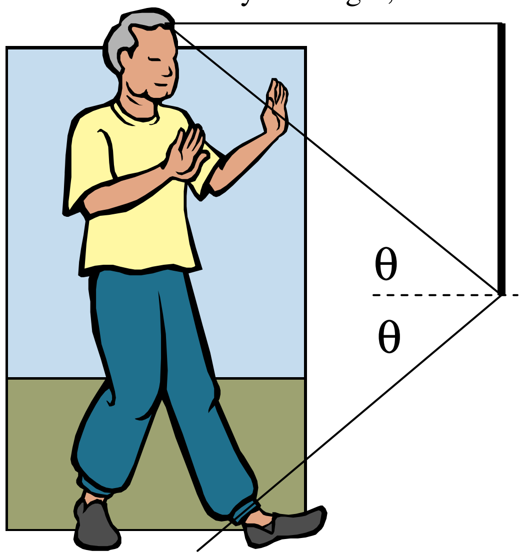
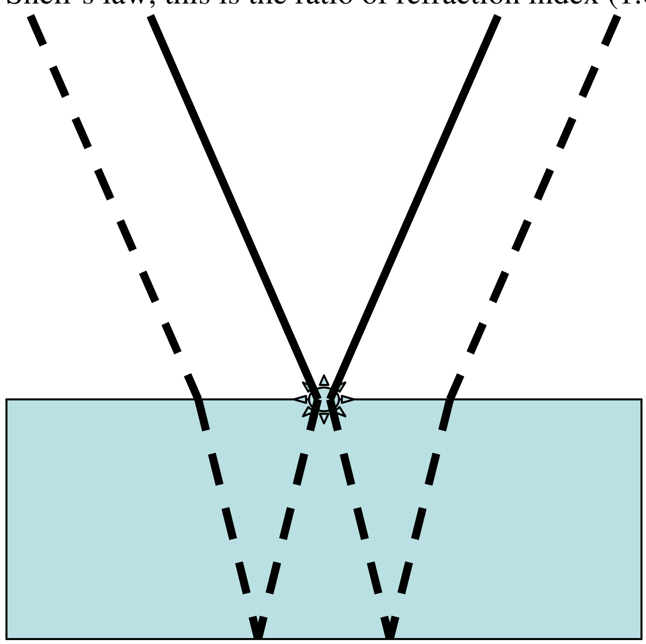
1. 2-4

Assuming eyes at top of the head, the law of reflection allows you to see all of yourself with a mirror half your height, the same height off the floor.

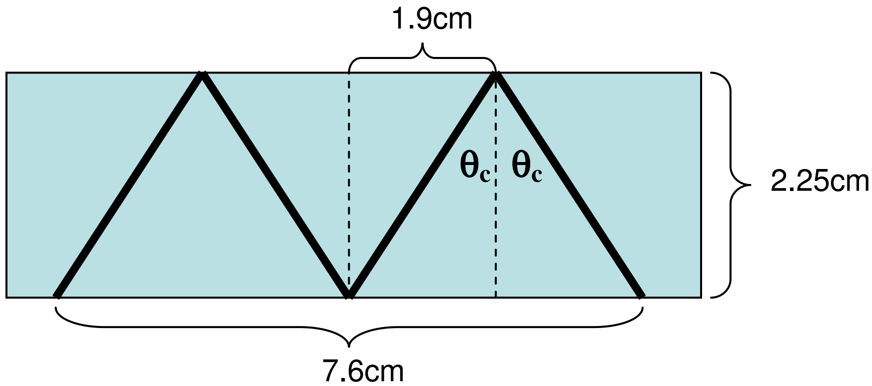


2. 2-6

The second image is from reflection off the bottom surface.
The ratio of distances (3mm/1.87mm) is the same as the ratio of sines of the angles; by Snell's law, this is the ratio of refraction index (1.6)



3. 2-7



$n_g \sin \theta_c = n_{air} \sin \pi/2 \sim 1$
$\theta_c = \text{asin}(1/n_g) = \text{atan}(1.9/2.25)$
$n_g = 1.55$

