Name: _____ **Date:** _____ **Class:** _____

Echolocation Worksheet Answers

1. After this activity, do you feel more or less comfortable with measuring time?
   Please circle one: **More** **Less** ←Subjective; answers will vary.

2. John and Sally are going to race their robots. John and Sally's robots begin the race at exactly the same time. If John takes 22 seconds to finish the race, and Sally takes 24 seconds, who won?
   Please circle your answer: **John** **Sally**

3. John and Sally are very competitive, so they are once again settling an argument by using their robots. Each robot is fitted with an ultrasonic sensor so it knows when to turn around before hitting the wall and come back to the starting line. The wall is 4 feet from the starting line. John and Sally start at the exact same time from the starting line. John's ultrasonic sensor threshold is set to < 12 inches, and Sally's is set to < 23 centimeters. John's robot takes 18 seconds round trip, and Sally's takes 20 seconds. Who won the race in the fastest time?
   Circle your answer: **John** **Sally**

4. Using the information in question 3, whose sensor detects the wall first?
   Circle your answer: **John** **Sally**

   Please justify your answer:
   Example answer: Since John won the race, he should be able to detect the wall at an earlier time. And, 12 inches is longer than 23 cm, so John's threshold of <12 inches is tripped sooner than Sally's.

5. Using the information in question 3, how fast are John and Sally's robots traveling? (Show your work.)
   round trip = 8 ft = 12(8)(2.54) cm
   John: 243 cm/18s = 13.55 cm/s
   Sally: 243 cm/20s = 12.19 cm/s

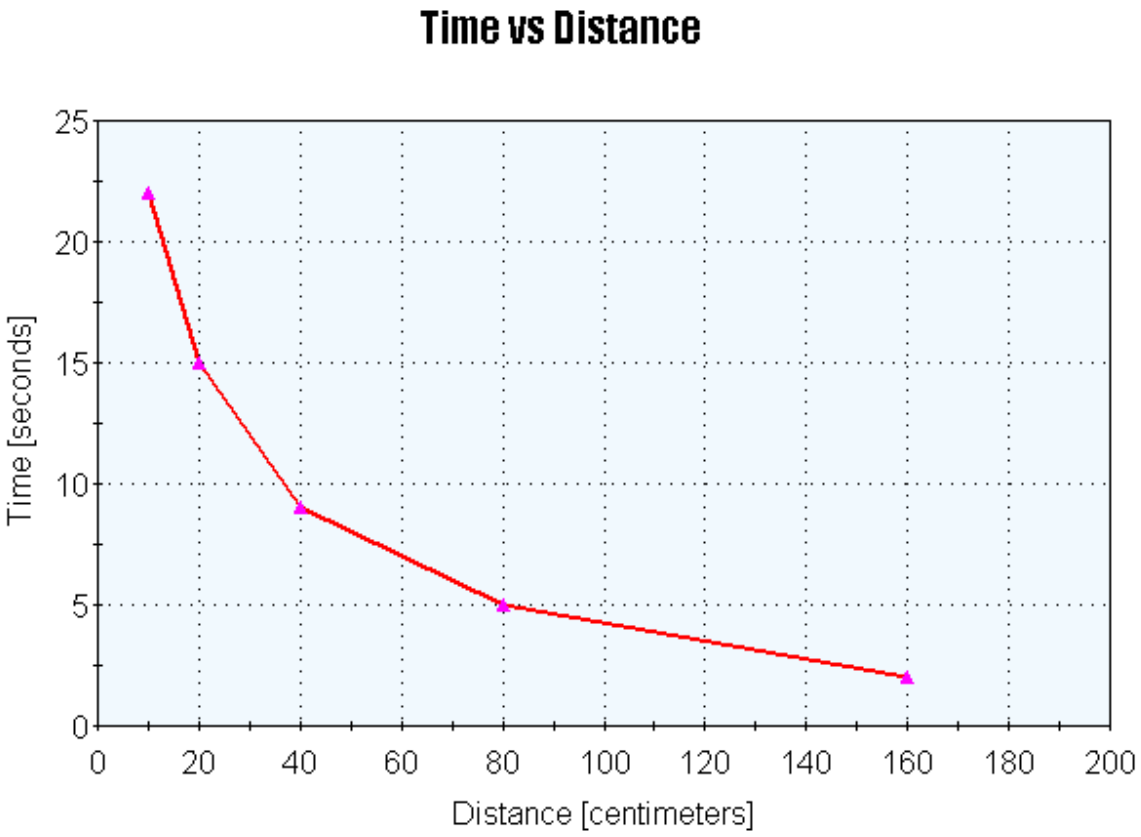
6. Does increasing the sensor's threshold value of John's robot from < 12 to < 15 inches help him detect the wall sooner or later than if he kept it at 12 inches?
   Please circle one: **Sooner** **Later** ↘ Subjective; answers will vary.

7. Did robotics help you understand measuring time better? Circle one: **Yes** **No**
   Explain:

   Example answer: Having the ability to see the robot move the distances and respond to the threshold changes helped me to mentally visualize the adjustments and better answer the questions.

8. Graph the following data from Sally testing her ultrasonic sensor's threshold and how long it took her robot to detect the wall before triggering it to turn around:

   Data: (10 cm, 22 s), (20 cm, 15 s), (40 cm, 9 s), (80 cm, 5 s), (160 cm, 2 s)



9. Refer to question 8 and the graph. For which distance does the robot take the longest to respond to the object? Please circle your answer:

   10 cm **20 cm** **40 cm** **80 cm** **160 cm**

10. Does changing the placement of the ultrasonic sensor to the back of the robot affect the distance that the robot detects the object? Circle one:

    sooner **no change** **later**

11. Describe how a bat uses echolocation or submarine uses sonar to detect prey or avoid obstacles?

    Example answer: A bat emits/makes a high-frequency/pitched noise that bounces/echoes/reflects off surfaces and returns back to it. Half the time it takes for the sound wave to return to the bat can be used to determine the distance from the bat to the object. This is directly similar to how the ultrasonic sensor works.

12. If you could make your own device that is inspired from nature, what would it come from, and what problem would it solve?

    Example answer: When considering threads, spider web filaments are one of the strongest materials with the lightest weights, so mimicking that, for example, in a mesh for Kevlar-like bullet-proof vests would be a great investment in research.

    This open-ended question has no limit to possible correct answers. As long as students support their answers by showing that they can approach solving problems by drawing correlations between designs found in nature and their design ideas, then their answers are correct.

13. Other than ultrasonic sensors that emulate animal echolocation, what is another use of biomimicry in engineering design?

    Example answer: Examples abound in industry. Expect students to come up with anything from Velcro mimicking plant burrs, helicopter blades like dragon flies wings, gecko feet adhesiveness for rock climbing shoes, or BigDog, which is a four-legged military robot for carrying objects, based on the idea of using legs for mobility over difficult terrain instead of wheels or treads.