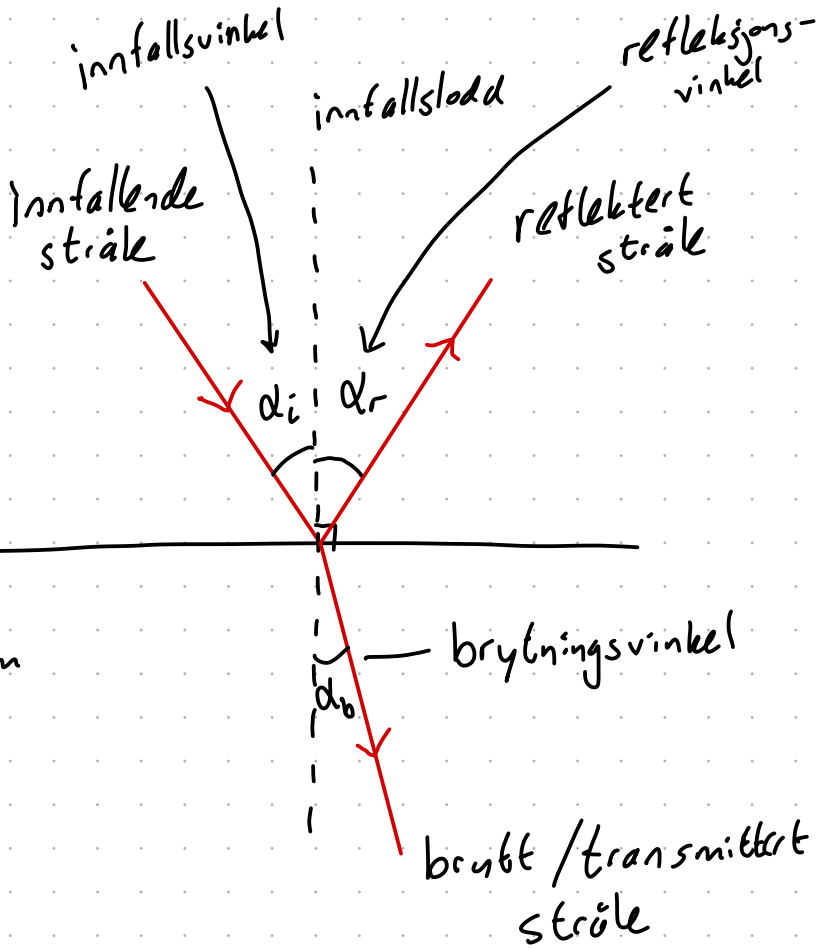
Oppsummering



brytningsindeks

Stoff 1, $n_1 = \frac{c_0}{c_1}$

Stoff 2, $n_2 = \frac{c_0}{c_2}$ ← lysfart i vakuum

↑ lysfart i stoff 2

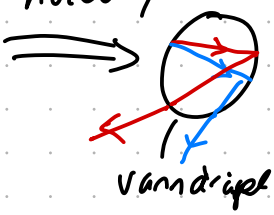
Refleksjonslov: $\alpha_i = \alpha_r$

Snells brytningslov: $n_1 \sin\alpha_1 = n_2 \sin\alpha_2$

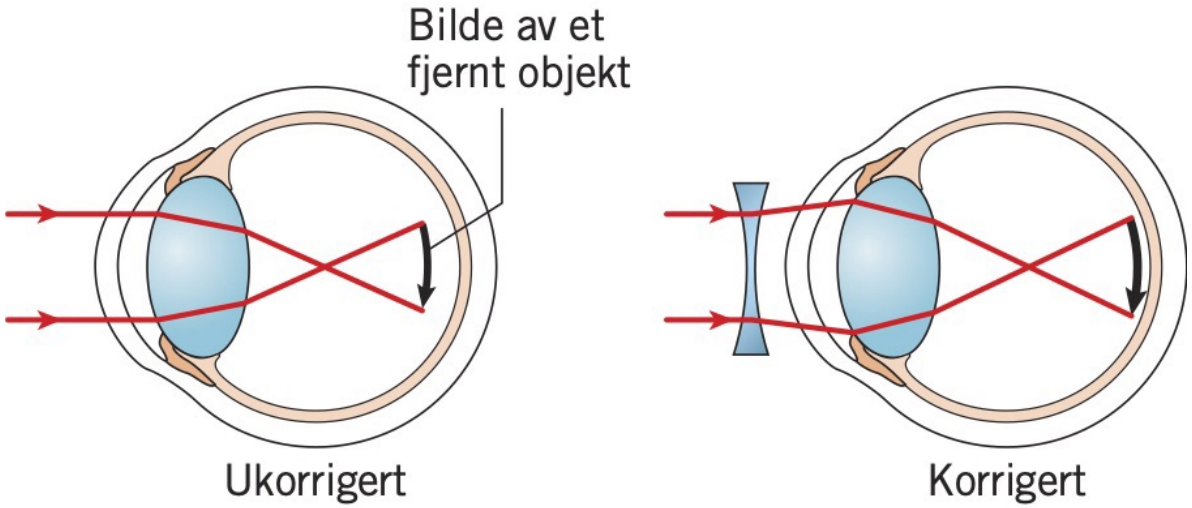
α_1 ↑ α_i ; α_2 ↑ α_b

NB! Brytningsindeksen avhenger av bølgelengden til lyset.

