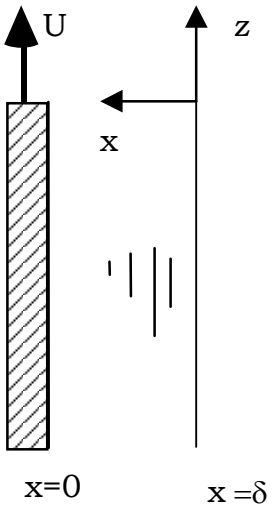
SOUTH DAKOTA SCHOOL OF MINES AND TECHNOLOGY
DEPARTMENT OF MATERIALS & METALLURGICAL ENGINEERING

MET 422	HQ 1	October 3, 2000
MI 222	(closed book)	11:00 AM

1. Write Newton's Law of Viscosity and give the units of each quantity in the equation. Use the CGS system of units.

2. A vertical sheet is moving upward at velocity U with a fluid film as shown below. Derive an equation showing the laminar velocity distribution in the film. Assume the z direction is up. Gravity acts on the fluid in the -z direction. There is no pressure gradient.



3. The natural convection of fluids is caused by fluid density differences arising from temperature differences. For two horizontal plates a distance L apart and with a temperature difference of ΔT, the velocity depends on the following parameters:

$$V = f(L, \rho, \eta, k, C_p, g, \beta, \Delta T)$$

where:

L [=] cm
ρ [=] $g\text{-}cm^{-3}$
η [=] $g\text{-}sec^{-1}\text{-}cm^{-1}$
k [=] $g\text{–}K^{-1}\text{-}sec^{-3}$ (thermal conductivity)
C_p [=] $cm^2\text{-}sec^{-2}\text{-}K^{-1}$
g [=] $cm\text{-}sec^{-2}$
β [=] K^{-1} (thermal coefficient of expansion)
ΔT [=] K

By dimensional analysis, reduce the above parameters to dimensionless groups.
Note: Buoyant force considerations require that g, β, and ΔT all appear in one group. That, is

$$V = f(L, \rho, \eta, k, C_p, g\beta \Delta T)$$

4. Using the attached sheet giving the Equations of Change, reduce equations A, B, and C to a simple laminar flow in a cylinder with axial (z) flow direction only. (Cross out the zero terms on the sheet and submit the sheet for your answer.)