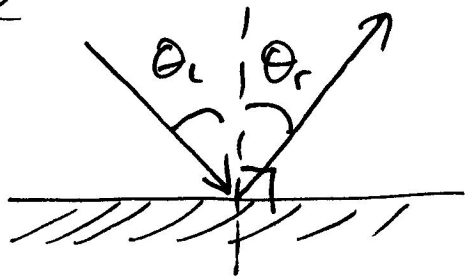
Ch. 20 Homework

Renew: Draw 7, 12, 24, 27, 30 Explain 36-38
Qs: 2, 3, 6, 8, 10, 13, 25, 28, 29
P: 1-3
Extra Problems: 1-12

Review

(7.)



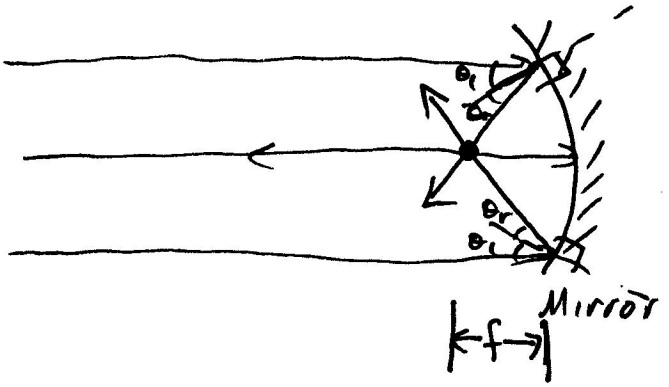
Measured to the normal line (dashed)

$\theta_i \equiv$ angle of incidence

$\theta_r \equiv$ angle of reflection

$\boxed{\theta_i = \theta_r}$

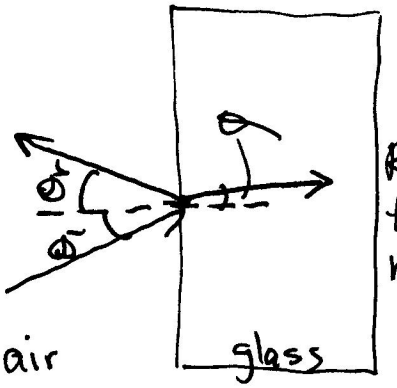
(12.)



Using $\theta_i = \theta_r$ for a mirror, we find the focal length where several parallel incoming rays cross.

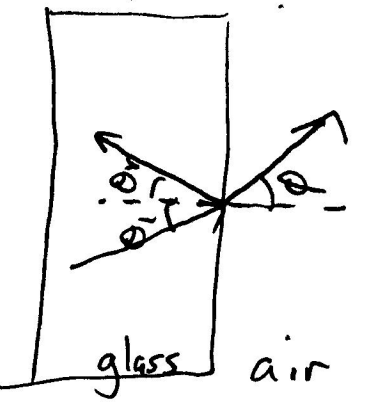
(24.)

Lo index to hi



φ is smaller, Ray bends toward normal

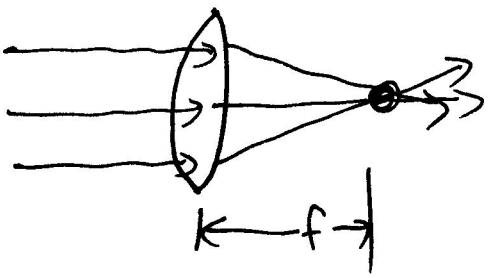
Hi index to lo



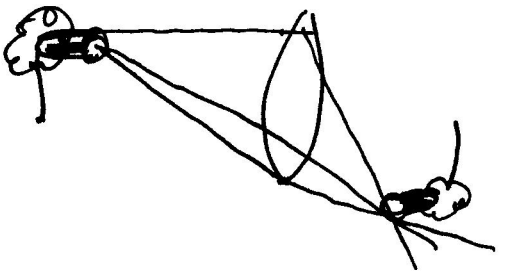
φ is larger, Ray bends away from normal

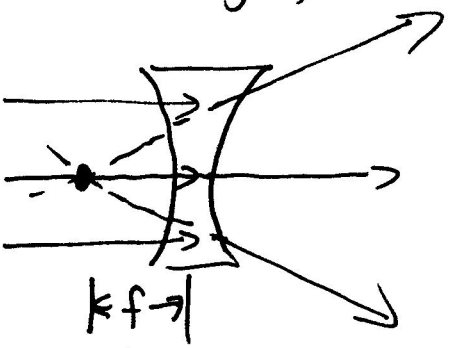
Review

(27.)

