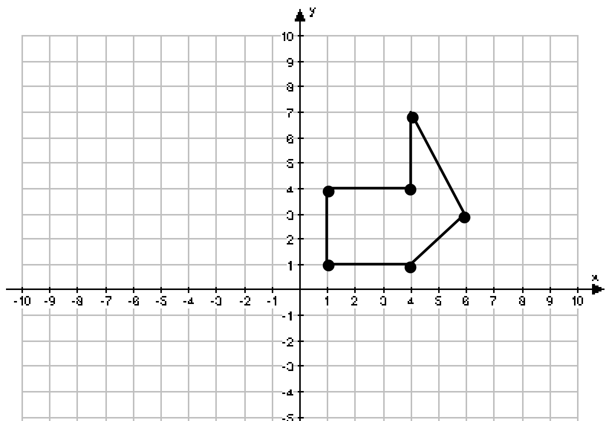
Sec 8.4 – Matrices Transformations
Voting methods & Matrix Applications

Name:

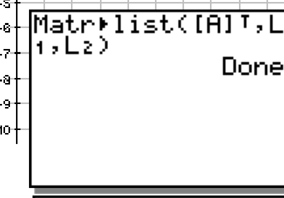


- Start by creating a picture on a Cartesian coordinate system *(preferably in the first quadrant)*
- *The picture at the right would be represented by the matrix:*

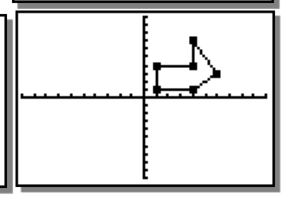
$$\begin{bmatrix} 1 & 4 & 6 & 4 & 4 & 1 & 1 \\ 1 & 1 & 3 & 7 & 4 & 4 & 1 \end{bmatrix}$$

- Enter this into the Matrix [A] in the calculator. Press MATRX , ◀ , ENTER . Change the dimensions of the matrix to match the points of your picture. For our example we will need to change the dimensions to 2 x 7

- To return to the home screen press 2nd MODE
- To have the calculator show your original picture. Press MATRX , ▶ , 8 . This will bring up `Matr▶list(` on the calculator. This function will enable us to put our matrix into the table of the calculator which can be graphed.
- Next, press MATRX , 1 . Before the Matrix can be transformed into the table it has to be turned vertically or "TRANSPOSED". Press MATRX , ▶ , 2 , , , 2nd , 1 , , , 2nd , 2 ,) , ENTER .



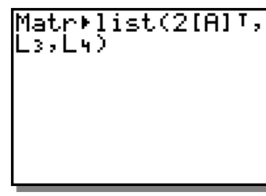
- Next hit 2nd , Y= (Stat Plot) , 1.
- Make sure your screen has the following options highlighed
- Finally push ZOOM, 6.



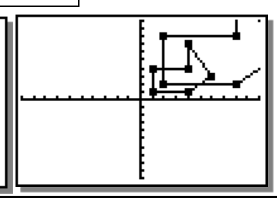
Dilations

To make the object dilate, using (0,0) as the center of dilation, multiply the matrix by a scalar.

- To have the calculator show your original picture. Press MATRX , ▶ , 8 . This will bring up `Matr▶list(` on the calculator. This function will enable us to put our matrix into the table of the calculator which can be graphed.



- Next, press, 2 , MATRX , 1 . Before the Matrix can be transformed into the table it has to be turned vertically or "TRANSPOSED". Press MATRX , ▶ , 2 , , , 2nd , 3 , , , 2nd , 4 ,) , ENTER .
- Next hit 2nd , Y= (Stat Plot) , 2.
- Make sure your screen has the following options highlighed
- Finally push ZOOM, 6.

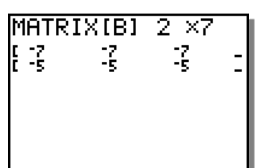


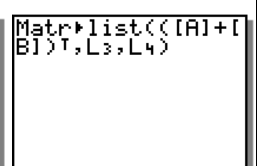
Translation

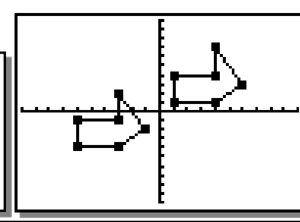
- To translate an object we have to set up a translation matrix. We can enter this in matrix [B]

$$\begin{bmatrix} -7 & -7 & -7 & -7 & -7 & -7 & -7 \\ -5 & -5 & -5 & -5 & -5 & -5 & -5 \end{bmatrix}$$

Shift left 7 and down 5





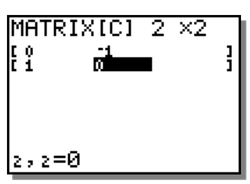


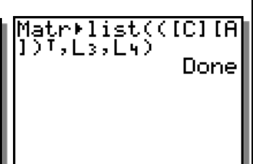
Rotation

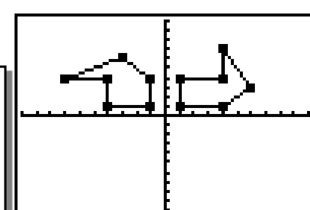
- To rotate an object we have to set up a rotation matrix. We can enter this in matrix [C]

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

Rotation by 90°





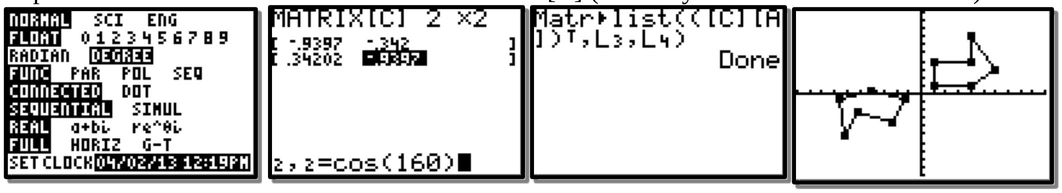


General Rotation

- To rotate an object we have to set up a rotation matrix. We can enter this in matrix [C] (be sure you are in DEGREE mode.)

$$\begin{bmatrix} \cos(160^\circ) & -\sin(160^\circ) \\ \sin(160^\circ) & \cos(160^\circ) \end{bmatrix}$$

Rotation by 160°



Press the MODE key and switch to DEGREE mode

Combination Transformations (Rotate 200° and Translate Right 6)

