a)
$x(t) = x_1 t + x_0$
$y(t) = y_1 t \ + y_0$
$z(t) = z_1 t + z_0$

b)
Using perspective projection camera model:
u is equivalent to image plane x coordinate, and v is equivalent to image plane y coordinate

$$u \ = \frac{f(x_1 t + x_0)}{z(t) = z_1 t + z_0} \qquad\qquad v \ = \frac{f(y_1 t + y_0)}{z(t) = z_1 t + z_0}$$

c)
Rewrite each equation to equal ‘t’ and equate to each other

$$u z_1 t + u z_0 = f x_1 t + f x_0 \tag{1}$$
$$t = \frac{f x_0 - u z_0}{u z_1 - f x_1}$$

$$v z_1 t + v z_0 = f y_1 t + f y_0$$
$$t = \frac{f y_0 - v z_0}{v z_1 - f y_1}$$

$$\frac{f x_0 - u z_0}{u z_1 - f x_1} \ = \frac{f y_0 - v z_0}{v z_1 - f y_1} \tag{2}$$

Cross multiply, bring right side to lift side, and move terms around to get implicit form of a line equation:

$$(f x_0 - u z_0)(v z_1 - f y_1) = (u z_1 - f x_1)(f y_0 - v z_0) \tag{3}$$

$$(f z_0 y_1 \ - \ f z_1 y_0)\, u \ + \ (f z_1 x_0 \ - \ f z_0 x_1)\, v \ - \ f^2 x_0 y_1 + f^2 x_1 y_0 \ = \ 0$$

$$(f z_0 y_1 \ - \ f z_1 y_0)\, u \ + \ (f z_1 x_0 \ - \ f z_0 x_1)\, v \ + \ f^2 x_1 y_0 \ - \ f^2 x_0 y_1 = 0 \tag{4}$$

d)
When the line is directly parallel to the z axis or axis which spans out of the camera, the fixing of x and y axis allows for the line to continually extend in the z direction which give the illusion of a single point being projected onto the image plane