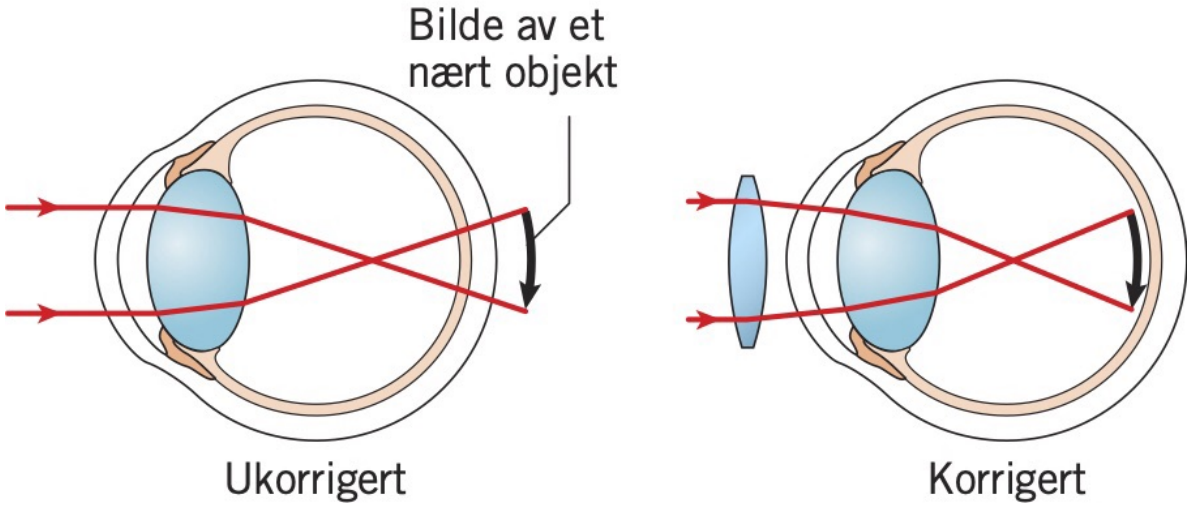
Gir opphav til regnbue hvitt lys



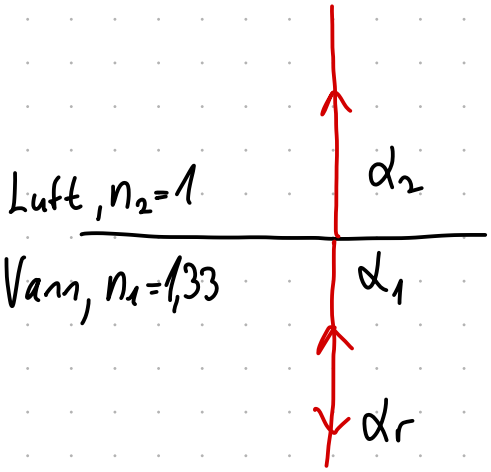
Nærsynthet



Langsynthet



8.3 Totalreflekssjon

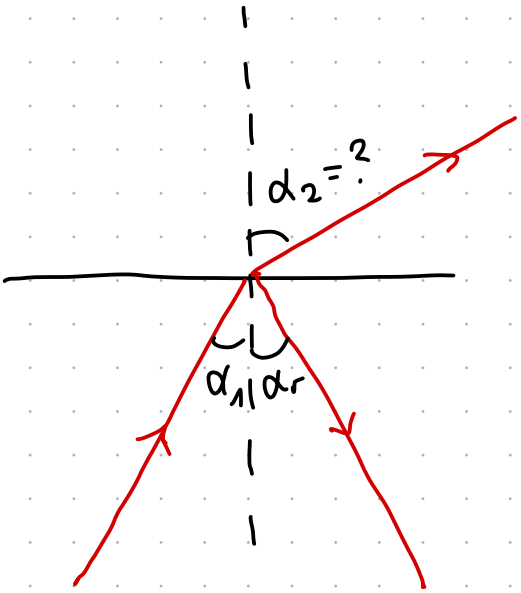


$\alpha_1 = \alpha_r$

$n_1 \sin\alpha_1 = n_2 \sin\alpha_r$

$n_1 \cdot 0 = n_2 \sin\alpha_2$

$\alpha_2 = 0$



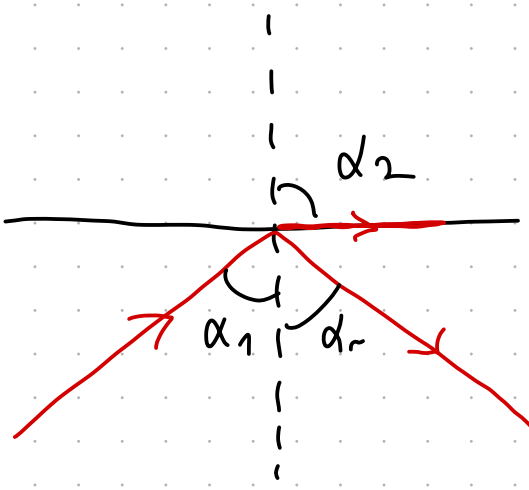
$\alpha_1 = 30°$ $\quad \alpha_r = \alpha_1 = 30°$

$n_1 \sin\alpha_1 = n_2 \sin\alpha_2$

$1{,}33 \cdot \sin 30° = 1 \cdot \sin\alpha_2$