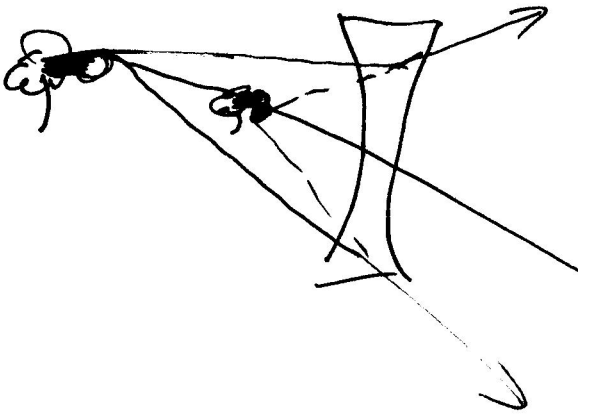


Converging



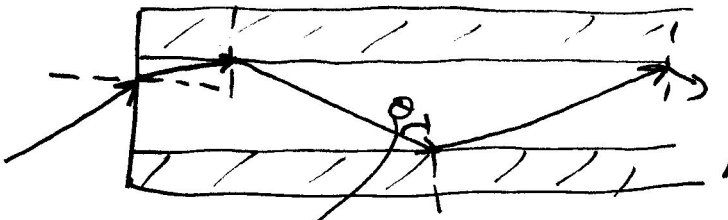


Diverging



(30.)

n_1 = air – low index
n_2 = Medium index
n_3 = High index



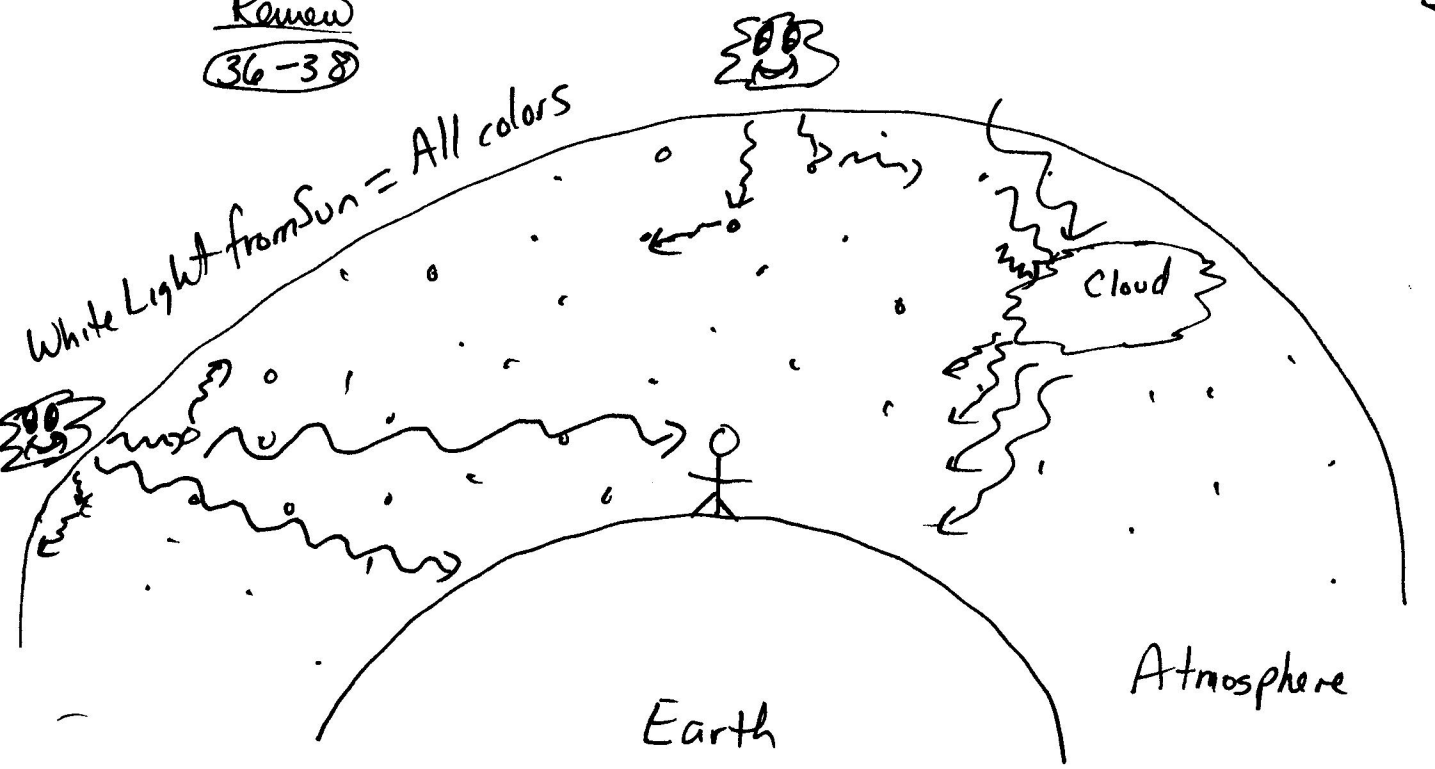
If $\theta > \theta_c$, total internal reflection occurs.

