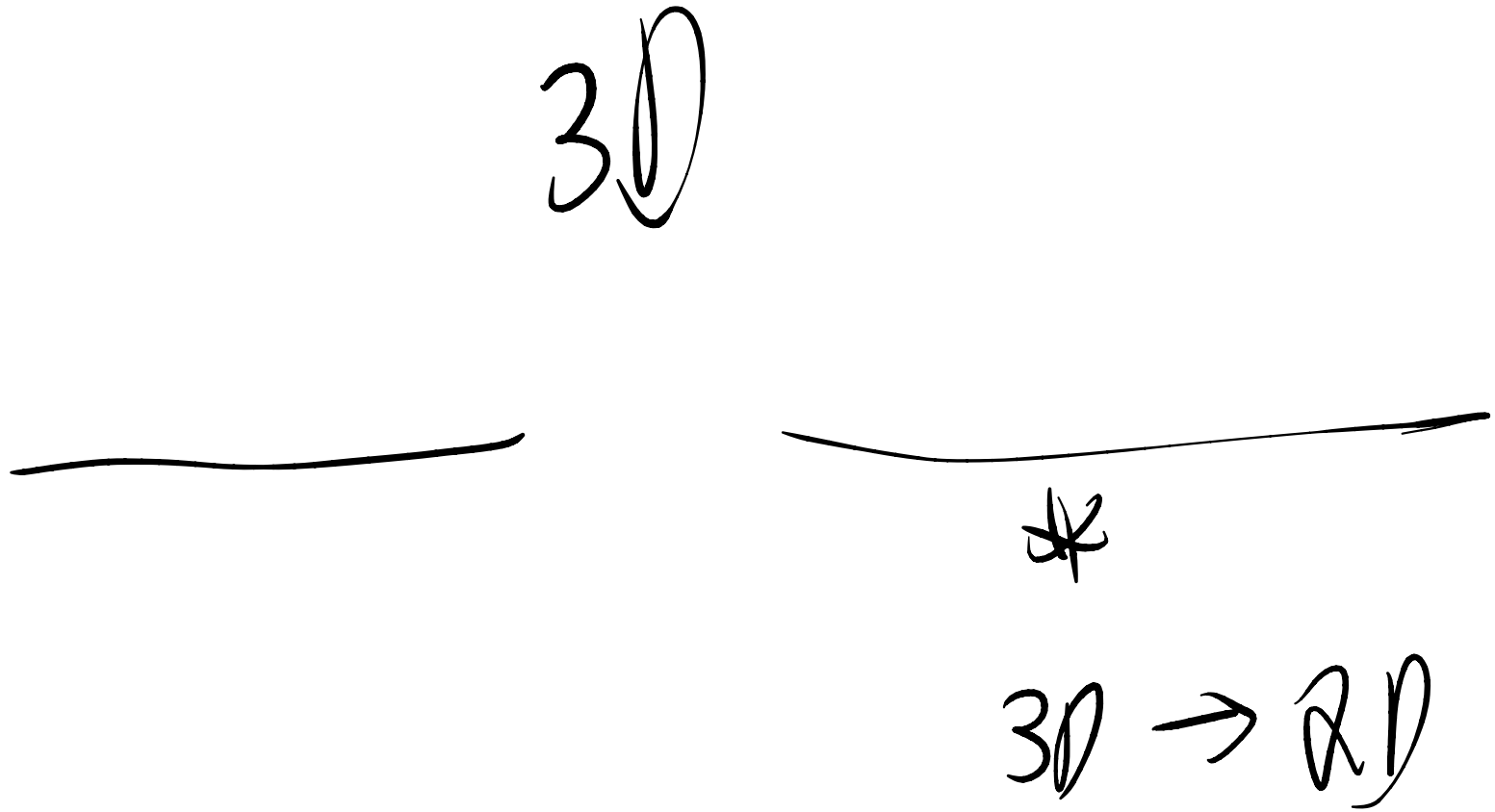
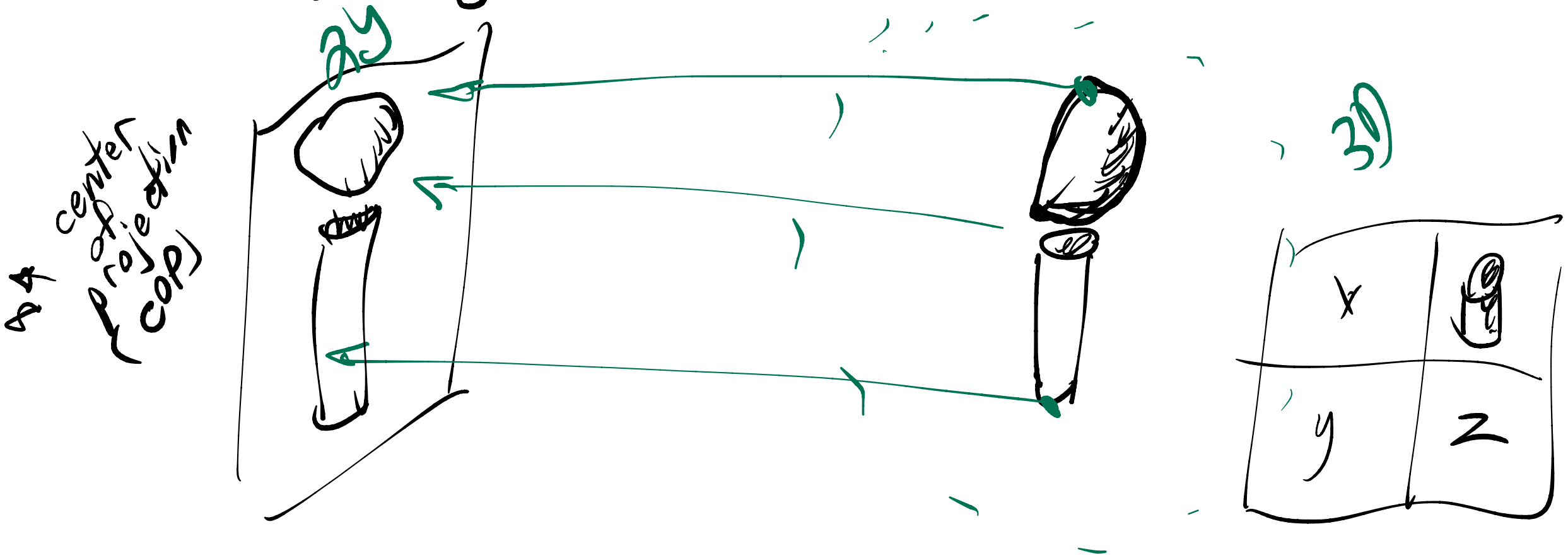

