Vökvar - fluids

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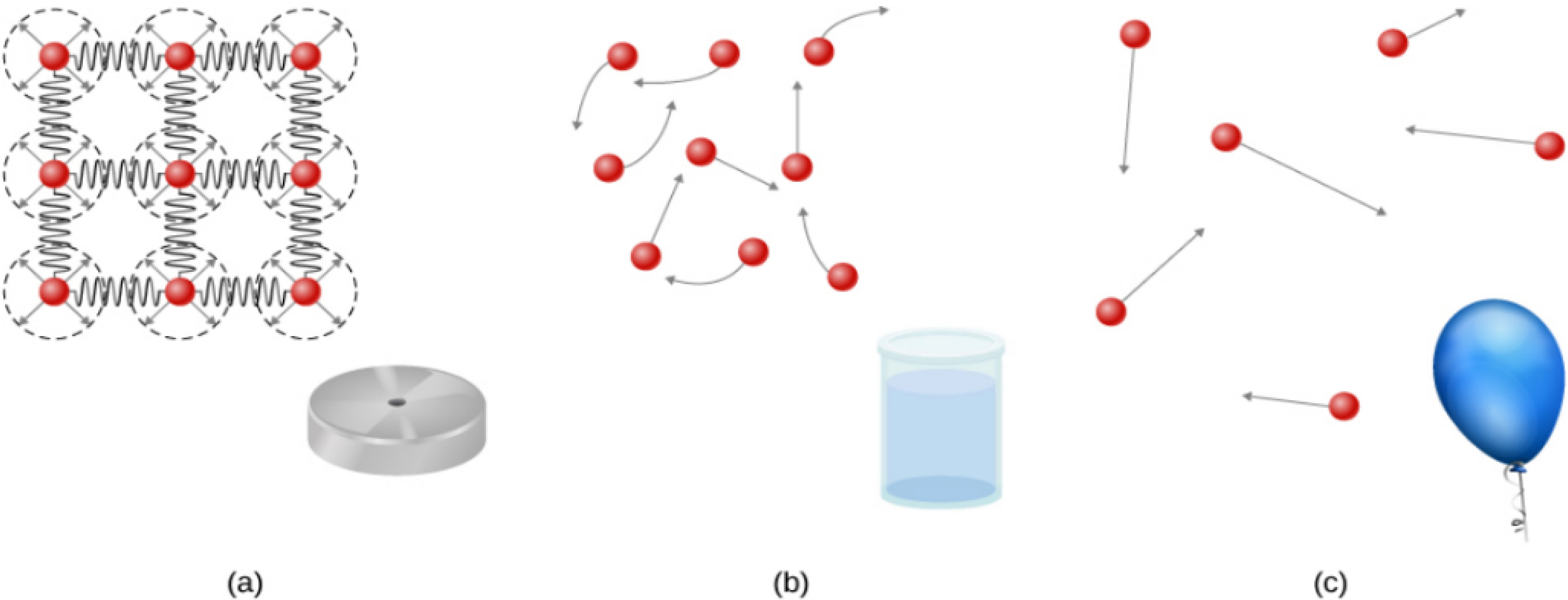

Figure 14.2 (a) Atoms in a solid are always in close contact with neighboring atoms, held in place by forces represented here by springs. (b) Atoms in a liquid are also in close contact but can slide over one another. Forces between the atoms strongly resist attempts to compress the atoms. (c) Atoms in a gas move about freely and are separated by large distances. A gas must be held in a closed container to prevent it from expanding freely and escaping.

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béttleiki - density

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Density

The average density of a substance or object is defined as its mass per unit volume,

$$\rho = \frac{m}{V} \tag{14.1}$$

where the Greek letter ρ (rho) is the symbol for density, m is the mass, and V is the volume.

Solids (0.0°C)		Liquids (0.0°C)		Gases (0.0°C, **101.3 kPa**)	
Substance	**$\rho(kg/m^3)$**	**Substance**	**$\rho(kg/m^3)$**	**Substance**	**$\rho(kg/m^3)$**
Aluminum	2.70×10^3	Benzene	8.79×10^2	Air	1.29×10^0
Bone	1.90×10^3	Blood	1.05×10^3	Carbon dioxide	1.98×10^0
Brass	8.44×10^3	Ethyl alcohol	8.06×10^2	Carbon monoxide	1.25×10^0

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Solids (0.0°C)		Liquids (0.0°C)		Gases (0.0°C, 101.3 kPa)	
Concrete	2.40×10^3	Gasoline	6.80×10^2	Helium	1.80×10^{-1}
Copper	8.92×10^3	Glycerin	1.26×10^3	Hydrogen	9.00×10^{-2}
Cork	2.40×10^2	Mercury	1.36×10^4	Methane	7.20×10^{-2}
Earth's crust	3.30×10^3	Olive oil	9.20×10^2	Nitrogen	1.25×10^0
Glass	2.60×10^3			Nitrous oxide	1.98×10^0
Gold	1.93×10^4			Oxygen	1.43×10^0
Granite	2.70×10^3				
Iron	7.86×10^3				
Lead	1.13×10^4				
Oak	7.10×10^2				
Pine	3.73×10^2				
Platinum	2.14×10^4				
Polystyrene	1.00×10^2				
Tungsten	1.93×10^4				
Uranium	1.87×10^3 — 4				

