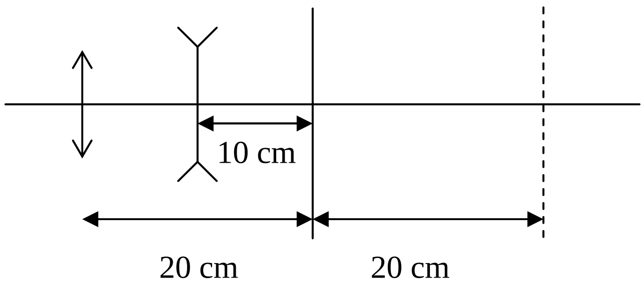
Name:______KEY________________

Phys.116 Exam III
6 April 2005

Please do not turn the page until you are told to do so. When you do so, make sure that you have all three problems on your copy of the test. In order to get credit on a problem, you must show your work. If you only write down an answer without the work leading up to it, you will get no credit for it, even if it is the right answer.

1) When an object is placed at the proper distance in front of a converging lens the image falls on a screen 20 cm behind the lens. A diverging lens is now placed halfway between the converging lens and the screen, and it is found that the screen must be moved 20 cm farther away from the lens to obtain a sharp image.

(a) (10 points) What is the focal length of the diverging lens? *(Hint: A sketch of the setup – NOT a ray diagram – would greatly help.)*



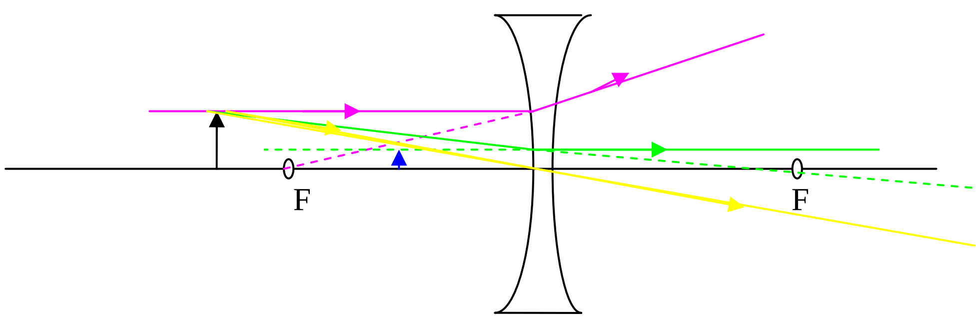
$d_o = -10\text{cm};\ d_i = 30\text{cm}$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{-10\text{cm}} + \frac{1}{30\text{cm}} = -\frac{1}{15\text{cm}}; \Rightarrow \boxed{f = -15\text{cm}}$$

(b) (5 points) Will the image through the two-lens combination be upright or inverted with respect to the original object? Please explain your answer.

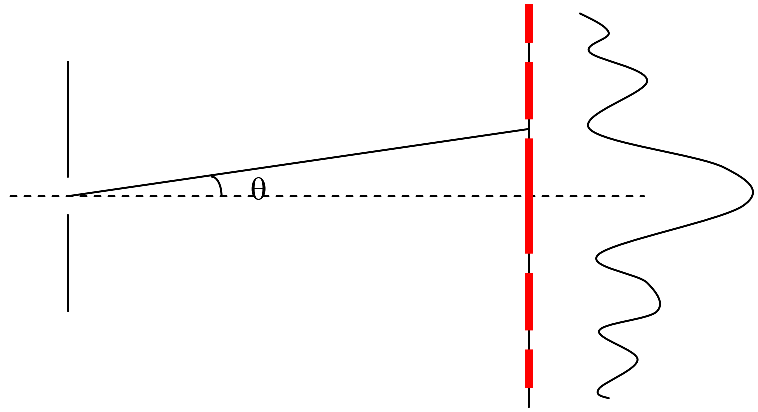
Inverted (it's real and inverted through the converging lens, and the image through the diverging lens of the image through the converging lens is virtual, and has the same orientation.)

(c) (5 points) Please draw a ray diagram, using the three main rays discussed in class. Make sure you use solid lines for the actual rays and dashed lines for their extensions, and that you mark the direction of travel of the rays with an arrow.



Problem1	
Problem2	
Problem3	
Total/60	

2) Light of wavelength 589 nm from a distant source is incident on a slit 1.0 mm wide, and the resulting diffraction pattern is observed on a screen 2.0 m away.
(a) (5 points) Please draw the diagram for the single slit setup including the slit, screen, and diffraction pattern.
(b) (5 points) On the same diagram, please draw the intensity graph of the diffraction pattern.



(c) (10 points) What is the distance between the two dark fringes on either side of the central bright fringe?

$$w \sin\theta = m\lambda; \text{ where } m = 1$$

$$\Rightarrow \theta = \sin^{-1}\left(\frac{\lambda}{w}\right) = \sin^{-1}\left(\frac{589\times10^{-9}\,\text{m}}{1\times10^{-3}\,\text{m}}\right) = 0.03°;$$

$$\tan\theta = \frac{y}{D}; \Rightarrow y = D\tan\theta = 2.0\text{m}\tan 0.03 = 1.18\times10^{-3}\,\text{m}.$$

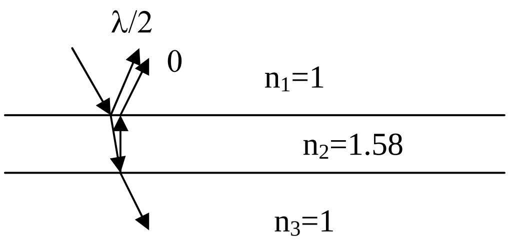
The distance from the central axis to either of the first minima is the same.

Therefore, the distance we're looking for is twice the y we obtained above.

$$\Delta y = 2(1.18\times10^{-3}\,\text{m}) = \boxed{2.36\times10^{-3}\,\text{m}}$$

3) Monochromatic light of variable wavelength is incident normally on a thin sheet of plastic film (n=1.58) in air (n=1). The reflected light is a minimum only for wavelengths of 512 nm and 640 nm in the visible spectrum.

a) (5 points) Please draw a clear diagram of the thin plastic film in air. Make sure you draw the reflected and refracted rays, where appropriate.



b) (5 points) What is the phase change due to reflection at the interfaces?

It's π at the first interface, and there is no phase change at the second interface. The net phase change is then π.

c) (2 points) What is the ratio of the orders of the minima for the two different wavelengths of light (m_2/m_1)?

$$2t = m_1\lambda_1 / n_2;\ 2t = m_2\lambda_2 / n_2;\ \Rightarrow \frac{m_2}{m_1} = \frac{\lambda_1}{\lambda_2} = \frac{512}{640} = \boxed{0.80}$$

$$\left(\text{or } \frac{m_1}{m_2} = 1.25\right)$$

d) (3 points) What are reasonable values for m_2 and m_1 based on their ratio?

$$\boxed{m_2 = 4 \text{ and } m_1 = 5}$$

e) (5 points) What is the thickness of the film? (use m_1=1 if you didn't get d)

$$t = \frac{m_1\lambda_1}{2n_2} = \frac{5\left(512\times10^{-9}\,\text{m}\right)}{2(1.58)} = \boxed{810\,\text{nm}}$$