Q.1 If the critical angle for total internal reflection from a medium to vacuum is 30°, the velocity of light in the medium is -

(A) 3×10^8 m/s (B) 1.5×10^8 m/s

(C) 6×10^8 m/s (D) $\sqrt{3} \times 10^8$ m/s

[B]

Sol. $\sin i_c = \frac{1}{{}_r\mu_d} = \frac{\mu_r}{\mu_d} = \frac{v_d}{v_r}$

$\sin 30° = \frac{V_d}{3\times10^8} \Rightarrow v_d = 1.5 \times 10^8$ m/s

Q.2 A piece of glass is placed on a wood having letters of different colours. The letters of which colour will appear maximum raised

(A) Red (B) Green

(C) yellow (D) violet **[D]**

Sol. Raise = $h_{ac}\left(1-\frac{1}{\mu}\right)$

For Raise to be maximum, μ has to maximum

$\mu \propto \frac{1}{\lambda}$

Q.3 Light travels through a glass of thickness t and refractive index n. If c is the velocity of light in vacuum, the time taken by light to travel through the plate is :

(A) t/nc (B) ntc (C) nt/c (D) tc/n

[C]

Q.4 The velocity of light in air is $3\text{x}10^{10}$ cm /sec. If the refractive index of glass with respect to air is 1.5, then velocity of light in glass is :

(A) 2×10^{10} cm/sec

(B) 4.5×10^{10} cm /sec

(C) 3×10^{10} cm/sec

(D) 1×10^{10} cm /sec **[A]**

Q.5 The refractive index of water is (4/3) and that of glass is (3/2) .If the speed of light in glass is 2×10^{8} m/s. The speed of light in water will be :

(A) 1×10^8 m/s (B) $(9/4) \times 10^8$ m/s

(C) $(8/3) \times 10^8$m/s (D) $4 \text{x}10^8$ m/s

[B]

Q.6 Critical angle for total internal reflection of light of a certain frequency at a denser-rarer boundary is 30°. At what angle should the same light be incident on the boundary from the side of denser medium that the reflected and the refracted rays are mutually perpendicular ?

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

(C) $\cos^{-1}\left(\frac{2}{\sqrt{5}}\right)$ (D) $\cos^{-1}\left(\frac{1}{\sqrt{5}}\right)$ **[C]**

Sol. $\frac{1}{\mu} = \sin 30° = \frac{1}{2}$

$\mu = 2$

$2 \sin i = 1. \sin (90° – i)$

$\tan i = \frac{1}{2}$

$\Rightarrow \cos i = \frac{2}{\sqrt{1^2+2^2}} = \frac{2}{\sqrt{5}} \Rightarrow i = \cos^{-1}\left(\frac{2}{\sqrt{5}}\right)$

Q.7 Green light of wavelength 5460 Å is incident on an air glass interface. If the refractive index of the glass is 1.5, the wavelength of the light in the glass would -

(A) decreases to 3640 Å

(B) remain the same 5460Å

(C) decreases to 4861 Å

(D) increase to 8190 Å **[A]**

Sol. $\lambda_{glass} = \frac{\lambda_{air}}{\mu}$

$\therefore \lambda_{glass} = \frac{5460}{1.5}$ Å = 3640 Å

Q.8 A beam of light composed of red and green rays is incident obliquely at a point on the face of rectangular glass slab. When coming out on the opposite parallel face, the red and green rays emerge from -

(A) Two points propagating in two different non parallel direction

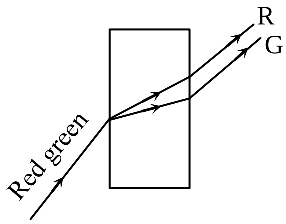
(B) Two points propagating in two different parallel directions

(C) One point propagating in two different directions

(D) One point propagating in the same directions

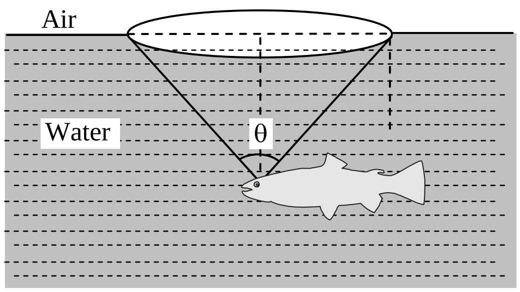
[B]

Sol.



