Densidade, Pressão, Empuxo

Densidade

densidade de massa $\rho = m / V$

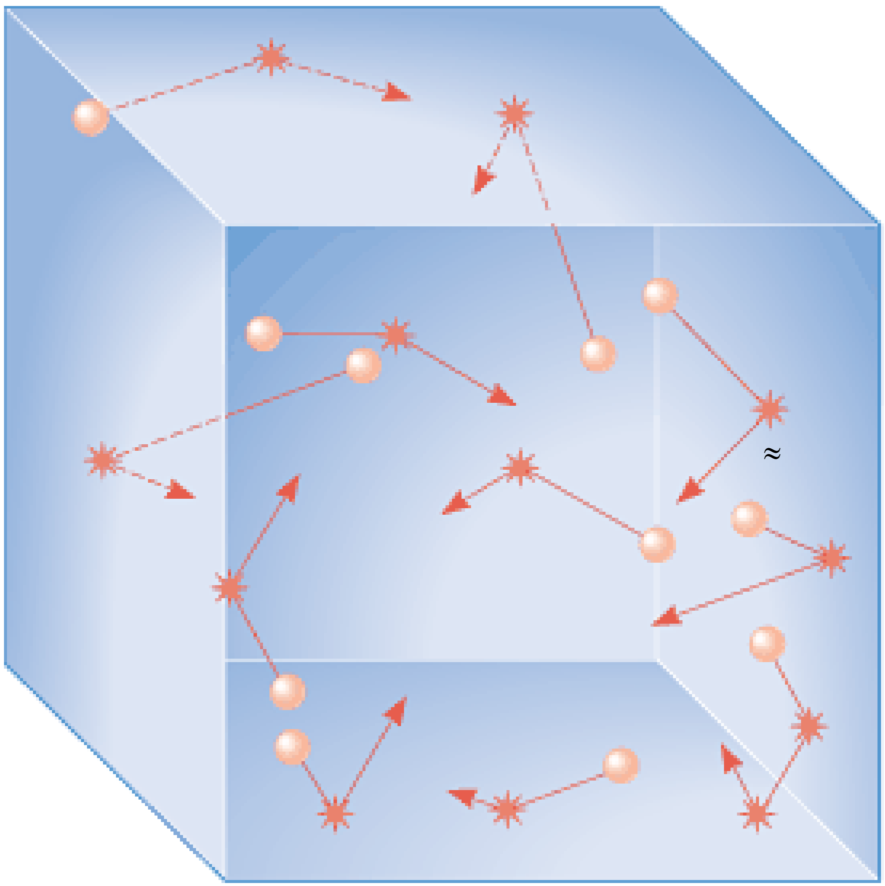
densidade de partículas $n = \#\,\text{de partículas} / V$

volume molar $V_m = V / N_a$

concentração

Propriedade (macroscópica) característica da substância.
(Mas depende da temperatura.)

Substância	densidade (kg/m^3)
Sólidos	
Aluminio	2700
Ouro	19300
Madeira	550
Líquidos	
Óleo	800
Água (4 °C)	1.000×10^3
Gáses	
ar	1.29
hidrogênio	0.0899

