sheet (6)

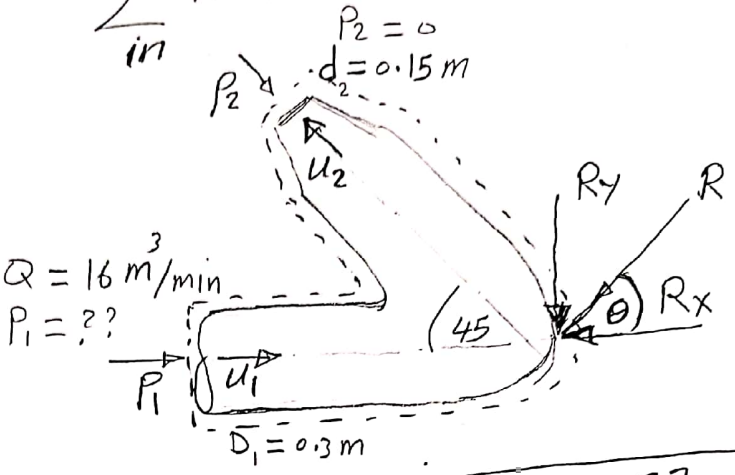
Momentum Equation

$$\sum \vec{F} = \sum_{out} \dot{m}\,\vec{u} - \sum_{in} \dot{m}\,\vec{u}$$

مجموع القوى الخارجية المؤثرة على المائع

وزن المائع فقط

wieght + shear pressure + reaction



1 Horizontal $\approx w = 0$

$\therefore Q = V_1 A_1 = V_2 A_2$

$\therefore \frac{16}{60} = V_1 \frac{\pi}{4}(0.3)^2 = V_2 \frac{\pi}{4}(0.15)^2$

$\therefore V_1 = 3.77$ m/s

$V_2 = 15.09$

B.equ: $\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1' = \frac{P_2}{\rho g}^{0} + \frac{V_2^2}{2g} + z_2$

$\therefore \frac{P_1}{9810} + \frac{(3.77)^2}{2g} = \frac{(15.09)^2}{2g}$

$\therefore P_1 = 106.75$ KPa

Momentum equ:

X-D: $P_1 A_1 + P_2 A_2 \cos 45 - R_x = \dot{m}(-u_2 \cos 45 - u_1)$ ($P_2 A_2 \cos 45$: zero)

$\therefore (106.75 \times 10^3)\frac{\pi}{4}(0.3)^2 - R_x = -1000\left(\frac{16}{60}\right)[15.09 \cos 45 + 3.77]$

$\therefore R_x = 11.396$ KN

Y-D:

$0 + 0 - R_y = \dot{m}(u_2 \sin 45 - 0)$

$\therefore -R_y = 1000\left(\frac{16}{60}\right)(15.09 \sin 45)$

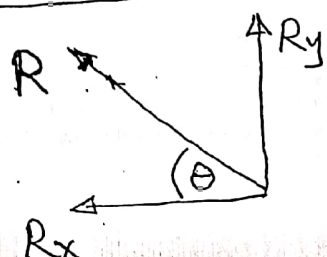
$\therefore R_y = -2.845$ KN

على الاتجاه السالب

القوة المؤثرة على الماء

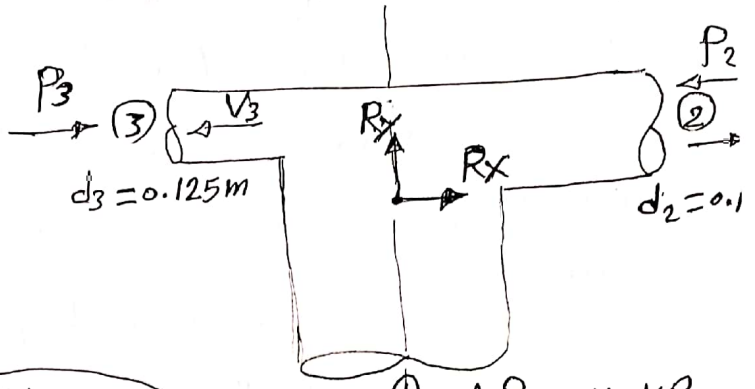
$\therefore R = \sqrt{R_x^2 + R_y^2} = 11.745$ KN

