Ch. 22

12. $(3\times10^{8}\ m/s)(10^{-9}\ s) = .3\ m$

15. $f\lambda = c \quad \lambda = 200m \rightarrow f = \frac{c}{\lambda} = \frac{3\times10^{8}\ m/s}{200\ m} = 1{,}500{,}000\ Hz$

24. $L = \frac{\lambda}{2} \quad \lambda = \frac{c}{f} = \frac{3\times10^{8}\ m/s}{90\times10^{6}\ 1/sec} = 3.\overline{3}\ m$

$L = \frac{3.3}{2} = 1.7\ m$

44. $I = \frac{P}{A} = \frac{P}{4\pi r^2} = \frac{100W}{4\pi(2.00)^2} = 1.99\ W/m^2$

but $I = \frac{1}{2}c\epsilon_0 E_0^2$

$\Rightarrow 1.99 = \frac{1}{2}(3\times10^{8})(8.85\times10^{-12})E^2$

$\therefore E = \left[\frac{2(1.99\ \frac{W}{m^2})}{(3\times10^{8}\ \frac{m}{s})(8.85\times10^{-12}\ \frac{C^2}{N\cdot m^2})}\right]^{1/2}$

$= 38.7\ \frac{V}{m}$

Ch. 22

45. $\ell = ct = (3\times10^8 \frac{m}{s})(2\times10^{-9} s) = .6m$

$r = \frac{2.5mm}{2} = 1.25mm = .00125m$

a) as above $\ell = .6m$

b) Volume of Cylinder $= \pi r^2 \ell = \pi(.00125m)^2(.6m)$

$= 2.945\times10^{-6} m^3$

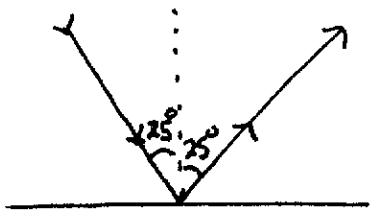
Energy Density $= \frac{Energy}{V} = \frac{3.0J}{2.945\times10^{-6} m^3} = 1.0\times10^6 \frac{J}{m^3}$

Ch. 23

1. Scattering $\sim \frac{1}{\lambda^4}$

$$\frac{\frac{1}{\lambda_r^4}}{\frac{1}{\lambda_b^4}} = \frac{\lambda_b^4}{\lambda_r^4} = \left(\frac{390\text{nm}}{780\text{nm}}\right)^4 = .0625 \text{ or } 6.25\%$$

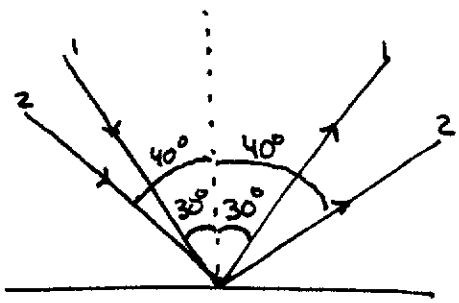
6.



$\theta_i = \theta_r$

Total subtended angle from incident ray $= 25° + 25° = 50°$

7.

