Daniel Rice
6-21-12 through 7-2-12

The following tests are to find the refractive indices of multiple objects, especially a scintillator found in the lab. These tests are based on Snell's law (figure 1). For our purposes $n_{scintillator} = n_{air} \cdot \frac{sin\theta_1}{sin\theta_2} = 1.000293 \cdot \frac{sin\theta_1}{sin\theta_2}$. In all of these tests, a laser is shone on an object. Critical points along the path of the laser beam are marked, and then connected with lines appropriately. Once we have the two angles needed in Snell's law, we find the sines of those angles by making right triangles and using basic trigonometry. The main source of error, and the only one left in the Test 3, is the inaccuracy of marking everything by hand.

Possibilities for the material of the scintillator include lucite ($n = 1.495$) and Bicron BC-408 ($n = 1.58$).

Test 1

- Red Laser pointer
  - Wavelength 650nm ± 10
  - Possible source of error for these tests:
    - ■Wide laser beam; measuring a blob, not a point
    - ■Unsteady laser due to being held by my hand
- Only one test on each each object
- No measurement for range of error

- Scintillator (figure 2)
  - Measuring entrance and exit sets of angles
  - Using tangent lines and cosines of the angles
  - $n = 1.566$
  - Possible sources of error:
    - ■Inaccuracy of tangent lines
    - ■Averaging cosines improperly

- For water $n = 1.333$
- Cup of water (figure 3)
  - Measured entrance set of angles only
  - Using a tangent line and cosines of the angles
  - $n = 1.4411$
  - Possible sources of error:
    - ■Inaccuracy of tangent line
    - ■Refractivity of the clear plastic cup
- Box with water (figure 4)
  - Measuring entrance and exit sets of angles
  - Using perpendicular lines and sines
  - $n = 1.454$
  - Possible sources of error:
    - ■Inaccuracy of perpendicular line
    - ■Refractivity of the clear rectangular box

Test 2

- Red laser pointer (see Test 1 for more detail)
- Scintillator (figure 5)
    - Measuring entrance set of angles
    - Using extended diameter
- Error found by finding the degree of error for each measurement taken and using the points of maximum error to find new results for n. Error accounted for:
    - Width of laser at the pointer
    - Width of laser upon entrance
    - Width of laser upon exit
    - Inaccuracy of the center point used to find the diameter
- Two tests done
    - $n = 1.507202 \pm 0.115869$
    - $n = 1.519216 \pm 0.122064$

Test 3

- Green laser pointer
    - Wavelength 532nm
    - This laser was much more focused. The width of the laser beam and the center point of the circle were not wider than the pen and pencil marks and thus were not taken into account for error measurements like those of Test 2.
    - Button taped down and laser set down so as not to move
- Scintillator (figures 6-8)
    - Measuring entrance set of angles
    - Using extended diameter
- The range of error was found by running the test 9 times and finding the range of results.
    - Current range of results: $n = 1.464009$ to $n = 1.555283$
    - Average refractive index: $n = 1.506134$
    - Can also be written as $n = 1.506134 \pm 0.049149$
    - The material of the scintillator is most likely lucite, which falls into the given range.

Test 4

- Rectangular scintillator, material unknown (figures 9-10)
- Perpendicular line found with a compass meaurement
- Otherwise the same as Test 3
- Three data points: 1.615349, 1.630729, and 1.597429

