1. BRIEFLY write out what the matrices A, B, C, D, and E are responsible for doing. Then write what values they have. Make sure to get the order correct (that is, matrix E only corresponds to one of the steps described in the viewing lecture).

p′ =A·B·C·D·E·p → from homework

$$\mathbf{p}_s = \mathbf{M}_{\mathrm{vp}}\mathbf{M}_{\mathrm{orth}}\mathbf{P}\mathbf{M}_{\mathrm{cam}}\mathbf{M}_{\mathrm{m}}\mathbf{p}_o$$

$$\begin{bmatrix} x_s \\ y_s \\ z_c \\ 1 \end{bmatrix} = \begin{bmatrix} \frac{n_x}{2} & 0 & 0 & \frac{n_x-1}{2} \\ 0 & \frac{n_y}{2} & 0 & \frac{n_y-1}{2} \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \frac{2}{r-l} & 0 & 0 & -\frac{r+l}{r-l} \\ 0 & \frac{2}{t-b} & 0 & -\frac{t+b}{t-b} \\ 0 & 0 & \frac{2}{n-f} & -\frac{n+f}{n-f} \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} n & 0 & 0 & 0 \\ 0 & n & 0 & 0 \\ 0 & 0 & n+f & -fn \\ 0 & 0 & 1 & 0 \end{bmatrix} \mathbf{M}_{\mathrm{cam}}\mathbf{M}_{\mathrm{m}} \begin{bmatrix} x_o \\ y_o \\ z_o \\ 1 \end{bmatrix}$$

A = Viewport Translation Matrix (MVP).

Role: Translating window coordinates to viewport coordinates

$$M_{vp} = \begin{bmatrix} \frac{n_x}{2} & 0 & 0 & \frac{n_x-1}{2} \\ 0 & \frac{n_y}{2} & 0 & \frac{n_y-1}{2} \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

B = Orthographic projection matrix

Role: determining position within orthographic view model and corresponding draw/rending/view planes

$$T_{ort} = \begin{bmatrix} \frac{2}{r-l} & 0 & 0 & -\frac{r+l}{r-l} \\ 0 & \frac{2}{t-b} & 0 & -\frac{t+b}{t-b} \\ 0 & 0 & \frac{2}{n-f} & -\frac{n+f}{n-f} \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

C = Perspective Matrix

Role: Transform coordinates from 3D world/space to 2D world coordinates

$$\begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 1/n & 0 \end{bmatrix} \begin{bmatrix} x_v \\ y_v \\ z_v \\ 1 \end{bmatrix}$$

Or

X’
Y’
Z’
1

= ($1/w_c$) *

X_c
Y_c
Z_c
w_c

Sorry for the bad formatting, Microsoft word wouldn’t let me format it how I wanted to.

Or like from the notes: the perspective matrix calculated via code would be:

M_{per} =

2n/(r–l)	0	(l+r)/(l–r)	0
0	2n/(t–b)	(b+t)/(b–t)	0
0	0	(f+n)/(n–f)	2fn/(f–n)
0	0	1	0

Where $M_{per} = M_{orth} * P$

Where P =

n	0	0	0
0	n	0	0
0	0	n+f	–fn
0	0	1	0

D = Camera Transformation Matrix

Role: Transforms world to view coordinates

From slides:

Transforms world to view coords:

-Aligning a viewing system with the world coordinate axes using a sequence of translate-rotate tforms.

-Translate view point to origin of world coordinate space.

-Rotate to align view coordinate axes (x_v, y_v, z_v) with world coordinate axes (x_w, y_w, z_w)

Values are dependent upon world but generally:

1	0	0	0
	1	0	0
0	0	1/f	0

E = Modeling Transformation Matrix

Role: To rotate the modeled geometry into a place that can be view by the camera in a mathematically “true” way. I.E. how to accurately model a 3D object from the camera after passing it from the view and perspective translation matricies.

Dependent upon geometry of actual model but uses:

Rotation:

Cos (theta)	–Sin(theta)	0
Sin(theta)	Cos (theta)	0
0	0	1

Translation:

1	0	dx
0	1	dy
0	0	1

So in summary:

Cos (theta)	–Sin(theta)	dx
Sin(theta)	Cos (theta)	dy
0	0	1

M_{cam} =

X_u	Y_u	Z_u	0
X_v	Y_v	Z_v	0
X_w	Y_w	Z_w	0
0	0	0	1

*

1	0	0	$-X_e$
0	1	0	$-Y_e$
0	0	1	$-Z_e$
0	0	0	1

P = point of object origin

Role: The original Coordinate of the object in game space

2. I wrote out what each matrix would be but in summary for an object with position $p_0 = (x_0, y_0, z_0, 1)$

$$\mathbf{p}_s = \mathbf{M}_{\mathrm{vp}}\mathbf{M}_{\mathrm{orth}}\mathbf{P}\mathbf{M}_{\mathrm{cam}}\mathbf{M}_{\mathrm{m}}\mathbf{p}_o$$

$$\begin{bmatrix} x_s \\ y_s \\ z_c \\ 1 \end{bmatrix} = \begin{bmatrix} \frac{n_x}{2} & 0 & 0 & \frac{n_x-1}{2} \\ 0 & \frac{n_y}{2} & 0 & \frac{n_y-1}{2} \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \frac{2}{r-l} & 0 & 0 & -\frac{r+l}{r-l} \\ 0 & \frac{2}{t-b} & 0 & -\frac{t+b}{t-b} \\ 0 & 0 & \frac{2}{n-f} & -\frac{n+f}{n-f} \\ 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} n & 0 & 0 & 0 \\ 0 & n & 0 & 0 \\ 0 & 0 & n+f & -fn \\ 0 & 0 & 1 & 0 \end{bmatrix} \mathbf{M}_{\mathrm{cam}}\mathbf{M}_{\mathrm{m}} \begin{bmatrix} x_o \\ y_o \\ z_o \\ 1 \end{bmatrix}$$

Where M_{cam} =

X_u	Y_u	Z_u	0
X_v	Y_v	Z_v	0
X_w	Y_w	Z_w	0
0	0	0	1

*

1	0	0	$-X_e$
0	1	0	$-Y_e$
0	0	1	$-Z_e$
0	0	0	1

And M_m =

Cos (theta)	-Sin(theta)	dx
Sin(theta)	Cos (theta)	dy
0	0	1