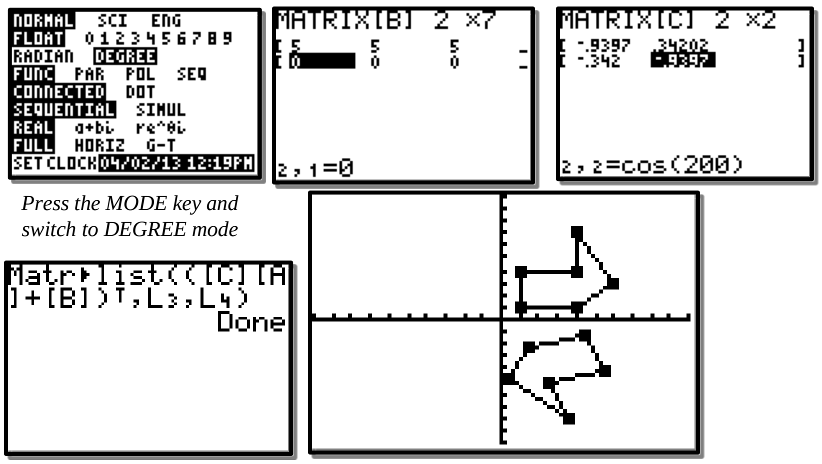
- To translate an object we have to set up the rotation matrix. We can enter this in matrix [C] (be sure you are in DEGREE mode.) and a translation matrix in [B].

$$[B] = \begin{bmatrix} 5 & 5 & 5 & 5 & 5 & 5 & 5 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Shift right 5

$$[C] = \begin{bmatrix} \cos(200^\circ) & -\sin(200^\circ) \\ \sin(200^\circ) & \cos(200^\circ) \end{bmatrix}$$

Rotation by 200°



Press the MODE key and switch to DEGREE mode

Programmers often use matrices to write visual code even for the mouse cursor For example let's suggest that the points A,B,C,D,E,F,G represent a mouse cursor. Programmers would use the matrix:

$$[S] = \begin{bmatrix} A & B & C & D & E & F & G \\ 3 & 4 & 5 & 5 & 2 & 3 & 2 \\ 2 & 3 & 2 & 5 & 5 & 4 & 3 \end{bmatrix}$$

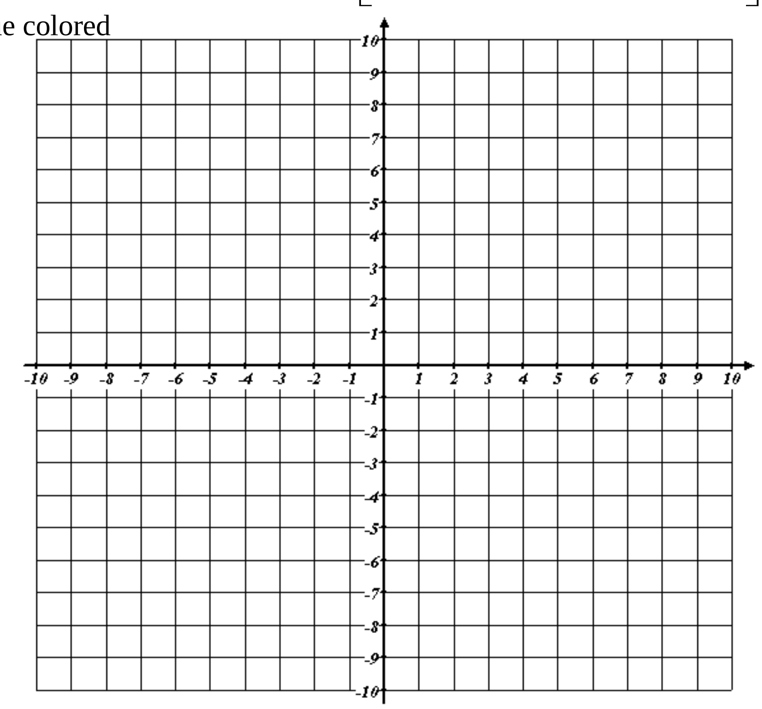
a. Draw the original mouse cursor on the graph using a blue colored pencil.

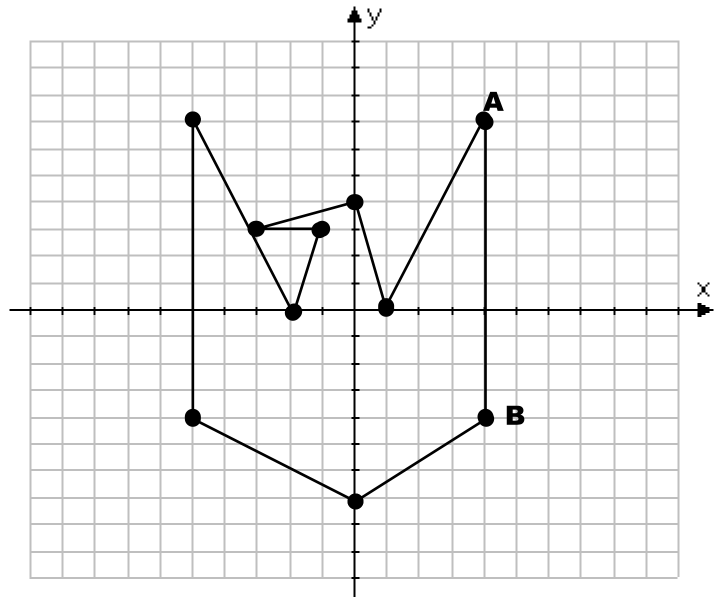
b. Usually mouse cursors are translated. To do this programmers add by a translation matrix. Add the following translation matrix to [S] and draw the new image using a red pen.

$$[S] + \begin{bmatrix} -8 & -8 & -8 & -8 & -8 & -8 & -8 \\ 4 & 4 & 4 & 4 & 4 & 4 & 4 \end{bmatrix}$$

c. To rotate an object counter clockwise programmers multiply a rotation matrix and [S]. Multiply the following and graph using a black or gray pencil. *(should be degree mode)*

$$\begin{bmatrix} \cos(130^\circ) & -\sin(130^\circ) \\ \sin(130^\circ) & \cos(130^\circ) \end{bmatrix} \begin{bmatrix} & [S] & \end{bmatrix}$$





Matrices are used to describe most graphics on computer (including computer/video games). Consider the following Phoenix bird. As a matrix it would be described as:

$$\begin{matrix} A & B & C & D & E & F & G & H & I & J & A \end{matrix}$$
$$\begin{bmatrix} 4 & 4 & 0 & -5 & -5 & -2 & -1 & -3 & 0 & 1 & 4 \\ 7 & -4 & -7 & -4 & 7 & 0 & 3 & 3 & 4 & 0 & 7 \end{bmatrix}$$

Once entered as a matrix several graphical transformations can be performed using matrix operations.

<u>DILATIONS:</u>

To dilate (bigger or smaller) from the origin point, you would only need to multiply the original matrix by a scalar multiple. e. g.

$$2\cdot\begin{bmatrix} 4 & 4 & 0 & -5 & -5 & -2 & -1 & -3 & 0 & 1 & 4 \\ 7 & -4 & -7 & -4 & 7 & 0 & 3 & 3 & 4 & 0 & 7 \end{bmatrix}$$

……would make the picture twice as big

$$\tfrac{1}{2}\cdot\begin{bmatrix} 4 & 4 & 0 & -5 & -5 & -2 & -1 & -3 & 0 & 1 & 4 \\ 7 & -4 & -7 & -4 & 7 & 0 & 3 & 3 & 4 & 0 & 7 \end{bmatrix}$$

……would make the picture shrink the picture to half size

<u>TRANSLATION Matrices:</u>

$$\begin{bmatrix} 4 & 4 & 0 & -5 & -5 & -2 & -1 & -3 & 0 & 1 & 4 \\ 7 & -4 & -7 & -4 & 7 & 0 & 3 & 3 & 4 & 0 & 7 \end{bmatrix} + h\begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} + k\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

In the above example all you would need to do is change ‘h’ to the a number to translate the picture **left** or **right** OR change ‘k’ to a number to tra the picture **up** or **down**.