3D
3D → 2D

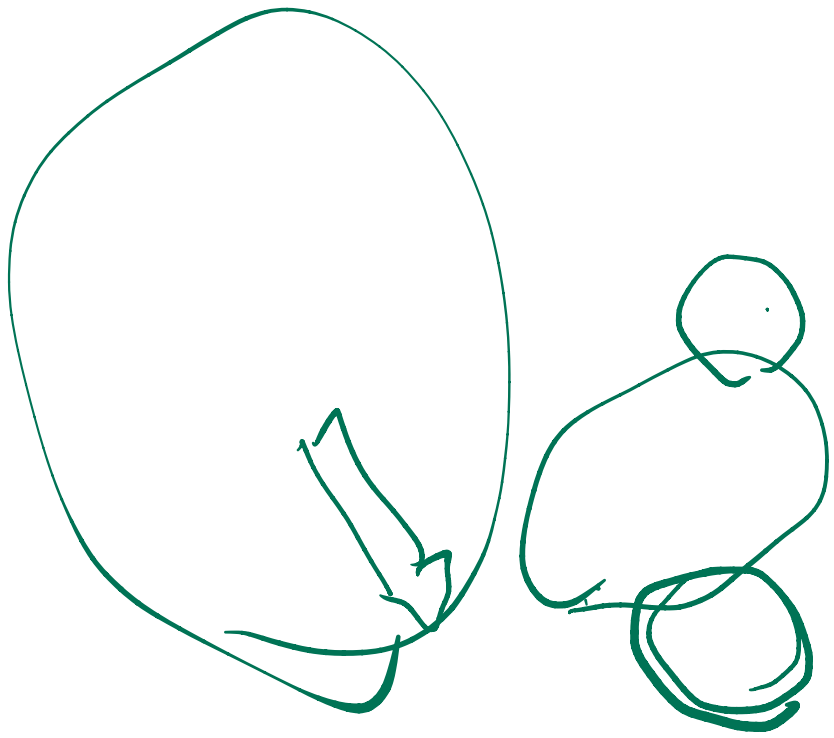
moving points into a subspace

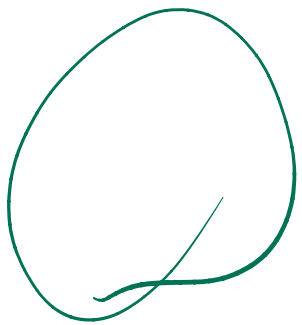
projecting 3D into 2D plane (view plane)

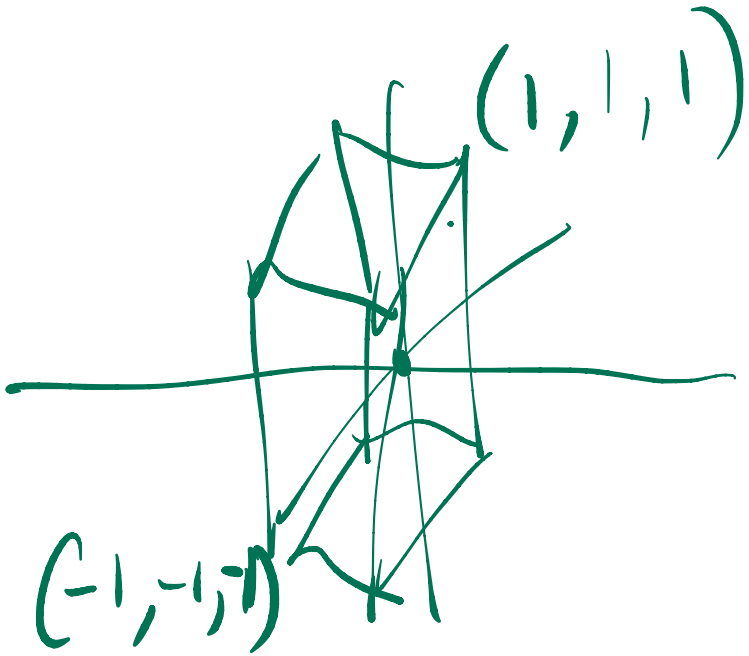


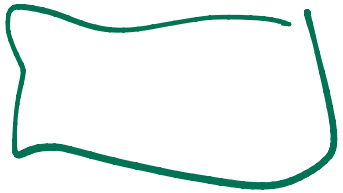
$$M = M_{T_1} M_{T_2} M_{T_3}$$

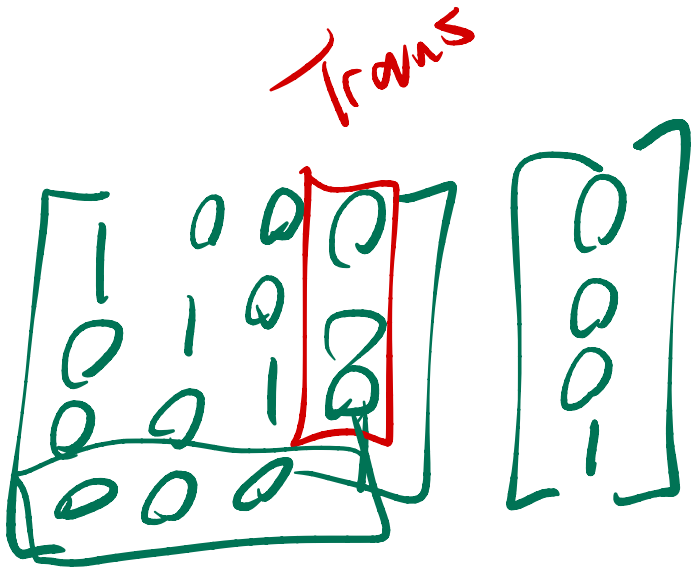
$$M^{-1} = M_{T_3}^{-1} M_{T_2}^{-1} M_{T_1}^{-1}$$






