*Energy and Waves Activity Bag*

# Wave Simulator: Teacher Instructions

## Traverse Waves

Teacher tips are in red.

### Challenge 1:

Ask students to try out features of the wave simulation. Challenge them to find and list 13 things that they can change or do with the simulation. Let them know that everyone will share what they find out after five minutes. When the time has elapsed, have students tell you what they have discovered. Afterward, share the complete list with students. The 13 things are:

- Change the frequency setting
- Change the amplitude setting
- Move the vertical ruler
- Move the horizontal ruler
- Move the reference line
- Pause (stop the moving wave)
- Play (make the wave move)
- Step along the path the wave makes
- Move the timer
- Step-time wave motion
- Reset the wave motion
- Reset the timer.

Allow for a few minutes for students to learn how to do things on the list that they did not discover themselves. It is ok if students do not figure out how to step-time wave motion. They will get directions for this later on.

### Challenge 2:

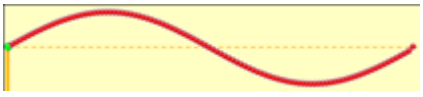
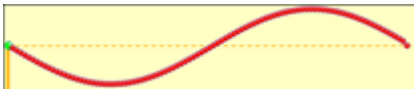
1. Ask students to use their simulators to make a wave in which:
   - Both ends touch the dotted yellow line
   - No ball is completely below the line
   - The amplitude setting is between 20 and 100

2. Ask students to pause the wave once they have it. It should look like:

3. Have students record their amplitude and frequency. Frequency settings of students will be similar, but amplitude settings can be anything above 20.

### Challenge 3:

1. Ask students to set the amplitude between 20 and 100 and then make the following two waves:

 and 

Students will need to use the pause and step functions to put both ends of the wave on the yellow dotted line. Have students record their amplitude and frequency. **Look for frequency settings around 10**.

2. Ask students to find the shape of the wave from **Challenge 2** within the new wave they just generated. **The shape from Challenge 2 is the first half of the Challenge 3 wave shown in the left-hand figure above, and it is also the second half of the Challenge 3 wave shown in the right-hand figure above.**

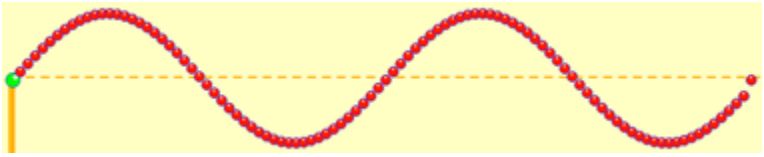
3. Ask "What is the relationship between the frequency setting of the first wave (Challenge 2) and this new wave (Challenge 3)? **The new wave has a frequency setting that is twice that of the old wave.**

4. Ask students to describe what they notice about this wave. They may say:
   - It has one dip and one high spot.
   - It touches the dotted line in three places.
   - The bottom is the same as the top, only upside down and moved to the right.

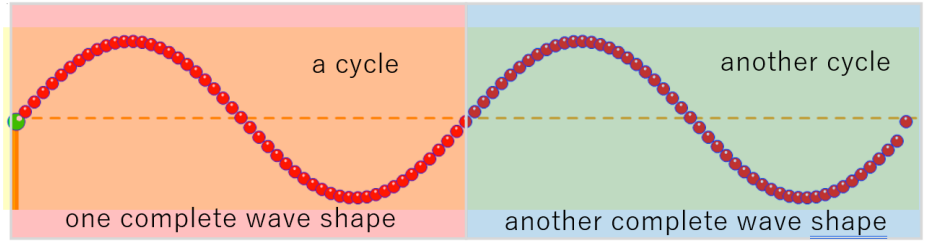
## Challenge 4

1. Introduce the terms crest and trough. The crest is the high point of a wave. A trough is a low point of a wave. Without using the computer to look at a wave, have students draw a wave that would be made by setting the frequency to 20.

2. After they have drawn their prediction have students change the frequency to 20, run the simulator, and pause it. The wave should look like:



3. Ask students what they notice about this wave. If students do not notice that the waveform repeats twice, point it out.



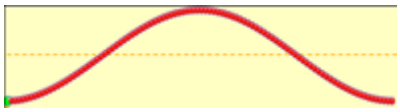
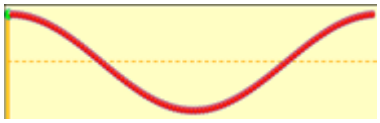

4. Introduce the term cycle. A wave cycle is one complete wave shape. There are two complete cycles in the **Challenge 4** wave. Ask students to respond to the following prompt:
   - **Without using the words "complete wave shape," write your own definition of a wave cycle so that someone else could identify a cycle when they see one.**

   They may use the wave simulator to check and revise definitions as needed.

5. Ask students what part, or fraction, of a cycle does this figure represent:

**The figure represents ½ of a cycle**.

6. Ask students if the following waves represent one full cycle, and why they do or do not. **Both of them do represent full cycles because they each end at the same place where they began, in relation to the yellow-dotted center line, and they also form only one wave shape.**

 and 

7. Ask students to set their frequency controls to 30, 40, and 50, and at each setting ask them to report how many crests and how many troughs are showing **3, 4, and 5 crests and troughs, respectively.** Then ask them how many cycles are showing at each frequency setting **3, 4, and 5 cycles**.

