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8.01 Physics I: Classical Mechanics, Fall 1999
Transcript – Lecture 23

The speed of sound is 340 meters per second--

it depends a little bit on the temperature--

about 770 miles per hour.

When I speak to you, my sound reaches you with that speed.

I produce a certain frequency here, a certain number of oscillations per second.

They reach you, your eardrum starts to oscillate with the same frequency and you hear that tone.

I have here a tuning fork which oscillates 440 times per second.

[tuning fork produces medium-pitched tone]

Your eardrum oscillates 440 times per second--

you hear this tone.

Here I have 256 oscillations per second.

[metal rod emits lower tone]

Your eardrum is now shaking, going back and forth 256 times per second.

If you stay where you are and you don't move and I move these tuning forks, you will hear a different frequency and that's what we call Doppler effect.

If my sound source approaches you, you will hear a frequency f prime which is larger than the frequency of the tuning fork.

If it moves away from you, which I will call receding, then f prime equals lower... lower frequency.

For instance, I move to you a sound source--

I call that a transmitter--

with a speed of about one meters per second.

Transmitter is the sound transmitter.

Then if it approaches you here, you will hear f prime, which is 1.003 times f.

This three here is the one part out of 340 that you get an increase in frequency.

If I move it away from you, then f prime would be 0.997 times the frequency of the source itself.

You stay where you are.

I have here a tuning fork which generates 4,000 hertz, a very high frequency.

If I move it to you with the speed of one meter per second, which I can do, then you get an increase in pitch of 0.3%.

That makes it 4,012 hertz.

And when I move it away from you there is a decrease of 0.3%.

And you can clearly hear that difference.

I will first make you listen to the 4,000 hertz without my moving.

[tuning fork produces very high pitched tone]

Can you hear it? Very high frequency.

Is it painful, really? High frequency.

Most of you are young enough you should be able to hear 4,000 hertz.

Okay, now I am going to move it to you one meter per second and away from you.

[high tone goes up and down slightly in pitch]

Did you hear it? Once more.

[tone goes up and down quickly again]

[class laughs]

When it comes to you, it's clear that the frequency goes up, and when it moves away from you, the frequency is down.

Now imagine that I'm going to rotate the sound source around in a circle.

Now the sound that you receive, the frequency that you receive will change in a sinusoidal fashion.

If this is that circle, and this is the radius of that circle, and if you are here in the plane of the circle, then when the source comes straight to you with the velocity v-- let's say it's a uniform circular motion--

f prime will be larger than f and it will, in this case, reach a maximum.

When it is at 90 degrees relative to you--

I don't have to give it a vector notation--

f prime equals f.

When it moves away from you, f prime is smaller than f, you hear a minimum.