SPEED OF SOUND AND SOUND OPENNESS

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Q No: Write down the note on speed of sound and Doppler effect of sound waves.

Abstract:

Speed of Sound

The speed of sound is the distance travelled per unit time by a sound wave as it propagates through an elastic medium. At 20 °C (68 °F), the speed of sound in air is about 343 meters per second (1,235 km/h; 1,125 ft/s; 767 mph; 667 km), or a kilometer in 2.9 s or a mile in 4.7 s. It depends strongly on temperature as well as the medium through which a sound wave is propagating.

Sound exposure

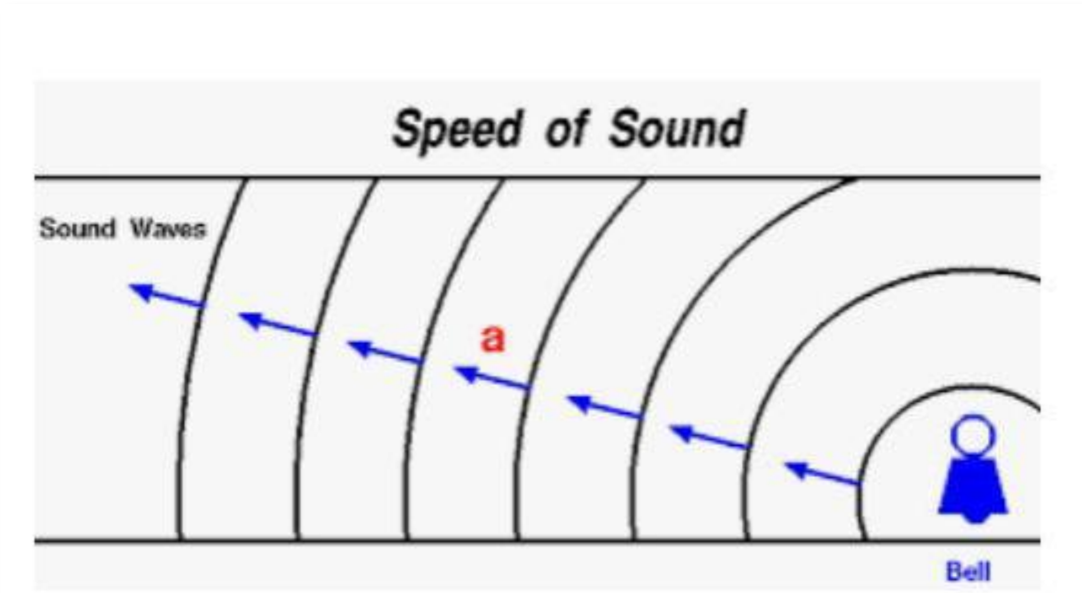
The speed of sound in an ideal gas depends only on its temperature and composition. The speed has a weak dependence on frequency and pressure in ordinary air, deviating slightly from ideal behavior.

In common everyday speech, speed of sound refers to the speed of sound waves in air. However, the speed of sound varies from substance to substance: typically sound travels most slowly in gases; it travels faster in liquids; and faster still in solids. For example, (as noted above), sound travels at 343 m/s in air; it travels at 1,481 m/s in water (almost 4.3 times as fast as in air); and at 5,120 m/s in iron (almost 15 times as fast as in air). In an exceptionally stiff material such as diamond, sound travels at 12,000 metres per second (39,000 ft/s)[1]—about 35 times as fast as in air—which is around the maximum speed that sound will travel under normal conditions.

Sound waves in solids are composed of compression waves (just as in gases and liquids), and a different type of sound wave called a shear wave, which occurs only in solids. Shear waves in solids usually travel at different speeds, as exhibited in seismology. The speed of compression waves in solids is determined by the medium's compressibility, shear modulus and density. The speed of shear waves is determined only by the solid material's shear modulus and density.

In fluid dynamics, the speed of sound in a fluid medium (gas or liquid) is used as a relative measure for the speed of an object moving through the medium. The ratio of the speed of an object to the speed of sound in the fluid is called the object's Mach number. Objects moving at speeds greater than Mach1 are said to be traveling at supersonic speeds.

