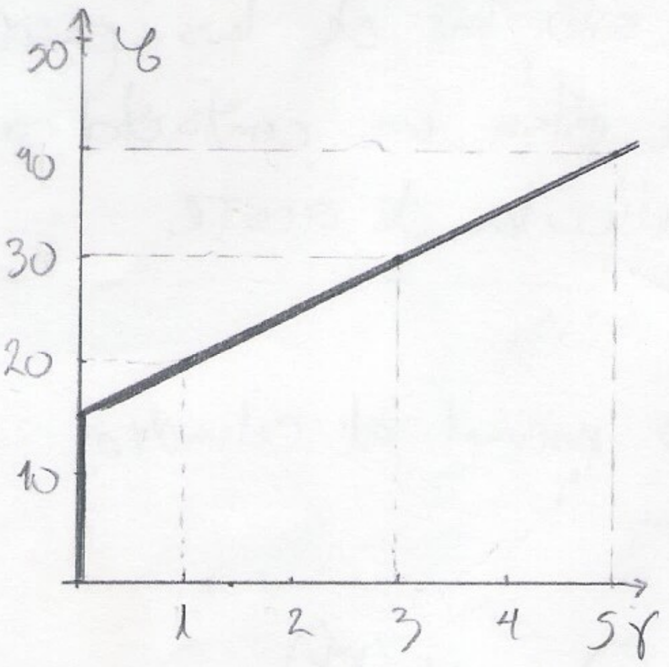
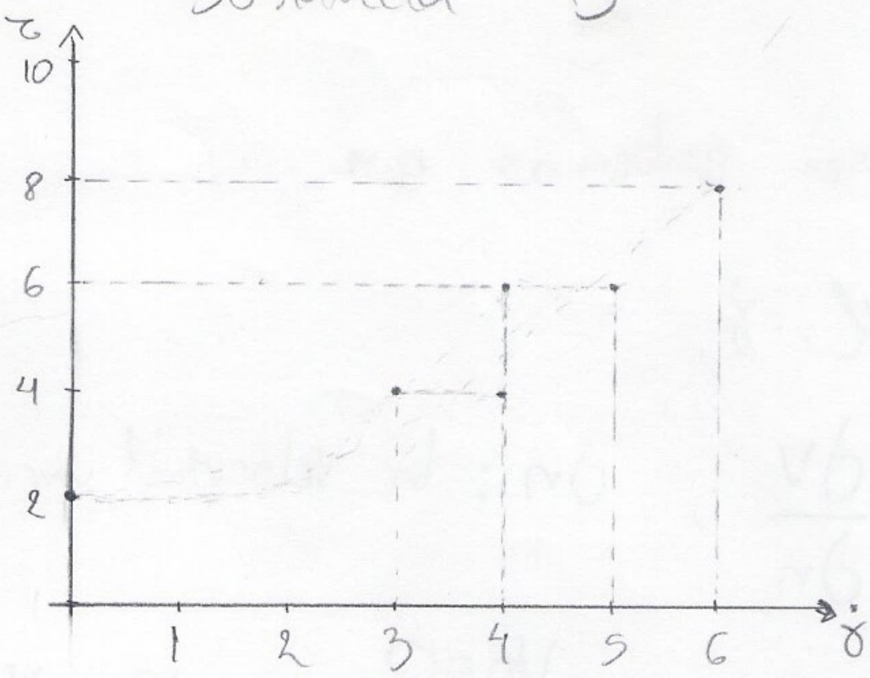
Ejercicios de Fenómenos I.

1.1. Sustancia A



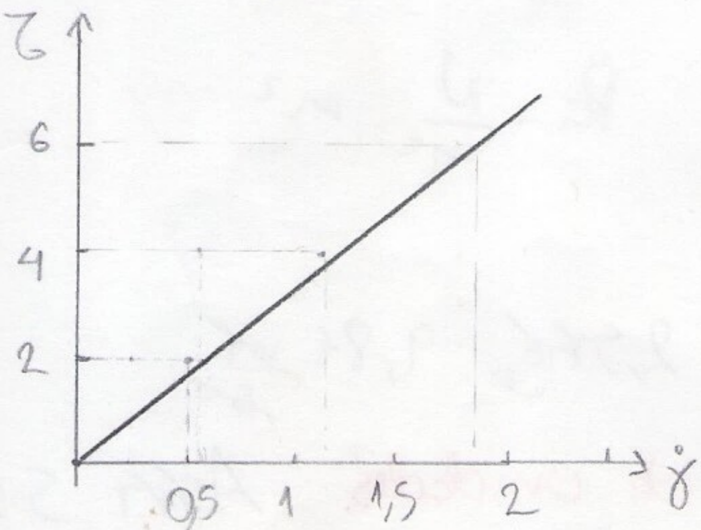
Fluido Bingham ideal

Sustancia B



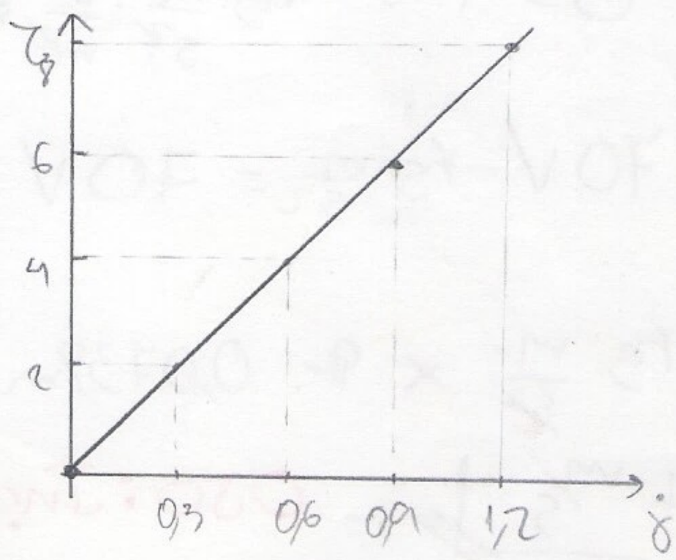
Ninguno de los fluidos

Sustancia C



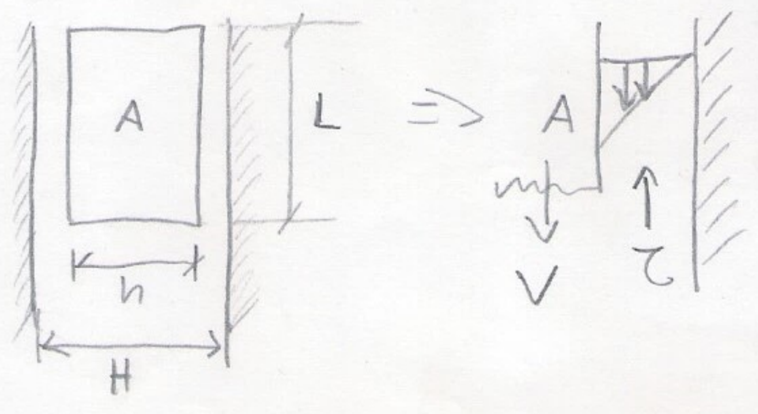
Fluido Newtoniano

Sustancia D



Fluido Newtoniano

Ejemplo Shames 1.7)



$m_A = 2{,}5\ kg$

$h = 73{,}8\ mm$

$H = 74{,}0\ mm$

$\mu = 7.10^{-3}\ N.s/m^2$

$V = ?$

Tomando el equilibrio entre la fuerza de empuje y la fuerza viscosa que detiene al cilindro para que baje, se tiene que

$W = F$, y sabiendo que $\frac{F}{A} = \tau$

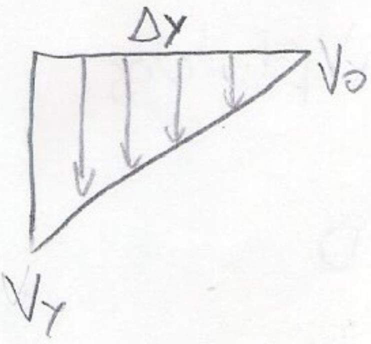
$F = \tau \cdot A$, donde el área será $A = 2 \cdot \pi \cdot r \cdot L$

pero $r = \frac{D}{2} \Rightarrow A = \pi \cdot D \cdot L \Rightarrow$ ⚠ Preguntar por qué el área es solo la de las paredes que están en contacto con la película de aceite.

