Archimedes' Principle

Weight (true weight) – force exerted by the earth on the object which on or near the earth's surface

Upthrust - is the force due to fluid, that pushes an object up.

Apparent weight - the weight of a body as affected by the upthrust of a fluid in which it is immersed, i.e. true weight minus the upthrust, mathematically it is given as,

$$W_{Apparent} = W_{True} - F_{Upthrust}$$

Archimedes' Principle

When a body is wholly or partly immersed in a fluid, it experiences an **upthrust** or apparent loss of weight, **equal to the weight of fluid displaced.**

$$F_{Upthrust} = W_{fluid\ displaced}$$

Given the mass of the of fluid displaced, weight is given by

$$W_{fluid\ displaced} = mg$$

But given the volume of the fluid displaced, $m = \rho V$, weight is given by

$$W_{fluid\ displaced} = mg = \rho V g$$

Relative density

The relative density (RD) of a substance is defined as the ratio of the density of the substance and the density of water. Thus

$$RD = \frac{Density\ of\ substance}{density\ of\ water\ (at\ same\ temperature)}$$

Relative density is a ratio and therefore has **no units**.

Note that since $density = mass/volume$, then if we consider **equal volumes** of the substance and water, the expression for RD becomes

$$RD = \frac{mass\ of\ substance/volume}{mass\ of\ water/volume\ (at\ same\ temperature)}$$

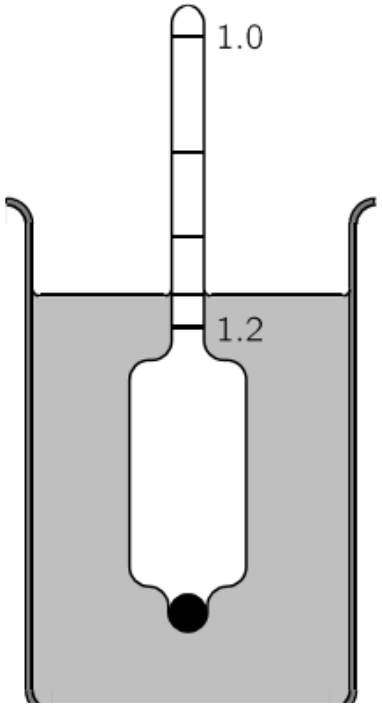
$$RD = \frac{mass\ of\ substance}{mass\ of\ water\ (at\ same\ temperature)}$$

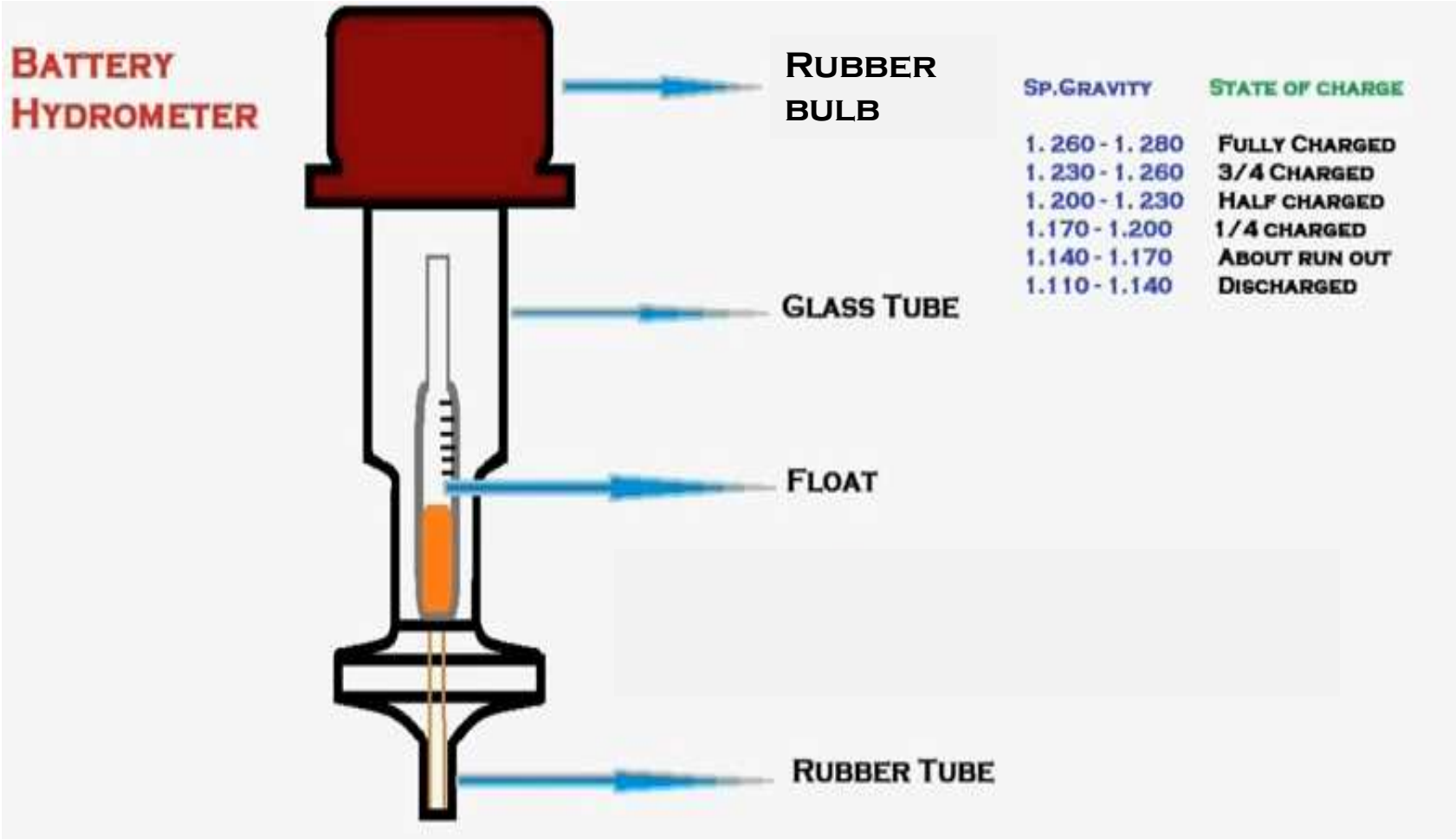
Relative density is sometimes known as the **specific gravity**. It may be determined for both solids and liquids