$$n_3 \sin\theta_c = n_2 \sin 90^{1}$$

$$\boxed{\sin\theta_c = \frac{n_2}{n_3}}$$

Ch. 20 HW

Review
(36-38)



Short λs scatter more off particles in atmosphere - (blues, purples)

Sunrise & Sunset - Long wavelengths (orange, red) don't scatter. They get thru to your eye

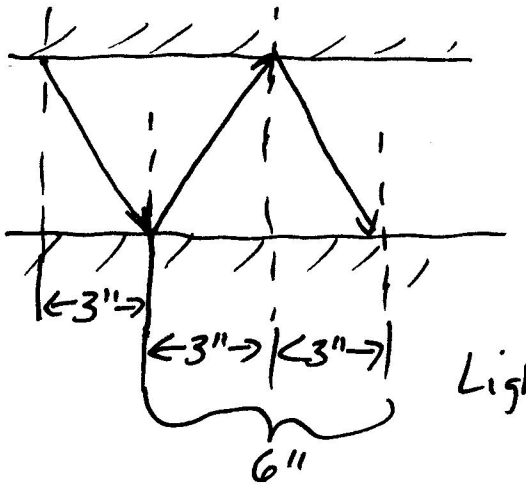
Noon - Less atmosphere, Sun looks yellowish if look directly at it., Sky around sun looks blue due to scatter

Clouds - Made of water droplets & dust. Water (like sugar) scatters a little of <u>all</u> colors. All colors combined look white.

Ch. 20 HW

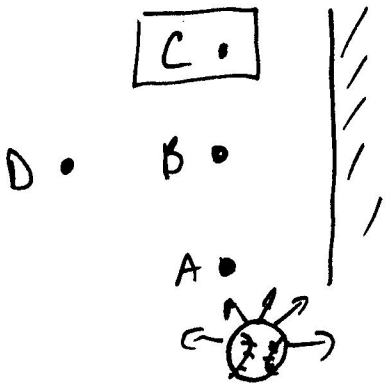
Questions

(2.)



Light will strike bottom mirror 6" over.

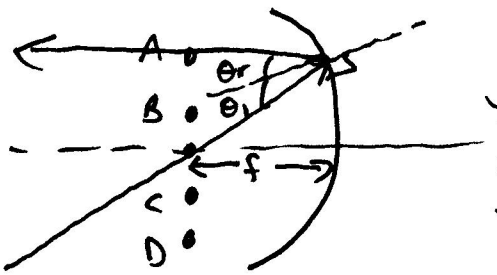
(3.)



C would give the best view

It might be possible to see it at B & D depending on light source.

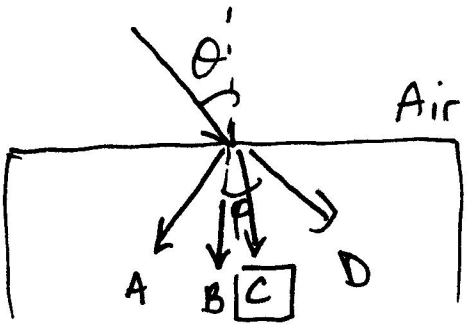
(6.)