<u>ROTATION Matrices:</u>

$$\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}\cdot\begin{bmatrix} 4 & 4 & 0 & -5 & -5 & -2 & -1 & -3 & 0 & 1 & 4 \\ 7 & -4 & -7 & -4 & 7 & 0 & 3 & 3 & 4 & 0 & 7 \end{bmatrix}$$

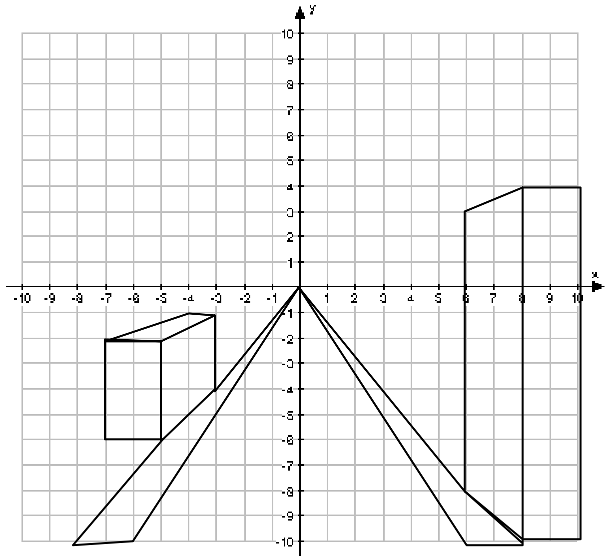
In the above example all you would need to do is change theta to an angle you wish to rotate the shape about the origin.

<u>ROTATION Matrices:</u>

$$\begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix}\cdot\begin{bmatrix} 4 & 4 & 0 & -5 & -5 & -2 & -1 & -3 & 0 & 1 & 4 \\ 7 & -4 & -7 & -4 & 7 & 0 & 3 & 3 & 4 & 0 & 7 \end{bmatrix}$$

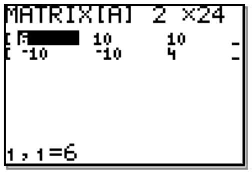
In the above example all you would need to do is change theta to an angle you wish to rotate the shape about the origin.

- Start by creating a picture on a Cartesian coordinate system *(preferably in the first quadrant)*
- *The picture at the right would be represented by the matrix:*



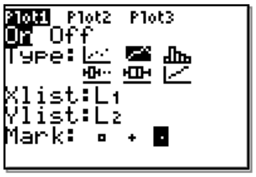
$$\begin{bmatrix} 6 & 10 & 10 & 8 & 8 & 6 & 6 & 8 & 8 & 0 & -5 & -8 & -5 & -7 & -7 & -4 & -3 & -5 & -7 & -5 & -5 & -3 & -3 & -3 & 0 & 5 \\ -10 & -10 & 4 & 4 & -10 & -8 & 3 & 4 & -10 & 0 & -10 & -10 & -6 & -6 & -2 & -1 & -1 & -2 & -2 & -2 & -6 & -4 & -1 & -4 & 0 & -10 \end{bmatrix}$$

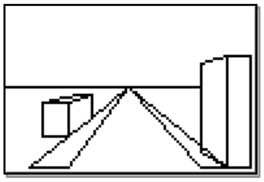
- Enter this into the Matrix [A] in the calculator.
  Press MATRX , ◄ , ENTER . Change the dimensions of the matrix to match the points of your picture.
  For our example we will need to change the dimensions to 2 x 26



- To return to the home screen press 2nd MODE
- To have the calculator show your original picture. Press MATRX , ► , 8 . This will bring up `Matr►list(` on the calculator. This function will enable us to put our matrix into the table of the calculator which can be graphed.
- Next, press MATRX , 1 . Before the Matrix can be transformed into the table it has to be turned vertically or "TRANSPOSED". Press MATRX , ► , 2 , , , 2nd , 1 , , , 2nd , 2 ,) , ENTER .

- Next hit 2nd , Y= (Stat Plot) , 1.
- Make sure your screen has the following options highlighed
- Finally push ZOOM, 6.
- You can turn the axes on or off by pressing 2nd, ZOOM and selecting the option **AxesOff** .





Dilations

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- To have the calculator show your original picture. Press MATRX , ► , 8 . This will bring up `Matr►list(` on the calculator. This function will enable us to put our matrix into the table of the calculator which can be graphed.
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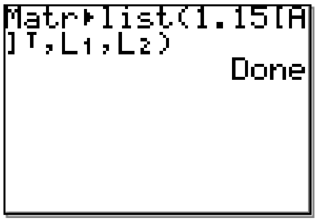
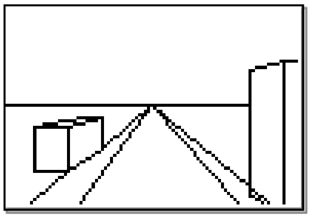
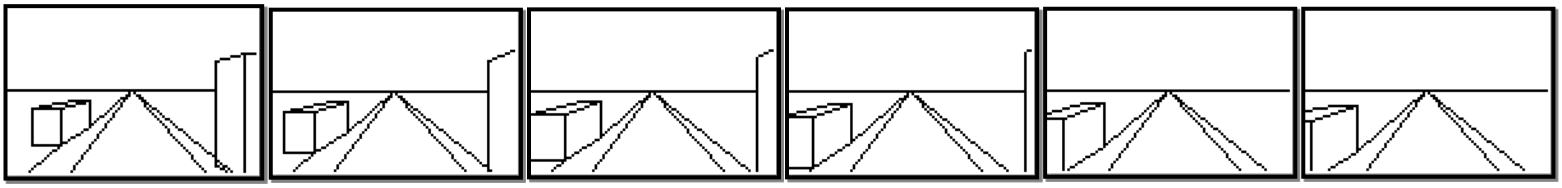
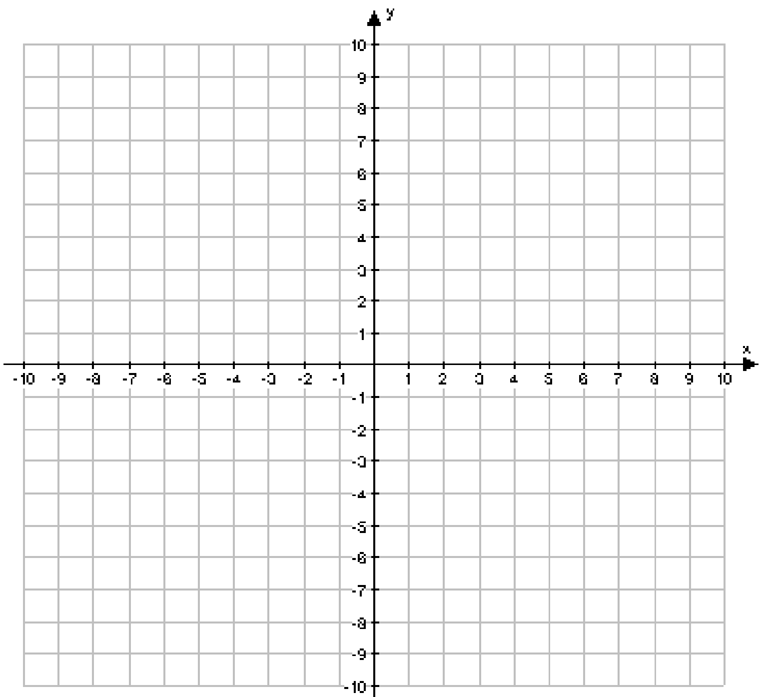
- Finally push ZOOM, 6.



