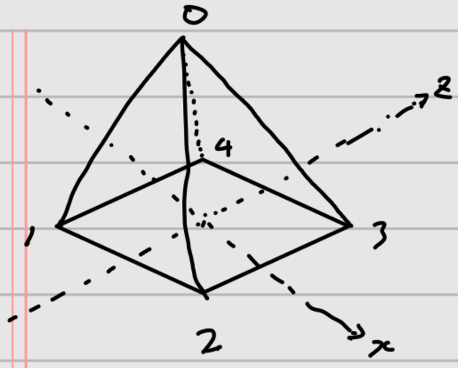
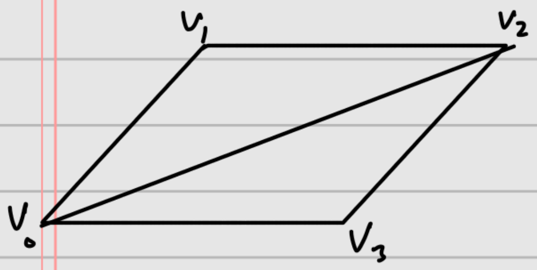
#1

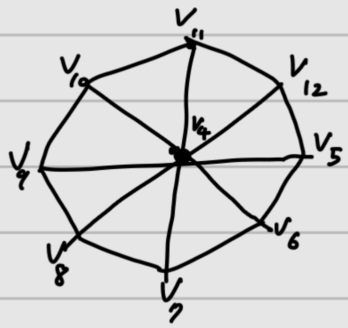


vertex list { {0, 1, 0},
{-0.5, 0, -0.5},
{0.5, 0, -0.5},
{0.5, 0, 0.5},
{-0.5, 0, 0.5} }

index list { {0, 1, 2}, {0, 2, 3}, {0, 3, 4}, {0, 4, 1},
{1, 3, 2}, {1, 4, 3} }

#2





vertex list $\{V_0 \sim V_{12}\}$

Index list $\{ \{V_0, V_2, V_1\}, \{V_0, V_3, V_2\},$
$\{V_4, V_5, V_{12}\}, \{V_4, V_{12}, V_{11}\}, \{V_4, V_{11}, V_{10}\}, \{V_4, V_{10}, V_9\}, \{V_4, V_9, V_8\},$
$\{V_4, V_8, V_7\}, \{V_4, V_7, V_6\}, \{V_4, V_6, V_5\} \}$

#3 $E = (-20, 35, -50)$ $L = (10, 0, 30)$ $U = (0, 1, 0)$

$$z = \frac{L-E}{\|L-E\|} \qquad L - E = (10+20, -35, 80) = (30, -35, 80)$$

$$\|L-E\| = \sqrt{30^2 + 35^2 + 80^2} \approx 92.3$$

$$z = \left(\frac{30}{92.3}, -\frac{35}{92.3}, \frac{80}{92.3} \right)$$

$$x = \frac{U \times z}{\|U \times z\|} \qquad U \times z = \left(\frac{80}{92.3}, 0, -\frac{30}{92.3} \right) \quad \|U \times z\| \approx 0.926$$

$$x = (0.936, 0, -0.351)$$

$$y = z \times x \approx (0.133, 0.926, 0.355)$$

$$-x \cdot E = 1.17, \quad -y \cdot E = -12.0 \quad -z \cdot E = 63.1$$

$$M_{view} \approx \begin{bmatrix} 0.936 & 0.133 & 0.325 & 0 \\ 0 & 0.926 & -0.379 & 0 \\ -0.351 & 355 & 0.867 & 0 \\ 1.17 & -12.0 & 63.1 & 1 \end{bmatrix}$$

#4

$$P = \begin{bmatrix} \frac{1}{a\cdot\tan(\theta/2)} & 0 & 0 & 0 \\ 0 & \frac{1}{\tan(\theta/2)} & 0 & 0 \\ 0 & 0 & \frac{f}{f-n} & 1 \\ 0 & 0 & \frac{-nf}{f-n} & 0 \end{bmatrix}$$

$$\frac{1}{a\cdot\tan(\theta/2)} = \frac{1}{\frac{4}{3}(0.4142)} = 1.811$$

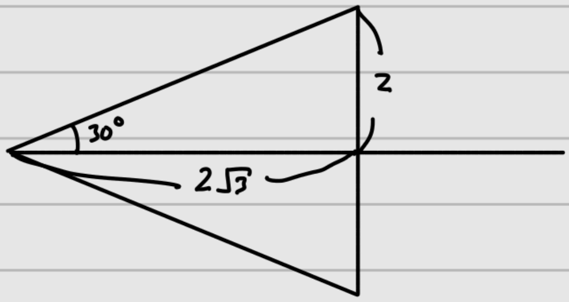
$$\frac{1}{\tan(\theta/2)} = \frac{1}{0.4142} = 2.414$$

