Stage Wave Check

Compare motion, sound, and light during a theater sound check.

PHY.4.1 "Analyze the characteristics and properties of simple harmonic motions, sound, and light."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline statements that explain what changes when amplitude or frequency changes. Circle statements about whether sound or light can travel through a vacuum.

Three Signals on Stage

1. At a theater sound check, a technician hangs a small weight from a spring beside the stage. She pulls the weight down 2 centimeters and lets go. The weight moves back and forth about its resting position, called equilibrium. In this nearly simple harmonic motion, the spring's restoring force points toward equilibrium and grows as displacement grows. The weight stops briefly at each turning point and moves fastest through equilibrium. Amplitude is the greatest distance from equilibrium; period is the time for one full cycle. Pulling down 4 centimeters increases amplitude, but for an ideal spring the period does not change.

2. Nearby, a speaker cone also moves back and forth. Its motion pushes and pulls the surrounding air, sending alternating regions of compression and rarefaction toward the audience. Sound is a mechanical wave, so it needs matter to travel and cannot cross a vacuum. The technician turns up the volume without changing the note. The cone moves farther, increasing the sound wave's amplitude, while its frequency stays the same. The audience hears a louder sound at the same pitch. When she increases the cone's vibration frequency instead, the pitch rises. In the same air, higher frequency also means shorter wavelength.

3. Above the stage, red and blue LEDs light the backdrop. Their light is an electromagnetic wave, not a vibration of air. Light can cross a vacuum, although sound cannot. Blue light has a higher frequency and a shorter wavelength than red light in the same medium. Increasing the brightness of the red LED increases the light's intensity, not its frequency or color. A louder speaker and a brighter LED therefore both send more energy to the audience, but neither change alone raises pitch or shifts color. The spring, the speaker, and the LEDs show why amplitude and frequency must be analyzed separately.

2 ANSWER WITH EVIDENCE

Use the passage

1. The technician pulls the weight down 4 centimeters instead of 2 centimeters. What changes about its motion, and what stays the same for an ideal spring?

2. At the weight's lowest turning point, how do its speed and the direction of the spring's restoring force compare with those at equilibrium?

3. The technician first raises the speaker's volume without changing its note, then raises its vibration frequency. How does each change affect pitch and wavelength in the same air?

4. Which stage signal could travel across a vacuum, sound or light? How do the blue and red LEDs compare in frequency and wavelength?

3 YOUR TURN

Your own words

A space museum has a spring-mounted satellite model, an alarm speaker, and a blue warning lamp. In 4 or 5 sentences, propose how to make the model swing farther without a longer period, make the alarm higher pitched without making it louder, and make the lamp brighter without changing color; explain which signal a visitor could detect across a vacuum.

ANSWER KEY

Stage Wave Check

PART 1 · READ AND MARK

Underline statements that explain what changes when amplitude or frequency changes. Circle statements about whether sound or light can travel through a vacuum. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	The technician pulls the weight down 4 centimeters instead of 2 centimeters. What changes about its motion, and what stays the same for an ideal spring?	**Its amplitude doubles from 2 to 4 centimeters, but its period stays the same for an ideal spring.**
2	At the weight's lowest turning point, how do its speed and the direction of the spring's restoring force compare with those at equilibrium?	**At the lowest turning point, its speed is zero and the restoring force points upward toward equilibrium. At equilibrium, its speed is greatest and the restoring force is zero.**
3	The technician first raises the speaker's volume without changing its note, then raises its vibration frequency. How does each change affect pitch and wavelength in the same air?	**Raising volume increases amplitude but leaves pitch and wavelength unchanged because frequency stays the same. Raising vibration frequency increases pitch and shortens wavelength.**
4	Which stage signal could travel across a vacuum, sound or light? How do the blue and red LEDs compare in frequency and wavelength?	**Light could travel across a vacuum, but sound could not. Blue light has a higher frequency and a shorter wavelength than red light in the same medium.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would pull the spring-mounted model farther from equilibrium, increasing its amplitude without changing its ideal-spring period. I would raise the alarm's vibration frequency while keeping its amplitude the same, making its pitch higher without making it louder. I would increase the blue lamp's intensity without changing its frequency, so it looks brighter but stays blue. Across a vacuum, the visitor could detect the lamp's light but could not hear the alarm.

Accept descriptions of the spring's period as approximately unchanged for small oscillations. For the museum task, look for separate, accurate changes to amplitude, frequency, and light intensity, plus the sound-light contrast across a vacuum.