$\sin\alpha_2 = \frac{1}{2} \cdot 1{,}33 = 0{,}665$

$\alpha_2 = \sin^{-1}(0{,}665) = 42°$



$\alpha_1 = 49°$ $\quad \alpha_r = \alpha_1 = 49°$

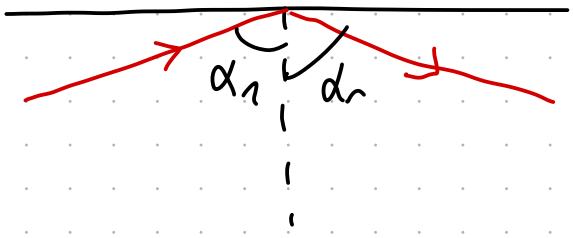
$n_1 \sin\alpha_1 = n_2 \sin\alpha_r$

"1"

$\sin\alpha_2 = 1{,}33 \cdot \sin 49°$

$= 1{,}33 \cdot 0{,}7547 = 1{,}00$

$\alpha_2 = \sin^{-1}(1{,}00) = 90°$



$\alpha_1 = 70°$

$\sin\alpha_2 = 1{,}33 \cdot \sin 70°$

$= 1{,}25$

α_2 finns ikke

$\alpha_n = \alpha_1 = 70°$

Når brytningsvinkelen er 90° har innfallsvinkelen nådd den såkalte grensevinkelen α_{gr}.