También sabemos que

$\tau = \mu \cdot \dot{\gamma}$,

$\dot{\gamma} = \frac{\partial V}{\partial n}$, ∂n: la velocidad varía en sentido normal al cilindro.



$V_0 = 0$
$V_y = V \Rightarrow \dot{\gamma} = \frac{V - 0}{\Delta y} = \frac{V - 0}{0{,}1\,mm} = \frac{V\ (m/s)}{0{,}0001\ \cancel{m}} = 10000\,V\ s^{-1}$

$\tau = 7 \cdot 10^{-3}\ kg \cdot \frac{\cancel{m}}{s^2} \cdot \frac{\cancel{s}}{m^2} \times 1 \cdot 10^4 \cdot V\ s^{-1}$

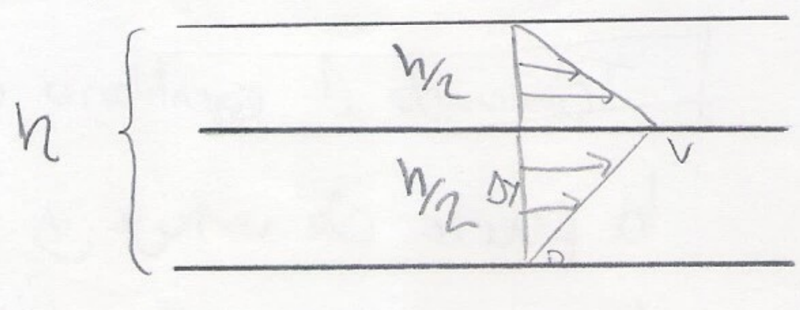
$Pa = \frac{N}{m^2} \cdot m^2$

$\tau = 70\,V\ kg \cdot \frac{m}{s^2} = 70\,V\ Pa$

$F = 70\,V\ kg \cdot \frac{\cancel{m}}{s^2} \times \pi \cdot 0{,}0738\,m \cdot 0{,}15\,\cancel{m} = 2{,}5\,kg \cdot 9{,}81\ \frac{\cancel{m}}{s^2}$

$V = 10{,}07\ m/s$ OJO: Inconsistencia de unidades. ASK S.S.

1.2) Guía)



$\mu = 1{,}494\ Pa \cdot s = \frac{N}{m^2} \cdot s$

$h = 2{,}5\ cm$

$A_p = 0{,}5\ m^2$

$V = 0{,}15\ m/s$

$\dot{\gamma} = \frac{V - 0}{\Delta y} = \frac{0{,}15\ m/s - 0}{0{,}0125\,m} = 12\ s^{-1}$

$\tau = \dot{\gamma}\,\mu = 12\ \cancel{s^{-1}} \times 1{,}494\ Pa \cdot \cancel{s} = 17{,}928\ Pa$

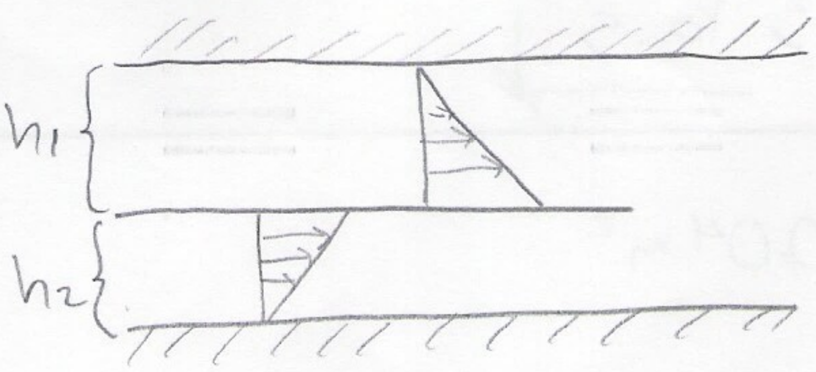
$F = \tau \cdot A = 17{,}928\ \frac{N}{\cancel{m^2}} \cdot 0{,}5\ \cancel{m^2} = 8{,}964\ N$

$\longrightarrow$

Pero como se tienen interfaces iguales, el valor es el doble.

$$F_T = F \times 2 = 17{,}928\ N$$

En el caso que esté a 1cm de una de las superficies



$h_1 = 1{,}5cm$

$h_2 = 1cm$

$$\dot{\gamma}_1 = \frac{0{,}15\ m/s}{0{,}015m} = 10\ s^{-1} \Rightarrow \tau_1 = 10\ \cancel{s^{-1}} \cdot 1{,}494\ Pa \cdot \cancel{s} = 14{,}94\ Pa$$

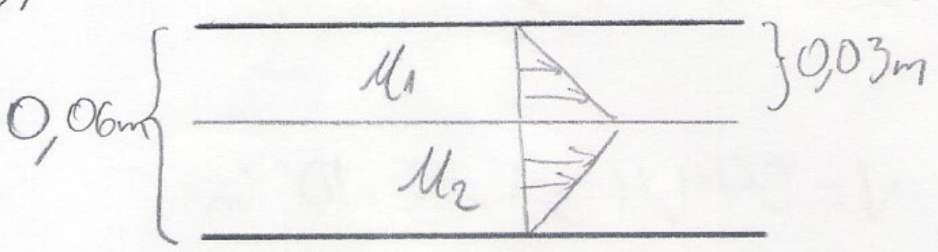
$$F_1 = \tau_1 \cdot A = 14{,}94\ N/\cancel{m^2} \times 0{,}5\ \cancel{m^2} = 7{,}47\ N$$

$$\dot{\gamma}_2 = \frac{0{,}15\ m/s}{0{,}010\ m} = 15\ s^{-1} \Rightarrow \tau_2 = 15\ \cancel{s^{-1}} \times 1{,}494\ Pa \cdot \cancel{s} = 22{,}41\ Pa$$

$$F_2 = \tau_2 \cdot A = 22{,}41\ N/\cancel{m^2} \times 0{,}5\ \cancel{m^2} = 11{,}205\ N$$

$$F_{Tot} = F_1 + F_2 = 7{,}47\ N + 11{,}205\ N = 18{,}675\ N$$

1.3)



$V = 0{,}3\ m/s$

$F_{Tot} = 29\ N$

$$\dot{\gamma}_1 = \frac{0{,}3\ m/s}{0{,}03\ m} = 10s^{-1} \quad y \quad \dot{\gamma}_2 = \frac{0{,}3\ m/s}{0{,}03\ m} = 10s^{-1}$$

$\tau_1 = 10s^{-1} \cdot \mu_1$ y $\tau_2 = 10s^{-1}\ \mu_2$

Pero sabemos que $\mu_1 = 2\mu_2$

$\tau_1 = 10s^{-1} \cdot 2\mu_2$

$\tau_2 = 10s^{-1} \cdot \mu_2$

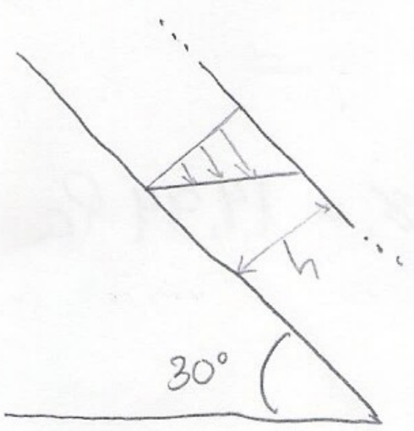
$\tau_1 = 20 s^{-1} \mu_2$ y $\tau_2 = 10 s^{-1} \cdot \mu_2$ y con $A = 1 m^2$

