2) $\frac{du}{dt} = u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}$

$= (U_0 \frac{x}{L})(\frac{U_0}{L}) +$

$\cancel{(-U_0 \frac{y}{L})(0)} = \frac{U_0^2}{L^2}x$

$\frac{dv}{dt} = u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y}$

$= (U_0 \frac{x}{L})(0) +$

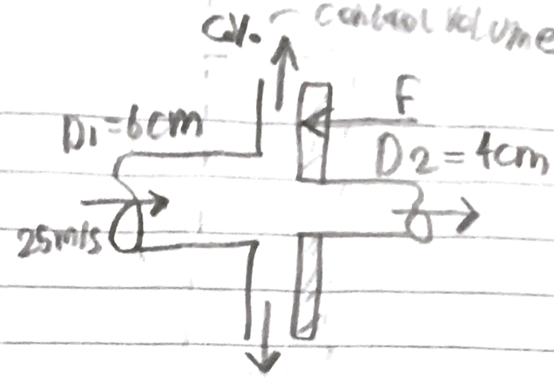
$(-U_0 \frac{y}{L})(-\frac{U_0}{L}) = \frac{U_0^2}{L^2}y$

a) $\boxed{\therefore \text{The acceleration vector is } \vec{a}\ (U_0^2/L^2)(x\hat{i} + y\hat{j}) \text{ or } |\vec{a}| \text{ is } (U_0^2/L^2)r}$

$|a| = 25 = \frac{U_0^2}{L^2}|r|$

$U_0 = \sqrt{\frac{25(1.5)^2}{\sqrt{2}}} = 6.3\ \frac{m}{s}$

b) $\boxed{\therefore U_0 = 6.3\ m/s}$

1) 

$Q_{in} = \frac{\pi}{4}(0.06)^2(25) = 0.0707\ \frac{m^3}{s}$

$Q_{hole} = \frac{\pi}{4}(0.04)^2(25) = 0.0314\ \frac{m^3}{s}$

$\Sigma F_x = -F_{plate} = \dot{m}_{hole}u_{hole}$

$+ \dot{m}_{upper}\cancel{u_{upper}}^{0} + \dot{m}_{lower}\cancel{u_{lower}}^{0} - \dot{m}_{in}u_{in}$

$= (998)(0.0314)(25) - (998 \times 25 \times 0.0707)$

$= 784 - 1764 \quad \therefore F = -980N$

$\boxed{\therefore \text{The horizontal force required to hold the plate is } 980\ N \text{ (left)}}$

3) Assumptions:

1. flow is steady

2. flow is incompressible

3. flow is two-dimensional

$$\frac{dP}{dt} = \cancel{\frac{\partial P}{\partial t}}^{0} + u\frac{\partial P}{\partial x} + V\frac{\partial P}{\partial y}$$

$$\cancel{+ W\frac{\partial P}{\partial z}}^{0} = (U_0 + bx)$$

$$(-PU_0b - Pb^2x) + (-by)$$

$$(-Pb^2y)$$

$$\boxed{\therefore \frac{dP}{dt} = P[-U_0^2 b - 2U_0 b^2 x + b^3(y^2 - x^2)}$$

4) $$\frac{dT}{dt} = -0.4\frac{dy}{dt} - 0.6\frac{dz}{dt}$$

$$-0.2 \times 2 \times (-1)(5-x)\frac{dx}{dt}$$

$$= -0.4V_y - 0.6V_z + 0.4(5-x)V_x$$

$$= -0.08t + 0.84 + 0.24x(5-x)$$

at $t = 10s$ & $x = 1m$

$$\frac{dT}{dt} = -0.08 \times 10 + 0.84 + 0.24 \times (5-1)$$

$$= 1^\circ C/m$$

$\boxed{\therefore \text{The temperature change is } 1^\circ C/m}$