(1, 1, 1)
(-1, -1, -1)





one combined Matrix

Viewport

persp or ortho

camera transform (world ⇒ camera)

$$= R_{-\mathbf{Z}\,axis} \; \overrightarrow{T}_{origin}$$

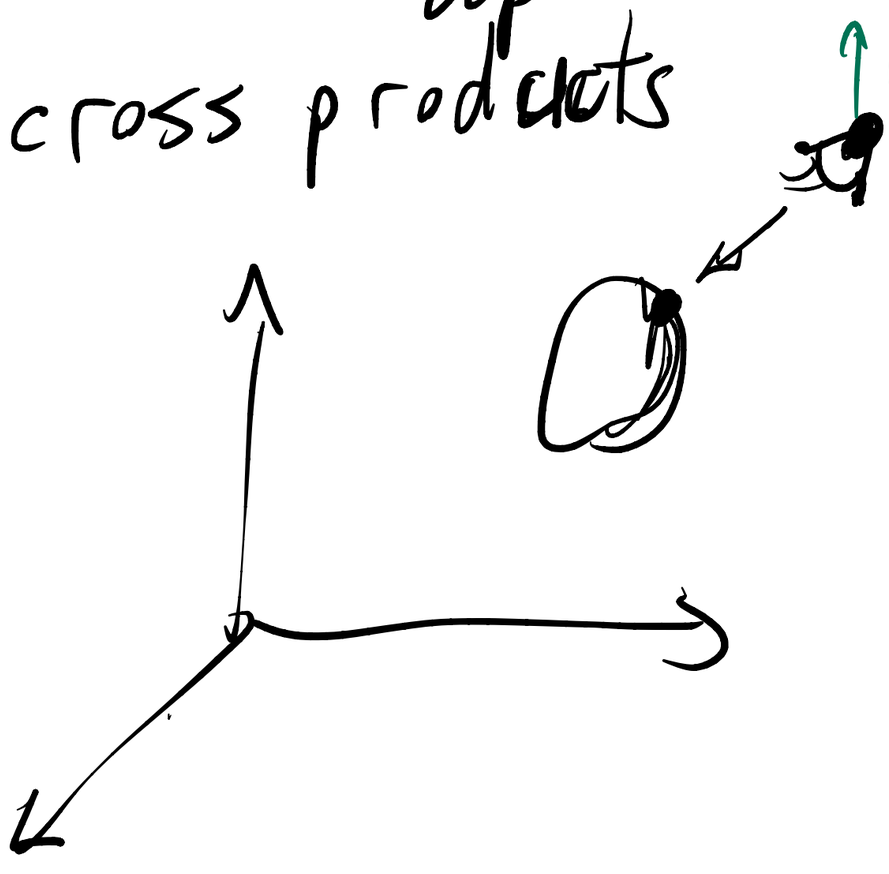
Lookat (eye, center, up)

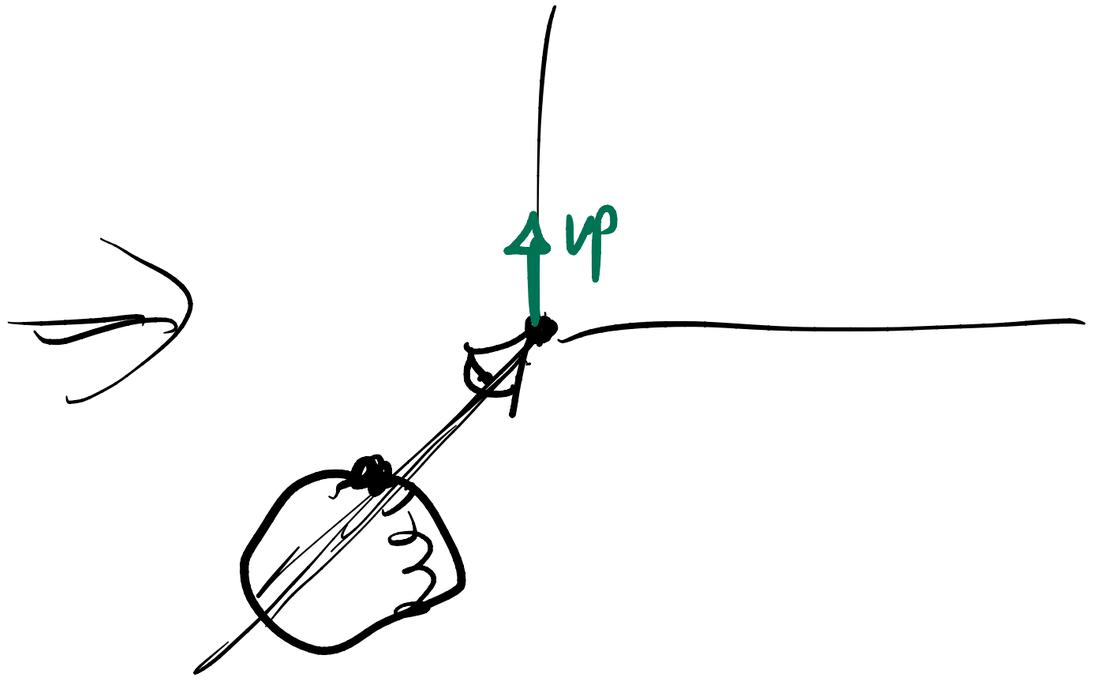
want; eye moved to (0,0,0)

