ATM 320 Homework # 3  
Due Thursday 29 September

Answer the following questions on a separate sheet of paper. **SHOW ALL WORK!**

1) The work per unit mass performed for a thermodynamic process is given by \( w = \int_i^f p \, d\alpha \), where the subscripts \( i \) and \( f \) refer to the initial and final states of the process, respectively. Using the First Law of Thermodynamics, derive the expressions given for \( w \) for the following types of processes:

a) Adiabatic \((dq = 0)\): \( w = c_v (T_i - T_f) \).

b) Isothermal \((dT = 0)\): \( w = RT_0 \ln(p_i/p_f) \).

c) Isobaric \((dp = 0)\): \( w = R(T_f - T_i) \).

\d d) Isochoric \((d\alpha = 0)\): \( w = 0 \).

2) A 0.2 m\(^3\) oven is heated from 20\(^\circ\)C to 200\(^\circ\)C. The initial pressure inside the oven (same as outside is 950 hPa).

a) If the oven is sealed (i.e., density does not change), how much heat is added to the oven?

b) Most ovens end up leaking air out into the environment in a way that maintains the pressure. How much heat is added to increase the temperature in this case? As a reminder, you need to account for the air that escapes from the oven by integrating.

3) Commercial aircraft typically cruise at 12.5 km altitude, which is equivalent to approximately 200 hPa. At this altitude, the temperature typically is around -50\(^\circ\)C. Compute:

a) The potential temperature of the air outside the aircraft.

b) The air temperature inside of the cabin, assuming that the air from outside is compressed to 750 hPa. What does this imply about what has to happen to the air taken from outside the airplane?

c) What amount of heat per kg would have to be added or substracted at a constant pressure to maintain a comfortable cabin temperature (i.e., 22\(^\circ\)C)?