Red and green light will emerge in two different points propagating in two different parallel directions

Q.9 A fish is a little away below the surface of a lake. If the critical angle is 49º, then the fish could see things above the water surface within an angular range of θº where



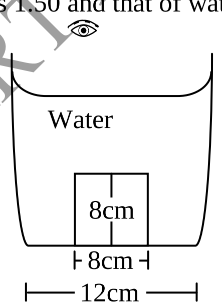
(A) θ = 49º (B) θ = 90º

(C) θ = 98º (D) θ = 24 $\frac{1^o}{2}$ **[C]**

Sol. According to figure in question

$\theta = 2C = 2 \times 49^o = 98^o$

Q.10 A cylindrical vessel of diameter 12 cm contains 800π cm^3 of water. A cylindrical glass piece of diameter 8.0 cm and height 8.0 cm is placed in the vessel. If the bottom of the vessel under the glass piece is seen by the paraxial rays (see figure), locate its image. The index of refraction of glass is 1.50 and that of water is 1.33.



(A) 2.1 cm (B) 7.1 cm

(C) 9.1 cm (D) 11.1 cm **[B]**

Q.11 Critical angle for light going from medium (1) to (2) is 60º. The speed of light in medium (1) is v ; then speed of light in medium (2) is -

(A) v/2 (B) $2v/\sqrt{3}$ (C) $\frac{\sqrt{3}}{2}$ v (D) 2v

Sol. **[B]**

$\sin i_c = \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} \quad \therefore \sin 60^o = \frac{v}{v_2}$

$\therefore v_2 = v/\sin 60^o = 2v/\sqrt{3}$

Q.12 A capillary tube is made of glass with the index of refraction 3, outer radius of the tube is 30 cm. The tube is filled with a liquid with the index of refraction 2. What should be the minimum internal radius of the tube r so that any ray that hits the tube would enter the liquid -

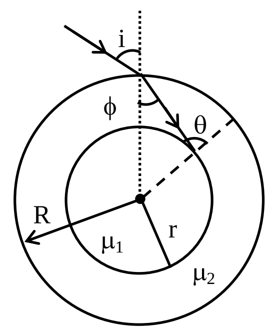
(A) 15 cm (B) 10 cm

(C) 20 cm (D) 45 cm

Sol. **[A]**

$\theta < \theta_c$

$\sin\theta < \sin\theta_c$



$\sin\theta < \frac{\mu_1}{\mu_2}$

$\sin\theta < \frac{2}{3}$

when i is maximum θ is also max and if $\sin\theta_{max} < \frac{2}{3}$ light will enter in liquid.

$i_{max} = \frac{\pi}{2} \quad \sin\phi = \frac{1}{\mu_2} = \frac{1}{3}$

Apply sine rule $\frac{\sin\phi}{r} = \frac{\sin(\pi-\theta)}{R} = \frac{\sin\theta}{R}$

$\frac{\sin\phi}{r} = \frac{\sin\theta}{R}$

$\frac{R}{3r} = \sin\theta$

$\frac{R}{3r} < \frac{2}{3}$

$r > \frac{R}{2}$

$r > \frac{30}{2}$

r > 15 cm

minimum radius = 15 cm

Q.13 The critical angle for total internal reflection of light going from medium I to medium II is given by the relation tan i_C = 5/9. The refractive index of the I medium with respect to the medium II is -

(A) 1.8 (B) 1.6

(C) $\sqrt{156}/5$ (D) $\sqrt{106}/5$ **[D]**

Q.14 Two media I and II are separated by a plane surface having speeds of light 2×10^8 m/s and 2.4×10^8 m/s respectively .What is the critical angle for a ray going from I medium to II ?