$F_1 = 20 \cdot \mu_2 \cdot 1$ y $F_2 = 10 \mu_2$

Finalmente $F_{tot} = 20 \mu_2 + 10 \mu_2 = 30 \mu_2 = 29 N$

$\mu_2 = 0{,}966 \text{ Pa.s}$ y $\mu_1 = 1{,}933 \text{ Pa.s}$

1.4)



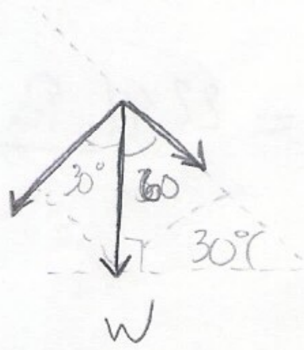
$A_c = 0{,}2 m \times 0{,}2 m = 0{,}04 m^2$

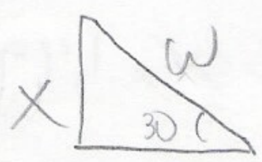
$m_c = 2 kg$

$h = 0{,}02 mm = 2 \cdot 10^{-5} m$

$\mu = 0{,}45 \text{ Pa.s}$

Si descomponemos el peso en dos compo.





$\text{Sen } 30° = \frac{X}{W}$

$X = W \cdot \text{Sen } 30° = 9{,}8 N$

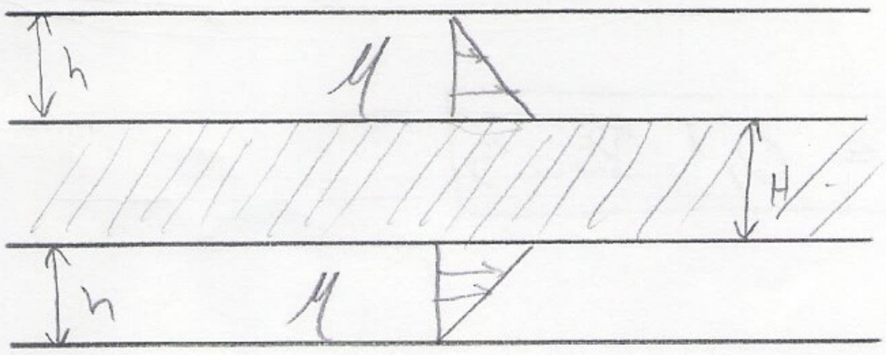
$F = \tau \times A \Rightarrow \tau = \frac{F}{A} = \frac{9{,}8}{0{,}04 m^2} = 245 \frac{N}{m^2}$

$\tau = \dot{\gamma} \cdot \mu \Rightarrow \dot{\gamma} = \frac{\tau}{\mu} = \frac{245 \text{ Pa}}{0{,}45 \text{ Pa.s}} = 544{,}4 \ s^{-1}$

$\dot{\gamma} = \frac{V - 0}{h} = \frac{V}{h} \Rightarrow V = h \cdot \dot{\gamma} \Rightarrow V = 544{,}4 \ s^{-1} \times 2 \times 10^{-5} m$

$V = 0{,}0109 \frac{\cancel{m}}{s} \times \frac{100 cm}{1 \cancel{m}} \Rightarrow V = 1{,}09 \ m/s$

1.9)



$\eta = 1\,Pa.s$

$h = 0{,}03\,cm$

$H = 0{,}04\,cm$

$A = 2\,cm \times 0{,}5\,cm = 1\,cm^2$

$A = 1\,\cancel{cm^2} \times \left(\frac{1\,m}{100\,\cancel{cm}}\right)^2 = 1.10^{-4}\,m^2$

$F_{max} = 100\,N \qquad V @ F_{max} = ?$

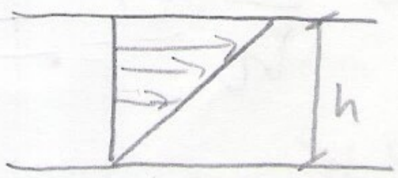
$F = \tau . A \Rightarrow \tau = \frac{F}{A} = \frac{50\,N}{1.10^{-4}\,m^2} = 5.10^5\,Pa$

$\tau = \eta \dot{\gamma} \Rightarrow \dot{\gamma} = \frac{\tau}{\eta} = \frac{5.10^5\,\cancel{Pa}}{1.\,\cancel{Pa}.s} = 5.10^5\,s^{-1}$

Trabajando con un solo lado de la cinta.

$\dot{\gamma} = \frac{V}{h} \Rightarrow V = h . \dot{\gamma} \Rightarrow V = 15000\,\frac{\cancel{cm}}{s} \times \frac{1\,m}{100\,\cancel{cm}} = 150\,m/s$

1.10) El primer experimento nos da los datos para calcular el área.



$\dot{\gamma} = \frac{\partial v_x}{\partial y} = \frac{V - 0}{h} = \frac{0{,}01\,m/s}{3.10^{-5}\,\cancel{m}} = 333{,}33\,s^{-1}$

$\tau = \dot{\gamma} . \eta = 333{,}33\,\cancel{s^{-1}} . 0{,}001\,Pas \Rightarrow 0{,}333\,Pa$

$F = \tau \times A \Rightarrow A = \frac{F}{\tau} = \frac{0{,}12\,N}{0{,}333\,Pa} = 0{,}36\,m^2$

Para F_1

$\dot{\gamma}_1 = \frac{\partial v_x}{\partial y} = \frac{V}{h} = \frac{0{,}01\,m/s}{3.10^{-5}\,\cancel{m}} = 333{,}33\,s^{-1}$

$\tau = 333{,}33 . \eta + \tau_0 = \frac{F_1}{A}$

$333{,}33\,\eta + \tau_0 = 48{,}33$

Para F_2

$\dot{\gamma}_2 = \frac{\partial v_x}{\partial y} = \frac{V}{h} = \frac{0{,}02\,m/s}{3.10^{-5}\,\cancel{m}} = 666{,}67\,s^{-1}$

$\tau = 666{,}67\,\eta + \tau_0 = \frac{F_2}{A}$

$666{,}67\,\eta + \tau_0 = 81{,}67$

$$48,33 = 333,33\,\mu + \tau_0 -$$
$$81,67 = 666,67\,\mu + \tau_0$$
$$33,33 = 333,33\,\mu \Rightarrow \boxed{\mu = 0,1 \ Pa.s}$$

$$81,67 = 666,67.\mu + \tau_0$$
$$\tau_0 = 15 \ N/m^2$$

1.11)

$$\Sigma F_x = 0 = m.a = mg \ Sen 30° - F$$

$$mg \ Sen 30° = F \Rightarrow F = 392 \ N$$

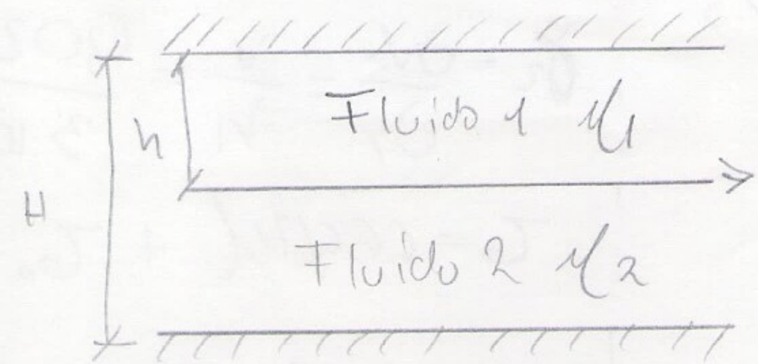
$$F = \tau.A \Rightarrow \tau = \frac{F}{A} = \frac{392 \ N}{0,05 m^2} = 7840 \ Pa$$