Mechanism which causes the collapse of interstellar gas clouds and subsequent star formation.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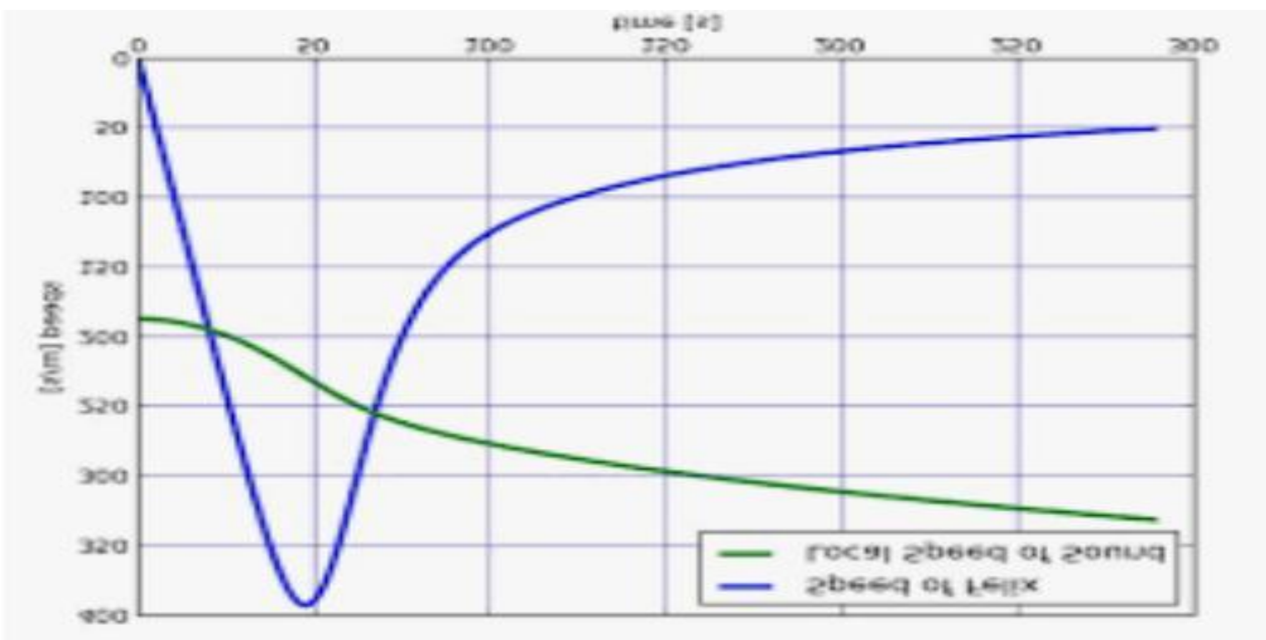
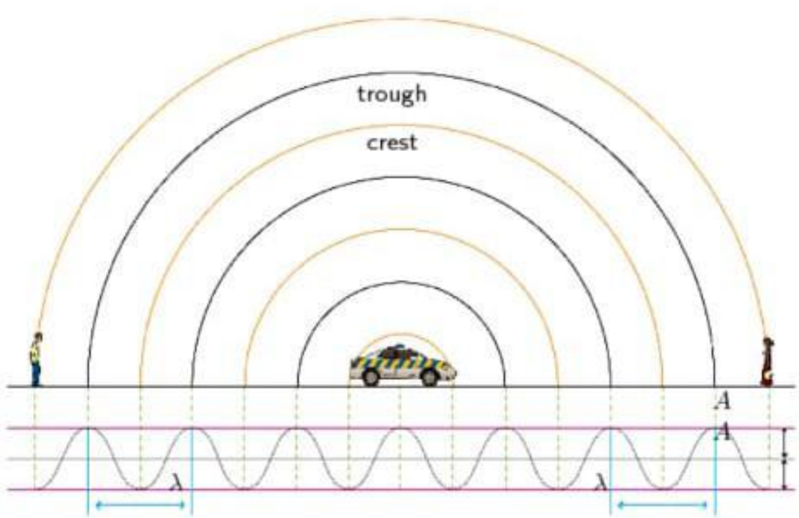