A beam coming thru the focal point of a curved mirror will exit parallel to optic axis.

Therefore, pt. [A] is where you expect it.

(8.)



Ray bends toward normal, Ray [C]

Glass is best choice

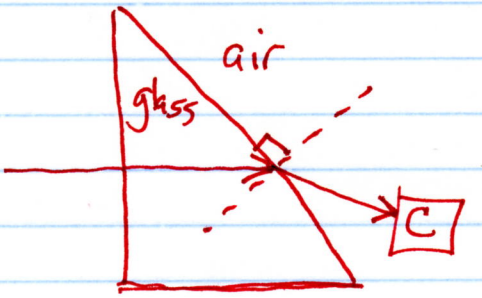
Ch. 20 HW

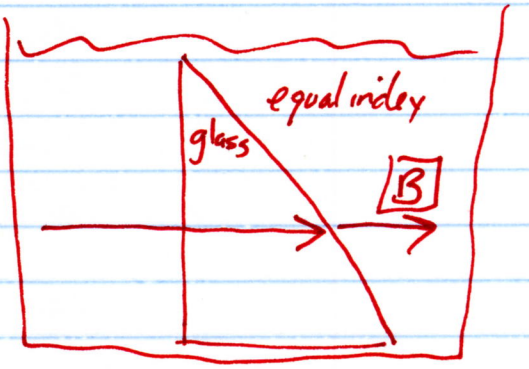
Phy 101

Q's

(5)

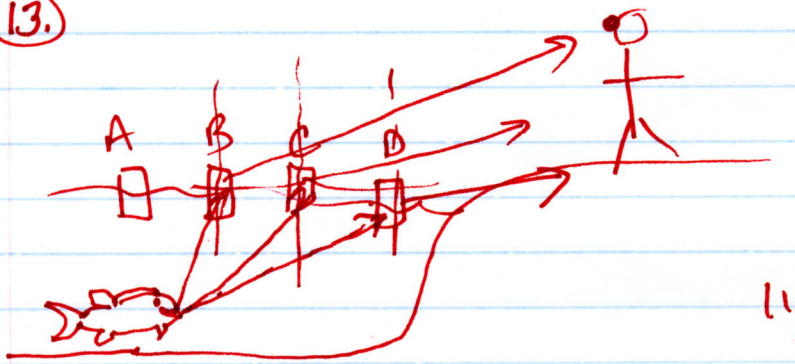
(10.)





If 2 indices are equal, light does not see boundary.

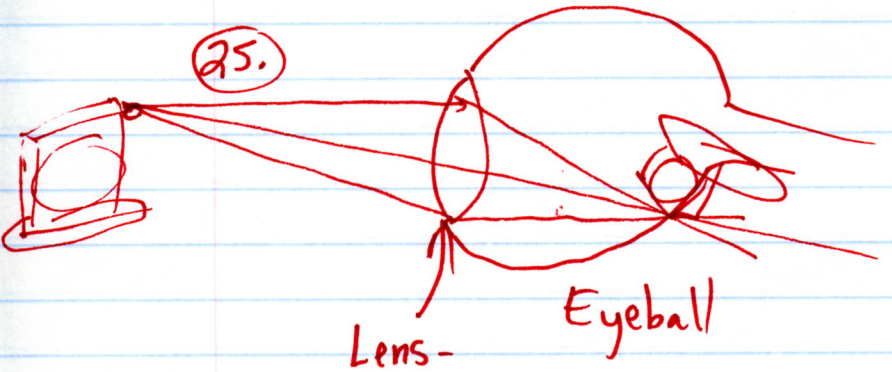
(13.)



[B] Best choice

due to refraction of light when it exits the water

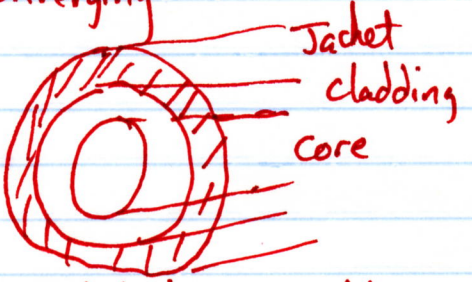
(25.)



Converging lenses produce upside down images

Our brains translate these to upright.

(28.)



