

# PHYS4520 Physics in Meteorology

## Problem Set 7

1. *Stream function.* If a two-dimensional vector  $\vec{u} = (u, v)$  is divergence-free:  $\nabla \cdot \vec{u} = 0$ , then  $\vec{u}$  can be expressed in terms of a scalar stream function  $\psi(x, y)$ ,

$$(u, v) = (-\psi_y, \psi_x).$$

- (a) Verify that  $\vec{u}$  given by the above relation is indeed divergence-free.
- (b) For a constant density ideal gas that is in geostrophic and hydrostatic balance on an  $f$ -plane,
- (i) find a stream function for the geostrophic velocity,
  - (ii) find a stream function for the vector  $(u_z, v_z)$  [hint: use the thermal wind balance equations].
2. “Due to the Coriolis effect, water swirls one way down the toilet in the Northern Hemisphere and the other way in the Southern Hemisphere”. Estimate the Rossby number for a toilet and explain whether the above statement is true or not.