Local Speed of Sound
Speed of Felix

Characteristics

- The speed of sound is a term used to describe the speed of sound waves passing through an elastic medium.
- The speed varies with the medium employed (for example, sound waves move faster through water than through air), as well as with the properties of the medium, especially temperature.
- The term is commonly used to refer specifically to the speed of sound in air.
- At sea level, at a temperature of 21 degrees Celsius (70 degrees Fahrenheit) and under normal atmospheric conditions, the speed of sound is 344 m/s (1238 km/h or 770 mph).
- The speed varies depending on atmospheric conditions; the most important factor is the temperature.
- Humidity has little effect on the speed of sound, nor does air pressure by itself.
- Air pressure has no effect at all in an ideal gas approximation.
- This is because pressure and density both contribute to sound velocity equally, and in an ideal gas the two effects cancel out, leaving only the effect of temperature.
- Sound usually travels more slowly with greater altitude, due to reduced temperature.

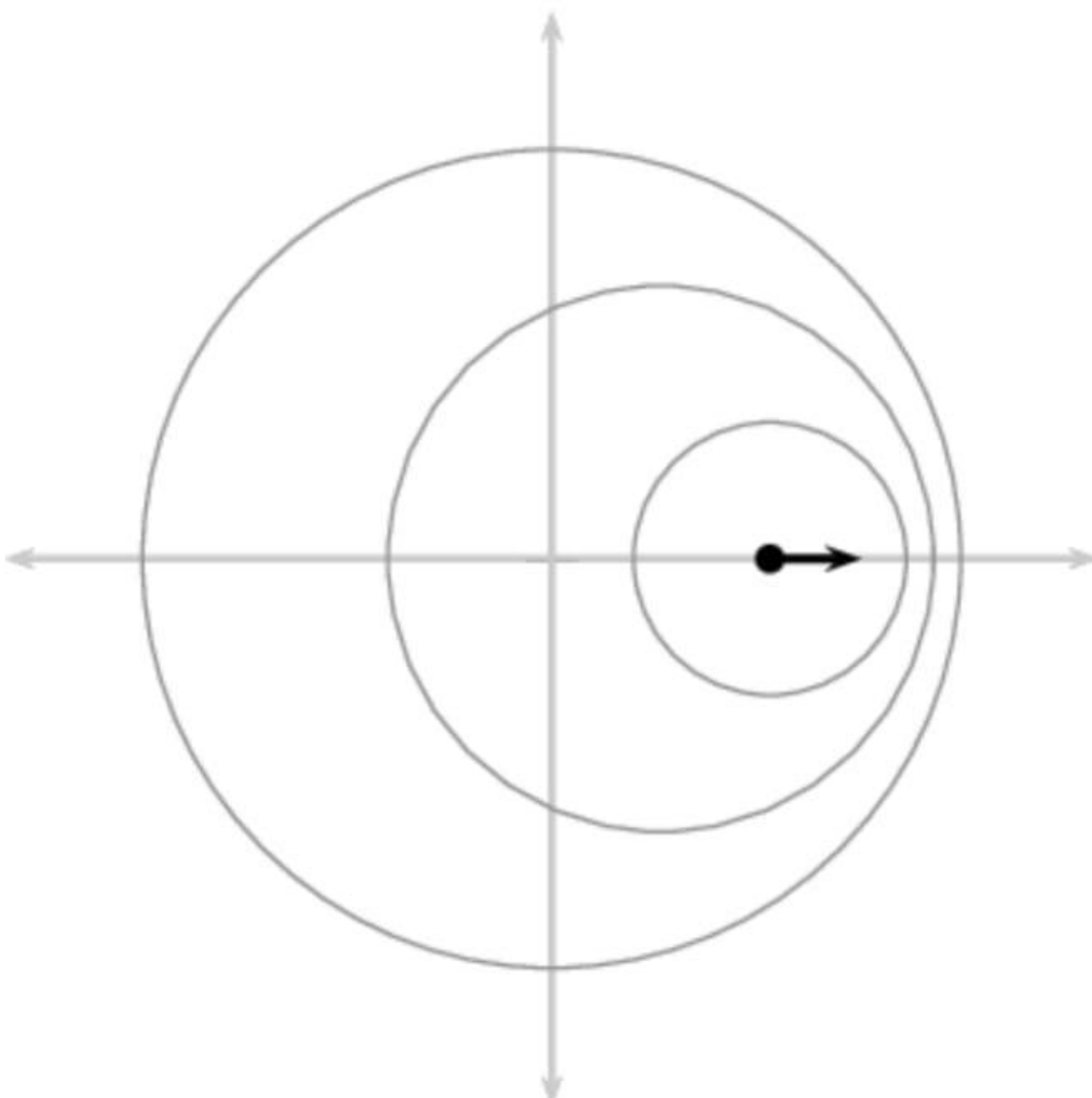
Doppler's effect of sound waves

The **Doppler effect** (or the **Doppler shift**) is the change in frequency of a wave in relation to an observer who is moving relative to the wave source. It is named after the Austrian physicist Christian Doppler, who described the phenomenon in 1842.

