81·6

Datum .... F·18 .... 20..........

Onderwerp :

3) A convex mirror of focal length f produces an ~~imag~~ image $(1/n)^{th}$ the size of the object. Calculate the dist of the object from the mirror in terms ~~of f, n~~ of f, n.

Sol:- Let focal length = f

We know that $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$ —— ①

Given $h_i = \frac{1}{n} h_o$

Since $\frac{v}{u} = \frac{h_i}{h_o} = \frac{1}{n}$

$v = \frac{u}{n}$ ⟶ ②

Substituting ② in ①

$$\frac{1}{f} = \frac{1}{u} + \frac{n}{u}$$

$$\frac{1}{f} = \frac{n+1}{u}$$

$$\boxed{u = f(n+1)}$$

81.7

Datum 2.18 20

Onderwerp :

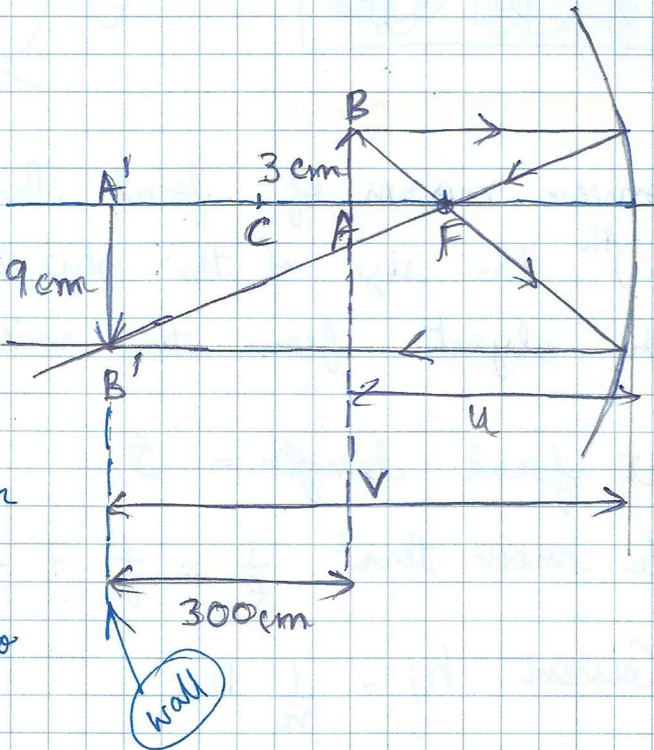
4) An object 3 cm tall is placed at a dist of 3 m from ~~from~~ a wall. How far from the wall must a concave mirror be placed in ~~ord~~ ~~ode~~ order that it may form ~~form~~ an image of a flame 9 cm high on the wall?

Sol:- $m = \frac{h_i}{h_o}$

$= \frac{9}{3} = 3$

$\frac{v}{u} = 3$

$v = 3u$



Since image is caught on the wall, it is real, inverted image. It is also magnified.

$\Rightarrow$ The object is placed b/w F and C of the concave mirror and image is beyond C.

$m = \frac{h_i}{h_o} = \frac{9}{3} = 3$

use this

$\frac{v}{u} = 3$, $v = 3u$ $(u = v - 300)$

$v = 3(v - 300)$

$= 3v - 900$

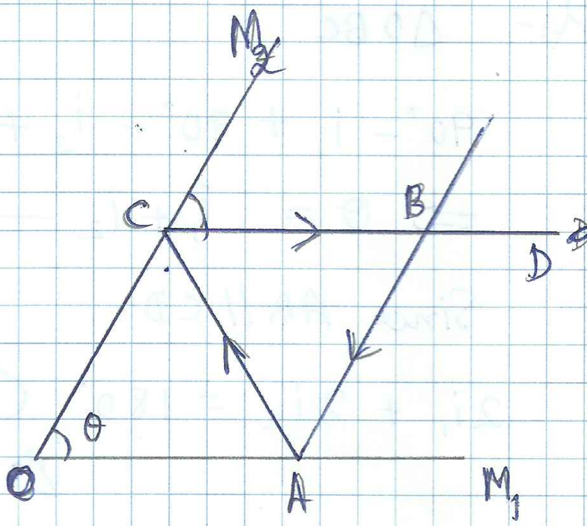
$2v = 900$

$v = 450$ cm

$\therefore$ The concave mirror must be placed 450 cm away from wall

Onderwerp :

