Density

$$\rho = \frac{m}{V} \qquad \text{density} = \frac{\text{mass}}{\text{volume}}$$

$$[\text{kgm}^{-3}] = \frac{[\text{kg}]}{[\text{m}^3]}$$

1. cube of Cu: 240g Sides: 3.0cm long

$$\rho = \frac{m}{V} = \frac{240}{3\times3\times3} = 8.9\ \text{gcm}^{-3}\ (3\text{sf})$$

or

$$\rho = \frac{m}{V} = \frac{0.24}{0.03\times0.03\times0.03} = 8900\ \text{kgm}^{-3}\ (3\text{sf})$$

2. Steel : $7850\ \text{kgm}^{-3}$

Steel sphere of radius 0.15m

$$V = \frac{4}{3}\pi r^3 = \frac{4}{3}\times\pi\times 0.15^3 = 0.014\ \text{m}^3$$

$$m = \rho V = 7850\times 0.014 = 110\ \text{kg}$$

Density of Air $\approx 1\ \text{kgm}^{-3}$

Density of Water $\approx 1000\ \text{kgm}^{-3}$

Seawater: 3.5% salt by weight

How much seawater in kg contains 1kg of salt?

Salt : water ratio = 3.5 : 96.5

$\therefore \frac{3.5}{3.5} : \frac{96.5}{3.5} = 1 : \frac{193}{7}$

Approx 28 kg of water + 1 kg of salt.

∴ 29 kg saltwater contains 1 kg of salt.

2 liquids: A $1000 kgm^{-3}$ & B $600 kgm^{-3}$

Mixture is $850 kgm^{-3}$

What is the mass of liquid B in 1kg of the mixture?

Volume of A = V_A Volume of B = V_B

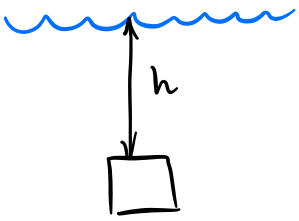
$\therefore 850 \times (V_A + V_B) = 1$ kg (of mixture)

$1000 V_A + 600 V_B = 1$ kg (of mixture)

} 2 eqⁿ, 2 unknowns

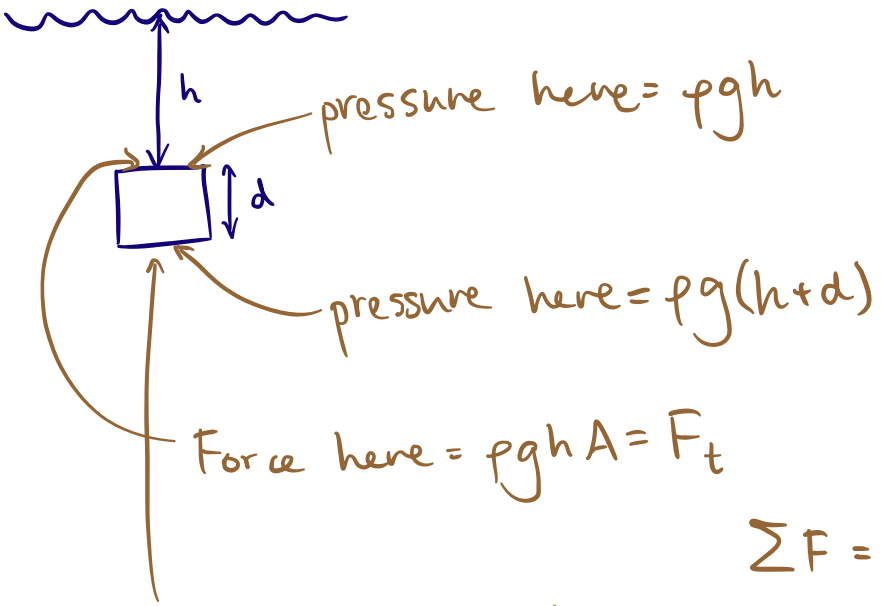
Solve $\Rightarrow V_B \times 600 = 264.7g$

