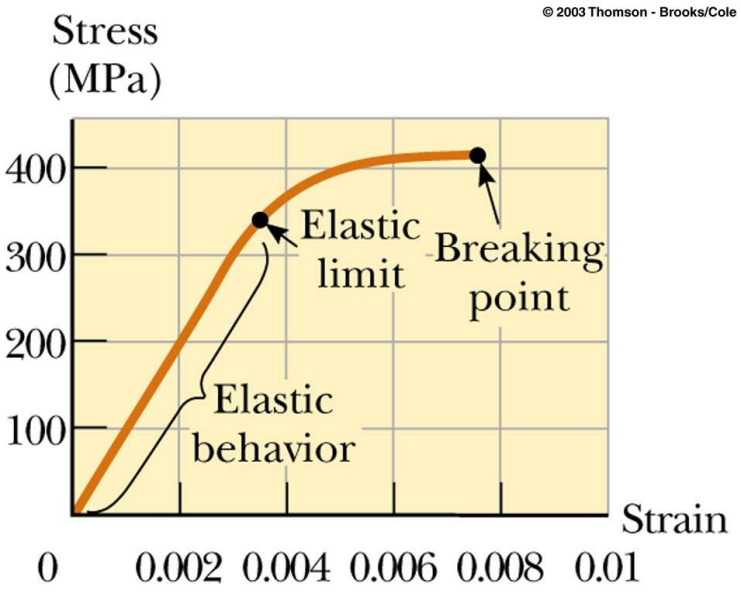
Chapter 9-Solids and Fluids

Stress/Strain=Elasticity modulus (E) or Young's modulus (Y) in Pa=N/m^2 (Pascal)



1 Pascal=1 atmosphere

Stress (same thing as pressure)=F/A F is force in N, A is area in m^2

Strain=$\Delta L/L_0$ L is length in m; or make sure whatever unit that both are same since they will cancel.

Young's modulus (Y or E) is a length change $E=(FL_o)/(A\Delta L)$

Bulk modulus (β) is for a volume change $\beta=(FV_o)/(A\Delta V)$

TABLE 9.1 **Typical Values for Elastic Moduli**

Substance	Young's Modulus (Pa)	Shear Modulus (Pa)	Bulk Modulus (Pa)
Aluminum	7.0×10^{10}	2.5×10^{10}	7.0×10^{10}
Bone	1.8×10^{10}	8.0×10^{10}	—
Brass	9.1×10^{10}	3.5×10^{10}	6.1×10^{10}
Copper	11×10^{10}	4.2×10^{10}	14×10^{10}
Steel	20×10^{10}	8.4×10^{10}	16×10^{10}
Tungsten	35×10^{10}	14×10^{10}	20×10^{10}
Glass	$6.5–7.8 \times 10^{10}$	$2.6–3.2 \times 10^{10}$	$5.0–5.5 \times 10^{10}$
Quartz	5.6×10^{10}	2.6×10^{10}	2.7×10^{10}
Rib Cartilage	1.2×10^{7}	—	—
Rubber	0.1×10^{7}	—	—
Tendon	2×10^{7}	—	—
Water	—	—	0.21×10^{10}
Mercury	—	—	2.8×10^{10}

Density is mass/volume φ=m/V mass in kg, Volume in m^3

1 kg=1000 g 1L=0.001m^3 1000mL=1L 1ml=1cm^3(=1cc)

Density of H_20=1000kg/m^3 a constant physical property; all pure substances have a constant density

TABLE 9.3 Density of Some Common Substances

Substance	ρ(kg/m^3)[a]	Substance	ρ(kg/m^3)[a]
Ice	0.917×10^3	Water	1.00×10^3
Aluminum	2.70×10^3	Glycerin	1.26×10^3
Iron	7.86×10^3	Ethyl alcohol	0.806×10^3
Copper	8.92×10^3	Benzene	0.879×10^3
Silver	10.5×10^3	Mercury	13.6×10^3
Lead	11.3×10^3	Air	1.29
Gold	19.3×10^3	Oxygen	1.43
Platinum	21.4×10^3	Hydrogen	8.99×10^{-2}
Uranium	18.7×10^3	Helium	1.79×10^{-1}

[a] All values are at standard atmospheric temperature and pressure (STP), defined as 0°C (273 K) and 1 atm (1.013×10^5 Pa). To convert to grams per cubic centimeter, multiply by 10^{-3}.