5) Two mirrors are inclined at an angle θ. A ray of light incident on the first mirror and parallel to second mirror is reflected from the second mirror parallel to first mirror. What is the value of θ ?



Sol :

$M_2\hat{C}D = C\hat{O}A = \theta$ (corresponding ∠s)

$O\hat{C}A = M_2\hat{C}D = \theta$ (law of reflection)

$OC \parallel AB$

$C\hat{O}A = B\hat{A}M_1 = \theta$ (corresponding ∠s)

$C\hat{A}O = B\hat{A}M_1 = \theta$ (law of reflection)

ΔCOA

$\theta + \theta + \theta = 180°$

$\Rightarrow \theta = 60°$

Using new cartesian co-ordinate system.

$h_o = +3\,cm$ ∴ Formula $m = \frac{h_i}{h_o} = -\frac{9}{3} = -3$ (So image is real & inverted)

$h_i = -9\,cm$

Formula $m = -\frac{v}{u}$ (for mirror)

$-3 = -\frac{v}{u}$ ∴ $v = 3u$

Since ~~u = 300~~

$u = v - 300$

$v = 3(v - 300)$

$= 3v - 900$

$2v = 900$

$v = 450\ cm.$

use this for problem (4)

~~Light – Reflection (Contd...)~~

81.9

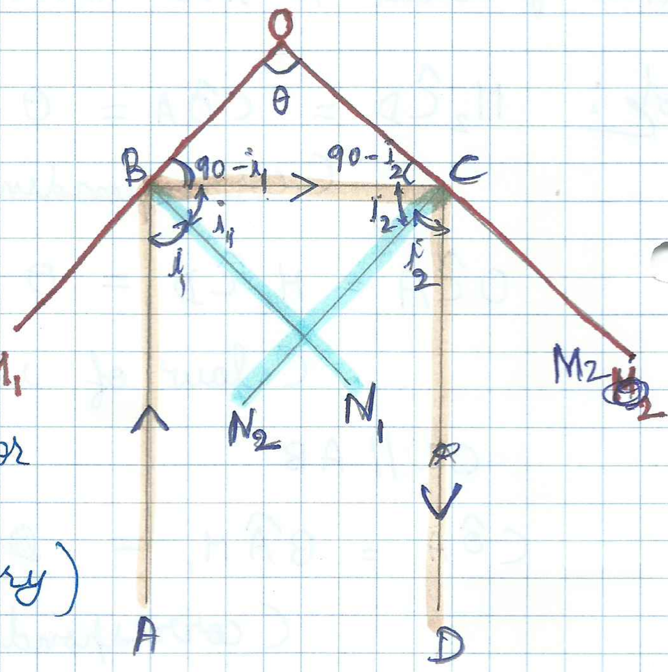
Light – Reflection (Contd....)

8.18

Datum .... 20........

Onderwerp :

6) How would you arrange two plane mirrors so that, whatever may be the angle of incidence, the incident ray on one mirror is parallel to the reflected ray from the other mirror?



Sol:- ΔOBC

$90° - i_1 + 90° - i_2 + \theta = 180°$

$\Rightarrow \theta = i_1 + i_2$ ——— (1)

Since $AB \parallel CD$

$2i_1 + 2i_2 = 180°$ (co-interior ∠s are supplementary)

$(i_1 + i_2) = 90°$ ——— (2)

From (1) and (2)

$\theta = 90°$

$\Rightarrow$ The 2 plane mirrors should be inclined ~~at an~~ at an angle of 90°.

