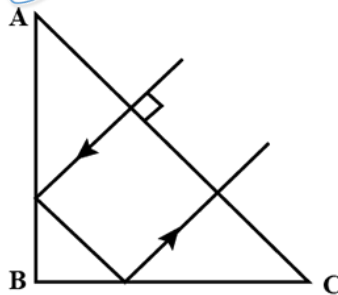
Q 6. A glass prism of refracting angle  $60^\circ$  gives a minimum deviation of  $30^\circ$ . What is the refractive index of the glass -

- (a) 1.2
- (b)  $\sqrt{2}$
- (c)  $\frac{1}{\sqrt{2}}$
- (d) can not be determined

Q 7. Calculate the deviation produced by a prism of angle 8 degree, for a material of refractive index 1.5

- (a)  $1^\circ$
- (b)  $2^\circ$
- (c)  $4^\circ$
- (d)  $8^\circ$

Q 8. A ray falls on a prism ABC ( $AB = BC$  &  $\angle B = 90^\circ$ ) and travels as shown in figure. The minimum refractive index of the prism material should be

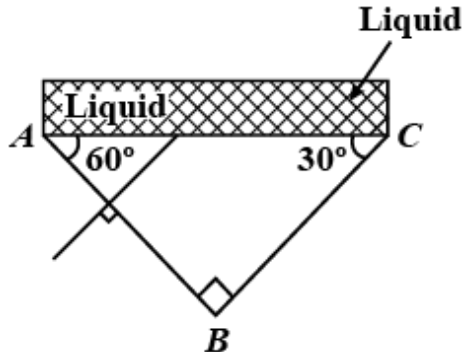


- (a)  $\frac{4}{3}$
- (b)  $\sqrt{2}$
- (c) 1.5
- (d)  $\sqrt{3}$

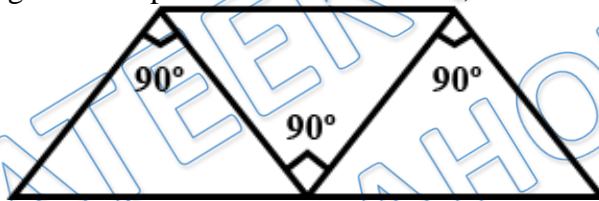
Q 9. A ray of light is incident normally on one of the faces of a prism of apex angle  $30^\circ$  and refractive index  $\sqrt{2}$ . The angle of deviation of the ray is ..... degrees.

- (a)  $15^\circ$
- (b)  $30^\circ$
- (c)  $45^\circ$
- (d)  $60^\circ$

- Q 10. Light is incident normally on face AB of a prism as shown in Figure. A liquid of refractive index  $\mu$  is placed on face AC of the prism. The prism is made of glass of refractive index  $3/2$ . Find the limits of  $\mu$  for which total internal reflection takes place on the face AC



- (a)  $\mu < \frac{3\sqrt{3}}{4}$                       (b)  $\mu < \sqrt{\frac{5}{2}}$   
 (c)  $\mu > \sqrt{2}$                       (d)  $\mu < \sqrt{3}$
- Q 11. Three right angled prisms of refractive indices  $\mu_1$ ,  $\mu_2$  and  $\mu_3$  are joined together so that the faces of the middle prism are each in contact with one of the outside prisms. If the ray passes through the composite block un deviated, then



- (a)  $1 + \mu_2^2 = \mu_1^2 + \mu_3^2$   
 (b)  $\mu_1^2 - \mu_3^2 + \mu_2^2 = 1$   
 (c)  $\mu_1^2 - \mu_3^2 - \mu_2^2 = 1$   
 (d)  $\mu_2^2 + \mu_3^2 - \mu_1^2 = 1$
- Q 12. The ratio of angle of minimum deviation of a thin prism in air and when dipped in water will be ( ${}_a\mu_g = 3/2$  and  ${}_a\mu_w = 4/3$ )
- (a) 4 : 1                      (b) 1 : 2  
 (c) 1 : 8                      (d) 4 : 3

- Q 13. The angle of minimum deviation for a prism is  $40^\circ$  and the angle of the prism is  $60^\circ$ . The angle of incidence in this position will be
- (a)  $15^\circ$                       (b)  $30^\circ$   
 (c)  $50^\circ$                       (d)  $60^\circ$