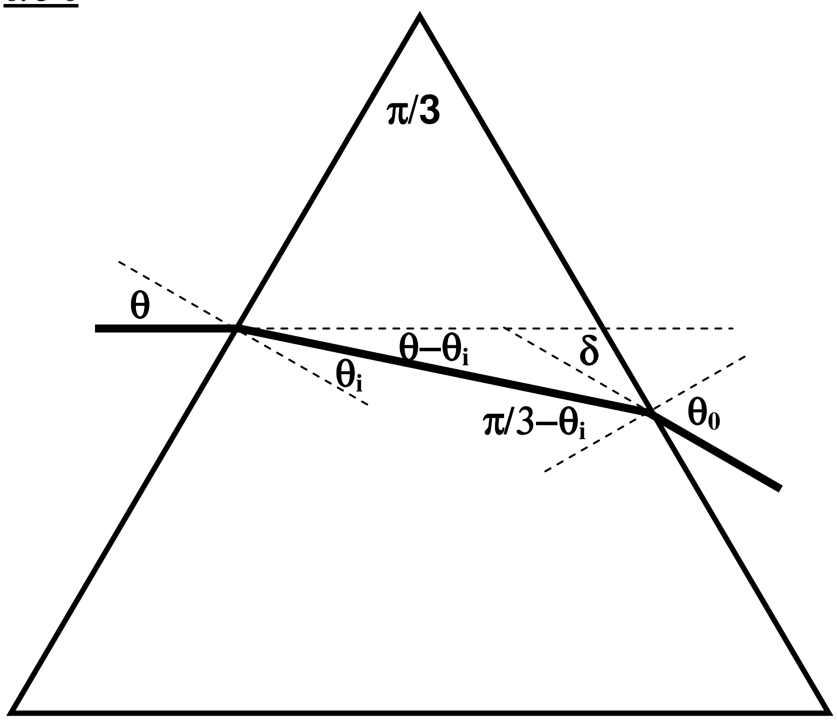
4. 2-10
Reflected image:
Use Eq. 2-12 to find
s'=-7.5cm.
Refracted image:
5cm/1.5=10/3cm from flat surface. See problem 8 below.

The reflected image therefore appears 10cm below the flat surface.

5. 2-32
At any interface *i*,
$n_i \sin\theta_i = n_{i+1} \sin\theta_{i+1}$
At interface i+1,
$n_{i+1} \sin\theta_{i+1} = n_{i+2} \sin\theta_{i+2}$
so
$n_i \sin\theta_i = n_i + 2 \sin\theta_{i+2}$