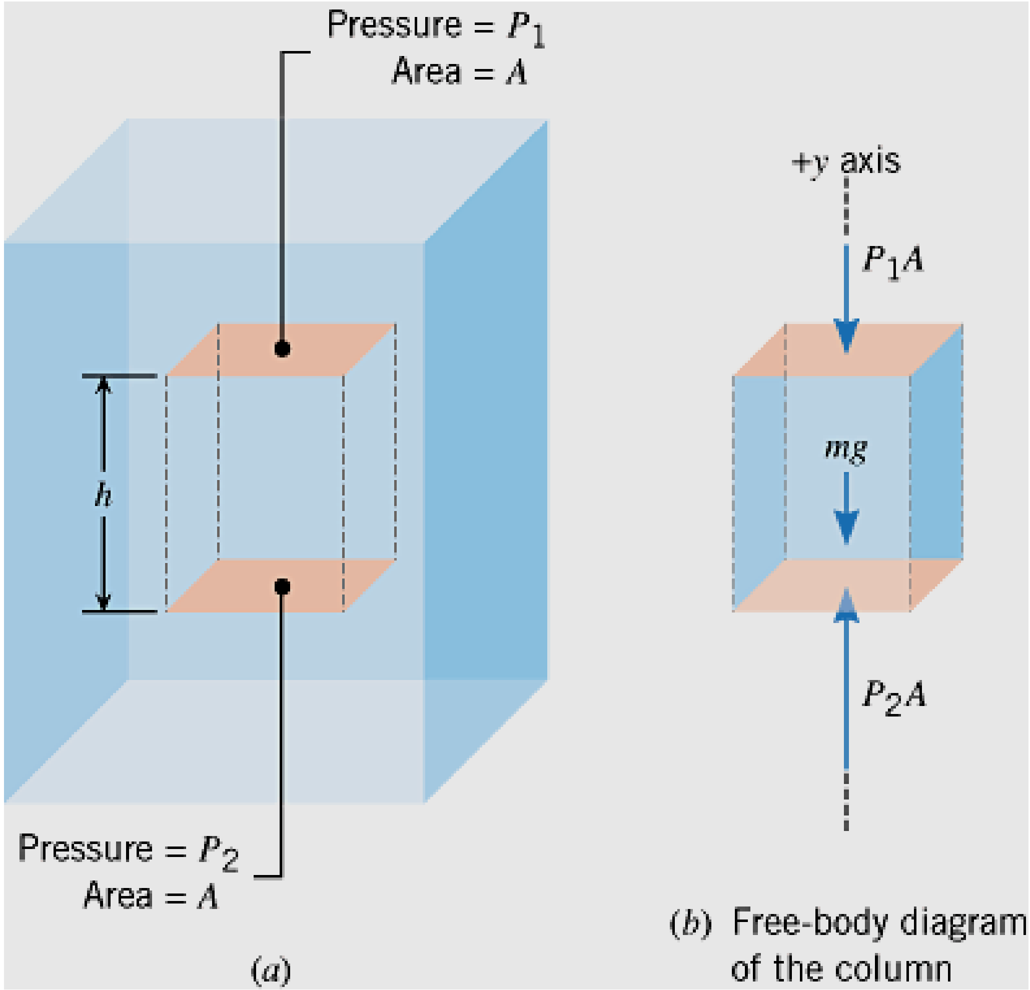


Pressão de um gás : impacto das partículas com as paredes.

