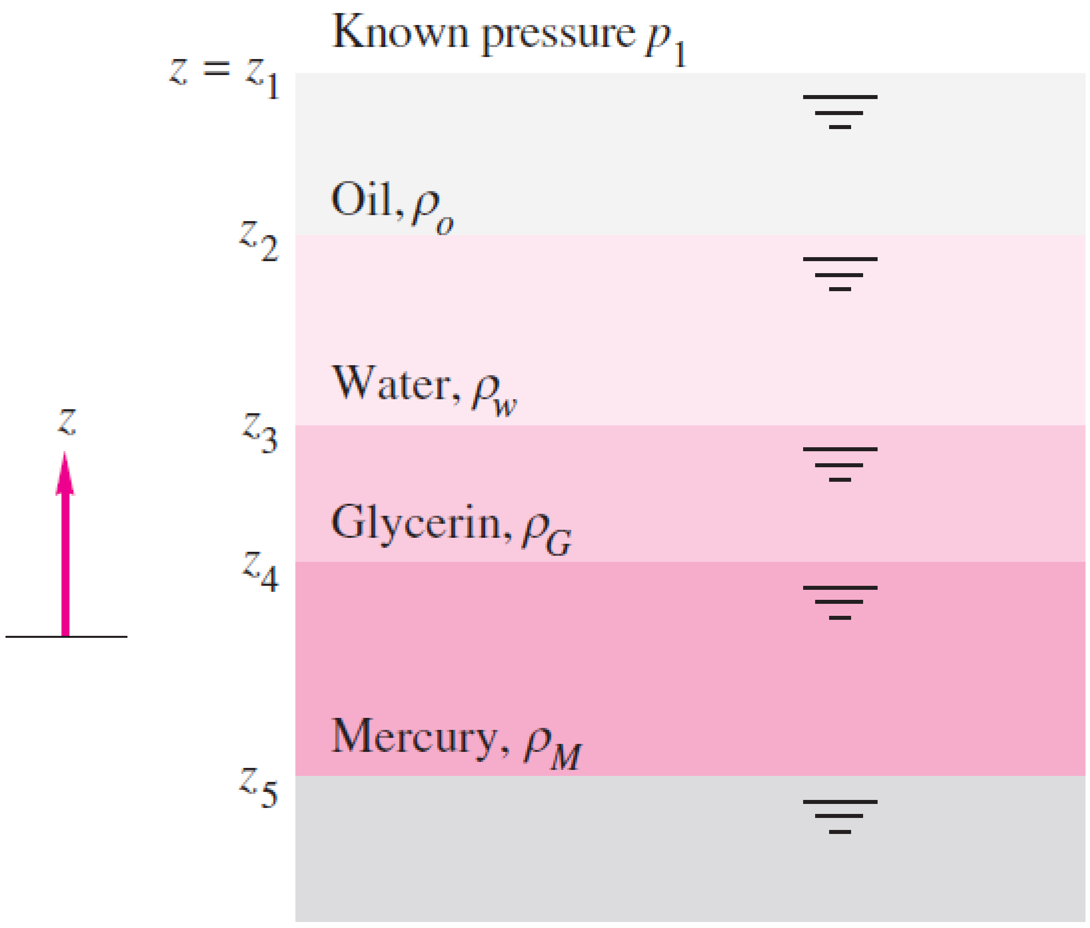
Estática dos Fluidos (parte 2)