Table 14.1 Densities of Some Common Substances

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Getur verið mjög háð hitastigi

Substance	$\rho(\mathrm{kg/m^3})$
Ice (0°C)	9.17×10^2
Water (0°C)	9.998×10^2
Water (4°C)	1.000×10^3
Water (20°C)	9.982×10^2
Water (100°C)	9.584×10^2
Steam (100°C, 101.3 kPa)	1.670×10^2
Sea water (0°C)	1.030×10^3

Table 14.2 Densities of Water

$$\text{Specific gravity} = \frac{\text{Density of material}}{\text{Density of water}}$$

Getur verið breytilegt í misleitum vökva

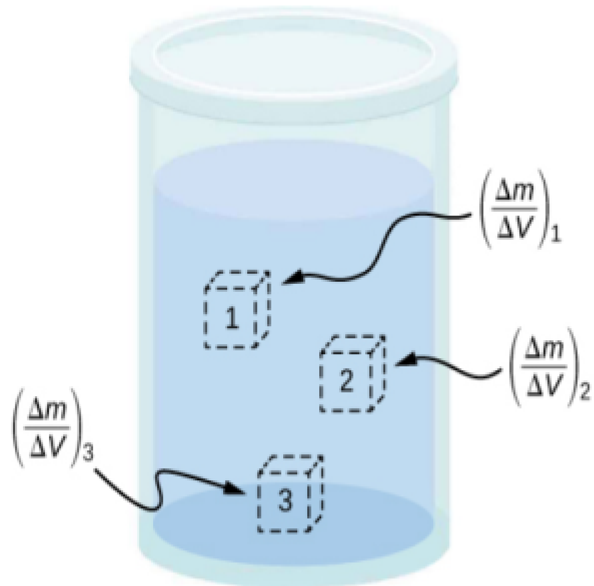

Figure 14.4 Density may vary throughout a heterogeneous mixture. Local density at a point is obtained from dividing mass by volume in a small volume around a given point.

Local density can be obtained by a limiting process, based on the average density in a small volume around the point in question, taking the limit where the size of the volume approaches zero,

$$\rho = \lim_{\Delta V \to 0} \frac{\Delta m}{\Delta V} \tag{14.2}$$

where ρ is the density, m is the mass, and V is the volume.

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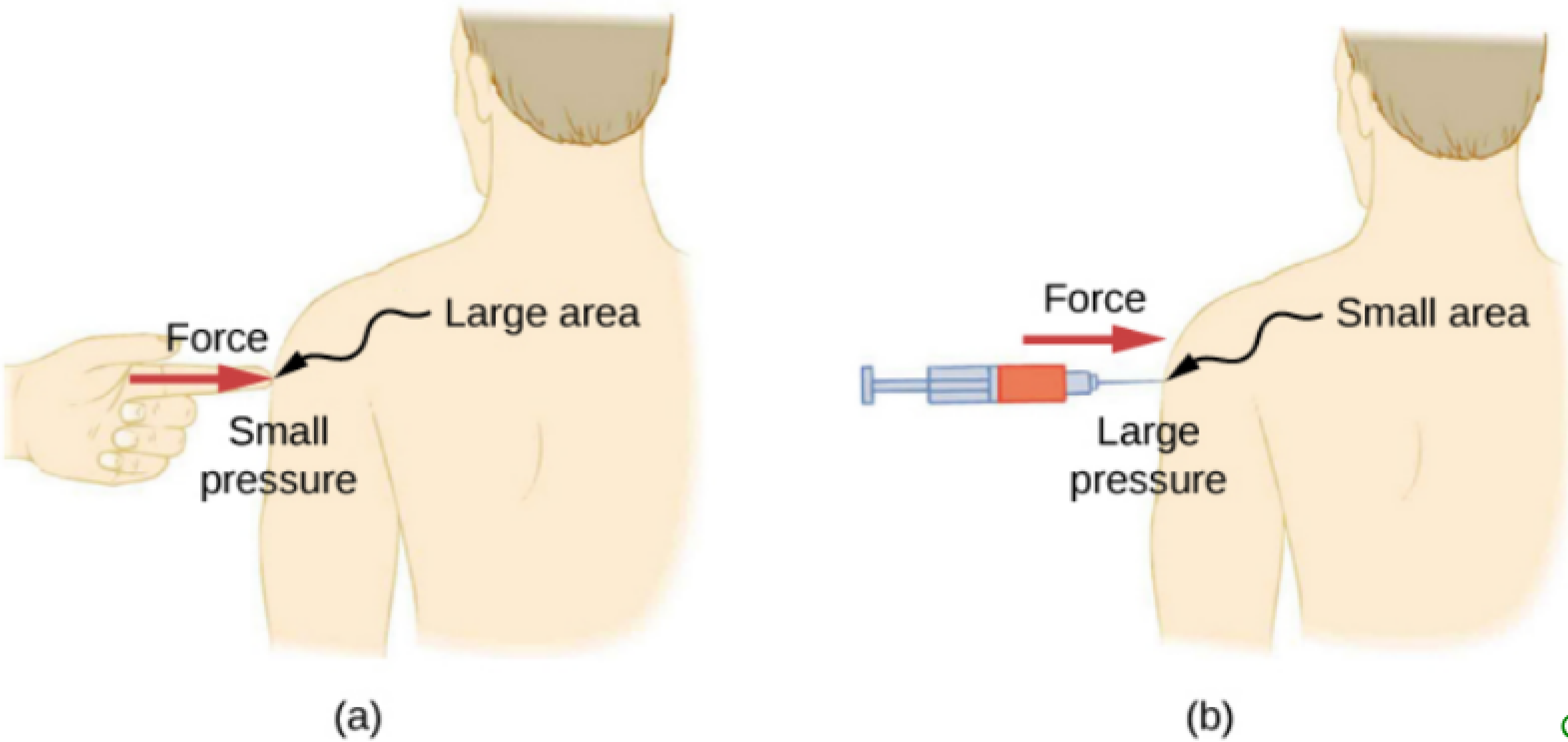
þrýstingur - pressure

