Mathematics 309 — Spring 2004 — Third homework

Due Wednesday, February 4.

You will need to use a computer for this assignment.

1. Place a hemi-spherical crown glass lens ($n = 1.5$) facing left, centred at $(0, 0)$, radius 1. Trace horizontal red rays leaving from $x = -2$ at $y = 0$, ± 0.1, ± 0.2, ± 0.3, ± 0.4, ± 0.5 up until they cross the x-axis on the other side of the lens. **Using the linear approximation!**

2. Same for red rays leaving $(-10, 0)$ with angles 0, ± 0.01, ± 0.02, ± 0.03, ± 0.04, ± 0.05 (in radians).

3. Same for red rays leaving $(-10, 0.1)$ with angles 0, ± 0.01, ± 0.02, ± 0.03, ± 0.04, ± 0.05 (in radians), but now up until $x = 3$.

4. Suppose a horizontal ray enters a water drop from the left at height y. Find a formula for the angle at which it comes out of the drop after n reflections inside. (Use the picture handed out in class.) Find its derivative with respect to y. For $n = 1$, find where it is a minimum, say $y_{\min}$.

5. Take $n = 1$. Use a computer to draw 11 rays as in the previous question at $y_{\min} \pm m\, dy$ for $dy = 0.01$, $|m| \leq 5$. Include some close up pictures of the rays coming out.