



Vertical and Phase Shifts

Student Activity

Name _____

Class _____

Before beginning the activity, clear out any functions from the $\boxed{Y=}$ screen, turn off all Stat Plots, and make sure that the calculator is in Radian mode.

You are also going to utilize the **Transformation Graphing App**. To start this app, press the $\boxed{\text{APPS}}$ and select **Transfrm** from the list. Press $\boxed{\text{ENTER}}$ twice to activate the application.

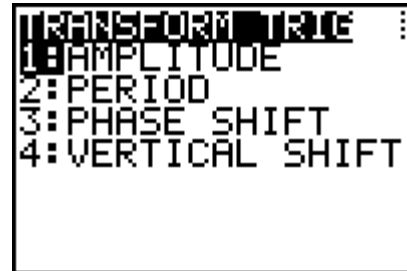


Problem 1 – Amplitude

In this problem, you will explore the amplitude of a function of the form $f(x) = a \sin(x)$.

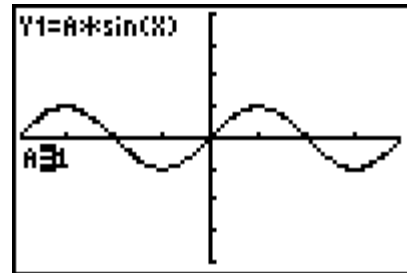
Press $\boxed{\text{PRGM}}$ to access the Program menu and select the **PHSESHFT** program.

You will see the menu options to the right. Choose **1:Amplitude**.



The program will graph the parent function $y = \sin(x)$ and enter $Y1 = a \sin(x)$ into the $\boxed{Y=}$ screen.

You will see **A=1** with the equals sign highlighted. Enter in values from -3.5 to 3.5 and press $\boxed{\text{ENTER}}$ to see the effect the values have on the graph.



- Describe how the different values of a affect the shape of the graph.
- What happens if a is negative?
- Complete the following statement:

For $a \neq 0$, the graph of $Y1 = a \sin(x)$ has an amplitude of _____.

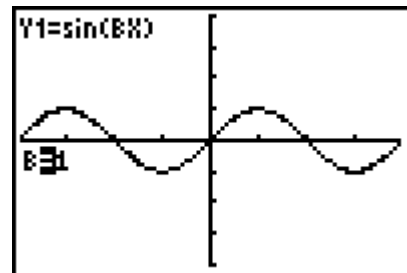
Problem 2 – Period

In this problem, you will explore the period of a function of the form $f(x) = \sin(bx)$.

Choose the **PHSESHFT** program again from the Program menu. Choose **2:Period**.

The program will graph the parent function $y = \sin(x)$ and enter $Y1 = \sin(bx)$ into the $\boxed{Y=}$ screen.

Enter the following values for B to see the effect the on the graph: 0.125, 0.25, 0.5, 0.75, 1, 2, 4, 8.





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- Describe how the value of b affects the shape of the graph.
- What happens to the period when $0 < b < 1$?
- What happens to the period when $b > 1$?
- Complete the following statement:

For $b > 0$, the graph of $Y_1 = \sin(bx)$ has a period of _____.

Problem 3 – A Simple Phase Shift

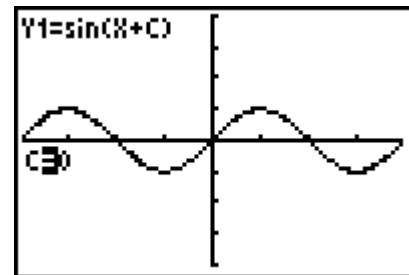
In this problem, you will explore the phase shift of a function of the form $f(x) = \sin(x + c)$

Choose the **PHSESHFT** program and select **3:Phase Shift**.

The program will graph the parent function $y = \sin(x)$ and enter $Y_1 = \sin(x + c)$ into the $\boxed{Y=}$ screen.

Enter the following values for C to see the effect the on the

graph: $-2\pi, -\frac{3\pi}{2}, -\pi, -\frac{\pi}{2}, -\frac{\pi}{4}, \frac{\pi}{4}, \frac{\pi}{2}, \pi, \frac{3\pi}{2}, 2\pi$



- Describe how the value of c affects the shape of the graph.