Pressure

Pressure (p) is defined as the normal force F per unit area A over which the force is applied, or

$$p = \frac{F}{A}. \qquad (14.3)$$

To define the pressure at a specific point, the pressure is defined as the force dF exerted by a fluid over an infinitesimal element of area dA containing the point, resulting in $p = \frac{dF}{dA}$.



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þrýstingur sem fall af dýpt

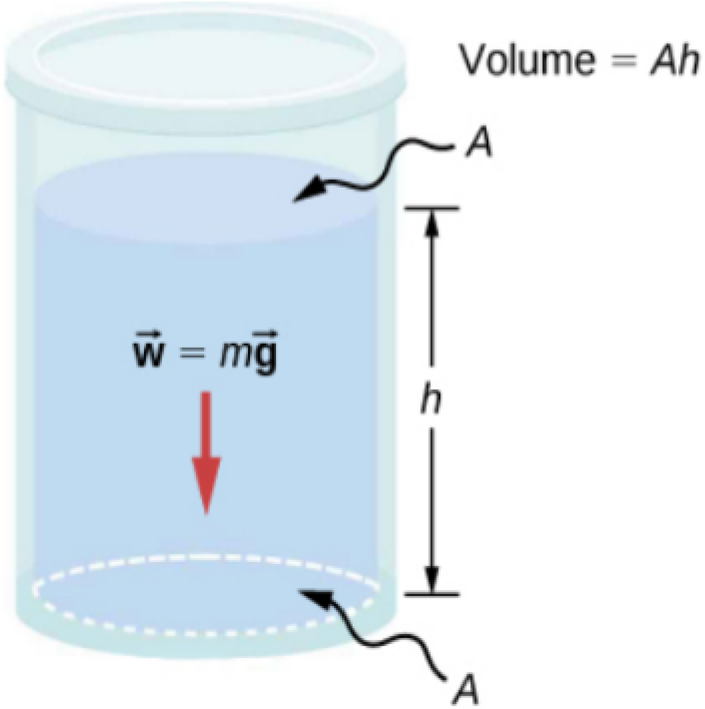

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Figure 14.6 The bottom of this container supports the entire weight of the fluid in it. The vertical sides cannot exert an upward force on the fluid (since it cannot withstand a shearing force), so the bottom must support it all.

Á dýpi h vegur vökvasúlan

$$w = mg = [\rho V] g = [\rho A h] g$$

því er þrýstingur á dýpi h

$$p(h) = \frac{F}{A} = p_0 + \rho h g$$

$$p(0) = p_0$$

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Pressure at a Depth for a Fluid of Constant Density

The pressure at a depth in a fluid of constant density is equal to the pressure of the atmosphere plus the pressure due to the weight of the fluid, or

$$\boxed{p = p_0 + \rho h g,} \tag{14.4}$$

Where p is the pressure at a particular depth, p_0 is the pressure of the atmosphere, ρ is the density of the fluid, g is the acceleration due to gravity, and h is the depth.

