Translating Sines
ID: 13514

Time required
20 minutes

Activity Overview
Students will explore translations of sine graphs and the effects of these translations on the amplitude and period of the curve.

Topic: Sine Graphs
- *Sine graphs*
- *Transformational graphing*
- *Period and amplitude*

Teacher Preparation and Notes
Students should already be familiar with the sine function from right-triangle trigonometry, and be able to find the amplitude and period of a sine function. This lesson uses the word "translations" instead of "vertical and phase shifts." If desired, you may introduce this terminology.

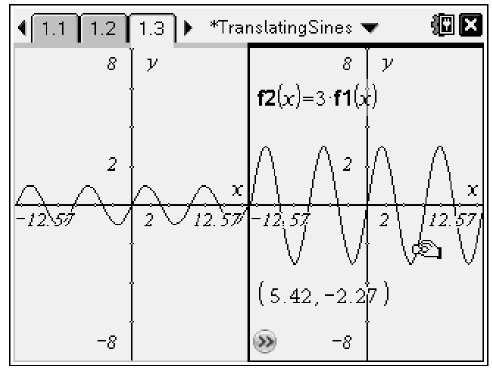
- *A possible source of confusion for students is that the Graphs & Geometry application displays decimal equivalences for radian measure instead of using the π symbol.*
- *This activity is intended to be* ***teacher-led****. You may use the following pages to present the material to the class and encourage discussion. Students will follow along using their handhelds. The majority of the ideas and concepts are only presented in this document, so be sure to cover all the material necessary for students' total comprehension.*
- *Problem 5 and the extension problems can be used as independent practice or as an assessment of student understanding.*
- ***To download the student TI-Nspire document (.tns file) and student worksheet, go to education.ti.com/exchange and enter "13514" in the quick search box.***

Associated Materials
- *TranslatingSines_Student.doc*
- *TranslatingSines.tns*

Suggested Related Activities
To download any activity listed, go to education.ti.com/exchange and enter the number in the quick search box.

- *What's My Sign (TI-Nspire technology) — 10091*
- *Vertical and Phase Shifts (TI-84 Plus) — 9608*
- *Graphing in Circles (TI-Nspire technology) — 9893*
- *Getting Triggy With It (TI-84 Plus) — 9774*

Problem 1 – Exploring *y* = *a* · sin(*x*)



For Problems 1–4, students will define a transformed function in terms of the parent function (e.g., **f2**(*x*) = 3·**f1**(*x*)). This will help students think algebraically when dealing with transformations.

On page 2.2, students should redefine the function **f2** graphed on the right as **f2**(*x*) = 3·**f1**(*x*) and observe any effects on the amplitude or period. They should discover that multiplying the function by a constant value, *a*, changes the amplitude by a factor of |*a*|. The period is not affected.

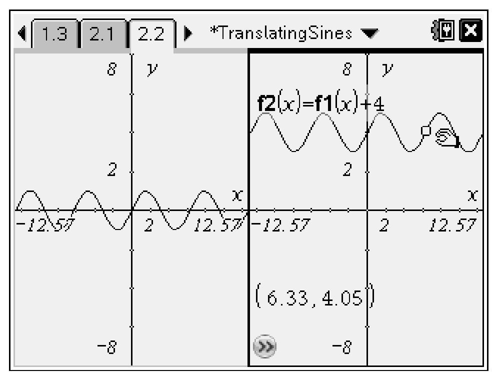
Have students redefine the function **f2** using different values of *a*, and observe any changes. They should find that multiplying the function by a negative value reflects the graph across the *x*-axis. The period is not affected.

