A summary of the vision correction calculations we did today:

**Near-Sightedness** (when a person’s near vision is still OK, but his/her far vision is not); that is, when a person’s Far Point ($FP$) is less than $FP_{\text{standard}}$ (which is $\infty$).

To find the focal length, $f$, of the correction lens needed for an eye whose Far Point ($FP$) is less than $\infty$…

- **Contact Lens:** (in cm)
  \[
  \frac{1}{f} = \frac{1}{\infty} + \frac{1}{-(FP)}
  \]
  Or:
  \[
  f = -(FP)
  \]
  (in m and diopters)
  \[
  R.P. = \frac{1}{FP_{\text{standard}}} + \frac{1}{-(FP)}
  \]
  Or:
  \[
  R.P. = -\frac{1}{FP}
  \]

- **Eyeglass Lens:** (in cm)
  \[
  \frac{1}{f} = \frac{1}{\infty} + \frac{1}{-(FP-2)}
  \]
  Or:
  \[
  f = -(FP-2)
  \]
  (in m and diopters)
  \[
  R.P. = \frac{1}{FP_{\text{standard}}} + \frac{1}{-(FP-.02)}
  \]
  Or:
  \[
  R.P. = -\frac{1}{FP-.02}
  \]

Keep in mind that this lens will correct only the far end of that eye’s focal range—and in so doing, it may result in bringing images of nearer objects too near (i.e. closer than the eye’s Near Point). This is why lenses designed for long-range viewing (e.g. driving) may or may not be usable for close-range viewing (e.g. reading). If not, then the wearer has a choice of constantly changing lenses (e.g. putting on different glasses) or using bi-focals.

**Far-Sightedness** (when a person’s far vision is still OK, but his/her near vision is not); that is, when a person’s Near Point ($NP$) is greater than $NP_{\text{standard}}$ (which is $25$ cm).

To find the focal length, $f$, of the correction lens needed for an eye whose Near Point ($NP$) is greater than $25$ cm…

- **Contact Lens:** (in cm)
  \[
  \frac{1}{f} = \frac{1}{25} + \frac{1}{-(NP)}
  \]

- **Eyeglass Lens:** (in cm)
  \[
  \frac{1}{f} = \frac{1}{23} + \frac{1}{-(NP-.02)}
  \]

Keep in mind that this lens will correct only the near end of that eye’s focal range—and in so doing, it may result in sending images of farther objects out too far (i.e. beyond that eye’s Far Point). This is why lenses designed for close-range viewing (e.g. reading) may or may not be usable for long-range viewing (e.g. driving). If not, then the wearer has a choice of constantly changing lenses (e.g. putting on different glasses) or using bi-focals.
4. In the drawing, the lenses have focal lengths of \( f_A = 4 \text{ cm} \), \( f_B = 12 \text{ cm} \), and \( f_C = -8 \text{ cm} \). The object is located at \( x = 0.00 \).

   a. Find the total magnification \((m)\) of this lens system.
      That is, find the ratio \( h_{final}/h_o \).

   b. What is the \( x \)-position of the final image?

   **Lens A:**
   \[
   \frac{1}{4} = \frac{1}{8} + \frac{1}{d_i} \quad d_i = 8
   \]
   The image of lens A (i.e., the object of lens B) is located 8 cm to the right of lens A (4 cm to the left of lens B).

   **Lens B:**
   \[
   \frac{1}{12} = \frac{1}{4} + \frac{1}{d_i} \quad d_i = -6
   \]
   The image of lens B (i.e., the object of lens C) is located 6 cm to the left of lens B (16 cm to the left of lens C).

   **Lens C:**
   \[
   \frac{-1}{8} = \frac{1}{16} + \frac{1}{d_i} \quad d_i = -5.33 \quad m_c = \left(\frac{-5.33}{16}\right) = 0.333
   \]

   a. \( m_T = m_A \cdot m_B \cdot m_C = (-1)(1.5)(0.333) = -0.500 \)

   b. The final image position is 5.33 cm to the left of lens C. That’s \( x = (30 - 5.33) = 24.7 \text{ cm} \)

4. Two lenses are placed 60.0 cm apart. When an object 4.00 cm tall is placed 20.0 cm in front of the first lens, the final image (from the second lens) is located halfway between the two lenses. If the magnification, \( m_1 \), of the first lens is \(-2.50\), find the final image’s height and also its orientation (upright or inverted) with respect to the original object.

   The facts given are shown here (with distances drawn to scale but not necessarily the heights):

   Also known: \( m_1 = -2.50 \), and \( h_o = 4.00 \text{ cm} \).

   To solve this, first note that \( m_1 = -(d_i/d_o) \).
   Rearranging this, we get \( d_i = -m_1(d_o) \).
   That is, \( d_i = -(-2.50)(20.0) = 50.0 \text{ cm} \).
   This is a real image (since the distance is positive), which means this is to the right of lens 1.

   So here is the diagram with these new facts also shown:

   Note that \( m_z = -(d_z/d_o) = -(30.0)/10.0 = 3.00 \).
   Then the total magnification for the two lenses is \( m_T = (m_1)(m_z) = (-2.50)(3.00) = -7.50 \).
   But by definition, \( m_T = h_{final}/h_o \).
   Therefore, \( h_{final} = m_T(h_o) = (-7.50)(4.00) = -30.0 \text{ cm} \).
   The final image height is 30.0 cm, oriented downward (inverted from the original orientation).