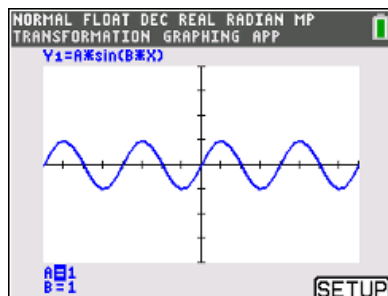# Basic Trigonometric Transformations
## Student Activity

Name _____

Class _____

In this activity, you will use the *Transformation Application* to change the values of parameters in trigonometric functions and to determine the effect that each change has on the shape of the graph. You will then use this knowledge to write equations for sine and cosine functions.

Before starting this activity, please make sure that your handheld is in radians, and set you window as follows: Xmin = $-4\pi$, Xmax = $4\pi$, Xscl = $\frac{\pi}{2}$, Ymin = -4, Ymax = 4, Yscl = 1. Once this is set, press **apps**, **:Transfrm**, **any key**. This will set you window and turn on the **Transformations Application**.

1. Press **y =** and type the following function into $Y_1$: $A * \sin(B * x)$. This will allow you to manipulate the parameters $A$ and $B$ on your graph. Press graph. You will see the letters $A$ and $B$ in the bottom left corner. Pressing the up and down arrows toggles you between the two parameters, pressing the left and right arrows allows you to change the value of the parameters. Change the values of *a* and *b* in the function $Y_1 = A * \sin(B * x)$.

   a. Describe how the values of *A* and *B* affect the shape of the graph.

   b. What happens to the graph if *A* is negative?

   c. Complete the following statement:

      For $A \neq 0$ and $B > 0$, the graph of $Y_1 = A * \sin(B * x)$ has an amplitude of _____ and a period of _____.

2. Press **y =** again and change the function in $Y_1$ to $\sin(x) + D$. Go back to the graph and change the value of *d* in the function $Y_1 = \sin(x) + D$.

   a. Describe how the value of *D* affects the shape of the graph.

   b. Complete the following statement:

      The graph of $Y_1 = \sin(x) + D$ has a vertical translation of _____.

3. Press **y =** again and change the function in $Y_1$ to $\sin(x + C)$. Go back to the graph and change the value of *C* in the function $Y_1 = \sin(x + C)$.

4. Press **y =** one more time and change the function in $Y_1$ to $A * \sin(B * (x + C)) + D$. Go back to the graph and change the values of *A*, *B*, *C*, and *D* in the function $Y_1 = A * \sin(B * (x + C)) + D$.

   a. Which of the four parameters have an impact on the horizontal translation of the graph?

   b. Complete the following statement:
      For $A \neq 0$ and $B > 0$, the graph of $Y_1 = A * \sin(B * (x + C)) + D$ has a horizontal translation of

      _____.

5. For functions of the form $Y_1 = A * \sin(B * (x + C)) + D$ or $Y_1 = A * \cos(B * (x + C)) + D$, with $A \neq 0$ and

   $B > 0$,

   a. the amplitude is _____.

   b. the period is _____.

   c. the horizontal translation is _____.

   d. the vertical translation is _____.

6. Press **y =**, in $Y_3$, type the function $Y_3 = -1.5 \sin\left(x + \frac{\pi}{4}\right) + 4$, in $Y_4$ type the function $Y_4 = \cos x$.
   Knowing that the cosine function is s horizontal translation of a sine function, write an equation for a cosine function that will have the same graph.

7. Repeat the process from question 6 using the equation $Y_3 = 3 \sin(2x) - 5$. Write an equation for a cosine function that will have the same graph.

8. a. Write an equation for a sine function with an amplitude of 4, a period of 12, a horizontal translation of 2, and a vertical translation of 3.

   b. Write an equation for a cosine function with the same parameters as the sine function in part (a).

9. a. Write an equation for the sine function whose graph is shown in the figure below.
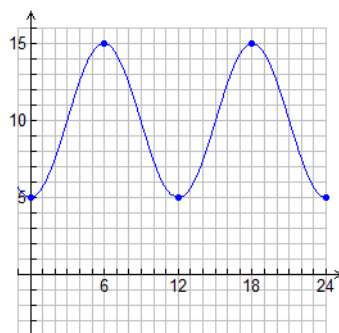


   b. Utilize a cosine function to write an equation for the same graph.

## Further Real World Extension

| Day ($\theta$) | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|
| Illumination $f(\theta)$ | 0.08 | 0.03 | 0.0 | 0.01 | 0.04 | 0.10 | 0.18 | 0.28 | 0.38 |
| Day ($\theta$) | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| Illumination $f(\theta)$ | 0.48 | 0.59 | 0.68 | 0.77 | 0.84 | 0.91 | 0.95 | 0.98 | 1.00 |

10. The table above gives the percentages of illumination of the moon on a nightly basis in the month of March 2024. The function $f$ given by $f(\theta) = a\sin\big(b(\theta + c)\big) + d$, where $a, b, c,$ and $d$ are constants, is used to model these data with $\theta$ representing the day of the month (March 1 = 1, March 2 = 2, etc.). $f(\theta)$ represents the percentage of the illumination of the moon on that day, written as a decimal. Assume that the period of $f$ is 29.5 days. Based on the data in the table, find the values for $a, b, c,$ and $d$.

$a =$ _____

$b =$ _____

$c =$ _____

$d =$ _____

11. Using the information in question 10, describe what each parameter, $a, b, c, and\ d$, mean in the context of the illumination of the moon.

$a = $ _____

$b = $ _____

$c = $ _____

$d = $ _____