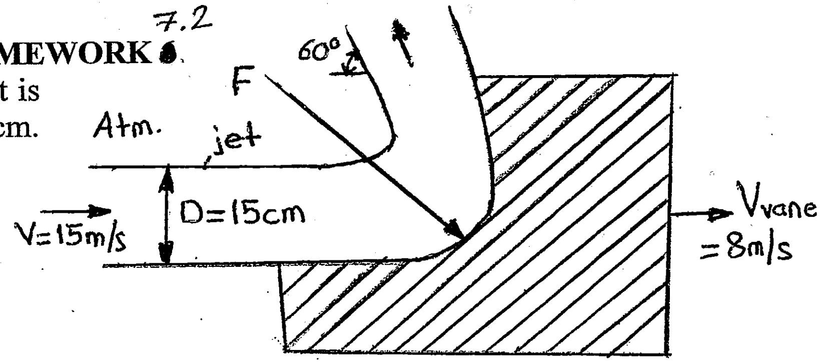
7.2

HOMEWORK 6.

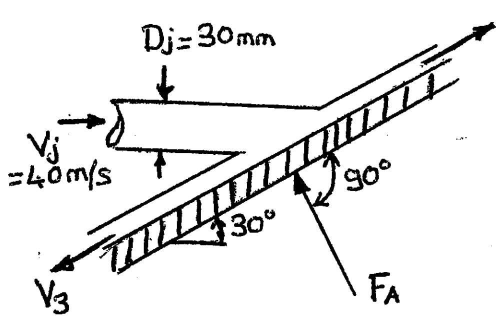
Q1) Find the force F acting on the vane. Water jet is on the horizontal plane and its diameter is 15 cm. Neglect the headloss.
$\rho_w = 1000\ kg/m^3$

$F = 1499.8\ N$



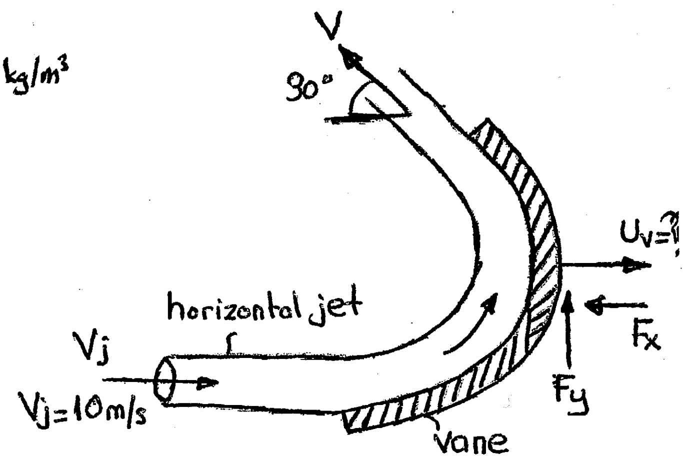
Q2) A horizontal circular jet of air strikes a stationary flat plate as indicated in the figure. The jet velocity is 40 m/s and the jet diameter is 30 mm. If the air velocity magnitude remains constant as the air flows over the plate surface in the direction shown, determine **(a)** the magnitude of F_A, the anchoring force required to hold the plate stationary, **(b)** the fraction of mass flow along the plate surface in each of the two directions shown, **(c)** the magnitude of F_A, the anchoring force to allow the plate to move to the right at a constant speed of 10 m/s. $\rho_w = 1000\ kg/m^3$, $\rho_{air} = 1.23\ kg/m^3$

