Example Exam Solutions

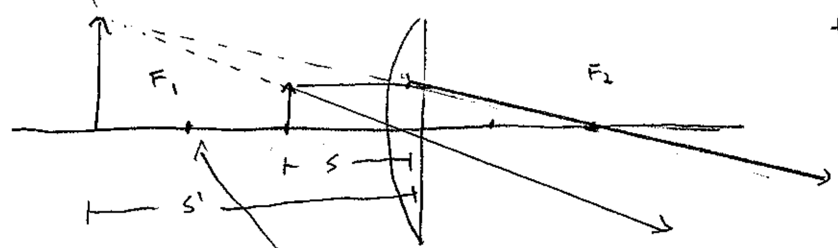
1.

$n = 1.5 \qquad s = R$

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \qquad R_1 = R, \quad R_2 = \infty$$

$$f = \frac{R}{(1.5-1)} = 2R$$

a.)



Position is within f, so image is virtual, erect

b.)

$$\frac{1}{s'} + \frac{1}{s} = \frac{1}{f}$$

$$\frac{1}{s'} + \frac{1}{R} = \frac{1}{2R}$$

so image should be here!

$$\frac{1}{s'} = -\frac{1}{2R}$$

$$\boxed{s' = -2R}$$

$$m = -\frac{s'}{s} = -\frac{-2R}{R}$$

$$\boxed{m = 2}$$

(2.)

$\vec{E} = \hat{k} E_0 \cos(kx - \omega t)$

a.) Traveling in the positive x-direction, $\hat{i}$.

b.) Polarized in the z-direction.

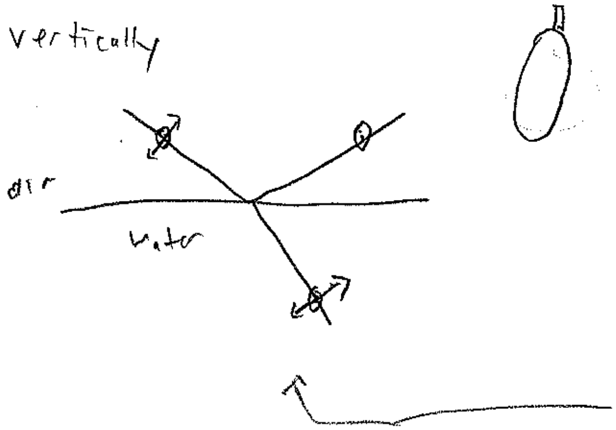
c.) $F = P A$ ← area
↑ pressure

$P_{rad} = \frac{I}{c}$

$I = \frac{E_0^2}{2\mu_0 c}$

$F = \left(\frac{E_0^2}{2\mu_0 c}\right)\left(\frac{1}{c}\right) \cdot A = \frac{E^2 A}{2\mu_0 c^2}$

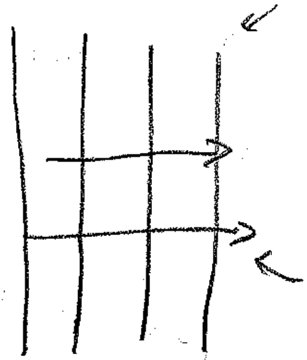
(3.) vertically



reflected light has a larger component of horizontally polarized light. as we can see from the case at Brewster's angle.

(4.) A half-wave plate rotates the polarization direction of linear polarized light by $\pi/2$, giving linearly polarized light out.
A slightly shorter wavelength will not give an exact $\pi/2$ rotation, leaving light slightly elliptical. so (b.)

(5.)



← wave fronts are surfaces of constant phase

← rays are perpendicular to wavefronts

(6.) for a mirror $f = R/2$

plano-convex $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = (2-1)\left(\frac{1}{R} - \frac{1}{\infty}\right)$

$f = R$ **plano-convex is longer**

fixed

(7)

↑ 3 points of constant zero intensity