University of Mosul

College of Science

Department of Physics

Second stage

Lecture 13

Sound and wave Motion

2024-2025

Lecture 13: Forced frequency and resonance

Preparation

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Forced frequency and resonance

Resonance is an event that occurs when the natural frequency of a system matches the frequency of the impacting force wave, causing massive vibrations.

Resonance condition The frequency of the external force is equal to the natural frequency of the vibrating body..

Resonance Result: The amplitude of the vibration increases to the maximum possible extent.

simulated resonance

Warning of resonance phenomenon

1-Buildings and bridges collapse as a result of the frequency of wind or earthquakes matching the frequency of the bridges.

2-Shattering of glass or ceramic vessels as a result of the compatibility ofthe frequency of the external force with the frequency of the vessel material.

Q1) Explain: Soldiers are advised when walking on a bridge to walk randomly and irregularly.

To prevent the frequency of footsteps from matching the natural frequency of the bridge, resonance occurs, increasing the amplitude of the vibration and ultimately leading to the collapse of the bridge.

Q2) Why are pushes on a swing given at certain regular intervals more effective than if given randomly during the swing cycle?

When the frequency of the payments is equal to the frequency of the vibration, resonance occurs and the amplitude of the vibration increases to the maximum.

Q3) What would happen if a vibrating tuning fork was placed near another tuning fork of the same frequency?

Since the two frequencies are equal, resonance occurs and the second fork begins to vibrate.

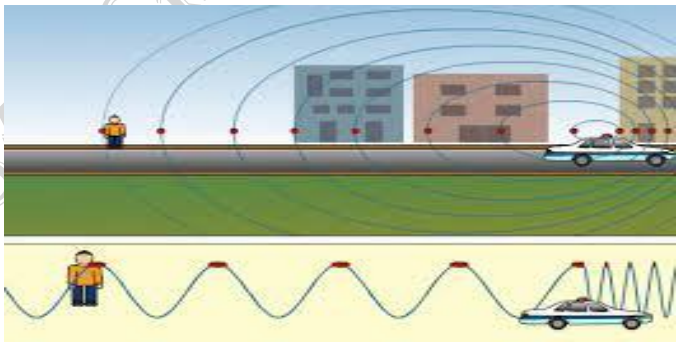
Q4 A tuning fork vibrating at a certain frequency is placed on a table without touching anything, causing a cup and another fork to vibrate. What is the reason for this?

Because they have the same natural frequency, resonance occurred and it began to vibrate.

Doubler Effect

Doppler effect: It is the change in frequency or wavelength as a result of the movement of the source towards or away from the listener

Relative motion: means the occurrence of proximity or distance between the source and the observer.



Comments:

1.In the case of getting closer, the frequency of the sound increases and its degree increases $f>f$.

1. In the case of distance, the frequency of the sound decreases and its degree decreases $f_{\text{person}} < s_{\text{ource}}$.

2. The frequency of the source is equal to the frequency that reaches the observer in two cases.

- The source and listener do not move (static).
- The source and the listener move at the same speed and in the same direction.

* The greater the relative speed between the source and the listener, the greater the frequency difference.

* Doppler phenomenon is a general wave phenomenon that occurs for all types of waves (sound, light, ...,).

Q1) The waves emanating from the ambulance, emitting a siren, and travelling along the road at a constant speed are illustrated in the accompanying graph. When placed on the same road, individuals (A) and (B) act as observers. While the vehicle is in motion, please respond to the following inquiries:

a. Determine the direction of movement of the ambulance concerning the observers.
b. Which observer will hear the whistle louder? Why?
c. Compare the wavelength of sound arriving at each of the observers.

a b

the solution:

a. in the direction of B. (because the frequency at B is greater as it appears from the figure)
b. (B), because the source of the sound gets closer to it, so the frequency increases and the pitch increases.
c. $\lambda_a > \lambda_b$ becuse of $f_b > f_a$