α_{gr} er gitt ved:

$$\alpha_{gr} = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$

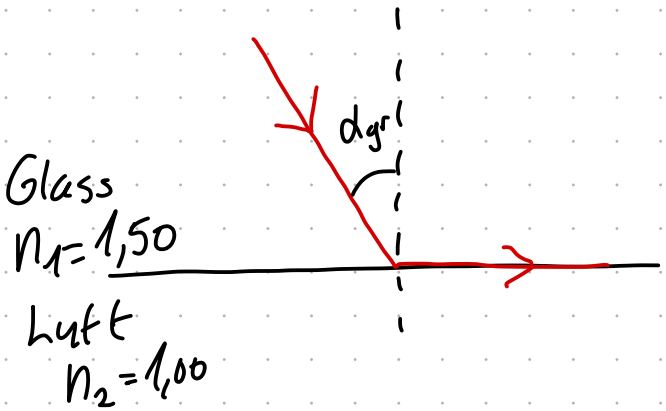
$$n_2 < n_1$$

Totalrefleksjon oppstår når:

1. lysstrålen møter et stoff med <u>mindre</u> brytningsindeks
2. innfallsvinkelen er <u>større</u> enn grensevinkelen

Grensevinkelen er gitt ved $\alpha_{gr} = \sin^{-1}\left(\frac{n_2}{n_1}\right)$

<u>Eksempel</u>



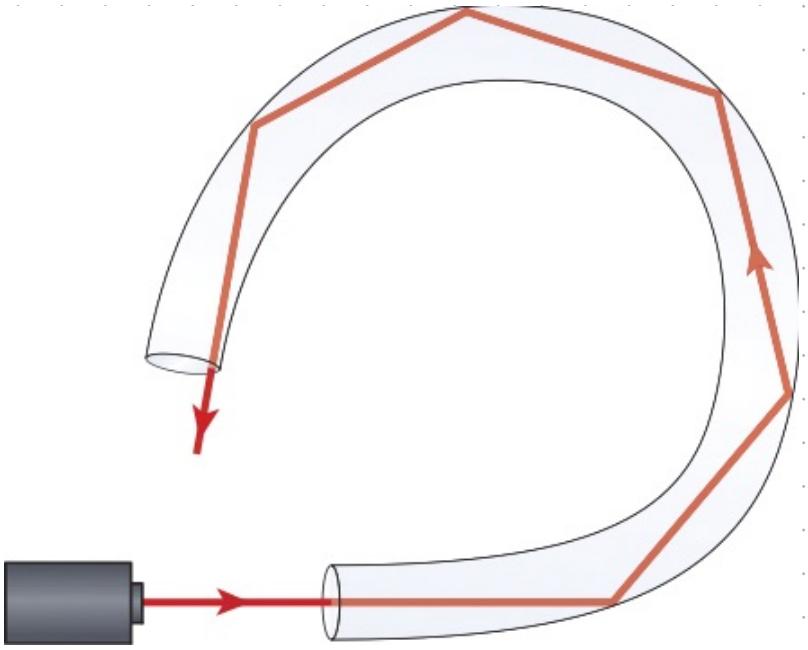
Hva er grensevinkelen?

