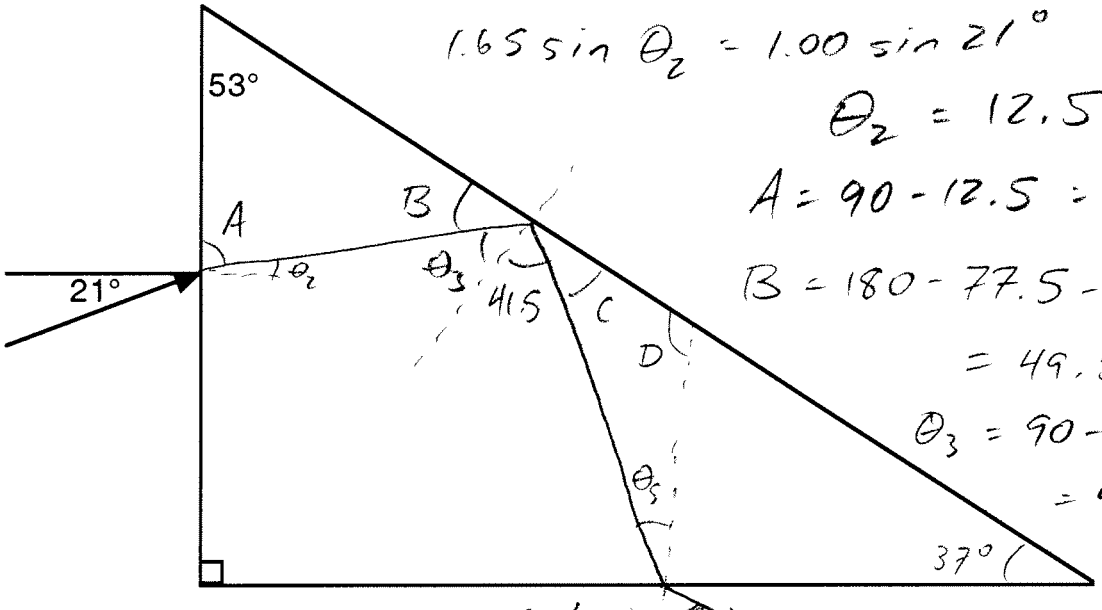
Physics 10164 - Exam 4C

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work even if you get the right answer. Clearly indicate your answer with a circle or a box and remember to include correct units and significant figures.

1. (30 pts) A ray of light enters a triangular prism as shown with an angle of incidence of 21°. The prism has an index of refraction of 1.65 and is surrounded by air. On the diagram below, show where the ray leaves the prism and calculate the angle of refraction of the ray after it leaves the prism.



$1.65 \sin\theta_2 = 1.00 \sin 21°$

$\theta_2 = 12.5°$

$A = 90 - 12.5 = 77.5°$

$B = 180 - 77.5 - 53$

$= 49.5°$

$\theta_3 = 90 - 49.5$

$= 41.5°$

$\theta_c = \sin^{-1}\left(\frac{1}{1.65}\right) = 37.3°$

$\theta_3 = 41.5° > \theta_c \Rightarrow$ reflection

$C = 90 - 41.5 = 49.5°$

$D = 90 + 37° = 127°$

$\theta_5 = 180 - 49.5 - 127 = 3.5°$

$1.65 \sin 3.5° = 1.0 \sin\theta_6$

$\boxed{\theta_6 = 5.8°}$

2. (30 pts) A 5.0 cm high object is placed in front of a concave mirror with a focal length of 12 cm. The virtual image is 8.0 cm high.

What is the distance from the object to the mirror?

q virtual, so q −, p +

$$M = \frac{8.0}{5.0} = +1.6 = -\frac{q}{p}$$

$$q = -1.6p$$

$$\frac{1}{p} + \frac{1}{-1.6p} = \frac{1}{12}$$

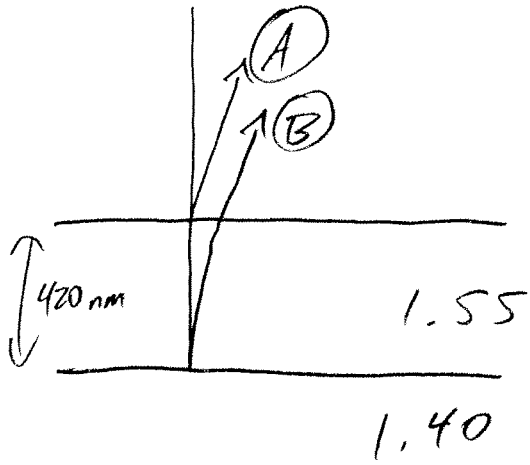
$$\frac{-1.6}{-1.6p} + \frac{1}{-1.6p} = \frac{1}{12}$$

$$\frac{-0.6}{-1.6p} = \frac{1}{12}$$

$$-1.6p = -7.2$$

$$\boxed{p = 4.5 \text{ cm}}$$

3. (40 pts) A 420-nm thick anti-reflective coating (n = 1.55) is placed on top of a glass surface (n = 1.40). What wavelengths of light in the visible region of the spectrum (between 400-700 nm) will undergo destructive interference?



$$\phi_A = \frac{1}{2}$$

$$\phi_B = 0 + \frac{2nt}{\lambda_0}$$

$$\Delta\phi = \frac{2nt}{\lambda_0} - \frac{1}{2} = \frac{1}{2}, \frac{3}{2}, \frac{5}{2}, \ldots$$

For $\Delta\phi = \frac{1}{2}$, $\frac{2nt}{\lambda_0} = 1$

so $\lambda_0 = 2nt = 2(1.55)(420)$

$= 1302$

For $\Delta\phi = \frac{3}{2}$, $\frac{2nt}{\lambda_0} = 2$

$\lambda_0 = \frac{2nt}{2} =$ **651 nm** ← correct range

$\frac{5}{2} \Rightarrow \lambda_0 = \frac{2nt}{3} =$ **434 nm** ← correct range

$\frac{7}{2} \Rightarrow \lambda_0 = \frac{2nt}{4} = 326$ nm