Figure 1

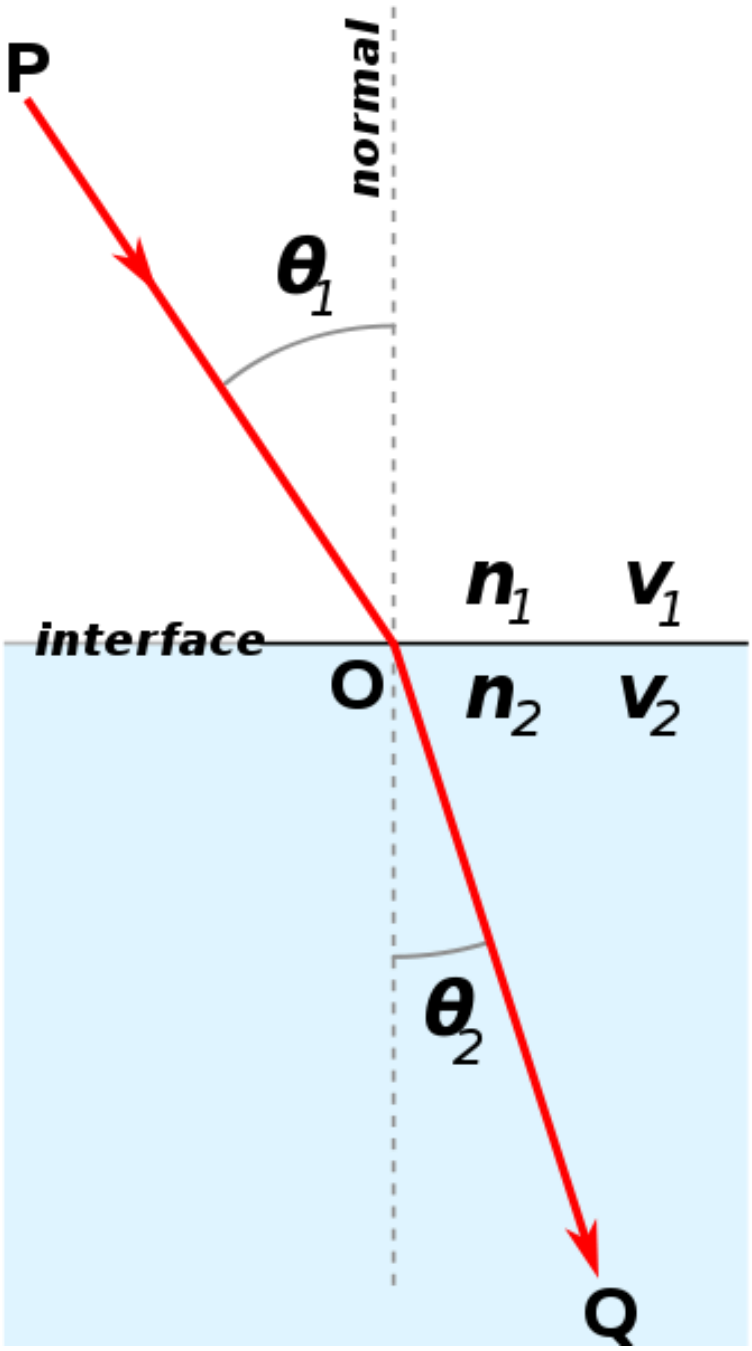


Figure 2

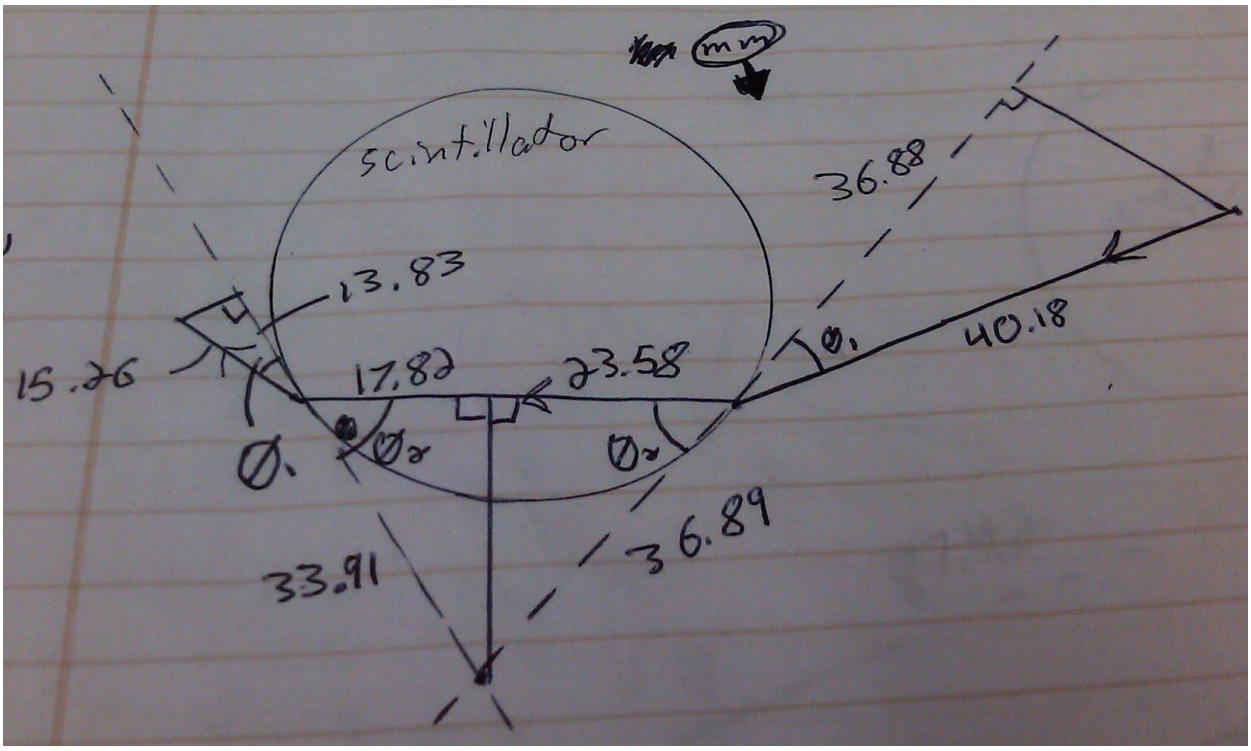


Figure 3

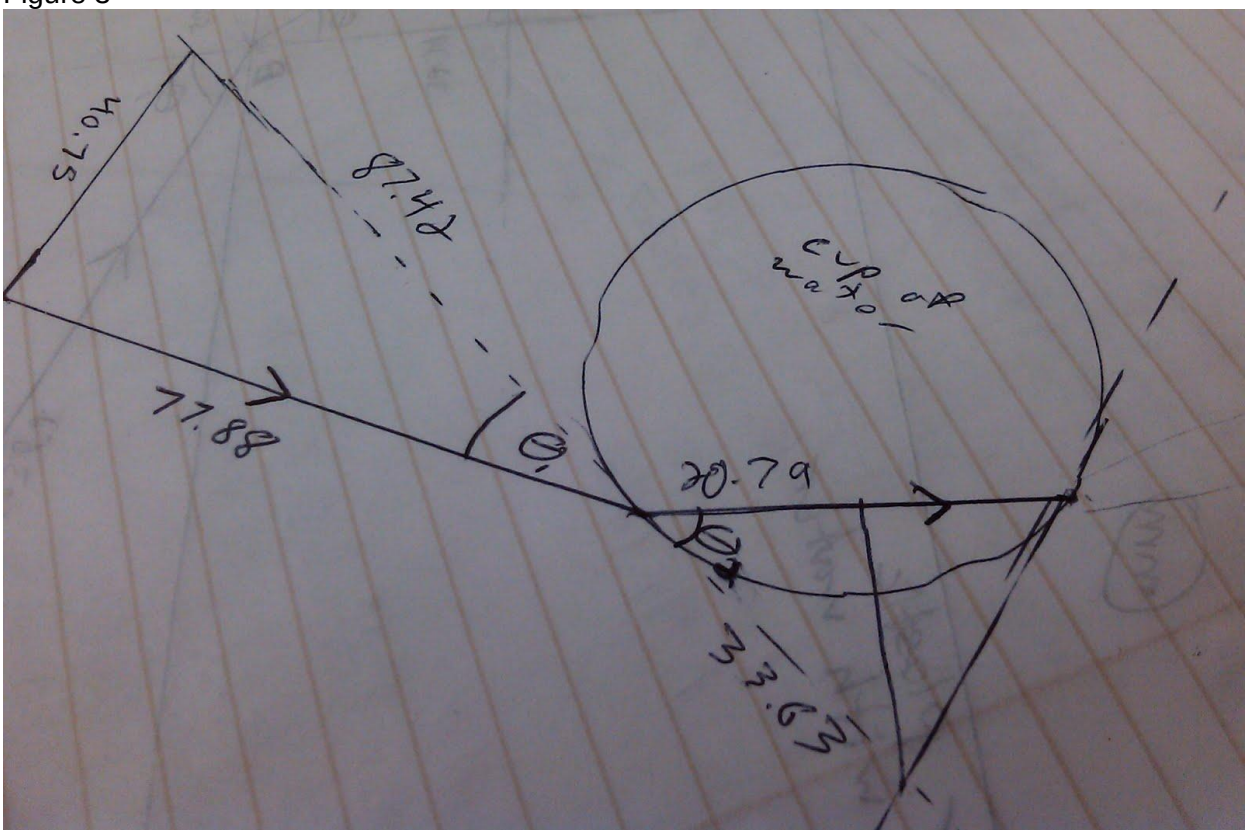


Figure 4