- Q 14. A ray of light is incident at an angle of  $60^\circ$  on one face of a prism of angle  $30^\circ$ . The ray emerging out of the prism makes an angle of  $30^\circ$  with the incident ray. The emergent ray is
- (a) Normal to the face through which it emerges  
 (b) Inclined at  $30^\circ$  to the face through which it emerges  
 (c) Inclined at  $60^\circ$  to the face through which it emerges  
 (d) None of these



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## Answer Key

<b>Q.1 a</b>	<b>Q.2 a</b>	<b>Q.3 b</b>	<b>Q.4 c</b>	<b>Q.5 c</b>
<b>Q.6 b</b>	<b>Q.7 c</b>	<b>Q.8 b</b>	<b>Q.9 a</b>	<b>Q.10 a</b>
<b>Q.11 a</b>	<b>Q.12 a</b>	<b>Q.13 c</b>	<b>Q.14 a</b>	

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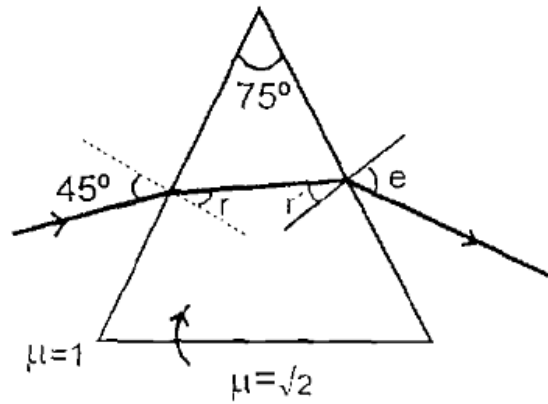


# Written Solution

**DPP-10 Geometrical Optics: Prism**

**By Physicsaholics Team**

Solution: 1



$$\mu_1 \sin i = \mu_2 \sin r$$

$$1 \times \sin 45^\circ = \sqrt{2} \sin r$$

$$\frac{1}{\sqrt{2}} = \sqrt{2} \sin r$$

$$\Rightarrow \sin r = \frac{1}{2} = 0.5$$

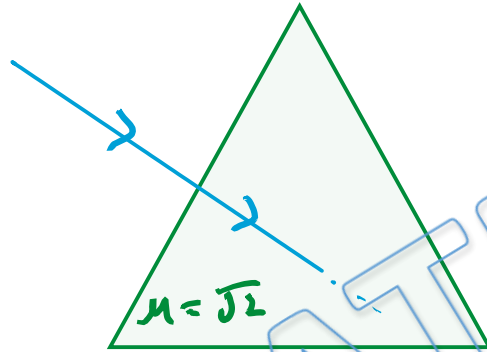
$$r = \sin^{-1}(0.5) = 30^\circ \quad \text{Ans}$$

Ans. a



Solution: 2

when light ray incident normally



$$i = 0$$

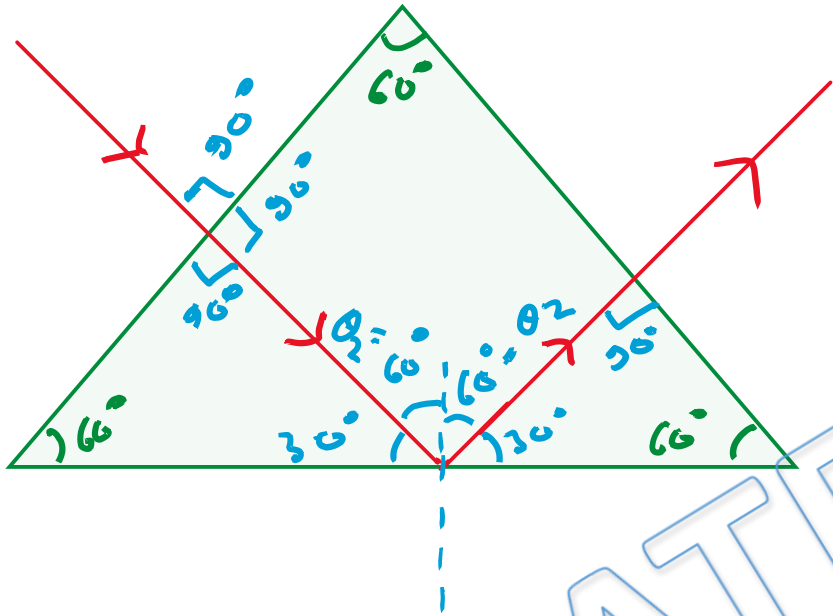
$$\rightarrow r = 0$$

Ans.

