

1. Your friend Alice uses corrective eyeglasses of power -10D .
 - 1.a) When Alice is not using her eyeglasses, is her retina located in front of or behind her eye's focal plane?
 - 1.b) When you look at Alice's eye behind her eyeglasses, how much smaller or bigger does the pupil of her eye appear compared to its actual size?
 - 1.c) If Alice wants to look at the moon through a Keplerian astronomical telescope, without her eyeglasses on, how does she have to adjust the eyepiece in order to see a clear image?
2. Two positive lenses L_1 and L_2 are separated by 5cm. Their diameters are 6 and 4cm, respectively, and their focal lengths are $f_1 = 9\text{cm}$ and $f_2 = 3\text{cm}$. If a diaphragm with a hole 1cm in diameter is located between them, 2cm away from L_2 , find
 - 2.a) the aperture stop,
 - 2.b) the locations and sizes of the pupils for an axial object point located 12cm to the left of L_2 .
3. **Plane waves and phasor representations** Throughout this problem, by "complete expression" of a wave we mean the space-time representation, e.g. $f(x, y, z, t) = A \cos(kx - \omega t)$ is a plane wave of wave-vector magnitude k and frequency ω propagating in the direction of the \hat{x} coordinate axis. By "phasor expression" we mean the complex representation of the wave, e.g. Ae^{ikx} for the same wave.
 - 3.a) Write the complete and phasor expressions for a plane wave $f_1(x, y, z, t)$ propagating at an angle 30° relative to the \hat{z} axis on the xz -plane (*i.e.*, the plane $y = 0$). The wavelength is $\lambda = 1\mu\text{m}$, and the wave speed is $c = 3 \times 10^8\text{m} \cdot \text{sec}^{-1}$.
 - 3.b) Write the complete and phasor expressions for a plane wave $f_2(x, y, z, t)$ of the same wavelength and wave speed as f_1 but propagating at angle 60° relative to the \hat{z} axis on the yz -plane.
 - 3.c) Use the complete expression to plot $f_1(x, y, z = 0, t = 0)$ and $f_2(x, y, z = 0, t = 0)$ using MATLAB. (*Note:* you will probably need to use `surf` or an equivalent command.)

- 3.d)** The plane $z = 0$ is illuminated by the superposition of the two waves f_1 and f_2 . Plot the waveform received at points A, B, C, D, E with Cartesian coordinates, respectively,

$$(0, 0, 0), \left(\frac{1}{4}, -\frac{1}{4\sqrt{3}}, 0\right), \left(\frac{1}{2}, -\frac{1}{2\sqrt{3}}, 0\right), \left(\frac{3}{4}, -\frac{3}{4\sqrt{3}}, 0\right), \left(1, -\frac{1}{2\sqrt{3}}, 0\right)$$

(all units in microns) as function of time. What do you observe?

- 4. Complex arithmetic** Consider the complex numbers $z_1 = 1 + i2, z_2 = 3 + i4, z_3 = -1 + i2$. Compute the numerical value of the following expressions, and express it in both Cartesian and polar form.

4.a) z_2 (polar form only)

4.b) $z_1 + z_2$

4.c) $\frac{z_2}{z_3}$

4.d) $\left| \frac{z_1}{z_3} \right|$

4.e) $\frac{z_1^2}{z_2 + z_3}$