RESOLUÇÃO — LISTA Ø5

EXERCÍCIO Ø1:

DENSIDADE DO AR $\rho \cong kP$ ONDE $k = k(T)$

$$dP = -\rho g\, dz \Rightarrow dP = -kPg\, dz \Rightarrow \frac{dP}{P} = -kg\, dz$$

$$\int_{P_0}^{P_A} \frac{dP}{P} = \int_0^z (-kg)\, dz \Rightarrow \ln P_A - \ln P_0 = -kgz$$

$$\Rightarrow \ln\left(\frac{P_A}{P_0}\right) = -kgz \Rightarrow P_A = P_0 e^{-kgz} \quad (1)$$

EXPANDINDO (1) EM SÉRIE DE TAYLOR

$$e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!} \Rightarrow P_A = P_0(1 - kgz + \ldots) \cong P_0 - P_0 kgz$$

COMO A VARIAÇÃO É MUITO PEQUENA (EM z)

$$P_0 k \cong \rho_0 = 1{,}0\ kg/m^3$$

ONDE $P_0 = 1{,}013 \times 10^5\ Pa$ $\qquad Pa = \frac{N}{m^2}$

$$\therefore P_A = P_0 - \rho_0 g z$$

PARA $z = 100\ m$:

$$P_A = 1{,}013 \times 10^5\ Pa - \left(1{,}0\ kg/m^3\right)\left(9{,}8\ m/s^2\right)(100\ m)$$

$$P_A \cong 1{,}003 \times 10^5\ Pa$$

OU AINDA, $\quad P_0 - P_A = 980\ Pa = 980\ \frac{N}{m^2} = \Delta P$

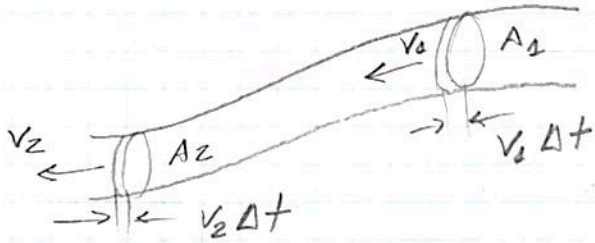
NO TÍMPANO $\Rightarrow$ ÁREA $= 0{,}6\ cm^2 = 0{,}6 \times 10^{-4}\ m^2$

A FORÇA EXERCIDA SERÁ: LEMBRANDO $P = \frac{F}{A}$

$$F = \left(980\ \frac{N}{m^2}\right)\left(0{,}6 \times 10^{-4}\ m^2\right)$$

$$F = 0{,}0588\ N \cong 0{,}06\ N$$

EXERCÍCIO 2:



NÃO VISCOSO $\eta = 0$

FLUXO: $Q = \frac{\Delta \text{VOLUME}}{\Delta t}$

$$Q_1 = \frac{(v_1 \Delta t) A_1}{\Delta t} = A_1 v_1 \therefore Q_2 = A_2 v_2$$

FLUXO CONSTANTE $\Rightarrow Q_1 = Q_2 \Rightarrow A_1 v_1 = A_2 v_2$

(a) TUBO HORIZONTAL — EQUAÇÃO DE BERNOULLI

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$

$$P_1 - P_2 = \frac{1}{2}\rho\left(v_2^2 - v_1^2\right) = \frac{1}{2}\rho\left(v_2^2 - \left(\frac{A_2}{A_1}\right)^2 v_2^2\right)$$

$$P_1 - P_2 = \frac{1}{2}\rho v_2^2\left(1 - \left(\frac{A_2}{A_1}\right)^2\right)$$