$\therefore \theta = \tan^{-1}\frac{2.845}{11.396} = 14^\circ$



Horizontal

$Q_2 = Q_3$

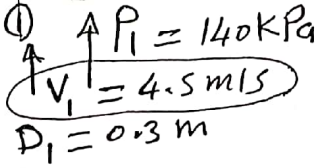


$\therefore Q_1 = V_1 \frac{\pi}{4} D_1^2 = 0.318 \ m^3/sec$

$\therefore Q_2 = Q_3 = 0.159 \ m^3/sec$

$\therefore V_2 = \frac{0.159}{\frac{\pi}{4}(0.175)^2} = 6.61 \ m/s$

$\therefore V_3 = \frac{0.159}{\frac{\pi}{4}(0.125)^2} = 12.96 \ m/s$



B.eq: ① ② $z_1 = z_2$

$\therefore \frac{P_1}{\rho g} + \cancel{z_1} + \frac{V_1^2}{2g} = \frac{P_2}{\rho g} + \cancel{z_2} + \frac{V_2^2}{2g}$ ($P_1 = 140\times10^3$, $V_1 = 4.5$, $V_2 = 6.61$, ??)

$\therefore P_2 = 128.3 \ KPa$

B.eq: ① ③ $z_1 = z_2$

$\therefore \frac{P_1}{\rho g} + \cancel{z_1} + \frac{V_1^2}{2g} = \frac{P_3}{\rho g} + \cancel{z_3} + \frac{V_3^2}{2g}$ ($P_1 = 140\times10^3$, $V_1 = 4.5$, $V_3 = 12.96$, ??)

$\therefore P_3 = 66.14 \ KPa$

Momentum:

X-D: $P_3 A_3 - P_2 A_2 + R_x = (-\dot{m}_3 V_3 + \dot{m}_2 V_2) - (0)$ (2.25 T. — الدخول)

$\therefore (66.14\times10^3)(\frac{\pi}{4})(0.125)^2 - (128.3\times10^3)(\frac{\pi}{4})(0.175)^2 + R_x =$

$-(159)(12.96) + (159)(6.61)$

$\therefore R_x = 1.265 \ KN$

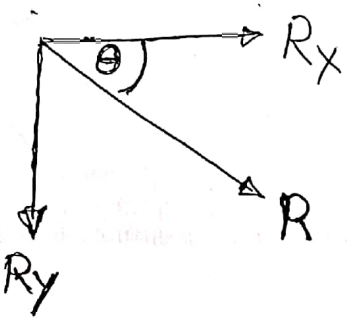
Y-D: $\therefore P_1 A_1 + R_y = 0 - \dot{m} V_1$

$\therefore (140\times10^3)\frac{\pi}{4}(0.3)^2 + R_y = -(318)(4.5)$

$\therefore R_y = -11.327 \ KN$

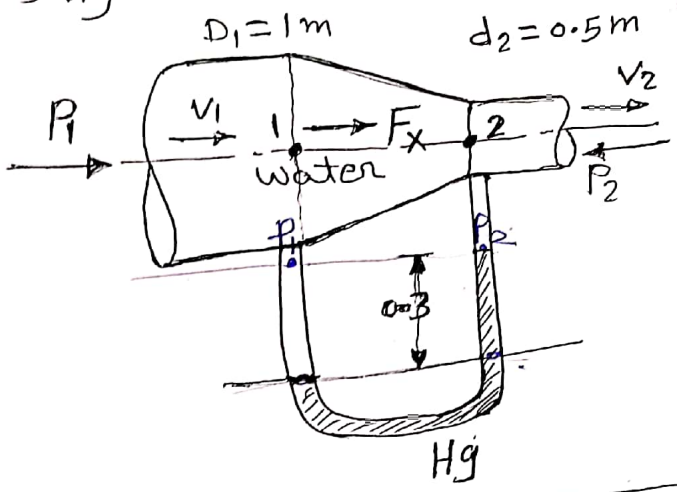
$\therefore R = 11.397 \ KN$

$\therefore \theta = \tan^{-1}\frac{11.327}{1.265} = 83.6^\circ$



$\therefore P_1 = 29430\ Pa$

$\frac{P_1}{\rho g} = 3\ m$ $\quad h_m = 0.3\ Hg$



Req: $Q = ?$ or $m' = ?$

$R_x = ?$ T.E.L. H.G.L.