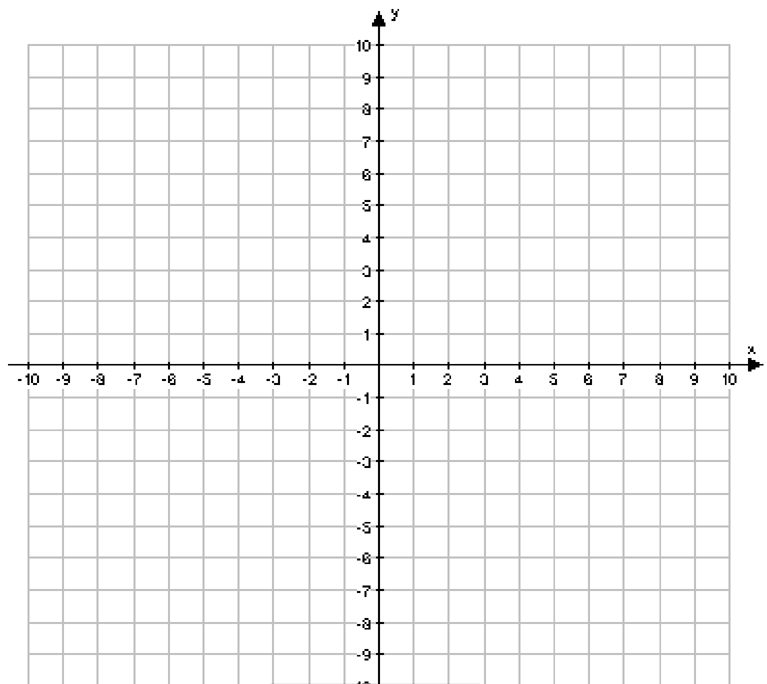




- If each screen was viewed in rapid succession it would give the appearance of flying into the picture.
- Create your own version of a drawing that you would like to animate using transformational matrices



Attempt #1



Attempt #2

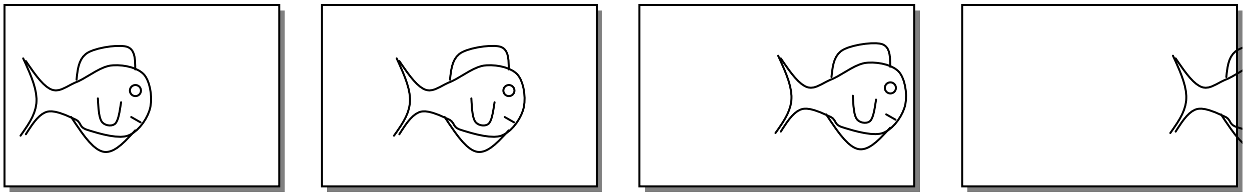
Using up to 10 fram[...]w rough sketches of your anticipated slides to create y[...]

Slide # 1 *Slide # 2* *Slide # 3* *Slide # 4*

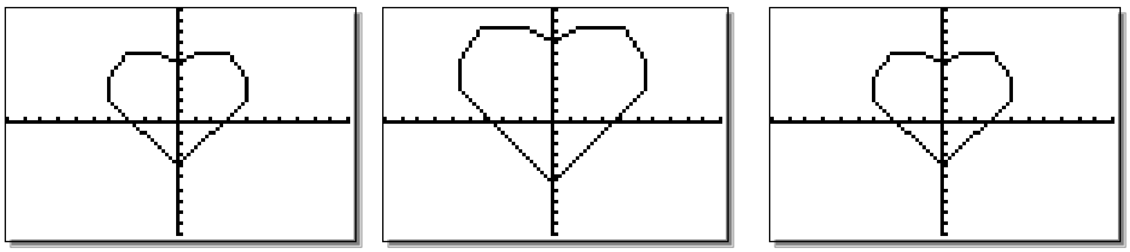
Slide # 5 *Slide # 6* *Slide # 7* *Slide # 8*

Slide # 9 *Slide # 10*

Summary: With a couple of similar pictures we can make an animation of a fish that blows bubbles, an eye that's *winking*, or just about anything you wish to make move. Animations for cartoons, movies, and flip books are created by making several similar pictures each with a slight change showing where the object has moved too. Creating a fish that moves to the right would require creating the following pictures:



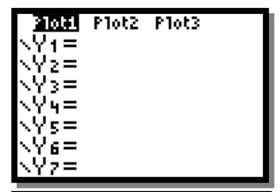
If these pictures were played in rapid succession on the TI-83 the fish would appear to move to the right. As you create each picture on the TI-83 you will need to store the picture.

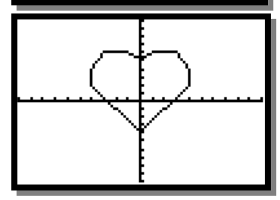


If these pictures were played in rapid succession on the TI-83 the heart would appear to beat. As you create each picture on the TI-83 you will need to store the picture.

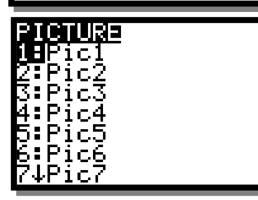
Storing your Pictures:

- First display the picture you would like to store as your first picture in your animation. You can turn on a plot by selecting it from the [Y=] button.
    - Press [Y =]. Highlight Plot1 by pressing the cursor up. Pressing [ENTER], will either "turn on" or "turn off" the plot (if the plot is highlighted then it is turned on). For the "Heart" example turn Plot1 on and Plot2 off .
    - Press [GRAPH]

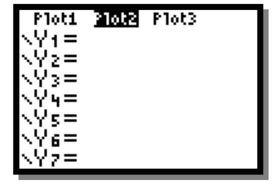


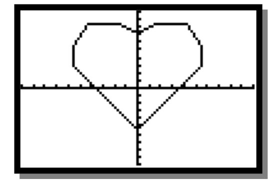


- With the picture you wish to store on the graph screen, press: [2nd], [PRGM] (DRAW), [◄], [1]. The calculator should say **StorePic**. The TI-82/83/84 allows you to save up to 10 different pictures. Next, we will need to select where we would like to store the picture. Press: [VARS], [4]. Now select where you would like to store the picture in Pic1 through Pic9. Select Pic1 if this is the first picture. After selecting the appropriate place to store the picture press [ENTER]. After pressing enter the picture that you are storing should re-appear.



