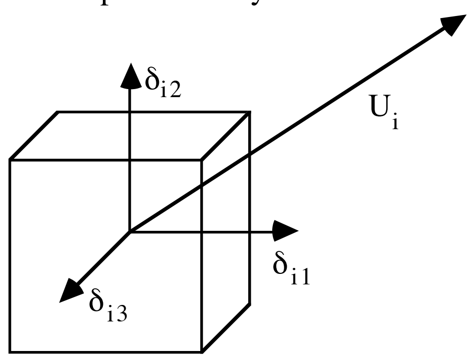
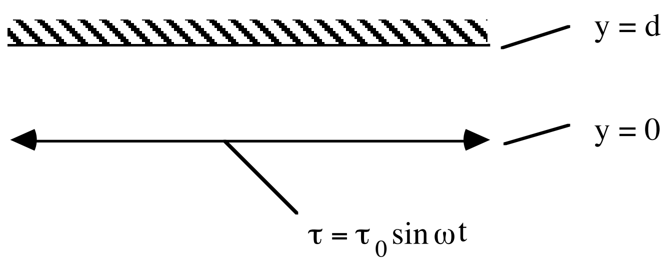
CHEG 544 Transport Phenomena I
First Hour Exam

Closed Books and Notes

1). (10 points) Using simple arguments based on the linearity of the creeping flow equations, prove that the drag on a cube under creeping flow conditions is the same regardless of its orientation relative to the direction of motion. (Hint: use the principle that a linear problem may be broken into the sum of several simpler problems)



2). (20 points) Consider the fluid confined within the gap of width d depicted below. If the plane y=0 is oscillated back and forth with some oscillatory **shear stress** $\tau = \tau_0 \sin\omega t$, solve for the asymptotic velocity distribution at large times ($\nu t/d^2 >> 1$). You may leave your answer in the form $u = \mathrm{Im}(g(y,t))$ where g is a complex function which you have explicity obtained.



3). (20 points) Resolve problem 2 for the case where the fluid is initially at rest (u=0 everywhere) and we look at the limits $\nu t/d^2 << 1$ and $\omega t << 1$. Note that in this limit the shear stress at the wall will be a linearly increasing function of time (i.e., $t \approx t_0 \omega t$) and the problem will admit a similarity transform. Obtain the similarity rule and similarity variable **in cannonical form**, together with the resulting ODE **and boundary conditions**, but do not try to obtain an explicit solution. How does the velocity of the plane at y=0 vary with time?