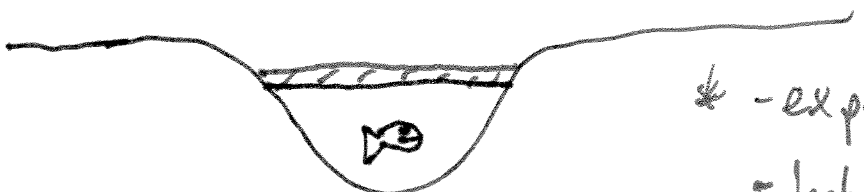
PHY 1122 Lecture 1

12.1 DENSITY

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

water = 1.00×10^3 kg/m^3
ice = 0.92×10^3 kg/m^3



* - expands when freezes
- habitat underneath permits life
- this also breaks rocks up to make soil

UNUSUAL!

- silicon
- bismuth
- antimony
- gallium

Water → High specific heat

Density is a function of T

specific gravity of a material:

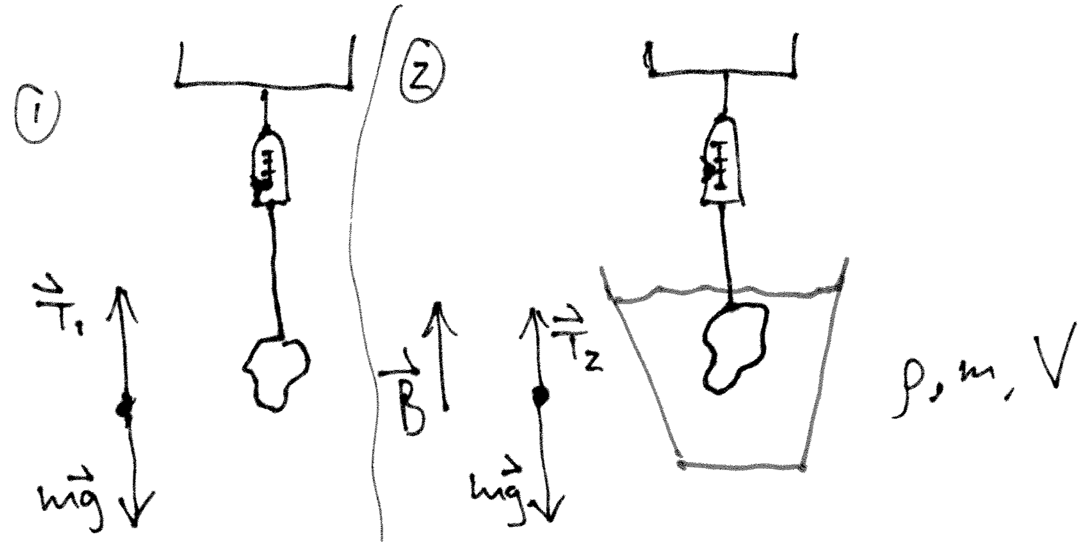
↳ ratio of its density to that of water at 4.0°C

$$1.0 \times 10^3 \frac{kg}{m^3} \quad \text{or} \quad 1.0 \frac{g}{cm^3}$$

12.3 BUOYANCY

Archimedes Principle

<u>Example</u>: A piece of Al is suspended from a string and then it is completely immersed is a container of water. The mass of the Al is 1.0 kg, and its density is 2.7×10^3 kg/m³. Calculate the tension in the string before and after the Al is immersed.



$\sum \vec{F} = 0$

$T_1 - mg = 0$

$T_1 = mg = (1.0\ kg)(9.8\ m/s^2)$

$= 9.8\ N$

$\sum \vec{F} = 0$

$T_2 + B - mg = 0$

$T_2 = mg - B = 9.8\ N - B$

What is B?

force equal to weight of fluid displaced.

