Show your work on numerical problems to receive full credit.

1. (3 points) Three lasers of wavelengths $\lambda_1$, $\lambda_2$, and $\lambda_3$ are sent through a two-slit pattern. The wavelengths of the lasers are in the order $\lambda_1 < \lambda_2 < \lambda_3$. Arrange the wavelengths in order from that whose first maximum would be closest to the central maximum to that whose first maximum would be furthest from the central maximum.

   $$\frac{\lambda_1}{\lambda_2} < \frac{\lambda_2}{\lambda_3}$$

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

   As $\lambda \uparrow$, $d \uparrow$ which $\Theta$

2. (10 points) A diverging lens with a focal length of 10.0 cm is placed 15.0 cm to the right of a converging lens with a focal length of 15.0 cm. If a 20.0 cm tall object is placed 45.0 cm to the left of the converging lens, state the location of the final image, height of the final image, orientation (inverted or upright) of the final image, and whether the image is real or virtual.

   **CONVERGING FIRST:**
   
   \[ d_o = 45.0 \text{ cm} \]
   \[ f = 15.0 \text{ cm} \]
   \[ \frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \]
   \[ \frac{1}{45.0} + \frac{1}{d_i} = \frac{1}{15.0} \]
   \[ d_i = 22.5 \text{ cm} \]
   \[ m = -\frac{22.5 \text{ cm}}{45.0 \text{ cm}} = -0.5 \]
   
   Inverted, half size

   **SERVES AS OBJECT FOR DIVERGING**: \[ d_o = -7.5 \text{ cm} \]
   \[ f = -10.0 \text{ cm} \]
   \[ \frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \]
   \[ \frac{1}{-7.5} + \frac{1}{d_i} = \frac{1}{-10} \]
   \[ d_i = 30.0 \text{ cm to the right of the diverging lens} \]
   \[ m = -\frac{30.0}{-7.5} = 4 \times 10 \text{ cm} \]
   
   40 cm tall, upright, real
3. (10 points)

a. A 632.8 nm He-Ne laser is directed through a double slit and measurements are made on the resulting interference pattern. The third order maximum is a distance of 18.3 cm from the central maximum when the viewing screen is a distance of 750 mm from the slits. What is the separation of the slits?

\[ d \sin \theta = m \lambda \]

\[ d = \frac{m \lambda}{\sin \theta} = 3 \left(\frac{632.8 \times 10^{-9} \text{ m}}{0.2370}\right) = \frac{3 (632.8 \times 10^{-9} \text{ m})}{0.2370} = 8.01 \times 10^{-6} \text{ m} \]

4. The viewing screen is now moved to a distance of 1000 mm. What is the new distance on the screen between the third order maximum and the central maximum?

\[ \sin \theta \text{ is still } 0.2370 \quad \tan \theta = 0.244 \]

\[ \tan \theta = \frac{x}{1800 \text{ mm}} \]

\[ x = \tan \theta (1800) = (0.244)(1800 \text{ mm}) = 244 \text{ mm} = 24.4 \text{ cm} \]

Equations:

\[ d \sin \theta = m \lambda \quad m = 0, 1, 2, 3, \ldots \]

\[ d \sin \theta = (m + \frac{1}{2}) \lambda \quad m = 0, 1, 2, 3, \ldots \]