Ref. White F.M., Mecânica dos Fluidos, McGraw-Hill

Pressão hidrostática diversos fluidos



$$p_2 - p_1 = -\rho_o g(z_2 - z_1)$$

$$p_3 - p_2 = -\rho_w g(z_3 - z_2)$$

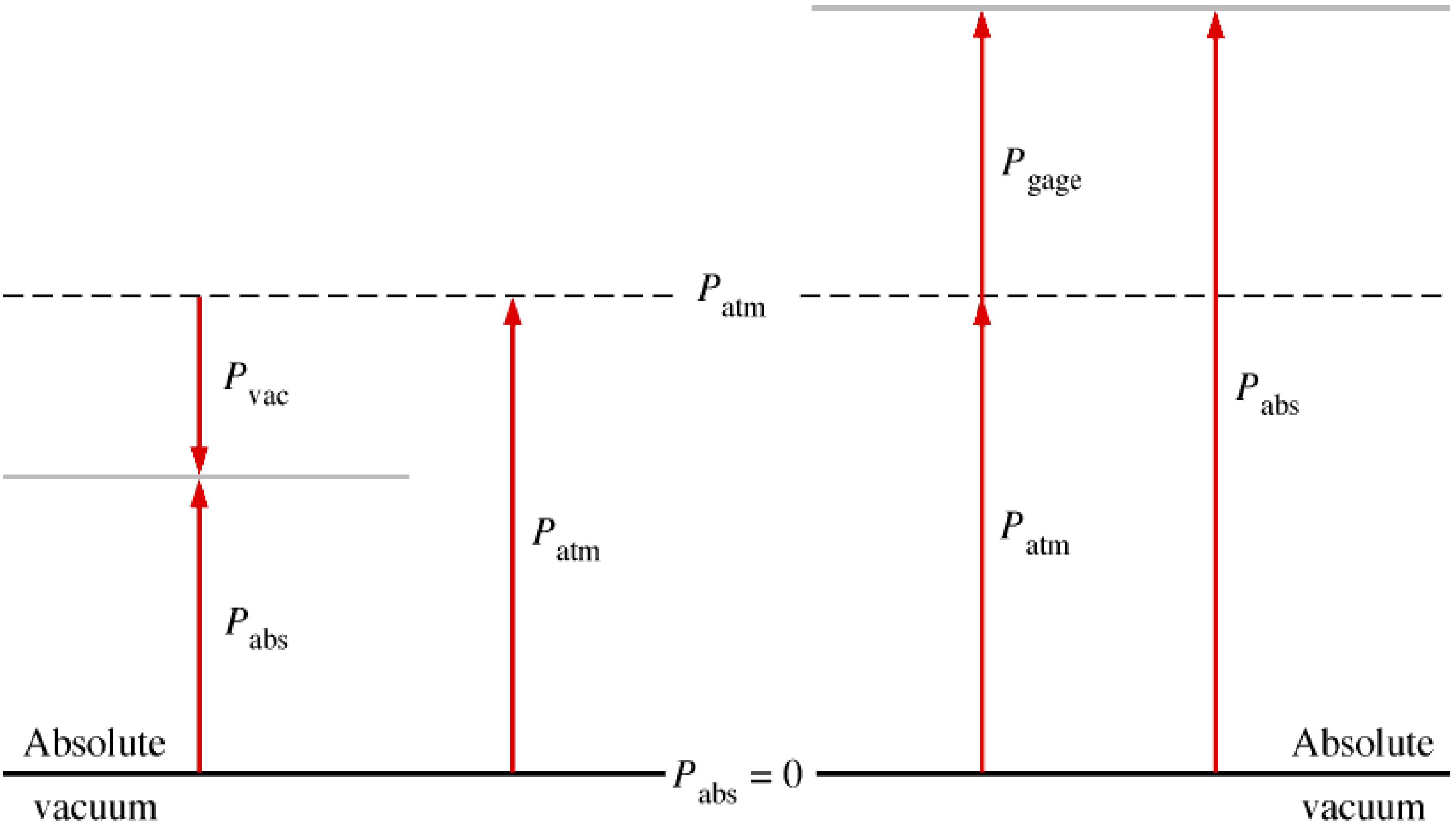
$$p_4 - p_3 = -\rho_G g(z_4 - z_3)$$