Ans. a



Solution: 3



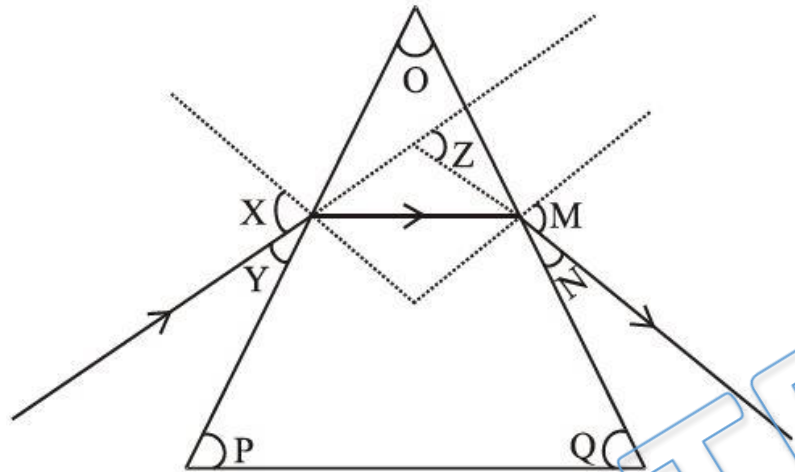
$$\therefore \theta_2 = 60^\circ > \theta_c (45^\circ)$$

So, TIR will take place at 2<sup>nd</sup> surface.

And then emerges out normally from 3<sup>rd</sup> surface.

Ans. b

## Solution: 4



Angle of prism =  $\angle O$ , (angle between two refracting surfaces)

Angle of incidence =  $\angle X$ , (angle between incident ray and normal),

Angle of emergence =  $\angle M$ , (angle between emergent ray and normal)

Angle of deviation =  $\angle Z$ , (angle between incident ray and emergent ray)

Solution: 5

then  $\sin h = A$

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

$$\Rightarrow \sqrt{3} = \frac{\sin \left( \frac{A+A}{2} \right)}{\sin A/2} = \frac{\sin A}{\sin A/2} = \frac{2 \sin A/2 \cos A/2}{\sin A/2}$$

$$\cos \frac{A}{2} = \frac{\sqrt{3}}{2}$$

$$\frac{A}{2} = 30^\circ$$

$$\boxed{A = 60^\circ} \text{ Ans.}$$

Ans. c

Solution: 6

$$\delta_{\min} = 30^\circ$$

$$A = 60^\circ$$

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

$$\mu = \frac{\sin\left(\frac{30+60}{2}\right)}{\sin\left(\frac{60}{2}\right)}$$

$$= \frac{\sin 45^\circ}{\sin 30^\circ} = \frac{1/\sqrt{2}}{1/2} = \frac{2}{\sqrt{2}}$$

$$\boxed{\mu = \sqrt{2}} \text{ Ans}$$

Ans. b

Solution: 7

for thin prism.

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

$$\delta = (1.5 - 1) (8^\circ)$$

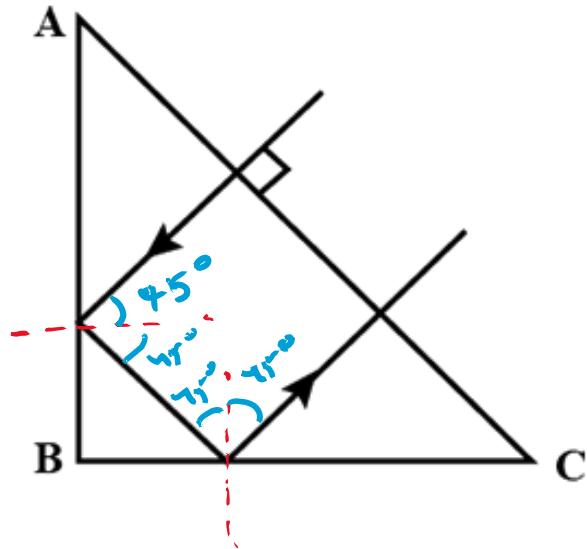
$$\delta = (0.5) (8^\circ)$$

$$\delta = 4^\circ \text{ Ans.}$$

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Ans. c

Solution: 8



$$\therefore \mu = \frac{1}{\sin \theta_c}$$

$$\text{So for } (\mu)_{\min}$$

$$\Rightarrow \sin \theta_c \Rightarrow \text{max.}$$

$$(\theta_c)_{\max} = 45^\circ \Rightarrow (\sin \theta_c)_{\max} = \frac{1}{\sqrt{2}}$$