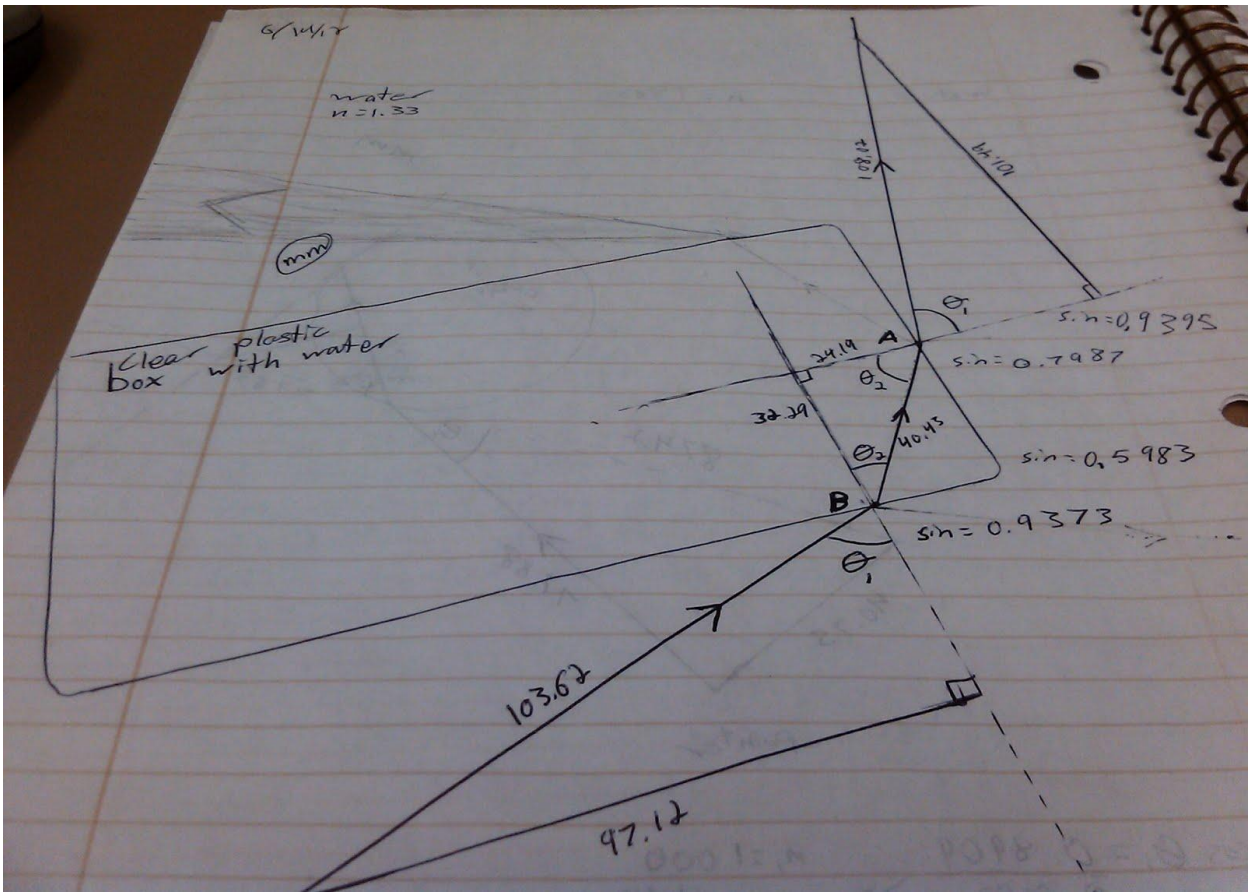

water
n = 1.33
clear plastic box with water
108.12
44.10
θ_1
sin = 0.9395
24.19
A
θ_2
sin = 0.7987
32.29
40.45
θ_2
sin = 0.5983
B
sin = 0.9373
θ_1
103.67
97.12