$$n_1 \sin\alpha_{gr} = n_2 \underbrace{\sin(90°)}_{=1}$$

$$\sin\alpha_{gr} = \frac{n_2}{n_1}$$

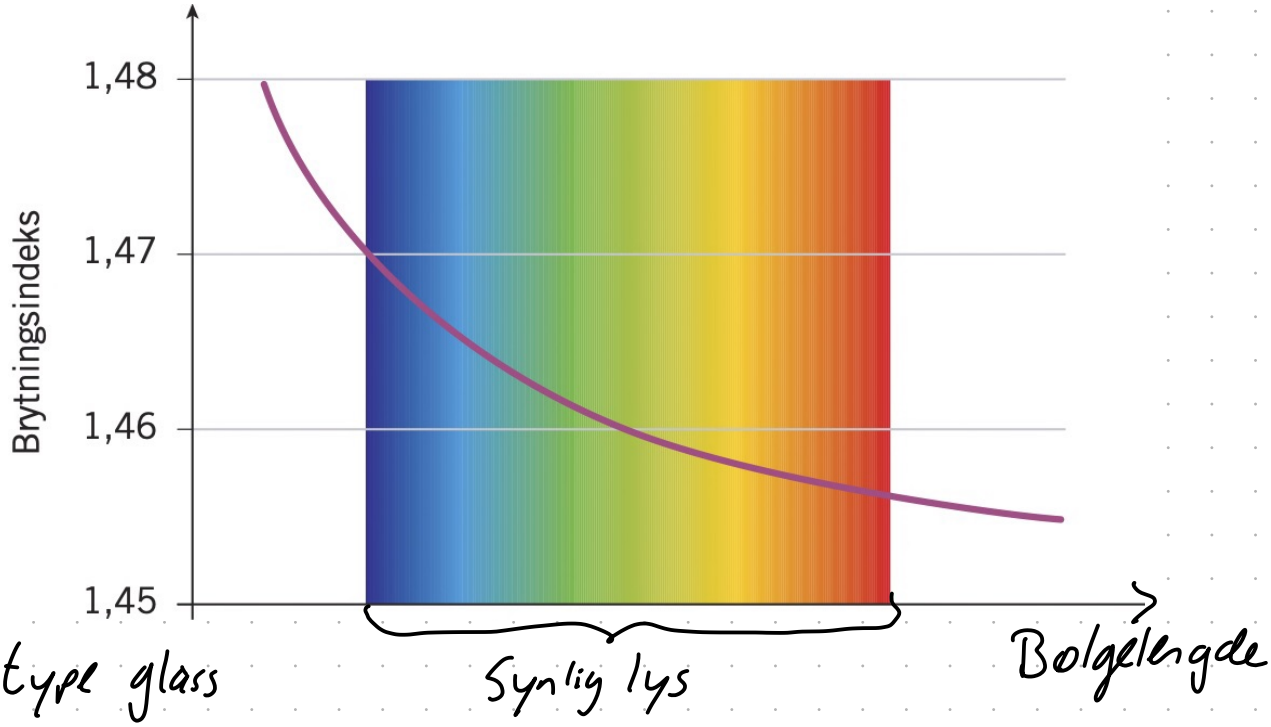
$$\alpha_{gr} = \sin^{-1}\left(\frac{1{,}00}{1{,}50}\right) = 41{,}8°$$

