#8 The Ratio of Heat Capacities, Cp/Cv, of Air

Pre-Lab Report

Lab section:

Name & Surname:

Table #:

***Before the Lab** complete this page YOURSELF! Hand it in in the first 5 min. of the session PERSONALLY!*

You MUST justify your answers and show all steps. NO COPYCAT answers, or NO credits!

Please read the relevant presentation on PHYS LAB Website.

Q1. Adiabatic process can be described by the equation: $P.V^{\gamma} = C$ where C is for constant. Take the differential of both sides and consult the relations in your book to get the following relation. **Show your formulae / derivation below explicitly or no credits!**

$$\gamma = 4\pi^2 \frac{MV}{A^2 P T^2}$$

(2nd Question is on the next page!)

Q2. Show the Dimensional **Analysis** of γ. **Show your formulae / derivation below explicitly or no credits!**

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Lab Report

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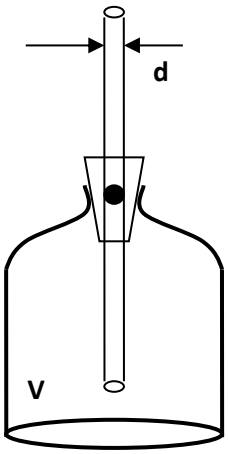
Complete this report YOURSELF except DATA taking parts! Use a pencil for plots only and a pen for the rest! **Show your work clearly, NO COPYCAT analysis allowed, or NO credits!**

OBJECTIVE : To determine the ratio of the specific heats of air, Cp / Cv.

THEORY : We can determine the ratio of the heat capacities air in a glass vessel by observing the oscillation of a steel ball inside the glass tube attached to the top of the glass bottle.



The pressure inside the bottle is given by:

$$P = p_o + \frac{Mg}{a}$$

where p_0 is the atmospheric pressure and M is the mass of the steel ball. This is the case when the ball is in equilibrium and it closes the opening completely but can move up and down easily. When the ball is disturbed away from the equilibrium position by an infinitesimal amount, dx, there will be a change in the pressure Δp. This change in the pressure applies a net force causing the ball to accelerate:

$$A\Delta P = M\frac{d^2x}{dt^2}$$

where A is the cross section of the glass tube. Changes in the pressure can be considered adiabatic, so that

$$PV^{\gamma} = cons.$$

where γ is the ratio of the specific heats. Through differentiation of this expression and using the expression for the volume change as Ax, we can show that the equation of motion can be expressed as:

$$\frac{d^2x}{dt^2} + \frac{\gamma PA^2}{MV}x = 0$$

where V is the volume of the bottle. Then the period of oscillations can be given as

$$T = 2\pi\sqrt{\frac{MV}{\gamma PA}}$$

and

$$\gamma = 4\pi^2 \frac{MV}{A^2 PT^2}$$

By measuring all the quantities on the right you can determine the ratio of the specific heat of air.

APPARATUS: Cp/CV apparatus and a stopwatch.

PROCEDURE :

After cleaning the inside of the tube and the steel ball, drop the ball into the tube. Start the time when the ball is at its lowest position and determine the total time for as many oscillations as possible as long as the amplitude of the oscillation is greater than 2-3 cm.

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DATA:

Description / Symbol		Value & Unit
cm Hg	h =	.....
Density of Mercury	ρ =	13.6 g / cm^3
Acceleration due to gravity	g =	.....
Flask Number	N =	.....
Volume of the Flask	V =	.....
Diameter of the ball	D =	.....
Mass of the ball	m =	.....

# of Trials	# of Oscillations *(n)*	Time for n Oscillations *t* ( )	Time for One Oscillation (Period) *T* ( )
1			
2			
3			
4			
5			

4

CALCULATIONS:

Description	Symbol	Calculations (show each step)	Result
Radius of the ball	R =	. . . . .	. . . . .
Cross sectional Area of the precision tube	A =	. . . . .	. . . . .
Atmospheric Pressure	P_o =	$\rho g h$ = ...	. . . . .
Pressure inside the bottle at Equilibrium Position of the Ball	$P_e = P_o + \frac{mg}{A}$ =	. . . . .	. . . . .

Description	Symbol	Calculations (show each step)	Result
Average Period	$T_{average}$ =	. . . . .	. . . . .
		. . . . .	
Ratio of Heat Capacities	$\gamma = C_p / C_v$ =	. . . . .	. . . . .

Consult to the resources for this experiment from PHYS LAB Website:

PHYL102 Intro

Presentation #7

PHYL102 Lab Book