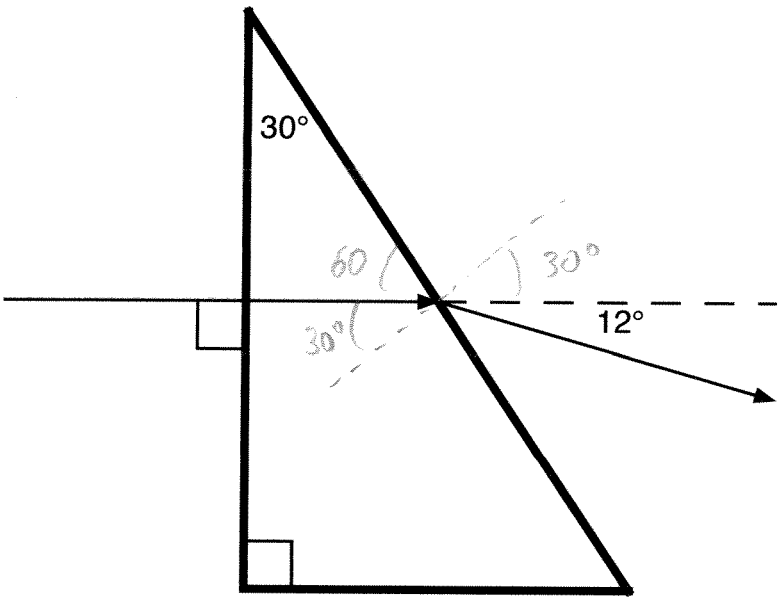
Physics 10164 - Exam 4C

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. (25 pts) Light is incident on a prism as shown below perpendicular to the left face. The transmitted beam that exits the right side of the prism makes an angle of 12° with the direction of the incident beam. Find the index of refraction of the prism.



$n_{prism} \sin\theta_{prism} = n_{Air} \sin\theta_{Air}$

$n_{prism} \sin 30° = 1.0 \sin 42°$

$n_{prism} = \frac{\sin 42°}{\sin 30°} = 1.34$

2. (25 pts) A concave mirror has a radius of curvature of 28.0 cm. The image seen in the mirror is upright and larger than the object by a factor of 2.5. Determine the location of the object.

$$f = +14.0\,cm$$

$$M = -\frac{q}{p} = +2.5$$

$$q = -2.5p$$

$$\frac{1}{p} - \frac{1}{2.5p} = \frac{1}{14}$$

$$\frac{2.5}{2.5p} - \frac{1}{2.5p} = \frac{1}{14}$$

$$\frac{1.5}{2.5p} = \frac{1}{14}$$

$$2.5p = 21$$

$$p = 8.4\,cm$$

3. (25 pts) A pair of slits is separated by 0.350 mm, and it is illuminated by light of wavelength 643 nm. An interference pattern is observed on a screen 5.90 meters away. Consider a point on the screen located at y = 2.71 cm away from the center of the pattern.

a) What is the path difference for the two slits at this location?
b) How many waves is this path difference?
c) Is this position a minimum, a maximum or something in between?

a) Path difference

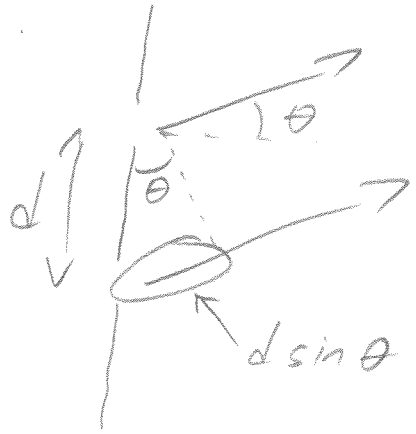
$= d \sin\theta$

$= \frac{dy}{L}$

$= \frac{(.350\times10^{-3})(.0271)}{5.90}$

$= 1.608\times10^{-6}\ m$

$= \boxed{1.6\times10^{-6}\ m}$



b) # of waves $= \frac{\text{path diff}}{\lambda} = \frac{1.6\times10^{-6}}{643\times10^{-9}} = \boxed{2.5}$

c) $2.5\lambda = \frac{5}{2}\lambda = \boxed{\text{minimum}}$

4. (25 pts) A vehicle with headlights separated by 2.3 meters is seen head-on by an observer in visible light (consider the wavelength for this problem to be 550 nm). If the observer is using a lens to see this car, what must be the aperture diameter of the lens in order to resolve the separate headlights if they are at a distance of 12 km away?

$$\theta_{min} = \frac{1.22\lambda}{D} = \frac{\text{separation}}{\text{distance}}.$$

$$\frac{1.22(550\times10^{-9})}{D} = \frac{2.3}{12000}$$

$$D = \frac{1.22(550\times10^{-9})(12000)}{2.3}$$

$$= 3.5\times10^{-3}\,m$$

or (3.5 mm)