- Next display the picture you would like to store as your second picture in your animation.
  - Press Y = . Highlight Plot2 by pressing the cursor up. Pressing ENTER , will either "turn on" or "turn off" the plot (if the plot is highlighted then it is turned on). For the "Heart" example turn Plot1 off and Plot2 on .
  - Press GRAPH

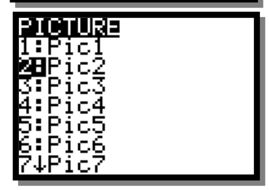




- With the picture you wish to store on the graph screen, press: 2nd , PRGM , ◄ (DRAW) , 1 . The calculator should say **StorePic**. The TI-82/83/84 allows you to save up to 10 different pictures. Next, we will need to select where we would like to store the picture. Press: VARS , 4 . Now select where you would like to store the picture in Pic1 through Pic9. After selecting the appropriate place to store the picture press ENTER . After pressing enter the picture that you are storing should re-appear.

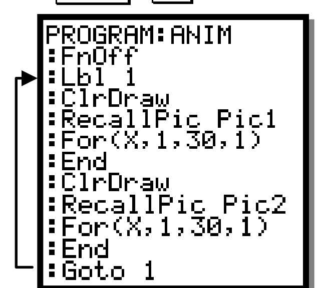
- Repeat this process until all of the pictures are stored.

  Next, we will need to create a program that displays each of the pictures in rapid succession to give the illusion of movement. It may help at this point to turn off all of the plots under Y =.



<u>**Creating an Animation Program:**</u>

- Start by creating a new program to do this press: PRGM and select NEW by pressing the ► , ► , ENTER and then typing in a name such as "A" , "N" ,"I" ,"M" ENTER .
- ***(FnOff)*** Now, we should have an almost blank screen ready to be programmed. The first thing we will need to do is force the calculator to be set up correctly. The first line we will put in a command to turn off any graphed equations. Press VARS , ► , 4 ,and 2 ENTER.
- ***(LBL 1)*** Next, we will need to set up a label so that the program can loop continuously through the animated sequence. Press: PRGM , 9 , 1 , ENTER.
- ***(ClrDraw)*** Now, we will need to clear the current screen to begin the animation. Press: 2nd , PRGM , 1 , ENTER.
- ***(RecallPic Pic1)*** Then, we will need to recall the first picture in the animation sequence. Press: 2nd , PRGM , ◄ , 2 , VARS , 4 , 1 , ENTER.



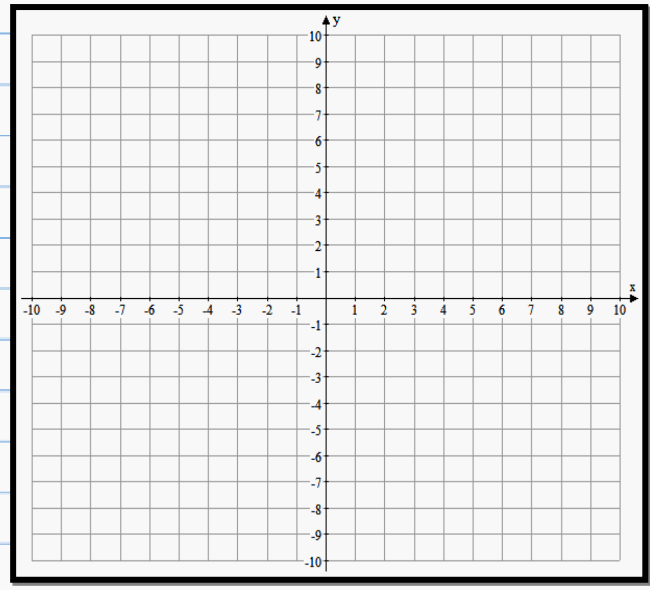
Example

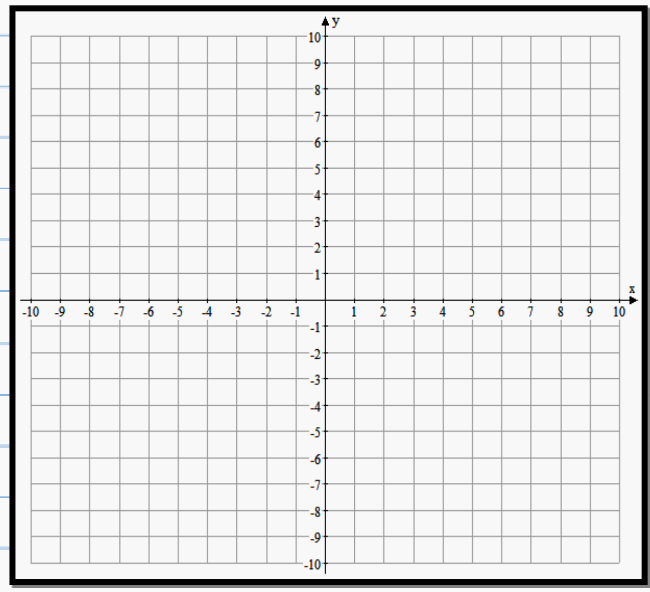
  (For) If we were to immediately clear this picture and display the next picture the animation would take place too quickly. So, we will need to set up some type of delay while this picture is being displayed. This can be done with a quick "FOR – Loop" as shown in example at the right *The FOR command is found by pressing* PRGM , 4 , X,T,ϑ,n , , , 1 , , , 3 , 0 , , , 1 ,) , ENTER. *The (X, 1, 30, 1) shown in Example 2 stands for (Variable, Beginning Count Number, Ending Count Number, Count By).* PRGM , 7 **(End)** ENTER**.** Try changing the Ending Number (30) for different delays.
- ***(ClrDraw)*** Now, we will need to clear the first picture. Press: 2nd , PRGM , 1 , ENTER.
- ***(RecallPic Pic2)*** Then, we will need to recall the first picture in the animation sequence. Press: 2nd , PRGM , ◄ , 2 , VARS , 4 , 2 , ENTER.