In function notation:

$f(x) \rightarrow -f(x)$ Reflection over *x*-axis

$f(x) \rightarrow a \cdot f(x)$ Changes the amplitude by a factor of |*a*|

Problem 2 – Exploring *y* = sin(*x*) + *a*

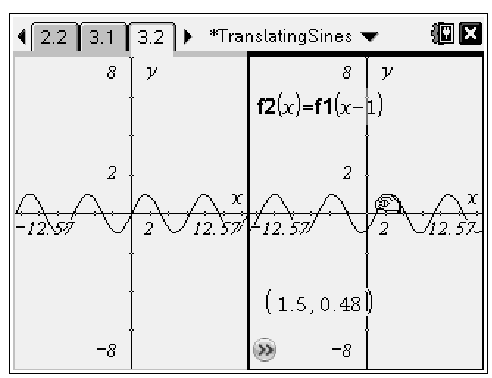


In this problem, students will discover that adding or subtracting a value to the function results in vertical translations. They should also be aware that such a transformation has no effect on the amplitude or period.

In function notation:

$f(x) \rightarrow f(x)+d$ Vertical translation *d* units

Problem 3 – Exploring $y = \sin(x - a)$



Here, students find that adding or subtracting a constant to the *input* of the function results in horizontal translations. Specifically:

f(*x* – 1) shifts to the right 1 unit

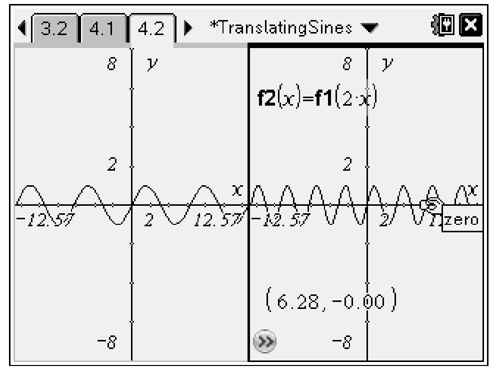
f(*x* + 1) shifts to the left 1 unit

Again, there are no changes to amplitude or period.

In function notation:

$f(x) \rightarrow f(x-c)$ Horizontal translation *c* units

Problem 4 – Exploring $y = \sin(a \cdot x)$

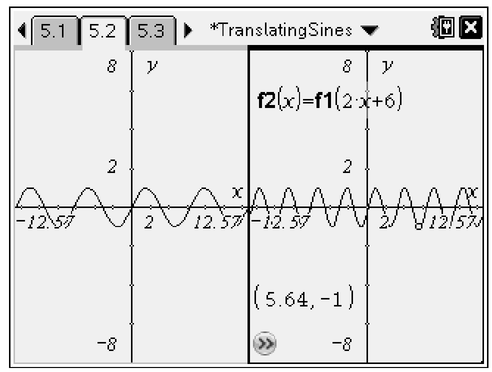


In Problem 4, students will discover that multiplying or dividing the input of the function by a constant value, *a,* stretches/compresses the graph horizontally, which changes the period by a factor of |*a*|. There is no change to the amplitude.

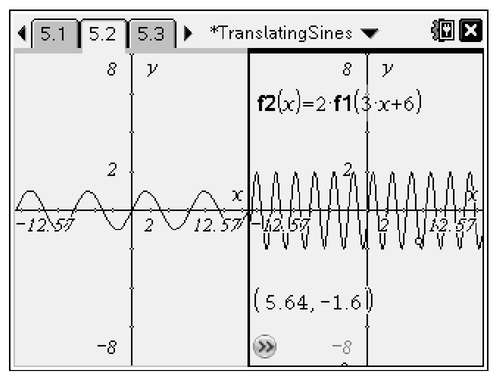
In function notation:

$f(x) \rightarrow f(a \cdot x)$ Changes the period by a factor of |*a*|

Problem 5 – Putting It All Together



This problem illustrates that care must be taken when the coefficient of *x* is not equal to 1. This was not encountered earlier as the factored form and non-factored forms were identical.



The function $y = 2 \cdot \sin(3(x + 2))$ undergoes the following:

- Amplitude increased by a factor of 2
- Horizontal shift left 2 units
- Period increased by a factor of 3 ($6\pi \approx 18.8495$)

Solutions – Student Worksheet Extension

1. Horizontal translation of 4 units
2. Reflection over the *x*-axis and amplitude changed by a factor of 2
3. Period changed by a factor of 4, horizontal translation of –3 units, and a vertical translation of 3 units
4. Amplitude changed by a factor of 3, period changed by a factor of 2, and a vertical translation of –8 units