# Physics 10164 – Exam 4A

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 diver is located at a depth of 35 meters, 120 meters away from the shoreline. The diver shines a laser up through the water (n = 1.33) at an angle so that the laser light emerges from the surface (into air) at a point 94 meters from the shore. The light is seen by a person standing on the roof of a building right on the shoreline. How tall is the building?
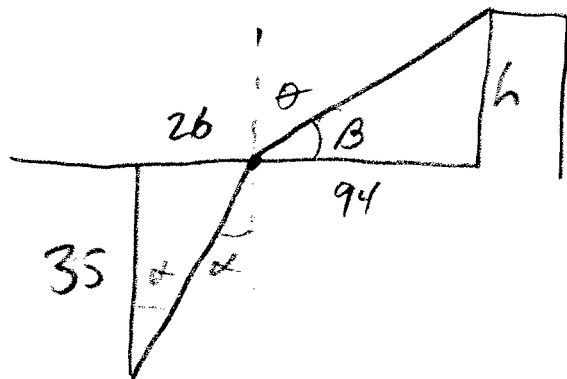
$$\alpha = \tan^{-1}\left(\frac{26}{35}\right) = 36.6°$$

$$1.33 \sin 36.6° = 1.0 \sin \theta$$

$$\theta = 52.5°$$

$$\beta = 90 - \theta = 37.5°$$

$$\tan \beta = \frac{h}{94}$$

$$h = 94 \tan 37.5° = \boxed{72 \, m}$$

2. (30 pts) A concave mirror forms an upright image of an object 8.0 cm away from the mirror, and the image is 1.5 times larger than the object. What is the focal length of the mirror?

$$P = 8.0 \text{ cm}$$
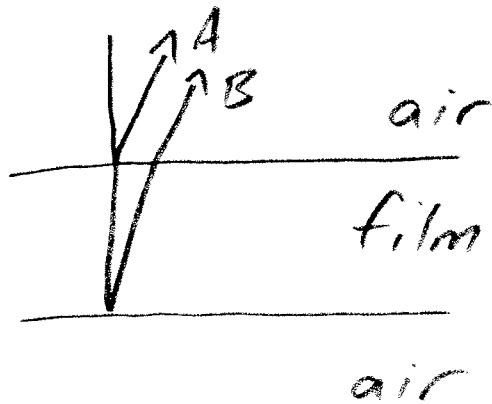
$$M = +1.5 = -\frac{q}{P}$$

$$q = -(1.5)(8) = -12$$

$$\frac{1}{8} + \frac{1}{-12} = \frac{1}{f}$$

$$\frac{3}{24} - \frac{2}{24} = \frac{1}{f} \qquad \boxed{f = 24 \text{ cm}}$$

3. (40 pts) A thin soap bubble ($n = 1.33$) surface is surrounded on both sides by air. What is the smallest non-zero thickness of the soap bubble that will result in destructive interference for reflected light of wavelength 620 nm?

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

air

film

$$\delta_B = 0 + \frac{2nt}{\lambda_o}$$

air

$$\delta_B - \delta_A = \frac{2nt}{\lambda_o} - \frac{1}{2} = \frac{1}{2}, \frac{3}{2}, \ldots,$$

$$\frac{2nt}{\lambda_o} - \frac{1}{2} = \frac{1}{2}$$

$$\frac{2nt}{\lambda_o} = 1$$

$$t = \frac{\lambda_o}{2n} = \frac{620}{2(1.33)} = \boxed{233\,nm}$$