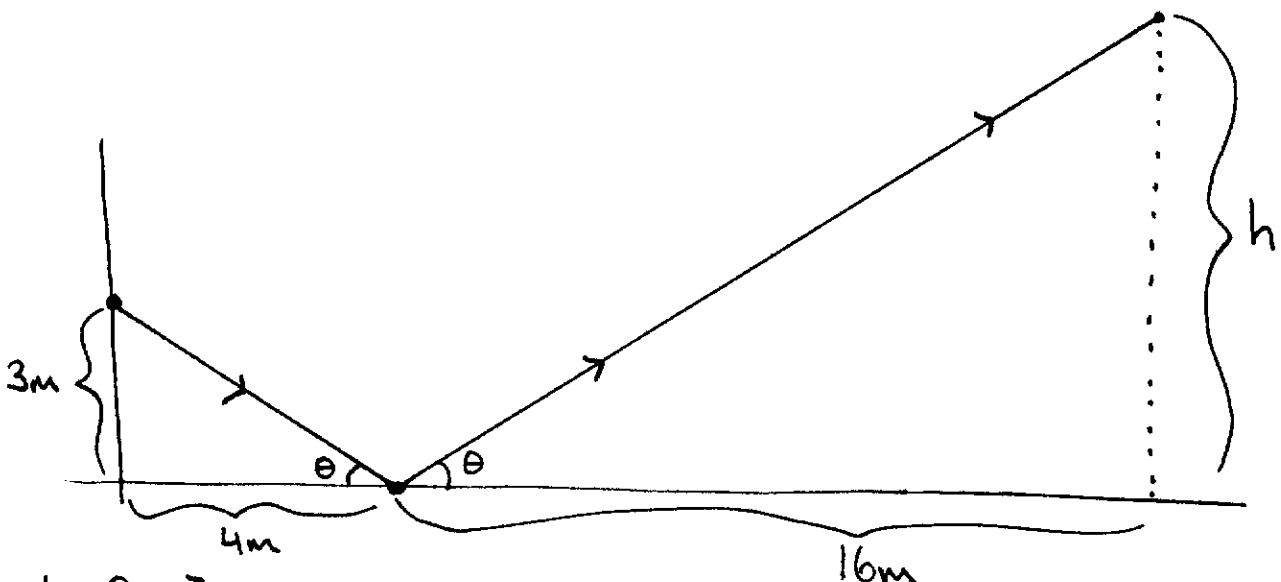


$\theta_i = \theta_r \quad \theta_{1i} = 30° \quad \theta_{2i} = 40°$

$\therefore \theta_{1r} = 30° \quad \theta_{2r} = 40°$

$|\theta_{1r} - \theta_{2r}| = |30° - 40°| = 10°$

9.



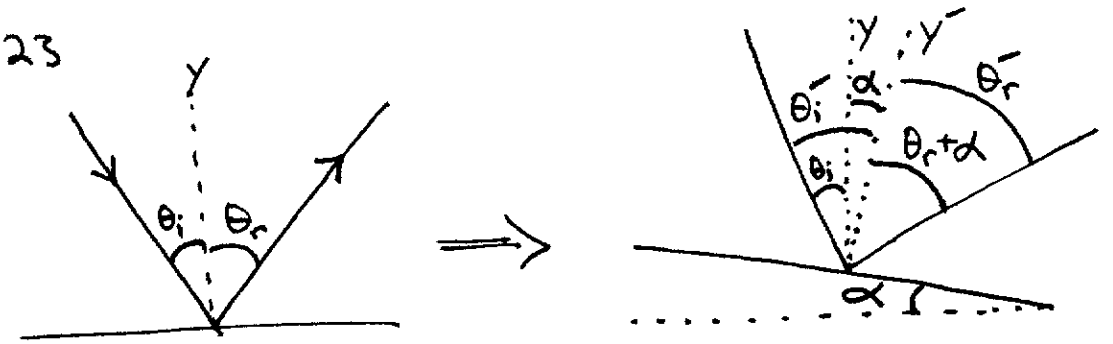
$\tan\theta = \frac{3}{4}$

$\tan\theta = \frac{h}{16}$

$\Rightarrow h = 16\tan\theta = 16\left(\frac{3}{4}\right) = 12\text{m}$

Ch. 23

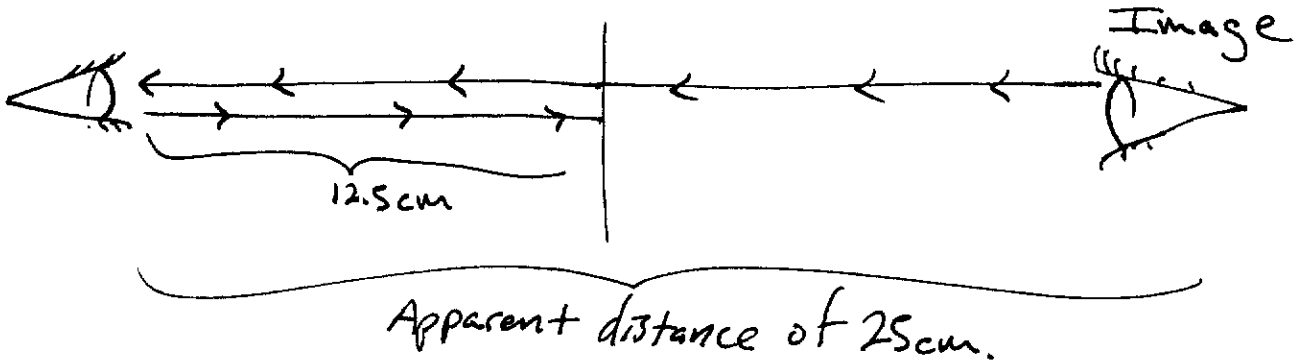
10.