$$\tau = \dot{\gamma}.\mu \Rightarrow \tau = \frac{\partial V_x}{\partial y}.\mu \Rightarrow \tau = \frac{V-0}{h}.\mu \Rightarrow \tau = \frac{V}{h}.\mu$$

$$h = \frac{V.\mu}{\tau} = \frac{100 \frac{km}{h} . \frac{1000 m}{1 km} . 2 \ mPa.s \ \frac{1 \ Pa}{1000 \ mPa} . \frac{1 h}{3600 s}}{7840 \ Pa}$$

$$h = 7,08.10^{-6} m \Rightarrow h = 7,08 \ \mu m$$

1.12)



$$h = ?$$
$$\tau = \mu_1 \dot{\gamma} + \mu_2 \dot{\gamma}$$
$$= \mu_1 \frac{V_0}{h} + \mu_2 \frac{V_0}{H-h}$$
$$= V_0 \left(\frac{\mu_1}{h} + \frac{\mu_2}{H-h} \right)$$

$$\frac{\tau}{\frac{\mu_1}{h}+\frac{\mu_2}{H-h}} = V_0 \Rightarrow V_0(h) = \frac{\tau}{\left(\frac{\mu_1}{h}+\frac{\mu_2}{H-h}\right)}$$

$$\frac{dv}{dh} = \frac{\delta\left[\tau\left(\frac{\mu_1}{h}+\frac{\mu_2}{H-h}\right)^{-1}\right]}{\delta h}$$

$\frac{\delta v}{\delta h} = 0 \Rightarrow$ pues está maximizando la velocidad en función de h.

$$0 = \frac{\partial\left[\cancel{\tau}\left(\frac{\mu_1}{h}+\frac{\mu_2}{H-h}\right)^{-1}\right]}{\partial h}$$

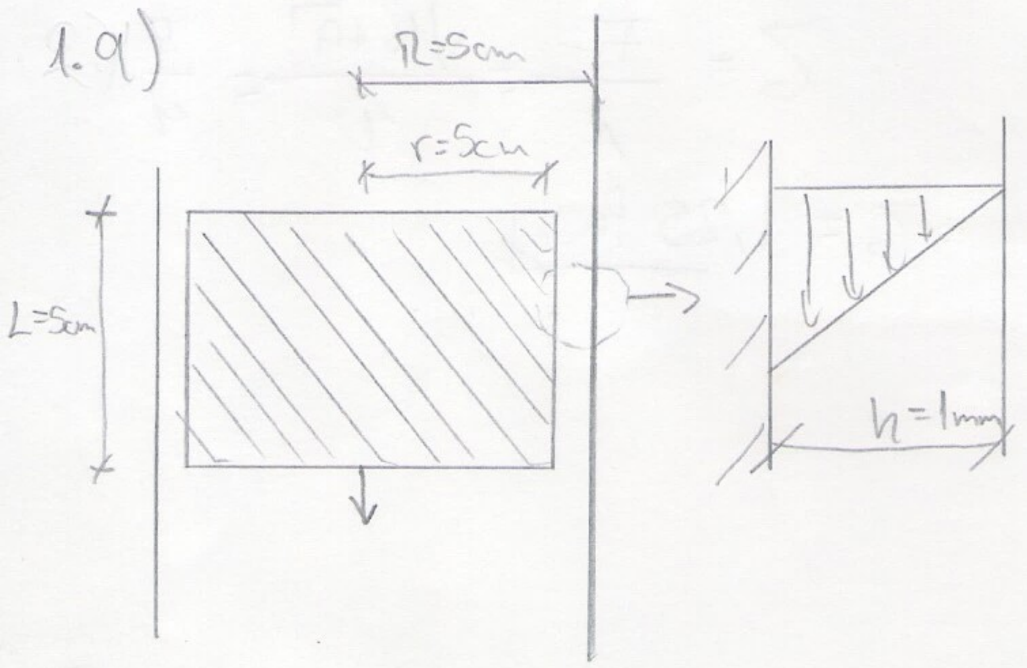
$$0 = \frac{\partial\left(\frac{\mu_1}{h}+\frac{\mu_2}{H-h}\right)^{-1}}{\partial h} = \cancel{-\left(\frac{\mu_1}{h}+\frac{\mu_2}{H-h}\right)^{-2}}\cdot\left(-\mu_1 h^{-2} + \mu_2(-1)(H-h)^{-2}\right)$$

$$0 = \frac{\mu_1}{h^2} - \frac{\mu_2}{(H-h)^2} \Rightarrow \frac{\mu_1}{h^2} = +\frac{\mu_2}{(H-h)^2} \Rightarrow \frac{H^2-2h+h^2}{h^2} = \frac{\mu_1}{\mu_2}$$

$$\frac{(H-h)^2}{h^2} = \frac{\mu_2}{\mu_1} \Rightarrow \frac{H-h}{h} = \sqrt{\frac{\mu_2}{\mu_1}} \Rightarrow H-h = h\sqrt{\frac{\mu_2}{\mu_1}}$$

$$H = h\left(1+\sqrt{\frac{\mu_2}{\mu_1}}\right) \Rightarrow \boxed{h = \frac{H}{1+\sqrt{\mu_2/\mu_1}}}$$

1.9)



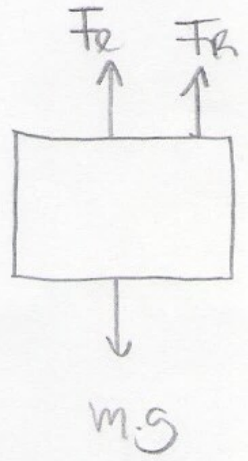
$\rho_F = 1700\ kg/m^3$

$M_c = 700\ g$

$d = 40\ cm$

$t = 2s$

Determinar la velocidad del fluido.



$$\sum F_y = \cancel{m}.\overset{0}{a} = 0$$

$$F_R + F_e = W$$

$$F_e = m_f . g$$
$$= \rho_{fl} . Vol . g$$
$$= \rho_{fl} . \pi . r^2 . h . g$$
$$F_e = 6{,}54\ N$$

$$W = m.g$$
$$W = 6{,}86\ N$$

$$F_R = \tau . A = \mu \dot{\gamma} A = \mu \left(\frac{\partial V_y}{\partial x}\right) . 2\pi . r . h$$

$$V = \frac{40cm}{2s} = 20\ cm/s$$

$$F_R = \mu \left(\frac{\partial V_y}{\partial x}\right) . 0{,}0157 = \mu \left(\frac{V-0}{h}\right) 0{,}0157 m^2$$

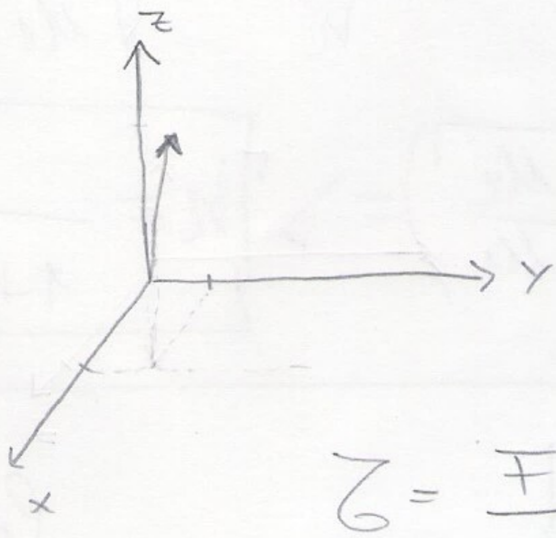
$$20 \frac{\cancel{cm}}{s} . \frac{1m}{100\cancel{cm}}$$
$$0{,}2 m/s$$

$$F_R = 6{,}86N - 6{,}54N \Rightarrow F_R = 0{,}32N$$

$$0{,}32N = \mu . 0{,}0157m^2 . \frac{0{,}2 \frac{\cancel{m}}{s}}{1.10^{-3}\cancel{m}} \Rightarrow 0{,}32N = \mu\, 3{,}14 \frac{m^2}{s}$$