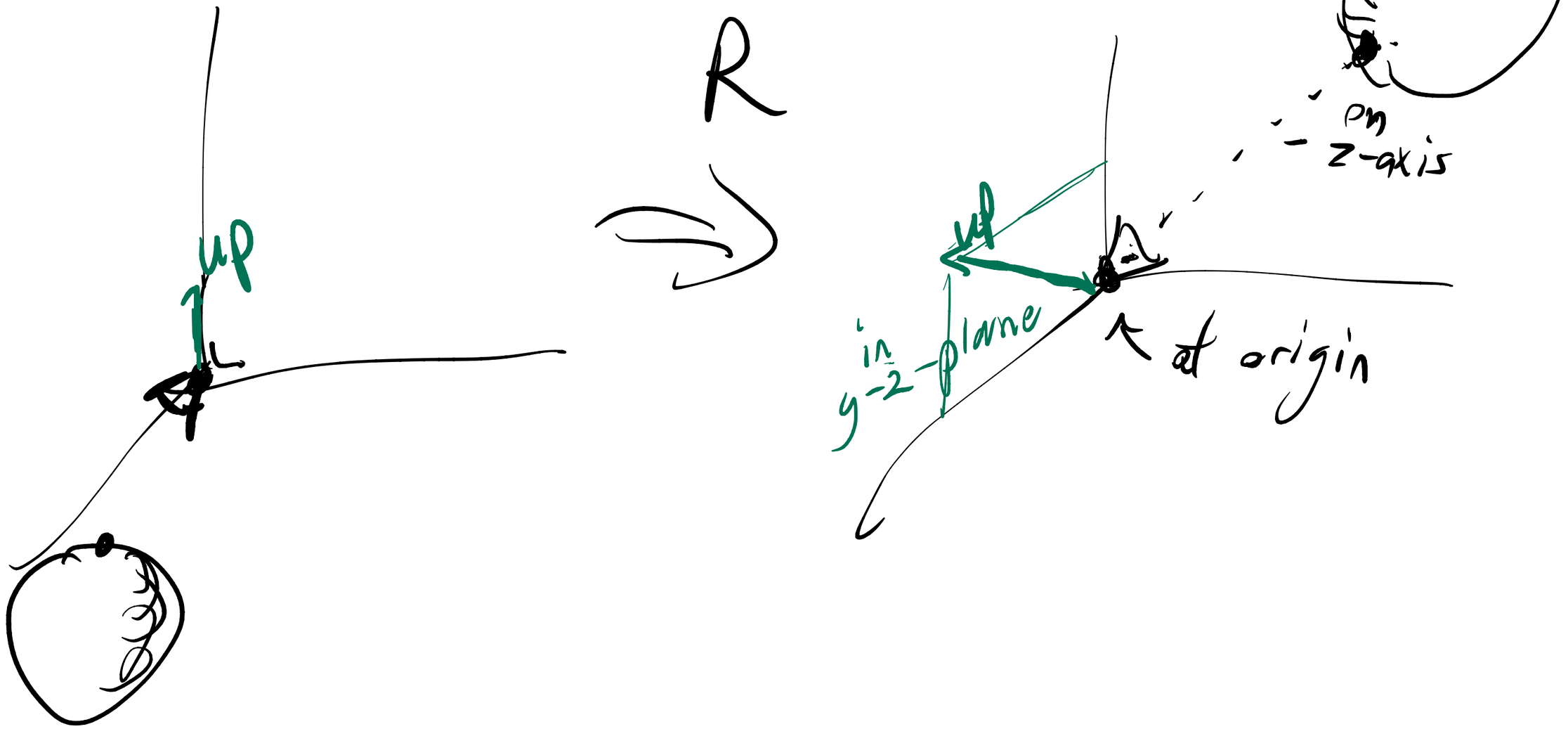
center on -z axis

up vector lie in yz-plane

cross products





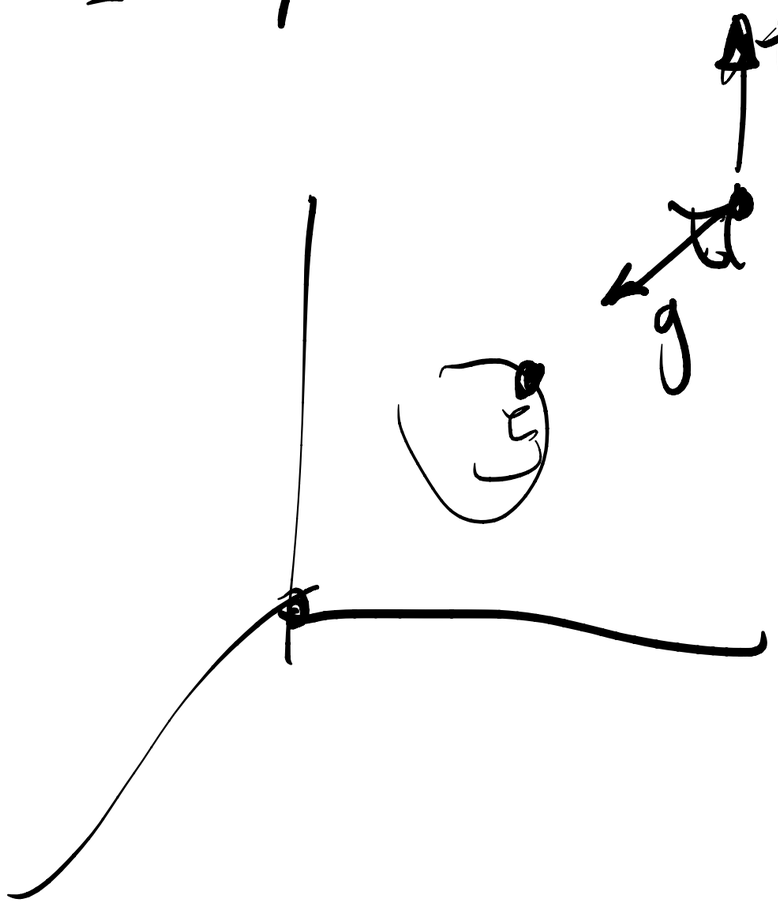

up
R
up
in
y-z-plane
at origin
pm
z-axis

e = eye position (eye)