Figure 5

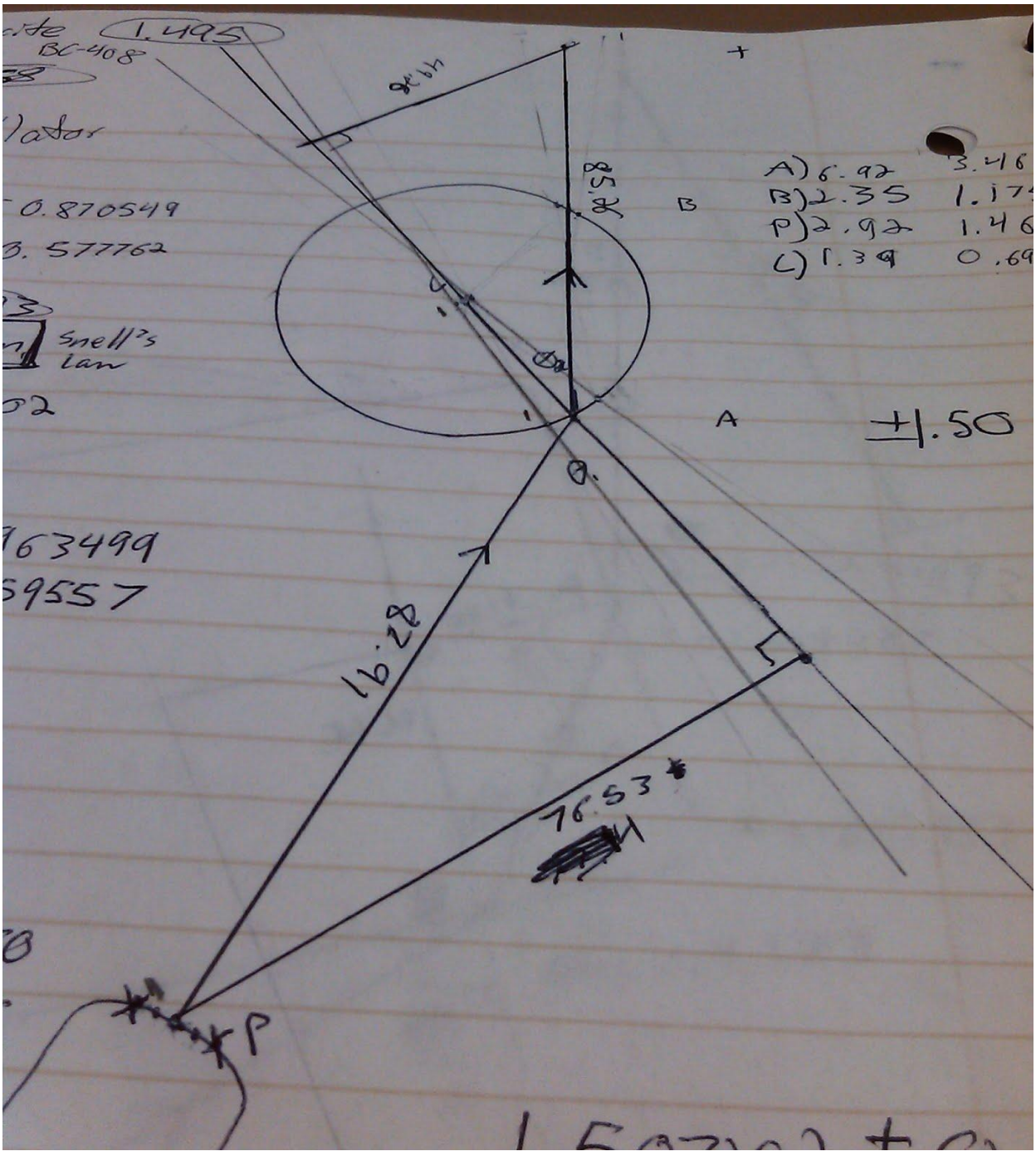

1.495
BC-408
Snell's
Ian
0.870549
3.577762
963499
59557
A) 6.92 3.46
B) 2.35 1.17
P) 2.92 1.46
C) 1.39 0.69
A
±1.50
16.28
76.53
P

