

Lab 1: Buoyancy
and density

8-28-13

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ERROR ANALYSIS ADDON:

accepted density = ρ_{acc} Given by instructor.

$$\rho_{exp} - \Delta\rho < \rho_{acc} < \rho_{exp} + \Delta\rho$$

IF TRUE, successful
experiment within
MARGINS of ERRORS.
RANDOM ERRORS

IF FALSE, a systematic
error was larger
than the random
error margin above.

$$P_{acc} = P_{exp} + \Delta P$$

ρ_{exp} = average density of 4 rods

$$\rho = \frac{m_{rod}}{V} = \frac{m_{rod}}{\left(\frac{T - T'}{\rho_w \cdot g}\right)} = \frac{m_{rod} \cdot g \cdot \rho_w}{T - T'}$$

$$T - T' = \rho_w \cdot V \cdot g$$

where T = weight in AIR

" T' = " " WATER

$$\rho = \frac{m_{rod} \cdot g \cdot \rho_w}{(m - m') \cdot g} = \frac{m_{rod} \cdot \rho_w}{(m - m')}$$

where $m - m' = \Delta m$ difference between in-AIR and under-water measurements via

mass scale.

note: $m_{rod} = m$

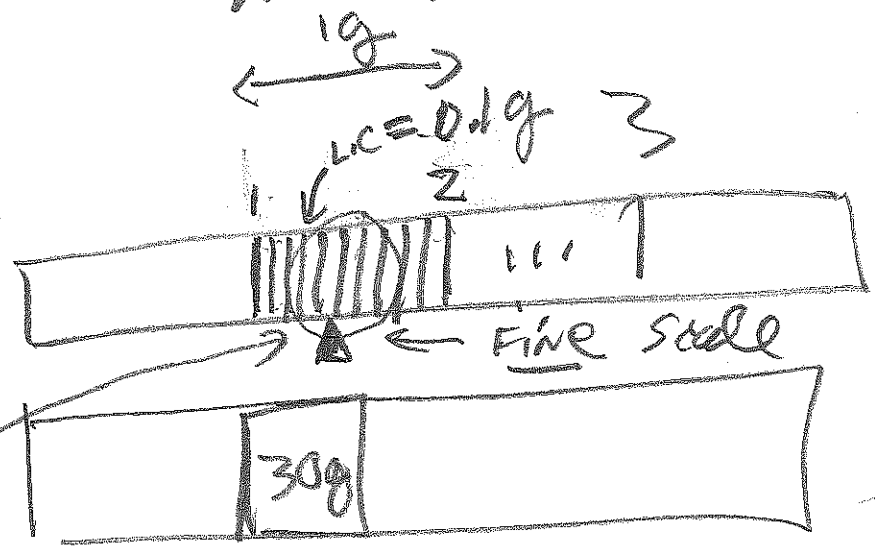
$$\rightarrow \rho = \frac{m \cdot P_w}{(m - m')}; \text{ MEASURED 4 TIMES TO GET AVERAGE}$$

$$\Delta \rho = \frac{P_{MAX} - P_{MIN}}{2}$$

IF THIS APPROACH
DOESN'T WORK, WE'LL
TRY ANOTHER BASED
ON INHERENT ERRORS
DUE TO INSTRUMENTATION

MASS scale

measurements:



30g + 1g

MAJOR scale

MENTALLY
DIVIDE IN HALVES

$$\text{ERROR} = \frac{\text{L.C.}}{2} = \frac{0.1\text{g}}{2} = 0.05\text{g}$$

Blow up

MARKER
round-up



MARKER
(ROUND UP)

$$31.50 \pm 0.05$$

accepted densities:

65

	kg/m^3	g/cm^3	
Al	2.7×10^3	2.7	DIRTY WHITE
Ca	8.9×10^3	8.9	reddish
BRASS	8.4×10^3	8.4	yellowish
steel	7.88×10^3	7.8	greyish
Ni	8.8×10^3	8.8	(RUST)
au	19.3×10^3	19.3	
Ag	10.5×10^3	10.5	

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BUOYANCY AND DENSITY In this experiment, we will measure the density of 3 rods using Archimedes' Principle applied to objects weighed by a mass scale in air or completely submerged under water. Your results should be within the error bars discussed below. **PROCEDURE:**

1. See lecture notes on hydrostatics, Ch. 12, including hints to #27.
2. See model set up and listen carefully to instructor comments.
3. Pay attention to "Add on" notes on this lab in today's posted lecture (8-28-13).

BUOYANCY AND THE DETERMINATION OF DENSITY

USE RODS OF THREE DIFFERENT MATERIALS

Instrument	MASS SCALE				
Reading	Weight OF ROD in air	Weight OF ROD in water	ROD VOLUME (SHOW WORK BELOW)	ROD DENSITY (SHOW WORK BELOW)	% ERROR
ROD 1	18.50 ± 0.05g				
MASS	18.60 ± 0.05g				
	18.50 ± 0.05g				
	18.60 ± 0.05g				

STANDARD DEVIATION OF MEAN

$AV_1 = 18.55 \pm \text{ERROR}$; $\text{ERROR} = \text{STDM OR } 0.05g$,
WHICH EVER IS LARGER