(A) $\sin^{-1}\left(\frac{1}{2}\right)$ (B) $\sin^{-1}\left(\frac{5}{6}\right)$

(C) $\sin^{-1}\left(\frac{5}{12}\right)$ (D) $\sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$ **[B]**

Q.15 If refractive index for water and glass are 4/3 and 5/3 respectively and light is tending to go from glass to water , the critical angle is:

(A) $\sin^{-1}$ (4/3) (B) $\sin^{-1}$ (5/3)

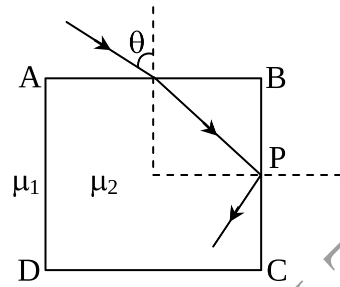
(C) $\sin^{-1}$ (4/5) (D) $\sin^{-1}$ (5/4) **[C]**

Q.16 If the critical angle for total internal reflection from a medium to vacuum is 30° the velocity of light in the medium is :

(A) 3×10^8 m/s (B) 1.5×10^8 m/s

(C) 6×10^8 m/s (D) $\times 10^8$ m/s **[B]**

Q.17 A cube of side a made of a material of refractive index μ_2 is immersed in a liquid of refractive index μ_1. A ray is incident on face A B at an angle θ as shown. Total internal reflection just takes place at point P on face BC. Then find the value of θ.



(A) $\sin\theta = \frac{\mu_2}{\mu_1}$

(B) $\sin\theta = \sqrt{\left[\left(\frac{\mu_2}{\mu_1}\right)^2 + 1\right]}$

(C) $\sin\theta = \sqrt{\left(\frac{\mu_1}{\mu_2}\right)^2 - 1}$

(D) $\sin\theta = \sqrt{\left(\frac{\mu_2}{\mu_1}\right)^2 - 1}$ **[D]**

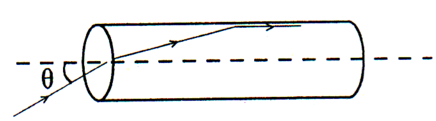
Q.18 A ray of light from a denser medium strikes a rarer medium at an angle of incidence i. If the reflected and refracted rays are mutually perpendicular to each other, what is the value of critical angle?

(A) $\sin^{-1}$ (cot i) (B) $\sin^{-1}$ (tan i)

(C) $\cos^{-1}$ (cot i) (D) $\cos^{-1}$ (tan i) **[B]**

Q.19 A transparent solid cylindrical rod has a refractive index of $\frac{2}{\sqrt{3}}$. It is surrounded by air. A light ray is incident at the midpoint of one end of the rod as shown in the figure.

[AIEEE-2009]

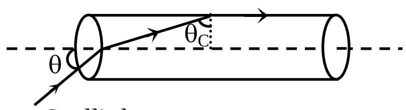


The incident angle θ for which the light ray grazes along the wall of the rod is -

(A) $\sin^{-1}\left(\frac{1}{2}\right)$ (B) $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$

(C) $\sin^{-1}\left(\frac{2}{\sqrt{3}}\right)$ (D) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$ **[D]**

Sol.



From Snell's law

$\mu_{air} \sin\theta = \mu_{cylider}. \sin(90 - \theta_C)$

$\Rightarrow \quad 1.\sin\theta = \frac{2}{\sqrt{3}}.\cos\theta_C$

$\Rightarrow \quad \sin\theta = \frac{2}{\sqrt{3}}\cos\left[\sin^{-1}\frac{1}{\mu_{cy}}\right]$

$= \frac{2}{\sqrt{3}}\cos\left[\sin^{-1}\frac{\sqrt{3}}{2}\right]$

$= \frac{2}{\sqrt{3}}\cos 60° = \frac{1}{\sqrt{3}}$

$\Rightarrow \quad \theta = \sin^{-1}\frac{1}{\sqrt{3}}.$

Q.20 Critical angle for light going from medium (i) to (ii) is θ. The speed of light in medium (i) is v, then speed in medium (ii) is -

