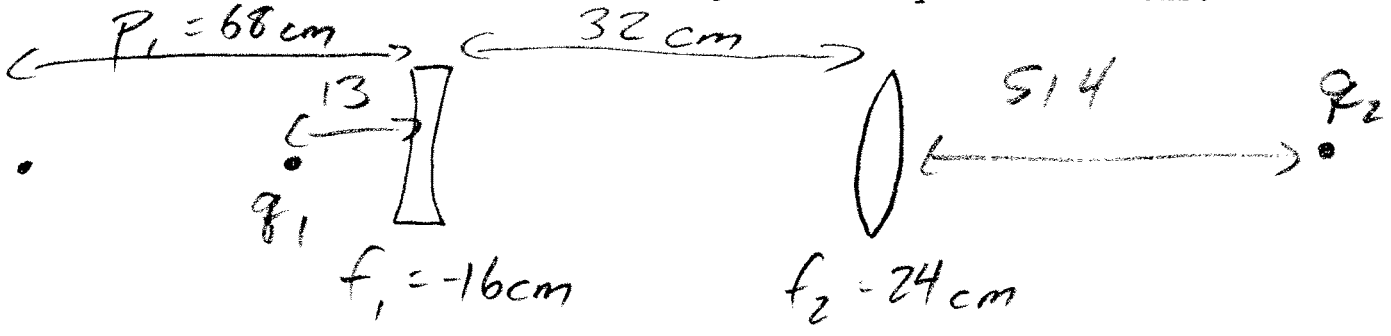
Physics 10164 - Exam 4B

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. (40 pts) Two lenses are separated by 32 cm. The front lens is diverging with a focal length of -16 cm. The back lens is converging with a focal length of 24 cm. If an object is located 68 cm in front of the front lens, determine the location and magnification of the final image formed by the back lens.



Lens 1: $\frac{1}{68} + \frac{1}{q} = \frac{1}{-16}$

$\frac{1}{q} = -\frac{1}{16} - \frac{1}{68}$ $\quad q_1 = -12.95$ cm

≈ -13 cm

$p_2 = 45$ cm $\quad (32 + 13)$

$\frac{1}{45} + \frac{1}{q_2} = \frac{1}{24}$

$\frac{1}{q_2} = \frac{1}{24} - \frac{1}{45}$ $\quad q_2 =$ **51.4 cm behind lens 2**

$M_1 = -\frac{q_1}{p_1} = -\frac{-13}{68} = 0.19$

$M_2 = -\frac{q_2}{p_2} = -\frac{51.4}{45} = -1.14$

$M_{TOT} = (0.19)(-1.14)$

$= \boxed{-0.22}$

2. (30 pts) Light of wavelength 583 nm is incident on two narrow slits separated by 0.35 mm. The slits form a vertically oriented interference pattern on the wall 1.6 m away. At a vertical distance of 8.0 mm from the center of the pattern, is there a bright fringe or dark fringe? Justify your answer.

$$\text{Path diff} = \frac{d y}{L}$$

$$= \frac{(.35 \times 10^{-3})(8 \times 10^{-3})}{1.6}$$

$$= 1.75 \times 10^{-6} \text{ or } 1750 \text{ nm}$$

$$\lambda = 583 \text{ nm}$$

$$\frac{dy}{L} = m\lambda \qquad m = \frac{1750}{583} = 3.00$$

m = 3 bright

3. (30 pts) A diffraction grating has 850 lines/mm.

a) What is the angular size of the first order (m = 1) spectrum created by visible light of wavelength 400-700 nm reflecting off the grating? This means the difference in angle between the ends of the reflected visible spectrum.

b) What is the highest order for which the entire visible spectrum can be seen?

$$d = \frac{1}{850{,}000} = 1.176 \times 10^{-6}\ m$$

a) $d \sin\theta = m\lambda$

400 nm : $\theta = \sin^{-1}\left(\frac{400\ nm}{1176\ nm}\right) = 19.9°$

700 nm : $\theta = \sin^{-1}\left(\frac{700\ nm}{1176\ nm}\right) = 36.5°$

$$\boxed{\Delta\theta = 16.6°}$$

b) Set $\theta = 90°$

Use longest λ

$$1.176 \times 10^{-6} \sin 90° = m(700\ nm)$$

$$m = 1.68$$

$$\boxed{m = 1}$$