Step 1: setting up a camera and image plane.

What are the dimensions of the image plane in 3d space?

\[
\tan \left( \frac{d}{2} \right) = \frac{\text{opp}}{\text{adj}} = \frac{h_2}{d} \rightarrow h = 2d \tan \left( \frac{d}{2} \right)
\]

\[
AR = \frac{nx}{ny} = \frac{w}{h} \\
w = AR \cdot h
\]
Step 2a: Calculating the 3d coordinates of a pixel.

\[ x = -\frac{w}{2} + \frac{w}{n_x} (i + 0.5) \]
\[ y = -\frac{h}{2} + \frac{h}{n_y} (n_y - 0.5 - j) \]
Calculating the intersection of a ray with a sphere.

\[ At^2 + 2tB + C = 0 \]

- **Quadratic eqn.**
- **A = \|\hat{r}\|^2**
- **B = \hat{r} \cdot (\hat{e} - \hat{c})**
- **C = \|\hat{e} - \hat{c}\|^2 - R^2**

**t = -B \pm \sqrt{B^2 - C}**

- what happens \( B^2 - C < 0 \)?
  - no intersection
  - \( B^2 - C = 0 \)? one intersection
  - \( B^2 - C > 0 \)? two intersections

always normalize \( \hat{r} \) (ray direction).