ASSIM, $$v_2 = \sqrt{\frac{2(P_1 - P_2)}{\rho\left(1 - (A_2/A_1)^2\right)}}$$

$P_1 - P_2 = 1{,}5 \times 10^3\ Pa$

$A_1 = \pi (0{,}045)^2\ m^2 \qquad A_2 = \pi (0{,}032)^2\ m^2$

$\rho = 950\ kg/m^3$

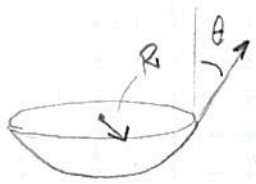
$$\therefore v_2 = \frac{2(1{,}5 \times 10^3)}{950\left(1 - (0{,}032/0{,}045)^2\right)}$$

$$v_2 \cong 6{,}39\ m/s$$

(b) VAZÃO $\Rightarrow Q_1 = Q_2 = v_2 A_2 \cong \left(6{,}39 \frac{m}{s}\right) \cdot \pi \cdot (0{,}032)^2\ m^2$

$$Q_2 \cong 0{,}02\ m^3/s$$

EXERCÍCIO 3:



$T_\gamma = 2\pi R \gamma \cos\theta$ FORÇA QUE EQUILIBRA A FRAÇÃO DO PESO SUPORTADA

MASSA = 2g = 0,002 kg

CADA PATA SUPORTA 1/8 DA MASSA

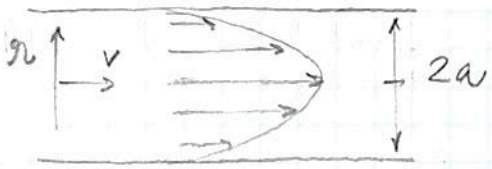
∴ PESO SUPORTADO $= \frac{1}{8} \times 0{,}002 \times 9{,}8 = 0{,}00245\,N$

γ (ÁGUA A 20°C) = 0,0728 N/m

$\theta = 45°$

$$R = \frac{T_\gamma}{2\pi\gamma\cos\theta} = \frac{0{,}00245}{2\pi(0{,}0728)\cos 45} \Rightarrow \boxed{R \cong 0{,}008\ mm}$$

EXERCÍCIO 4:



$F_p = (p_1 - p_2)\pi r^2$ PROPULSORA

$F_v = \eta\, 2\pi r \Delta x \frac{dv}{dr}$ VISCOSA

$F_v = F_p$

$$\eta\, 2\pi r \Delta x \frac{dv}{dr} = (p_1 - p_2)\pi r^2$$

$$\therefore \frac{dv}{dr} = \frac{(p_1 - p_2)\pi r^2}{\eta\, 2\pi r \Delta x} = \frac{1}{2\eta}\frac{\Delta P}{\Delta x} r$$

$$\int_0^v dV = \int_r^a \frac{1}{2\eta}\frac{\Delta P}{\Delta x} r\, dr \Rightarrow V = \frac{1}{4\eta}\cdot\frac{\Delta P}{\Delta x}(a^2 - r^2)$$

$$V_{MÁX} = \frac{1}{4\eta}\cdot\frac{\Delta P}{\Delta x}\cdot a^2 \quad (r = 0 \rightarrow \text{CENTRO})$$

$V_{MAX} = 10\ cm/s$

$V_{MAX} = 0{,}1\ m/s$

$a = 0{,}01\ m$

$\Delta x = 1\ m$

QUEDA DE PRESSÃO $\Rightarrow$ $\Delta P = V_{MÁX}\cdot\frac{4\eta\cdot\Delta x}{a^2}$

$$\Delta P = \frac{(0{,}1)(1{,}19)(1)}{(0{,}01)^2}$$

$$\boxed{\Delta P \cong 1{,}2 \times 10^3\ Pa}$$

VISCOSIDADE

ÁGUA (0°C)	1,79
ÁGUA (37°C)	0,69

$$\frac{\Delta\eta}{\Delta t} = -\frac{1{,}1}{37}$$

$$\frac{\Delta\eta}{\Delta t} \cong -0{,}03/°C$$

ÁGUA (20°C) $\cong 1{,}79 - 20(0{,}03) \cong 1{,}19$

EXERCÍCIO 5:

