Sound Program of Study Content Assessment: Explanations

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This document is a supplement to the answer key for the Sound Content Assessment. For each question, there is typically a statement identifying the science concepts that are targeted, and it is followed by an explanation of how those concepts apply to the situation represented in the question. The correct response is identified, indicating how it follows from understanding the science concepts and applying them to the context of the question, and further information may be given about what an incorrect response can reveal about a student s understanding.

Question 1:
Our vocal chords are open when we make sound (air flows through the vocal chords), and they stretch to varying degrees to makes sounds of different pitch, but the reason there is sound is because the vocal chords vibrate. Sound results from the vibration of material objects, which makes (c) the correct answer to the question.

Question 2:
This question deals with the language that is typically used to refer to differences in sound that are a function of pitch. Sound can differ in pitch and volume, and it is helpful to use different language to describe differences in their characteristics so that it is clear what we are talking about. The terms high or low are typically used to describe *pitch* differences in sound whereas loud or soft/quiet are terms used to describe *volume* (or loudness) differences in sound. Thus, (b) is the correct response.

Question 3:
When a rubberband is plucked, it may initially tighten, and it will vibrate, and if it is pulled back far when plucked it will likely make a louder sound that if it is only pulled back a little bit when plucked. Since the rubberband vibrates, and sound results from the vibration of material objects, (a) is the correct response.

Questions 4 and 5:
This items asks about the relationship between the *tension* of a material and its *pitch* (tension is a physical characteristic of a material). When the rubberband is stretched more tightly, tension is greater in the rubberband. Greater tension will result in the rubberband vibrating more rapidly. Faster vibrations represent higher pitches; thus, (b) is the correct answer to Questions 4 and 5.

Question 6:
The relationship in question in this item is between the *thickness* of a material and its *pitch* (thickness is physical characteristic of a material). The cup is used in this case to establish that the rubberbands are of the same length (the part of the rubber band that sounds is across the opening of the cup, which is the same for each) and that they are equally under tension. The amount of material that is set into vibrational motion determines how fast it will vibrate: a greater amount of material will vibrate more slowly than less material in response to the same force setting it into vibrational motion. In this case, the thinnest rubberband has the least amount of material, so it would have the highest pitch, and (c) would be the correct response (conversely, the thickest rubber band would have the lowest pitch because it has the most material).

Question 7:
When you blow into a bottle, the air from your mouth exerts a force on the air in the bottle, causing it to vibrate. The vibrating air in turn causes the water and the bottle to vibrate (evidence of the vibrations can be seen in waves on the surface of the water, and they can be felt in the bottle). Because all three materials end up vibrating, the purpose of this question is to ascertain whether students know what is responsible for the sound that we hear. This is a key question because situations of different sounds from blowing on and tapping a bottle with liquid are key phenomena in the Big Book text.
In this situation, the vibration of the air is the only one that is at a frequency in our range of hearing (the other vibrations being of a lower frequency than we can hear because their quantities are greater in mass than the air, which means they vibrate more slowly). Thus, the correct response is answer choice (a).

Question 8:
Question 8 asks about the relationship between *pitch* and the *length* of a material (length is a physical characteristic of a material). The longest string would have the lowest pitch because the greater the amount of material, the slower the vibration of it. Answering the question correctly requires being able to visually identify the longest string, which is response (c).

Question 9:
Question 9 asks about the relationship between the speed of *vibration* and the *length* of a material. If the greater the amount of material the slower the rate of vibration, then less material results in a faster rate of vibration. Shorter strings would vibrate more quickly than longer strings, so the correct answer to this question is that the shortest string would vibrate the fastest. Answering the question correctly requires being able to visually identify the shortest string, which is response (a).

Questions 10, 11, and 12:
These three questions provide a reference situation — the pitch of a sound produced by tapping a bottle with a particular amount of water in it — to which a new situation is compared. When you tap a bottle with water in it, the sound you hear comes from the glass and liquid vibrating together. The two materials vibrate together because the particles in the liquid are in contact with the bottle and fully contiguous (as opposed to having gaps, such as if the bottle were filled with salt or sand, and particles could move into gaps without affecting adjacent particles).

Question 10 and 11: In these questions, the amount of liquid in the bottle in the question is different from the amount in the reference situation. Adding more water increases the amount of vibrating material; hence, the pitch will be lower. The inverse is also true — taking water out will result in a higher pitch.

Question 12: shows the same amount of liquid as the initial picture, but it is heavier. A heavier liquid compared to a lighter liquid is the same comparison as a greater amount of material to less material because the weight of material being vibrated is greater (which is also true if one object is longer than the other). So, the bottle containing syrup will vibrate more slowly than the bottle containing water, which means it will have a lower pitch.

Questions 13 and 14:
Scientists study sound through the use of an oscilloscope, which produces transverse wave patterns (also called sine waves) that represent the vibrations of sounds. Waves can vary in height (amplitude) or length (wavelength), and as representations of sound, these correspond to differences in intensity (volume) and frequency (speed of vibration). It is important to know how to distinguish, in a vibration picture from an oscilloscope, the difference between the frequency of vibrations (pitch) and their intensity (loudness) because they can vary independently.

Question 13: The diagram shows a vibration pattern for one second of time compared to the equilibrium position (or at rest line). By convention, a vibration is thought of a cycle starting from the point where the line is displaced above the equilibrium position, continues with displacement below the equilibrium position, and ends when it approaches equilibrium once again, just prior to repeating the cycle. The vibration pattern in the diagram exhibits two of these cycles thus, there are two vibrations in a second, answer choice (b).

Question 14: The indication of height in the wave patterns shown in the diagram indicates the amount of displacement from equilibrium, which refers to the strength of the wave (regardless of the frequency of the wave movement). This quantity, with respect to sound, indicates the intensity of the sound; that is, its volume or loudness.

