

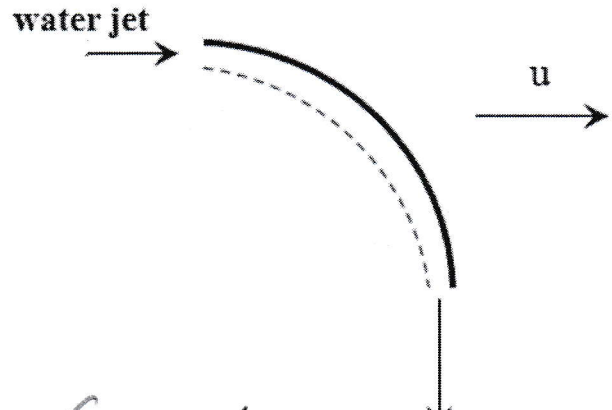
Faculty of Engineering	Philadelphia University	Mechanical Eng. Dep.
Course name: hydraulic machines	First Quiz	Course number: 620528
Instructor: Eng. Laith Batarseh	Thursday 22/3/2018	Allowed time: 10 minutes

Student Name:

Student ID number:

**Problem:**

A 7 cm diameter free jet of water having a velocity of 15 m/s impinges on a smooth vane as shown in the figure. What will be the force acting on the vane when the vane is moving in the horizontal direction at 10 m/s.



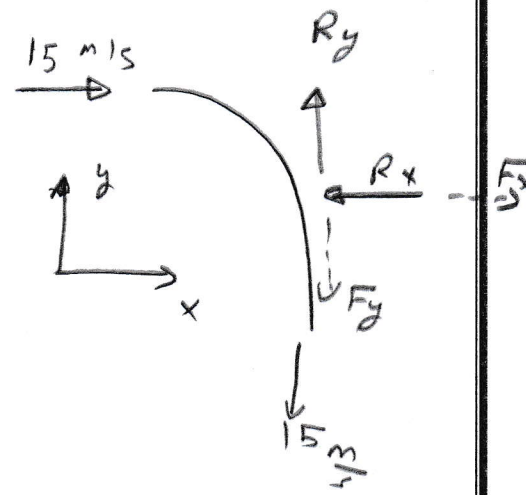
*Solution:- Assume Frictionless Surface and open to Atmosphere*

$$F_x = \sum M_{in, x} - \sum M_{out, x}$$

$$F_x = \rho Q V V_n \quad ; \quad V_n = V - u = 15 - 10 = 5 \frac{m}{s}$$

$$Q = AV_n = \frac{\pi}{4} (0.07)^2 (5) = 0.0192 \frac{m^3}{s}$$

$$F_x = 998 \times 0.0192 \times 5 \approx 96 \text{ N.}$$

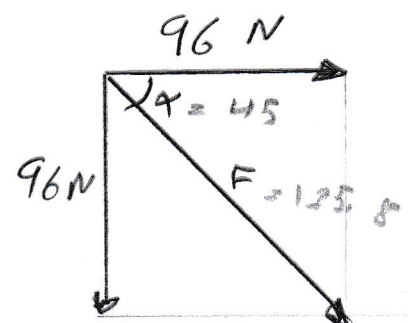


$$-F_y = \sum M_{in, y} - \sum M_{out, y} \Rightarrow -F_y = 0 - (-\rho Q V V_n)$$

$$\Rightarrow F_y = -\rho Q V V_n = (998)(0.0192)(5) = -96 \text{ N}$$

$$F = \sqrt{96^2 + 96^2} = 135.8 \text{ N}$$

$$\alpha = \tan^{-1} \frac{96}{96} = 45^\circ$$



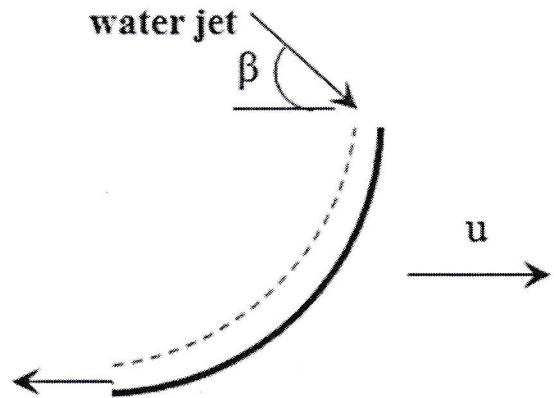
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**Problem:**

A 10 cm diameter free jet of water having a velocity of 20 m/s impinges on a smooth vane as shown in the figure. If  $\beta = 30$  degree, what will be the force acting on the vane when the vane is moving in the horizontal direction at 5.0 m/s.



Solution..

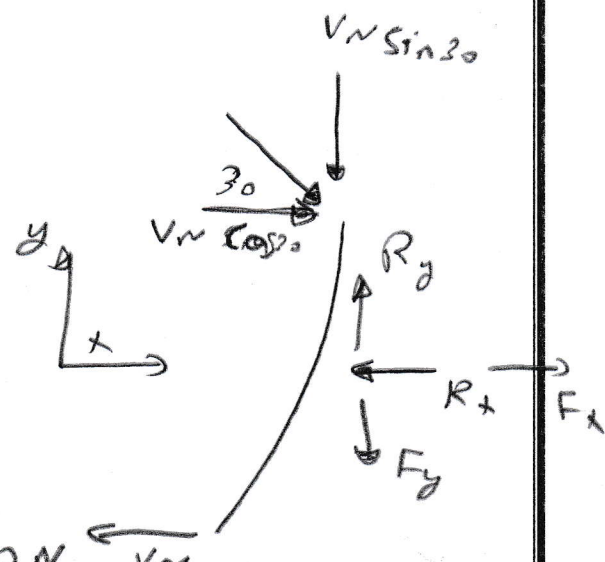
$$F_x = \sum M_{in, x} - \sum M_{out, x}$$

$$= \rho Q_v [V_v \cos 30 - (-v_v)]$$

$$= \rho Q_v V_v [1 + \cos 30] ; V_v = V - u = 20 - 5 = 15 \frac{m}{s}$$

$$Q_v = A V_v = \frac{\pi}{4} (0.1)^2 (15) = 0.118 \frac{m^3}{s}$$

$$F_x = (998) (0.118) (15) (1 + \cos 30) = 3290 N$$



$$-F_y = \sum M_{in, y} - \sum M_{out, y} \Rightarrow -F_y = -\rho Q_v V_v \sin 30 - 0$$

$$\Rightarrow F_y = 998 \times 0.118 \times 15 \times \sin 30 = 883 N$$

$$F = \sqrt{(3290)^2 + (883)^2} = 3406.5 N$$

$$\theta = \tan^{-1} \frac{883}{3290} = 15^\circ$$