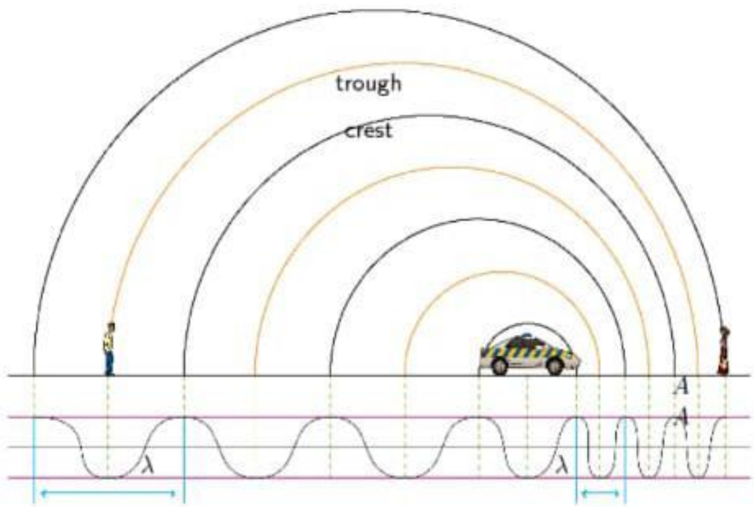


A common example of Doppler shift is the change of pitch heard when a vehicle sounding a horn approaches and recedes from an observer. Compared to the emitted frequency, the received frequency is higher during the approach, identical at the instant of passing by, and lower during the recession.

The reason for the Doppler effect is that when the source of the waves is moving towards the observer, each successive wave crest is emitted from a position closer to the observer than the crest of the previous wave. Therefore, each wave takes slightly less time to reach the observer than the previous wave. Hence, the time between the arrivals of successive wave crests at the observer is reduced, causing an increase in the frequency. While they are traveling, the distance between successive wave fronts is reduced, so the waves "bunch together". Conversely, if the source of waves is moving away from the observer, each wave is emitted from a position farther from the observer than the previous wave, so the arrival time between successive waves is increased, reducing the frequency. The distance between successive wave fronts is then



increased, so the waves "spread out".