$$\boxed{\mu = 0{,}102\ Pa.s}$$

2.1) $F = 4i + 3j + 9k$



$$F_z = \int -P n_s dA$$

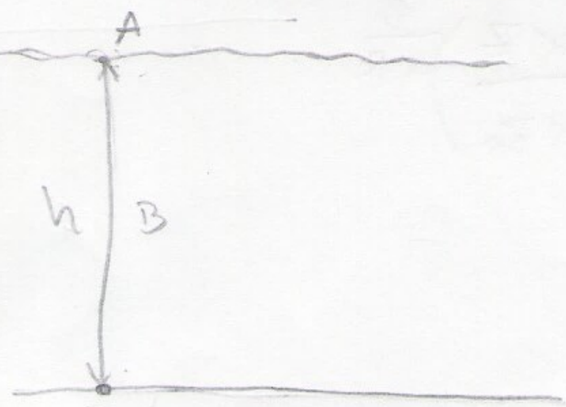
$$9 = +P \int dA$$

a) $P = \frac{9}{4} \Rightarrow P = 2{,}25\ Pa$

$$\tau = \frac{F}{A} = \frac{\sqrt{16+9}}{4} = \frac{5}{4}$$

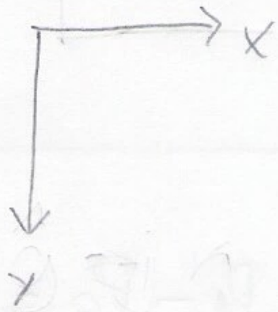
$$\tau = 1{,}25\ Pa$$

2.2)



$\rho = 450 + ah$, $a = 12\ kg/m^4$

$$\int_{P_A}^{P_B} dP = -\int_A^B \rho \cdot g\, dh$$



$$P_B - P_A = +g \int_A^B (450 + ah)\, dh$$

$$P_B - P_A = +g \left[\int_A^B 450\, dh + a \int_A^B h\, dh \right]$$

$$P_B - P_A = +g \left[450(B - A) + a/2\, h^2 \Big|_A^B \right]$$

$$P_B - P_A = +g \left[450(10 - 0) + a/2 \left[10 - 0 \right] \right]$$

$$P_B - P_A = +g \left[(4500 + 600) \right]$$

$$P_B - P_A = +g \left[5100 \right] \Rightarrow \underline{P_B = 151\ kPa}$$

2.4)

$PV = RT \cdot M$

$PV = R(T_0 - \alpha z) \cdot M$

$P \cdot \frac{\cancel{M}}{\rho} = R(T_0 - \alpha z) \cancel{M}$

$\rho = \frac{P}{R(T_0 - \alpha z)}$

$\boxed{\frac{dP}{dz} = -\rho g}$

$V = \frac{M}{\rho} \Rightarrow \rho = \frac{M}{V}$

$\frac{dP}{P} = \frac{-g}{R(T_0 - \alpha z)} dz$

$dP = -\rho g dz$

d

$$\int_{P_0}^{P} \frac{dP}{P} = \int_{z_0}^{z} \frac{-gM}{R(T_0 - \alpha z)} dz \Rightarrow \ln\left(\frac{P}{P_0}\right) = \frac{-g}{R} \int_{z_0}^{z} \frac{1}{T_0 - \alpha z} dz$$

$$\ln\left(\frac{P}{P_0}\right) = -\frac{g}{R} \left[\ln(T_0 - \alpha z) \cdot -\frac{1}{\alpha} \right] \Big|_{z_0}^{z}$$

$$\ln \frac{P}{P_0} = \frac{g}{R\alpha} \left[\ln(T_0 - \alpha Z) - \ln(T_0 - \alpha z_0) \right]$$

$$\frac{P}{P_0}=\left(\frac{T_0-\alpha z}{T_0-\alpha z_0}\right)^{\frac{g}{\alpha R}} \Rightarrow P=P_0\left(\frac{T_0-\alpha z}{T_0-\alpha z_0}\right)^{\frac{g}{\alpha R}}$$

2.5)

$$P_1-P_0=\rho_1 g\,(z_3-z_1) \qquad P_2-P_0=\rho_1 g\,(z_4-z_2)$$

$$P_2=\rho_1 g\,(z_4-z_2)+P_0$$

$$(z_2-z_1)\cdot\rho_2\cdot g=P_2-P_1$$

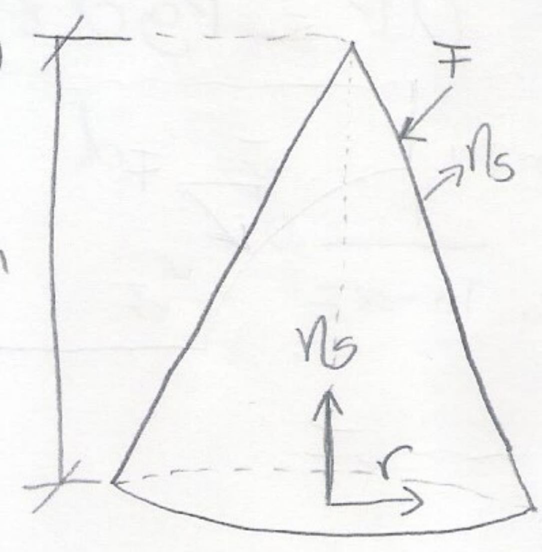
$$(z_2-z_1)\rho_2 g=P_2-\rho_1 g(z_3-z_1)-P_0$$

$$(z_2-z_1)\rho_2\cancel{g}=\rho_1\cancel{g}(z_4-z_2)+\cancel{P_0}-\rho_1\cancel{g}(z_3-z_1)-\cancel{P_0}$$

$$(z_2-z_1)\rho_2=\rho_1\left[(z_4-z_2)-(z_3-z_1)\right]$$

$$\frac{\rho_2}{\rho_1}=\frac{(z_4-z_2)-(z_3-z_1)}{(z_2-z_1)}$$

2.7)



$h=2000\,m$
$r=5500\,m$
$T=303{,}15-0{,}015z$
$P_0=101\,kPa$
$R=8{,}314\,kJ/kmol.K$
$PM=28{,}95\,kg/kmol$

$F_V=-\int P n_s dA$

$n_s=+$

$dA=r\,dr\,d\theta$

$PV=RT$

$$P\frac{1}{\rho}=RT \Rightarrow \rho=\frac{P}{RT}=\frac{P}{R(303{,}15-0{,}015z)}$$

$$\frac{dP}{dz} = -\rho g \; ; \quad \frac{dP}{dz} = \frac{-g}{R} \cdot \frac{P}{(303{,}15 - 0{,}015z)}$$; Intercambiamos variables.