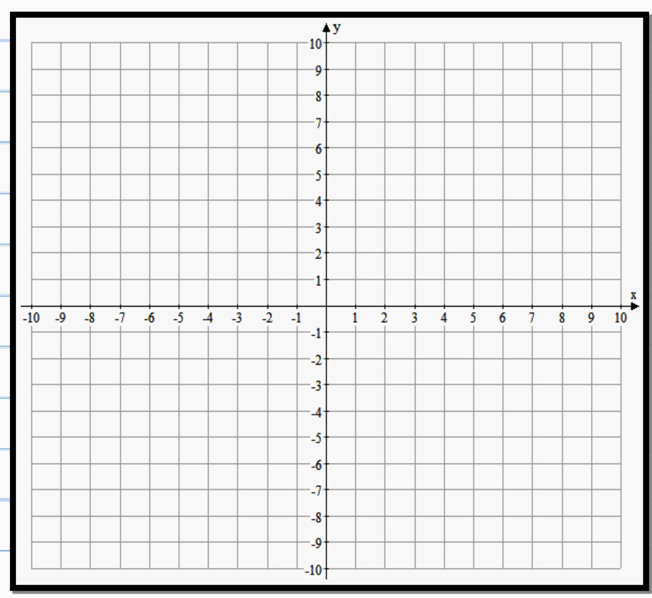
  Again, if we were to immediately clear this picture & display the next the animation would take place too quickly. We need to create another "FOR-Loop". PRGM , 4 , X,T,ϑ,n , , , 1 , , , 3 , 0 , , , 1 ,) , ENTER, PRGM , 7 , ENTER .
- If there are additional pictures to include in the animation the procedure is the same for adding more pictures.
- ***(Goto 1)*** Finally, we need to loop the animation back to the beginning to set up a continuous animation sequence. Press: PRGM , 0 , 1 . Go back to the HOME SCREEN 2nd , MODE and Execute PRGM the ANIM program.
- Press the ON button to interrupt the animation.

PROEJCT - SHEET (INITIAL PICTURES)

NAME:

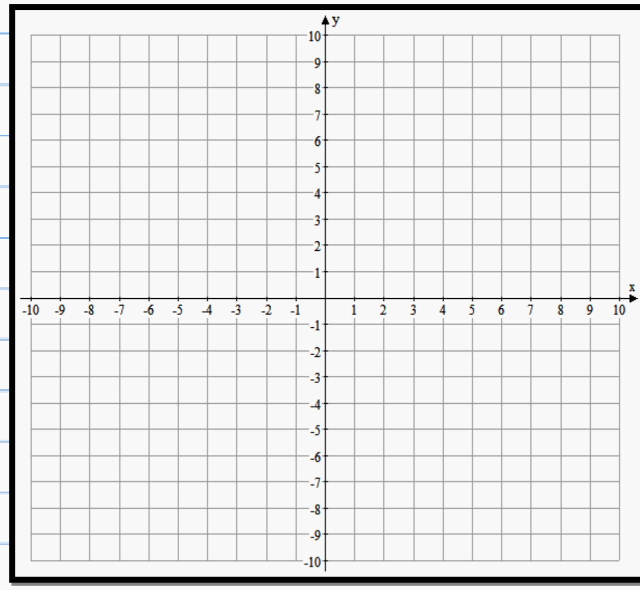


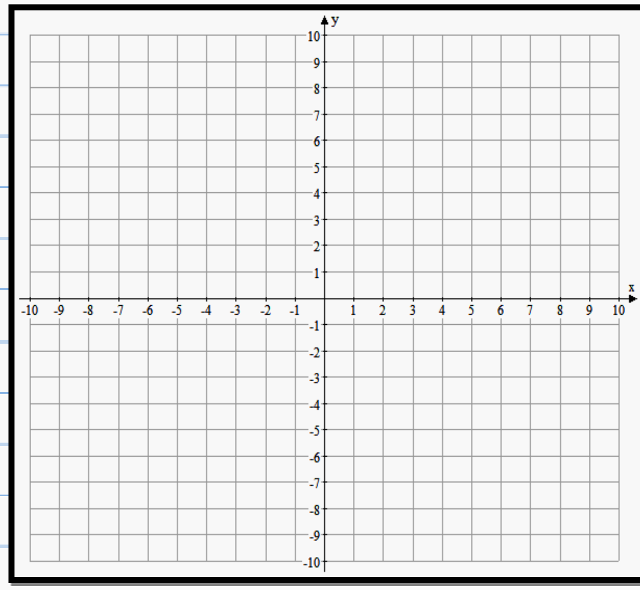


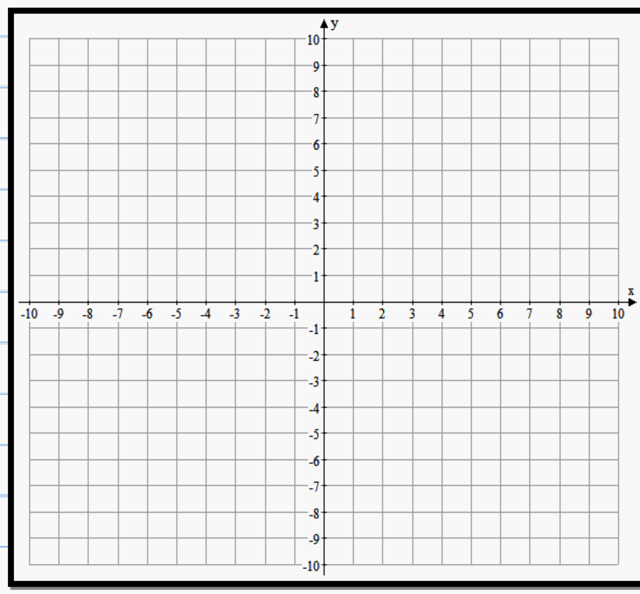


PROEJCT - SHEET (TRANSFORMATIONS)

NAME:







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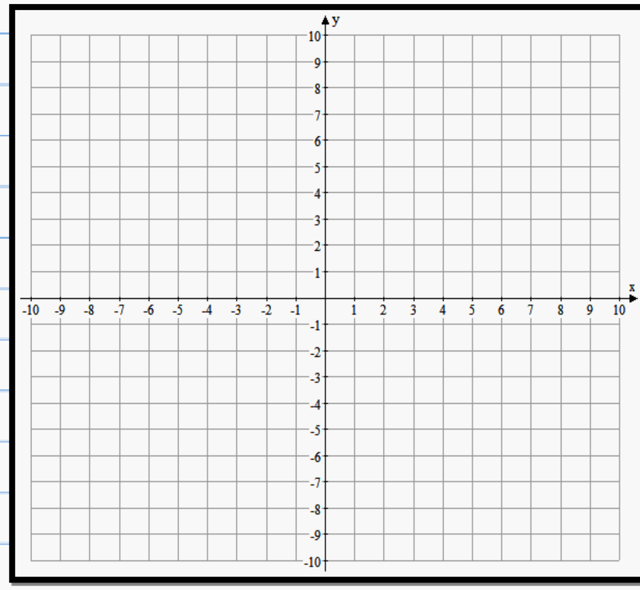