~~Refraction of ~~k~~ Light~~

Refraction of light

81·10

Datum .... 20........

Onderwerp : **Important Information**

$\sin 0^\circ = 0$	$\cos 0^\circ = 1$
$\sin 30^\circ = 0.5$	$\cos 30^\circ = 0.86$
$\sin 60^\circ = 0.86$	$\cos 60^\circ = 0.5$
$\sin 90^\circ = 1$	$\cos 90^\circ = 0$

As x° increases $\sin x^\circ$ increases, $\cos x^\circ$ decreases

Challenging Exercise :-

1) A ray of light is incident at an $\angle^{e}$ 60° on a ~~a~~ parallel side of a glass slab of thickness 0.1 m ~~0.1 m~~ and refractive index 1.5. Calculate the S_L.

Sol:- By Snell's law

$$\frac{\sin i}{\sin r} = 1.5$$

$$\sin r = \frac{\sin i}{1.5}$$

$$= \frac{\sin 60^\circ}{1.5} = \frac{0.86}{1.5} = 0.573$$

$$r = \sin^{-1}(0.573)$$

$$= 34.956^\circ$$

$$S_L = \frac{0.1 \times \sin(60 - 34.956)}{\cos(34.956)}$$

$$= 0.051 \text{ m}$$

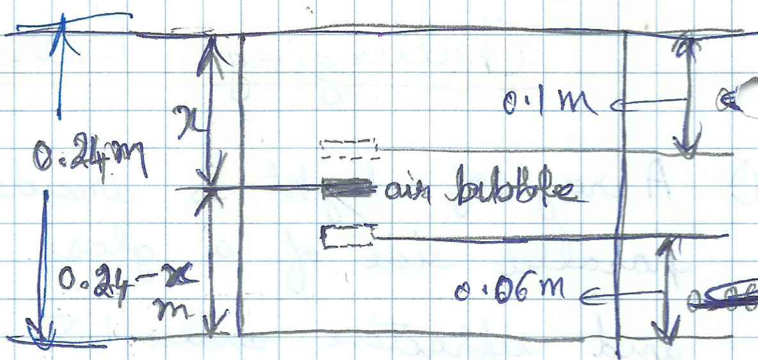
Lateral Shift = 0.051 m

01.18

Onderwerp :

Datum 81.11 20

2. A small air bubble is situated in a glass cube of edge 0.24m. When veiwed from one face it appears to be 0.1m from the face and when viewed from the opp face it appears to be ~~0.06m~~ 0.06m from the face. Calculate refractive index of ~~glass~~ glass.



Sol:- Side of cube = 0.24m

$$n = \frac{\text{real depth}}{\text{apparant depth}}$$

$$n = \frac{x}{0.1} = \frac{(0.24 - x)}{0.06}$$

$$0.06x = 0.1\ (0.24 - x)$$

$$0.06x = 0.024 - 0.1x$$

$$6x = 2.4 - 10x$$

$$x = \frac{2.4}{16} = 0.15m$$

$$n = \frac{\text{Actual depth}}{\text{apparant depth}}$$

$$= \frac{0.15}{0.1}$$

$$n = 1.5$$

81.12

Datum 81.18 20

Onderwerp : Prove that the incident ray is // to ~~the~~ the emergent ray.