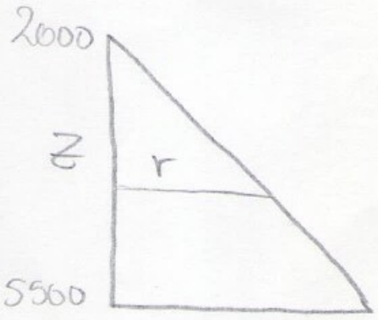
$$\frac{dP}{P} = -\frac{g}{R}\,\frac{dz}{(303{,}15-0{,}015z)} \; ; \Rightarrow \int_{P_0}^{P}\frac{dP}{P} = -\frac{g}{R}\int_{z_0}^{z}\frac{dz}{303{,}15-0{,}015z}$$

$$\ln\left(\frac{P}{P_0}\right) = -\frac{g}{R}\ln\left(\frac{303{,}15-0{,}015z}{303{,}15-0{,}015z_0}\right)\cdot(-0{,}015)^{-1}$$

$$\ln\left(\frac{P}{P_0}\right) = 2275\,\ln\left(\frac{303{,}15-0{,}015z}{303{,}15-0{,}015z_0}\right) \Rightarrow P = P_0\left(\frac{303{,}15-0{,}015z}{303{,}15}\right)^{2275}$$

$$F_v = -\int_0^{2\pi}\int_{5500}^{0} P_0\left(\frac{303{,}15-0{,}015z}{303{,}15}\right)^{2275} r\,dr\,d\theta$$

Relación entre z y r



$$\frac{2000}{5500} = \frac{2000-z}{r} \Rightarrow 2000r = 11.10^6 - 5500z$$

$$z = 2000 - 0{,}3636r$$

$$F_v = -2\pi\cdot P_0\int_{5500}^{0}\frac{(303{,}15 - 30 + 5{,}454.10^{-3}r)^{2275}}{303{,}15}\,r\,dr$$

$$F_v = -2093{,}36\int_{5500}^{0}(273{,}15 + 5{,}454.10^{-3}r)^{2275}\,r\,dr$$

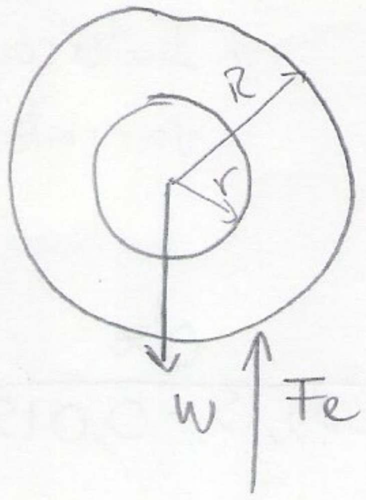
$$= 8{,}9.10^{6}\ \text{MN}$$

$(4r^4 + 3r^3)^2 =$

$((4r+3)r^3)^2$

$(4r+3)^2\cdot r^6$

2.9)



$$W = Fe$$

$$W = (M_{co} + M_{ac}) . g$$

$$W = \left(\left[\frac{4R^3}{3}\pi - \frac{4r^3\pi}{3}\right]\rho_{co} + \frac{4r^3\pi}{3}\rho_{ac}\right) g$$

$$Fe = \rho_{H_2O} . \frac{\pi 4}{3} R^3 . g$$

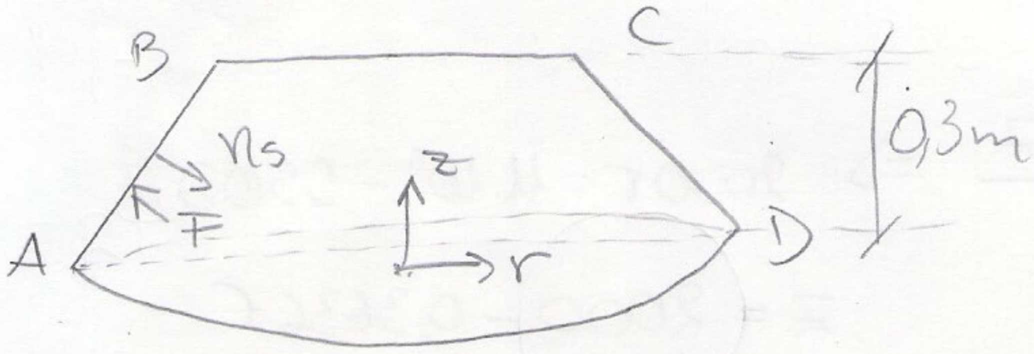
$$W = g\left(\frac{4R^3\pi}{3}\rho_{co} - \frac{4r^3\pi\rho_{co}}{3} + \frac{4r^3\rho_{ac}\pi}{3}\right) g$$

$$\rho_{H_2O} . \frac{\cancel{\pi} . 4 . R^3}{\cancel{3}} = \frac{4}{\cancel{3}}\cancel{\pi}\left(R^3\rho_{co} + r^3(\rho_{ac} - \rho_{co})\right)$$

$$\rho_{H_2O} . R^3 = R^3 . \rho_{co} + r^3(\rho_{ac} - \rho_{co}) \Rightarrow r^3 = \frac{\rho_{H_2O} . R^3 - \rho_{co} . R^3}{\rho_{ac} - \rho_{co}}$$

$$r^3 = \frac{R^3(\rho_{H_2O} - \rho_{co})}{\rho_{ac} - \rho_{co}} \Rightarrow \underline{r = 3{,}98 \, cm}$$

2.11)



$$F = -\int P \, n_s \, dA$$

$$n_s = -$$

$$dA = r dr d\theta$$

$$P = P_{atm} + 0{,}6 . \rho . g + (0{,}3 - z)\rho g$$

$$F = \int_0^{2\pi}\int_{0,6}^{0,3}\left(P_{atm} + 0{,}6\rho . g + (0{,}3 - z)\rho g\right) r dr d\theta$$

$$z = ar + b$$

$$\begin{cases} z = 0 \\ r = 0{,}6 \end{cases} \quad \begin{cases} z = 0{,}3 \\ r = 0{,}3 \end{cases} \Rightarrow$$

$$0 = a . 0{,}6 + b \Rightarrow b = -0{,}6a$$

$$0{,}3 = a . 0{,}3 + b \Rightarrow 0{,}3 = a . 0{,}3 - 0{,}6 . a$$

$$\underline{a = -1} \qquad \underline{b = 0{,}6}$$

$$F = \int_0^{2\pi}\int_{0,6}^{0,3} (P_{atm} + 0,9\rho g - z\rho g) r\,dr\,d\theta$$

$$= \int_0^{2\pi}\int_{0,6}^{0,3} (P_{atm} + 0,9\rho g + r\rho g - 0,6\rho g) r\,dr\,d\theta$$

$$= \int_0^{2\pi}\int_{0,6}^{0,3} (P_{atm} + 0,3\cdot\rho g + r\cdot\rho g) r\,dr\,d\theta$$

$$= 2\pi \int_{0,6}^{0,3} (103940\, r + 9800\, r^2\, dr)$$

$$= 92,044 \text{ KN}$$

$z = 1,5 \rightarrow r = 0,6$

$z = 1,8 \Rightarrow r = 0,3$

$1,5 = a\cdot 0,6 + b$

$1,8 = 0,3a + b$

$1,5 - a\cdot 0,6 + 1,8 - 0,3a$

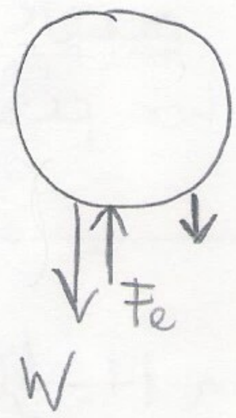
$-0,3 = 0,3a \Rightarrow a = -1$

b) $F = (2,4\cdot g\cdot\rho + P_0) A_{EF}$

$= 124520 \cdot 0,6^2\cdot\pi$

$= 140,8 \text{ KN}$

2.10



Dentro del globo se tiene aire a 101000 Pa

$\frac{Kg}{m^3}$

$PV = RT$

$\frac{P}{\rho} = RT \Rightarrow \rho = \frac{P}{RT}$

$M_{aire}\cdot g + M_{globo}\cdot g = F_e$

Masa del globo = 470 Kg

$Vol_{glob}\cdot\rho_{aire}\cdot \cancel{g} + 470\,Kg\cdot\cancel{g} = Vol_{glob}\cdot\rho_{aire\,II}\cdot\cancel{g}$

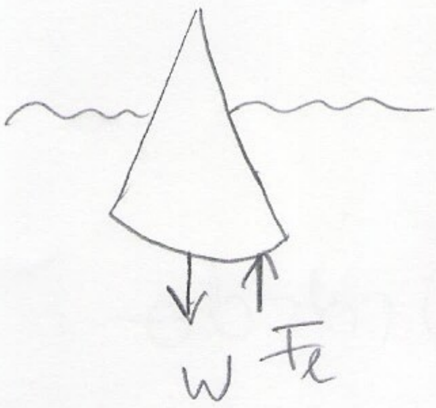
$\rho_{aire\,atm} = \frac{101000}{RT} = 1,18$