Sol:

$V_1 \frac{\pi}{4} D_1^2 = V_2 \frac{\pi}{4} d_2^2$

$\therefore V_2 = 4V_1$ #

Manometer:

$\frac{29430}{P_1} + 0.3 * 10^3 * g = P_2 + 0.3 * 13600 * g$

$\therefore P_2 = -7652\ Pa$

B.eq: $\frac{P_1}{\rho g} + \cancel{Z_1} + \frac{V_1^2}{2g} = \frac{P_2}{\rho g} + \cancel{Z_2} + \frac{V_2^2}{2g}$

$\therefore 3 + \frac{V_1^2}{2g} = \frac{-7652}{(1000)(9.81)} + \frac{(4V_1)^2}{2g}$

$\therefore V_1 = 2.22\ m/s$

$\therefore V_2 = 8.88\ m/s$

$\therefore Q = V_1 A_1 = (2.22)\frac{\pi}{4}(1)^2$

$\therefore Q = 1.744\ m^3/sec$

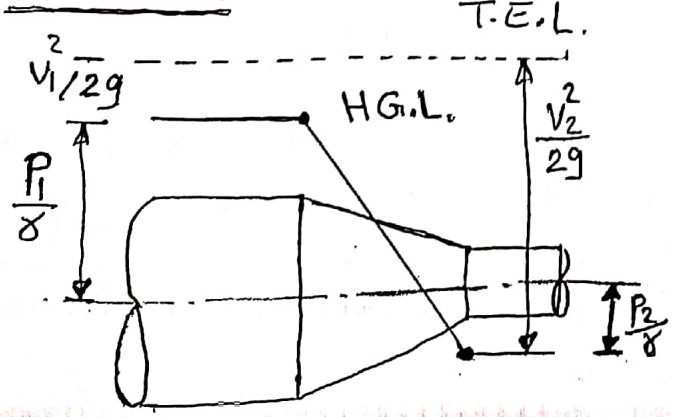
Momentum: $\therefore \Sigma F = m'(V_{xo} - V_{xi})$

$\therefore P_1 A_1 - P_2 A_2 + F_x = m'(V_2 - V_1)$

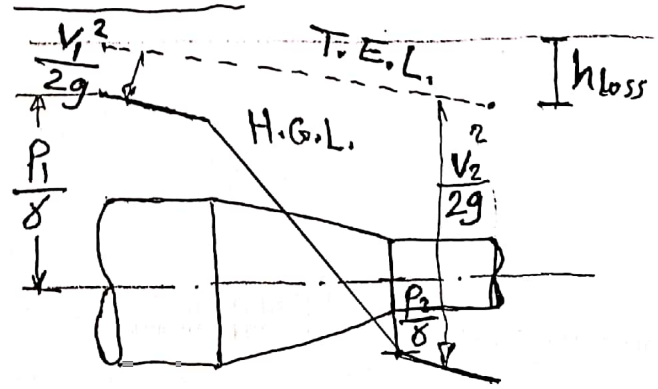
$\therefore 29430)(\frac{\pi}{4})(1)^2 + 7652(\frac{\pi}{4})(0.5)^2 + F_x = (1744)(8.88 - 2.22)$

$\therefore F_x = -13.002\ KN$

No losses:



with losses:

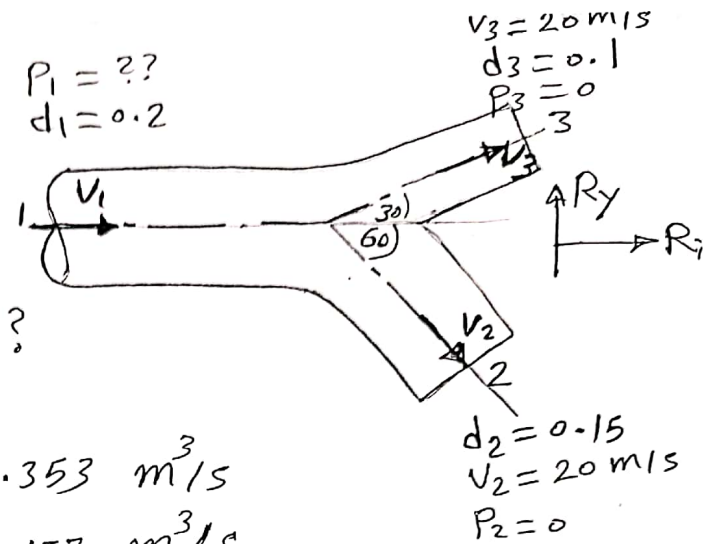


Horizontal

$z_1 = z_2 = z_3$

No losses

$Q_1 = ??$ $R_x = ?$ $R_y = ?$



Solo

$\therefore Q_2 = V_2 \frac{\pi}{4} d_2^2 = 20 \frac{\pi}{4} (0.15)^2 = 0.353 \ m^3/s$