Optisk fiber til f.eks. bredbånd benytter totalrefleksjon inni fiberen

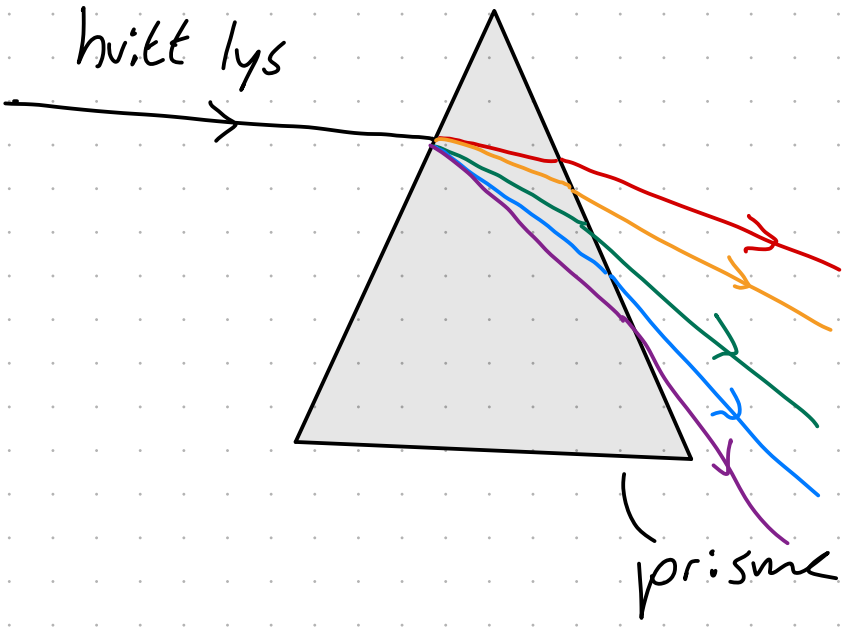


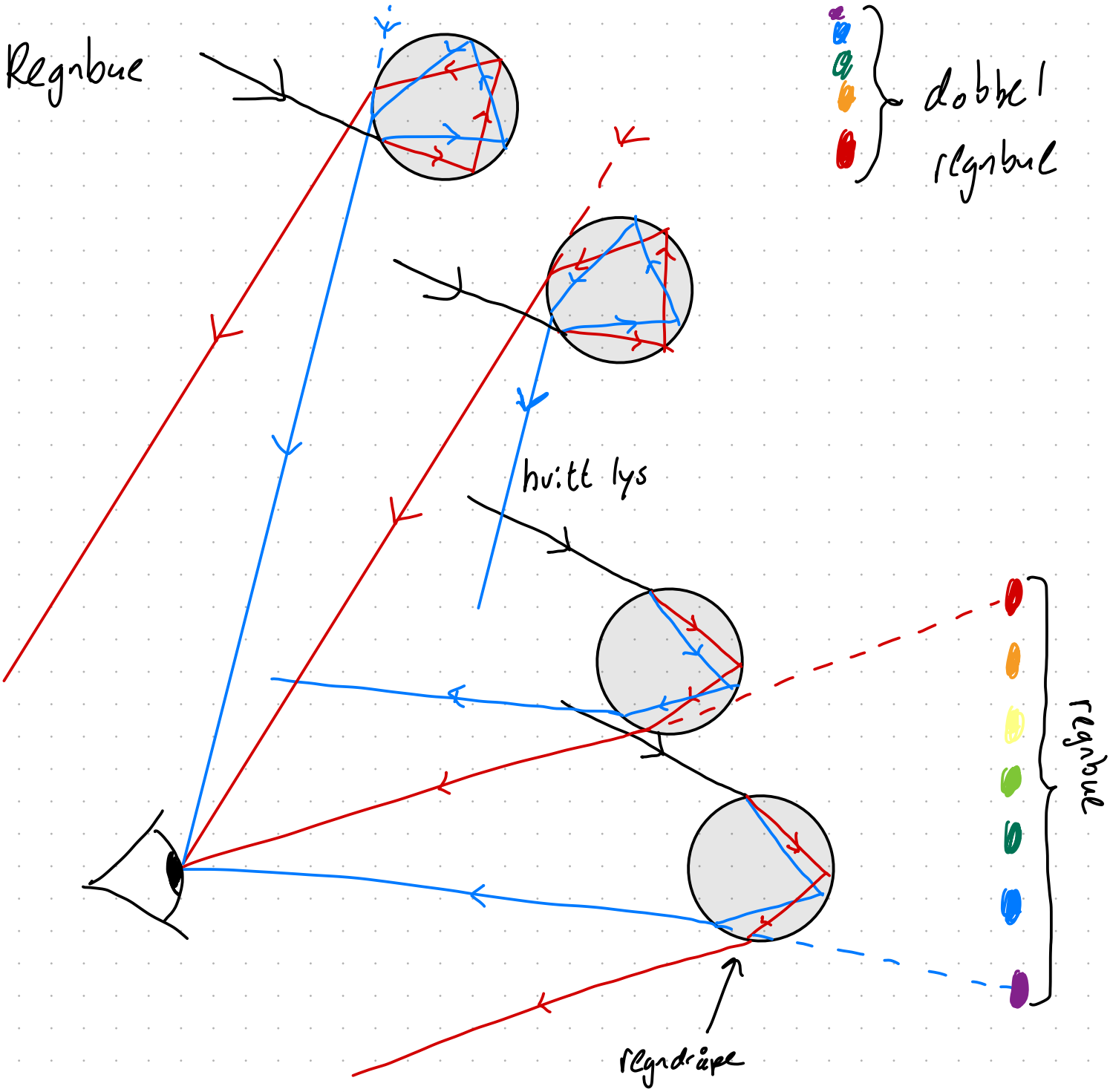
8.4 Lysbrytning og farger