$$p_5 - p_4 = -\rho_M g(z_5 - z_4)$$

$$\text{Sum} = p_5 - p_1$$

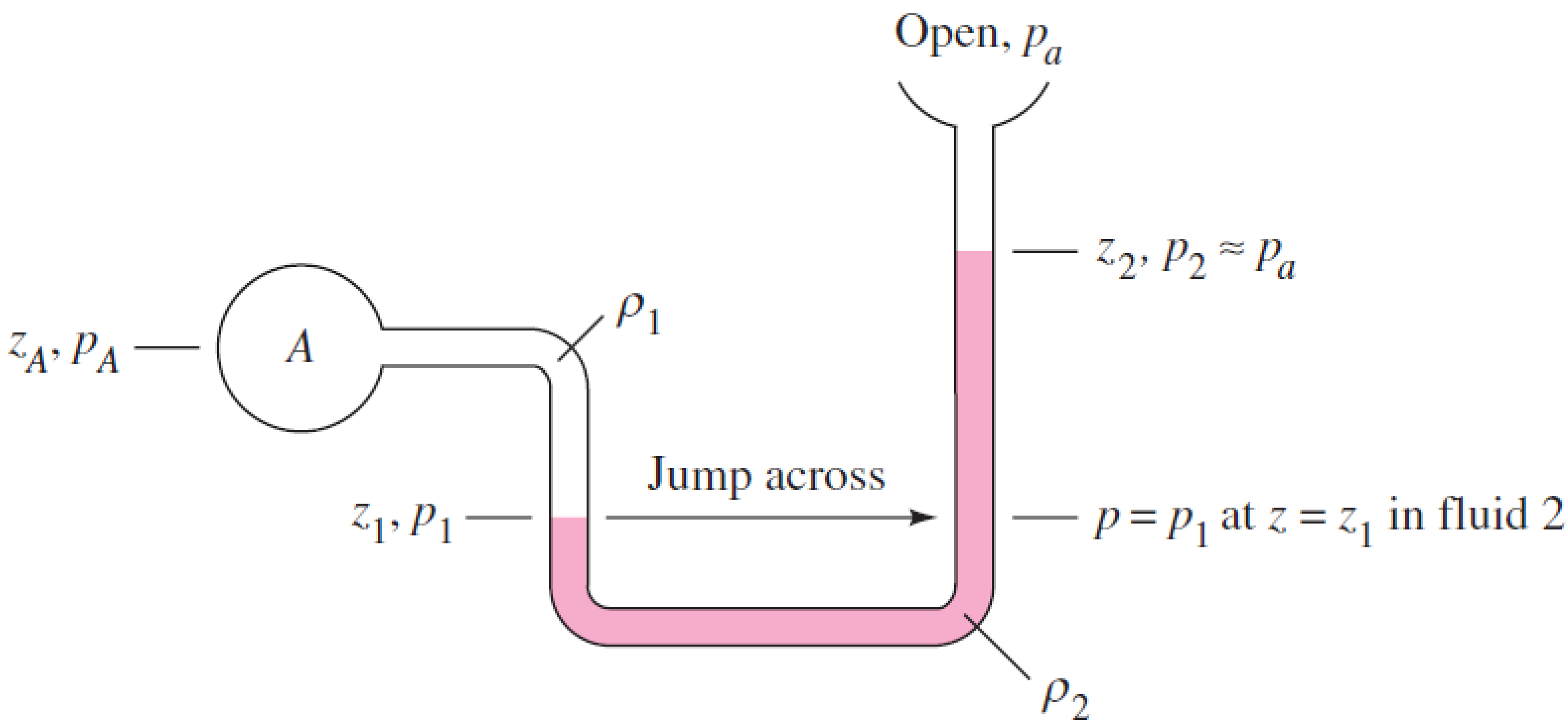
$$p_5 = p_1 + \gamma_0 |z_1 - z_2| + \gamma_w |z_2 - z_3| + \gamma_G |z_3 - z_4| + \gamma_M |z_4 - z_5|$$

