EXPERIMENT NUMBER 10

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SEMESTER - 2ND
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SUBJECT – QUANTUM. & SEMICONDUCTOR PHYSICS LAB

AIM OF THE EXPERIMENT

TO CALCULATE CHANGE IN FREQUENCY IN FREQUENY OF SOUND EMITTED BY SOURCE MOVING RELATIVE TO OBSERVER USING DOPPLER EFFECT.

APPARATUS-

Source, Detector/Observer.

THEORY :

Doppler Effect is the change in frequency of electromagnetic waves due to the relative motion between source and observer. The effect was first observed by Christian Doppler in 1842. The effect is used to measure velocities usually by reflection of a transmitted wave from the moving objects like galaxies (red shift), radar for speeding cars and thunderstorms, etc.

It is commonly observed when a vehicle with sounding a siren approaches, passes and recedes from an observer. The received frequency is higher during its approach, identical at the instant of passing and is lower in recession. The relative increase in frequency is explained as given. As the source moves toward the observer, there forms a compression of waves between the source and the observer reducing its length which in effect increases the frequency.

For waves that propagate in a medium like sound waves, the velocities of the observer and the source are relative to the medium in which the waves are transmitted. Therefore the total Doppler Effect is the result of motion of source, observer or medium. Each of these effects can be analyzed separately.

The apparent frequency observed by the observer is,

$$f = f_0 \frac{v + v_o}{v - v_s} \qquad (1)$$

f =apparent frequency,
f_0 = frequency of the source,
v = velocity of sound,
v0 = velocity of the observer and
v s = velocity of source.
The choice plus (+) or minus (-) sign is according to the convention that if the source and observer are moving towards the perceived frequency (f) is higher than the original frequency (f0), using eq (1). In a similar way, if the source and observer are moving away the perceived frequency (f) is lower than the original frequency (f0), see eq (2).

$$f = f_0 \frac{v - v_o}{v + v_s}$$

The Doppler Effect for light waves is commonly expressed in terms of colors rather than frequency. A red shift occurs when the source and observer are moving away each other and a blue shift occurs when the source and observer are moving towards each other.

DIAGRAM:

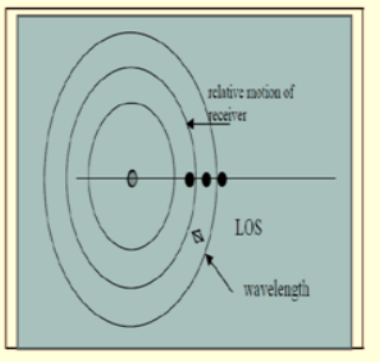


Figure 1

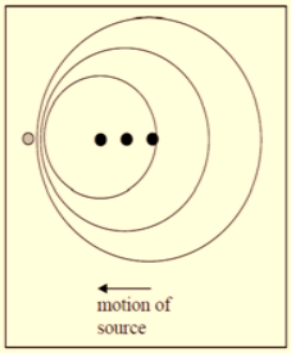
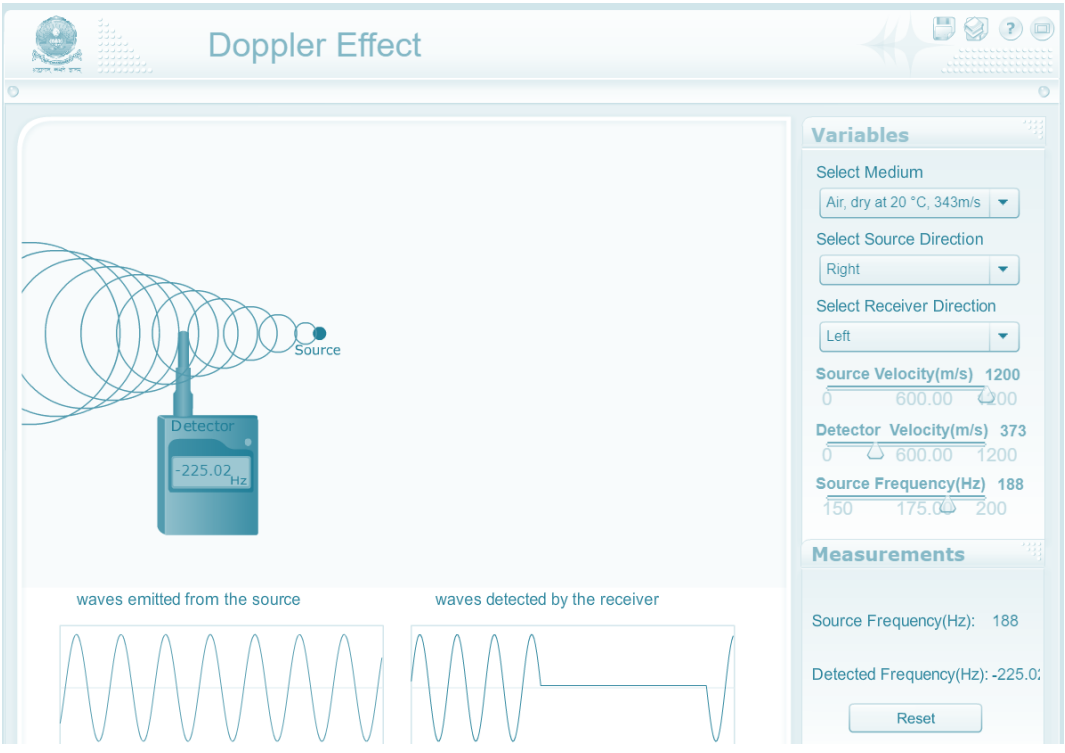


Figure 2

CIRCUIT DIAGRAM:



FORMULA USED

Moving towards the source $f = f_0 \frac{v + v_o}{v - v_s}$

Moving away from source $f = f_0 \frac{v - v_o}{v + v_s}$

PROCEDURE:

1. Click the start button.
2. Click on the drop down combo box for selecting the medium.
3. Select the detector direction and source direction from the drop down combo box.
4. The velocity of the source and observer are adjusted by clicking on the slider.
5. The frequency of the source is adjusted by clicking on the slider.
6. The detected frequency can be calculated using the equation (1).
7. The reset button reset all the default values.
8. The user can do the experiment with another set of values.