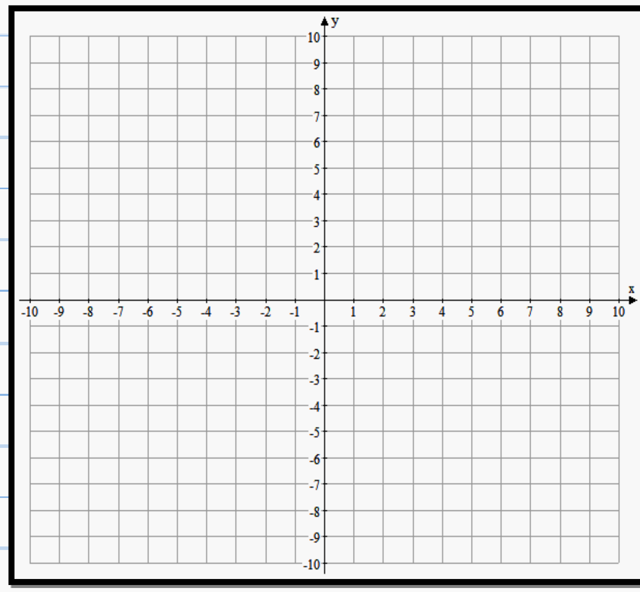

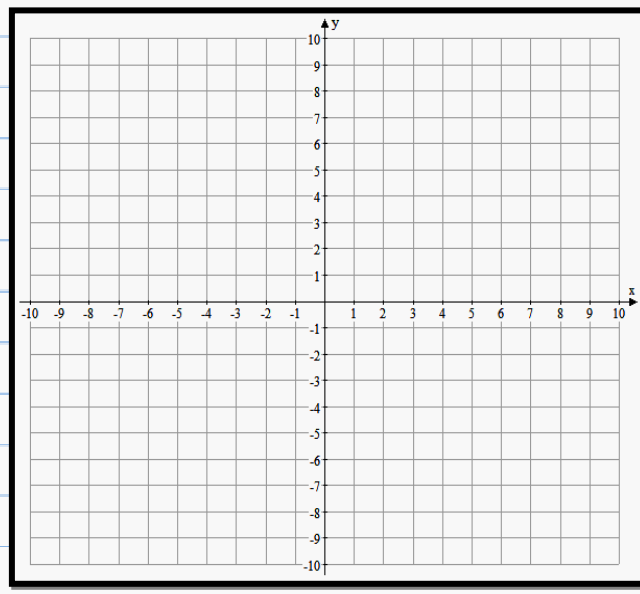

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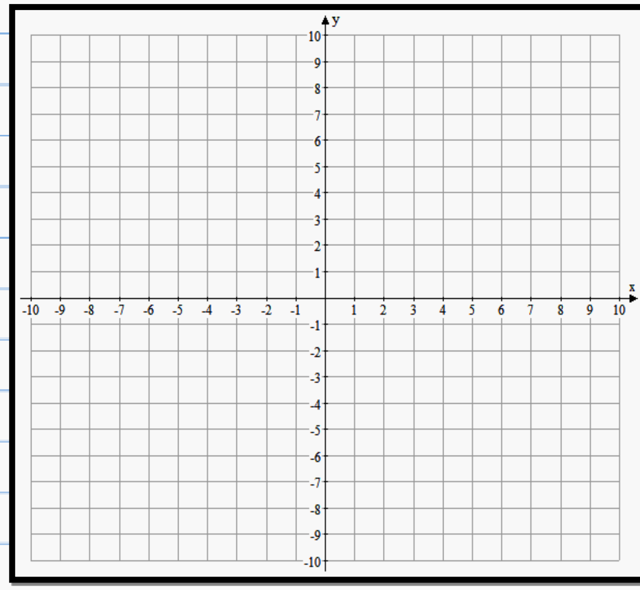

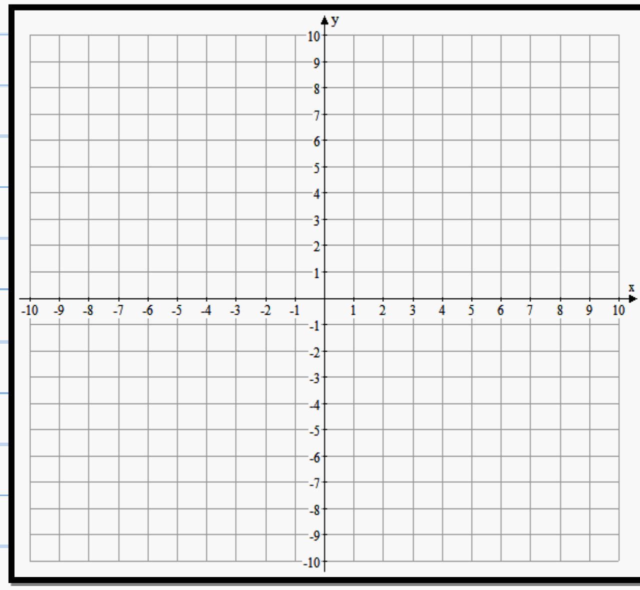

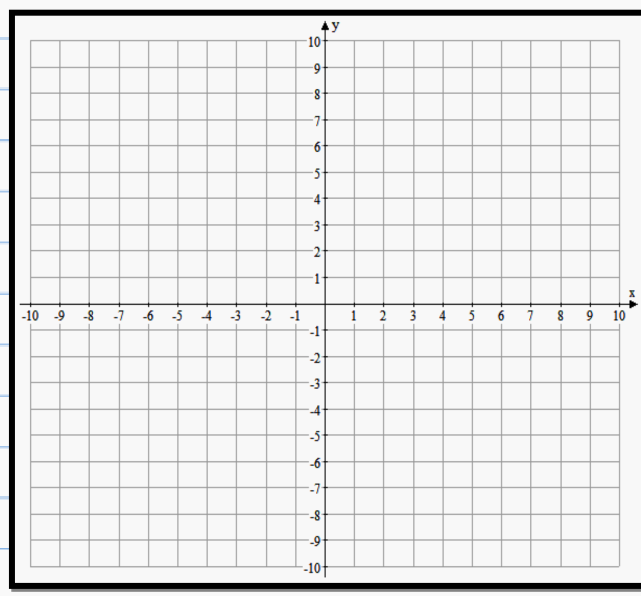

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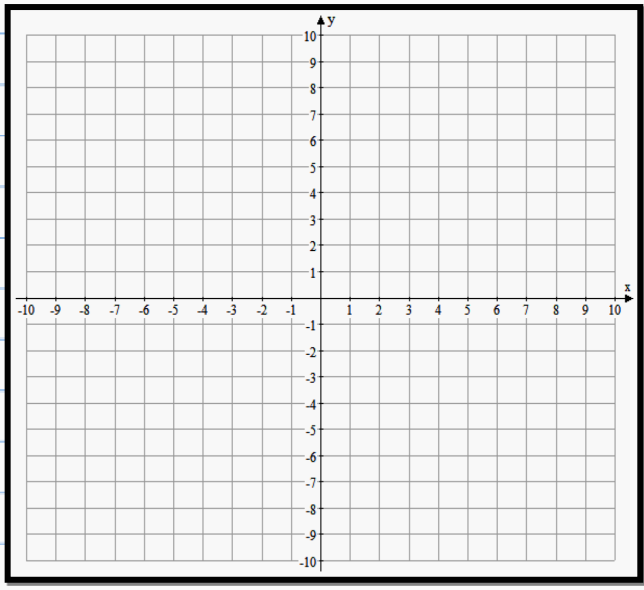

