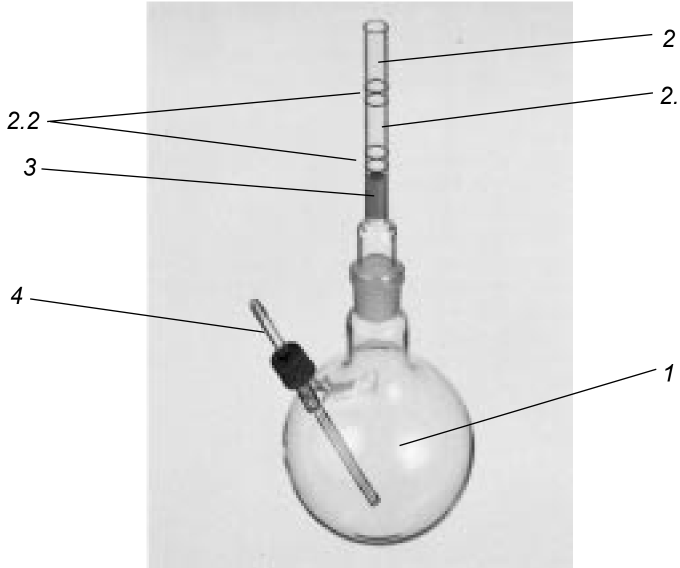
Gas oscillator, Flammersfeld

04368.00

Operating Instructions



1 PURPOSE

Gas oscillator 04368.00 (fig. 1) is used to measure the adiabatic coefficient $\kappa = C_p/C_V$ of gases and to introduce the concept of entropy.
The device can be used for demonstration experiments or for laboratory work.

2 METHOD OF MEASUREMENT

A body which can move and which constitutes the upper seal of a vertical precision tube, closing off a volume of gas beneath itself, will rise within the tube when gas is introduced into the system, due to the resulting overpressure beneath the body. If the rising body uncovers a vent in the tube, gas may escape and the body will fall closing the vent again. If gas is fed continuously to the system, the body will raise and fall periodically in the tube. If the gas feeding rate is set in such a way that the unavoidable loss of gas due to the clearance between the body and the side of the tube is compensated for, an undamped adiabatic oscillation occurs. The adiabatic coefficient can be calculated with the help of the period T:

$$\kappa = \frac{C_p}{C_V} = \frac{4\ mV}{T^2\ p\ r^4}$$

where

m = mass of the oscillating body
r = radius of the oscillating body
V = system volume
p = exterior air pressure

3 DEVICE INFORMATION

3.1 Description

Gas oscillator 04368.00 (fig. 1) consists of a standing round glass flask *1*, a precision glass tube *2*, a cylindrical oscillating body *3* and a gas feeding tube *4*.
Both the flask and the tube have NS 29/32 standard ground joints.
Precision glass tube *2* is provided with a slanting vent *2.1* (vent valve). Four annular marks *2.2* are distributed symmetrically about this vent to control the amplitude of the oscillating body *3*.
Gas feeding tube *4*, set gas tight into the inclined sleeve of the glass flask by means of a screwing connector cap GI 18, is fitted with an olive which is suitable for use with 7 mm flexible tubing.

3.2 Specifications

Precision glass tube	di = 12 ± 0.01 mm
Oscillating body	d = 11.90 ± 0.04 mm
System volume (up to the vent)	approx. 1.13 dm^3

4 HANDLING

4.1 Preparing the device

Before assembling the device, please check that all components are free of dust, clean and dry.
The oscillating body is rubbed with graphite (e. g. a soft pencil) in order to avoid electrostatic loads, but is not yet introduced into the tube.
The vent must be completely open.
The precision glass tube must be secured at the standard ground joint by means of a securing clamp (43611.00).
The gas feeding tube is introduced into the glass flask through the hole in the screw cap connector until its end is about 5 mm above the bottom of the flask; it is then secured by tightening the screw cap.

4.2 Set-up

To set up the experiment, the gas oscillator is held by a universal clamp at its standard ground joint and fixed to a support as shown in fig. 2. To carry out measurements, the precision glass tube must be in an exact vertical position. The fork light barrier gives off an impulse every time the oscilla-

ting body interrupts the light beam. The number of impulses is counted during a given period of time by means of a digital counter. The height of the light barrier must be set so that counting occurs just below the upper turning point, in order to avoid double counts.
The pressure cartridge containing the gas used for measurement must be connected to the gas oscillator over a reducing valve.

4.3 Measuring κ

A slight gas flow is set, the oscillating body is carefully let into the precision tube and the gas flow is varied until the body oscillates symmetrically around the vent. The blue annular control marks help to determine whether the oscillation is symmetric.
Time *t* for a large number of oscillations is measured and used to calculate period *T*.

Data of the oscillating body, volume *V* of the oscillator (up to the vent) and ambient air pressure *p* must be known in order to determine the adiabatic coefficient:

$$\kappa = \frac{64\, mV}{T^2\, p\, d^4}$$

The diameter d of the oscillating body must be determined very precisely (e. g. using a micrometer), as the fourth power of this value is involved. The actual local pressure must be entered for *p*, such as given by a mercury barometer.

Example of measurement for nitrogen (N_2):
t = 503.9 s for 1446 impulses
T = 0.3485 s
$d_{oscillator}$ = 11.91 mm
$m_{oscillator}$ = 4.7617 g
V = 1.133315 dm^3
p = 987.8 mbar (1 mbar = 10^2 kg m^{-1} s^{-2})
Using the equation above, this allow to calculate κ = 1.40.

4.4 Maintenance

The gas oscillator requires no particular maintenance. However, two points must be taken into account to increase the lifetime and keep the device in good conditions:

1. Only set down the precision glass tube on a soft surface to avoid breakage (the vent acts as a controlled breaking point).
2. Do not drop the oscillating body, because this may modify its surface.

5. LITERATURE

Experimental units in Physics,
Thermodynamics 1 16300.01
University laboratory work in Physics 16502.01

6. ACCESSORIES

Complete accessory requirements for set-up shown in fig. 3:

Gas oscillator		04368.00
"PASS" support		02002.55
"PASS" support rod, 400 mm		02026.55
"PASS" double clamp	(2 x)	02040.55
Universal clamp with articulation		37716.00
Fork light barrier		11207.02
Electronic digital counter, 4 decades		13600.93
Demonstration stop chronometer		03074.00
Fine regulating valve for pressure flasks		33498.00
Flexible rubber tube, di = 4 mm		39280.00
Communicating tubes (3 x)		

Gases, e. g.:

Pressure flask, CO2	41772.06
Pressure flask, He	41772.03
Pressure flask, N2	41772.04