g = gaze direction (center - eye) ⇒ want u orthonormal

t = up direction (up) v basic

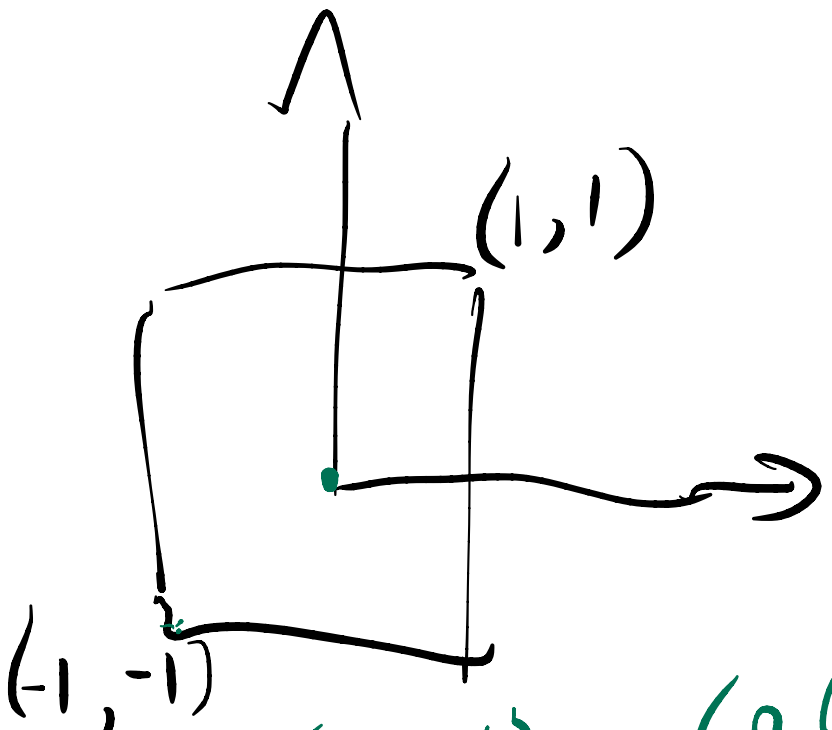
w vectors

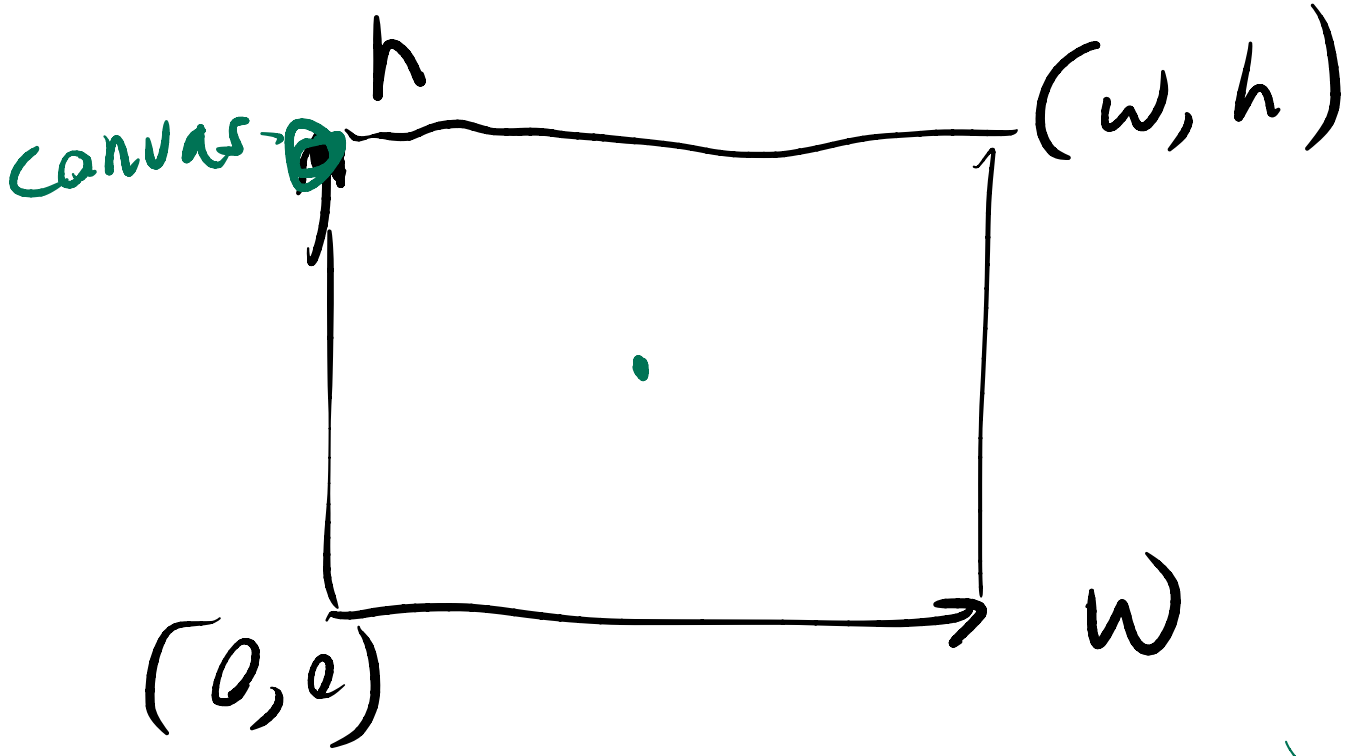


$$w = \frac{-g}{|g|}$$

$$u = \frac{t \times w}{|t \times w|}$$

$$v = w \times u$$





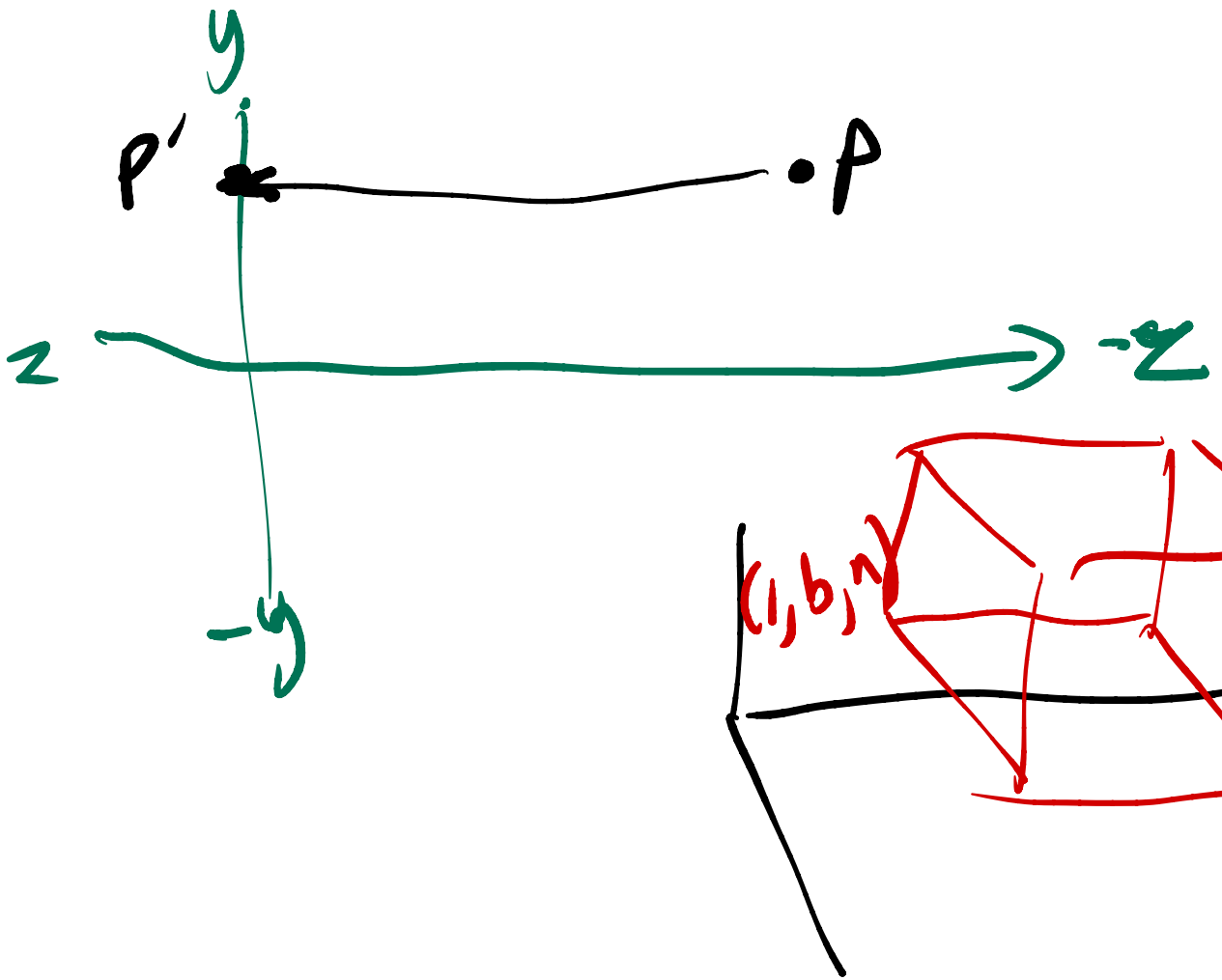
$(-1,-1) = (0,0)$

$(0,0) = \left(\frac{w}{2}, \frac{h}{2}\right)$

$(1,1) = (w,h)$

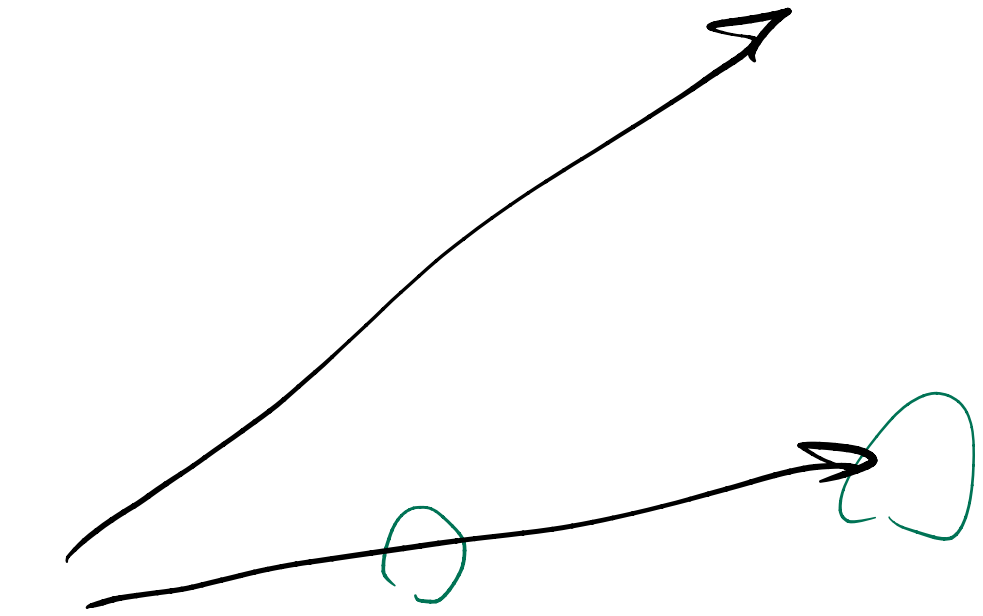
$T = \left(\frac{w}{2}, \frac{h}{2}\right) S\left(\frac{w}{2}, \frac{h}{2}\right)$

