Report on Measuring Sound and Deriving Equations for Torque and Inertia

# Introduction

This report explores the principles of measuring sound to determine changes in frequency and speed, particularly as sound waves move through different mediums. Additionally, it discusses the derivation of equations for torque and inertia, and the procedure for plotting related variables in a lab setting.

# Measuring Sound to Determine Changes in Frequency

## Frequency and Mediums

Frequency Consistency: When sound waves transition from one medium to another, the frequency remains constant. This is because the frequency of a sound wave is determined by the source and is independent of the medium.

Speed and Wavelength Changes: Although frequency remains unchanged, the speed and wavelength of sound can vary with the medium. The relationship is defined by the equation:

$\lambda = \frac{v}{f}$

where λ is the wavelength, v is the speed of sound, and f is the frequency.

## Doppler Effect

The Doppler Effect describes the change in frequency or wavelength of a wave in relation to an observer moving relative to the wave source. Changes in the medium's density can also affect sound speed, altering the frequency and indicating relative motion.

# Deriving Equations for Torque and Inertia

## Torque, Inertia, and Angular Acceleration

The relationship between torque (τ), inertia (I), and angular acceleration (α) is given by:

$\tau = I \alpha$

## Example Derivation

1. Start with the basic equation:

$\tau = I \alpha$

2. Assume a generic inertia formula:

$I = mR^2$

where m is mass and R is the radius.

3. Substitute the inertia formula:

$\tau = mR^2 \alpha$

4. Isolate mass (m) if plotting mass against angular acceleration:

$m = \frac{\tau}{R^2 \alpha}$

5. Linearizing the equation:

$\begin{aligned} &m = \left( \frac{\tau}{R^2} \right) \frac{1}{\alpha} \\ &\text{Here, the slope (M) of the linear graph is:} \\ &\text{slope} = \frac{\tau}{R^2} \end{aligned}$

6. Plotting:

$\begin{aligned} &\text{Plot m on the vertical axis and } \frac{1}{\alpha} \text{ on the horizontal axis.} \\ &\text{The slope of the linear graph should match } \frac{\tau}{R^2}. \end{aligned}$

# Lab Expectations

For Lab 11, ensure the following:

- \*\*Graphs:\*\* Submit all required graphs, including both original and linearized versions.

- \*\*Proofs:\*\* Include detailed proofs for the relationship between torque and radius for each run.

- \*\*Analysis:\*\* Validate that the sum of torques equals zero for all experiments.

# Conclusion

This report summarized the principles of measuring sound to determine changes in frequency and speed in different mediums, explained the Doppler Effect, and provided a detailed derivation of equations for torque and inertia. Proper understanding and execution of these concepts are crucial for accurate measurement and analysis in physics experiments.