$$\frac{f}{f-n} = \frac{100}{100-1} = 1.01$$

$$\frac{-nf}{f-n} = \frac{-100}{100-1} = -1.01$$

$$P \approx \begin{bmatrix} 1.811 & 0 & 0 & 0 \\ 0 & 2.414 & 0 & 0 \\ 0 & 0 & 1.01 & 1 \\ 0 & 0 & -1.01 & 0 \end{bmatrix}$$

#5



$\therefore 2\sqrt{3}$

#6

$$\begin{bmatrix} 1.86603 & 0 & 0 & 0 \\ 0 & 3.73205 & 0 & 0 \\ 0 & 0 & 1.02564 & 1 \\ 0 & 0 & -5.12821 & 0 \end{bmatrix} \quad P = \begin{bmatrix} \frac{1}{r\tan(\theta/2)} & 0 & 0 & 0 \\ 0 & \frac{1}{\tan(\theta/2)} & 0 & 0 \\ 0 & 0 & A & 1 \\ 0 & 0 & B & 0 \end{bmatrix}$$

$1.86603 \times r = 3.73205$

$r \approx 2$ $\quad \tan(\theta/2) \approx 0.268$ $\quad \cot(0.268) = 213.789$

$a = 106.894$

$A = \frac{f}{f-n}$, $B = \frac{-nf}{f-n}$ $\quad n = -\frac{B}{A} = 5$

$\frac{f}{f-5} = 1.02564$ $\quad 0.02564f = 5 \times 1.02564$

$f \approx 200$

$\therefore r=2 \quad a=106.894$

$n=5 \quad f=200$

#7 $Ar = B \rightarrow \underline{\underline{r = \frac{B}{A}}}$ $\frac{1}{B} = \tan(\alpha/2) \rightarrow \frac{\alpha}{2} = \cot(\frac{1}{B})$

$\underline{\underline{\alpha = 2\cot(\frac{1}{B})}}$

$-nC = D \rightarrow \underline{\underline{n = -\frac{D}{C}}}$

$C(f + \frac{D}{C}) = f$

$(C-1)f = -D$

$\underline{\underline{f = \frac{D}{1-C}}}$

#8 $u = vP$

$(uT)_w = (vPT)_w$ $u_w = (vP)_w$

$\left(\frac{vP}{(vP)_w}\right)T = \frac{1}{(vP)_w}(vP)T = \frac{1}{(vPT)_w}(vPT) = \frac{vPT}{(vPT)_w}$

#9 $$PP^{-1} = \begin{bmatrix} \frac{1}{r\tan(\frac{\alpha}{2})} & 0 & 0 & 0 \\ 0 & \frac{1}{\tan(\alpha/2)} & 0 & 0 \\ 0 & 0 & \frac{f}{f-n} & 1 \\ 0 & 0 & \frac{-nf}{f-n} & 0 \end{bmatrix} \begin{bmatrix} r\tan(\alpha/2) & 0 & 0 & 0 \\ 0 & \tan(\alpha/2) & 0 & 0 \\ 0 & 0 & 0 & -\frac{f-n}{nf} \\ 0 & 0 & 1 & \frac{1}{n} \end{bmatrix}$$

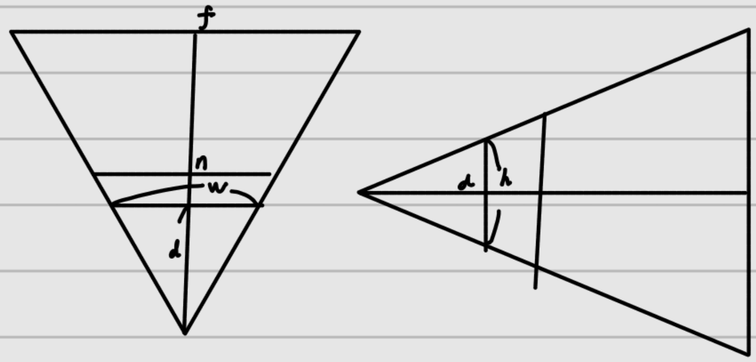
$$= \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

#10 $\left[\frac{x}{z}, \frac{y}{z}, 1, \frac{1}{z}\right] \cdot P = [x_{ndc}, y_{ndc}, z_{ndc}, 1]$ 이므로,