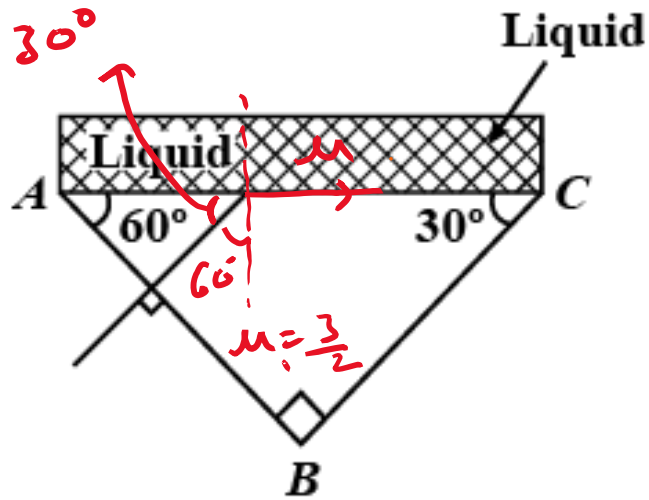
$$\Rightarrow \boxed{(\mu)_{\min} = \sqrt{2}} \text{ Ans}$$

Ans. b





Solution: 10



for TIR  $i$  critical angle

$$\frac{3}{2} \sin i_c = \mu \sin 90^\circ$$

$$\frac{3}{2} \sin i_c = \mu$$

$$\sin i_c = \frac{2\mu}{3}$$

$i \geq i_c$  for TIR.

$$\sin i \geq \sin i_c$$

$$\sin 60^\circ \geq \frac{2\mu}{3}$$

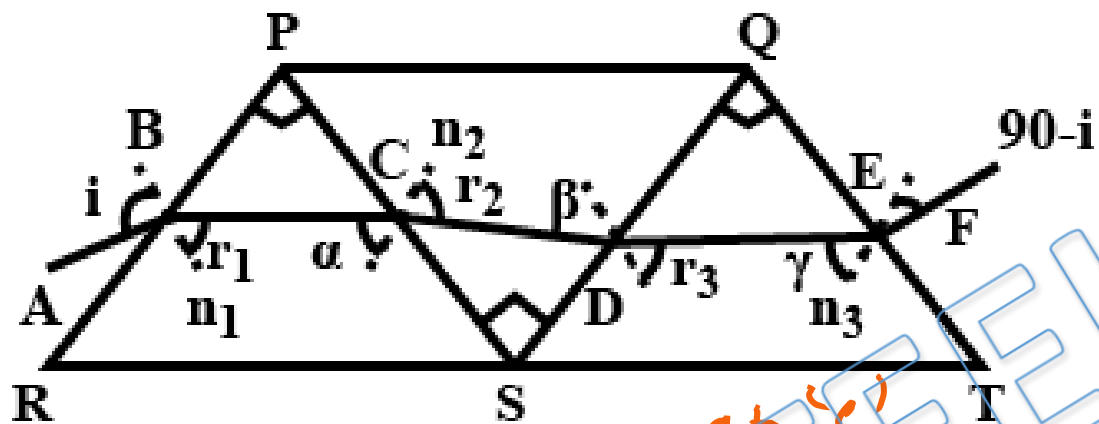
$$\frac{\sqrt{3}}{2} \geq \frac{2\mu}{3}$$

$$\mu \leq \frac{3\sqrt{3}}{4}$$

Ans.