Yes, still transmits

Fibers usually have a high index core surrounded by a lower index cladding and then a jacket of plastic to protect it.

Total internal reflection is between core & cladding.

Qs

(29.) Translucent fur - acts like sugar reflecting a little bit of all colors, thus bear looks white. Black skin - absorbs all colors of light. The light which gets thru fur is absorbed into skin warming the bear. When the bear's skin re-radiates radiation (infrared light), that light is partially reflected by fur back into body.

Problems

(1.) $v_{\text{light in medium}} = \frac{c}{n} = \frac{3\times10^8 \text{ m/s}}{1.52} = 1.97\times10^8 \text{ m/s}$

(2.) $v = 2.5\times10^8 \text{ m/s} = \frac{c}{n}$

$$n = \frac{c}{v} = \frac{3\times10^8 \text{ m/s}}{2.5\times10^8 \text{ m/s}} = 1.2$$

(3.) $v = \frac{3\times10^8 \text{ m/s}}{2.4} = 1.25\times10^8 \text{ m/s}$

The slower light moves when it enters a material, the more it bends. Thus, diamond would bend the light more than crown glass.

Extra Problems

(1.) $E = hf = \frac{hc}{\lambda}$ $\quad c = \lambda f$

a) $E = \frac{(6.63 \times 10^{-34}\ J\,s)(3 \times 10^{8}\ m/s)}{6 \times 10^{-7}\ m} = 3.3 \times 10^{-19}\ J$

b) $E = \frac{(6.63 \times 10^{-34}\ J\,s)(3 \times 10^{8}\ m/s)}{5.14 \times 10^{-7}\ m} = 3.87 \times 10^{-19}\ J$

c) $E = \frac{(6.63 \times 10^{-34}\ J\,s)(3 \times 10^{8}\ m/s)}{4.5 \times 10^{-7}\ m} = 4.4 \times 10^{-19}\ J$

(2.)

a) $E = hf$

$f = \frac{E}{h} = \frac{9.95 \times 10^{-16}\ J}{6.63 \times 10^{-34}\ J\,s} = 1.5 \times 10^{18}\ Hz$

b) $c = \lambda f$

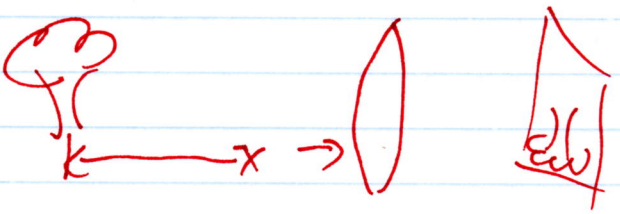
$\lambda = \frac{c}{f} = \frac{3 \times 10^{8}\ m/s}{1.5 \times 10^{18}\ Hz} = 2 \times 10^{-10}\ m$

$= 0.2$ nanometer

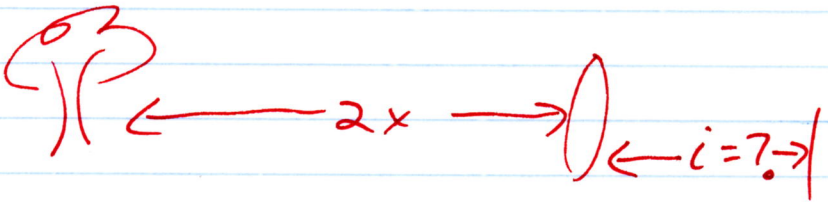
c) Just in the X-ray portion, really a gamma ray.

Extra

③



If



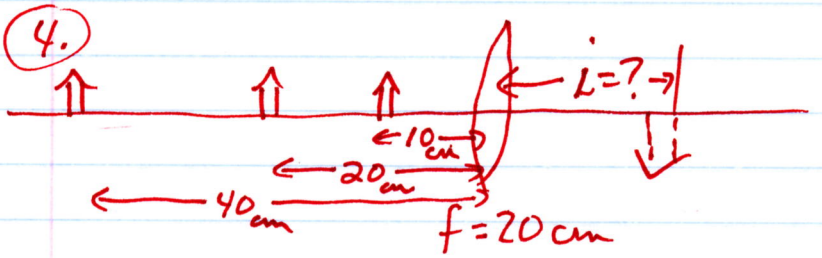
$\frac{1}{f} = \frac{1}{o} + \frac{1}{i}$ If we double the object distance for the same focal length lens, then

$$\frac{1}{i} = \frac{1}{f} - \frac{1}{o}$$

and $\frac{1}{i}$ is a larger number

and $\frac{1}{i}$ is smaller ∴ Move screen IN

④



$$\frac{1}{f} = \frac{1}{o} + \frac{1}{i} \Rightarrow \frac{1}{i} = \frac{1}{f} - \frac{1}{o}$$

