Physics 7E

Eli Griffiths

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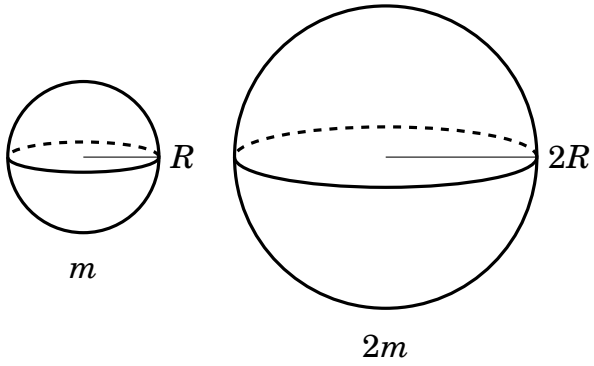
1.1 Density and Pressure

Definition 1.1 (Density). Density is the mass per unit volume:

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

The units are $[\rho] = \mathrm{kg/m^3}$.

Example 1.1. The first sphere has mass and radius m and R and the second $2m$ and $2R$ respectively. Since the volume of a sphere scale cubicaly, the spheres ratio of volumes are $\frac{1}{8}$ meaning the density of the first sphere is $\frac{1}{8}$ of the second.



Consider a fluid. That is, something that takes shape of the container it is in. Since it is in contact with the walls of the container, there is a normal force being exerted on the liquid by the container. This force is quantified by pressure

Definition 1.2 (Pressure). Pressure is the magnitude of the normal force per unit area:

$$\boxed{p = \frac{F_\perp}{A}}$$

with units $[p] = \mathrm{N/m^2} = \mathrm{Pa}$.

Example 1.2. Consider two evacuated discs pressed against each other with a vacuum in the middle. What is the force that holds them together? Each disk has a radius of 15cm. Therefore the force on each one is

$$F_\perp = pA = p_{\text{air}}\left[\pi(0.15)^2\right].$$

Pressure can also be expressed at a singular point in the form of a differential

$$p = \frac{\mathrm{d}F_\perp}{\mathrm{d}A}.$$

Theorem 1.1 (Pressure at Depth in a Fluid). The pressure at a depth inside of some fluid is

$$\boxed{p = P_0 + \rho g k}.$$

where P_0 is the pressure on the top surface of the fluid, ρ the density of the fluid, and k the depth that is being examined.

Proof. ■

Theorem 1.2 (Pascals Law). A change in pressure at any point in an enclosed fluid at rest is transmitted undiminished to all points in the fluid.

Theorem 1.3 (Archimedes Principle). A body in a fluid experiences a bouyant force equal to the weight of fluid displaced. That is, the bouyant force is determined by the fluid element the body represents.