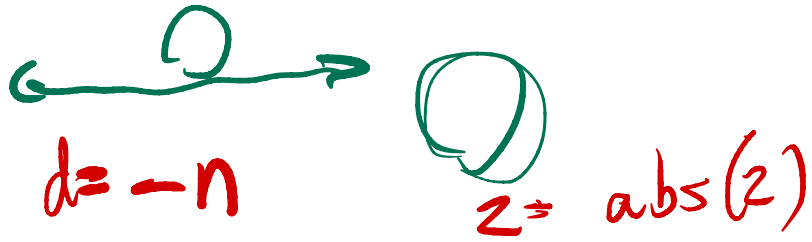
$$n_x = w$$
$$n_y = h$$

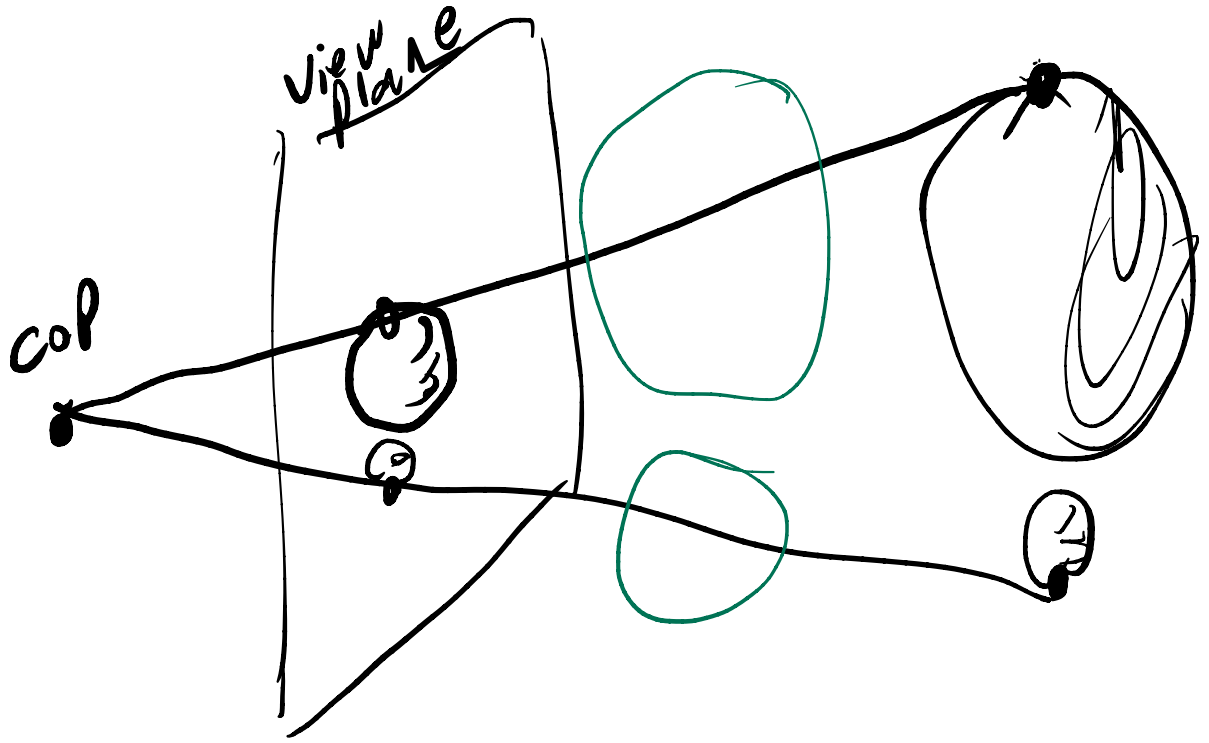


$$p = (x, y, z)$$
$$p' = (x, y, 0)$$

$x \in [left, right]$
$y \in [bottom, top]$
$z \in [near, far]$







$$\frac{y_s}{d} = \frac{y}{z}$$

$$y_s = \frac{y\,d}{z} = \frac{-y\,n}{z}$$

$$V = \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} 0,0,n,1 \\ 0,0,f,1 \end{bmatrix}$$

$$V' = \begin{bmatrix} x \cdot n \\ y_n \\ z(n+f) - f_n \\ z \end{bmatrix} = \begin{matrix} x \\ y \\ z \\ w \end{matrix}$$