$\therefore Q_3 = V_3 \frac{\pi}{4} d_3^2 = 20 \frac{\pi}{4} (0.1)^2 = 0.157 \ m^3/s$

$\therefore Q_1 = Q_2 + Q_3 = 0.510 \ m^3/s$

$\therefore V_1 = \frac{Q_1}{\frac{\pi}{4} d_1^2}$ $\therefore V_1 = 16.25$ m/s

B.equ: $\frac{P_1}{\rho g} + \cancel{z_1} + \frac{V_1^2}{2g} = \frac{P_2}{\rho g} + \cancel{z_2} + \frac{V_2^2}{2g}$ $\therefore P_1 = 67969$ Pa

Momentum:

X-D: $P_1 A_1 - 0 - 0 + R_x = \dot{m}_2 V_2 \cos 60 + \dot{m}_3 V_3 \cos 30 - \dot{m}_1 V_1$ $\therefore R_x = -4.173$ KN

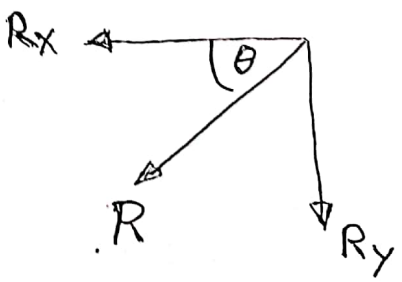
Y-D: $R_y = (\dot{m}_3 V_3 \sin 30 - \dot{m}_2 V_2 \sin 60) - (0)$

الخروج الدخول

$\therefore R_y = -4.544$ KN

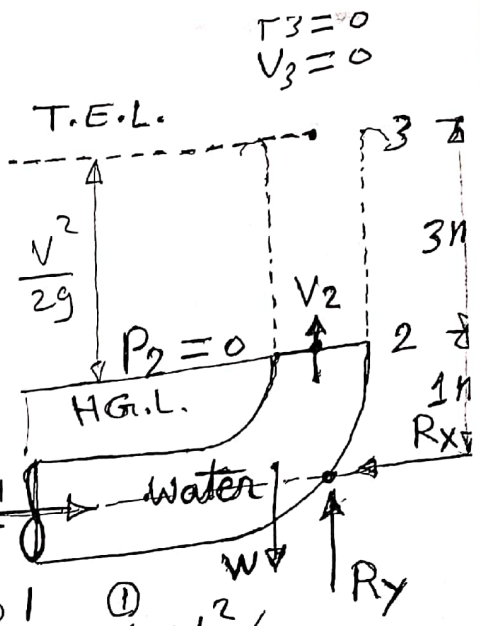
$\therefore R = \sqrt{(4173)^2 + (4544)^2}$

$= 6.169$ KN



$\therefore \theta = \tan^{-1} \frac{4544}{4173}$

$= 47.4^\circ$



Vertical $z_1 \neq z_2$

$D_1 = D_2 = 0.2\,m$

weight of water = 250N

bend ≠ 1000N (غير مؤثر)

Req: $Q = ??$ $R_x = ?$ $R_y = ?$

T.E.L. H.G.L.

Sol:

B. equ: $\frac{P_1}{\rho g} + \cancel{z_1} + \frac{V_1^2}{2g} = \frac{P_2}{\rho g} + \cancel{z_2} + \frac{V_2^2}{2g}$

$\therefore P_1 = 9810\ Pa$

$\frac{P_1}{\rho g} + \cancel{z_1} + \frac{V_1^2}{2g} = \frac{P_3}{\rho g} + \cancel{z_3} + \frac{V_3^2}{2g}$