$$P = \frac{F}{A}$$

Unidade SI: Pa = N/m^2

pressão atmosférica: 10^5 Pa ✍ 1 bar, equivalente à ✍ 1 kg/cm^2



Pressão hidrostática

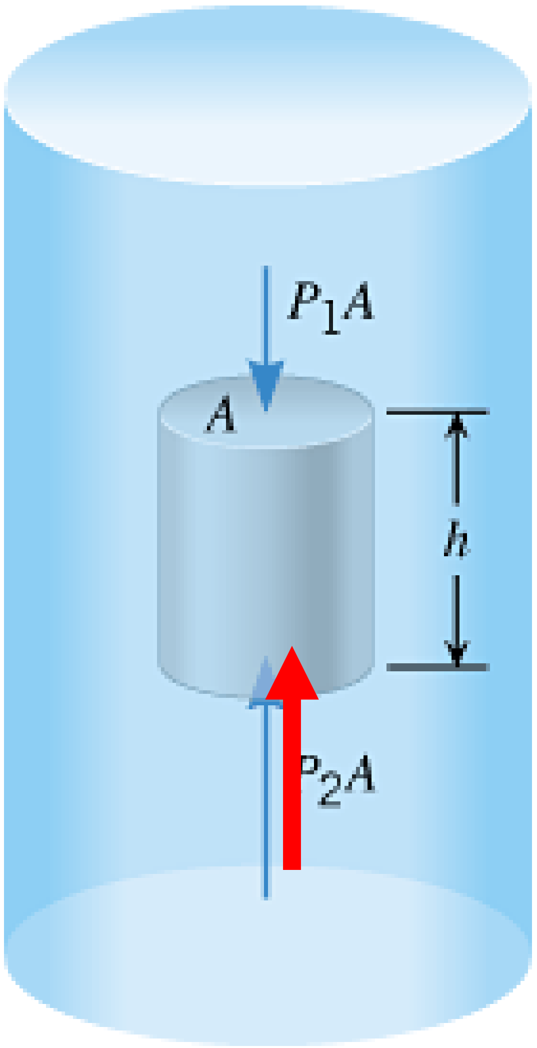
Em equilíbrio, qualquer volume dentro do fluido está parado: as forças sobre o volume se cancelam:

$$\sum F_y = P_2A - P_1A - mg = 0$$

$$P_2 - P_1 = \frac{mg}{A} = \frac{\rho h A g}{A}$$

$$\Delta P = \rho h g$$

1. As forças são iguais em todas as direções! uma pressão por ponto
2. A pressão é devido ao *peso* da coluna acima do ponto em questão



Empuxo

O líquido exerce uma força sobre um objeto, por causa das diferenças de pressão hidrostática acima e abaixo deste

$$\Delta P = P_2 - P_1 = \rho_{\text{líquido}} hg$$

$$F_{\text{empuxo}} = \Delta PA = \rho_{\text{líquido}} hgA =$$

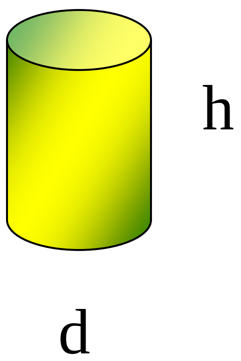
$$= \rho_{\text{líquido}} Vg = m_{\text{líquido}} g$$

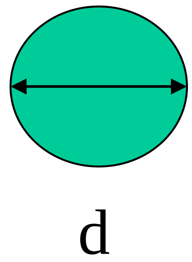
Empuxo = a força peso do líquido deslocado.

(um objeto com a mesma densidade que o líquido flutua: $F_{peso} = F_{empuxo}$)