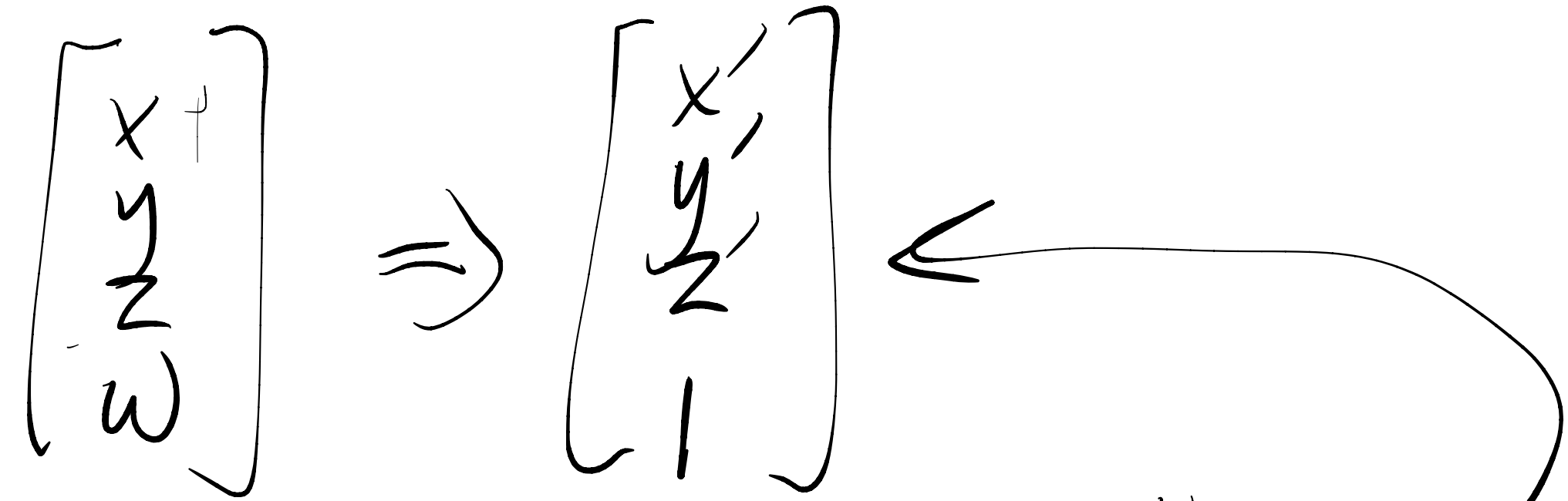
$$V'' = \frac{V'}{w} = \begin{bmatrix} \frac{x \cdot n}{z} \\ \frac{y \cdot n}{z} \\ n+f - \frac{f_n}{z} \end{bmatrix}$$

$$n = n^2 + nf - fn = n^2/n$$

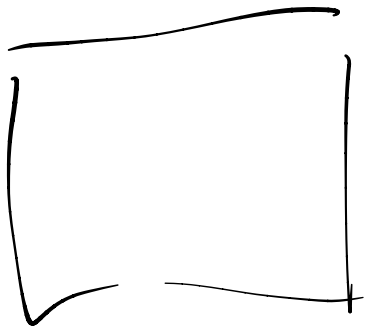
$$f = f_n + f^2 - fn = f^2/f$$

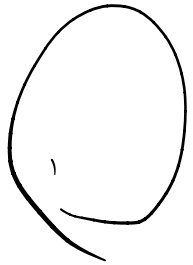
$(0, 0, n) \rightarrow$

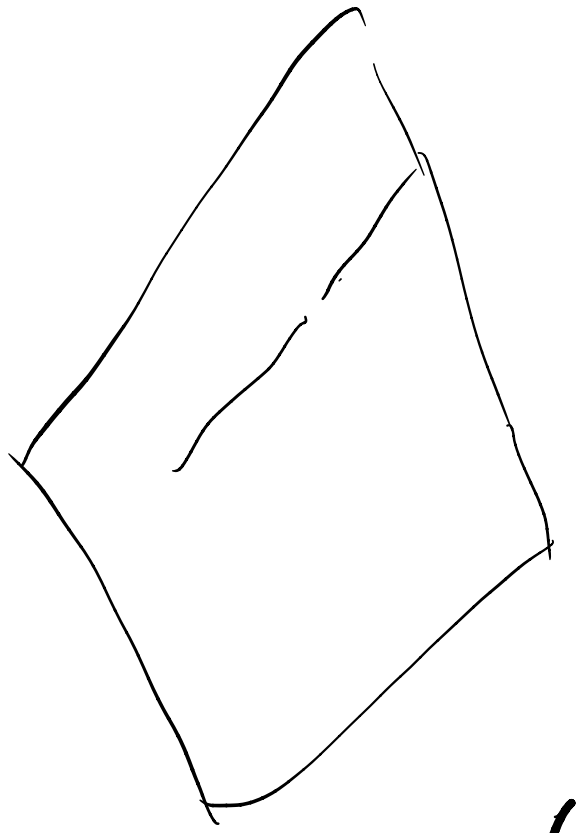
$$= \begin{bmatrix} \frac{x \cdot n}{2} \\ \frac{y \cdot n}{2} \\ n+f - \frac{fn}{2} \end{bmatrix}$$