$Q = 5$ LITROS/MIN $= 0{,}005\ m^3/min \cong 8{,}3 \times 10^{-5}\ m^3/s$

ÁREA DA AORTA $= 4{,}5\ cm^2 = 4{,}5 \times 10^{-4}\ m^2$

CAPILARES $\longrightarrow$ DIÂMETRO $= 8\ \mu m \Longrightarrow$ RAIO $= 4 \times 10^{-6}\ m$

$\hookrightarrow 5 \times 10^9$ NA REDE CAPILAR

a) $Q = A\langle v \rangle \Rightarrow 8{,}3 \times 10^{-5} = (4{,}5 \times 10^{-4})\langle v \rangle$

$\langle v \rangle \cong 0{,}2\ m/s$

b) $Q_c = \dfrac{Q_T}{n} = \dfrac{8{,}3 \times 10^{-5}}{5 \times 10^9} \cong 1{,}7 \times 10^{-14}\ m^3/s$

$A_{CAPILAR} = \pi (4 \times 10^{-6})^2\ m^2 \cong 5{,}0 \times 10^{-11}\ m^2$

$\therefore \quad 1{,}7 \times 10^{-14} = (5 \times 10^{-11})\langle v \rangle_c \Rightarrow \langle v \rangle_c \cong 3{,}4 \times 10^{-4}\ m/s$

EXERCÍCIO 6:

PLASMA $\Rightarrow \rho = 1{,}04\ g/cm^3 = 1{,}04 \times 10^3\ kg/m^3$

a) PRESSÃO MANOMÉTRICA $= \rho_{PLASMA}\, g\, h \qquad h = 1\ m$

$P_{PLASMA} = (1{,}04 \times 10^3)(9{,}8)(1) \cong 1{,}02 \times 10^4\ Pa$

$1\ mmHg = 133{,}3\ Pa$

$\therefore \quad P_{PLASMA} \cong 76{,}5\ mmHg$

b) $P_{VEN} = 3\ mmHg \cong 400\ Pa$

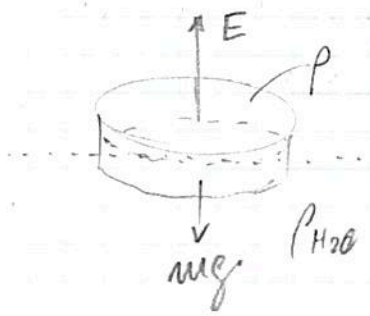
ASSIM,

$\rho g h = 400\ Pa$

$(1{,}04 \times 10^3)(9{,}8)\, h = 400$

$h \cong 0{,}039\ m$

EXERCÍCIO 7:



$mg = 300\ N \qquad mg - E = 250\ N$

$E = 50\ N = \rho_{H_2O} \cdot g \cdot V$

$\rho g V = 300\ N \qquad 50 = 1000(9{,}8)\, V \Rightarrow V \cong 5{,}1 \times 10^{-3}\ m^3$

$\rho \cong 6 \times 10^3\ kg/m^3$ VOLUME DESLOCADO!

EXERCÍCIO 8:

$$Q = A\langle v \rangle$$

RAIO $\cong$ 1cm = 0,01m ÁREA $= \pi R^2 \cong 3{,}14 \times 10^{-4}\ m^2$

$$\langle v \rangle = 0{,}30\ m/s$$

$$\therefore\ Q \cong 9{,}4 \times 10^{-5}\ m^3/s$$

EXERCÍCIO 9:

$$A_T = 20\ cm^2 = 20 \times 10^{-4}\ m^2$$

$$Q = 90\ ml/s = 9{,}0 \times 10^{-5}\ m^3/s$$

$$\langle v \rangle = \frac{Q}{A} = \frac{9{,}0 \times 10^{-5}}{20 \times 10^{-4}} = 0{,}045\ m/s$$