$\rho_{aire} = 1,067$

$Vol_{glb} = 4188,79\ m^3$

$\frac{P}{RT} = 1,067 \Rightarrow T = \frac{P}{1,067\cdot R} = 329,5\,K = 56,34\,°C$

2.13)



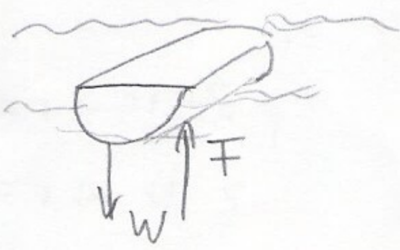
$$W = F_e \qquad F_e = m_{liq} \cdot g$$
$$m \cdot g = F_e \qquad = \rho_{H_2O} \cdot Vol_{liq} \cdot g$$

$$\rho_{Hi} \cdot Vol \cdot \cancel{g} = \rho_{H_2O} \cdot Vol_{liq} \cdot \cancel{g}$$

$$Vol_{liq} = 0{,}893\, Vol_{sol} \Rightarrow$$

Si el 89,3 está sumergido $\Rightarrow 100 - 89{,}3 \Rightarrow 10{,}4\%$ no lo está

2.14)



$$W = F_e$$
$$= m_{liq} \cdot g$$
$$6940\cancel{g} = \rho_{H_2O} \cdot Vol_{liq} \cdot \cancel{g}$$

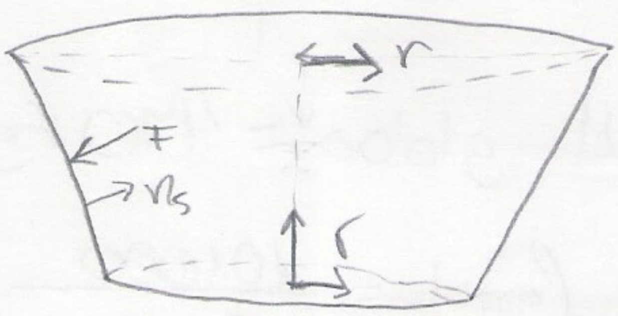
¿?

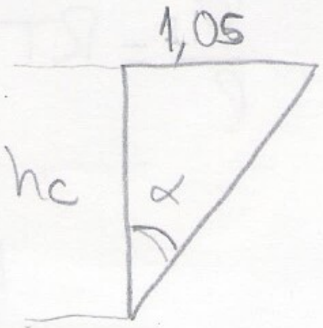
$Vol_{liq} = 6{,}61\ m^3$ es el volumen de líquido desplazado.

$$Vol\ bote = \frac{\pi r^2 h}{2} = \frac{\pi \cdot (1m)^2 \cdot (4m)}{2} = 6{,}283\ m^3$$

Como el $V_{bote} <$ Vol líquido desplazado, entonces quiere decir que el bote ya se ha hundido con todo ese peso los pescadores mienten.

2.15)





$$\tan 17 = \frac{1{,}05}{h_c}$$

$$h_c = \frac{1{,}05}{\tan 17} = 3{,}43\,m$$

$$F = -\int P\, n_s\, dA \Rightarrow \quad n_s = \oplus \qquad dA = r\,dr\,d\theta$$

$$P = P_0 + 10\rho g + (3{,}43 - z)\rho g = P_0 + 13{,}43\rho g - \rho g z$$

Relación entre r y z | $z=0 \Rightarrow r=0{,}2$ | $0=0{,}2a+b$

$z=3{,}43 \Rightarrow r=1{,}25$ | $b=-0{,}2a$

$3{,}43=1{,}25a-0{,}2a$

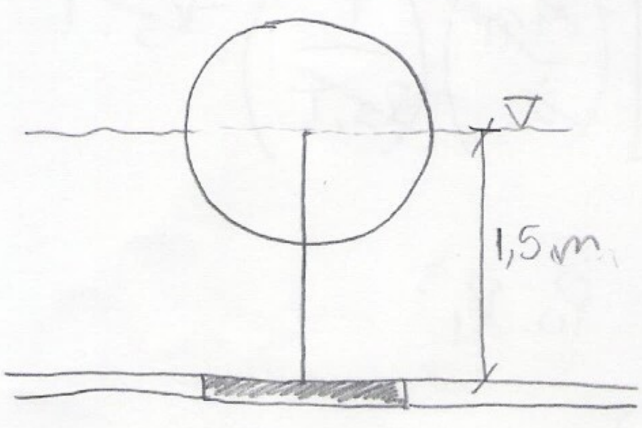
$3{,}43=1{,}05a \Rightarrow a=3{,}27 \Rightarrow b=-0{,}654$ | $z=3{,}27r-0{,}654$

$P=291516-\rho g z=291516-\rho g\,3{,}27r+\rho g\,0{,}654$

$=301326-49050$

$$F=-2\pi\int_{0{,}2}^{1{,}25} 301326r-49050r^2\,dr=1{,}24\,MN$$

2.16)

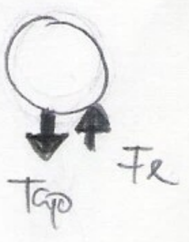


Tapón: 25 cm $d=12{,}5\,r$ $\rho=7500$

2,5 cm $=h$

$Vol_{Tap}=\pi(0{,}0125m)^2\,0{,}025m$

$=1{,}23\cdot10^{-3}$



$P_{Tap}+P_0\cdot A=\rho_{H_2O}\cdot Vol_{des}\cdot g$

$\rho_T\cdot Vol_{Ta}\cdot g+P_0\cdot\pi\cdot(0{,}125)^2=\rho_{H_2O}\cdot Vol\cdot g$

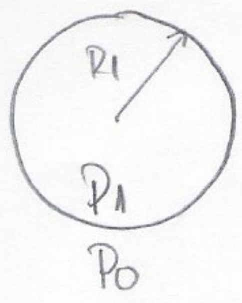
$90{,}2+4958=9800\cdot Vol$

$0{,}51=Vol. \Rightarrow \Rightarrow \frac{4}{3}\pi r^3-0{,}51 \Rightarrow r=0{,}497m$

2.20) Para un burbuja resultante, se tiene que

$n_f = n_i$, donde n_i corresponde a las dos burbujas

Para R_1



$$P_1 - P_0 = \frac{2\sigma}{R_1}$$

$$P_1 = \frac{2\sigma}{R_1} + P_0$$

$$n_1 = \frac{P_1 V_1}{R_g \cdot T} = \left(\frac{2\sigma}{R_1} + P_0\right)\cdot\left(\frac{4}{3}\pi R_1^3\right)\cdot\left(\frac{1}{R_g \cdot T}\right)$$

e igual para n_2

$$n_2 = \frac{P_2 V_2}{R_g T} = \left(\frac{2\sigma}{R_2} + P_0\right)\cdot\left(\frac{4}{3}\pi R_2^3\right)\cdot\left(\frac{1}{R_g \cdot T}\right)$$

b) Para la burbuja final, $PV = n R_g T$

$$P_R \cancel{\frac{4}{3}\pi} R^3 = \left[\left(\frac{2\sigma}{R_2} + P_0\right)R_2^3 + \left(\frac{2\sigma}{R_1} + P_0\right)R_1^3\right]\left(\cancel{\frac{4\pi}{3}}\right)\left(\frac{1}{\cancel{R_g \cdot T}}\right)\cdot R_g \cdot T$$

$$P_R R^3 = 2\sigma R_2^2 + P_0 \cdot R_2^3 + 2\sigma \cdot R_1^2 + P_0 \cdot R_1^3$$

$$P_R R^3 = 2\sigma\left(R_2^2 + R_1^2\right) + P_0\left(R_2^3 + R_1^3\right)$$

$$\left(\frac{2\sigma}{R} + P_0\right)R^3 = P_0\left(R_1^3 + R_2^3\right) + 2\sigma\left(R_2^2 + R_1^2\right)$$

$$\boxed{R^3 \cdot P_0 + 2\sigma R^2 = P_0\left(R_1^3 + R_2^3\right) + 2\sigma\left(R_2^2 + R_1^2\right)}$$