Figure 6

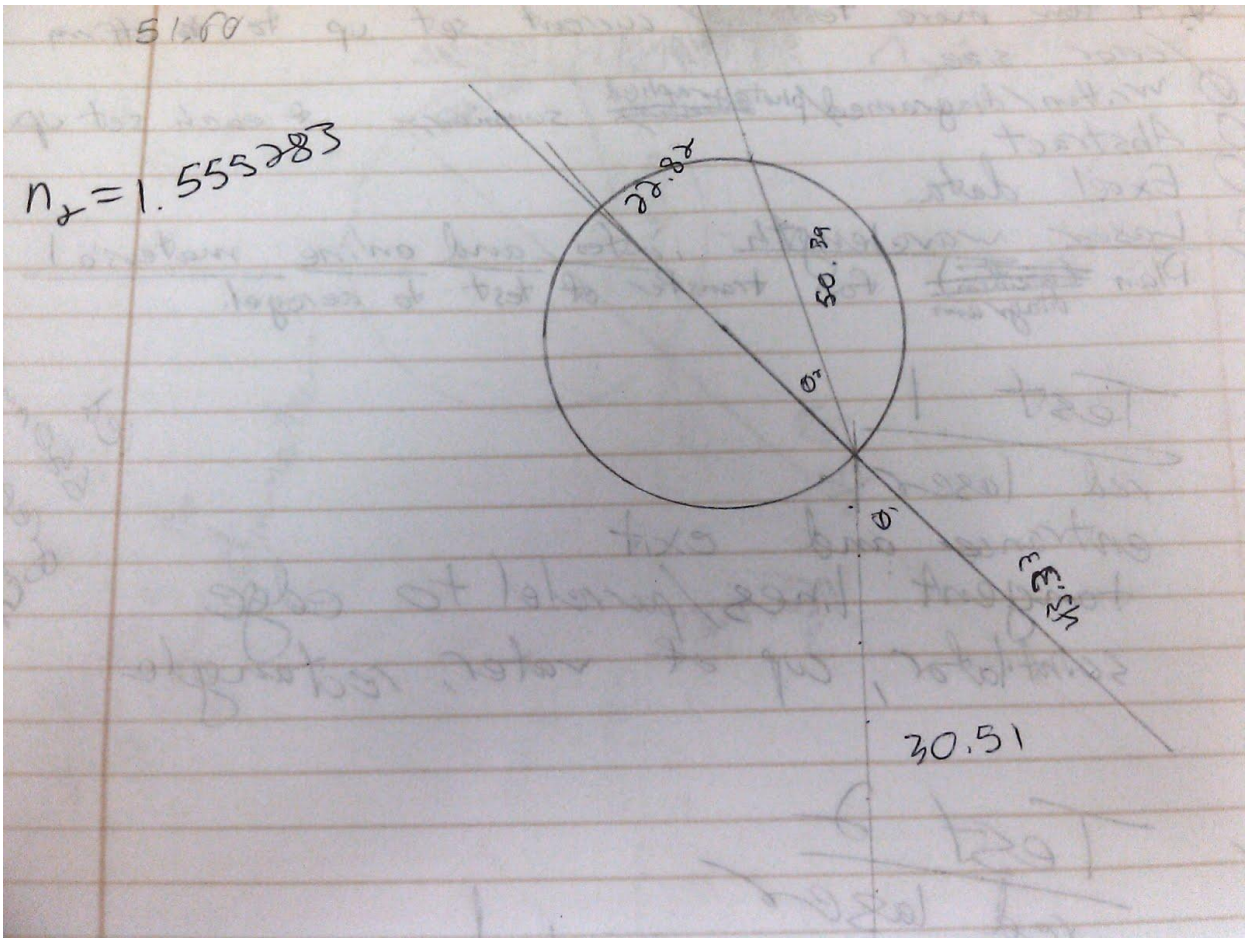


Figure 7

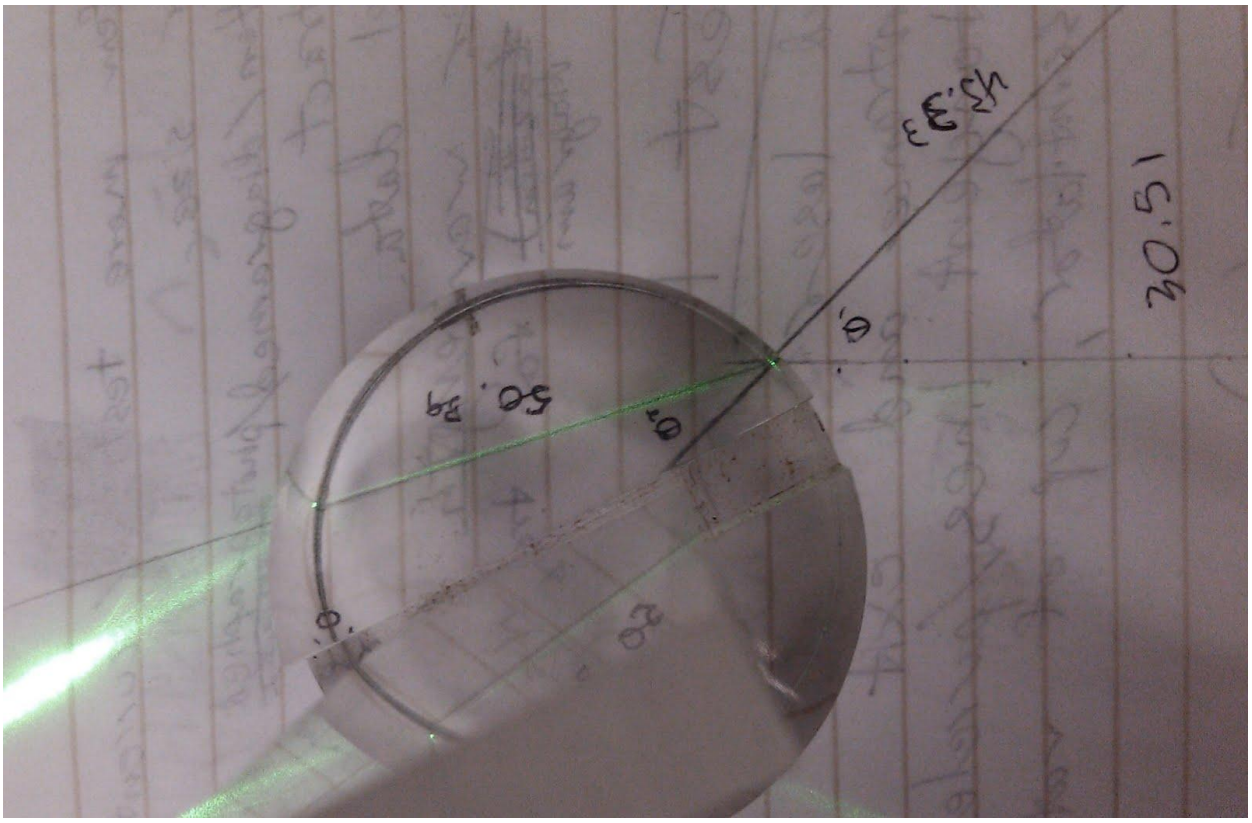