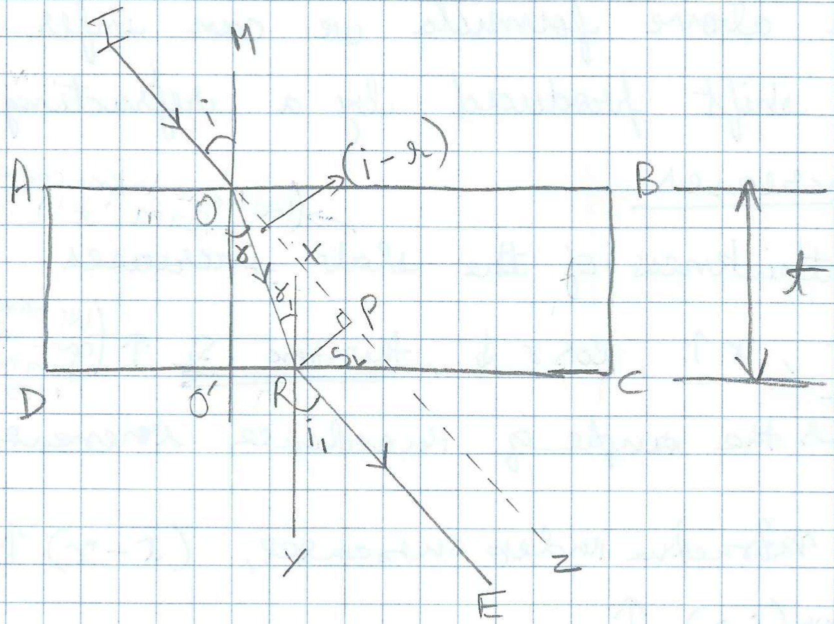
At surface AB

$$n_1 \sin i = n_2 \sin r \longrightarrow (1)$$

At suface CD

$$n_2 \sin r_1 = n_1 \sin i_1 \longrightarrow (2)$$

Since AB // CD $r = r_1$ (Alternate ∠les)



(2) becomes $n_2 \sin r = n_1 \sin i_1$

$\therefore n_1 \sin i = n_1 \sin i_1$

$\therefore i = i_1$

Thus emergent ray is parallel to the incident ray.

RP is the lateral shift suffered by the incident ~~ind.~~ ~~incident~~ ray IO in glass.

P.T.O ~~P.T.O~~

81·13

SJ·18

Datum .... 20........

Onderwerp :

$\tan\theta = \frac{\text{Opp. Side}}{\text{Adj Side}}$

From $\Delta OO'R$, $\cos r = \frac{t}{OR}$

From ΔORP, $\sin(i-r) = \frac{S_L}{OR}$

$\therefore S_L = OR \times \sin(i-r)$

$$\boxed{S_L = \frac{t}{\cos r} \times \sin(i-r)}$$

There are 3 terms in this eqn

From above formula we can infer that the lateral shift produced by a refracting parallel-sided slab increases

(i) as the thickness of the slab increases. (we have taken care of term 't')

(ii) As $i \uparrow$, $r \uparrow$, $\cos r \downarrow$, therefore $S_L \uparrow$ (We have taken care of term '$\cos r$')

$\Rightarrow$ as the angle of incidence increases

(iii) As the refractive index increases, $(i-r)\uparrow$,

So $\sin(i-r)\uparrow$

$\Rightarrow$ as the refractive index of the medium ~~wrt~~ with respect to (wrt) the surrounding medium increases

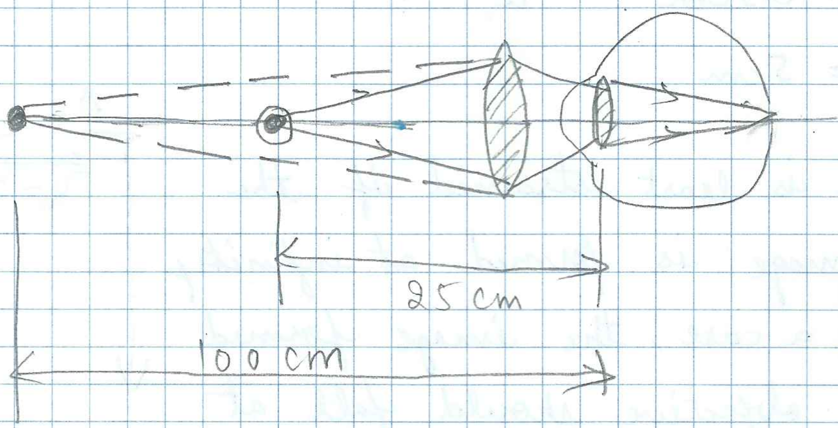
[We have taken care of the term "$\sin(i-r)$"]

