2026 MCAS Sample Student Work and Scoring Guide

High School Introductory Physics
Question 37: Constructed-Response

Reporting Category: Waves
Practice Category: Evidence, Reasoning, and Modeling

Standard: HS.PHY.4.1 - Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling within various media. Recognize that electromagnetic waves can travel through empty space (without a medium) as compared to mechanical waves that require a medium.

Item Description: Explain whether the resistance in a circuit component should be increased or decreased for a given situation, calculate the wavelength of a sound wave produced by the circuit component, compare how the wavelength travels in air with how it travels in water, and explain the reasoning.

This item can be found in the released item sets on the MCAS Resource Center.

Scoring Guide

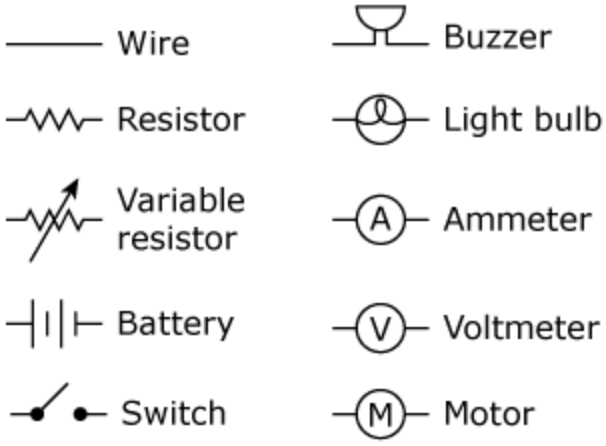
Select a score point in the table below to view the sample student response.

Score*	Description
3A **3B**	The response demonstrates a thorough understanding of waves traveling through different media. The response correctly identifies how the resistance of a circuit should be changed to increase the volume of a buzzer's sound and clearly explains the reasoning. The response correctly calculates the wavelength of a sound wave. The response also correctly compares the wavelength of the sound wave in air with the wavelength of the sound wave in water and clearly explains the reasoning.
2	The response demonstrates a partial understanding of waves traveling within various media.
1	The response demonstrates a minimal understanding of waves traveling within various media.
0	The response is incorrect or contains some correct work that is irrelevant to the skill or concept being measured.

*Letters are used to distinguish between sample student responses that earned the same score (e.g., 3A and 3B).

Module Introduction

A group of students performed several investigations using components from a circuit kit. The schematic symbols for the different types of components in the kit are shown.

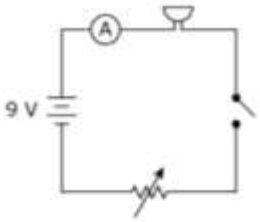


While performing the investigations, the students used the components to build a variety of circuits. They used an ammeter to measure the current through different circuit components and a voltmeter to measure the voltage drop across them.

Score Point 3A

This question has three parts.

The students built a circuit that includes a buzzer, as shown. When the amount of current passing through the buzzer increases, the volume of the buzzer's sound also increases.



Part A

The students want to increase the volume of the sound coming from the buzzer.

Identify whether the students should increase or decrease the resistance in the variable resistor to increase the volume of the buzzer's sound. Explain your reasoning.

The student should decrease the resistance of the resistor. When the student decrease the resistance the current will go up. This is because the voltage stays the same and resistance is inversely proportional to current (I=V/R). When the current goes up the volume of the buzzer will go up.

Part B

When the students close the switch and set the variable resistor to 1950 Ω, the buzzer produces a sound with a constant frequency of 2900 Hz. Sound waves travel through air at a speed of 343 m/s.

Calculate the wavelength of the sound wave produced by the buzzer when the variable resistor is set to 1950 Ω. Show your calculations and include units in your answer.

$$V = \lambda f$$

$$\lambda = \frac{V}{f}$$

$$\lambda = \frac{343}{2900} = 0.12 \text{ m}$$

Part C

The students place the circuit in a waterproof container and then put the container under water while the buzzer is making sound. The frequency of the buzzer's sound wave does not change as it moves from the air in the container into the water.

Compare the wavelength of the sound wave in air with the wavelength of the sound wave in water. Explain your reasoning.

When the sound wave enters the water its wavelength increases. Velocity is directly proportional to wavelength so as long as the frequency is constant increasing the velocity will increase the wavelength ((wavelength)=V/(frequency)). Because the speed of sound is faster in water than in air and because the frequency of the sound did not change the wavelength of the sound in water be longer than in air.

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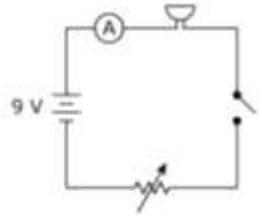
Score Point 3B

This question has three parts.

The students built a circuit that includes a buzzer, as shown. When the amount of current passing through the buzzer increases, the volume of the buzzer's sound also increases.



Part A

The students want to increase the volume of the sound coming from the buzzer.

Identify whether the students should increase or decrease the resistance in the variable resistor to increase the volume of the buzzer's sound. Explain your reasoning.

They should decrease the resistance because that would increase the current throught the curcuit.

Part B

When the students close the switch and set the variable resistor to 1950 Ω, the buzzer produces a sound with a constant frequency of 2900 Hz. Sound waves travel through air at a speed of 343 m/s.