Brytningsindeksen i materialer varierer med bølgelengden/frekvensen til lyset

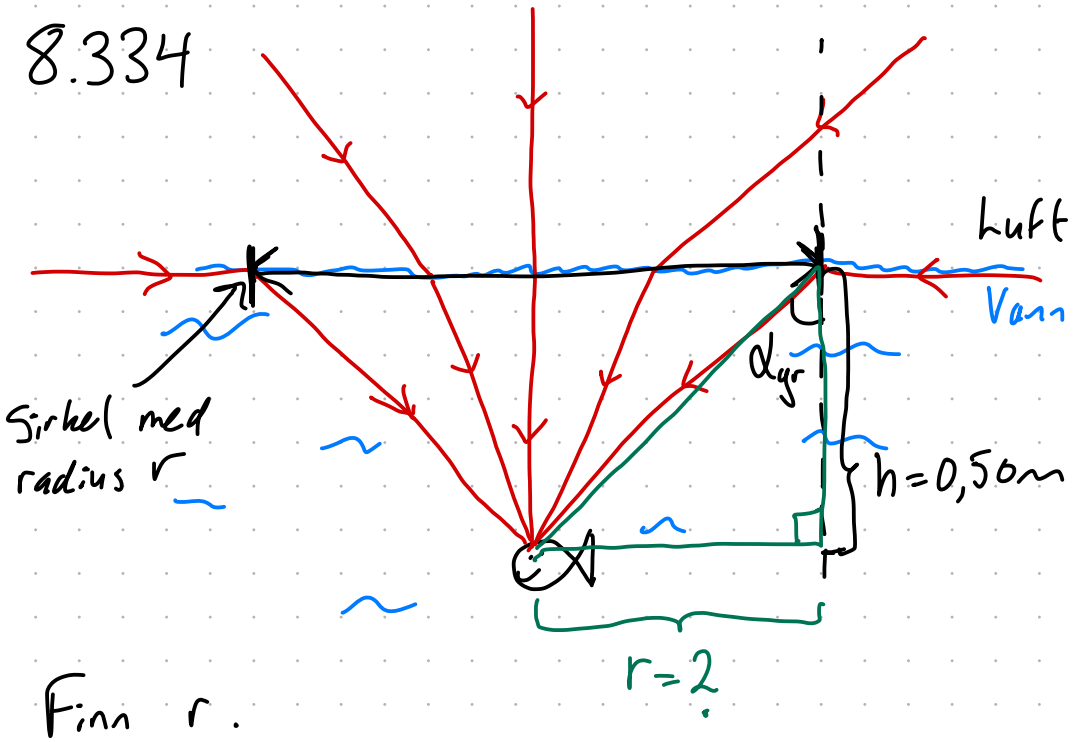


En type glass




Regnbue
dobbel regnbue
hvitt lys
regnbue
regndråpe

8.334



Finn r.