Para la parte a) $P_1 = P_2 = P_i$

$$\overset{n}{P_R R^3} \overset{=}{=} \overset{n}{P_i\left(R_1^3 + R_2^3\right)}$$

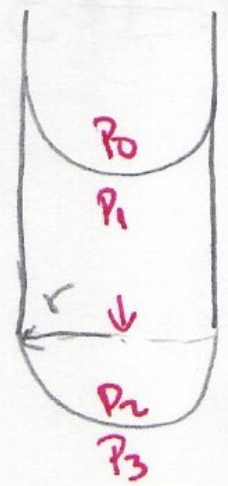
$n_f = \frac{P_R \cdot V}{\cancel{RT}}$, $n_i = P_i \frac{4\pi}{3}\left[R_1^3 + R_2^3\right]\frac{1}{\cancel{RT}}$

$P_R R^3 = P_i\left[R_1^3 + R_2^3\right]$

$$\left(\frac{2\sigma}{R} + P_0\right)R^3 = P_i\left(R_1^3 + R_2^3\right)$$

$$\boxed{2\sigma R^2 + P_0 R^3 = P_i\left(R_1^3 + R_2^3\right)}$$

2.21)



$$P_0 - P_1 = \frac{2\theta}{R} \qquad P_2 - P_1 = \rho . g h$$

$$P_2 - P_0 = \frac{2\theta}{r} \qquad P_3 = P_0 = 101 \text{ kPa}$$

$$P_2 = \frac{2\theta}{r} + P_0 \quad , \quad P_1 = P_0 - \frac{2\theta}{R}$$

$$\frac{2\theta}{r} + \cancel{P_0} + \frac{2\theta}{R} - \cancel{P_0} = \rho g h \quad ; \qquad R =$$

$$\cos \cancel{\phi} = \frac{r}{R} \ , \quad R = \frac{r}{\cos \cancel{\phi}} \ ;$$

$r = 1.10^{-3}$ m

$\phi = 10°$

$\theta = 0{,}06$ N/m

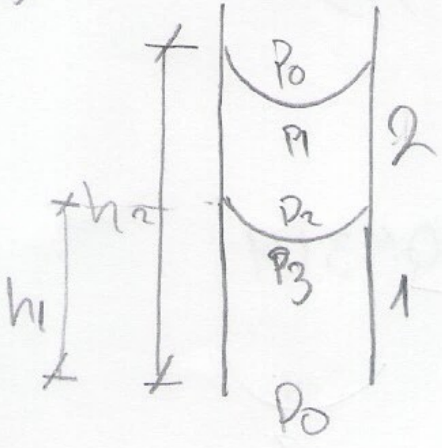
$\rho = 900$ kg/m^3

$g = 9{,}8$ m/s^2

$$\frac{2\theta}{r} + \frac{2\theta . \cos\phi}{r} = \rho g h \Rightarrow$$

$$120 - 118{,}18 = 8820 h \Rightarrow h = 0{,}027 \text{ m} = 2{,}7 \text{ cm}$$

2.22)



$$P_0 - P_1 = \frac{2\theta}{r} \qquad P_2 - P_1 = \rho_2 g (h_2 - h_1)$$

$$P_2 - P_3 = \frac{2\gamma}{r} \qquad P_0 - P_3 = \rho_1 g h_1$$

$$P_0 - P_1 = \frac{2\theta}{r} \ , \quad P_1 = P_2 - \rho_2 . g . (h_2 - h_1) \ ; \quad P_2 = \frac{2\gamma}{r} + P_3 \ ; \quad P_3 = P_0 - \rho_1 g h$$

$$P_2 = \frac{2\gamma}{r} + P_0 - \rho_1 . g . h_1 \ ; \quad P_1 = \frac{2\gamma}{r} + P_0 - \rho_1 . g h_1 - \rho_2 . g (h_2 - h_1)$$

$$\cancel{P_0} - \frac{2\gamma}{r} - \cancel{P_0} + \rho_1 g h_1 + \rho_2 g (h_2 - h_1) = \frac{2\theta}{r}$$

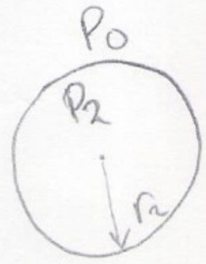
$$\frac{2\gamma}{r} = \rho_1 . g . h_1 + \rho_2 . g (h_2 - h_1) - \frac{2\theta}{r}$$

$$\boxed{\gamma = \frac{r . \rho_1 . g . h_1}{2} + \frac{r . \rho_2 . g (h_2 - h_1)}{2} - \theta}$$

2.23) En el fondo:

$$P_1 - P_0 = \frac{2\theta}{r_1} \Rightarrow P_1 = \frac{2\theta}{r_1} + P_0 \text{, además } + \rho g h$$

$$n_i = \frac{PV}{RT} = \left(\frac{2\theta}{r_1} + P_0 + \rho g h\right)\left(\frac{4}{3}\pi r_1^3\right) . \left(\frac{1}{R_s . T}\right)$$



$$P_2 = \frac{2\theta}{r_2} + P_0 \ , \quad n_f = \left(\frac{2\theta}{r_2} + P_0\right) . \left(\frac{4}{3}\pi r_2^3\right) . \left(\frac{1}{R_s . T}\right)$$

$$\left(\frac{2\theta}{r_1} + P_0 + \rho g h\right)\cancel{\left(\frac{4}{3}\pi\right)} r_1^3 . \cancel{\left(\frac{1}{RT}\right)} = \left(\frac{2\theta}{r_2} + P_0\right) r_2^3 \cancel{\left(\frac{4}{3}\pi\right)} \cancel{\left(\frac{1}{RT}\right)}$$

$$\left(\frac{2\sigma}{r_1} + P_0 + \rho g h\right) r_1^3 = 2\sigma r_2^2 + P_0 r_2^3$$

b) $3{,}2 \cdot 10^{-3} = 0{,}148\, r_2^2 + 89000\, r_2^3$

$r_2 = 3{,}3 \cdot 10^{-3}\ m = 3{,}3\ mm$

Ahora necesito el tiempo que tarda en caer los 30 m

Colocamos la EC(II) como una expresión de velocidad con respecto al tiempo!

$$t = \frac{moro}{50}\left[\ln(50V + Pmar \cdot Vl \cdot g - moro \cdot g) - \ln(Pmar \cdot Vl \cdot g - moro \cdot g)\right]$$

despejo V
$\Rightarrow$

$$e^{\frac{50t}{moro}} = \cancel{e}^{\cancel{\ln}\left(\frac{50V + Pmar \cdot Vl \cdot g - moro \cdot g}{Pmar \cdot Vl \cdot g - moro \cdot g}\right)} \quad 1$$

$$e^{50t/moro} = \frac{50V + Pmar \cdot Vl \cdot g - moro \cdot g}{Pmar \cdot Vl \cdot g - moro \cdot g}$$

despejo V y sé que Velocidad $\Rightarrow V = \frac{dx}{dt}$

$$e^{50t/moro}(Pmar \cdot Vl \cdot g - moro \cdot g) = 50V + Pmar \cdot Vl \cdot g - moro \cdot g$$

$$V = \underbrace{\frac{e^{50t/moro}(Pmar \cdot Vl \cdot g - moro\, g) + moro\, g - Pmar \cdot Vl \cdot g}{50}}_{a}$$

$$\frac{dx}{dt} = a \Rightarrow \int_0^{30\,m} dx = \int_0^t a\, dt$$

evaluando, y despejando $\boxed{t = 1\,s}$