$\therefore V_1 = 7.67\ m/s$

Momentum equ: $\therefore Q = V_1 \cdot A_1 = (7.67)\frac{\pi}{4}(0.2)^2$

$\therefore Q = 0.241\ m^3/s$

X-D: $\therefore P_1 A_1 - R_x = \dot{m}(0 - V_1)$

$(9810)\frac{\pi}{4}(0.2)^2 \quad 241 \quad 7.67$

$\therefore R_x = 2156.7\ N$

Y-D: $\therefore R_y - W = \dot{m}(V_2 - 0)$

$250 \quad 241 \quad 7.67$

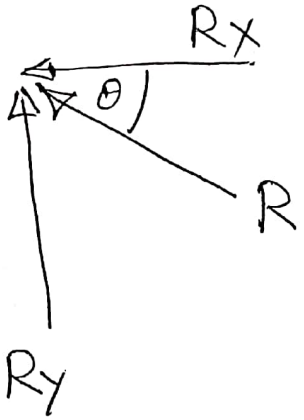
$\therefore R_y = 2098.5\ N$

$\therefore R = \sqrt{(2156.7)^2 + (2098.5)^2}$

$= 3009.1\ N$

$\therefore \theta = \tan^{-1}\frac{2098.5}{2156.7}$

$= 44.2^\circ$

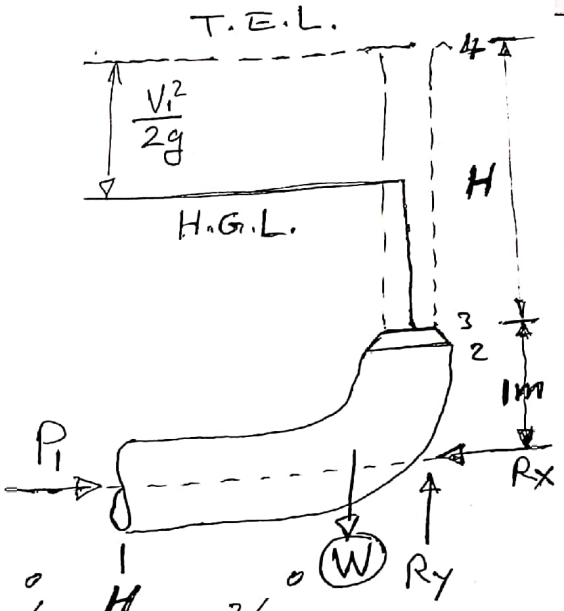


$Q = 0.241\ m^3/s$ $\quad V_4 = 0$

$d_3 = 0.1\ m$ $\quad D_1 = 0.2\ m$

T.E.L. $\quad$ H.G.L. $\quad P_1 = ??$

$H = ??$ $\quad R_x = ?$ $\quad R_y = ?$



Sol:

$V_1 = 7.67\ m/s$

$V_3 = \dfrac{0.241}{\frac{\pi}{4}(0.1)^2} = 30.7\ m/s$

B.equ: ③④

$$\frac{P_3}{\rho g}^{0} + Z_3^{0} + \frac{V_3^2}{2g}^{\frac{(30.7)^2}{2g}} = \frac{P_4}{\rho g}^{0} + Z_4^{H} + \frac{V_4^2}{2g}^{0}$$

$\therefore H = 48.04\ m$

B.equ ①④

$$\frac{P_1}{\rho g} + Z_1^{0} + \frac{V_1^2}{2g}^{7.67} = \frac{P_4}{\rho g}^{0} + Z_4^{49.04} + \frac{V_4^2}{2g}^{0}$$

$\therefore P_1 = 451.7\ KPa$

Momentum:

X-D: $P_1 A_1 - R_X = \dot{m}(0 - V_1)$ $\quad \therefore R_X = 16.04 KN$

$(451.7 \times 10^3)\frac{\pi}{4}(0.2)^2 - R_X = 241(-7.67)$ ⇑

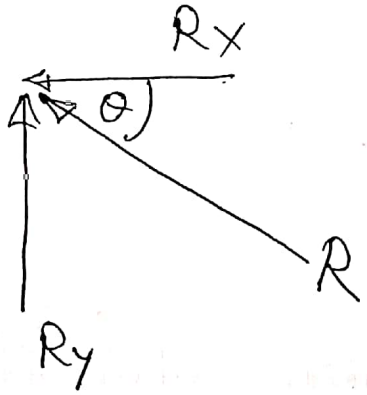
Y-D: $R_y - W^{1250} = \dot{m}^{241}(V_3^{30.7} - 0)$ $\quad \therefore R_y = 8.65\ KN$