Ex, 14.1

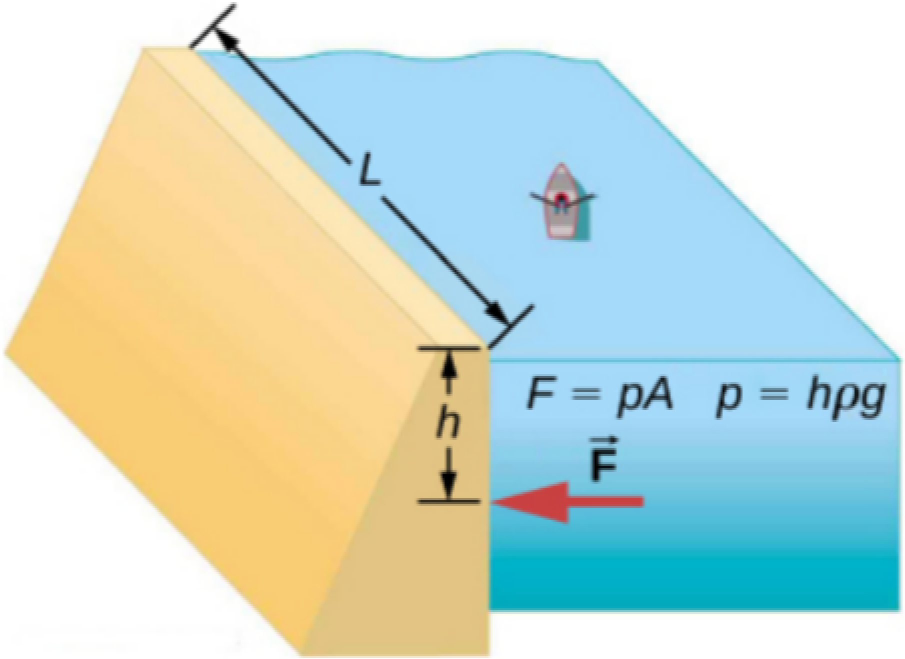
$L = 500\,m$

$h = 80,0\,m$

Meðal þrýstingur á garð

$$\langle p \rangle = \langle h \rangle \rho g = 40\,m\left(1000\,\frac{kg}{m^3}\right)\left(9,80\,m/s^2\right)$$

$$= 3,92 \cdot 10^5\,\frac{N}{m^2}$$



$$F = \langle p \rangle A = \langle h \rangle \rho g A$$

$$= 1,57 \cdot 10^{10}\,N$$

Þrýstingur vökva í jafnvægi í föstum þyngdarkrafti

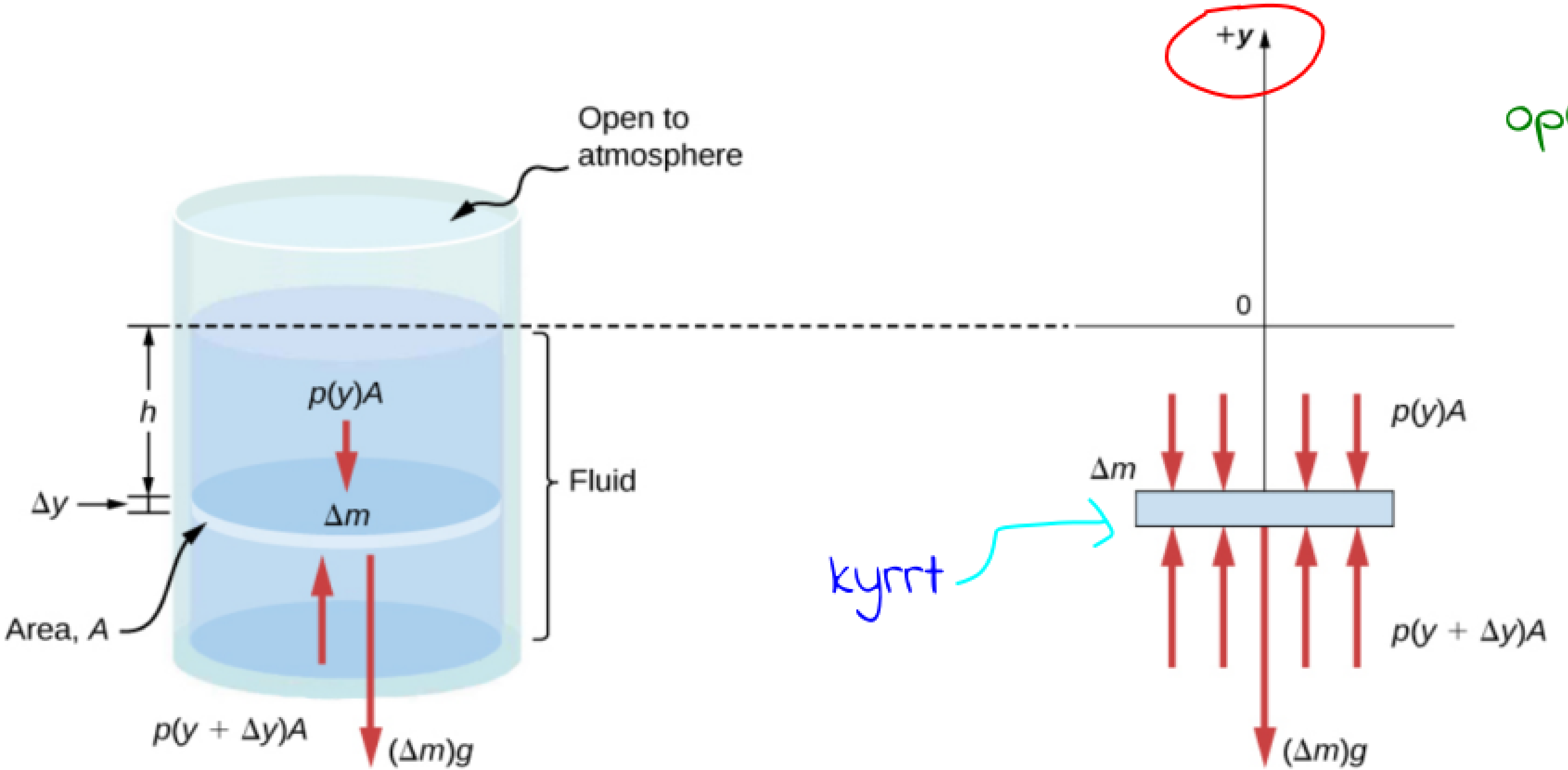


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Figure 14.8 Forces on a mass element inside a fluid. The weight of the element itself is shown in the free-body diagram.