$$\rho = \frac{m}{V} \Rightarrow V_{Al} = \frac{m}{\rho} = \frac{1.0\ kg}{2.7\times10^3\ \frac{kg}{m^3}}$$

$$= 3.7\times10^{-4}\ m^3$$

Buoyant force = weight of water displaced

$$B = m_w g = \rho_w V_{Al}\, g$$

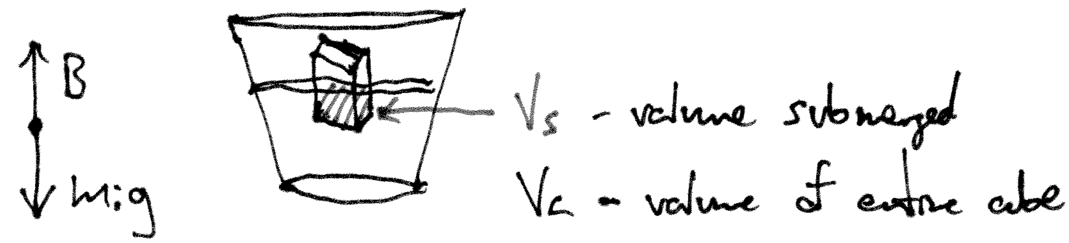
$$= (1.0\times10^3\ kg/m^3)(3.7\times10^{-4}\ m^3)(9.8\ m/s^2)$$

$$= 3.6\ N$$

Therefore

$$T_2 = 9.8\,N - B = 9.8\,N - 3.6\,N = \underline{\underline{6.2\,N}}$$

<u>Example</u>: An ice cube floats in a glass of water. What fraction of the cube lies above the water level?



$$\rho_i = 0.92 \times 10^3\ kg/m^3$$

Upward buoyant force = weight of displaced water

$$B = \rho_w V_s \cancel{g} = m_i \cancel{g}$$

$$\rho_w V_s = \rho_i V_c$$

fraction of ice beneath the water is

$$\frac{V_s}{V_c} = \frac{\rho_i}{\rho_w}$$

Hence, fraction of ice cube above water level is

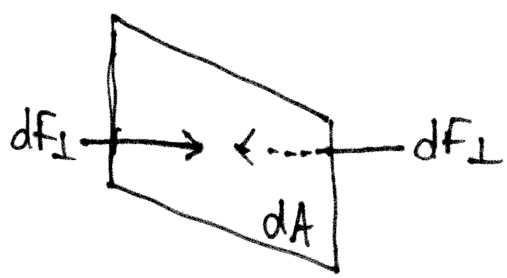
$$f = 1 - \frac{\rho_i}{\rho_f} = 1 - \frac{920}{1000} = 0.08$$

or 8%

12.2 Pressure

When a fluid is at rest, it exerts a force ~~pend~~ perpendicular to any surface in contact with it, such as a container wall or an immersed body.

If we think of an imaginary surface within the fluid, the fluid on the 2 sides of the surface exert equal and opposite forces on the surface.



PRESSURE

$$p = \frac{dF_\perp}{dA}$$

If pressure is the same at all points of a finite plane with surface area A, then

$$\boxed{p = \frac{F_\perp}{A}} \qquad [p] = \left[\frac{F}{A}\right] = \frac{N}{m^2} = Pa$$

Atmospheric Pressure

P_{atm} - the pressure of Earth's atmosphere

P_{atm} @ sea level : 1.013×10^5 Pa = 1 atm

= 1.013 bar = 1013 millibar

= 14.70 lb/in^2

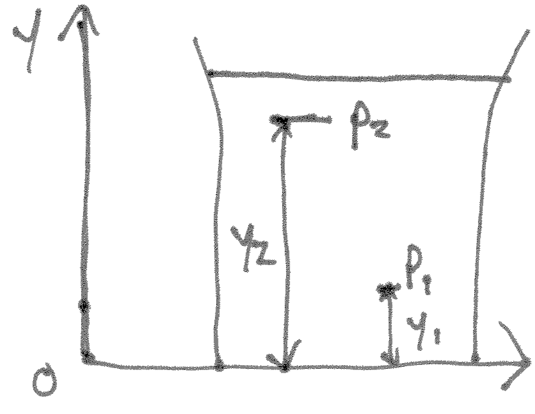
↳ 12 in × 12 in × 14.70 lb/in^2

= 2116.8 lbs!

Pressure is a function of depth

$$\frac{dp}{dy} = -\rho g$$

Derivation in textbook.



If ρ and g are constants, can remove differential, giving

$$P_2 - P_1 = -\rho g (y_2 - y_1)$$