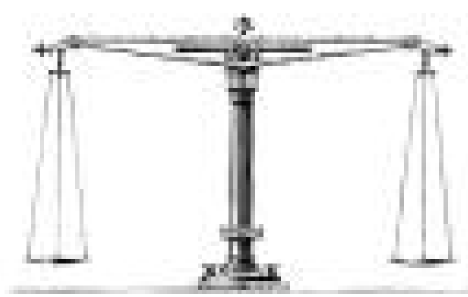
Como medir densidades

Método Geométrico





$$\rho = \frac{m}{V}$$

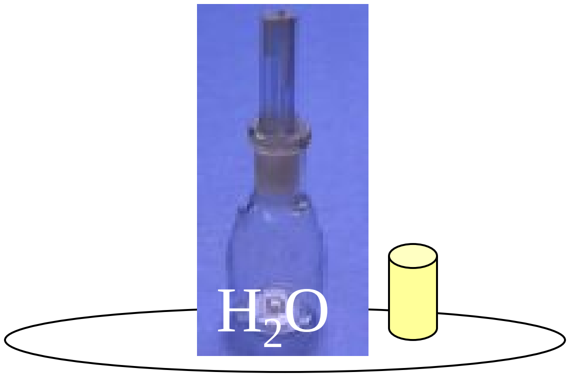


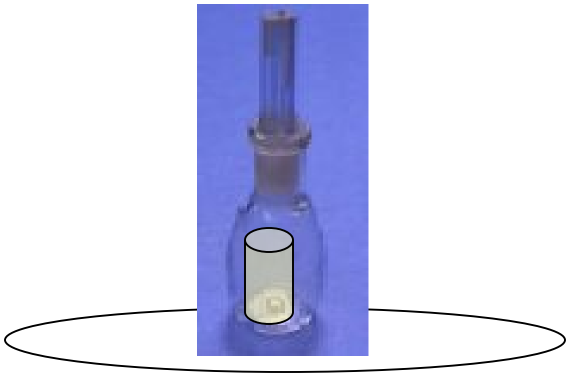
Picnômetro: volume fixo e bem definido

$$\frac{\rho_{\text{líquido x}}}{\rho_{\text{líquido padrão}}} = \frac{m_{\text{líquido x}}/V}{m_{\text{líquido padrão}}/V} = \frac{m_{\text{líquido x}}}{m_{\text{líquido padrão}}}$$