$$p(y+\Delta y)A - p(y)A - g\Delta m = 0, \quad \Delta m = |\rho A \Delta y| = -\rho A \Delta y$$

$$\rightarrow \quad \frac{p(y+\Delta y) - p(y)}{\Delta y} = -\rho g \quad \rightarrow \quad \boxed{\frac{dp}{dy} = -\rho g}$$

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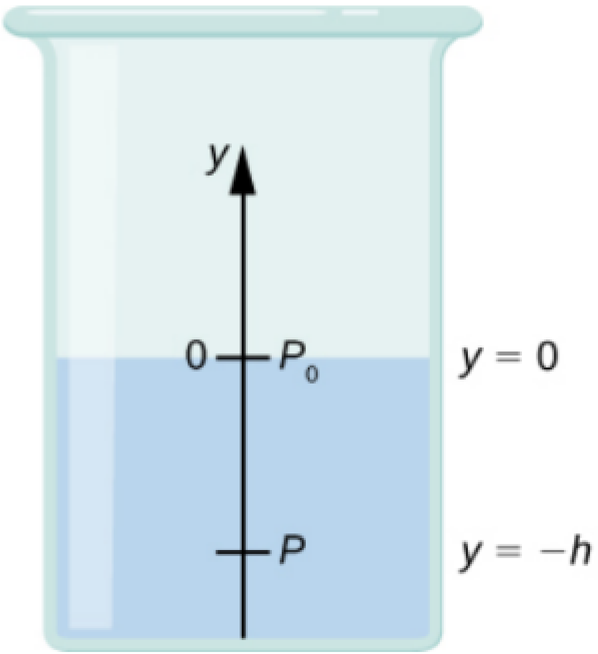
Reynum



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

$$\rightarrow \quad dp = -\rho g\, dy$$

heildum

$$\int_{P_0}^{P} dp' = -\int_{0}^{-h} \rho g\, dy$$

$$\rightarrow \quad \{P - P_0\} = -\rho g(-h) = \rho g h$$

$$\rightarrow \quad \boxed{P = P_0 + \rho g h}$$

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..en í andrúmslofti í jafnvægi?

kjörgas - ideal gas: $pV = nRT$

$$\to p = \frac{nRT}{V} = \frac{nRm}{V}\frac{T}{m} = \frac{nmN_A}{V}\frac{k_B T}{m}$$

$$= \rho \frac{k_B T}{m}$$

massi sameindar

En höfðum líka

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

$$= -g\left[\frac{pm}{k_B T}\right]$$

n : fjöldi móla

N_A : Tala Avogadrosar

k_B : fasti Boltzmanns

$$\to \frac{dp}{dy} = -p\left[\frac{mg}{k_B T}\right] = -\alpha p$$

aðgreinum breytistærðir

$$\frac{dp}{p} = -\alpha\, dy \rightarrow \int_{p_0}^{p(y)} \frac{dp}{p} = -\alpha \int_0^y dy$$

$$\rightarrow \ln\left[\frac{p(y)}{p_0}\right] = -\alpha y \rightarrow \boxed{p(y) = p_0 e^{-\alpha y}}$$

$$\alpha = \frac{mg}{k_B T} = \frac{4{,}8 \cdot 10^{-26}\,\mathrm{kg} \cdot 9{,}81\,\mathrm{m/s^2}}{1{,}38 \cdot 10^{-23}\,\mathrm{J/K} \cdot 300\,\mathrm{K}} \approx \frac{1}{8800\,\mathrm{m}}$$

fyrir N_2

Stefna þrýsings

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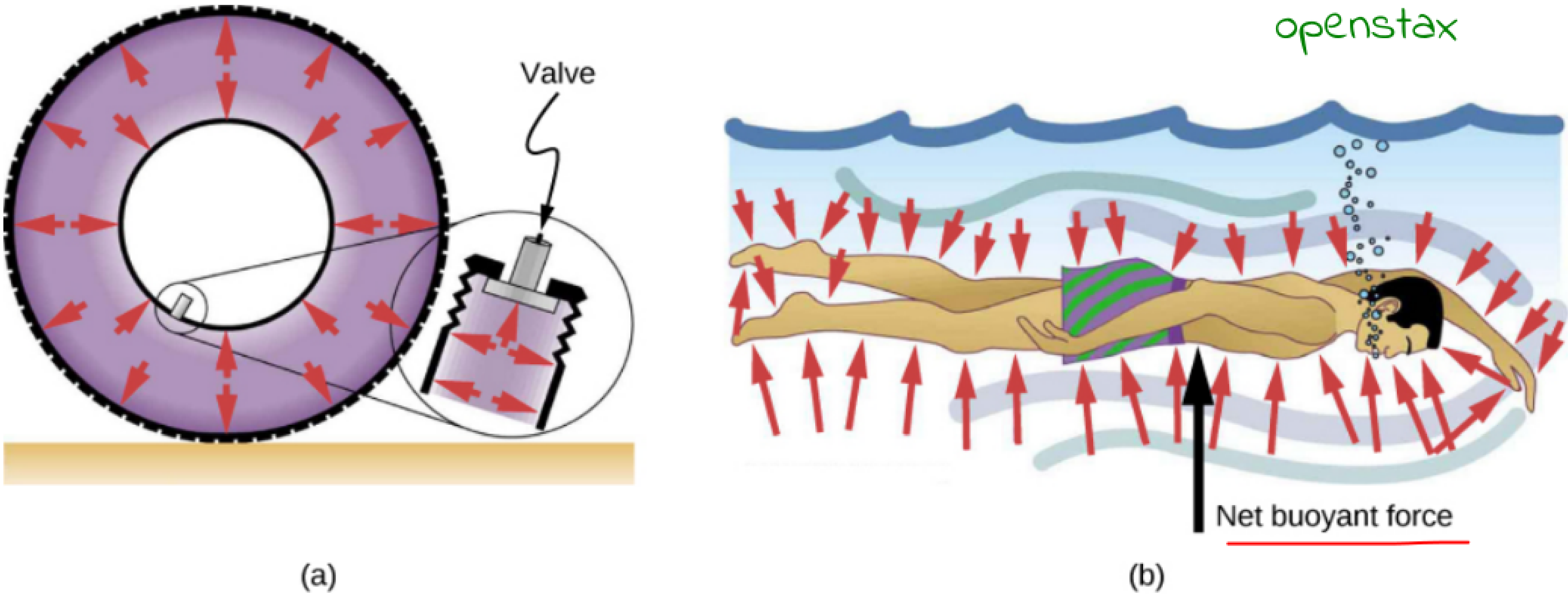