Opplysninger: $n_2 = 1{,}33$

$n_1 = 1{,}00$

$h = 0{,}50\,m$

Snells lov: $n_1 \sin\alpha_1 = n_2 \sin\alpha_2$

$$1 \cdot \underbrace{\sin 90^\circ}_{=1} = 1{,}33 \sin\alpha_{gr}$$

$$\sin\alpha_{gr} = \frac{1}{1{,}33}$$

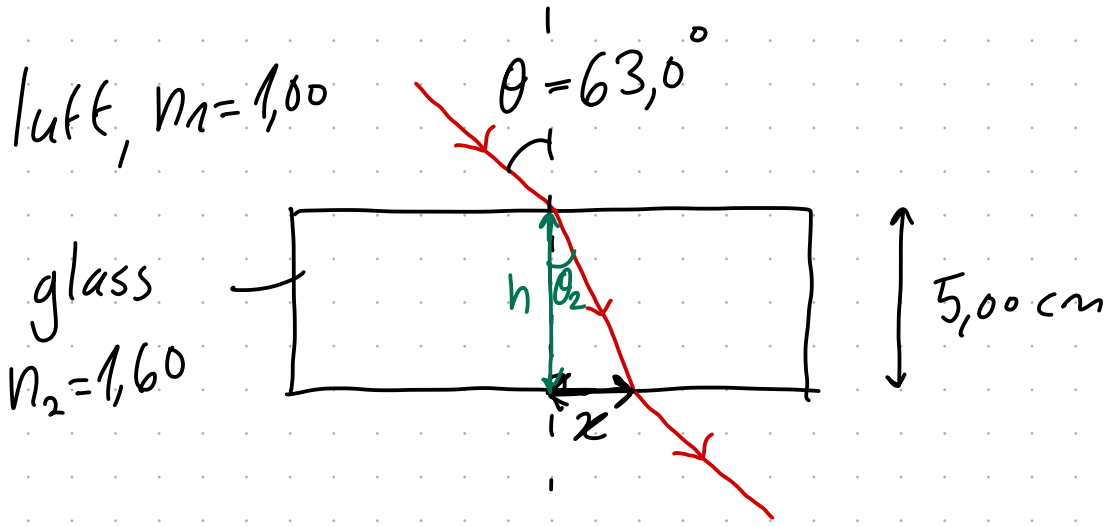
$$\alpha_{gr} = \sin^{-1}\left(\frac{1}{1{,}33}\right) = 48{,}753^\circ$$

$$\tan\alpha_{gr} = \frac{r}{h} \Rightarrow r = h \cdot \tan\alpha_{gr}$$

$$r = 0{,}50\,m \cdot \tan 48{,}753^\circ = 0{,}57\,m$$

Radiusen = 0,57 m

Eksamen vår 2018



a) Finn x

$$\tan\theta_2 = \frac{x}{h} \Rightarrow x = h \cdot \tan\theta_2$$

Vi finner θ_2 med Snells lov.

$$\underbrace{n_1}_{=1}\frac{\sin\theta}{n_2} = \frac{n_2}{n_2}\sin\theta_2$$

$$\sin\theta_2 = \frac{\sin\theta}{n_2}$$

$$\theta_2 = \sin^{-1}\left(\frac{\sin\theta}{n_2}\right) = \sin^{-1}\left(\frac{\sin 63°}{1{,}60}\right)$$

$$\theta_2 = 33{,}84°$$

$$x = h \cdot \tan\theta_2 = 5{,}00\,\text{cm} \cdot \tan 33{,}84°$$

$$\underline{x = 3{,}35\,\text{cm}}$$

b) Hvor lang tid bruker lyset gjennom prismet?

$$\text{Strekning} = \text{fart} \cdot \text{tid}$$

$$s = v \cdot t \quad \rightarrow \quad t = \frac{s}{v}$$

t ?

1. Strekning

$$s \cdot \frac{\cos\theta_2}{\cos\theta_2} = \frac{h}{s} \cdot s \,/\, \cos\theta_2$$

$$s = \frac{h}{\cos\theta_2} = \frac{5{,}00\ \text{cm}}{\cos(33{,}84°)} = 6{,}020\ \text{cm} = 6{,}020 \cdot 10^{-2}\ \text{m}$$

2. Fart

$$n_2 = \frac{c_0}{v}$$

$$v = \frac{c_0}{n_2} = \frac{3{,}00 \cdot 10^8\ \frac{\text{m}}{\text{s}}}{1{,}60} = 1{,}875 \cdot 10^8\ \frac{\text{m}}{\text{s}}$$

$$t = \frac{6{,}020 \cdot 10^{-2}\ \text{m} \cdot \text{s}\ \ 10^{-8}}{1{,}875 \cdot 10^8\ \frac{\text{m}}{\text{s}} \cdot \text{s}\ \ 10^{-8}} = \frac{6{,}020}{1{,}875} \cdot \underbrace{10^{-2} \cdot 10^{-8}}_{10^{-10}}\ \text{s}$$

$10^{-8} \cdot 10^{8} = 1$

$$t = 3{,}21 \cdot 10^{-10}\ \text{s}$$