

**Phy 352 (Fluid Dynamics) Spring 2013, Problem Set 3**

1. Consider a viscous, incompressible fluid between two parallel plates. The plates are of infinite extent in the  $x$  and  $z$  directions, and the fluid flow is along the  $x$  direction. The lower plate coincides with the  $x$ -axis and the plates are separated along the  $y$ -direction by an amount  $b$ . The lower plate is held fixed and the upper plate moves with a velocity  $U\hat{\mathbf{x}}$ . This is called a planar Couette flow. Show that the flow velocity increases linearly with  $y$  from the bottom plate.
2. Consider a rocket ejecting fluid of density  $\rho$  at a speed  $U$  and pressure  $p$  from an orifice of cross-sectional area  $A$  into an external atmosphere of pressure  $p_a$ . What is the thrust force developed by the rocket?
3. Consider a unidirectional  $\hat{\mathbf{x}}$ -directed flow inside an infinite viscous fluid with no pressure gradient. The velocity has a value  $v_x(y)$  at time  $t = 0$ . Investigate the behavior of the velocity at subsequent times.