Figure 14.10 (a) Pressure inside this tire exerts forces perpendicular to all surfaces it contacts. The arrows represent directions and magnitudes of the forces exerted at various points. (b) Pressure is exerted perpendicular to all sides of this swimmer, since the water would flow into the space he occupies if he were not there. The arrows represent the directions and magnitudes of the forces exerted at various points on the swimmer. Note that the forces are larger underneath, due to greater depth, giving a net upward or buoyant force. The net vertical force on the swimmer is equal to the sum of the buoyant force and the weight of the swimmer.

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brýstingur mældur

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Absolute Pressure

The absolute pressure, or total pressure, is the sum of gauge pressure and atmospheric pressure:

$$p_{abs} = p_g + p_{atm} \tag{14.11}$$

where p_{abs} is absolute pressure, p_g is gauge pressure, and p_{atm} is atmospheric pressure.

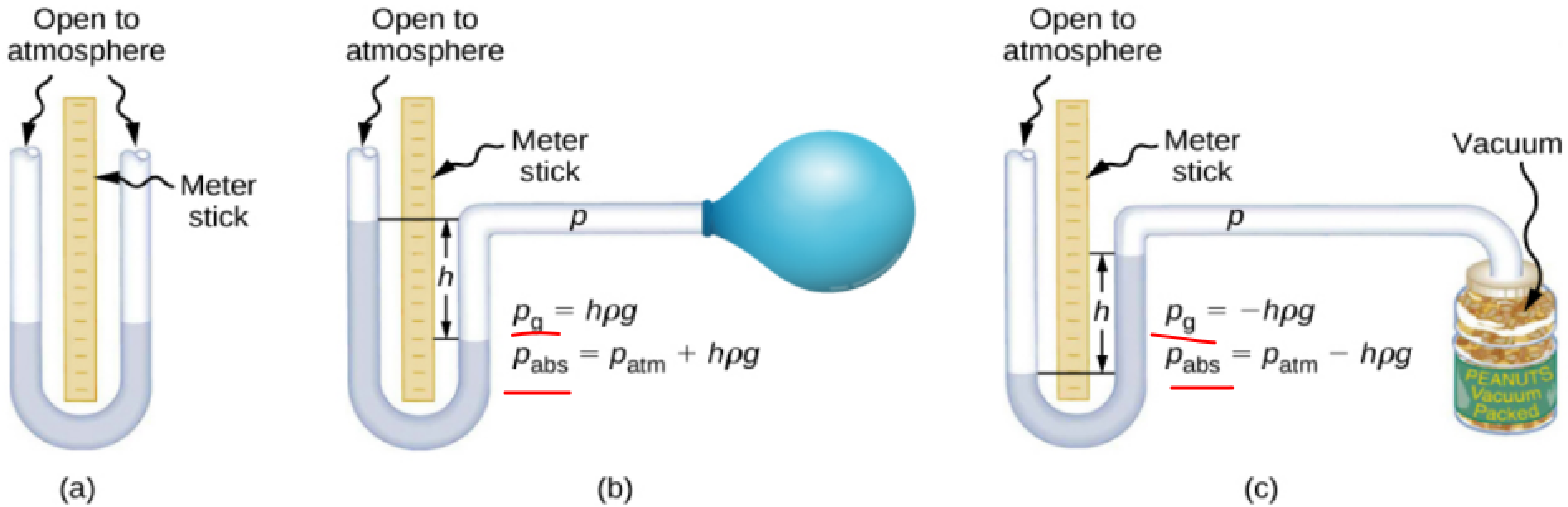

Figure 14.12 An open-tube manometer has one side open to the atmosphere. (a) Fluid depth must be the same on both sides, or the pressure each side exerts at the bottom will be unequal and liquid will flow from the deeper side. (b) A positive gauge pressure $p_g = h\rho g$ transmitted to one side of the manometer can support a column of fluid of height h. (c) Similarly, atmospheric pressure is greater than a negative gauge pressure p_g by an amount $h\rho g$. The jar's rigidity prevents atmospheric pressure from being transmitted to the peanuts.