Pressões absoluta e manométrica



Manometria: tubo U

- Manômetro comum:

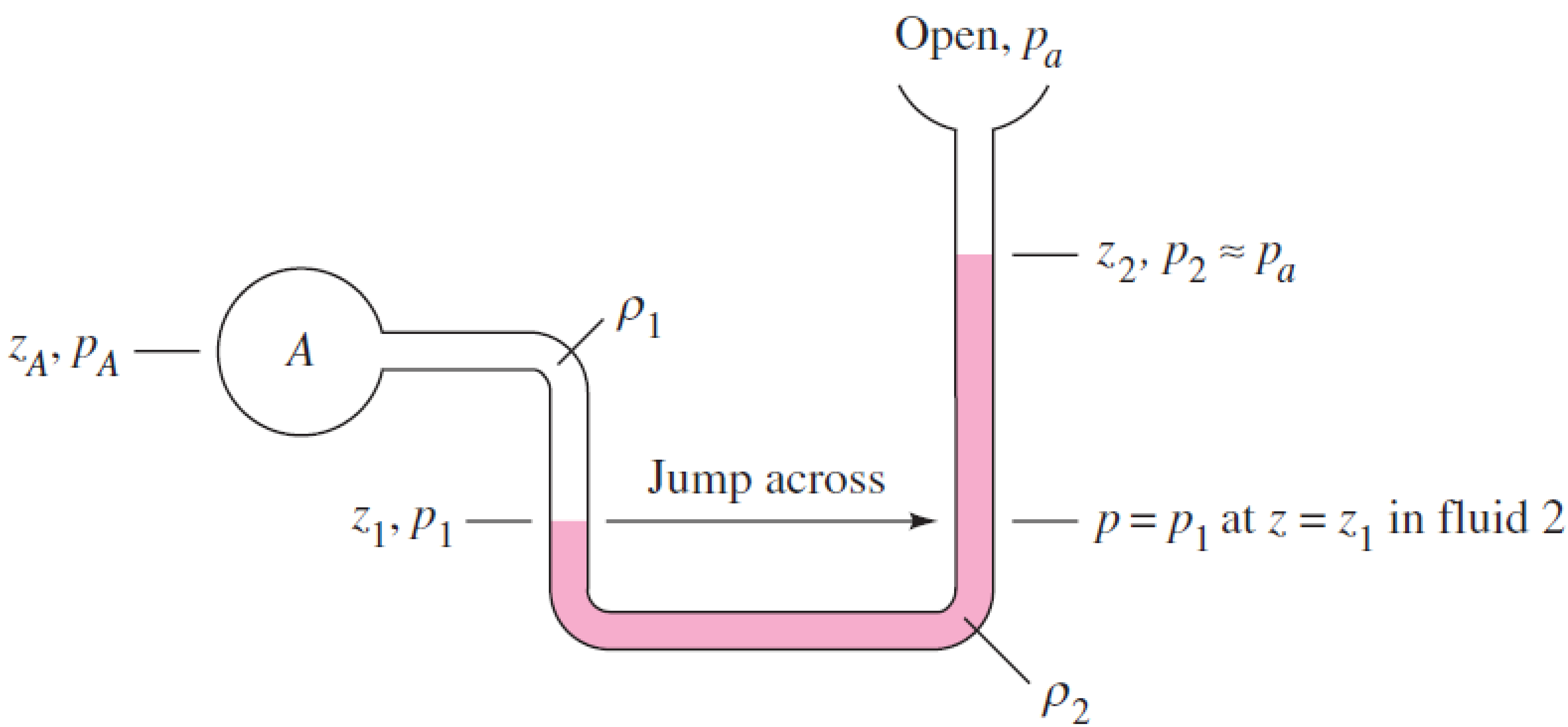


$$p_A + \gamma_1 |z_A - z_1| - \gamma_2 |z_1 - z_2| = p_2 \approx p_{atm}$$

$$P_{man} = \gamma_2(Z_2 - Z_1) - \gamma_1(Z_A - Z_1)$$

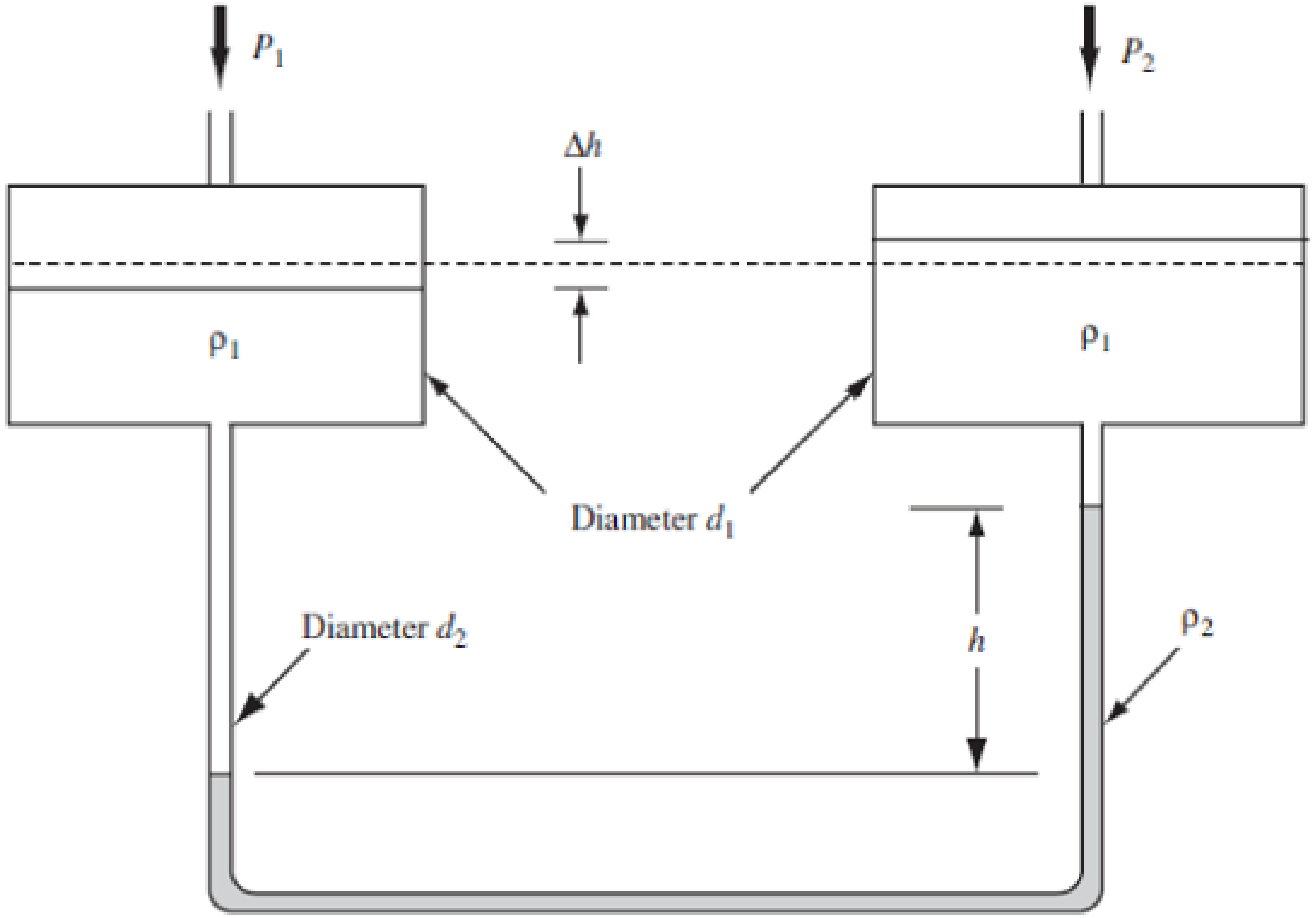
Manometria: Tubo U

- Manômetro baixas pressões: $\gamma_2 \approx \gamma_1$
- Manômetro altas pressões: $\gamma_2 \gg \gamma_1$