Problem 4 – Vertical Shift

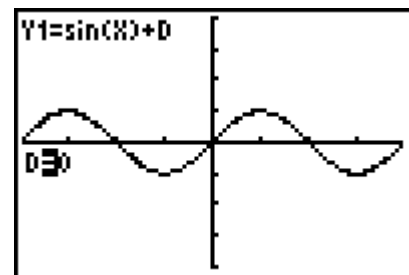
In this problem, you will review the vertical shift of a function of the form $f(x) = \sin(x) + d$.

Choose the **PHSESHFT** program and select **3:Vertical Shift**.

The program will graph the parent function $y = \sin(x)$ and enter $Y_1 = \sin(x) + d$ into the $\boxed{Y=}$ screen.

Enter the following values for D to see the effect the on the

graph: -3 to 3 in 0.5 increments.



- Describe how the value of d affects the shape of the graph.
- Complete the following statement:

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



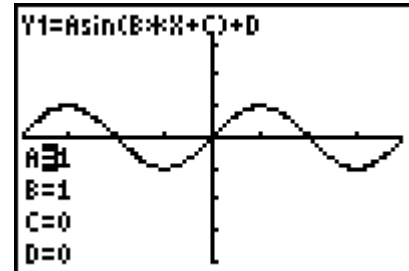
Problem 5 – Combining Transformations

In this problem, you will see which parameters impact the phase shift of the parent function, $y = \sin(x)$. You are to enter in various values for a , b , c , and d , and observe what happens. Try to write an equation that defines the phase shift in terms of the parameters that affect it.

Select the **TRIGCOMB** program from the Program menu. Choose **1:Phase Shift** from the menu options.

Enter values to change a , b , c , and d in the function

$$Y_1 = a \sin(bx + c) + d.$$



- Which of the four parameters result in a phase shift of the graph?
- Complete the following statement:
For $a \neq 0$ and $b > 0$, the graph of $Y_1 = a \sin(bx + c) + d$ has a phase shift of _____

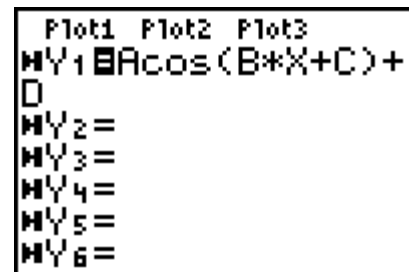
Problem 6 – Bringing It All Together

- For functions of the form $f(x) = a \sin(bx + c) + d$, with $a \neq 0$ and $b > 0$, the graph has:
 - amplitude = _____
 - phase shift = _____
 - period = _____
 - vertical shift = _____

The same characteristics hold true for functions of the form $g(x) = a \cos(bx + c) + d$.

To verify this, press $\boxed{Y=}$ and arrow up to **Plot1** and press $\boxed{\text{ENTER}}$ to turn off the stat plot. Then, change the sine equation to a cosine equation.

Press $\boxed{\text{GRAPH}}$ and repeat Problems 1–4 with the cosine function.



Finally, you will apply what they have learned about vertical and phase shifts. You are given the equations and graphs of two sine functions and asked to find equations of cosine functions that coincide.



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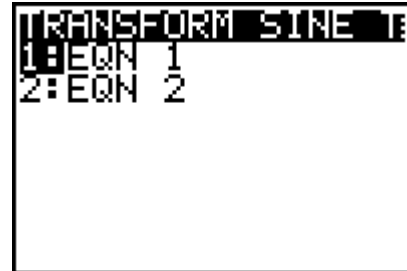
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First, you first have to quit the **Transformation Graphing APP**. To do this, press the **[APPS]** and select **Transform** from the list. Choose **1:Uninstall**.



Select the **TRIGCOMB** program from the **Program** menu. Choose **2:Sine To Cosine** and select **1:EQN 1**.

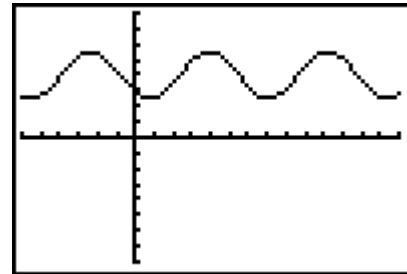


You will see the graph of the following function:

$$Y_1(x) = -1.5 \sin\left(x + \frac{\pi}{4}\right) + 4.$$

Press **[Y=]** and enter the cosine function into **Y₂** that matches the sine function.

What is the equation that matches?



Clear out your function in **Y₂**.

Do the same process with the second equation. Choose the **TRIGCOMB** program and select **2:Sine To Cosine**. Choose **2:EQN 2** for the function: **Y₁ = 3 sin(2x) - 5**.

What is the equation that matches?