Hydrometer

The relative densities of liquids are frequently measured with a hydrometer. The denser the liquid in which the hydrometer floats, the greater the length of stem exposed above the surface of the liquid.

Application – measure the state of the charge in the battery





Examples

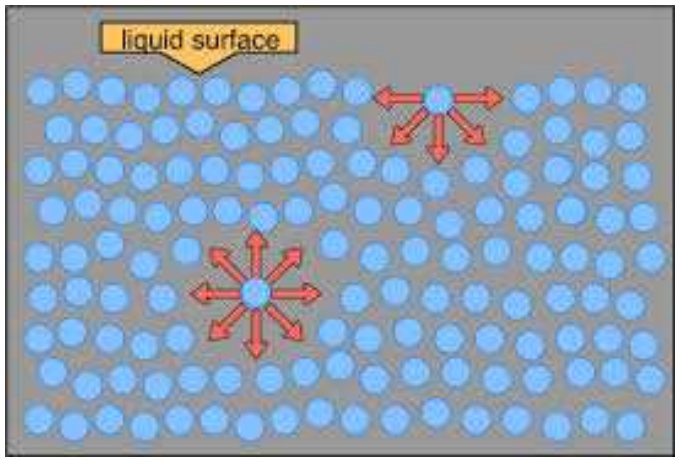
Example 6.3: Relative density of aluminium.

The density of aluminium is 2700 kg m^{-3} . Find the relative density of aluminium given that the density of water is 1000 kg m^{-3}.

Example 6.4: Relative density of a mixture.

10 cm^3 of a liquid A whose relative density is 0.8 is mixed with 15 cm^3 of a liquid B whose RD is 1.2. If there is no contraction on mixing, find the relative density of the mixture.

Surface tension



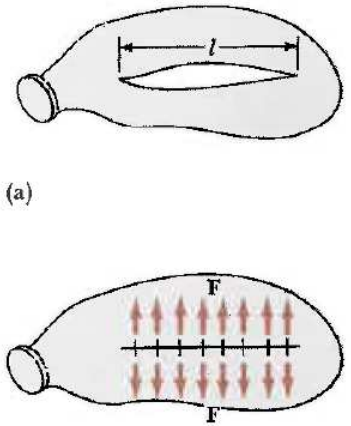
For a liquid at rest, the net force on the molecules inside the liquid is zero since each molecule is surrounded by other molecules that provide opposing forces that keep it in balance. For a molecule at the surface of a liquid, however, the only neighbouring molecules are inside the liquid, thus the net attractive force on molecules at the surface of a liquid is directed inward. This net inward force makes the surface of the liquid act in some ways like a membrane under tension.

The **surface tension** (γ) of a liquid is defined as the force per unit length acting **perpendicular** to any line in the surface and acting in, or tangentially to, the surface. Mathematically it is

$$\gamma = \frac{F}{l}$$

The unit is Nm^{-1}.

Force due to tension is similar to the force exerted by the stitches on the sewed water bag, when it is filled with water



Surface tension

Analogous

Example 6.6: Force due to surface tension on a microscope slide.

A microscope slide of length 6.0 cm and thickness 2.0 mm is hung vertically with its lower edge in the water.

(a) Calculate the total force due to surface tension acting on the slide (γ for water is 7.3×10^{-2} Nm^{-1}).

(b) In what direction does the force act?