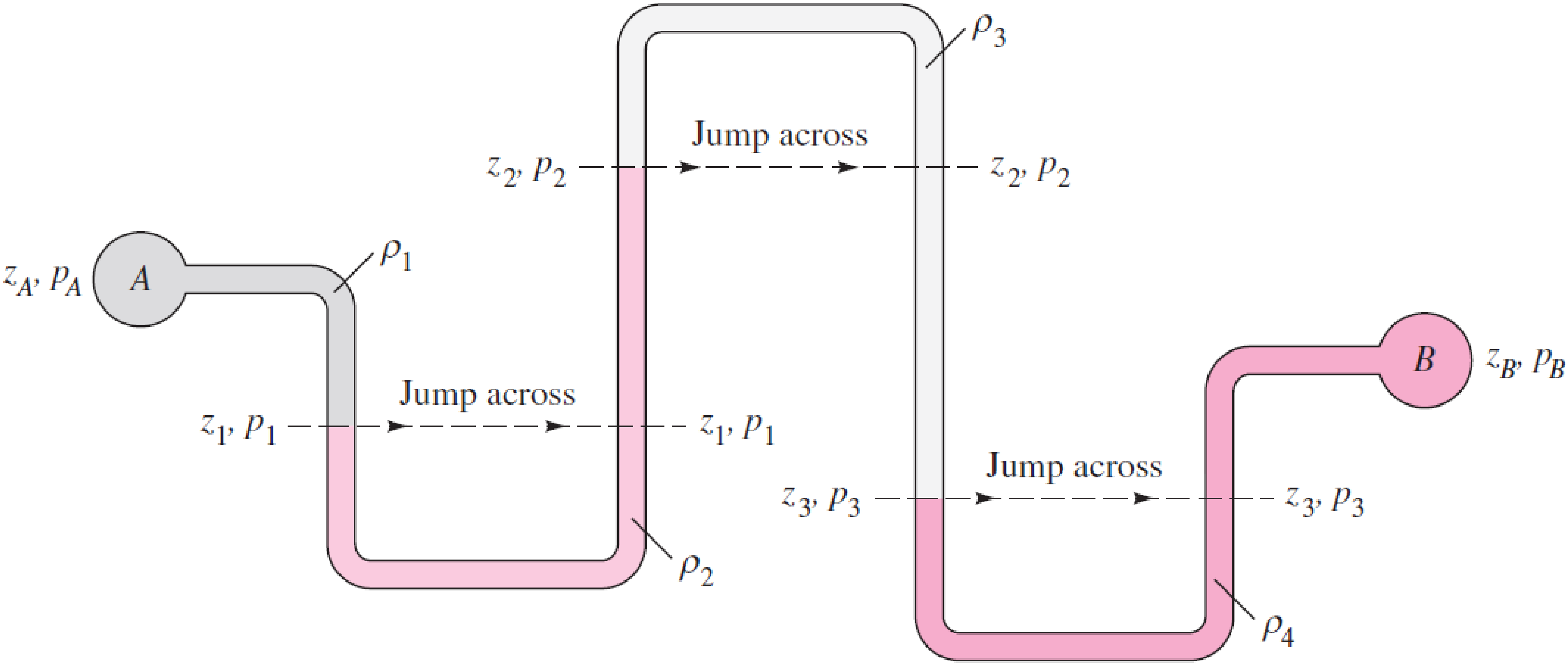
Manometria: tubo U

- Pressões muito baixas: micromanômetro, onde $\gamma_2 \gg \gamma_1$



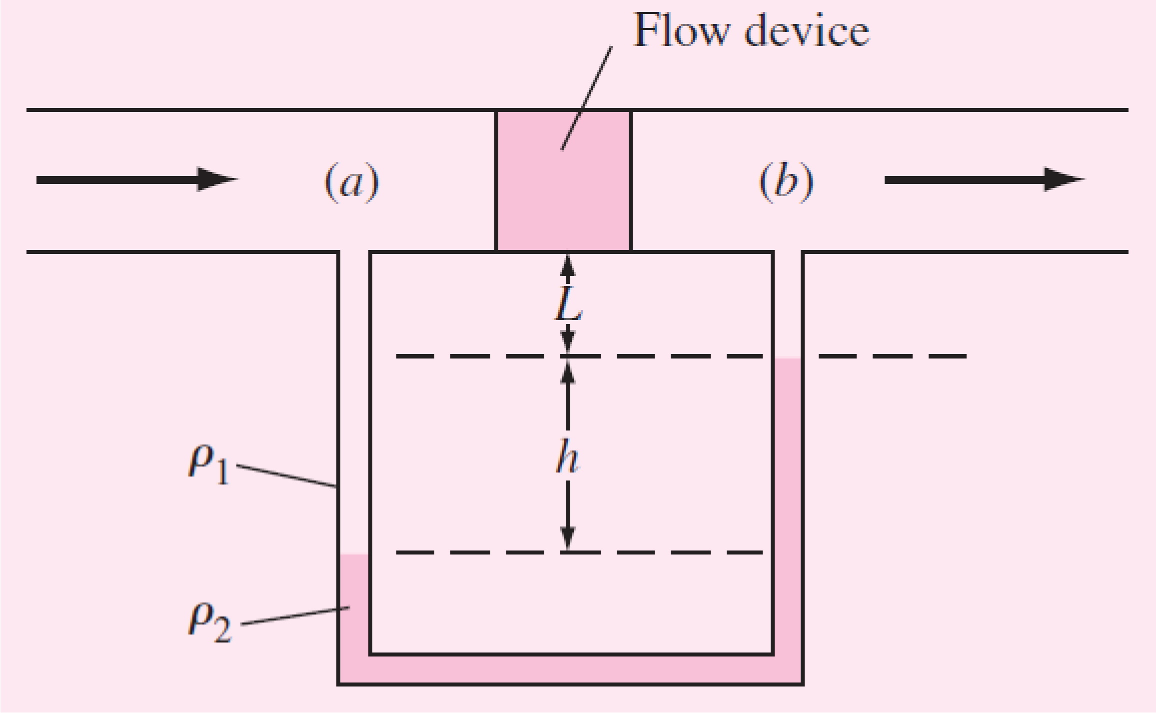
Manômetria

- Podemos fazer manômetros mais complicados...



