ATMO 551a Homework 3 Due October 22, 2010

1. Calculate the dry adiabatic temperature lapse rate of the atmosphere of Titan in K/km. Assume the atmosphere is made of 97% N_2 and 3% methane.

2. Gravity calculations
   a. calculate the gravity at the surface and at 5 km altitude at the pole
   b. calculate the gravity at the surface and at 5 km altitude at 45^o latitude
   c. calculate the gravity at the surface and at 5 km altitude at the equator
   d. What is the percentage change in the gravity between the surface and 5 km in each of the cases?

Consider 2 atmospheric cases. In both cases, assume the surface pressure is 1000 mb and the latitude is 45^o. To make things simple, assume the air is completely dry and contains no water.
- In Case 1, the surface temperature is 280.5 K and temperature decreases with altitude at 5 K/km.
- In Case 2, the surface temperature is 288K and temperature decreases with altitude is 6.5 K/km.

3. Calculate the pressure at 5 km altitude

Use the equation below from page 10 of the notes entitled "Physical Properties of the Atmosphere"

$$\frac{P_2}{P_1} = \exp\left[-\frac{gm}{R\dot{T}}\ln\left(\frac{T_2}{T_1}\right)\right] = \exp\left[\ln\left(\left[\frac{T_1}{T_2}\right]^{\frac{gm}{R\dot{T}}}\right)\right] = \left[\frac{T_1}{T_2}\right]^{\frac{gm}{R\dot{T}}}$$

and the average gravity to calculate the pressure at 5 km altitude.
   a. sum the values of gravity at the surface and 5 km and divide by 2 to get the approximate average gravity between the surface and 5 km altitude to use in the equation
   b. Calculate the temperature and the pressure at 5 km altitude for Case 1
   c. Calculate the temperature and the pressure at 5 km altitude for Case 2
   d. Which pressure is higher? Explain why.
   (*hint: Think in terms of the pressure scale height*)

4. Determine the potential temperature, θ.
   a. Calculate the potential temperature at 5 km altitude for Case 1
   b. Calculate the potential temperature at 5 km altitude for Case 2
   c. What would the temperature of the air parcel be if it were lowered to the surface in each Case?
   d. Which value is higher? Explain why

5. Calculate the stability (dθ/dz) at 5 km altitude for each Case.

6. At what frequency would a parcel oscillate if it were displaced at 5 km altitude in each Case?

7. a. What is the restoring acceleration for a vertical displacement of 100 m in each Case?
   b. How large is this compared to *g*?

8. **Venus Surface Temperature**: Along the lines of the argument given in class, estimate the surface temperature of Venus assuming the atmospheric temperature equals the radiative equilibrium temperature at 300 mb and the surface pressure is 92 bars. State any assumptions you make. Account for the fact that the heat capacity of CO_2 changes with temperature

SHOW ALL WORK