$M = -i/o$

a) $\frac{1}{i} = \frac{1}{20} - \frac{1}{40} = 0.025$ $i = 40$ cm $M = -40/40 = 1$

b) $\frac{1}{i} = \frac{1}{20} - \frac{1}{20} = 0$ $i = \text{inf}$ $M = -\frac{\infty}{20} = \text{No image}$

c) $\frac{1}{i} = \frac{1}{20} - \frac{1}{10} = -0.05$ $i = -20$ cm $M = -\frac{-20}{10} = 2$

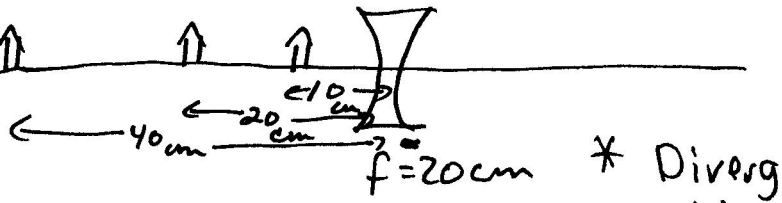
Ch. 20 HW

Phy 101

(10)

Extra

(5.)



* Diverging lenses have negative focal lengths

$\frac{1}{f} = \frac{1}{o} + \frac{1}{i}$ $\quad M = -i/o$

a) $\frac{1}{i} = \frac{1}{f} - \frac{1}{o} = \frac{1}{-20} - \frac{1}{10} = -0.15$ $\quad i = -6.7\text{cm}$ $\quad M = 0.67$

b) $\frac{1}{i} = -\frac{1}{20} - \frac{1}{20} = -0.1$ $\quad i = -10\text{ cm}$ $\quad M = 0.5$

c) $\frac{1}{i} = -\frac{1}{20} - \frac{1}{40} = -0.075$ $\quad i = -13.3\text{cm}$ $\quad M = 0.33$

(6.) $M = 1 = \frac{+i}{o}$ $\quad \frac{1}{f} = \frac{1}{o} + \frac{1}{i}$

a) converging $f = +12\text{ cm}$

$\frac{1}{f} = \frac{1}{o} + \frac{1}{i}$ $\quad$ Real Image $i = o$ $\quad \frac{1}{f} = \frac{1}{o} + \frac{1}{o} = \frac{2}{o}$

$f = \frac{o}{2} \Rightarrow o = 2f$

$\boxed{o = 24\text{cm}}$

b) diverging $f = -12\text{cm}$

$\frac{1}{f} = \frac{1}{o} - \frac{1}{o} = 0$ $\quad$ Virtual Image $i = -o$ $\quad f = \infty$ | Lens up against object

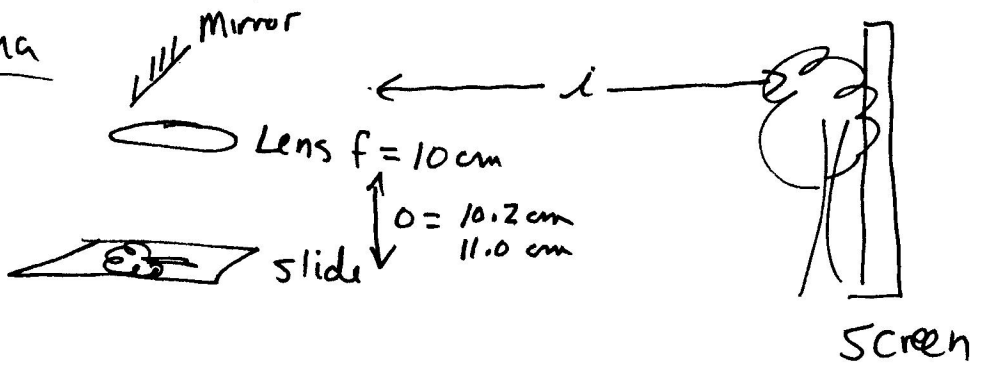
Ch. 20 HW

Phy 10

(11)