U$ 150.86

Picnômetro: medir volume deslocado





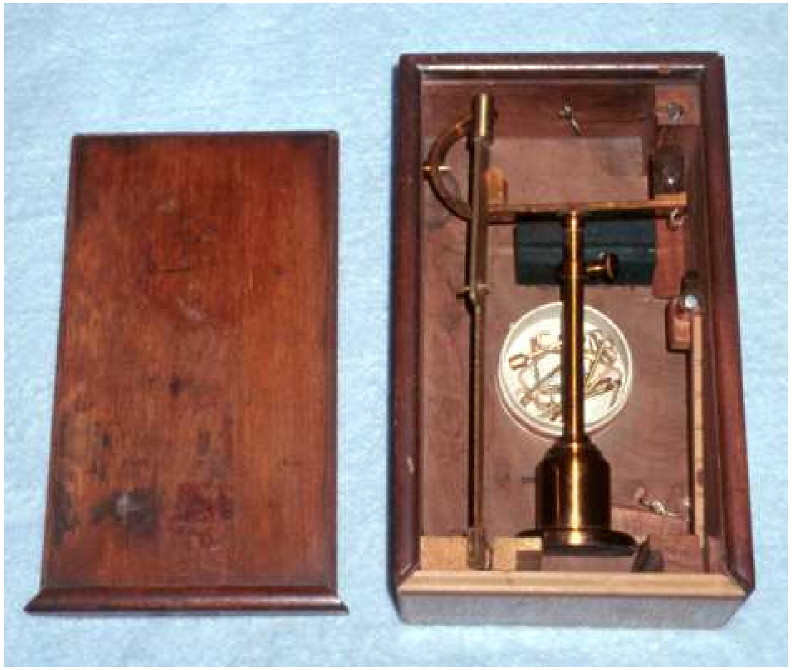
$m_1 = m_P + m_{H2O} + m_C$

$m_2 = m_P + m_{H2O} + m_C - m_{deslocado}$

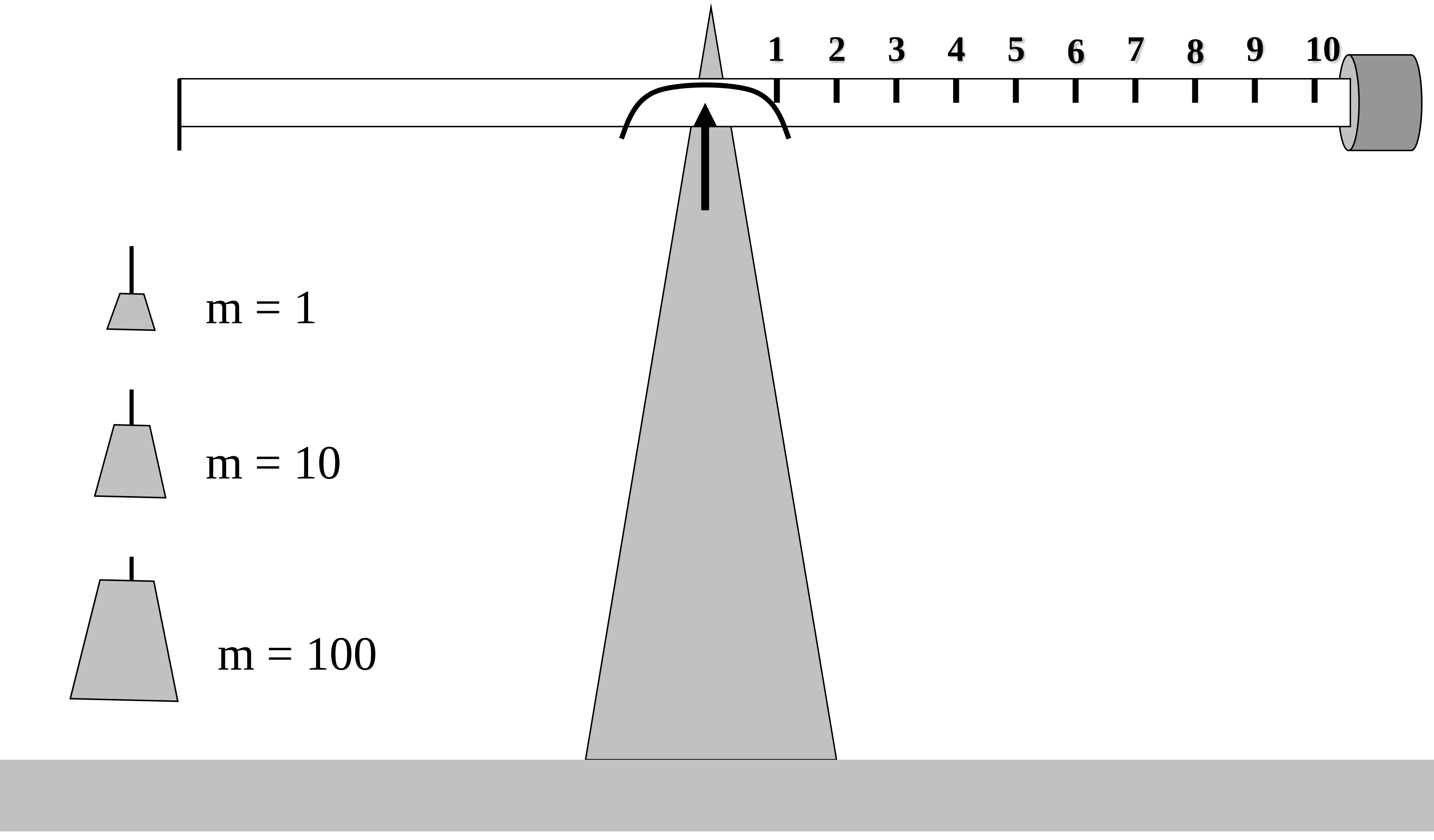
$$\rho_c = \frac{m_c}{V_c} = \frac{m_c}{V_{\text{deslocado}}} = \frac{m_c}{(m_1 - m_2)/\rho_{\text{líquido padrão}}} = \rho_{\text{líquido padrão}} \frac{m_c}{(m_1 - m_2)}$$