When the mirror moves through an angle α such that the normal axis to the mirror rotates from y to y' then so does the reflected angle change from θ_r to θ_r'. But the total angle the new beam moves through is, $\theta_r'+\alpha$. From the diagram we see that $\theta_r' = \theta_r + \alpha$.

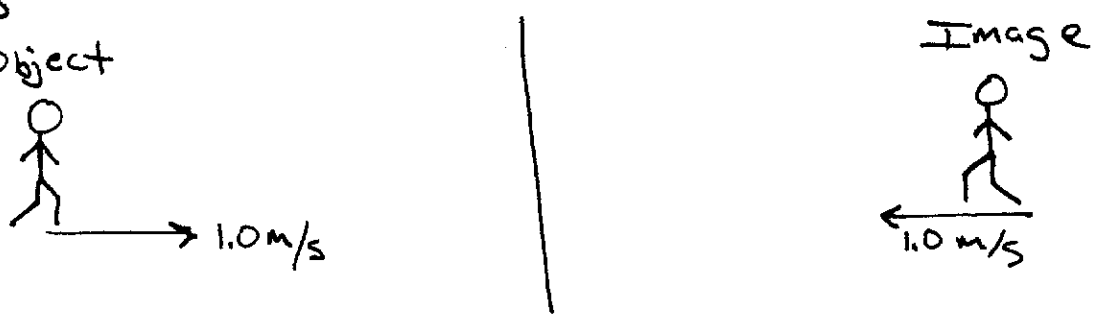
$\therefore$ Total angle $= \theta_r'+\alpha = \theta_r+\alpha+\alpha = \theta_r+2\alpha$

11. Objects need to appear 25cm away. This occurs when the mirror is 12.5cm from the person.



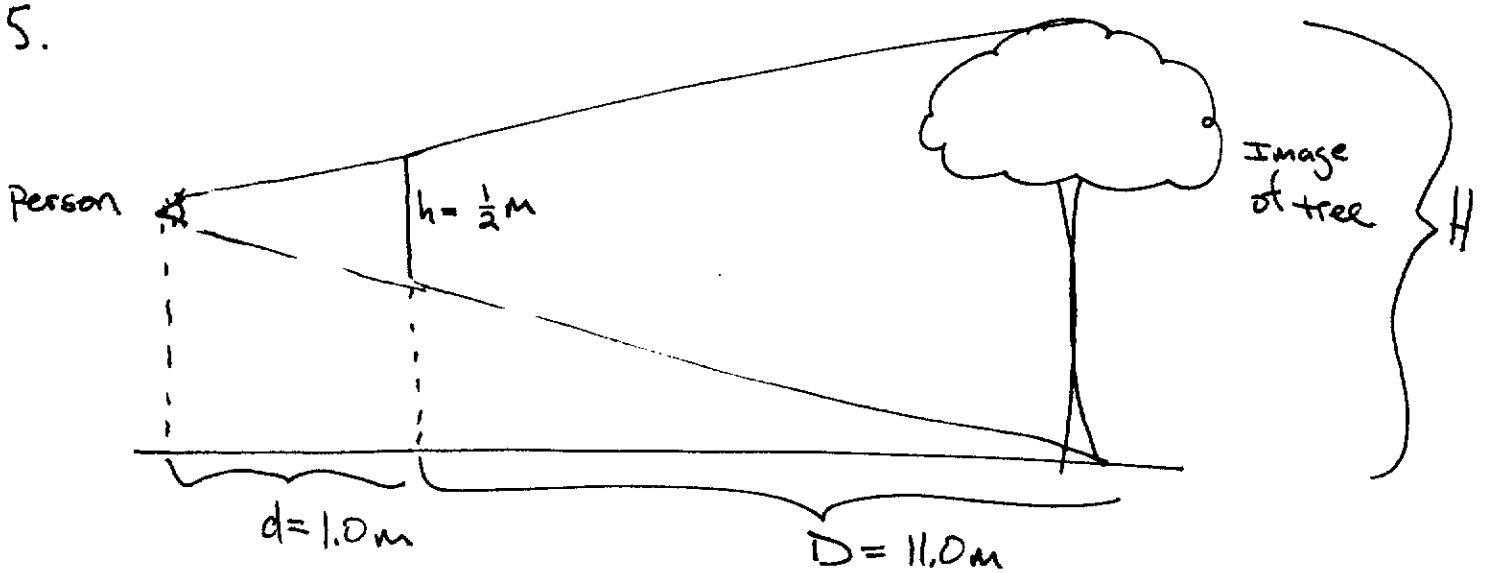
Ch. 23

12.



