# *Archimedes' Principle*
# Density, ρ, Density, ρ, Density
# (sometimes said "rho", "rho", "rho" – but not your boat)

*Purpose:* In this lab you will verify *Archimedes' Principle* by measuring the buoyancy force, apparent weight, and weight of the displaced water of several submerged and floating objects. You will also calculate the density and volume of the displaced water.

*Equipment:* spring scale and pan balance
graduated cylinder
Two containers (overflow cup and handled cup)
Specific Gravity masses
Tray
Beaker

**Part 1: Density- old school!**

*Procedure:* A) Measure the mass of the metal cube with a pan balance and record it as $m_o$ in the data table below.

B) With a ruler measure the length, width, and height of the metal cube and calculate its volume.

$m_o$ = _____ g  L = _____ cm  w = _____ cm  h = _____ cm  V = _____ $cm^3$

ρ = _____ g/_____ $cm^3$ = _____ $g/cm^3$

**Part 2: Density- semi old school! (water displacement #1)**

*Procedure:* A) Measure the mass of the metal cube with a pan balance and record it as $m_o$ in the data table below.

B) Fill up the overflow cup until water comes out (make sure you have a beaker under the spout). After it stops dripping have your partner hold the graduated cylinder under the spout and lower the metal cube into the water and collect the water that comes out of the overflow cup and record it as volume in m*l*.

$m_o$ = _____ g  V = _____ m*l*  ρ = _____ g/_____ m*l* = _____ $g/cm^3$

**Part 3: Density- (water displacement #2 and S.G.)**

*Procedure:* A) Measure the weight of the metal cube with a spring scale in air and record it as $F_o$ in the data table below.

B) Fill up the overflow cup until water comes out (make sure you have a beaker under the spout). Measure the weight of the "handled" cup and record it as $F_c$. Have your partner hold the "handled" cup under the spout and lower the metal cube under the water and collect the water. Measure the weight of the cup and water and record it as $F_{c+w}$. Find the weight the water ($F_w$) by subtracting the weight of the cup and water and record it as $F_w$. $F_w$ is also $F_f$ (weight of fluid)

$F_o$ = ____ N  $F_c$ = ____N  $F_{c+w}$ = _____N  $F_w = F_{c+w} - F_c$ = ____N - ____N = ____N

C) Find the S.G. of the cube by dividing $F_o$ by $F_f$

S.G. = $F_o/F_f$ = ____N/____N = _____ (this is your density!)

**Part 4: Density- (S.G.)**

*Procedure:* A) Measure the weight of the metal cube with a spring scale in air and record it as $F_o$ in the data table below.

B) Measure the $\Delta F$ ($F_B$) of the metal cube by placing it in water and subtracting its weight in water ($F_{app}$) from its weight in air and recording it as "$F_B$"

$F_o$ = _____N  $F_{app}$ = _____N  $F_B = F_o - F_{app}$ = _____N - ____N = _____N

C) S.G. = $F_o/F_B$ = ____N/____N = _____ (this is your density!)

**Part 5: Density of floating object- (S.G.)**

*Procedure:* A) Measure the height of the test tube and record it in the data table below as $h_o$.

B) Put @ 50 m*l* of water in a graduated cylinder and lower the test tube into it. Measure the amount of the test tube under the water and record it as $h_{subm}$

C) $h_o$ = ____cm  $h_{subm}$ = ____cm

D) Find the S.G. S.G. = $h_{subm}/ h_o$ = ____cm/____cm = ____ (this is your density!)

$\rho_t$

| | density | S.G. |
|---|---|---|
| Brass | 8700 kg/m$^3$ | 8.70 |
| Aluminum | 2700 kg/m$^3$ | 2.70 |
| Steel | 7900 kg/m$^3$ | 7.90 |
| Lead | 11300 kg/m$^3$ | 11.30 |