Figure 8

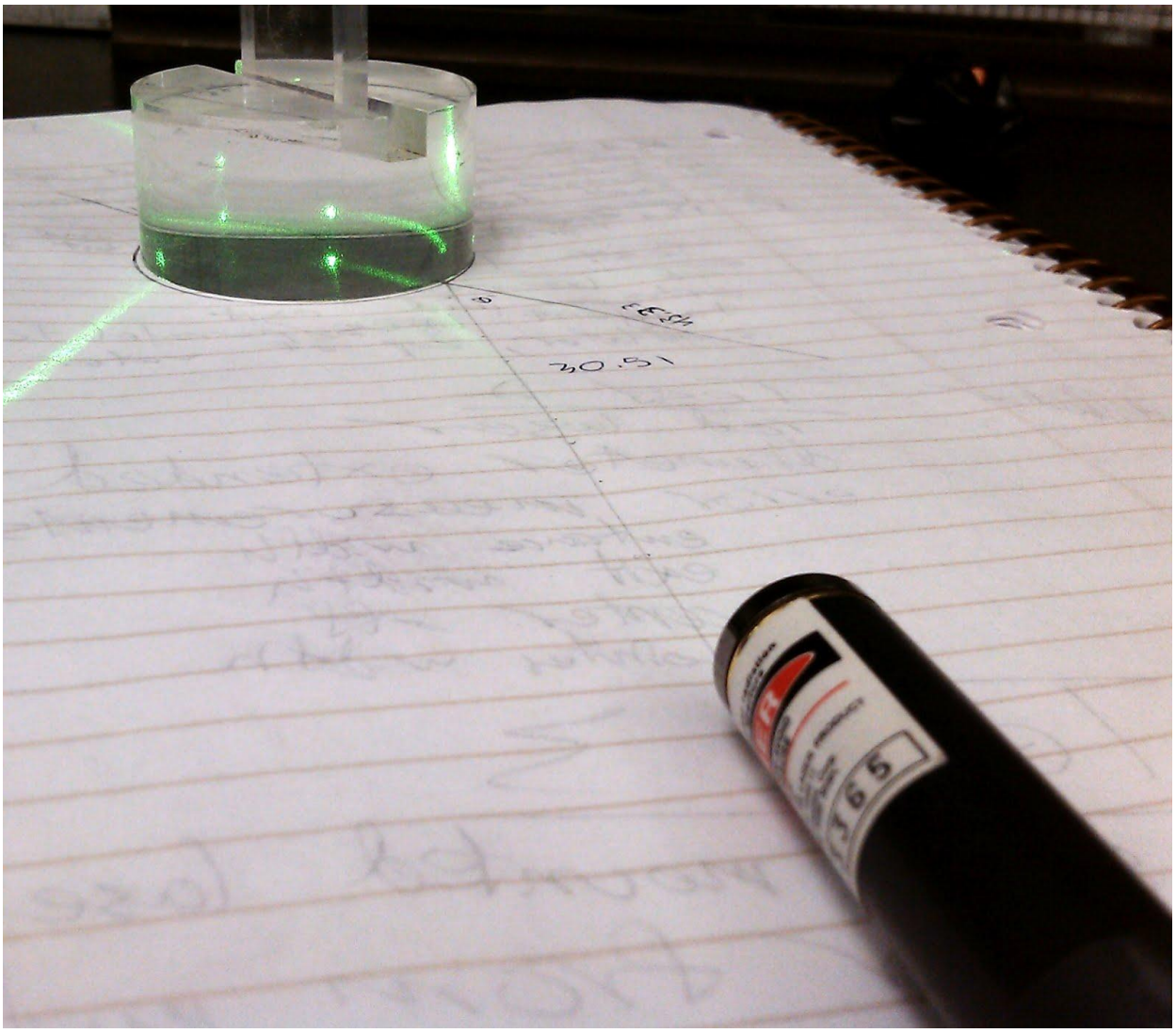


Figure 9