Object and image appear to approach each other at 2.0 m/s

15.



$$\frac{h}{d} = \frac{H}{D+d} \Rightarrow H = \frac{h(D+d)}{d} = \frac{\frac{1}{2}(11+1)}{1} = 6.0\ \text{m}$$

18.

Slide 1 ——— 1
——— 2

Slide 2 ——— 3
——— 4

4 total surfaces each reflecting 4% of the incident light

$\therefore (96.00\%)^4 = 84.9\%$ of original light gets through.

20.

eyes 4" below top of head → mirror 2" below top of head.

Top of mirror = $6' - 2'' = 70''$

bottom of mirror = $70'' - 36'' = 34''$

29. $V = \frac{c}{n} = \frac{3 \times 10^8 m/s}{2.42} = 1.24 \times 10^8 m/s$

30. $\lambda = \frac{\lambda_0}{n} = \frac{540nm}{1.33} = 406nm$

36. $N = \frac{d}{\lambda} = \frac{d}{\lambda_0/n} = \frac{1 \times 10^{-2} m}{500 \times 10^{-9} m / 1.60} = 3.2 \times 10^4$

Ch. 23

38. a) $t = \frac{l}{v_r} = \frac{l}{c/n} = \frac{(12\,mi)(1609\,m/mi)}{(3\times10^8\,m/s)(1.52)} = 9.79\times10^{-5}\,sec$

$= 97.9\,\mu s$

b) $l_b = l - 1.8\,mi = 10.2\,mi$

$v_b = \frac{l_b}{t} = \frac{(10.2\,mi)(1609\,m/mi)}{9.789\times10^{-5}\,s} = 1.68\times10^8\,m/s$

c) $t = \frac{\Delta l}{v_b} = \frac{(1.8\,mi)(1609\,m/mi)}{1.677\times10^8\,m/s} = 1.73\times10^{-5}\,sec$

44. $n_{air}\sin\theta_{air} = n_{water}\sin\theta_{water}$

$\Rightarrow \sin\theta_{air} = \frac{n_{water}\sin\theta_{water}}{n_{air}} = \frac{1.33(\sin 35^\circ)}{1} = 0.7646$

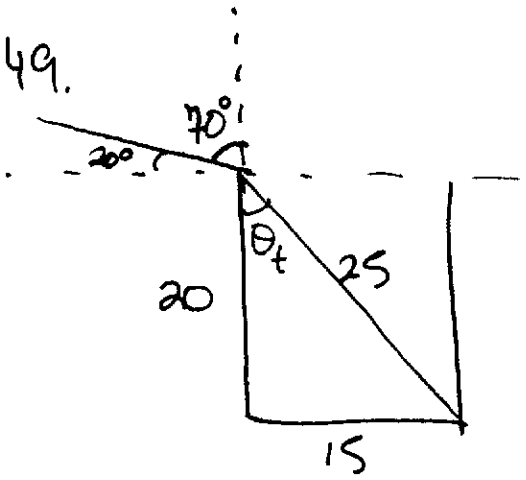
$\arcsin(.7646) = 50^\circ$

46. No

$\arctan\left(\frac{4}{3}\right) = 53.1° >$ critical angle

$\therefore$ image of coin is reflected off the water/air interface

49.



$$n_{air} \sin 70° = n_{liquid} \sin\theta_{liquid} = n_{liquid}\left(\frac{3}{5}\right)$$

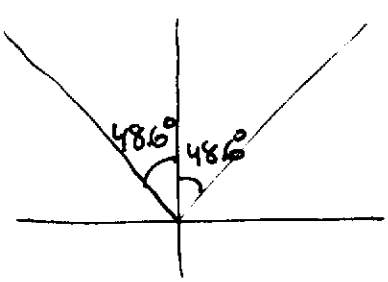
$$\Rightarrow n = \frac{(1.00)(\sin 70°)}{3/5}$$

$$= 1.6$$

64. $$\sin\theta_c = \frac{n_t}{n_i} = \frac{1.33}{1.55} = 0.85806$$

$$\arcsin(0.85806) = 59.1°$$

67. $$\sin\theta_c = \frac{n_{air}}{n_{water}} = \frac{1}{1.33} = 0.7502$$



$$\arcsin(.7502) = 48.6°$$

$\therefore$ total cone angle $= 2(48.6) = 97.2°$