Physics 10164 - Summer 2018 - Exam #3

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) The intensity of sunlight that reaches the Earth's surface at our latitude at noon on a sunny day is about 980 Watts/m^2.

a) How much energy is contained in a 12 m^3 volume of space just about the Earth's surface?
b) How much time does it take for the sunlight to deliver 1.0 kW-hr of energy to a solar panel array of area 5.0 m^2?
c) What is the rms value of the electric field for this light?

a) $U_{tot} = \frac{980}{c} = 3.267 \times 10^{-6} \frac{J}{m^3}$

$Energy = U_{tot} * Vol = (3.267 \times 10^{-6})(12) = \boxed{3.9 \times 10^{-5} J}$

b) $Energy = 1.0 kW \cdot hr = 3.60 \times 10^6 J$

$Power = I * Area = 4900 Watts$

$time = \frac{Energy}{Power} = \frac{3.60 \times 10^6}{4900} = \boxed{730 s}$

c) $U_{tot} = 3.267 \times 10^{-6} = \epsilon_0 E_{rms}^2$

$\boxed{E_{rms} = 610 N/C}$

2. (30 pts) An object is 36 cm in front of a convex mirror, and it produces an image that is 21 cm behind the mirror.

a) What is the image distance if the object is moved to a location 21 cm in front of the mirror?

b) At what object distance does the resulting image have a magnification of +0.25?

a) $\frac{1}{36} + \frac{1}{-21} = \frac{1}{f} \Rightarrow f = -50.4$

$$\frac{1}{21} + \frac{1}{q} = \frac{1}{-50.4}$$

$$\frac{1}{q} = -\frac{1}{50.4} - \frac{1}{21} \Rightarrow \boxed{q = -15\text{ cm}}$$

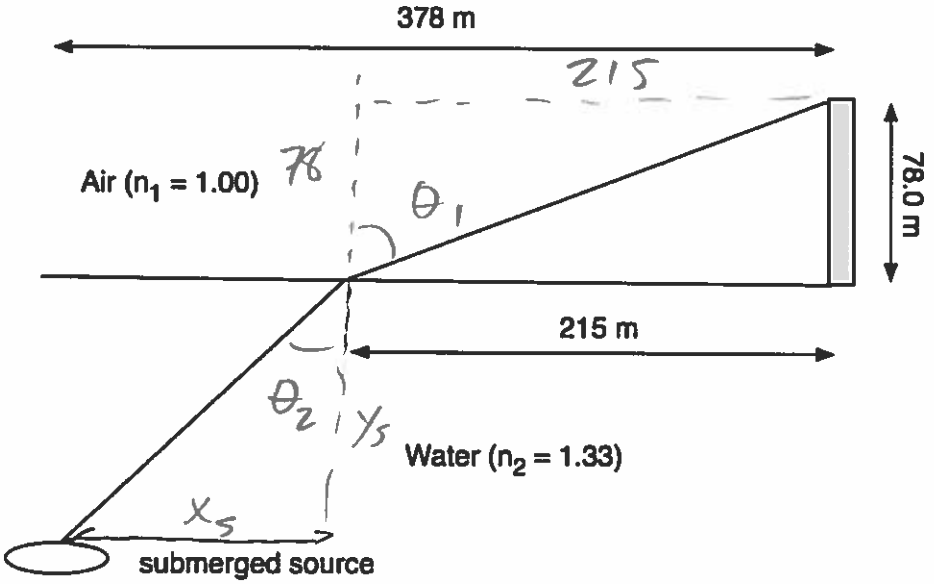
b) $+0.25 = -\frac{q}{p} \Rightarrow p = -4q$ or $q = -\frac{p}{4}$

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{-50.4}$$

$$\frac{1}{p} - \frac{4}{p} = \frac{1}{-50.4}$$

$$\frac{-3}{p} = -\frac{1}{50.4} \Rightarrow \boxed{p = 150\text{ cm}}$$

#3. (20 pts) A submerged source 378 m from the shoreline fires a laser beam through the water, and the beam breaks the surface a distance of 215 meters from the shoreline. At the water's edge, the laser beam illuminates a target at the top of a 78.0 meter building. At what depth below the surface is the laser source? The drawing below is not necessarily to scale.



$$\theta_1 = \tan^{-1}\left(\frac{215}{78}\right) = 70.06^\circ$$

$$1.00 \sin 70.06^\circ = 1.33 \sin\theta_2$$

$$\theta_2 = \sin^{-1}(.7068)$$

$$= 44.98^\circ$$

$$x_s = 378 - 215 = 163$$

$$\tan 44.98^\circ = \frac{163}{y_s}$$

$$\boxed{y_s = 163\ m}$$

#4. (20 pts) A myopic person has a far point of 58 cm and a near point of 21 cm. You want to prescribe glasses for this person that will sit 2.0 cm in front of the eyes and will correct the far point for the myopic person to a normal far point value of ~~25 cm~~ ∞.

a) What must be the focal length of the lenses of the glasses?
b) What is the new near point for this person?

a) Want $p = \infty$ & $q = -56$

56 cm in front of lenses, 58 cm in front of eye

$$\boxed{f = -56\text{ cm}}$$

b) For what p is $q = -19$ cm?

19 cm in front of lens, 21 cm in front of eye

$$\frac{1}{p} + \frac{1}{-19} = \frac{1}{-56}$$

$$\frac{1}{p} = -\frac{1}{56} + \frac{1}{19} \Rightarrow p = 29\text{ cm}$$

in front of lens,

So new near point = $\boxed{31\text{ cm}}$