(A) v (1– cos θ) (B) v / sin θ

(C) v / cos θ (D) v (1 – sin θ) **[B]**

Sol. $_2\mu_1 = \frac{1}{\sin\theta} = \frac{\mu_1}{\mu_2} = \frac{v_2}{v_1} \Rightarrow v_2 = \frac{v_1}{\sin\theta}$

$\therefore \boxed{v_2 = \frac{v}{\sin\theta}}$

Q.21 A microscope is focused on a mark on a piece of paper and then a slab of glass of thickness 3 cm and refractive index 1.5 is placed over the mark. How should the microscope be moved to get the mark again in focus ?

(A) 2 cm upwards

(B) 1 cm upwards

(C) 4.5 cm upwards

(D) 1 cm downwards **[B]**

Q.22 A bird in air looks at a fish vertically below it and inside water in a tank. If the distances of the fish as estimated by the bird is S_1 and that of bird as estimated by the fish is S_2 then the refractive index of liquid μ is -

(A) $\frac{S_1}{S_2}$ (B) $\frac{S_1+S_2}{S_1-S_2}$

(C) $\frac{S_2}{S_1}$ (D) $\frac{S_1+S_2}{S_1}$ **[C]**

Q.23 A layer of benzene (μ_1 = 1.5) 6 cm deep floats on water (μ_2 = 1.33) 4 cm deep. When viewed vertically through air the apparent distance of the bottom of the vessel below the surface of the benzene will be -

(A) 14 cm (B) 7 cm

(C) 21 cm (D) 3.5 cm **[B]**

Q.24 A mark is made on the bottom of a vessel, over this mark, a glass slab of thickness 3.5 cm and refractive index 7/4 is placed. Now water (refractive index 4/3) is poured into the vessel so that the surface of water is 8 cm above the upper surface of the slab. Looking down normally through the water, the apparent depth of the mark below the surface of water will be -

(A) 6.33 cm (B) 7.5 cm

(C) 8 cm (D) 10 cm **[C]**

Q.25 The refractive index of water is 4/3 and that of glass is 5/3. What will be the critical angle for the ray of light entering water from the glass ?

(A) $\sin^{-1}\frac{4}{5}$ (B) $\sin^{-1}\frac{5}{4}$

(C) $\sin^{-1}\frac{1}{2}$ (D) $\sin^{-1}\frac{2}{1}$ **[A]**

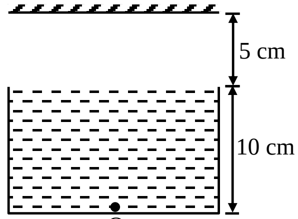
Sol. $\mu_w = \frac{4}{3}$; $\mu_g = \frac{5}{3}$

Ray of light moves from glass to water

$\sin C = \frac{1}{_w\mu_g} = \frac{\mu_w}{\mu_g} = \frac{4/3}{5/3} = \frac{4}{5}$

$\boxed{C = \sin^{-1}\left(\frac{4}{5}\right)}$

Q.26 Consider the situation shown in figure. Water $\left(\mu_w = \frac{4}{3}\right)$ is filled in a beaker upto a height of 10 cm. A plane mirror is fixed at a height of 5 cm from the surface of water. Distance of image from the mirror after reflection from it of an object O at the bottom of the beaker is -



(A) 15 cm (B) 12.5 cm
(C) 7.5 cm (D) 10 cm **[B]**

Sol. Distance of first image (I_1) formed after refraction from the plane surface of water is $\frac{10}{4/3}$ = 7.5 cm

from water surface $\left(d_{app} = \frac{d_{actual}}{\mu}\right)$

Now distance of image is 5 + 7.5 = 12.5 cm from the plane mirror.