$\therefore R = \sqrt{(16.04)^2 + (8.65)^2}$

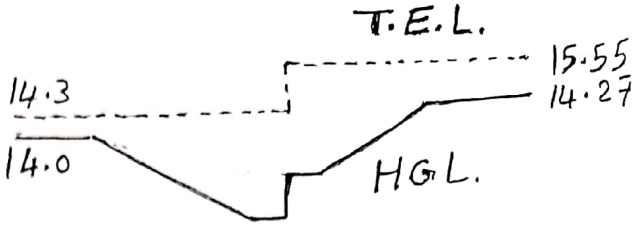
$= 18.22\ KN$

$\theta = \tan^{-1}\dfrac{8.65}{16.04}$

$= 28.3^0$



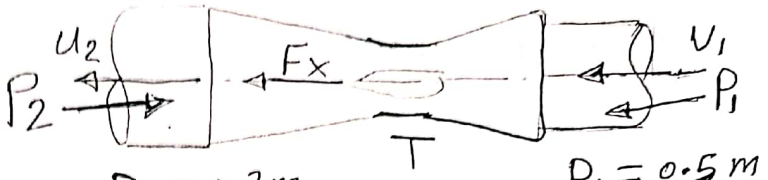
turbine power = 12000 W
No losses
$\eta_T = 100\%$



Req:

$P_2 = ??$ $F_x = ??$

Sol:



$D_2 = 0.7m$
$V_2 = ?$
$P_2 = ?$

$D_1 = 0.5\ m$
$V_1 = 5\ m/s$
$P_1 = 140\ KPa$

$Q_{1,2} = (5)\frac{\pi}{4}(0.5)^2$

$Q = 0.982\ m^3/sec$

$\therefore U_2 = \frac{0.982}{\frac{\pi}{4}(0.7)^2}$

$\therefore V_2 = 2.55\ m/s$

$\because P = \rho . g . Q . H_T$

$\therefore H_T = \frac{12000}{(10^3)(9.81)(0.982)} = 1.246m$

B.equ: ①② $\frac{P_1}{\rho g} + \cancel{Z_1} + \frac{V_1^2}{2g} - H_T = \frac{P_2}{\rho g} + \cancel{Z_2} + \frac{V_2^2}{2g}$

$\therefore \frac{140\times10^3}{(10^3)(9.81)} + \frac{5^2}{2g} - 1.246 = \frac{P_2}{\rho g} + \frac{(2.55)^2}{2g}$

$\therefore P_2 = 137.03\ KPa$

Momentum:

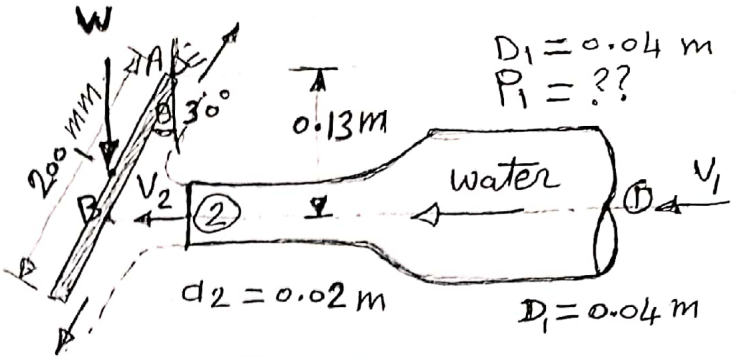
$\therefore P_1 A_1 - P_2 A_2 + F_x = \dot{m}(U_2 - U_1)$

$\therefore (140*10^3)\frac{\pi}{4}(0.5)^2 - (137*10^3)\frac{\pi}{4}(0.7)^2 + F_x = 982(2.55-5)$

$\therefore F_x = 22.83\ KN$

$C_d = 0.97$
$m = 5\ kg$
$\theta = 30^\circ$

$P_2 = 0$
$d_2 = 0.02\ m$



Sol:

$\dot{m} = C_d \cdot \rho \cdot V_2 A_2$

Momentum:

$\because \Sigma F = \dot{m}(V_o - V_i)$

$\therefore -F_w = \dot{m}(0 - V_2)$

$\therefore F_w = C_d \cdot \rho \cdot A_2 \cdot V_2^2$

$\therefore \boxed{F_w = 0.3047\, V_2^2 = F_w}$

توجد قوه مساويه لها في المقدار وعكس الاتجاه هما التي تحرك الـ plate الموثره على الطائر

قبل الدوران

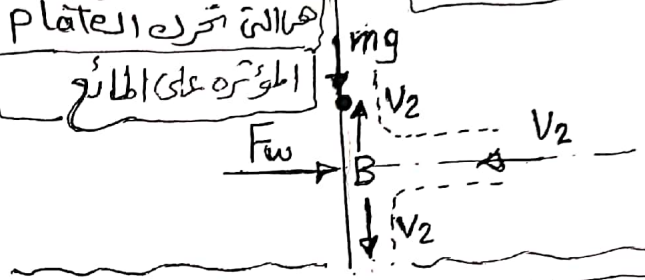


Plate equilibrium:

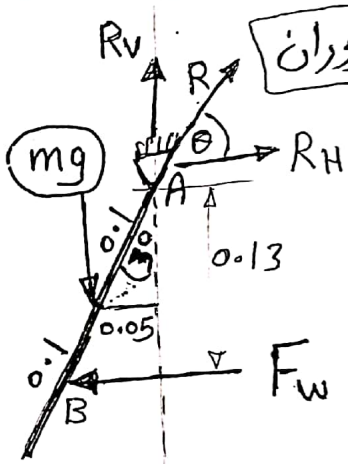
$\Sigma M_A = 0$

$F_w(0.13) = mg(0.1 \sin 30)$ (5) (0.05)

$\therefore 0.3047\, V_2^2 (0.13) = (5)(9.81)(0.05)$

$\therefore \boxed{V_2 = 7.87\ m/s}$

بعد الدوران



Continuity: $V_2 \frac{\pi}{4}(0.02)^2 = V_1 \cdot \frac{\pi}{4}(0.04)^2$

$\therefore \boxed{V_1 = 1.97\ m/s}$

B.eq: $\frac{P_1}{\rho g} + \cancel{z_1} + \frac{V_1^2}{2g} = \frac{P_2}{\rho g} + \cancel{z_2} + \frac{V_2^2}{2g}$ ($P_2 = 0$, $V_1 = 1.97$, $V_2 = 7.87$)

$\therefore \boxed{P_1 = 29028\ Pa = 29.03\ KPa}$

Hinge Reactions: غير مطلوب

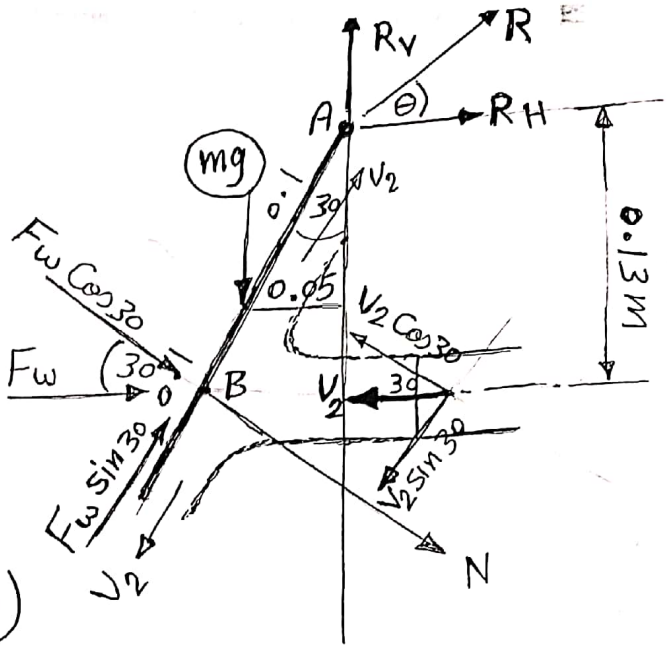
$\Sigma F_x = 0 \longrightarrow \therefore R_H = F_w = 18.87\ N$

$\Sigma F_y = 0 \longrightarrow \therefore R_V = mg = 49.05\ N$

$\therefore \boxed{R = \sqrt{R_V^2 + R_H^2} = 52.6\ N}$ $\quad \therefore \boxed{\theta = \tan^{-1}\frac{49.05}{18.87} \simeq 79^\circ}$

8] pipe

Sol:



Momentum in N-D:

$$\Sigma F = \dot{m}(V_o - V_i)$$

$$\therefore -F_w \cos 30 = \rho \cdot A_2 V_2 (0 - V_2 \cos 30)$$

$$\therefore F_w = 0.3047 V_2^2 \quad \text{---- ①}$$

Cot.equ: $V_1 = V_2 \left(\frac{0.02}{0.04}\right)^2 \longrightarrow \boxed{V_1 = 0.25 V_2}$

