Thermal Fluids I
January 17, 2007
Handout is on-line at: evan.lemley.org

- HW#2 – due Friday Jan. 26 by 5:00 p.m.
  - 3.16, 3.20, 3.34, 3.38, 3.47, 3.54, 3.57
- Lecture on calculating work done by ideal gas
  - Work done by system on boundary is:
    - $W=\int_{V_1}^{V_2} p \ dV$
    - This form is used for expansion and contraction of gases
  - Ideal Gases
    - **Ideal (Perfect) Gas Law**
      - $pV=n\overline{R}T$
      - $\overline{R}=8.314\frac{kJ}{kgmol-K}$
      - The gas constant for a particular gas (air in this example) may be found as
      - $R_{air}=\frac{\overline{R}}{M_{air}}=\frac{8.314\frac{kJ}{kgmol-K}}{28.97\frac{kg}{kgmol}}=0.287\frac{kJ}{kg-K}$
      - Rewrite the Ideal Gas Law in terms of mass and the gas constant for air in this example as
      - $p \ V=m_{air}R_{air}T$
    - **Isotropic (Constant Temp) Process**
      - For a constant temperature process in a closed system (i.e. mass is constant) – $pV = mRT=C$. Where $C$ is a constant. Note C can be written as $p_1V_1$ or as $p_2V_2$.
      - $W=\int_{V_1}^{V_2}\frac{C}{V}dV=C\ln(\frac{V_2}{V_1})=p_1V_1\ln(\frac{V_2}{V_1})$
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    - **Polytropic process -** $pV^n=C$ **where *C* is a constant.**
      - these occur in ideal gases for various processes and the value of *n* changes depending on the type of process (e.g. $n = 1$ is a isotropic process).
      - Note that $p_1V_1^n=C\rightarrow p_1V_1=\frac{CV_1}{V_1^n}=CV_1^{1-n}$ This also holds for $p_2V_2$.
      - $W=\int_{V_1}^{V_2}\frac{C}{V^n}dV=\frac{C}{1-n}(V_2^{1-n}-V_1^{1-n})=\frac{p_2V_2-p_1V_1}{1-n}$