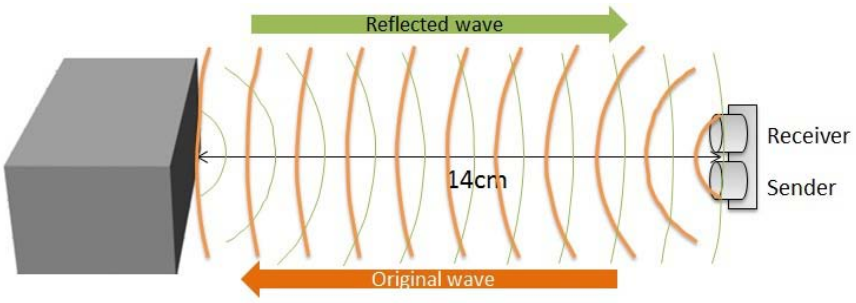
Name: _____ **Date:** _____

Measuring Distance with Sound Waves Activity – Distance and Time Worksheet



Part I: Distance and Time

1. Look around and choose a stationary object.
2. Turn on the LEGO® Ultrasonic sensor and obtain ultrasonic measurements in centimeters. Log that distance in Table 1.
3. Take two more distance measurements and log them in Table 1, for a total of three measurements (Take 1, Take 2 and Take 3).
4. Obtain the average of these three measurements and log it in the last column of Table 1.

Table 1			
Distance to object **Take 1 (in cm)**	Distance to object **Take 2 (in cm)**	Distance to object **Take 3 (in cm)**	Distance to object **Average (in cm)**

5. Convert the average measured distance to the object from Table 1 into meters, and log the conversion in Table 2.
6. Ask your instructor for a value of the speed of sound at current classroom temperature and log it in Table 2.
7. Calculate the time it takes for a sound wave to get from the sensor to the object (one way trip) using the distance formula. Log the calculation in Table 2.
8. Calculate the time it takes for a sound wave to travel from the sensor to the object and back (round-trip). Log the calculation in Table 2.
9. Convert the round-trip time of a sound wave from seconds into microseconds. Log the calculation in Table 2. Remember that $1\ second = 1\ 000\ 000\ microseconds$ or $1\ microsecond = 10^{-6}\ seconds$.

Table 2				
Distance to object **Average (meters)**	Speed of sound **(m/s)**	Time to the object **(s)**	Round-trip time **(s)**	Round-trip time **(microseconds)**

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Part II: Frequency

Recall that the frequency of a wave is defined as a number of cycles a wave completes in a second. For example, if the frequency of the wave is 10 Hz, then we can say that this wave completes 10 full cycles in 1 second. We also know that the wave completes 1 cycle in 0.1 seconds or 100,000 microseconds. We can figure this out by phrasing the problem as follows:

A wave competes 10 cycles in 1 second, hence 1 cycle is completed after x number of seconds.

Set up a proportion $\frac{10(cycles)}{1\ (s)} = \frac{1\ (cycle)}{x\ (s)}$, solve for *x*, and convert into microseconds to get the above result. Since it takes 100,000 microseconds for a wave to complete 1 cycle, then after 4,000,000 microseconds, the wave completes 40 cycles.

Questions

1. How many cycles does the LEGO® Ultrasonic sensor wave make in 1 second? Note that the frequency of a LEGO Ultrasonic sensor wave is **40 000 Hz.**
   _____ **(cycles)**

2. Calculate the time it takes for LEGO Ultrasonic sensor wave to travel one cycle?

   _____ **(microseconds)**

3. How many cycles does the LEGO® Ultrasonic sensor wave go through, traveling from a sensor to the object and back? To answer this question, use the calculated round-trip time in Table 2.

   _____ **(cycles)**