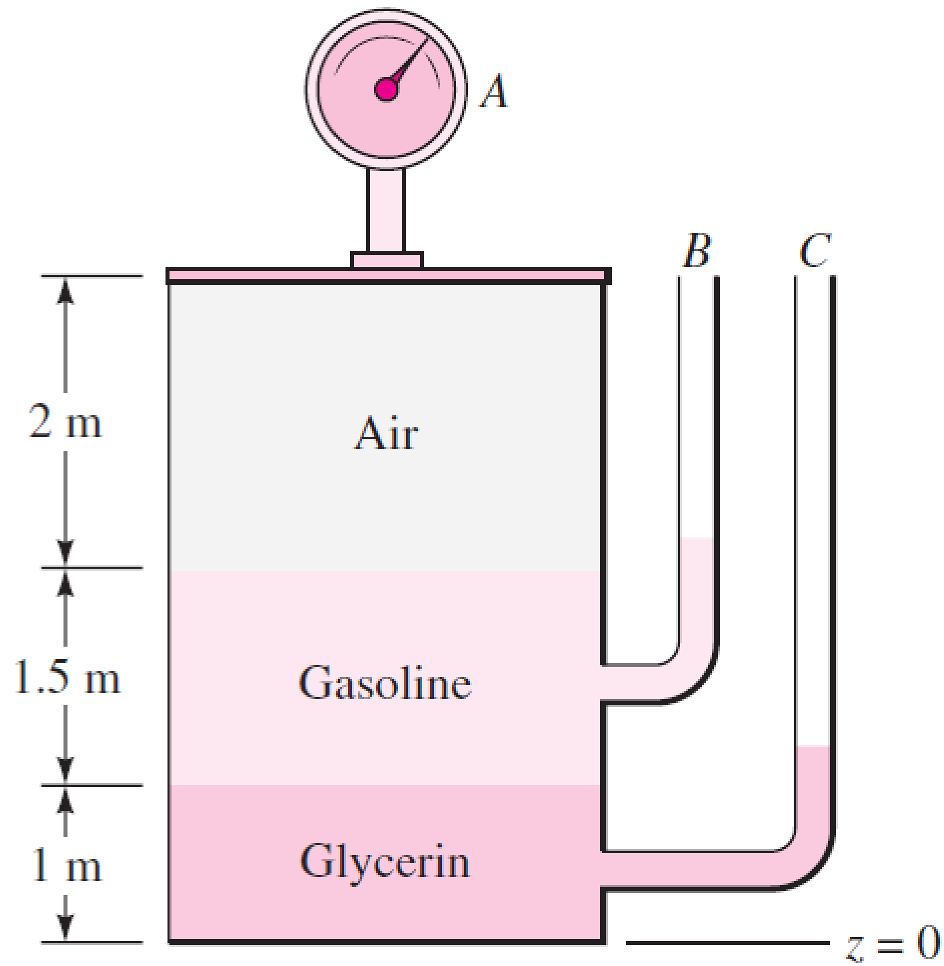
$$p_A - p_B = (p_A - p_1) + (p_1 - p_2) + (p_2 - p_3) + (p_3 - p_B)$$
$$= -\gamma_1(z_A - z_1) - \gamma_2(z_1 - z_2) - \gamma_3(z_2 - z_3) - \gamma_4(z_3 - z_B)$$