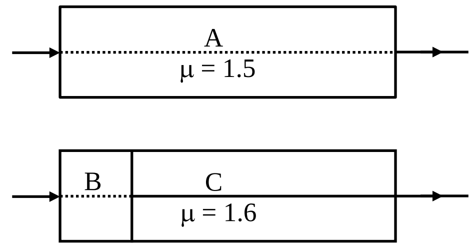
Q.27 A beam of light is converging towards a point 1 on an screen. A parallel plane plate of glass whose thickness in the direction of the beam = t, refractive index = μ, is introduced in the path of the beam. The convergence point is shifted by -

(A) $t\left(1-\frac{1}{\mu}\right)$ away (B) $t\left(1+\frac{1}{\mu}\right)$ away

(C) $t\left(1-\frac{1}{\mu}\right)$ nearer (D) $t\left(1+\frac{1}{\mu}\right)$ nearer

[A]

Q.28 Two transparent slabs are of equal thickness, one is made of material A of refractive index 1.5 and the other is made of two materials B and C the ratio of their thickness being 1:2. The refractive index of C is 1.6 .If monochromatic parallel beams passing through the slabs have the same number of waves; the refractive index of B is -



(A) 1.4 (B) 1.3
(C) 1.1 (D) 1.5 **[B]**

Q.29 If the critical angle for a medium is 60°, then the refractive index of the medium is-

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

Sol. $\sin i_c = \frac{1}{\mu}$ ∴ $\mu = \frac{1}{\sin i_c}$

∴ $\mu = \frac{1}{\sin 60°}$ ∴ $\mu = \frac{2}{\sqrt{3}}$

Q.30 A film of air is enclosed between a pair of thin microscope slides and the combination is then inserted in water. A ray of white light is projected through water and the light reflected by the film of air sandwiched between the two slides is received on a screen. If the angle of incidence of the ray on the film is gradually decreased; from 90°, the reflected light -

(A) will turn red and then vanish
(B) will remain white and then vanish
(C) will remain white at all angle of incidence
(D) will turn blue and then vanish **[D]**

Q.31 A bird in air looks at a fish vertically below it and inside water. x is the height of the bird above the surface of water and y the depth of the fish below the surface of water. If refractive index of water with respect to air is μ. The distance of the bird as observed by the fish is -

(A) x + y (B) $x + \frac{y}{\mu}$
(C) μx + y (D) μx + μy **[C]**

Q.32 A fish rising vertically with speed 3 ms^{-1} to the surface of water sees a bird diving vertically towards it with speed 9 ms^{-1} ?

Given ${}_a\mu_W = \frac{4}{3}$. The actual velocity of dive of the bird is -

(A) 6 ms^{-1} (B) 4 ms^{-1}

(C) 8.4 ms^{-1} (D) 4.5 ms^{-1} **[D]**

Q.33 The refractive index of glass is 1.9. If a light through a glass slab of thickness d in time t and takes the same time to travel through a transparent beaker filled with water upto a thickness 1.5d, then the refractive index of water is -

(A) 1.27 (B) 1.33 (C) 1.20 (D) 1.50

[A]

Sol. $\frac{v_{glass}}{v_{water}} = \frac{\mu_{water}}{\mu_{glass}}$

$\text{Time} = \frac{\text{Distance}}{\text{speed}}$

$\therefore \frac{d}{v_{glass}} = \frac{1.5d}{v_{water}} \Rightarrow \frac{v_{glass}}{v_{water}} = \frac{1}{1.5}$

$\therefore \frac{\mu_{water}}{\mu_{glass}} = \frac{1}{1.5} \Rightarrow \frac{\mu_{water}}{1.9} = \frac{1}{1.5}$

$\Rightarrow \mu_{water} = 1.27$

Q.34 Just before the time of sun set or shine the sun appears to be oval because -

(A) the sun changes its shape at that time

(B) of the scattering of light

(C) of the effects of refraction

(D) of the effects of diffraction **[C]**

Q.35 The twinkling of stars is due to -

(A) the fact that star do not emit light continuously

(B) frequent absorption of star light by their own atmosphere

(C) the fact that refractive index of the earth's atmosphere fluctuates

(D) intermittent absorption of star light by earth atmosphere **[C]**

Q.36 Which statement is correct ?

