2022 MCAS Sample Student Work and Scoring Guide

High School Introductory Physics
Question 21: Constructed-Response

Reporting Category: Waves
Practice Category: Mathematics and Data
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: Calculate the speed of a sound wave and compare the characteristics of mechanical and electromagnetic waves.

View item in MCAS Digital Item Library

Scoring Guide

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

Score*	Description
4A	The response demonstrates a thorough understanding of electromagnetic and mechanical waves and their properties. The response correctly calculates the speed of a sound wave. The response clearly describes two differences between light waves and sound waves. The response also clearly describes one difference between radio waves and visible light waves.
4B	
3	The response demonstrates a general understanding of electromagnetic and mechanical waves and their properties.
2	The response demonstrates a limited understanding of electromagnetic and mechanical waves and their properties.
1	The response demonstrates a minimal understanding of electromagnetic and mechanical waves and their properties.
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., 4A and 4B).

Score Point 4A

This question has three parts.

A person at a baseball game is seated 200 m away from a batter. The person sees the batter hit a ball, and then hears the sound of the ball being hit 0.58 s later.

Part A

Calculate the speed of the sound wave created when the bat hits the ball. Show your calculations and include units in your answer.

The speed of the sound wave is 344.83 m/s.

speed= $\frac{d}{\Delta t} = \frac{200m}{0.58s} \approx 344.83$ m/s

Part B

Besides the difference in speed of the two types of waves, describe **two** additional differences between the visible light waves and the sound waves produced when the ball is hit.

Visible light waves are electromagnetic waves, so they do not need a medium to travel through. Sound waves are mechanical waves, so they need a medium to travel through. Also, visible light waves are transverse waves, meaning the movement of the particles in the wave is perpendicular to the direction of the wave movement. Sound waves are longitudinal waves, so the molecule movement is parallel to the direction of the wave moment.

Part C

The game is also broadcast over the radio for people who cannot attend the game. Radio waves carry the broadcast signal.

One way that visible light waves differ from radio waves is that they can be seen by humans, while radio waves cannot. Describe a second difference between the two types of waves.

A second difference between radio waves and visible light waves is that radio waves have a lower frequency than visible light waves. According to the electromagnetic spectrum, radio waves have the lowest frequency. Visible light waves are in the middle of the spectrum and have a higher frequency than radio waves.

Back to Scoring Guide

Score Point 4B

This question has three parts.

A person at a baseball game is seated 200 m away from a batter. The person sees the batter hit a ball, and then hears the sound of the ball being hit 0.58 s later.

Part A

Calculate the speed of the sound wave created when the bat hits the ball. Show your calculations and include units in your answer.

Formula : Average speed = $\frac{d}{\Delta t}$

$\frac{200m}{.58s}$

The speed of the sound wave created when the bat hits the ball is 344.8m/s

Part B

Besides the difference in speed of the two types of waves, describe **two** additional differences between the visible light waves and the sound waves produced when the ball is hit.

Two differences between visible light waves and sound waves is visible light is electromagnetic and sound waves are mechanical, and visible light is transverse and sand waves a longitudinal.

Part C

The game is also broadcast over the radio for people who cannot attend the game. Radio waves carry the broadcast signal.

One way that visible light waves differ from radio waves is that they can be seen by humans, while radio waves cannot. Describe a second difference between the two types of waves.

Another difference between radio waves and visible light is the radio waves have a greater wavelength.

Back to Scoring Guide

Score Point 3

This question has three parts.

A person at a baseball game is seated 200 m away from a batter. The person sees the batter hit a ball, and then hears the sound of the ball being hit 0.58 s later.

Part A

Calculate the speed of the sound wave created when the bat hits the ball. Show your calculations and include units in your answer.

$$S = \frac{d}{\Delta t}$$
$$S = \frac{200}{0.58}$$
$$S \approx 344.83 \text{ m/s}$$

Part B

Besides the difference in speed of the two types of waves, describe **two** additional differences between the visible light waves and the sound waves produced when the ball is hit.

Visible light waves can travel through a vacuume while sound waves cannot. And light waves can be seen while sound wave can be heard.

Part C

The game is also broadcast over the radio for people who cannot attend the game. Radio waves carry the broadcast signal.

One way that visible light waves differ from radio waves is that they can be seen by humans, while radio waves cannot. Describe a second difference between the two types of waves.

Radio waves has a longer wavelength than visible light waves.

Back to Scoring Guide

Score Point 2

This question has three parts.

A person at a baseball game is seated 200 m away from a batter. The person sees the batter hit a ball, and then hears the sound of the ball being hit 0.58 s later.

Part A

Calculate the speed of the sound wave created when the bat hits the ball. Show your calculations and include units in your answer.

speed=344.83 m/s

$v = \frac{d}{\Delta t} \quad d = 200m \quad \Delta t = 0.58s \quad v = \frac{200}{0.58}$

$v = 344.83$

Part B

Besides the difference in speed of the two types of waves, describe **two** additional differences between the visible light waves and the sound waves produced when the ball is hit.

Two differences between the light waves and sound waves are sound waves are longitudinal while light waves are transverse and sound waves are electromagnetic waves while light waves are mechanical waves.

Part C

The game is also broadcast over the radio for people who cannot attend the game. Radio waves carry the broadcast signal.

One way that visible light waves differ from radio waves is that they can be seen by humans, while radio waves cannot. Describe a second difference between the two types of waves.

Another difference between visible light waves and radio waves is visible light waves travel much faster than radio waves.

Back to Scoring Guide

Score Point 1

This question has three parts.

A person at a baseball game is seated 200 m away from a batter. The person sees the batter hit a ball, and then hears the sound of the ball being hit 0.58 s later.

Part A

Calculate the speed of the sound wave created when the bat hits the ball. Show your calculations and include units in your answer.

344 m/s

$$200m\,\frac{(2.00m)}{0.58s} = 344 \text{ m/s}$$

Part B

Besides the difference in speed of the two types of waves, describe **two** additional differences between the visible light waves and the sound waves produced when the ball is hit.

1.) You can't see sound waves in person
2.) You can't hear light waves in person

Part C

The game is also broadcast over the radio for people who cannot attend the game. Radio waves carry the broadcast signal.

One way that visible light waves differ from radio waves is that they can be seen by humans, while radio waves cannot. Describe a second difference between the two types of waves.

1.) Radio waves can travel from one place to another through something, while light waves can't.

Back to Scoring Guide

Score Point 0

This question has three parts.

A person at a baseball game is seated 200 m away from a batter. The person sees the batter hit a ball, and then hears the sound of the ball being hit 0.58 s later.

Part A

Calculate the speed of the sound wave created when the bat hits the ball. Show your calculations and include units in your answer.

116.0c $200m \times 0.58s = 116.0c$

Part B

Besides the difference in speed of the two types of waves, describe **two** additional differences between the visible light waves and the sound waves produced when the ball is hit.

the visible light waves was gone when it hit the Ball. The sound became more loud then when you don't hit it.

Part C

The game is also broadcast over the radio for people who cannot attend the game. Radio waves carry the broadcast signal.

One way that visible light waves differ from radio waves is that they can be seen by humans, while radio waves cannot. Describe a second difference between the two types of waves.

another way that visible light is always there and the radio waves not a lot of people hear it.

Back to Scoring Guide