A.) 1.) $R(Y, \theta) = \begin{bmatrix} \cos(\theta) & 0 & \sin(\theta) & 0 \\ 0 & 1 & 0 & 0 \\ -\sin(\theta) & 0 & \cos(\theta) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

2.) $R(z,\theta) = \begin{bmatrix} \cos(\theta) & -\sin(\theta) & 0 & 0 \\ \sin(\theta) & \cos(\theta) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

3.) IT can be written as the following with a vector n = (-Dy/Dr, Dx/Dr, 0). This vector and rotation angle θ = Dr / R are used to do 3d rotation

4.) P1 = (1,1,1) First we want to Translate P0 to the origin. P0 = (1,1,0) $T(po) = \begin{bmatrix} 1 & 0 & 0 & -X0 \\ 0 & 1 & 0 & -Y0 \\ 0 & 0 & 1 & -Z0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

Now we rotate about the X axis

L = Sqrt(P1x + P1y + P1z)
V = Sqrt(P1y^2 + P2z^2) = sqrt(2) Sin(θ) = P1y/V Cos(θ) = P1z/V
So the matrix is

$Rx = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & P1z/v & -P1y/V & 0 \\ 0 & P1y/V & P1z/V & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

Sin(θ) = -P1x/L
Cos(θ) = V/L
Now we do the same thing about the Y axis

$Ry = \begin{bmatrix} V/L & 0 & -P1x/L & 0 \\ 0 & 1 & 0 & 0 \\ P1x/L & 0 & V/L & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

Now we rotate by an angle θ about the Z axis

$R(z,\theta) = \begin{bmatrix} \cos(\theta) & -\sin(\theta) & 0 & 0 \\ \sin(\theta) & \cos(\theta) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$

Finally. We take the inverse of rotation Ry then the inverse of rotation Rx and then finally the inverse of our translation T(p0)

So our overall ModelView matrix looks like this

[M] = [T(P0)]^-1 * [Rx]^-1 * [Ry]^-1 * [Rz(θ)] * [Ry] * [Rx] * [T(P0)]

B.)

1. We have the following defined 3D coordinates:

$u = x / [(1 / f) (D - z)] = x' / w'$
$v = y / [(1 / f) (D - z)] = y' / w'$
$\lambda = D - f = z' / w'$

We get this matrix using this

$$\begin{bmatrix} x' \\ y' \\ z' \\ w' \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & -(1 / f)(D - f) & (D / f) * (D - f) \\ 0 & 0 & -(1/f) & D/f \end{bmatrix} \bullet \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

2. $u = (f*x) / -z$
$v = (f*y) / -z$

3. This would be:

$$\begin{bmatrix} x' \\ y' \\ z' \\ w' \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & -(1/f) & 0 \end{bmatrix} \bullet \begin{bmatrix} x \\ y \\ z \\ 1 \end{bmatrix}$$

If at $z = -f$, we plug $-f$ into the 2nd formulas for u and v for z. This results in bing $-(-f)$, which gives the equations

$u = (f \bullet x) / f$
$v = (f \bullet y) / f$