Exemplo



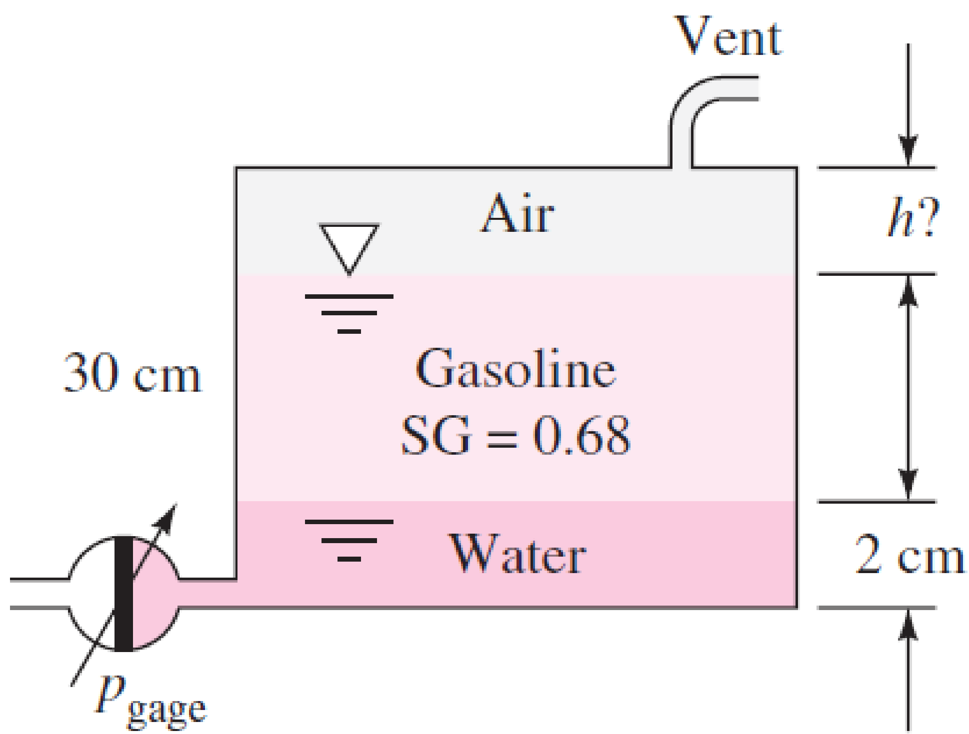
$$p_a - p_b = (\rho_2 - \rho_1)gh$$

P2.11 In Fig. P2.11, pressure gage *A* reads 1.5 kPa (gage). The fluids are at 20°C. Determine the elevations *z*, in meters, of the liquid levels in the open piezometer tubes *B* and *C*.



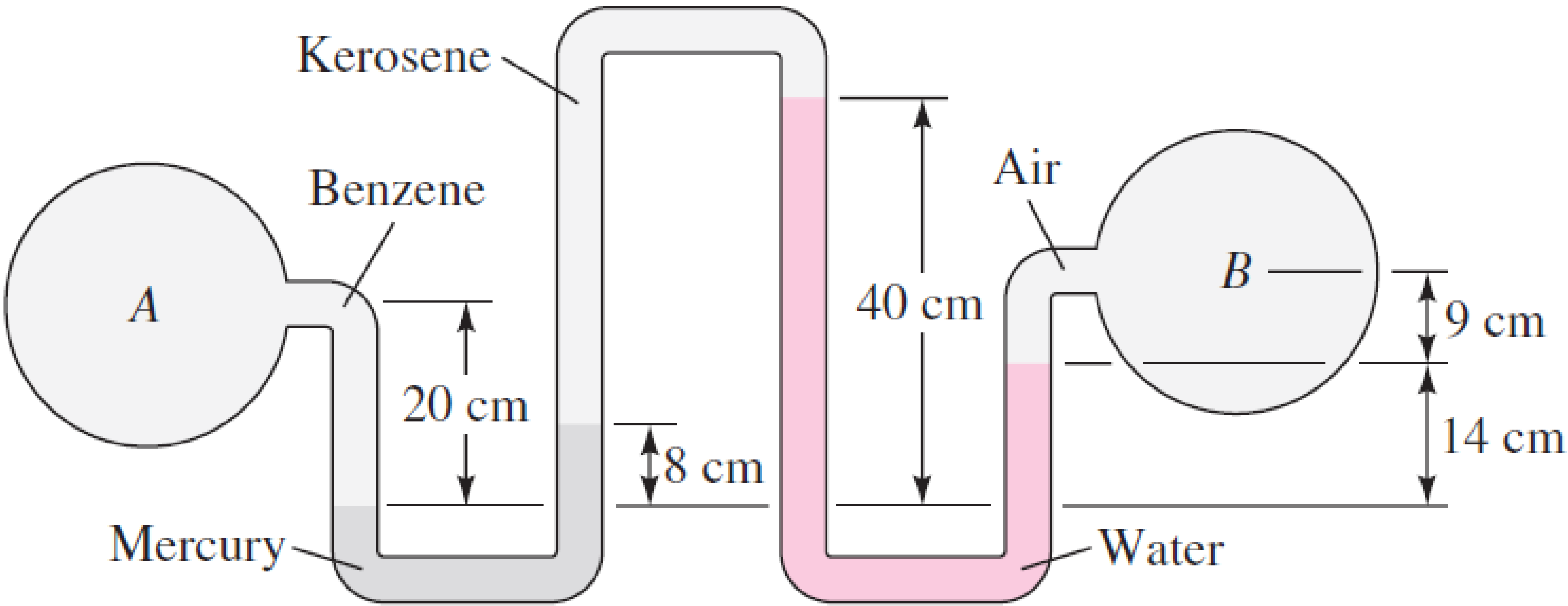
P2.11

P2.22 The fuel gage for a gasoline tank in a car reads proportional to the bottom gage pressure as in Fig. P2.22. If the tank is 30 cm deep and accidentally contains 2 cm of water plus gasoline, how many centimeters of air remain at the top when the gage erroneously reads "full"?



