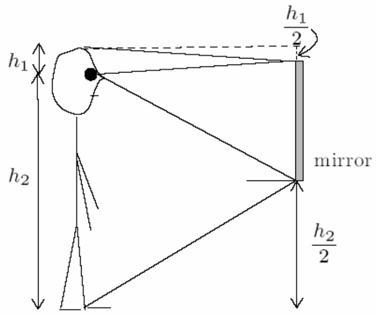
2-4. See the figure below. Let the height of the person be $h = h_1 + h_2$.

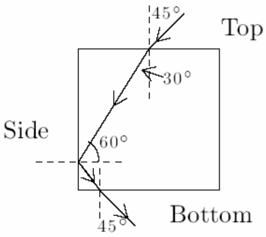


The person must be able to see the top of his head and the bottom of his feet. From the figure it is evident that the mirror height is:

$$h_{\text{mirror}} = h - h_1/2 - h_2/2 = h/2$$

The mirror must be half the height of the person. So for a person of height six ft person, the mirror must be 3 ft high.

2-5. Refer to the figure.

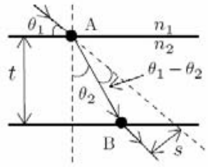


At Top: $(1)\sin 45 = \sqrt{2}\sin\theta' \Rightarrow \theta' = 30$
At Side: $\sqrt{2}\sin 60° = (1)\sin\theta', \sin\theta' = \sqrt{1.5} > 1$
Thus total internal reflection occurs.
At Bottom: reverse of Top: $\theta' = 45°$

2-6. The microscope first focuses on the scratch using direct rays. Then it focuses on the image I_2 formed in a two-step process: (1) reflection from the bottom to produce an intermediate image I_1 and (2) refraction through the top surface to produce an image I_2. Thus, I_1 is at $2t$ from top surface, and I_2 is at the apparent depth for I_1, serving as the object: $s' = \frac{2t}{n}$ or $n = \frac{2t}{s'} = \frac{3}{1.87} = 1.60$

2-8. Referring to the figure one can see that,

$s = \text{AB}\sin(\theta_1 - \theta_2)$ and $\text{AB} = \frac{t}{\cos\theta_2}$. Therefore,
$s = \frac{t\sin(\theta_1 - \theta_2)}{\cos\theta_2}$. For $t = 3\,\text{cm}$, $n_2 = 1.50$, $\theta_1 = 50°$,
Snell's law gives, $\sin\theta_2 = \frac{n_1}{n_2}\sin\theta_1 = \frac{1}{1.5}\sin 50°$.
Then, $\theta_2 = 30.71°$ and $s = \frac{3\sin(50° - 30.71°)}{\cos 30.71°} = 1.153\text{cm}$.



2-9. Image of near end: $s = 60\text{cm}$, $\frac{1}{60} = \frac{1}{s'} = \frac{1}{-40}$, $s' - 24\text{cm}$

Image of far end: $s = 60 + 100\,\text{cm}$, $\frac{1}{160} + \frac{1}{s'} = \frac{1}{-40}$, $s' = -32\text{cm}$. So, $L' = \Delta s' = -24 - (-32) = 8\text{cm}$

2-10. (a) See Figure 2-34 in the text. Image due to rays directly from bubble through plane interface:
$\frac{n_1}{s} + \frac{n_2}{s'} = 0$ or $\frac{1.5}{s} + \frac{1}{s'} = 0 \Rightarrow s' = -3.33\,\text{cm}$.

(b) Image due to rays first reflected in spherical mirror, then refracted through plane interface:
reflection: $\frac{1}{2} + \frac{1}{s_1'} = -\frac{2}{R}$ and $\frac{1}{2.5} + \frac{1}{s_1'} = -\frac{2}{-7.5}$ $s_1' = -7.5\text{cm}$
refraction: $\frac{n_1}{s} + \frac{n_2}{s_2'} = 0$ or $\frac{1.5}{15} + \frac{1}{s_2'} = 0$ $s_2' = -10\text{cm}$
Thus the images are at 3.33 cm and 10 cm behind the interface.

2-32. Refer to Figure 2-39 in the text.

(a) Let the angle with the normal to the interface in each region of index of refraction n_i be θ_i. Then applying Snell's law sequentially at each interface leads to,

$$n_0 \sin\theta_0 = n_1 \sin\theta_1 = n_2 \sin\theta_2 ... = n_i \sin\theta_i ... = n_f \sin\theta_f$$

That is,

$$n_0 \sin\theta_0 = n_f \sin\theta_f$$

(b) In each medium the lateral displacement is $t_i \tan\theta_i$. The total lateral displacement y due to N media can be written as,

$$y = \sum_{i=1}^{n} t_i \tan\theta_i$$

where $\sin\theta_i = (n_0/n_i)\sin\theta_0$.

2-34. The focal length is the image position for incident parallel light rays (object at ∞). In all cases the following relation is to be used

$$\frac{n_1}{s} + \frac{n_2}{s'} = \frac{n_2 - n_1}{R} \Rightarrow \frac{n_1}{\infty} + \frac{n_2}{f} = \frac{n_2 - n_1}{R} \Rightarrow \frac{n_2}{f} = \frac{n_2 - n_1}{R}$$

For the situation in which the center of curvature in medium with $n = 4/3$:

For light incident from the medium of index 1: $\frac{4/3}{f} = \frac{4/3 - 1}{10}$ or $f = +40\text{cm}$

For light incident from the medium of index 4/3: $\frac{1}{f} = \frac{1 - 4/3}{-10}$ or $f = +30\text{cm}$

For the situation in which the center of curvature is in the medium with $n = 1$,

For light incident from the medium of index 4/3: $\frac{4/3}{\infty} + \frac{1}{f} = \frac{1 - 4/3}{10}$ or $f = -30\text{cm}$

For light incident from the medium of index 1: $\frac{1}{\infty} + \frac{4/3}{f} = \frac{4/3 - 1}{-10}$ or $f = -40\text{cm}$