Balança de Mohr-Westphal:
empuxo é proporcional à densidade

U$ >>150.86

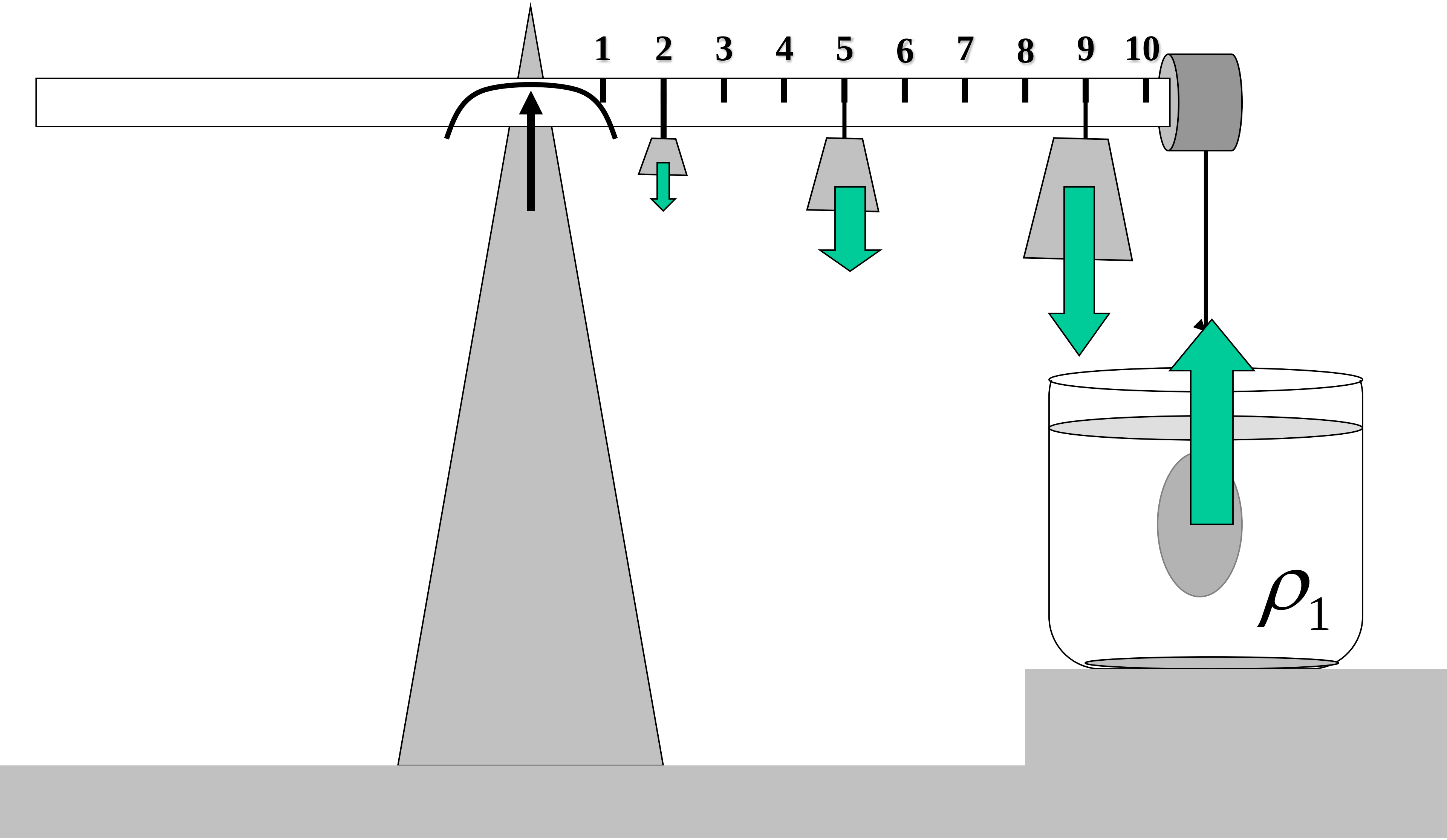


Balança de Mohr-Westphal



Balança de Mohr-Westphal

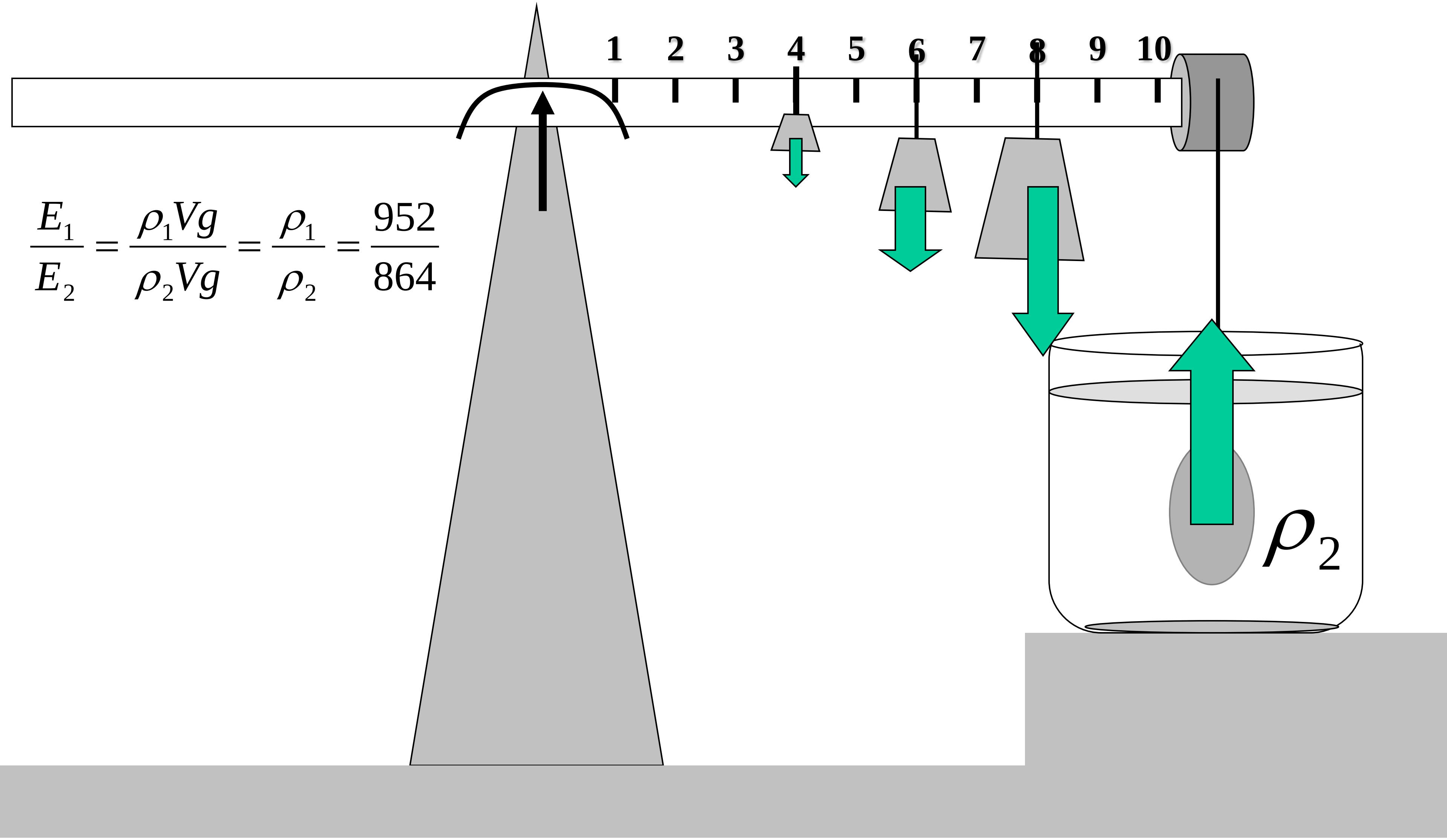
$$E_1 = \rho_1 V g = 952 \text{ unidades arbitrárias}$$



Balança de Mohr-Westphal

$$E_2 = \rho_2 V g = 864\ \text{u.a.}$$

$$\frac{E_1}{E_2} = \frac{\rho_1 V g}{\rho_2 V g} = \frac{\rho_1}{\rho_2} = \frac{952}{864}$$



