

More Waves Notes

Standing waves, Natural Frequencies, Resonance, Frequencies of String Instruments, etc.

1. When two identical sets of waves pass through one another in opposite directions, _____ are produced. They are called this because the waves look like they are standing still.
2. Standing waves are the result of constructive and destructive interference. Wherever the passing waves add to one another (constructive interference), an _____ is produced. Wherever the passing waves cancel one another out (destructive interference), a _____ is produced.
3. Standing Waves Rules and Definitions:
 1. Nodes and antinodes always _____.
 2. At a "free end" of the vibrating object, particles are free to move, so there is a(n) _____.
 3. At a "fixed end" of the vibrating object, particles cannot move, so there is a(n) _____.
 4. There are usually many standing wave patterns that can occur in a vibrating object. The pattern with the longest wavelength is called the _____. The pattern with the next longest wavelength is called the _____. The next pattern is the _____. Etc. These overtones are also called harmonics, but their definition is a little different.
4. Draw the fundamental vibrational mode and the first two overtones for a string that is fixed on both ends.
5. Draw the fundamental vibrational mode and the first two overtones for a pipe that is open on one end (one fixed end and one free end).
6. An object's _____ frequency is "the frequency or frequencies at which an object tends to vibrate when struck, hit, plucked, or somehow disturbed." **An object can have more than one natural frequency, and these are the standing wave patterns that we have been drawing.**

7. _____ occurs when one object's vibrations match the natural frequency of another object, causing the second object to vibrate with increasing amplitude.
8. An example of resonance happens when someone is swinging, and someone else pushes at a frequency that _____ the natural frequency of the swing. Another example happens when someone sings at a wine glass with a pitch that _____. Yet another example of resonance happens when a string is shaken at one of the string's natural frequencies, causing visible _____ waves to appear.
9. What is "pitch," as it relates to sound?
10. What determines the frequency that will be produced when a guitar string is plucked?
11. What determines the speed of the waves that are produced when a guitar string is plucked?
12. When two identical sets of waves pass through one another in opposite directions, _____. They are called this because the waves look like they are standing still.

Problems:

13. You pluck a guitar string and measure the string's length (40cm) and the fundamental frequency (185Hz – F#) of the sound that is produced.
 - a. Draw the string in its fundamental (1st harmonic) vibrational mode.
 - b. What is the wavelength of the waves that are traveling along the string when its frequency is 185Hz? (show a full wavelength on your diagram).
 - c. Calculate the speed of the waves moving along the string.
 - d. If you want to pluck the same string, but you want to play an A (220Hz), you need to press down the string to shorten the part that is vibrating. How long should the vibrating part be?

14. An instrument string's length is 50cm and its fundamental frequency is 245Hz (B).
- Draw the string in its fundamental (1st harmonic) vibrational mode.
 - What is the wavelength of the waves that are traveling along the string when its frequency is 245Hz? (show a full wavelength on your diagram).
 - Calculate the speed of the waves moving along the string.
 - Where would you need to press down the string if you wanted to play a G (784Hz) on the same string?

More Practice:

- Define *natural frequency*:
- Define *resonance*:
- Explain how singing at a glass with just the right frequency can cause the glass to break.
- Draw the fundamental vibrational mode and the first two overtones for a pipe that is open on both ends (both ends are free).

5. An instrument string's length is 30cm and its fundamental frequency is 180Hz.
- Draw the string in its fundamental (1st harmonic) vibrational mode.
 - What is the wavelength of the waves that are traveling along the string when its frequency is 180Hz? (show a full wavelength on your diagram).
 - Calculate the speed of the waves moving along the string.
 - Where would you need to press down the string if you wanted to play a note with a frequency of 560Hz on the same string?