Name: ____

CVEN 311-503 – "Fluid Dynamics"
Quiz #4 – Fall 2011
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Several useful equations are printed on the back of the page.

1. An oscillating track paint sprayer produces a flow velocity (at the paint nozzle) described by the equations:

$$u = 9 \quad \text{ft/sec}$$

$$v = 3 \cdot \sin\left(-t\frac{\pi}{2}\right) \quad \text{ft/sec}$$

   (a) What are the minimum and maximum flow speeds in the flow field?
   (b) Determine an expression for the acceleration vector $\vec{a}$ in the flow field.

2. A fire hose sprays a 0.5 cfs jet of water through a 3 inch diameter circular nozzle. The spray is directed at a vertical wall close by. If the jet strikes the wall at a perpendicular angle, what will be the reactive force of the jet on the wall?

Useful equations:

$$\frac{d}{dx}(\sin\theta) = (\cos\theta)\frac{d\theta}{dx}$$

$$\vec{Y} = \frac{D\vec{X}}{Dt} = \frac{\partial\vec{X}}{\partial t} + \left(\vec{V}\cdot\nabla\right)\vec{X} = \begin{cases} Y_x = \dfrac{\partial X_x}{\partial t} + u\dfrac{\partial X_x}{\partial x} + v\dfrac{\partial X_x}{\partial y} + w\dfrac{\partial X_x}{\partial z} \\ Y_y = \dfrac{\partial X_y}{\partial t} + u\dfrac{\partial X_y}{\partial x} + v\dfrac{\partial X_y}{\partial y} + w\dfrac{\partial X_y}{\partial z} \\ Y_z = \dfrac{\partial X_z}{\partial t} + u\dfrac{\partial X_z}{\partial x} + v\dfrac{\partial X_z}{\partial y} + w\dfrac{\partial X_z}{\partial z} \end{cases}$$

$$\vec{a} = \frac{D\vec{V}}{Dt}$$

where $\vec{X}$ and $\vec{Y}$ are generic vector quantities

The 1-dimensional momentum equation states that:

$$\begin{matrix}\text{Reactive}\\ \text{Force}\end{matrix} + \begin{matrix}\text{Net Pressure}\\ \text{Forces}\end{matrix} = \sum_{OUT} Momentum\ Flux - \sum_{IN} Momentum\ Flux$$

where momentum flux is

$$\dot{m}V = \rho QV = \frac{\dot{\gamma}}{g}V$$