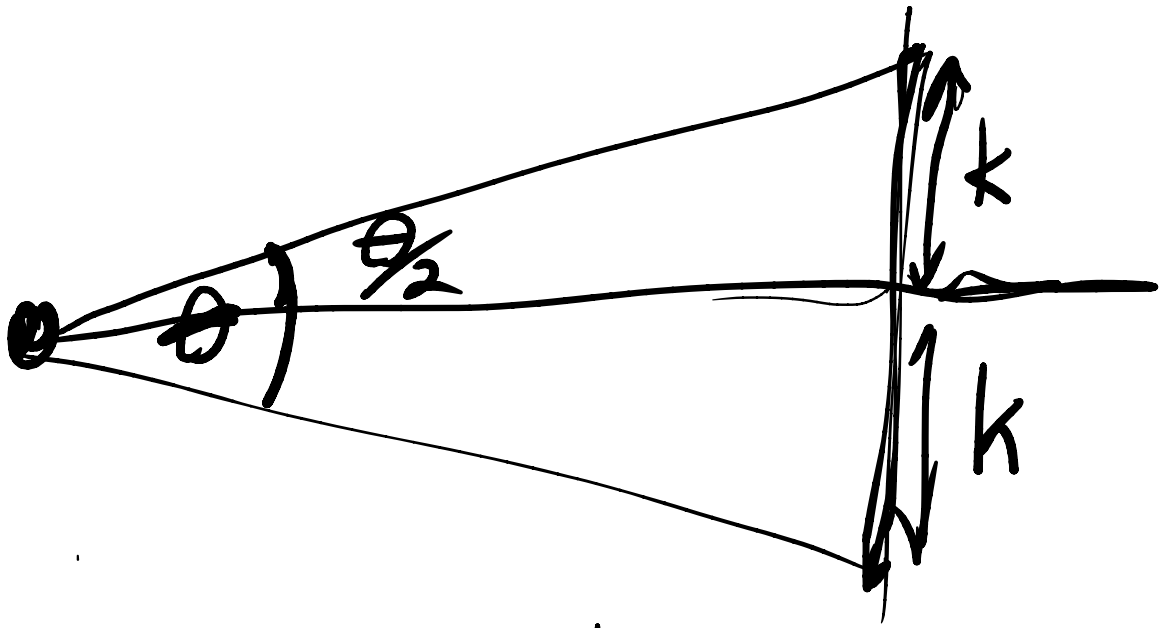
all λ that when you divide w gives the same are considered equal



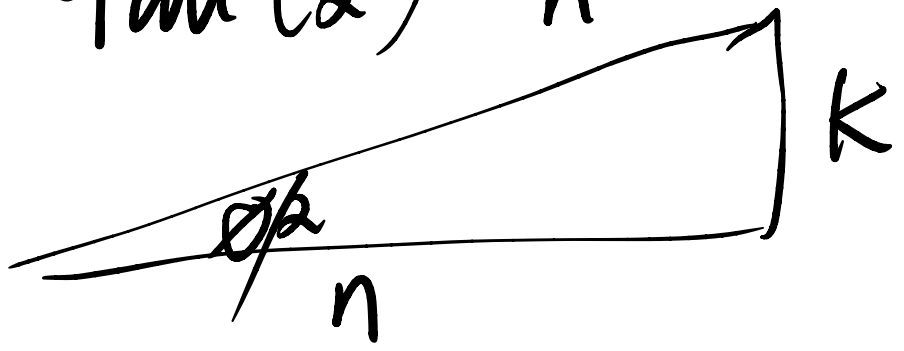


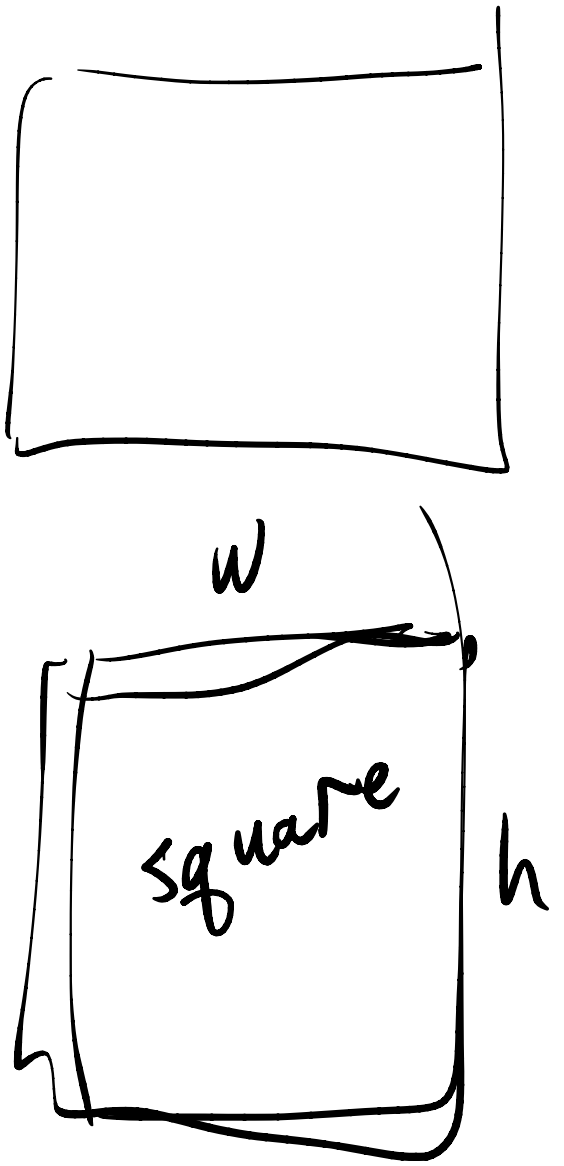


$$k = \tan\left(\frac{\theta}{2}\right) \cdot n$$



$$\tan\left(\frac{\theta}{2}\right) = \frac{k}{n}$$

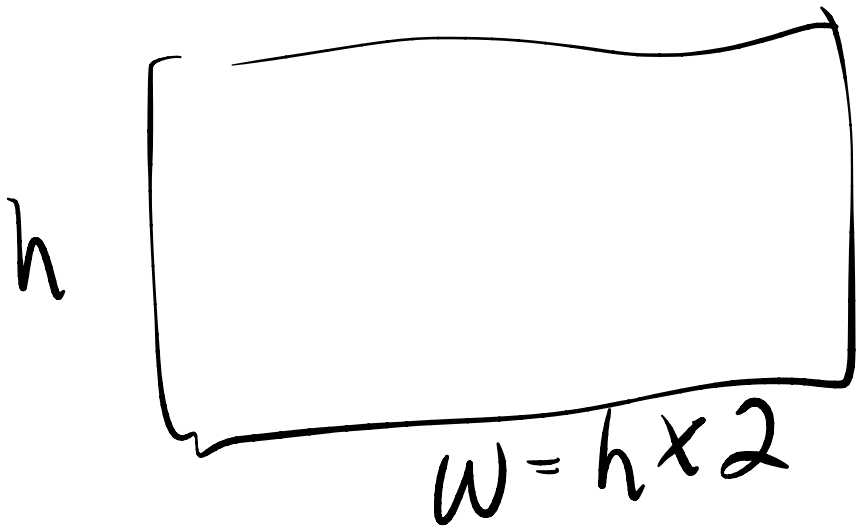




fov ⇒ in y or in x

"fovy"

w=h



ortho = (l, r, b, t, n, f)

(-2k, 2k, -k, k, n, f)