a) 0.6954 N b) $\frac{M_2}{M_J} = 0.933$; $\frac{M_3}{M_J} = 0.0670$ c) 0.391 N



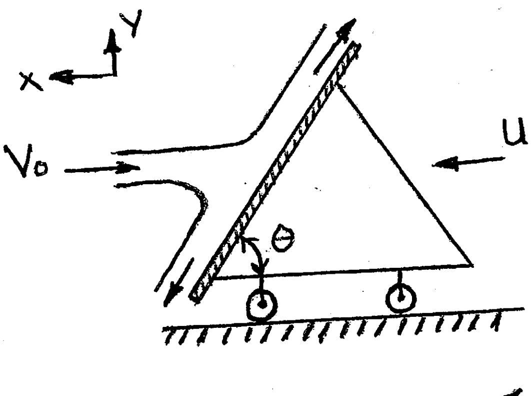
Q3) As shown in the figure a jet of water 2.5 cm in diameter strikes a vane with a velocity of $V_j = 10$ m/s. The vane has a horizontal velocity of U_v. If the force exerted by the water jet on the vane is 5 N. What is the velocity U_v of the vane? Neglect the weights of jets, air-entrainment into the jets and energy losses in the system. $\rho_w = 1000\ kg/m^3$

$U_v = 7.7\ m/s$

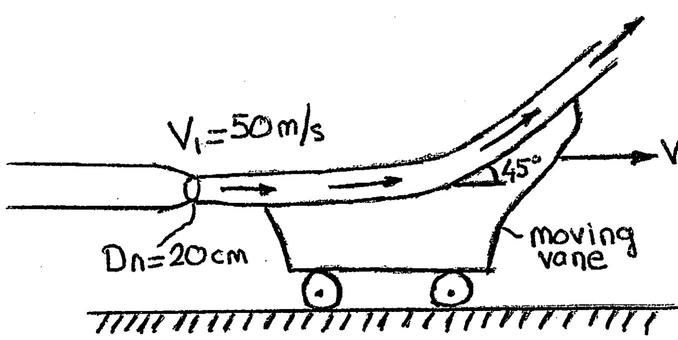


Q4) A flat plate is moving with velocity is moving with velocity u to the left in the arrow direction as shown in the figure. Derive en expression for the force K which is necessary to move the plate, taking into account the friction force as well which is given as $K = \eta F_y + F_x$ where η is the friction coefficient. V_o = velocity of the jet.

$\vec{K} = \eta \rho Q (V_o + u) \sin\theta \cos\theta \, \vec{j} + \rho Q (V_o + u) \sin^2\theta \, \vec{i}$



Q5) A vane on wheels moves with constant velocity V_o. When a stream of water having a nozzle exit velocity of V_1 is turned 45° by the vane as shown in the figure. Determine the magnitude and the direction of the force F exerted by the stream of water on the vane surface. The speed of the water jet leaving the nozzle is 50 m/s and the vane is moving right with a constant speed of 15 m/s. Assume that the water flow is frictionless and the change in water elevation across the vane is negligible. Also neglect weights of jet water on the vane.

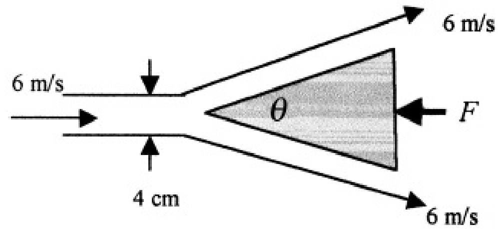


$F = 29466.6\ N$

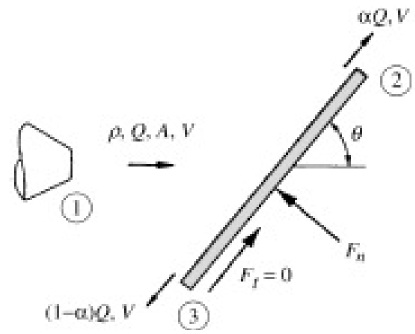
$\alpha = 67.5°$

CE 371 HOMEWORK 9

1) A wedge splits a sheet of water, as shown in the figure. Both wedge and sheet are very long into the paper. If the force required to hold the wedge stationary is $F = 124$ N per meter of depth into the paper, what is the angle θ of the wedge?
$\rho_{water} = 998 \text{ kg/m}^3$



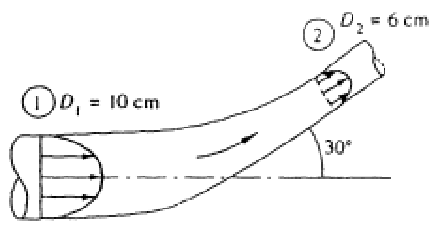
2) When a jet strikes an inclined plate, it breaks into two jets of equal velocity V but unequal fluxes αQ at (2) and $(1 - \alpha)Q$ at (3), as shown. Find α, assuming that the tangential force on the plate is zero.