(A) When light proceeds from denser to rarer medium and the angle of incidence is greater than critical angle total internal reflection of light takes place

(B) When light proceeds from rarer to denser medium total internal reflection of light takes place

(C) When light proceeds from denser to rarer medium, total internal reflection always takes place

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

Q.37 When the surface of the lake is calm, a fish, submerged in water will see the entire outside world within an inverted cone whose apex is situated at the eye of the fish and the cone subtends an angle of : ($\mu_W = 4/3$)

(A) 10º (B) 60º (C) 98º (D) 30º

[C]

Q.38 A ray of light from a denser medium strikes a rarer medium at an angle of incidence i. The reflected and refracted rays make an angle of 90° with each other. The angles of reflection and refraction are r and r′. The critical angle is –

(A) $\sin^{-1}(\tan r)$ (B) $\sin^{-1}(\tan r')$

(C) $\tan^{-1}(\sin r)$ (D) $\tan^{-1}(\sin i)$

[A]

Q.39 Mirages are observed in deserts due to phenomenon of -

(A) Interference of light

(B) Total internal reflection

(C) Scattering of light

(D) Double reflection of light

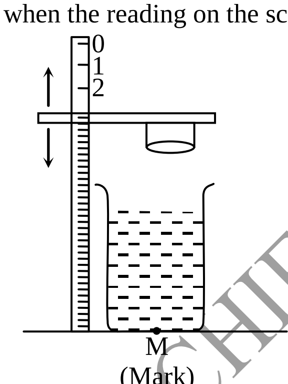
[B]

Q.40 We see the sun a little before it rises on the horizon and a little after it sets below the horizon. This is a consequence of the phenomenon of –
(A) Total internal reflection (B) Refraction
(C) Dispersion (D) Scattering of light
[A]

Q.41 A cut diamond (or air bubble in water) shines brilliantly due to -
(A) Its molecular structure
(B) Absorption of light
(C) Total internal reflection
(D) Some inherent property **[C]**

Q.42 A man, standing on a platform, is aiming at the fish with the help of a bow and an arrow. The arrow will -
(A) hit the fish if he aims it above the fish
(B) hit the fish if he aims at the fish
(C) not be able to hit the fish
(D) hit the fish if he aims it below the fish **[D]**

Q.43 A beaker containing liquid is placed on a table, underneath a microscope which can be moved along a vertical scale. The microscope is focused, through the liquid onto a mark on the table when the reading on the scale is a.



It is next focused on the upper surface of the liquid and the reading is b. More liquid is added and the observations are repeated, the corresponding readings are c and d. The refractive index of the liquid is -

(A) $\frac{d-b}{d-c-b+a}$ (B) $\frac{b-d}{d-c-b+a}$

(C) $\frac{d-c-b+a}{d-b}$ (D) $\frac{d-b}{a+b-c-d}$ **[A]**

Q.44 The critical angle of light going from medium A to medium B is θ. The speed of light in medium A is V, the speed of light in medium B is:

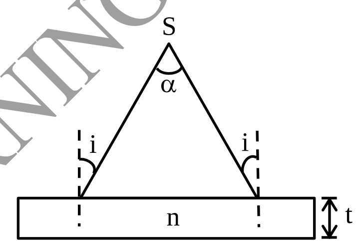
(A) $\frac{V}{\sin\theta}$ (B) $V\sin\theta$

(C) V cot θ (D) V tan θ

Sol. **[A]**
A medium is denser then B medium

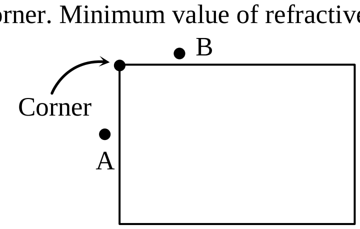
$${}_B\mu_A = \frac{V_B}{V_A} = \frac{1}{\sin\theta}\ ;\ V_B = \frac{V_A}{\sin\theta} = \frac{V}{\sin\theta}$$

Q.45 A diverging beam of light from a point source S having divergence angle α, falls symmetrically on a glass slab as shown. The angles of incidence of the two extreme rays are equal. If the thickness of the glass slab is t and the refractive index n, then the divergence angle of the emergent beam is – **[IIT-JEE -2000]**



