2026 MCAS Sample Student Work and Scoring Guide

High School Introductory Physics
Question 20: Constructed-Response

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

Standard: HS.PHY.4.5 - Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy.

Item Description: Describe how constructive interference affects the amplitude of a wave, calculate the period and wavelength of a wave, and explain why waves with different wavelengths have different frequencies.

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.

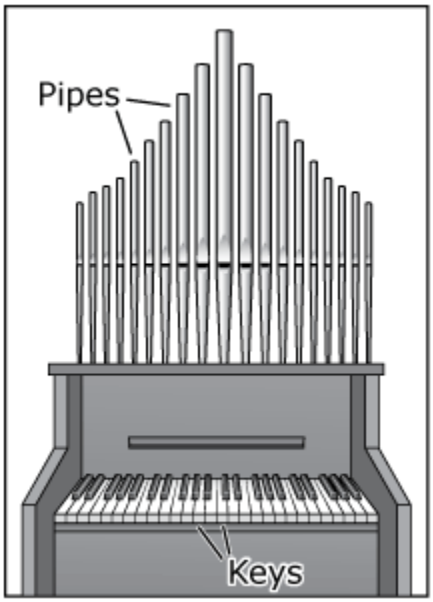
Score*	Description
4A **4B**	The response demonstrates a thorough understanding of wave behaviors in technological devices. The response correctly identifies that constructively interfering sound waves result in a sound wave with a greater amplitude. The response correctly calculates the period and wavelength of a sound wave. The response also correctly identifies that a sound wave with a higher frequency has a shorter wavelength and clearly explains the reasoning.
3	The response demonstrates a general understanding of wave behaviors in technological devices.
2	The response demonstrates a limited understanding of wave behaviors in technological devices.
1	The response demonstrates a minimal understanding of wave behaviors in technological devices.
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).

Question Introduction

This question has four parts.

Pipe organs are musical instruments that produce sound waves using pipes. Each pipe is designed to produce a sound wave with a specific frequency when a key is pressed. A pipe organ is shown.



Score Point 4A

Part A

A sound wave reaches the end of an organ pipe, is reflected, and then constructively interferes with another sound wave.

Select from the drop-down menus to correctly complete the sentence.

When the sound waves constructively interfere, the amplitude of the resulting wave is greater than that of the original waves.

Part B

An organ pipe produces a sound wave with a frequency of 20 Hz.

Calculate the period of the sound wave. Show your calculations and include units in your answer.

T=1/f
T=1/20
T=0.05s

Part C

The 20 Hz sound wave travels through the air at a speed of 343 m/s.

Calculate the wavelength of the sound wave. Show your calculations and include units in your answer.

v= λ (f)
343m/s= λ (20Hz)
λ =17.15m

Part D

A different pipe from the same organ produces a sound wave with a frequency of 32 Hz.

Identify whether the wavelength of the 32 Hz sound wave is longer than, shorter than, or equal to the wavelength of the 20 Hz sound wave. Explain your reasoning.

The wavelength of the 32 Hz sound wave is shorter than the wavelength of the 20 Hz sound wave. This is because as the frequency increases, the wavelength decreases because the speed of sound stays the same. When the frequency is a higher number, the wavelength must be lower for it to multiply to the same speed.

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Score Point 4B

Part A

A sound wave reaches the end of an organ pipe, is reflected, and then constructively interferes with another sound wave.

Select from the drop-down menus to correctly complete the sentence.

When the sound waves constructively interfere, the amplitude of the resulting wave is greater than that of the original waves.

Part B

An organ pipe produces a sound wave with a frequency of 20 Hz.

Calculate the period of the sound wave. Show your calculations and include units in your answer.

$$T = \frac{1}{f} = \frac{1}{20} = 0.05s$$

Part C

The 20 Hz sound wave travels through the air at a speed of 343 m/s.

Calculate the wavelength of the sound wave. Show your calculations and include units in your answer.

$$v = \lambda f$$
$$\lambda = \frac{v}{f} = \frac{343}{20} = 17.15m$$

Part D

A different pipe from the same organ produces a sound wave with a frequency of 32 Hz.

