Physics 10164 - Spring 2019 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. (25 pts) The intensity of moonlight during a full moon is approximately 0.024 Watts/m² when the moon is high in the sky.

a) What is the rms value of the magnetic field associated with this light?
b) How much energy in the form of moonlight is contained within the volume of an open football stadium of 350,000 m³ volume?
c) If the playing field has an area of 5100 m², how much time would it take to collect enough energy from moonlight to boil a pot of water? Assume 820,000 Joules of energy is needed.

a) $0.024 = c * u_{tot} \Rightarrow u_{tot} = 8.0 \times 10^{-11}\ J/m^3$

$$8.0 \times 10^{-11} = \frac{B_{rms}^2}{\mu_0} \Rightarrow \boxed{B_{rms} = 1.0 \times 10^{-8}\ T}$$

b) $E = u_{tot} * Volume = \left(8.0 \times 10^{-11}\ \frac{J}{m^3}\right)(350{,}000\ m^3)$

$$= \boxed{2.8 \times 10^{-5}\ J}$$

c) $Power = \left(0.024\ \frac{W}{m^2}\right)(5100\ m^2) = 12.24\ W$

$$time = \frac{Energy}{Power} = \frac{820{,}000}{12.24} = \boxed{6700\ s}$$

2. (25 pts) A mirror has a focal length of +35 cm.

a) At what <u>object distance</u> does the resulting image have a magnification of +1.8?

b) If we move the object to a new location, the resulting image has a magnification of -0.35. What is the new <u>image distance</u>?

a) $+1.8 = -\frac{q}{p} \Rightarrow q = -1.8p$

$\frac{1}{p} - \frac{1}{1.8p} = \frac{1}{35}$

$\frac{1.8}{1.8p} - \frac{1}{1.8p} = \frac{1}{35}$

$\frac{0.8}{1.8p} = \frac{1}{35}$

$28 = 1.8p$

$\Rightarrow \boxed{p = 16 \text{ cm}}$

b) $-0.35 = -\frac{q}{p} \Rightarrow q = 0.35p$

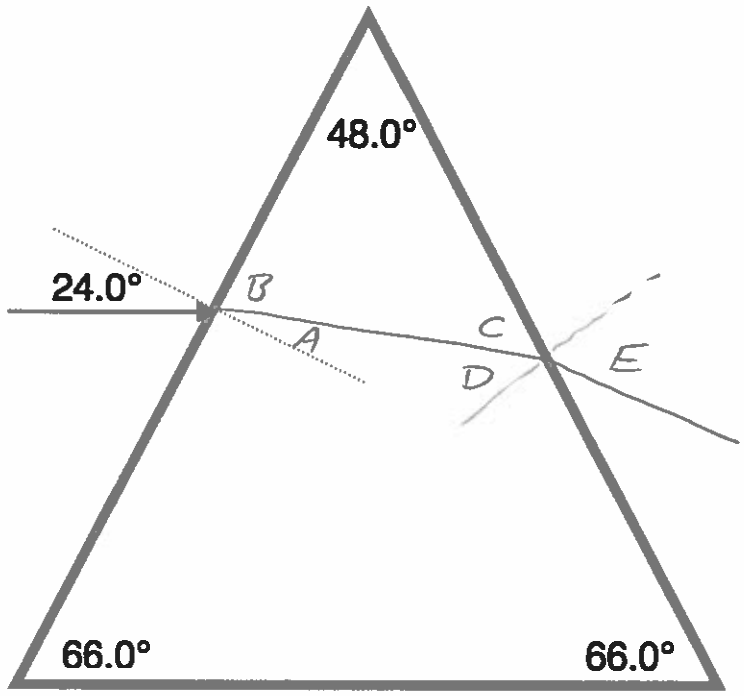
or $p = \frac{q}{0.35}$

$\frac{1}{p} + \frac{1}{q} = \frac{1}{35}$

$\frac{0.35}{q} + \frac{1}{q} = \frac{1}{35}$

$\frac{1.35}{q} = \frac{1}{35} \Rightarrow \boxed{q = 47 \text{ cm}}$

3. (25 pts) The prism below has an index of refraction of 1.48 for blue light and 1.43 for red light, and the prism is surrounded by air. Light is incident on the left face of the prism as shown. What is the angular separation (2 SF) between the red and blue light that emerges from the right side of the prism?



Blue

$1.0 \sin 24° = 1.48 \sin A$

$\Rightarrow A = 15.95°$

$A + B = 90 \Rightarrow B = 74.05°$

$B + 48 + C = 180 \Rightarrow C = 57.95°$

$C + D = 90 \Rightarrow D = 32.05°$

$1.48 \sin 32.05° = 1.0 \sin E$

$E = 51.75°$

Red

$1.0 \sin 24° = 1.43 \sin A$

$A = 16.52°$

$B = 73.48°$

$C = 58.52°$

$D = 31.48°$

$E = 48.30$

$\boxed{\Delta\theta = 3.4°}$

4. (25 pts) A person has a near point of 48 cm and a far point of infinity. We want to prescribe eyeglasses for this person to correct the near point to be 25 cm. The eyeglasses will sit 2.0 cm in front of the eye.

a) What must be the focal length of these lenses?
b) What is the new far point for this person wearing the glasses? Keep in mind that the new far point must account for the extra 2.0 between the lenses and the eye! I am asking what the far point is for the eye, not the lenses.

a) An object is 25 cm in front of eye

so 23 cm in front of lens

Results in image 48 cm in front of eye

46 cm in front of lens

$$\frac{1}{23} + \frac{1}{-46} = \frac{1}{f} \qquad \boxed{f = 46\text{ cm}}$$

b) What p results in $q = \infty$?

$$\frac{1}{p} + \frac{1}{\infty}^{0} = \frac{1}{f} \qquad p = 46\text{ cm in front of lens}$$

$$= \boxed{48\text{ cm in front of eye}}$$