by induction,
$n_i \sin\theta_i = n_f \sin\theta_f$

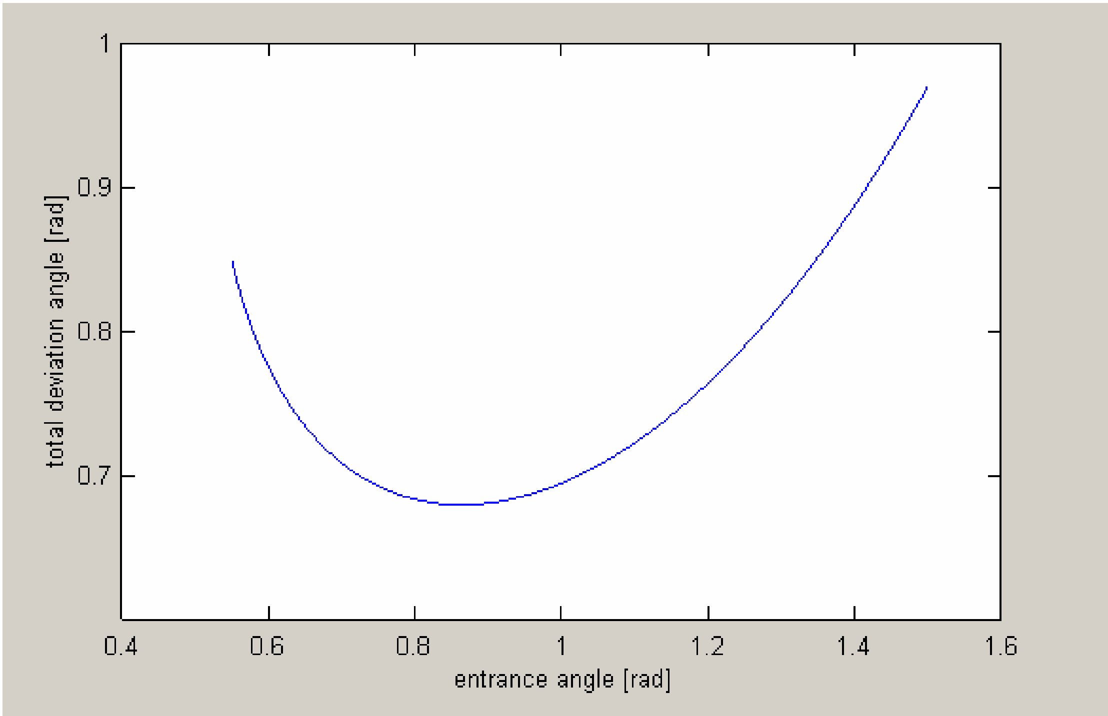
6. 3-6




```
clear
ng=1.52;
ii=1;
for theta=0.55:0.0001:1.5
 theta_i=asin(sin(theta)/ng);
 theta_0=asin(ng*sin(pi/3-theta_i));
 delta=theta+theta_0-pi/3;
 t(ii)=theta;
 d(ii)=delta;
 ii=ii+1;
end
plot(t,d);
xlabel('entrance angle [rad]');
ylabel('total deviation angle [rad]')

%check
[a,b]=min(d)
2*t(b)-pi/3
```

a = 0.67943
b = 3134
ans = 0.67940

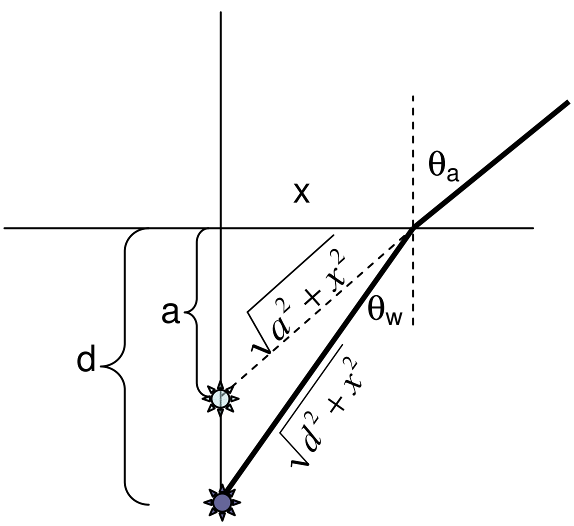


So minimum deviation is ~0.6794 rad.

7. 3-7

Just re-do the above w/ ng=1.525 and 1.535 and take the difference:
0.7026-0.6872=0.0154 rad (~0.9 deg)

8. Prove that to someone looking straight down into a swimming pool, any object in the water will appear to be 3/4 of its true depth. (HINT: n_{water}=4/3)



$$n_w \sin\theta_w = n_a \sin\theta_a$$

$$n_w \frac{x}{\sqrt{d^2+x^2}} = \frac{x}{\sqrt{a^2+x^2}}$$

For infinitesimal x, $\frac{a}{d} = \frac{1}{n_w} = 3/4$

9. Light is incident in air perpendicularly on a sheet of crown glass having an index of refraction of 1.552. Determine both the reflectance and the transmittance.

$$R = \left(\frac{n_i - n_t}{n_i + n_t}\right)^2 = 0.043 \qquad T = \frac{4n_i n_t}{(n_i + n_t)^2} = 0.957$$