Identify whether the wavelength of the 32 Hz sound wave is longer than, shorter than, or equal to the wavelength of the 20 Hz sound wave. Explain your reasoning.

$$v = \lambda f$$
$$\lambda = \frac{v}{f} = \frac{343}{32} = 10.72m$$

The wavelength of the 32Hz sound wave is shorter than the wavelength of the 20Hz sound wave. The 32Hz sound wave has a wavelength of 10.72m and the 20Hz sound wave has a wavelength of 17.15m

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Score Point 3

Part A

A sound wave reaches the end of an organ pipe, is reflected, and then constructively interferes with another sound wave.

Select from the drop-down menus to correctly complete the sentence.

When the sound waves constructively interfere, the wavelength of the resulting wave is greater than that of the original waves.

Part B

An organ pipe produces a sound wave with a frequency of 20 Hz.

Calculate the period of the sound wave. Show your calculations and include units in your answer.

$T=1/f$
$T=1/20$ Hz
$T=0.05$s

Part C

The 20 Hz sound wave travels through the air at a speed of 343 m/s.

Calculate the wavelength of the sound wave. Show your calculations and include units in your answer.

wavelength=v/f
wavelength=343m/s /20Hz
wavelength=17.15m

Part D

A different pipe from the same organ produces a sound wave with a frequency of 32 Hz.

Identify whether the wavelength of the 32 Hz sound wave is longer than, shorter than, or equal to the wavelength of the 20 Hz sound wave. Explain your reasoning.

The wavelength from the 32 Hz pipe would be shorter than from the 20 Hz pipe because frequency is inversely proportional to wavelength, so the greater the frequency, the shorter the length.

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Score Point 2

Part A

A sound wave reaches the end of an organ pipe, is reflected, and then constructively interferes with another sound wave.

Select from the drop-down menus to correctly complete the sentence.

When the sound waves constructively interfere, the amplitude of the resulting wave is less than that of the original waves.

Part B

An organ pipe produces a sound wave with a frequency of 20 Hz.

Calculate the period of the sound wave. Show your calculations and include units in your answer.

T=1/f
T=1/20
T=0.05

Part C

The 20 Hz sound wave travels through the air at a speed of 343 m/s.

Calculate the wavelength of the sound wave. Show your calculations and include units in your answer.

343/20=17.15

Part D

A different pipe from the same organ produces a sound wave with a frequency of 32 Hz.

Identify whether the wavelength of the 32 Hz sound wave is longer than, shorter than, or equal to the wavelength of the 20 Hz sound wave. Explain your reasoning.

longer because it has more frequency

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Score Point 1

Part A

A sound wave reaches the end of an organ pipe, is reflected, and then constructively interferes with another sound wave.

Select from the drop-down menus to correctly complete the sentence.

When the sound waves constructively interfere, the wavelength of the resulting wave is less than that of the original waves.

Part B

An organ pipe produces a sound wave with a frequency of 20 Hz.

Calculate the period of the sound wave. Show your calculations and include units in your answer.

T=1/F
1/20 = 0.05

The period of the sound wave is 0.05 f

Part C

The 20 Hz sound wave travels through the air at a speed of 343 m/s.

Calculate the wavelength of the sound wave. Show your calculations and include units in your answer.

20 HZ x 343 m/s = 6860 λ

Part D

A different pipe from the same organ produces a sound wave with a frequency of 32 Hz.

Identify whether the wavelength of the 32 Hz sound wave is longer than, shorter than, or equal to the wavelength of the 20 Hz sound wave. Explain your reasoning.

I think it has a greater wavelength because it has a longer sound wave than 20 HZ

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Score Point 0

Part A

A sound wave reaches the end of an organ pipe, is reflected, and then constructively interferes with another sound wave.

Select from the drop-down menus to correctly complete the sentence.

When the sound waves constructively interfere, the amplitude of the resulting wave is less than that of the original waves.

Part B

An organ pipe produces a sound wave with a frequency of 20 Hz.

Calculate the period of the sound wave. Show your calculations and include units in your answer.

20 x 20 = 400

Part C

The 20 Hz sound wave travels through the air at a speed of 343 m/s.

Calculate the wavelength of the sound wave. Show your calculations and include units in your answer.

20 x 343 =6860

Part D

A different pipe from the same organ produces a sound wave with a frequency of 32 Hz.

Identify whether the wavelength of the 32 Hz sound wave is longer than, shorter than, or equal to the wavelength of the 20 Hz sound wave. Explain your reasoning.

32-20 =12

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