14

Loftvog

Unit	Definition
SI unit: the Pascal	1 Pa = 1 N/m^2
English unit: pounds per square inch (lb/in.^{2} or psi)	1 psi = 6.895×10^3 Pa
Mismunandi einingar Other units of pressure	1 atm = 760 mmHg = 1.013×10^5 Pa = 14.7 psi = 29.9 inches of Hg = 1013 mbar
	1 bar = 10^5 Pa
	1 torr = 1 mm Hg = 133.3 Pa

Table 14.3 Summary of the Units of Pressure

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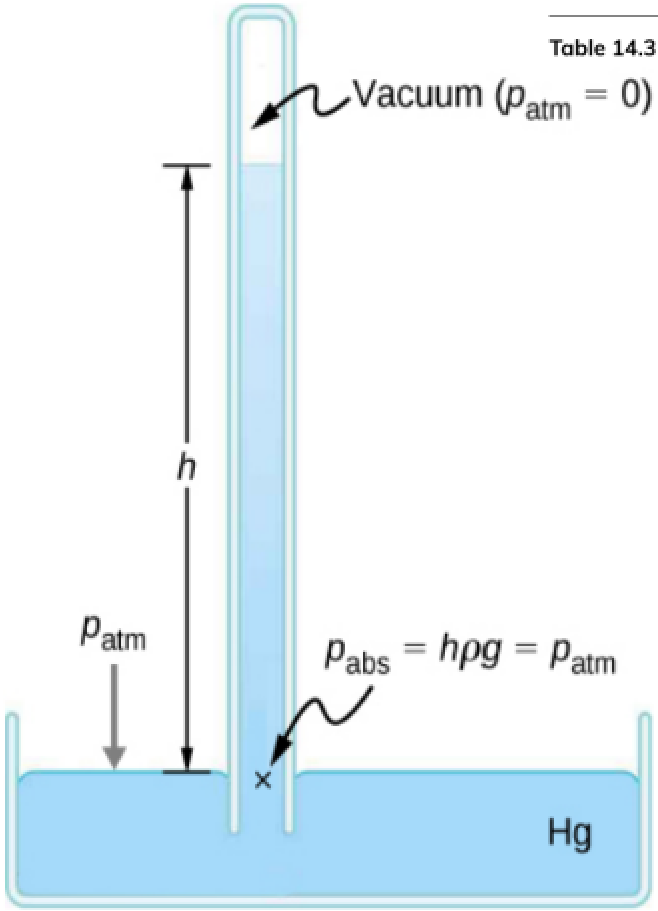

Figure 14.13 A mercury barometer measures atmospheric pressure. The pressure due to the mercury's weight, $h\rho g$, equals atmospheric pressure. The atmosphere is able to force mercury in the tube to a height h because the pressure above the mercury is zero.