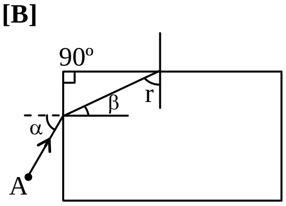
(A) Zero (B) α
(C) $\sin^{-1}(1/n)$ (D) $2\sin^{-1}(1/n)$ **[B]**

Q.46 A 90º corner is made from a transparent optical material with a refractive index such that A cannot see B when he is standing behind the corner. Minimum value of refractive index is-



(A) $\sqrt{3}$ (B) $\sqrt{2}$
(C) $\sqrt{5}$ (D) $\sqrt{7}$

Sol. **[B]**

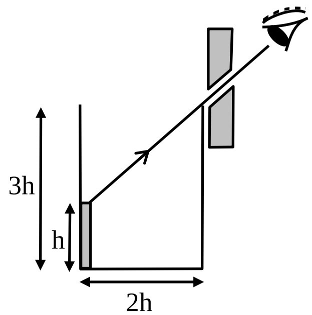


$r_{min} > \theta_c$
r = 90 – B
r is minimum when β is maximum.
Maximum value of β is θ_c
∴ $90^\circ - \theta_c > \theta_c$

$$45^\circ > \theta_c \Rightarrow \frac{1}{\sqrt{2}} > \frac{1}{\mu}$$

$$\Rightarrow \mu > \sqrt{2}$$

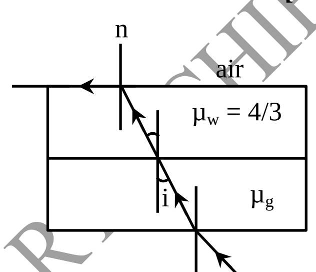
Q.47 An observer can see through a pin-hole the top end of the thin rod of height h, placed as shown in the figure. The beaker height is 3h and its radius h. When the beaker is filled with a liquid up to a height 2h, he can see the lower end of the rod. Then the refractive index of the liquid is – **[IIT-JEE 2002]**



(A) $\frac{5}{2}$ (B) $\sqrt{\frac{5}{2}}$

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

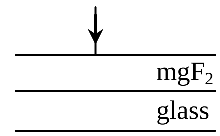
Q.48 In the given figure, at water-air interface, light ray incident at critical angle then the value of μ_g is – **[IIT-JEE 2003]**



(A) $\frac{3}{4\sin i}$ (B) $\frac{1}{\sin i}$

(C) $\frac{4}{3\sin i}$ (D) none of these **[B]**

Q.49 White light is incident normally on a glass surface (n = 1.52) that is coated with a film of mg F_2 (n = 1.38). For what minimum thickness of the film will yellow light of wavelength 550 nm (in air) be missing in the reflected light ?

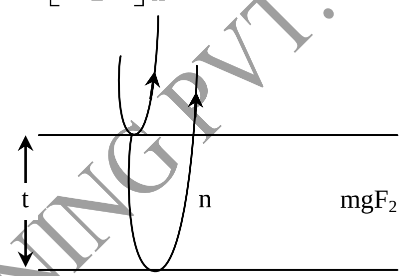


(A) 99.6 nm (B) 49.8 nm

(C) 19.6 nm (D) 10.6 nm

Sol. **[A]**

$$2t = \left[\frac{2m+1}{2}\right]\frac{\lambda}{n}$$



$$t_{min} = \frac{\lambda}{4n} = \frac{5.5\times10^{-7}}{4\times1.38} = 99.6 \text{ nm}$$

Q.50 A small girl of height 1 m can just see her image in a vertical plane mirror 4m away from her. Her eyes are 0.92 m from the floor. In order that she sees her full image in the mirror, the shortest vertical dimension of the mirror is -

(A) 0.50 m (B) 0.70 m

(C) 0.46 m (D) 0.56 m **[A]**

Sol. The minimum size of plane mirror required to see the full image of anyone is half of the height required.