81.14

Onderwerp :

Datum 21.12 20

4) A person suffering from defective vision can see objects clearly only beyond 100 cm from the eye. Calculate the power of the lens required so that he can see clearly the object placed at least distance of distinct vision ~~(D=25~~
D = 25 cm



An object at 25 cm should be shifted to a virtual position at 100 cm

$\therefore u = 25 cm \quad V = -100 cm$

$\frac{1}{f} = \frac{1}{u} - \frac{1}{V}$

$f = \frac{uV}{V-u} = \frac{25 \times 100}{100-25}$

$= \frac{\cancel{25} \times 100}{\cancel{75}\,3}$

$= \frac{100}{3}$ cm

$f = \cancel{4}\ \frac{1}{3}$ m

$\boxed{P = 3 D}$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$f = \frac{uV}{u+V}$

Since V is −ve

$f = \frac{-uV}{u-V}$

$= \frac{uV}{V-u}$

$= \frac{25 \times 100}{100-25}$

$= \frac{\cancel{25} \times 100}{\cancel{75}\,3}$

$= \frac{100}{3}$

81.15

Onderwerp :

Datum .... 20......

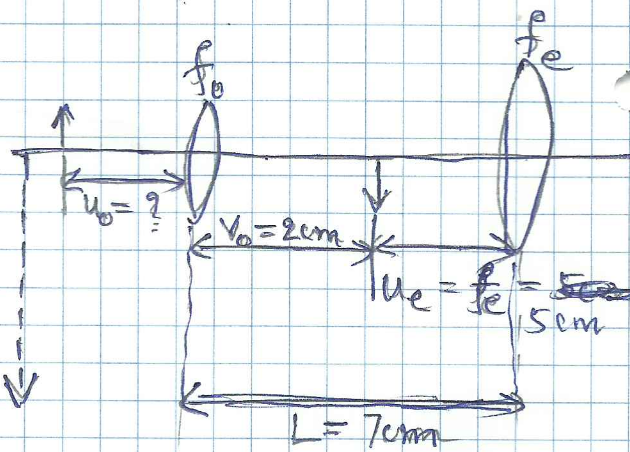
11.18

3) The seperation L b/w the objective ($f = 0.5cm$) and ~~the~~ the eye piece ($f = 5cm$) of a compound microscope is 7cm.
Where should a small object be placed so that the ~~eye~~ eye is least strained to see the image?

Sol:- $L = 7cm$ $D = 25cm$

$f_o = 0.5cm$ $u_o = ?$

$f_e = 5cm$



The eye is least strained if the final image is formed at infinity. In such a case, the image formed by the objective should fall at the focus of the eyepiece

$u_e = f_e = 5cm \quad \because \quad V_e = \infty$

$\therefore V_o = L - u_e$ or f_e

$= 7 - 5 = 2cm \qquad V_o = 2cm$

$\frac{1}{f_o} = \frac{1}{V_o} + \frac{1}{u_o}$

$\frac{1}{V_o} = \frac{1}{f_o} - \frac{1}{u_o}$ $\qquad u_o = \frac{V_o f_o}{V_o - f_o} = \frac{2 \times 0.5}{2 - 0.5} = \frac{1}{1.5} = \frac{10}{15} = \frac{2}{3}$

$\cancel{v = \frac{u_o f_o}{u_o - f_o}} =$

$u_o = \frac{2}{3} cm$

$$\boxed{u_o = \frac{2}{3} cm}$$

1) A camera has a lens of f 70 mm. It is focussed to infinity. By how much distance should it be moved forward / backward to focus on an object at 70 cm ?