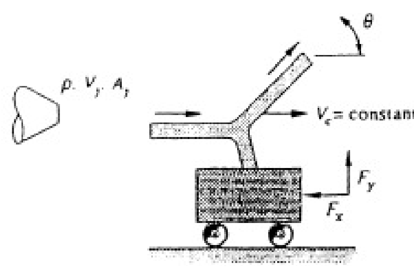
3). For the elbow duct in the figure oil enters section 1 at 350 N/s, where the flow is laminar, and exits at section 2, where the flow is turbulent:

$$u_1 = V_{av}\left(1 - \frac{r^2}{R_1^2}\right), \quad u_2 = V_{av}\left(1 - \frac{r}{R_2}\right)^{1/7}$$

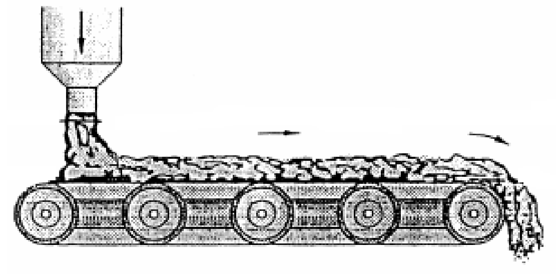
Assuming steady incompressible flow, compute the force, and its direction, of the oil on the elbow due to momentum change only (no pressure change or friction effects)
$\gamma_{oil} = 8720 \text{ N/m}^3$



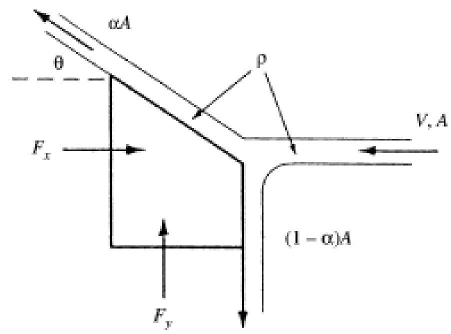
4) In the figure shown, the jet strikes a vane which moves to the right at constant velocity V_c on a frictionless cart. Compute **(a)** the force F_x required to restrain the cart and **(b)** the power P delivered to the cart. Also find the cart velocity for which **(c)** the force F_x is a maximum and **(d)** the power P is a maximum.



5) Gravel is dumped from a hopper, at a rate of 650 N/s, onto a moving belt, as in The figure. The gravel then passes off the end of the belt. The drive wheels are 80 cm in diameter and rotate clockwise at 150 r/min. Neglecting system friction and air drag, estimate the power required to drive this belt.



6) A liquid jet of density ρ and area A strikes a block and splits into two jets, as shown in the figure. All three jets have the same velocity V. The upper jet exits at angle θ and area αA, the lower jet turns down at 90° and area (1 − α)A. **(a)** Derive a formula for the forces (F_x,F_y) required to support the block against momentum changes.
(b) Show that $F_y = 0$ only if $\alpha \geq 0.5$.
(c) Find the values of α and θ for which both F_x and F_y are zero.



ANSWERS

1) θ = 48°
2) α = 0.5(1+cosθ)
3) F_x = 256 N, F_y = 254 N
4) a) $F_x = \rho A_j(V_j-V_c)^2(1-\cos\theta)$; **b)** $P = \rho A_j V_c(V_j-V_c)^2(1-\cos\theta)$ **c)** $V_c = 0$ **d)** $V_c = V_j/3$
5) P = 2600 W

6) a) $F_x = \dot{m}V(1-\alpha\cos\theta)$, $F_y = \dot{m}V(\alpha\sin\theta+\alpha-1)$ $(\dot{m} = \rho AV)$

c) α=1, θ=0