PHYS/OCEA 4411/5411 "Atmospheric Dynamics 1"

Assignment #1
Due: Monday, 28 September 2009, at the beginning of class

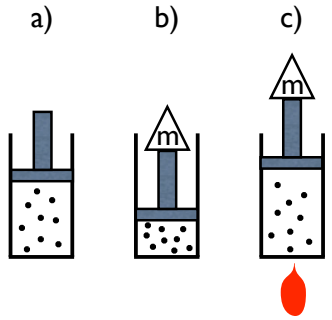
1) In class, we determined p(z) under hydrostatic equilibrium assuming constant temperature. However, temperature decreases approximately linearly in the troposphere, at a lapse rate of

$$-\frac{dT}{dz} = C = 6.5\ K/km$$

a) Determine a new equation for p(z) in terms of the lapse rate, the surface temperature T_0 and pressure p_0, assuming hydrostatic equilibrium.
b) Plot both solutions for p(z) between 0 and 10 km altitude, assuming reasonable values for the constants.
c) Show in the limit $C \to 0$ (i.e., an isothermal atmosphere) that the two solutions are identical.

2) We saw that pressure in as gas in hydrostatic equilibrium decreases exponentially with altitude. How does pressure vary with altitude in a pool of fresh water?

3) Consider a piston of cross-sectional area A that contains a gas, as shown in the diagram below. Assume standard atmospheric pressure p_0 and temperature T_0 outside the piston, and that the piston is thermally well-insulated from the surrounding environment.



a) If the piston is taken to be massless, what is the pressure inside the piston?
b) Assume the the temperature inside the piston is initially the same as the environment. Suppose mass m is placed on the piston. What is the resulting pressure p_1 and temperature T_1 of the gas inside?
c) Suppose that a flame adds J joules of heat per unit mass to the gas in the piston. What is the resulting pressure and temperature of gas air inside?

Continued on reverse

d) Which pair of cases in the diagram above corresponds best to the example in class of neighbouring warm and cold air masses?
e) Which pair of cases corresponds best to that of parcel buoyancy oscillations (i.e., gravity waves)?

4) What layer of the atmosphere is the most stably stratified?

Continued on reverse