→ using fig ①, $u = \infty$; $v = f = 7$ cms

using fig ② $\frac{1}{f} = \frac{1}{u'} + \frac{1}{v'}$

$$\frac{1}{v'} = \frac{1}{f} - \frac{1}{u'}$$

$$v' = \frac{u'f}{u'-f}$$

$$= \frac{70 \times 7}{70-7} = \frac{490}{63}$$

$$v' = 7.78 \text{ cm}$$

Lens dist. to be moved

$= v' - v = 7.78 - 7 = 0.78$ cm

$= 7.8$ mm

Fig ①

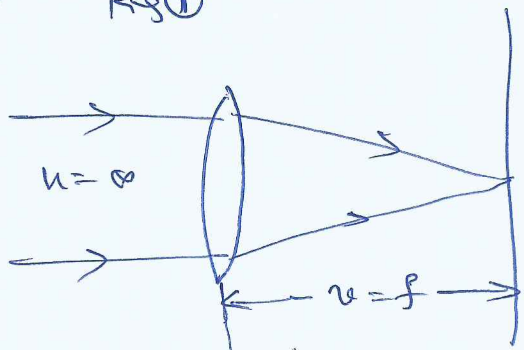
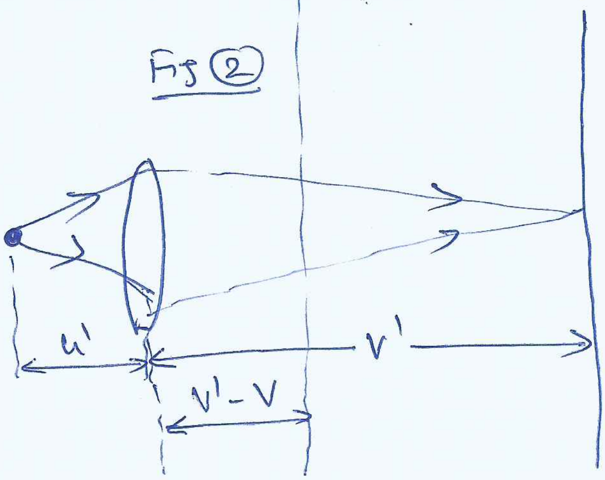


Fig ②



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② Find the power of the lens required to correct a myopic eye the far point at 50 cm.

soln → The far point at 50 cm has to be shifted as virtual image at infinity

∴ Concave lens of $f = 50$ cm is required

$$f = -50 \text{ cm} = -0.5 \text{ m}$$

$$P = \frac{1}{f} = \frac{1}{-0.5} = -2D$$

problem

A small fish, 0.4 m below the surface of a lake, is viewed through a simple converging lens of $f = 3$ m. The lens is kept at 0.2 m above the water surface such that the fish lies on the optical axis of the lens. Find the position of the image of the fish as seen by the observer. μ of water $= 4/3$.

(denser to rarer medium)

Ans: First refraction takes place from water to air. As a result the fish appears to be nearer than 0.4 m.

Real depth $u = 0.4$ m

$v = ?$

$${}_a\mu_w = \frac{\text{real depth}}{\text{apparent depth}} = \frac{u}{v}$$

$$\therefore v = \frac{u}{{}_a\mu_w} = \frac{0.4\text{ m}}{4/3} = \boxed{0.3\text{ m}}$$

${}_a\mu_w$ = refractive index of water wrt to air

$$= \frac{\mu_{water}}{\mu_{air}} = \frac{4/3}{1} = \frac{4}{3}$$

$\boxed{v = 0.3\text{ m}}$ This implies the image of fish at 0.3 m below the surface of the lake acts as an object for the lens which is 0.2 m above water surface.