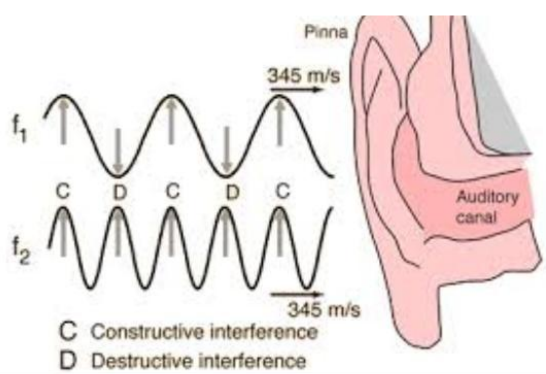


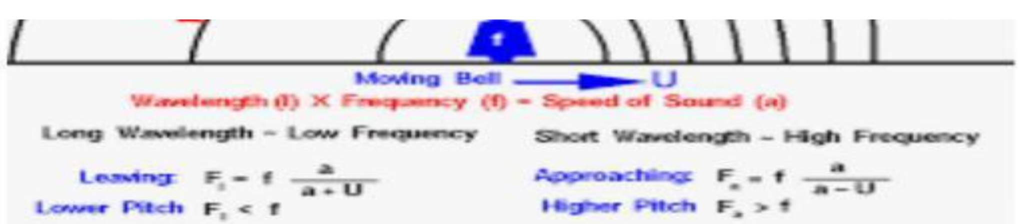
For waves that propagate in a medium, such as sound waves, the velocity of the observer and of the source are relative to the medium in which the waves are transmitted. The total Doppler effect may therefore result from motion of the source, motion of the observer, or motion of the medium. Each of these effects is analyzed separately. For waves which do not require a medium, such as light or gravity in general relativity, only the relative difference in velocity between the observer and the source needs to be considered.

Q No: Write down Beats phenomenon and coupled Oscillations.

<u>Beats phenomenon</u>

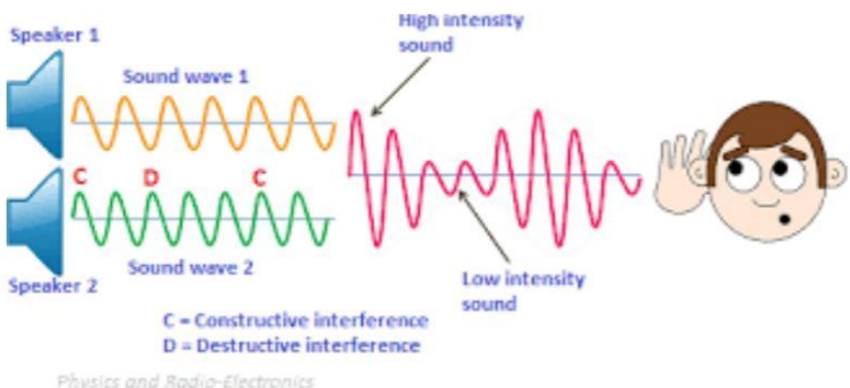
The classical beat phenomenon has been observed in most combined structure-liquid damper systems. The focus of this paper is to provide a better understanding of this phenomenon, which





Doppler Effect

is caused by the coupling that is introduced through the mass matrix of the combined system. However, beyond a certain level of damping in the secondary system (liquid damper), the beat phenomenon ceases to exist. This is due to coalescing of the modal frequencies of the combined system to a common frequency beyond a certain level of damping in the secondary system. Numerical and experimental results are presented in this paper to elucidate the beat phenomenon in combined structure-liquid damper systems.



In acoustics, a **beat** is an interference pattern between two sounds of slightly different frequencies, perceived as a periodic variation in volume whose rate is the difference of the two frequencies.