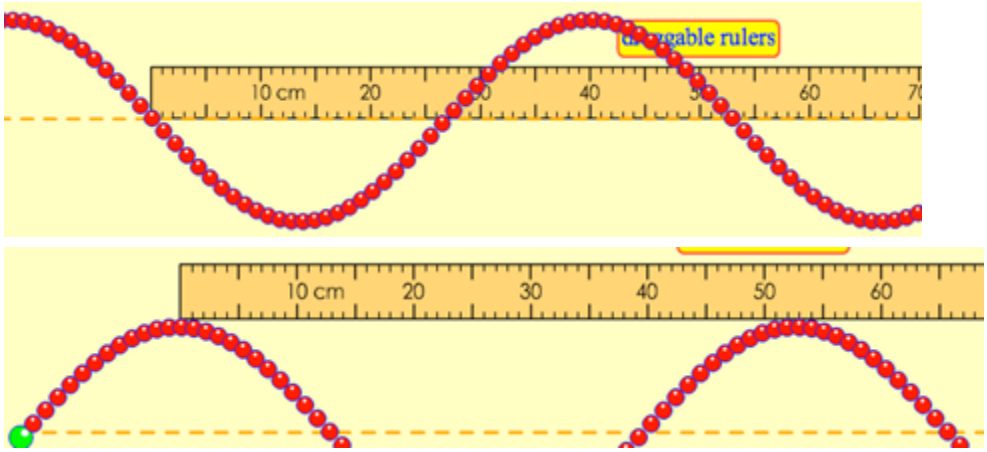
## Challenge 5

1. Ask students for their ideas on how they could measure the length of one whole cycle. Where do they think the measurement should start and end?

2. After students have chosen a way to measure one cycle, they should measure and record one whole cycle.

3. Ask students to measure again using a different starting point. Ask if they got the same result. **The two measurements should be identical.**

4. Ask students to set their frequency setting to 20 and measure the length of one whole cycle.



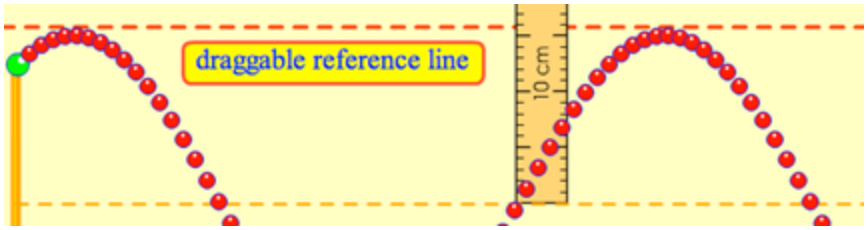

**For a frequency of 20, look for measurements near 53 cm.**

5. Introduce the term wavelength: the length of a wave's complete shape, for example
   - from crest to adjacent crest or trough to adjacent trough
   - From where it crossed the yellow-dotted center line heading down to where it crosses the centerline going downward again.

## Challenge 6

1. Ask students to set the amplitude to 80, run a wave, and pause it.

2. Ask them to use the draggable vertical ruler to measure the height in centimeters from the dotted cent line to a crest. Point out the draggable reference line as a tool. There are many ways to do this. A student might measure the height of crests by setting the reference line to touch the tops of the highest balls and setting the vertical ruler to measure the distance between the dotted center line and the reference line.



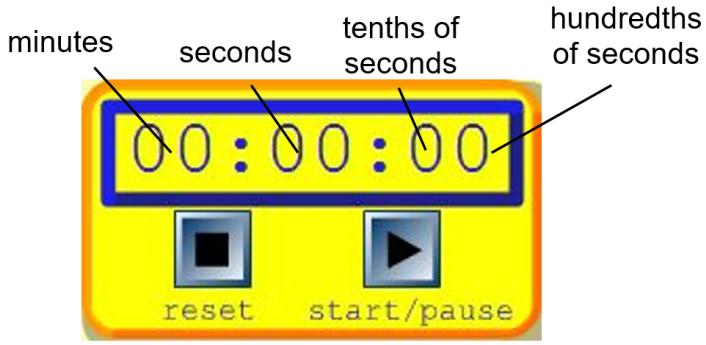

Look for measurements just under 16cm.

3. Introduce the term amplitude. Explain that amplitude is the distance from the center point of a wave to the highest or lowest point of a wave. It is NOT measured from lowest to highest points.

4. Point out that so far, the class has measured lengths and heights of waves. It is also important to know how fast a transverse wave moves up and down (or side to side). Ask students what additional tool or tools they would need to measure how quickly a wave rises and falls. **You need a timer to measure how fast something happens.**

## Challenge 7

1. Ask students to time one cycle of a wave. Explain how to use the timer in the wave simulator.




2. Give these instructions:
   - Set the frequency to 30.
   - Use the step function and any marker you choose to stop the wave in a position where you can know when you finish a whole cycle.
   - When you are ready to measure, reset the time to 0.
   - Use the step function to step through one cycle.
   - Record the time it took for a whole cycle.

   **Look for times around 0.91 seconds.**

3. Introduce the term period. Students have just now measured the period of a wave: the time it takes for a wave's shape to repeat.

4. Introduce the term frequency. Frequency is the number of cycles of a wave that occur in a given amount of time. It is also the number of periods in a second. Frequency is often given as the number of cycles per second.

You may give the students the **Wave Exploration: Student Activity Sheet** for independent practice.