→ Hence, $u_1 = 0.2\text{m} + 0.3\text{ m} = -0.5$ m

$f = +3$ m, $v_1 = ?$

Len's formula $\cancel{\frac{1}{f} = \frac{1}{u} + \frac{1}{v}}$ $\quad \frac{1}{v} = \frac{1}{f} + \frac{1}{u}$

$$\frac{1}{v} = \frac{1}{3} - \frac{1}{0.5} = \frac{1}{3} - 2 = \frac{1-6}{3} = -\frac{5}{3}$$

$$\boxed{v_1 = -\frac{3}{5} = -0.6\text{ m} = -(0.4 + 0.2)\text{ m}}$$

⇒ The lens is 0.2 m above water surface and image is 0.4 m below water surface. Hence, the images coincides with its actual position of the fish.

81.18

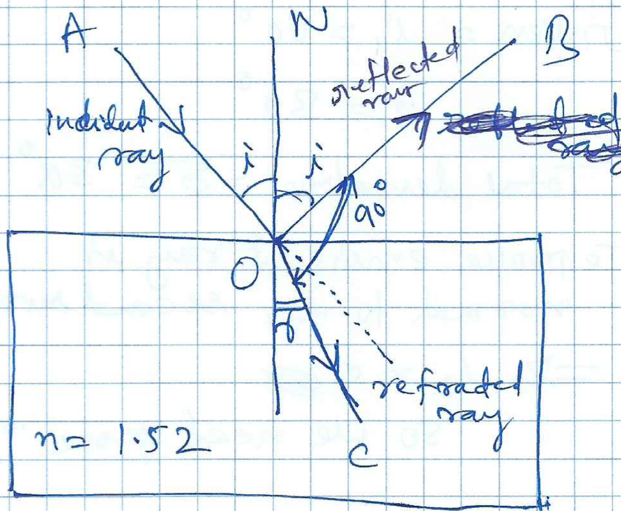
P1.18

Datum .... 20.......

Onderwerp :

$\Rightarrow$ The object must be placed 0.112 m away from ~~the~~ the optic centre to obtain a real image of magnification ~~magnificati~~ = 4.

6). A ray of light falls on a transparent glass ~~sl~~ slab of $n = 1.52$. If the reflected ray and refracted ~~refracted~~ ray are mutually $\perp^r$, what is the $\angle^{le}$ of ~~incidence~~ incidence ?



From figure $i + r = 90°$

$\therefore r = (90 - i)$

From Snell's law

$$n = \frac{\sin i}{\sin r}$$

$$= \frac{\sin i}{\sin(90 - i)}$$

$$\frac{\sin i}{\sin(90-i)} = 1.52 \longrightarrow (1)$$

$\sin 0 = 0$
$\sin 30° = 0.5$
$\sin 60 = 0.86$
$\sin 90 = 1$
$\cos 0 = 1$
$\cos 30 = 0.86$
$\cos 60 = 0.5$
$\cos 90 = 0$

We know that

$$\sin(A - B) = \sin A \cos B - \cos A \sin B$$

$$\sin(90 - i) = \sin 90° \cos i - \cos 90° \sin i$$

$$= 1 \times \cos i - 0$$

$$\sin(90 - i) = \cos i \longrightarrow (2)$$

Using (2) in (1)

$$\frac{\sin i}{\cos i} = 1.52$$

$$\tan i = 1.52$$

$$i = \tan^{-1}(1.52) = \underline{\underline{56°39'}}$$

81.19

Datum 21.18 20

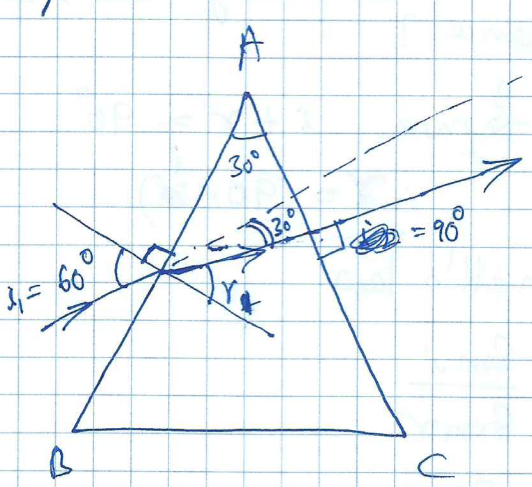
Onderwerp :