Select medium: Air/Glass/Steel/Water

Select source direction: Left/ Right

Select receiver direction: Left/ Right

OBSERVATIONS

Selected medium: Air, dry at 20°C
Velocity of sound = 343 m/s

S. No.	Direction	Source Velocity (V_s) m/sec	Detector Velocity (V_o) m/sec	Source Frequency (f_o) Hz	Detected Frequency (f) Hz
1.	Towards the Source	234	145	164	723.96
2.	Away from the Source	234	145	164	37.15

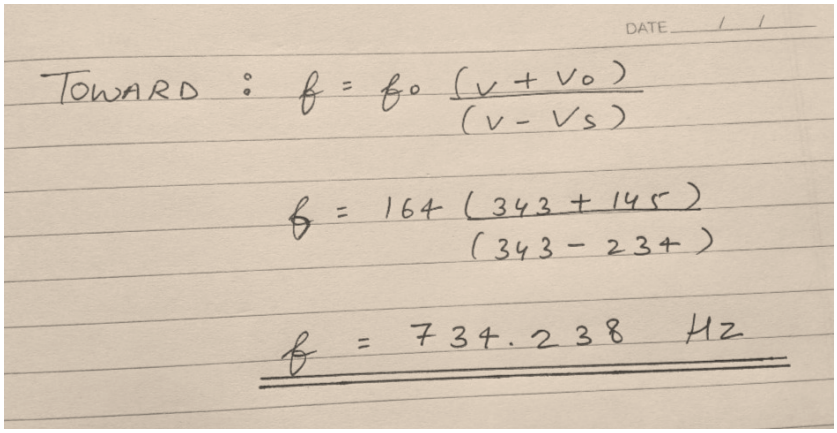
CALCULATIONS

Formula Used

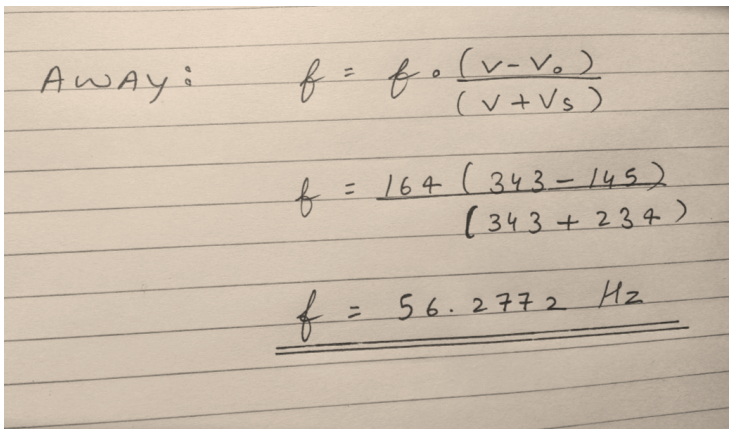
Moving towards the source $f = f_0 (v + v_0)/ (v – v_s)$

Moving away from source $f = f_0 (v - v_0)/ (v + v_s)$

For Towards the Source:



Away from the Source:



1. SOURCES OF ERROR

2. Base frequency should match with sound source.
3. Too small frequency range (the movement is so fast that the frequency shifts more than expected) or noise from the movement.

RESULTS AND DISCUSSION

MOVING TOWARDS THE SOURCE
f = 734.238 Hz

MOVING AWAY FROM THE SOURCE

f =56.2772Hz

Doppler Effect is the change in frequency of electromagnetic waves due to the relative motion between source and observer. The effect is used to measure velocities usually by reflection of a transmitted wave from the moving objects like galaxies (red shift), radar for speeding cars and thunderstorms, etc. It is commonly observed when a vehicle with sounding a siren approaches, passes and recedes from an observer.

LEARNING OUTCOMES

It will provide the modest experience that allows students to develop and improve their experimental skills and develop ability to analyze data.

Ability to demonstrate the practical skill on measurements and instrumentation techniques of some Physics experiments. Students will develop the ability to use appropriate physical concepts to obtain quantitative solutions to problems in physics.

Students will demonstrate basic experimental skills by setting up laboratory equipment safely and efficiently, plan and carry out experimental procedures, and report verbally and in written language the results of the experiment.

Students will develop skills by the practice of setting up and conducting an experiment with due regards to minimizing measurement error.

EVALUATION COLUMN (To be filled by concerned faculty only)

Sr. No.	Parameters	Maximum Marks	Marks Obtained
1.	Post Lab Quiz Result.	5	
2.	Worksheet completion including writing learning objectives/Outcomes.(To be submitted at the end of the day)	10	
3.	Student Engagement in Simulation/Demonstration/Performance and Controls/Pre-Lab Questions.	5	
4.	Total Marks	20	