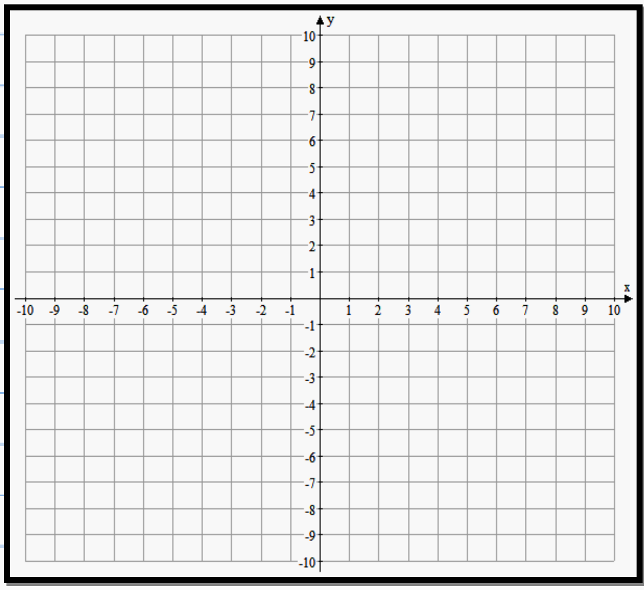

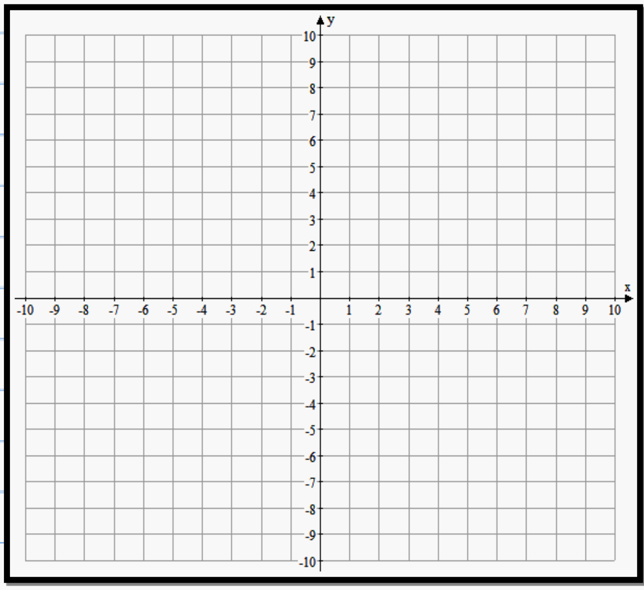

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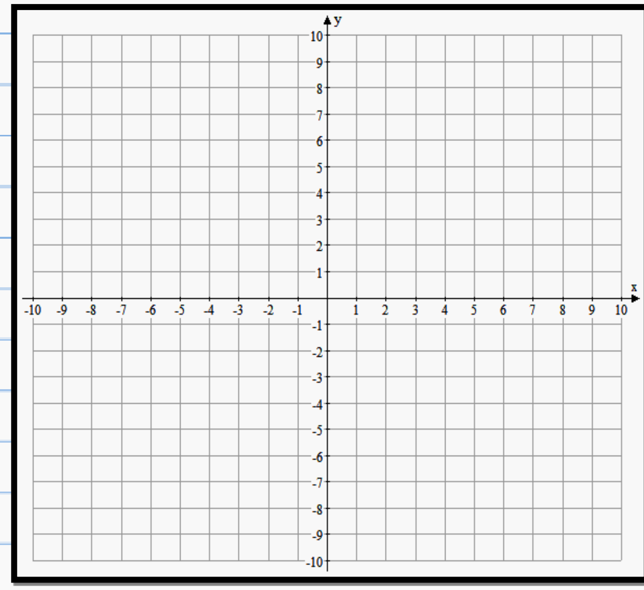

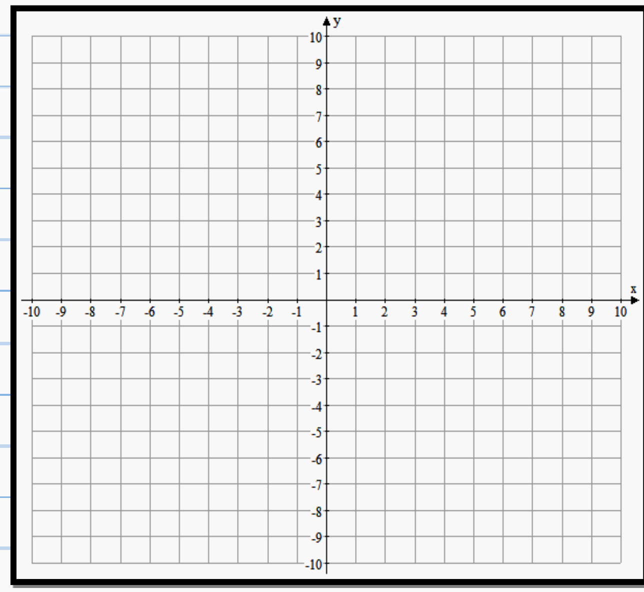

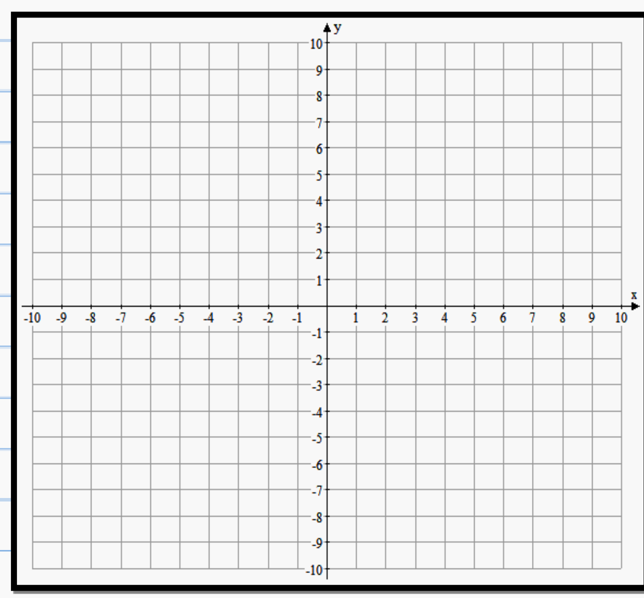

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