7) A ray of light is incident at an $\angle^{\underline{e}}$ 60° on one face of a 30° prism. The emergent ray from the prism makes an $\angle^{e}$ of 30° with the incident ~~ray~~ ray. Show that the emergent ray is normal to ~~the~~ the surface ~~of~~ from which it emerges. Calculate n of the material of the prism.

Given = $i_1 = 60^\circ$

$A = 30^\circ$

Total deviation $= \delta = 30^\circ$



To prove emergent ray is normal to the second surface

$\Rightarrow i_2 = 0$

So we need prove $r_2 = 0$

From figure,

$r_1 = i_1 - \delta$

$= 60 - 30$

$\boxed{r_1 = 30^\circ}$

We know that $A = r_1 + r_2$

$r_2 = A - r_1$

$= 30 - 30$

$\boxed{r_2 = 0^\circ}$

Since $r_2 = 0$, $i_2 = 0$ $\Longrightarrow$ So emergent ray is ~~normal to~~ normal to the second surface

Refractive index $n = \dfrac{\sin i_1}{\sin r_1} = \dfrac{\sin 60}{\sin 30} = \dfrac{\sqrt{3}/2}{1/2} = \sqrt{3}$

$n = \sqrt{3}$

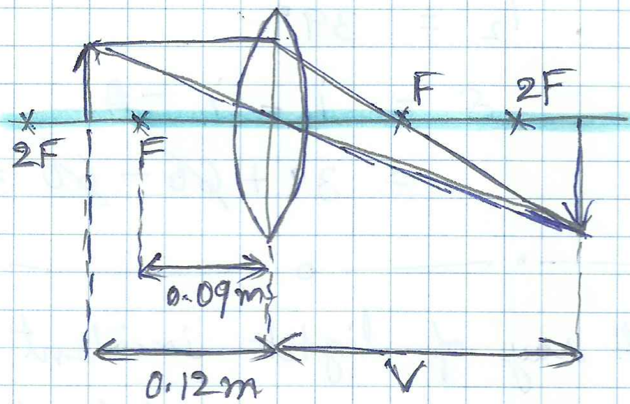
81.20

Datum 15.18 20

Onderwerp :

5. The real image formed by a convex lens ~~is~~ 3 ~~time~~ times the object in size, when the object is 0.12 m from ~~a~~ the lens. What is the f of the lens? Where must ~~the~~ the object be placed to obtain a real image ~~magnified~~ magnified 4 times?

Sol:- Part 1



Given:- $h_i = 3h_o$ $\quad \frac{h_i}{h_o} = \frac{V}{u} = 3$

$u = 0.12m$

$f = ?$

$\frac{V}{u} = 3 \qquad V = 3u$

$= 3 \times 0.12m$

$= 0.36m$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{V}$

$f = \frac{uV}{u+V} = \frac{0.12 \times 0.36}{0.12 + 0.36} = 0.09m$

$f = 0.09m$

Part 2

Given $h_i = 4h_o$

$f = 0.09m$

$\frac{V}{u} = \frac{h_i}{h_o} = 4 \qquad V = 4u$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{V} = \frac{1}{u} + \frac{1}{4u} = \frac{1}{u}\left(1 + \frac{1}{4}\right) = \frac{5}{4u}$

$\therefore f = \frac{4u}{5}$; $u = \frac{0.09 \times 5}{4} = \frac{0.45}{4} = 0.1125m$

P.T.O