PHYSICS 232 - Solution Key to Sample Test 2

1a. $I = \frac{1}{2}\epsilon_0 c E_0^2 = 0.48\ W/m^2$

1b. $p = I/c = 1.6 \times 10^{-9} Pa.$
$F = pA = 1.2 \times 10^{-12} N.$

1c. Power $= I \cdot 4\pi R^2 = 96.5\ W.$

2a. $n = \frac{\sin 63^o}{\sin 40.9^o} = 1.36.$

2b. $\theta_{crit} = \sin^{-1}\frac{1}{n} = 47.3^o.$

3a. When light hits a polarizer, only the component parallel to the axis of the polarizer goes through. If light is unpolarized, then the two components have equal intensities, each intensity being equal to half the total intensity of the incident light. Therefore, $I = I_0/2 = 39.7\ W/m^2$.

3b. $I = \frac{1}{2}\cos^2 31^o \cos^2 59^o = 7.74\ W/m^2$

3c. $I = 0$, because the two polarizers are perpendicular to each other.

4. For the first lens, $\frac{1}{s} + \frac{1}{s_1'} = \frac{1}{f_1}$, so $s_1' = \frac{sf_1}{s-f_1} = 33.3$ cm.
Image has height $y_1' = -ys_1'/s = -1.33$ mm.

For second lens, image of first lens becomes object at distance (from second lens)

$$s_2 = (15\ cm) - s_1' = -18.3\ cm$$

so object is now virtual and forms an image at s', where $\frac{1}{s_2} + \frac{1}{s'} = \frac{1}{f_2}$, so $s' = \frac{s_2 f_2}{s_2 - f_2} = -22$ cm (virtual image at 22 cm to the left of the second lens).

The height is $y' = -y_1' s'/s_2 = 1.6$ mm (erect image).

5. $d\sin\theta = m\lambda$, where $m = 2$, $\lambda = 632.8$ nm, $\theta = 43.2^o$. So $d = \frac{m\lambda}{\sin\theta} = 1849$ nm.
For $\theta' = 53.4^o$, we obtain $\lambda' = \frac{d\sin\theta'}{m} = 742$ nm.