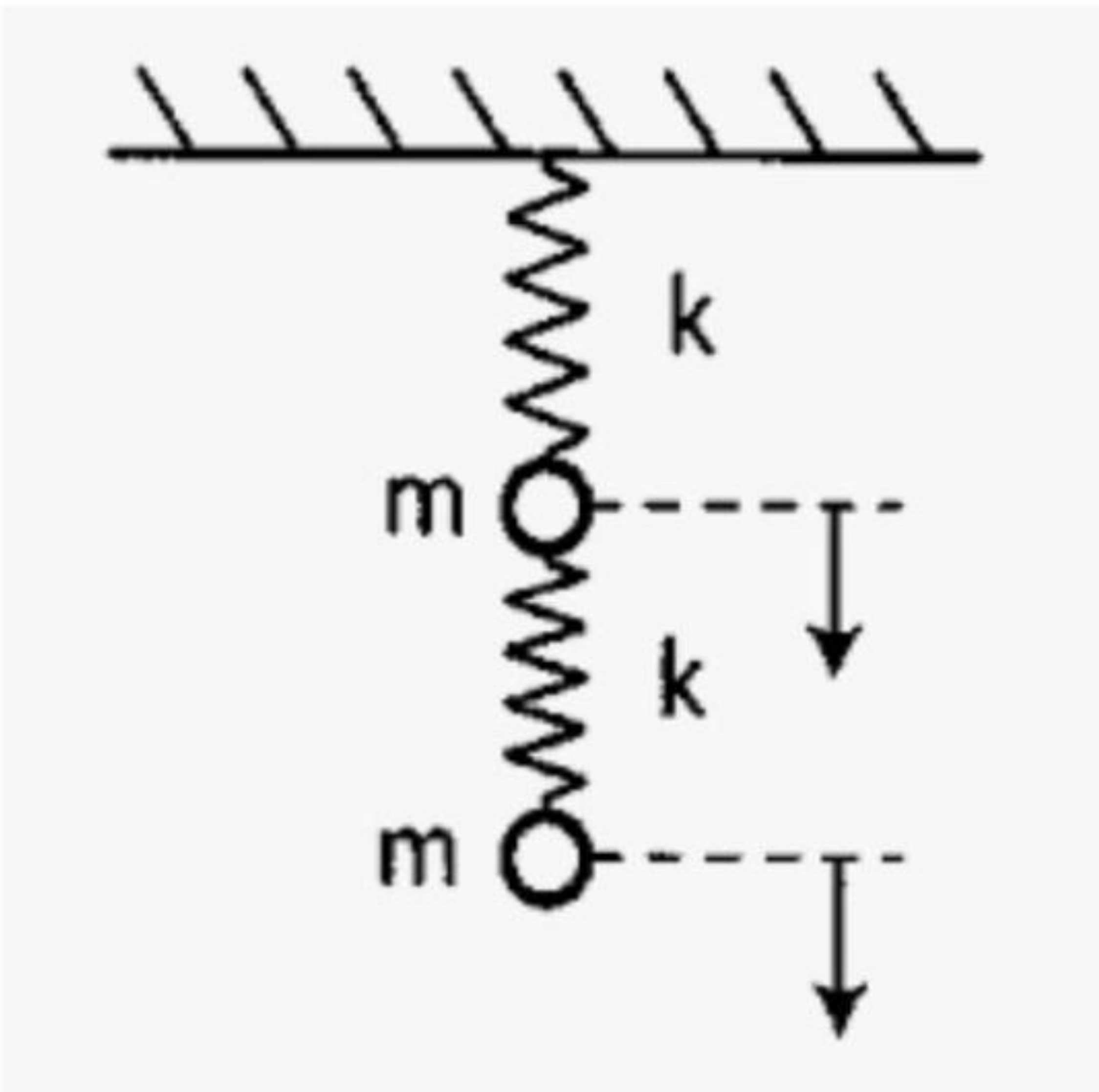
With tuning instruments that can produce sustained tones, beats can be readily recognized. Tuning two tones to a unison will present a peculiar effect: when the two tones are close in pitch but not identical, the difference in frequency generates the beating. The volume varies like in a tremolo as the sounds alternately interfere constructively and destructively. As the two tones gradually approach unison, the beating slows down and may become so slow as to be imperceptible. As the two tones get further apart, their beat frequency starts to approach the range of human pitch perception, the beating starts to sound like a note, and a combination toniest produced. This combination tone can also be referred to as a missing fundamental, as the beat frequency of any two tones is equivalent to the frequency of their implied fundamental frequency.

Coupled Oscillation's

Coupled oscillators are oscillators connected in such a way that energy can be transferred between them. The motion of coupled oscillators can be complex, and does not have to be periodic. ... A solid is a good example of a system that can be described in terms of coupled oscillations.

Coupled Oscillations occur when two or more oscillating systems are connected in such a manner as to allow motion energy to be exchanged between them. Coupled oscillators occur in nature (e.g., the moon and earth orbiting each other) or can be found in man-made devices (such as with the pacemaker).

Consider two identical cart masses connected in motion by springs (two end springs, one middle spring). The photo's above were taken when the carts were oscillating in their normal modes (i.e., the symmetric mode and the antisymmetric mode). Normal modes occur when both carts oscillate at the same frequency. You can see a video of these normal mode oscillations by



clicking on each of the photo's above.