EXERCÍCIO 10:

$$\Pi = \rho g (h_2 - h_1)$$

EM SOLUÇÕES COM ESPÉCIES IMPERMEANTES EM BAIXAS CONCENTRAÇÕES $\Rightarrow$ $\Pi V = nRT$, $\Pi = C_m RT$ } EQUAÇÃO DE VAN'T HOFF

$$R = 0{,}0827\ \frac{atm.l}{mol.K}$$

10 g DE SACAROSE $\Rightarrow n = \frac{10}{360} \cong \frac{1}{36}$ MOLES $V = 1\ l$

$$\therefore\ \Pi = \left(\frac{1}{36}\right) \times (0{,}0827)(360)$$

$$\Pi = 0{,}827\ ATM$$

EXERCÍCIO 11:

$d = 2{,}2cm = 0{,}022\ m$ $R = 0{,}011\ m$

$V = 60\ cm/s = 0{,}6\ m/s$ $\eta = 0{,}004\ \frac{kg}{m.s}$ $\rho = 1000\ kg/m^3$

$$\mathcal{R} = \frac{\rho d \langle v \rangle}{\eta} = \frac{1000(0{,}022)(0{,}6)}{0{,}004} = 3300$$

$\mathcal{R} > 2000 \Rightarrow$ TURBULENTO

EXERCÍCIO 12:

$$\Pi = \rho g h \qquad \rho \cong \rho_{H_2O} = 1000\ kg/m^3 \qquad \Pi = (1000)(9{,}8)(30) = 2{,}94 \times 10^5\ Pa = 2{,}9\ atm$$

$\Pi V = nRT$

$$C_m = \frac{\Pi}{RT} = \frac{2{,}9\ atm}{\left(0{,}0827\ \frac{atm.l}{mol.K}\right)} \cdot \frac{1}{293K} \cong 0{,}12\ mol/litro$$

0,12 OSMOL

EXERCÍCIO 13: $R = \frac{\rho d \bar{v}}{\eta}$

a) $v = 70\ m/s \quad d = 0{,}15 m$

$\rho_{AR} = 1{,}2\ kg/m^3 \quad \eta_{AR} = 1{,}8 \times 10^{-5}\ Pa.s$

$R = \frac{(1{,}2)(0{,}15)(70)}{1{,}8 \times 10^{-5}}$

$R = 7 \times 10^5$ TURBULENTO

b) $v = 1\ m/s \quad d = 0{,}03 m$

$\rho_{ÁGUA} = 1000\ kg/m^3 \quad \eta_{ÁGUA} = 10^{-3}\ Pa.s$

$R = \frac{1000(1)(0{,}03)}{10^{-3}}$

$R = 30000$ TURBULENTO

c) $v = 10 m/s \quad d = 2 \times 10^{-4}$

$R = \frac{1000(10)(2 \times 10^{-4})}{10^{-3}} = 2000$

$\simeq$ LAMINAR

EXERCÍCIO 14:

SUPONDO $T = 20°C$

$h = 100\ m$

$\gamma = 0{,}0728 \frac{N}{m}$

$h = \frac{2\gamma}{\rho g r} \Rightarrow r = \frac{2\gamma}{\rho g h}$

$r = \frac{2(0{,}0728)}{(9{,}8)(1000)100} \simeq 1{,}5 \times 10^{-7} = 0{,}15\ \mu m$

DIÂMETRO $\simeq 0{,}3\ \mu m$

DIÂMETRO DO XILEMA $\simeq 20\ \mu m$ ($\simeq 67$ VEZES MAIOR)

EXERCÍCIO 15:

180 litros por dia (125 ml/min)

$W = PV$

$V = 0{,}18\ m^3/DIA$

$\Pi_{SANGUE} = 28\ mm\ Hg$

$\Pi_{SANGUE} = 3732 \frac{N}{m^2}$

$W = 3732 \frac{N}{m^2} \cdot (0{,}18 \frac{m^3}{dia})$

$W \simeq 672\ J/dia$