Calculate the wavelength of the sound wave produced by the buzzer when the variable resistor is set to 1950 Ω. Show your calculations and include units in your answer.

$$v = \lambda f$$

$$343 = \lambda\,(2900)$$

$$\frac{343}{2900} = \frac{\lambda(2900)}{2900}$$

$$\lambda = 0.118275862\ \text{m}$$

Part C

The students place the circuit in a waterproof container and then put the container under water while the buzzer is making sound. The frequency of the buzzer's sound wave does not change as it moves from the air in the container into the water.

Compare the wavelength of the sound wave in air with the wavelength of the sound wave in water. Explain your reasoning.

The wavelength of the sound wave in water is greater than the wavelength of the sound wave in air becuase the speed of the wave is increasing as it goes from a gas to liquid.

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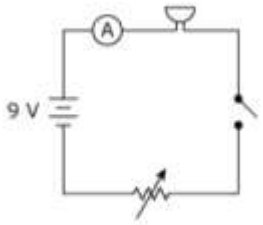
Score Point 2

This question has three parts.

The students built a circuit that includes a buzzer, as shown. When the amount of current passing through the buzzer increases, the volume of the buzzer's sound also increases.



Part A

The students want to increase the volume of the sound coming from the buzzer.

Identify whether the students should increase or decrease the resistance in the variable resistor to increase the volume of the buzzer's sound. Explain your reasoning.

The student should lower the resistance. Lowering the resistamce would increase the current and that would cause the buzzer to make a louder sound.

Part B

When the students close the switch and set the variable resistor to 1950 Ω, the buzzer produces a sound with a constant frequency of 2900 Hz. Sound waves travel through air at a speed of 343 m/s.

Calculate the wavelength of the sound wave produced by the buzzer when the variable resistor is set to 1950 Ω. Show your calculations and include units in your answer.

$\lambda = \frac{v}{f}$

$v = 343$

$f = 2900$

$\frac{343}{2900} \approx .118$ meters

Part C

The students place the circuit in a waterproof container and then put the container under water while the buzzer is making sound. The frequency of the buzzer's sound wave does not change as it moves from the air in the container into the water.

Compare the wavelength of the sound wave in air with the wavelength of the sound wave in water. Explain your reasoning.

Since the sound does not change, that means the frequency will also not change. Since the frequency does not change, the wavelength should also stay the same.

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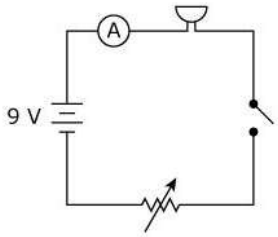
Score Point 1

This question has three parts.

The students built a circuit that includes a buzzer, as shown. When the amount of current passing through the buzzer increases, the volume of the buzzer's sound also increases.



Part A

The students want to increase the volume of the sound coming from the buzzer.

Identify whether the students should increase or decrease the resistance in the variable resistor to increase the volume of the buzzer's sound. Explain your reasoning.

The student should decrease the amount of resistance in the variable resistor because the less resistance the more current can get through to the buzzer.

Part B

When the students close the switch and set the variable resistor to 1950 Ω, the buzzer produces a sound with a constant frequency of 2900 Hz. Sound waves travel through air at a speed of 343 m/s.

Calculate the wavelength of the sound wave produced by the buzzer when the variable resistor is set to 1950 Ω. Show your calculations and include units in your answer.

The wavelength of the sound that is coming from the buzzer is 510.1λ

$2900 \times 343 \div 1950 = 510.1$

Part C

The students place the circuit in a waterproof container and then put the container under water while the buzzer is making sound. The frequency of the buzzer's sound wave does not change as it moves from the air in the container into the water.

Compare the wavelength of the sound wave in air with the wavelength of the sound wave in water. Explain your reasoning.

The wavelength of the buzzer will decrease in the water since the water is more dense than air, making it harder for the wavelength to travel though the water than it is air.

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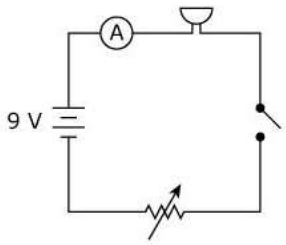
Score Point 0

This question has three parts.

The students built a circuit that includes a buzzer, as shown. When the amount of current passing through the buzzer increases, the volume of the buzzer's sound also increases.



Part A

The students want to increase the volume of the sound coming from the buzzer.

Identify whether the students should increase or decrease the resistance in the variable resistor to increase the volume of the buzzer's sound. Explain your reasoning.

the student should increase the resistance to increase the sound of th buzzer because there will be more voltage to go to the buzzer there for making it louder

Part B

When the students close the switch and set the variable resistor to 1950 Ω, the buzzer produces a sound with a constant frequency of 2900 Hz. Sound waves travel through air at a speed of 343 m/s.

Calculate the wavelength of the sound wave produced by the buzzer when the variable resistor is set to 1950 Ω. Show your calculations and include units in your answer.

$2900 - 1950 = 950$

$343 \div 9.50 = 36.1$

Part C

The students place the circuit in a waterproof container and then put the container under water while the buzzer is making sound. The frequency of the buzzer's sound wave does not change as it moves from the air in the container into the water.

Compare the wavelength of the sound wave in air with the wavelength of the sound wave in water. Explain your reasoning.

the sound waves will move slower through the water because they will spead out and have a harder time moving through the water

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