Ans. a

Solution: 11



$$\alpha = 90 - r_1$$

$$\beta = 90 - r_2$$

$$r = 90 - r_3$$

at 'B'

$$1 \times \sin i = \mu_1 \sin r_1$$

$$\Rightarrow \sin^2 i = \mu_1^2 \sin^2 r_1 \quad \text{--- (1)}$$

at 'C'

$$\mu_1 \sin \alpha = \mu_2 \sin r_2$$

$$\mu_1 \sin(90 - r_1) = \mu_2 \sin r_2$$

$$\Rightarrow \mu_1^2 \cos^2 r_1 = \mu_2^2 \sin^2 r_2 \quad \text{--- (2)}$$

at 'D'

$$\mu_2 \sin \beta = \mu_3 \sin r_3$$

$$\mu_2 \sin(90 - r_2) = \mu_3 \sin r_3$$

$$\mu_2^2 \cos^2 r_2 = \mu_3^2 \sin^2 r_3 \quad \text{--- (3)}$$

at 'E'

$$\mu_3 \sin r = 1 \times \sin E$$

$$\mu_3 \sin(90 - r_3) = \sin(90 - i)$$

$$\mu_3^2 \cos^2 r_3 = \cos^2 i \quad \text{--- (4)}$$

$$\text{(1) + (4)} \Rightarrow \sin^2 i + \cos^2 i = \mu_1^2 \sin^2 r_1 + \mu_3^2 \cos^2 r_3$$

$$\Rightarrow 1 = \mu_1^2 \sin^2 r_1 + \mu_3^2 \cos^2 r_3 \quad \text{--- (5)}$$

$$\text{(1) + (2) + (3)}$$

$$1 + \mu_2^2 \sin^2 r_2 + \mu_2^2 \cos^2 r_2$$

$$= \mu_1^2 \sin^2 r_1 + \mu_3^2 \cos^2 r_3$$

$$+ \mu_1^2 \cos^2 r_1 + \mu_3^2 \sin^2 r_3$$

$$1 + \mu_2^2 = \mu_1^2 + \mu_3^2$$

$$\boxed{1 + \mu_2^2 = \mu_1^2 + \mu_3^2}$$

Ans.

Ans. a

Solution: 12

$$\delta_{\min} = (\mu - 1) A$$

$$\frac{\delta_a}{\delta_w} = \frac{(\mu_w - 1) A}{(\mu_a - 1) A}$$

$$\frac{\delta_a}{\delta_w} = \frac{(3/2 - 1)}{(3/8 - 1)} = \frac{1/2}{5/8}$$

$$\frac{\delta_a}{\delta_w} = \frac{4}{5} \text{ Ans.}$$

$$\mu_w = \frac{\mu_a}{\mu_w} = \frac{3/2}{4/3}$$

$$\mu_w = \frac{9}{8}$$

Ans. a

Solution: 13

at  $\delta_{\min}$

$$i = e$$

$$\therefore \delta_{\min} = 2i - A$$

$$40 = 2i - 60$$

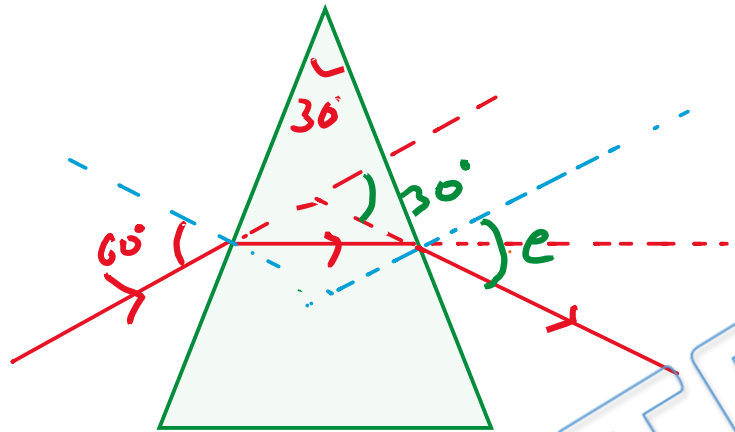
$$2i = 100$$

$$i = 50^\circ$$

Ans

Ans. c

Solution: 14



$$\therefore S = i + e - A$$
$$30^\circ = 60^\circ + e - 30^\circ$$

$$e = 0$$

$\Rightarrow$  if  $e = 0$ ,  $i$  is the angle with the normal at emerging face.  
So) angle with emerging face =  $90 - e = 90 - 0 = 90^\circ$

Ans. a

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