Extra

(7.)



$$\frac{1}{f} = \frac{1}{o} + \frac{1}{i} \longrightarrow \frac{1}{i} = \frac{1}{f} - \frac{1}{o}$$

$M = -\frac{i}{o}$

a) $\frac{1}{i} = \frac{1}{10} - \frac{1}{10.2} = 0.00196$ $\quad i = 510\text{ cm}$ $\quad M = -50$

b) $\frac{1}{i} = \frac{1}{10} - \frac{1}{11} = 0.0091$ $\quad i = 110\text{ cm}$ $\quad M = -10$

(8.) Snell's Law $\quad n_1 \sin\theta_1 = n_2 \sin\phi$

Law Ref. $\quad \theta_i = \theta_r$

a) $\theta_{ref} = 27°$

$1 \sin 27 = 1.628 \sin\phi$ $\quad \sin\phi = \frac{\sin 27}{1.628} = 0.279$

$\boxed{\phi = 16.2°}$

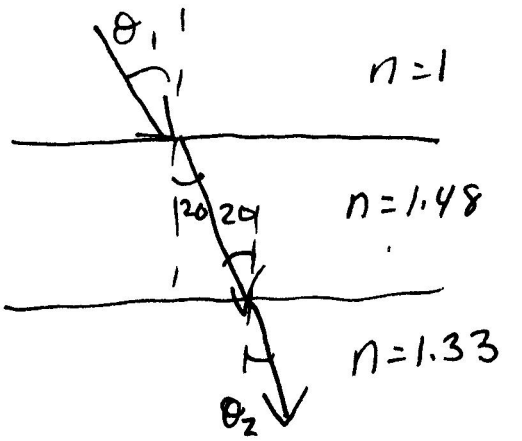
b) $\theta_{ref} = 27°$

$1 \sin 27 = 1.923 \sin\phi$ $\quad \sin\phi = \frac{\sin 27}{1.923} = 0.236$

$\boxed{\phi = 13.7°}$

Extra

(9.)



air to oil $n_1 \sin\theta_1 = n_2 \sin 20$

$1 \sin\theta_1 = 1.48 \sin 20$

$\sin\theta_1 = \frac{1.48}{1} \sin 20 = 0.506$

$\theta_1 = 30.4°$

oil to water

$n_1 \sin 20 = n_2 \sin\theta_2$

$1.48 \sin 20 = 1.33 \sin\theta_2$

$\sin\theta_2 = \frac{1.48}{1.33} \sin 20 = 0.381$

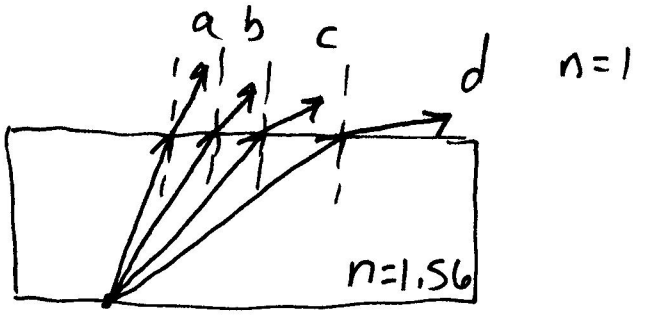
$\theta_2 = 22.4°$

(10.) Purple light bends more toward the normal inside the prism than red light. This must mean that the index of refraction of the prism depends on the light's wavelength.

Blue bends better!

Extra

(11.)



(12.) a) Ray a 15° in glass

$1.56 \sin 15 = 1 \sin\phi$ $\phi = 23.8°$

b) Ray b 30° in glass

$1.56 \sin 30 = 1 \sin\phi$ $\phi = 51.2°$

c) Ray c $39.8\overset{6}{\blacksquare}°$ in glass

$1.56 \sin 39.8\overset{6}{\blacksquare} = 1 \sin\phi$ $\phi = 88.9°$

d) Ray d 45° in glass

$1.56 \sin 45 = 1 \sin\phi$ $\phi =$ Error - undefined!

$\sin\phi = 1.103$

Total internal reflection!