$[x_{ndc}, y_{ndc}, z_{ndc}, 1] \cdot P^{-1} = \left[\frac{x}{z}, \frac{y}{z}, 1, \frac{1}{z}\right]$, $w = \frac{1}{z}$ 이므로,

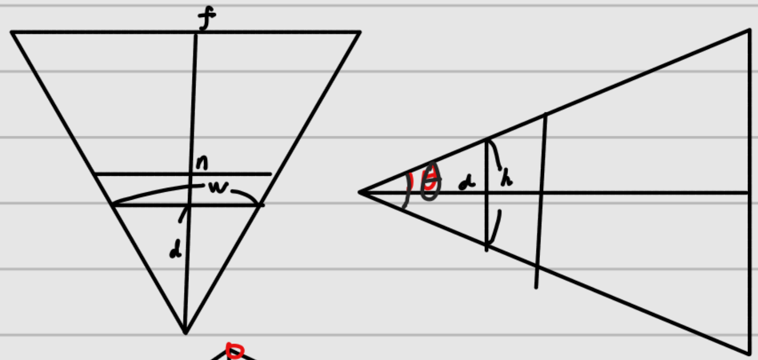
$\left[\frac{x}{z}, \frac{y}{z}, 1, \frac{1}{z}\right] \cdot \frac{1}{w} = [x, y, z, 1]$

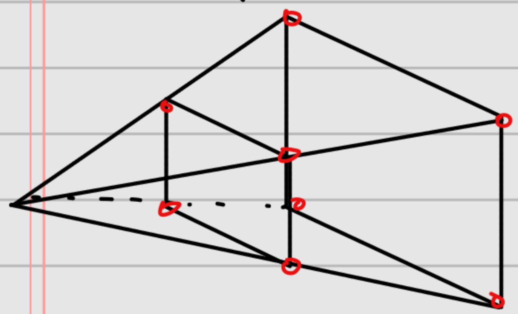
#11

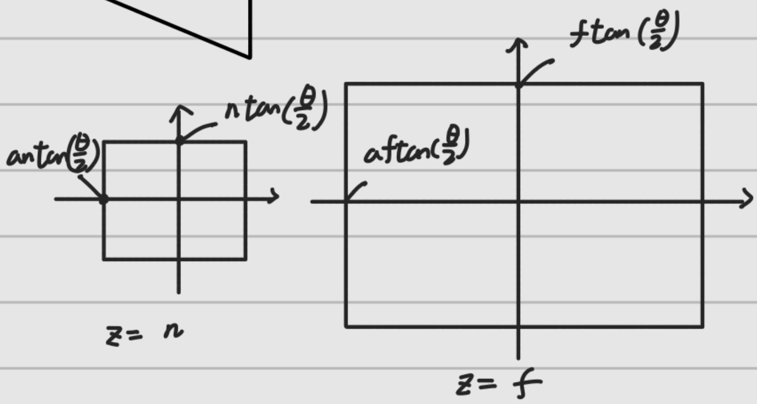


$$1 = \frac{A(w/2)}{n} \rightarrow A = \frac{2n}{w} \qquad B = r \cdot A = \frac{2n}{h}$$

#12







vertex list { $\{-an\tan(\frac{\theta}{2}), n\tan(\frac{\theta}{2}), n\}$, $\{an\tan(\frac{\theta}{2}), n\tan(\frac{\theta}{2}), n\}$,
$\{-an\tan(\frac{\theta}{2}), -n\tan(\frac{\theta}{2}), n\}$, $\{an\tan(\frac{\theta}{2}), -n\tan(\frac{\theta}{2}), n\}$,
$\{-af\tan(\frac{\theta}{2}), f\tan(\frac{\theta}{2}), f\}$, $\{af\tan(\frac{\theta}{2}), f\tan(\frac{\theta}{2}), f\}$,
$\{-af\tan(\frac{\theta}{2}), -f\tan(\frac{\theta}{2}), f\}$, $\{af\tan(\frac{\theta}{2}), -f\tan(\frac{\theta}{2}), f\}$ }

#13

$T(u+v) = T(u) + T(v)$ 만족.
$T(au) = aT(u)$ 만족 $\Rightarrow$ 선형임.

$$[x, y, z]\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ t_x & t_y & 1 \end{bmatrix} = [x + t_x z, \; y + t_y z, \; z]$$

#14 $[x, y, z, 1]\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ t_x & t_y & t_z & 1 \end{bmatrix} = [x+t_x, y+t_y, z+t_z, 1]$

↳ S_{xyz} w=1 위의 점을 평행이동시키는 것과 같다.