

METR 3113 – Atmospheric Dynamics I
Fall 2016

Problem Set #5

Distributed Friday, 14 October 2016
Due Wednesday, 26 October 2016

INSTRUCTIONS: For each of the problems below, apply all 6 steps in the problem-solving handout. Pay close attention to neatness, and describe your work at each step of the solution process.

1. Coriolis Force. If a baseball player throws a ball a horizontal distance of 100 m at 30 degrees North latitude in 4 seconds, by how much is the ball deflected laterally owing to the Coriolis force?

2. Coriolis Force. A locomotive of mass 200,000 kg travels at a speed of 50 m s⁻¹ along a straight horizontal track at 43 degrees North latitude. What lateral force is exerted on the rails? Compare the magnitudes of the upward reaction force exerted by the rails for cases where the locomotive is traveling eastward and westward.

3. Coriolis Force. Find the horizontal displacement of a body dropped from a fixed (to Earth) platform at height h above the equator, neglecting the effects of air resistance. What is the numerical value of the displacement if h = 5 km?

4. Coriolis Force. A bullet is fired directly upward, in a calm atmosphere, with an initial speed w_0 at latitude ϕ . Neglecting air resistance, by what distance will it be displaced horizontally when it returns to the ground? (Neglect $2\Omega u \cos \phi$ compared to g in the vertical momentum equation).

5. Hydrostatic Equation. Determine the pressure (in hPa) at an altitude of 3000 m if the surface pressure is 1000 hPa and the density decreases linearly with height according to:

$$\rho(z) = \rho_o - 10^{-4} z$$

where z is the altitude in meters and ρ_o is the surface density = 1 kg/m³. At what altitude would this same pressure be attained if the density decreases exponentially with height according to

$$\rho(z) = \rho_o e^{-10^{-4} z}$$

where z again is in meters? BE CAREFUL WITH UNITS!!!