

EXP.1: The Ratio of Heat Capacities, C_p/C_v , of Air

Lab Report

Complete this report YOURSELF except DATA taking parts! This report will not be submitted (except the very last page), but you should carefully complete it as preparation for the applied exam.

Suggested Pre-Lab Question

Q1. Adiabatic process can be described by the equation: $P \cdot V^\gamma = C$ where C is for constant. Take the differential of both sides and consult the relations in your book to get the following relation.

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

1

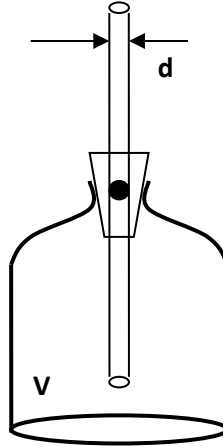
Q2. Show the Dimensional Analysis of γ . Show your formulae / derivation below explicitly or no credits!

EXP.1: The Ratio of Heat Capacities, C_p/C_v , of Air

Experiment

OBJECTIVE : To determine the ratio of the specific heats of air, C_p / C_v .

THEORY : We can determine the ratio of the heat capacities of 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.



2 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 pressure can be considered adiabatic, so that

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

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:

$$\frac{d^2x}{dt^2} + \frac{\gamma P A^2}{mV} x = 0$$

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

EXP.1: The Ratio of Heat Capacities, C_p/C_v , of Air

$$T = 2\pi \sqrt{\frac{mV}{\gamma P A^2}}$$

and

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

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



APPARATUS: C_p/C_v 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.

EXP.1: The Ratio of Heat Capacities, C_p/C_v , of Air

DATA:

Description / Symbol

Value & Unit

Height in the mercury

barometer $h =$

Density of Mercury $\rho =$ 13.6 g / cm³

Acceleration

due to gravity $g =$

Flask Number $N =$

Volume of the Flask $V =$

Diameter of the ball $D =$

Mass of the ball $m =$

4

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

EXP.1: The Ratio of Heat Capacities, C_p/C_v , of Air

CALCULATIONS:

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

5

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

Post-Lab Report

Aim of the experiment:

Suggestions for possible solutions to the problems experienced during the experiment:

Conclusion:

6 I have completed this experiment myself as specified in the lab sheet and as explained by the lab instructor.

Name & Surname:

Student ID:

Lab Section:

Table #:

Date:

Signature of the
student

As the instructor of this Lab Section I confirm that the student has participated in and completed this experiment on time.

Stamp of the PHYS
Labs and signature of
the instructor

This page serves as proof of the fact that the student participated in and completed the experiment, only if it is submitted in time and accepted by the Lab instructor. The student and the instructor shall sign it along with the stamp of the Physics Laboratories.