1. Projection Transformation

   Let $(x_c,\, y_c,\, z_c)$ be a point in camera coordinates and let $(x_p,\, y_p,\, z_p)$ be its perspective projection onto the viewplane. Then

$$x_p = -x_c/z_c, \qquad y_p = -y_c/z_c, \qquad z_p = -1.$$

2. Clipping Equations

   Let v_0 and v_1 be the endpoints of a line segment in the camera's viewplane $z = -1$. If the line segment crosses the line $x = 1$, or $x = -1$, or $y = 1$, or $y = -1$ (respectively), then we solve for t in the equation

$$(1-t)v_0 + tv_1 = (1,\, y_c)$$

$$(1-t)v_0 + tv_1 = (-1,\, y_c)$$

$$(1-t)v_0 + tv_1 = (x_c,\, 1)$$

$$(1-t)v_0 + tv_1 = (x_c,\, -1)$$

   (respectively) to find the point where the line segment should be clipped.

3. Viewport Transformation

   Let $(x_p,\, y_p,\, -1)$ be a point within the viewplane's view rectangle and let $(x_{vp},\, y_{vp})$ be its result of its transformation to the renderer's pixel-plane. Then

$$x_{vp} = 0.5 + (w/2)(x_p + 1),$$

$$y_{vp} = 0.5 + (h/2)(y_p + 1).$$

   Points $(x_{vp},\, y_{vp})$ in the renderer's pixel-plane have coordinates that satisfy

$$0.5 \le x_{vp} < w + 0.5 \qquad \text{and} \qquad 0.5 \le y_{vp} < h + 0.5$$

   where w and h are the width and height of the framebuffer's viewport.

4. Pixelplane to Pixel Transformation

   Let $(x_{vp},\, y_{vp})$ be a point in the renderer's pixel-plane and let $(x,\, y)$ be the equivalent pixel in the framebuffer's viewport. Then

$$x = (\texttt{int})\texttt{Math.round}(x_{vp}) - 1$$

$$y = h - (\texttt{int})\texttt{Math.round}(y_{vp})$$

   Pixels $(x,\, y)$ in a framebuffer's viewport have integer coordinates that satisfy

$$1 \le x \le w \qquad \text{and} \qquad 1 \le y \le h$$

   with the pixel $(0,\, 0)$ being in the upper left hand corner.