Pressure in fluids



$P = \rho g h$

pressure = density of fluid × gravity × depth



$\Sigma F = F_b - F_t$

$= \rho g(h+d)A - \rho g h A$

$= \rho g A d$

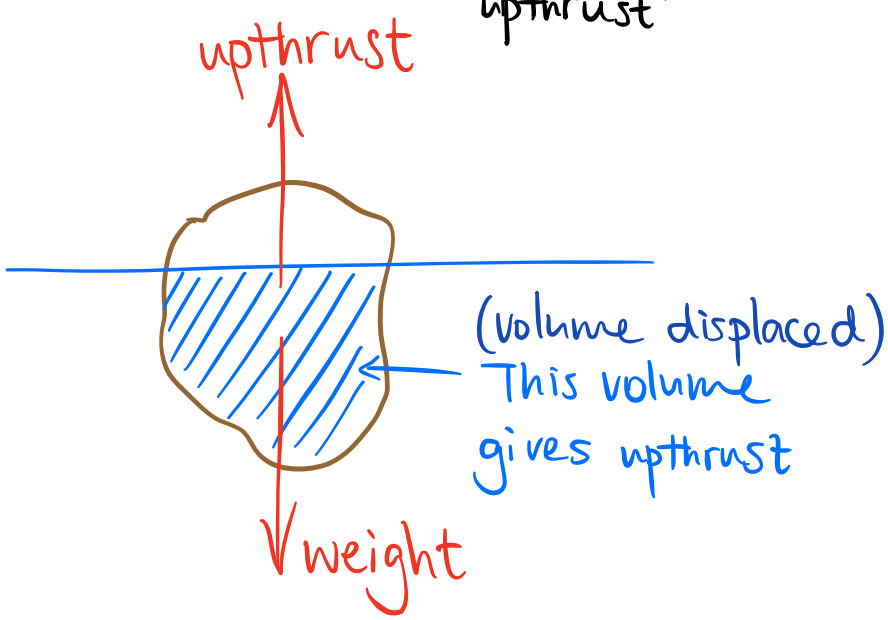
$= \rho g V$ ← weight of fluid displaced

"upthrust"

Upthrust = $U = \rho V g$

"how much force pushing up on the object"

When floating:

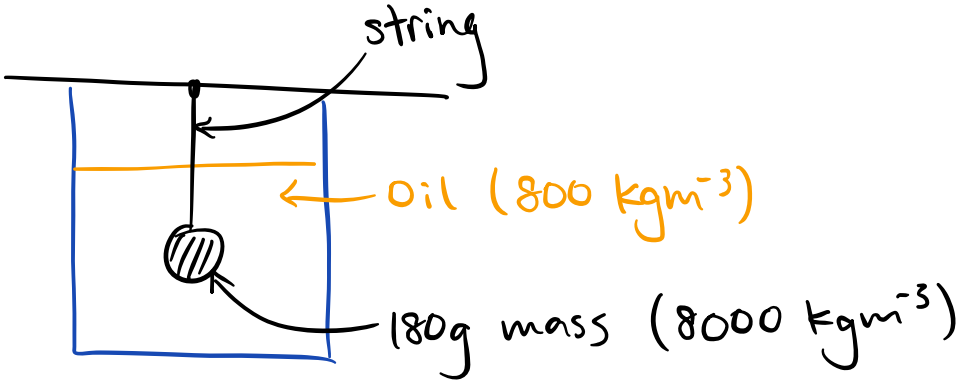


Skydiver

Volume of skydiver
$= 0.35\ m^3$

Density of air $= 1.2\ kgm^{-3}$

Upthrust $= \rho Vg = 1.2 \times 0.35 \times 9.81 = 4.12\ N$



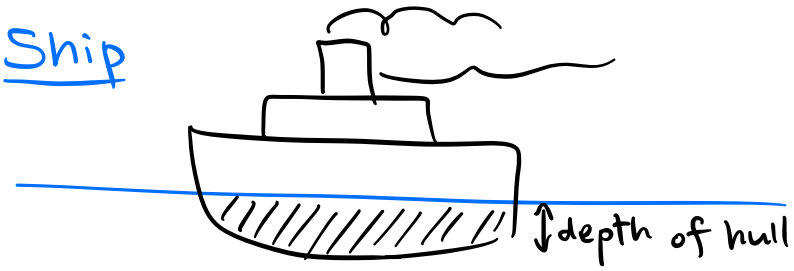
Volume of mass $= \frac{m}{\rho} = \frac{0.180}{8000} = 2.25 \times 10^{-5}$

$\therefore$ Upthrust $= \rho Vg = 800 \times 2.25 \times 10^{-5} \times 9.81$

$\approx 0.177\ N$ (3sf)

Tension in string $= 0.180 \times 9.81 - 0.177 = 1.59\ N$ (3sf)

Ship



Ship is 60m × 10m

Mass of ship = 1.5×10^6 kg

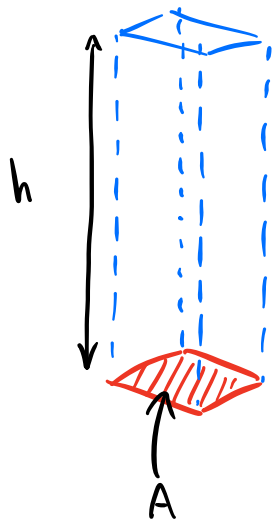
$$\text{Upthrust} = \rho V g = 9810V = 1.5 \times 10^6 \times 9.81$$

$$V = 1500 \text{ m}^3$$

Depth of hull = $1500 \div 60 \div 10 = 2.5$m

If in saltwater, depth would decrease.

ρgh derivation



mass of column of water $= \rho Ah$

Weight $= \rho Ahg$

$$\text{pressure} = \frac{F}{A} = \frac{\rho Ahg}{A} = \rho gh$$