Lögmál Pascals

$$\Delta p_{\text{top}} = \frac{Mg}{A}.$$

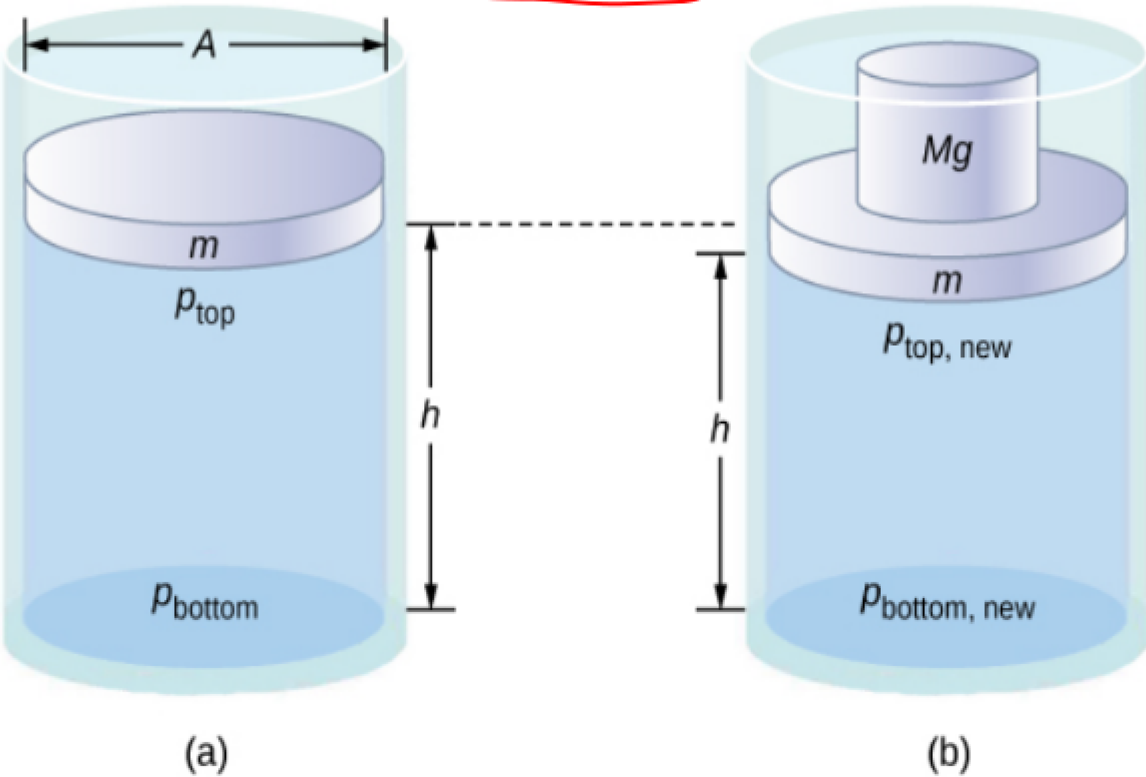

Figure 14.15 Pressure in a fluid changes when the fluid is compressed. (a) The pressure at the top layer of the fluid is different from pressure at the bottom layer. (b) The increase in pressure by adding weight to the piston is the same everywhere, for example, $p_{\text{top new}} - p_{\text{top}} = p_{\text{bottom new}} - p_{\text{bottom}}$.

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Vökva-kerfi - hydrolic systems

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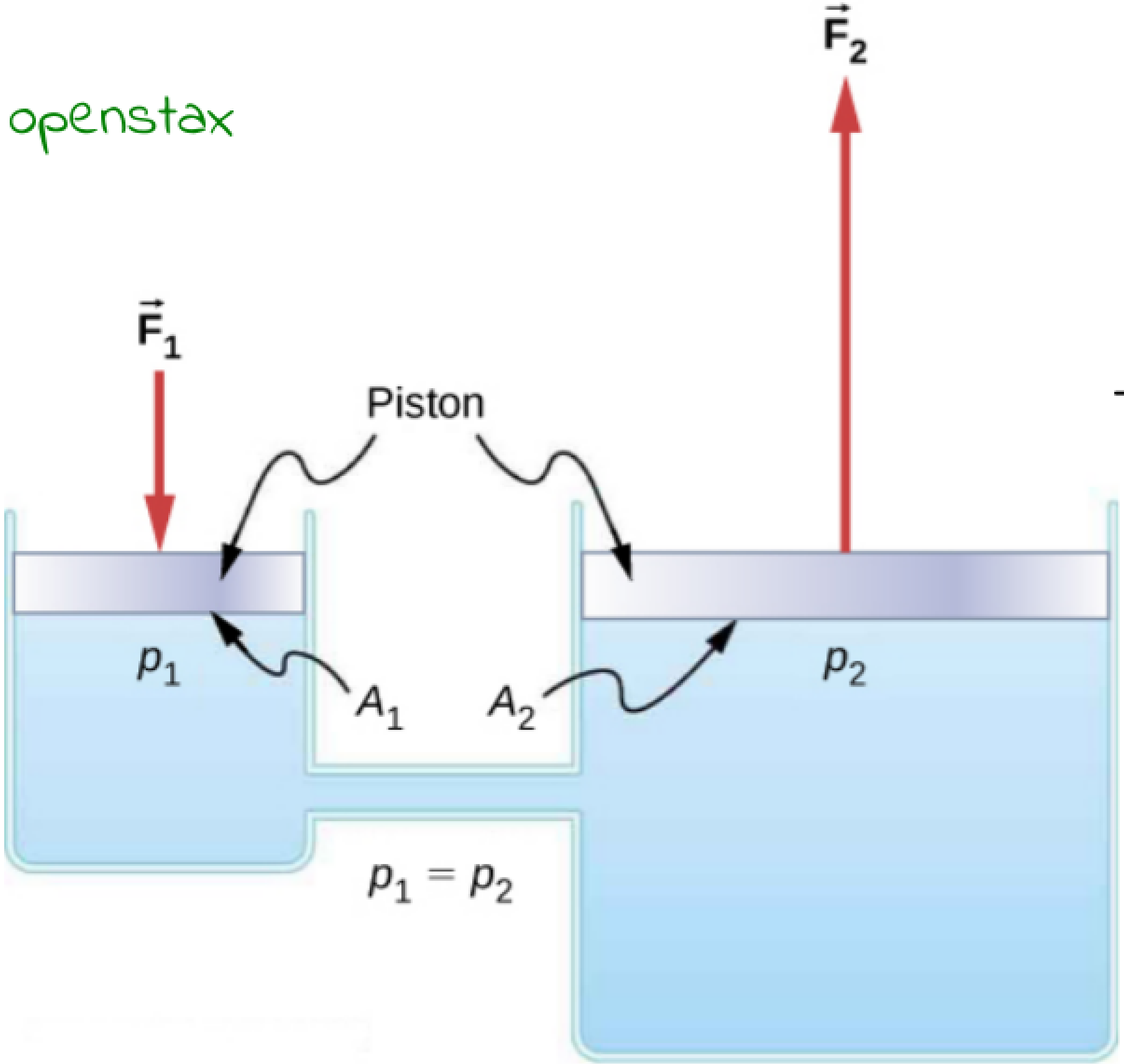

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$\longrightarrow \quad F_2 = \underbrace{\left(\frac{A_2}{A_1}\right)}_{} F_1$$

t.d.: > 1

Nýting:
Lyftur (tjakkar)
Bremsukerfi
Stýri
...