P2.22

P2.31 In Fig. P2.31 all fluids are at 20°C. Determine the pressure difference (Pa) between points *A* and *B*.



2-12 A Figura P2-12 mostra um pistão instalado em um cilindro. A massa do pistão é 15 kg. A pressão absoluta em A e B são 100 kPa e 125 kPa, respectivamente. Determine o valor e a direção de $\mathbf{F_R}$ necessária para manter o pistão em equilíbrio estático. Assuma que a pressão atmosférica atua sobre a haste exposta.

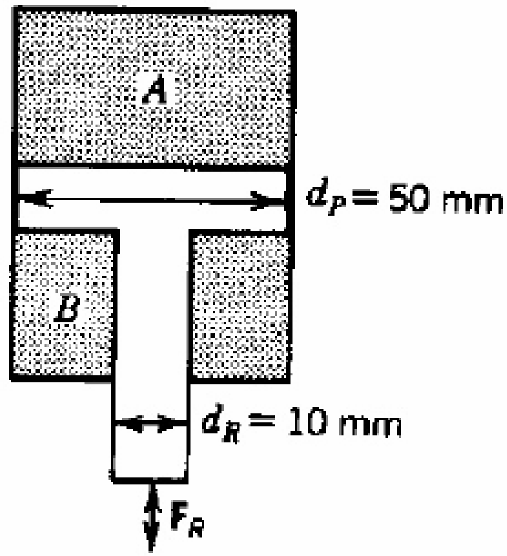


Figura P2-12 Arranjo pistão-cilindro.

Liquid	ρ, kg/m^3	μ, kg/(m · s)	Υ, N/m*	p_v, N/m^2	Bulk modulus K, N/m^2	Viscosity parameter $C^{\dagger}$
Ammonia	608	2.20 E−4	2.13 E−2	9.10 E+5	1.82 E+9	1.05
Benzene	881	6.51 E−4	2.88 E−2	1.01 E+4	1.47 E+9	4.34
Carbon tetrachloride	1590	9.67 E−4	2.70 E−2	1.20 E+4	1.32 E+9	4.45
Ethanol	789	1.20 E−3	2.28 E−2	5.7 E+3	1.09 E+9	5.72
Ethylene glycol	1117	2.14 E−2	4.84 E−2	1.2 E+1	3.05 E+9	11.7
Freon 12	1327	2.62 E−4	—	—	7.95 E+8	1.76
Gasoline	680	2.92 E−4	2.16 E−2	5.51 E+4	1.3 E+9	3.68
Glycerin	1260	1.49	6.33 E−2	1.4 E−2	4.35 E+9	28.0
Kerosene	804	1.92 E−3	2.8 E−2	3.11 E+3	1.41 E+9	5.56
Mercury	13,550	1.56 E−3	4.84 E−1	1.1 E−3	2.85 E+10	1.07
Methanol	791	5.98 E−4	2.25 E−2	1.34 E+4	1.03 E+9	4.63
SAE 10W oil	870	1.04 E−1‡	3.6 E−2	—	1.31 E+9	15.7
SAE 10W30 oil	876	1.7 E−1‡	—	—	—	14.0
SAE 30W oil	891	2.9 E−1‡	3.5 E−2	—	1.38 E+9	18.3
SAE 50W oil	902	8.6 E−1‡	—	—	—	20.2
Water	998	1.00 E−3	7.28 E−2	2.34 E+3	2.19 E+9	Table A.1
Seawater (30‰)	1025	1.07 E−3	7.28 E−2	2.34 E+3	2.33 E+9	7.28

Gas	Molecular weight	R, $m^2/(s^2 \cdot K)$	ρg, N/m^3	μ, $N \cdot s/m^2$	Specific-heat ratio	Power-law exponent n^*
H_2	2.016	4124	0.822	9.05 E−6	1.41	0.68
He	4.003	2077	1.63	1.97 E−5	1.66	0.67
H_2O	18.02	461	7.35	1.02 E−5	1.33	1.15
Ar	39.944	208	16.3	2.24 E−5	1.67	0.72
Dry air	28.96	287	11.8	1.80 E−5	1.40	0.67
CO_2	44.01	189	17.9	1.48 E−5	1.30	0.79
CO	28.01	297	11.4	1.82 E−5	1.40	0.71
N_2	28.02	297	11.4	1.76 E−5	1.40	0.67
O_2	32.00	260	13.1	2.00 E−5	1.40	0.69
NO	30.01	277	12.1	1.90 E−5	1.40	0.78
N_2O	44.02	189	17.9	1.45 E−5	1.31	0.89
Cl_2	70.91	117	28.9	1.03 E−5	1.34	1.00
CH_4	16.04	518	6.54	1.34 E−5	1.32	0.87