B.equ: $\frac{P_1}{\rho g} + \cancel{Z_1} + \frac{V_1^2}{2g} = \frac{\cancel{P_2}^{=0}}{\rho g} + \cancel{Z_2} + \frac{V_2^2}{2g}$ ($V_1 = 0.25 V_2$)

$$\therefore \boxed{P_1 = 468.75 V_2^2}$$

Plate equilibrium:

$$\Sigma M_A = 0 \longrightarrow \therefore F_w (0.13) = mg (0.05)$$

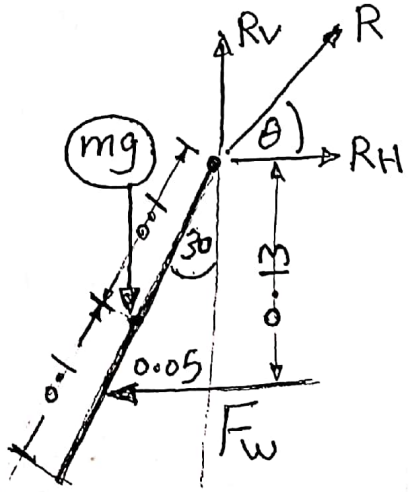
$$\therefore F_w = 0.3047 V_2^2$$

$$\therefore V_2 = 7.87 \text{ m/s}$$

$$\therefore V_1 = 1.97 \text{ m/s}$$

$$\therefore \boxed{P_1 = 29028 \text{ Pa}} \quad \#$$

Hinge Reaction:



$$R_V = mg = 49.05 \text{ N}$$

$$R_H = F_w = 18.87 \text{ N}$$

$$\therefore R = 52.55 \text{ N}$$

$$\therefore \theta = 79^\circ \quad \#$$

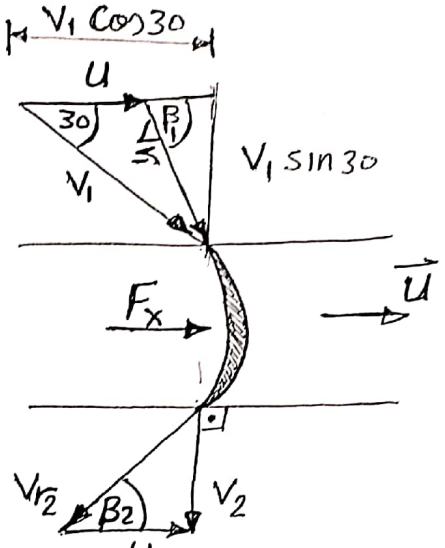
3] $V_1 = 36\ m/s$ $\quad d_{jet} = 0.1\ m$

$U = 15\ m/s$

$V_{r_2} = 0.85\, V_{r_1}$

$\beta_1 = ?\quad \beta_2 = ?\quad F_x = ?$

Power $= ?\quad \eta = ?$



Sol:

$$\tan\beta_1 = \frac{V_1 \sin 30}{V_1 \cos 30 - u} \qquad (36),\ (15)$$

$\therefore \beta_1 = 48^\circ$

$$V_{r_1}^2 = (V_1 \sin 30)^2 + (V_1 \cos 30 - u)^2$$

$\therefore V_{r_1} = 24.2\ m/s$

$\therefore V_{r_2} = 0.85(24.2)$

$\therefore V_{r_2} = 20.57\ m/s$

$V_2^2 = (20.57)^2 - (15)^2$

$\therefore V_2 = 14.08\ m/s$

$\tan\beta_2 = \frac{14.08}{15}$

$\therefore \beta_2 = 43.2^\circ$

Continuity: $\quad \dot{m} = \rho . V_1 . \frac{\pi}{4} d_j^2 = 10^3 (36) \frac{\pi}{4} (0.1)^2$

$\therefore \dot{m} = 282.7\ kg/s$

Momentum equ: X-D: V_r في اتجاه

$\therefore \Sigma F_x = \dot{m}(V_{xo} - V_{xi})$

$\therefore F_x = (282.7)(-V_{r_2}\cos\beta_2 - V_{r_1}\cos\beta_1)$

($\dot{m}$ = 282.7, $-V_{r_2}$ = −20.57, $\cos\beta_2$ = cos 43.2, V_{r_1} = 24.2, $\cos\beta_1$ = cos 48°)

$\therefore F_x = -8.817\ KN$

$\therefore$ Power $= F_x \cdot u$

$= (8.817)(15) = 132.25\ KW$

$$\therefore \eta = \frac{\text{out put } W}{\text{in put } W} = \frac{132.25 * 10^3}{\frac{1}{2}(282.7)(36)^2}$$

$\frac{1}{2} \dot{m} V_1^2$

$\eta = 72.2\ \%$