Gauge pressure $P_{absolute}$-$P_{atmosphere}$=P_{gauge} where P absolute (P) is a total pressure, P atmosphere (P_{atm}) is due to the atmosphere, and P gauge (P_{gauge}) is the "net" pressure.

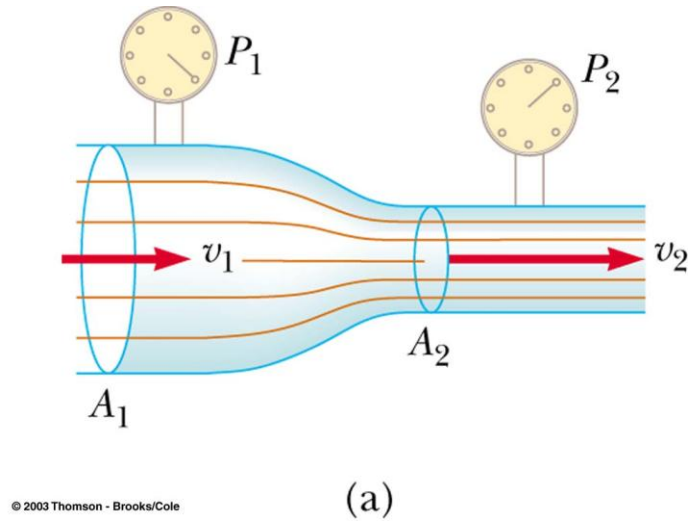
P_{gauge}=P-P_o=φghwhere g is 9.8 m/s^2 and h is height in m above ground

Buoyant Force=force of fluid pushing up on an object making it float, in N.

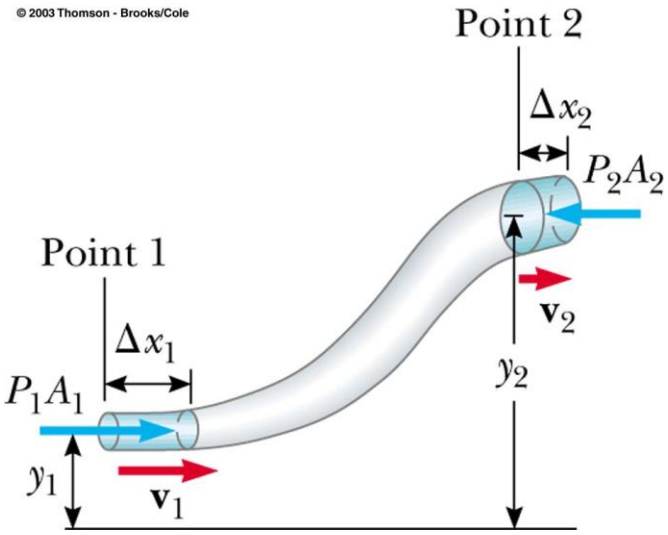
F_B=weight of fluid displaced=weight of the part of the object that's submerged

F_B=mg=φVg since φ=m/V, the m=φV remember V=Ah

Equation of continuity $A_1v_1=A_2v_2$ A is cross-sectional area and v is fluid speed in m/s



Ideal fluid-nonviscous, incompressible, steady, without turbulence



Bernoulli's equation is sort-of conservation of fluid pressure

$P_1+1/2\varphi v_1^2+\varphi gy_1= P_2+1/2\varphi v_2^2+\varphi gy_2$ each factor is a pressure

P is pressure in Pa, φ is density in kg/m^3, v is velocity in m/s, g is 9.8 m/s^2, and y is height about ground in m.

$1/2\varphi v_1^2$ is KE/volume φgy_1 is PE/volume or pressures

If there is no change is **height=y** (or horizontal) from initial to final conditions, then leave out the φgy factor.