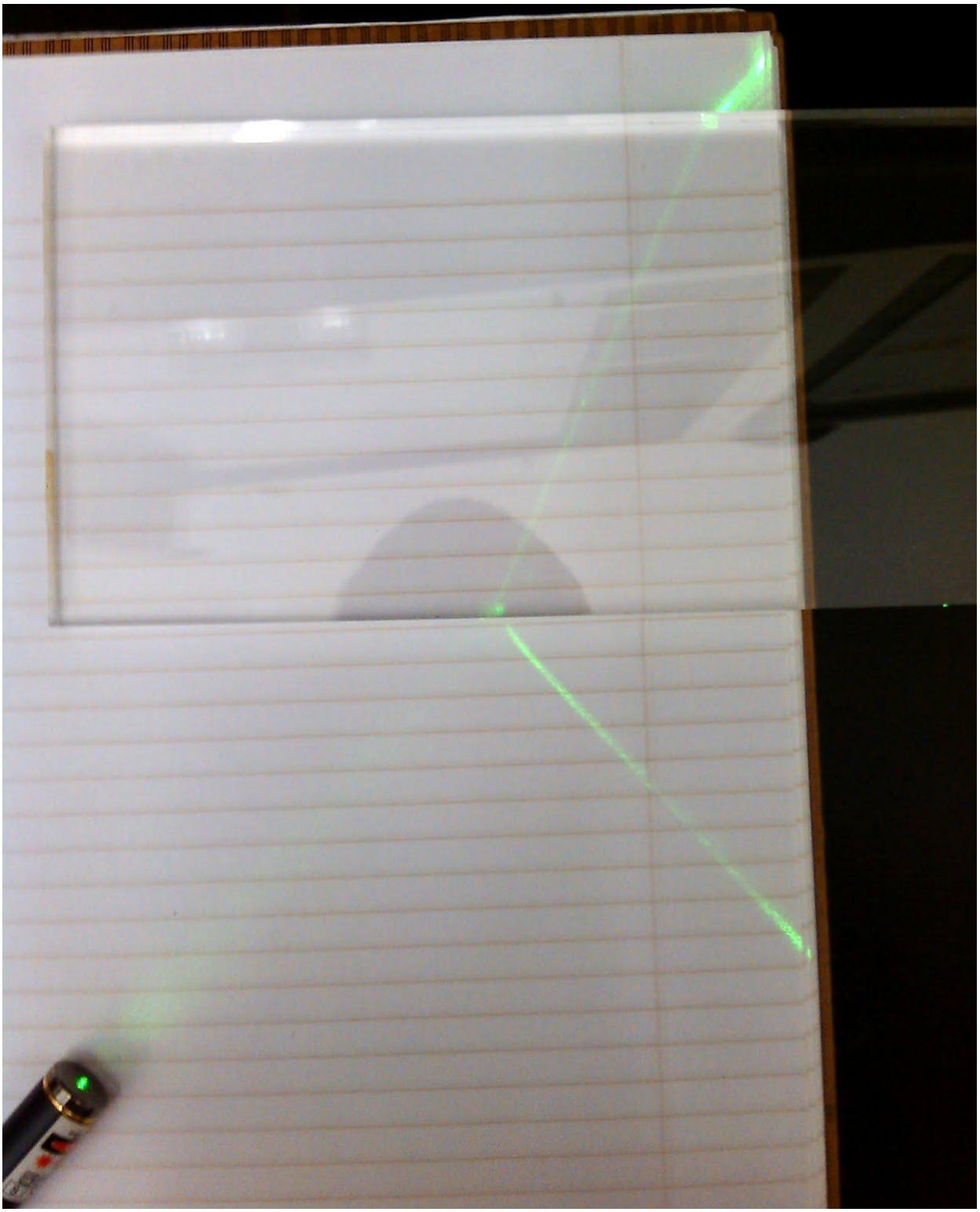
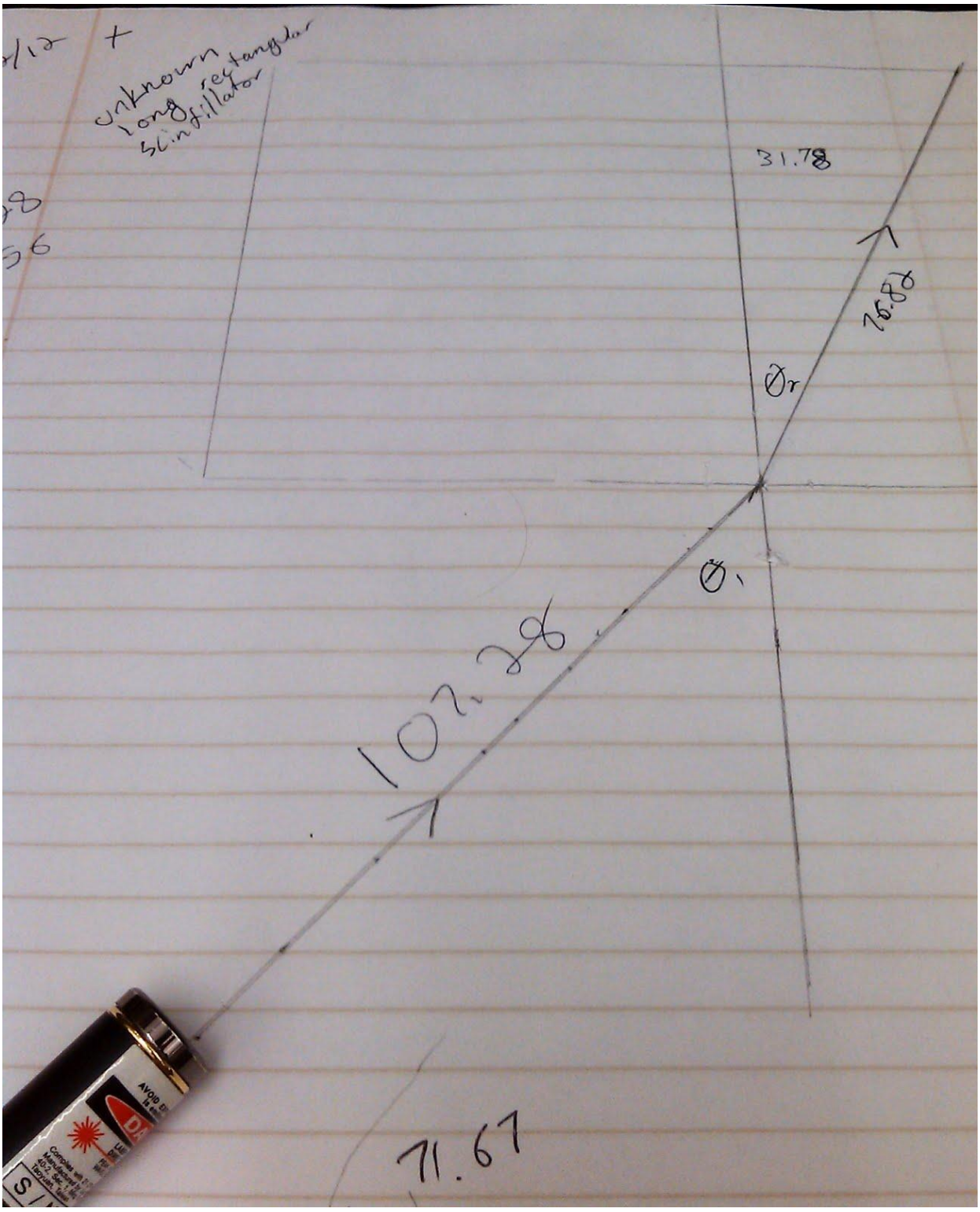


Figure 10


unknown
long rectangular
scintillator
31.78
76.82
ϕ_r
ϕ_i
102.28
71.67