Mini-quiz

1. O que pesa mais, 1 kg de chumbo, ou 1 kg de pluma?
2. O que tem mais *massa?*
3. O que acontece com a densidade de um sólido se a temperatura aumenta?
4. Porque a densidade de água é (quase exatamente) 1 g/cm^3 ?
5. Pode usar uma balança num ambiente sem gravidade (em queda livre)? Na lua?
6. Pode usar a balança de Mohr-Westphal na lua?

process measurement solutions

solartron mobrey

Density and viscosity systems

for oil and petrochemical applications

IP7002

Mercury Pycnometer Product Resources

Berthold Industrial Systems

In Line Density Meter LB 379

The Compelling Advantages

•Non-contacting, continuous measurement - no contact with medium being measured
•Minimum radiation exposure (dose rate ≤ 1 µSv/h at 10 cm from surface)
•241Am radiation source in ultrasafe capsule with long half-life (433 years)]
•Complete stainless steel construction of measuring section
•Simple installation in existing pipelines
•High statistical accuracy and long-term stability by the use of a highly sensitive scintillation counter with patented drift compensation
•Ideal for food industry applications
•Calibration and measurement output directly in measured variables (g/cm3, %, °Bx, °Be, g/l)
•Very simple calibration by microprocessor controlled amplifier

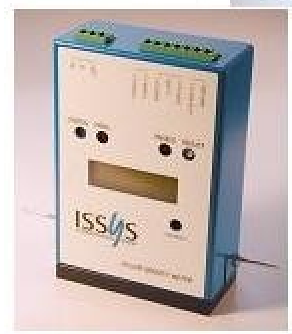
The Principle of Measurement Density Measurement is based on the absorption of Gamma radiation as it passes through the process material. Absorption is proportional to changes in material density, and as the measuring path is held constant, this indicates product density.

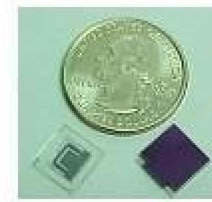
Micro Density Meters

Model 102B - Smallest Sample Volume Requirements in the World!

The ISSYS Micro Density Meter, Model 102B will accurately measure fluid density or specific gravity over a programmable temperature range of 0ºC to 90ºC. Because microfluidic tubes are used, **only 1 microliter of fluid** is required to perform the measurement. This ultimately saves system weight. While the competition's temperature controlled density meter weighs up to 28kg (60 lbs), the ISSYS Micro Density Meter weighs only 1 kg (2.2lbs). It's an instrument grade (5-digits of resolution) density meter that can be literally held in your hand. <u>If you have to carry an accurate, temperature controlled density meter anywhere, you'll want to take the Micro Density Meter</u>.





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A Density / Specific Gravity Meter Based on Silicon Microtube Technology

D. Sparks*, S. Massoud-Ansari, M. Straayer, R. Smith, R. Schneider, J. Cripe, Y.Zhang, G. Meng

Integrated Sensing Systems Inc.
391 Airport Industrial Dr
Ypsilanti, MI 48198
* (734)547-9896 ext 119
fax (734)547-9964
dsparks@mems-issys.com

Abstract

A new product for measuring fluid density and/or specific gravity has been developed. At the core of this sensor is a resonating silicon microtube. Measurements can be made with a microliter of sample fluid. Since the product is MEMS-based the overall system size is a fraction of current density meters and its weighs much less than the conventional desk-top, temperature controlled, density meters. The system includes a dynamic temperature control system that operates between 0ºC and 90ºC with an accuracy of less than 0.01ºC. Because accurate temperature control is required to take precise density readings, a platinum temperature sensor has been integrated on-chip. Applications for this device include the pharmaceutical, biomedical, nuclear, perfume, petroleum and beverage industries as well as in distilleries, hematology and urology.

Figure 2. Silicon microtube sensor chip on top of a conventional glass tube sensor.

Figure 1. An ISSYS Microtube vs. Human Hair (Same Scale)