Thermodynamics Study Guide

Important equations:

$$PV = nRT = Nk_BT \qquad \text{(ideal gas law)}$$

$$E = N \cdot f \cdot \tfrac{1}{2}k_BT \qquad \text{(equipartition theorem)}$$

$$\Delta E = Q + W \qquad \text{(first law / energy conservation)}$$

$$W = -\int P\,dV = -(\text{area under } PV \text{ graph}) \qquad \text{(work done during compression)}$$

$$\text{Energy supplied} = C\,\Delta T = mc\,\Delta T \qquad \text{(definitions of } C \text{ and } c\text{)}$$

$$S = k_B \ln(\text{multiplicity}) \qquad \text{(definition of entropy)}$$

$$\Delta S = \frac{Q}{T} \qquad \text{(change in entropy due to heat input or output)}$$

$$\text{Engine efficiency} \equiv \frac{W_{\text{net}}}{Q_h} \quad \left(\text{must be less than } 1 - \frac{T_c}{T_h}\right)$$

$$\text{Refrigerator coef. of performance} \equiv \frac{Q_c}{W_{\text{net}}} \quad \left(\text{must be less than } \frac{T_c}{T_h - T_c}\right)$$

You should understand when these formulas apply and when they don't; for instance, the equipartition theorem applies only to forms of energy that are quadradic in some coordinate or velocity. You should also be able to derive other closely related formulas from these; for instance, from the equipartition theorem you can derive formulas for heat capacities of solids and gases, and for rms speeds of molecules.

You should understand the following terms/concepts:

temperature
degree of freedom
rms speed
heat
work
latent heat
isothermal
adiabatic
entropy
second law of thermodynamics

Finally, you should know the approximate numerical values of the following: the freezing and boiling temperatures of water, in Celsius and kelvin; room temperature in kelvin; atmospheric pressure in N/m^2; the number of liters in a m^3; the gas constant; Avogadro's number; Boltzmann's constant; and the number of joules in a calorie (i.e., the specific heat capacity of water).