Physics 2311. Thermodynamics Equations

Constants, such as $R = 8.314 J/mol \cdot K$ and $k_B = 1.38 \times 10^{-23}$ J/K, will be provided as needed.

17 p.496 One possible temperature conversion equation: $T_F = \frac{9}{5}T_C + 32°F$

17-1a Linear thermal expansion: $\Delta L = \alpha L_i \Delta T$

17-2 Volume thermal expansion: $\Delta V = 3\alpha V_i \Delta T$

17-3 Ideal Gas Law (equation of state for an ideal gas):

$$PV = nRT$$

Special case: $[P_i V_i = P_f V_f]$ (Constant Temp. Called Boyle's Law).
Special case: $[\frac{P_i}{T_i} = \frac{P_f}{T_f}]$ (Constant Vol. Called Gay-Lussac's Law).
Special case: $[\frac{V_i}{T_i} = \frac{V_f}{T_f}]$ (Constant Pressure. Called Charles' Law).

17-4 Ideal Gas Law (alternative form):

$$PV = Nk_B T$$

18-3 Pressure in terms of microscopic quantities: [SKIP]

$$P = \frac{2}{3}\frac{N}{V}(\frac{1}{2}mv_{rms}^2)$$

18-3 Temperature in terms of microscopic quantities (monatomic gas):

$$\frac{1}{2}mv_{rms}^2 = \frac{3}{2}kT$$

18-5 Root Mean square speed:

$$v_{rms} = \sqrt{\overline{v^2}}$$

19-2 Heat added to a liquid or solid:

$$Q = mc\Delta T$$

19- - Heat capacity

$$C = mc$$

19-4 Latent heat of fusion or vaporization: [SKIP]

$$Q = \pm mL_{f\ or\ v}$$

19-5 First Law of Thermodynamics.

$$\Delta E_{int} = Q - W$$

19-8 Work done *by* a gas.

$$W = \int_{V_i}^{V_f} P dV$$

19-9,10 First Law applied to special gas processes.

- isothermal (**19-9**)

$$W_{by} = -nRT \ln \frac{V_i}{V_f}$$

- isobaric (**19-10a**)

$$W_{by} = P \Delta V$$

- isovolumetric (p. 553)

$$W_{by} = 0$$

- adiabatic (p. 559)

$$W_{by} = -\Delta E_{int}$$

19-11 Molar specific heat of ideal gas

- Constant volume: $Q = nC_V \Delta T$
- Constant pressure: $Q = nC_P \Delta T$

p. 557 Total internal energy of ideal monatomic gas:

$$E_{int} = \frac{3}{2} nRT$$

19-12 Relation between C_P and C_V:

$$C_P - C_V = R$$

19-13 Change in internal energy of ideal gas, any process:

$$\Delta E_{int} = nC_V \Delta T$$

19-16 Adiabatic process for ideal gas: [SKIP]

$$PV^{\gamma} = \ constant$$

20-7,-8 Entropy for some reversible process: [SKIP]

$$dS = \frac{dQ_r}{T} \qquad OR \qquad \Delta S = \int \frac{dQ_r}{T}$$

p.591 Entropy for adiabatic free expansion (or isothermal expansion) : [SKIP]

$$\Delta S = nR \ln \frac{V_f}{V_i}$$