Generally True

$$\Delta U = Q_{\to s} + W_{\to s} \qquad W_{\to s} = -\int_i^f P dV \qquad \binom{N}{n} = \frac{N!}{n!(N-n)!} \qquad N! \approx \left(\frac{N}{e}\right)^N \sqrt{2pN}$$

$$C_V = \left(\frac{\partial U}{\partial T}\right)_{N,V} \qquad Q_{\to s} = C\Delta T = cm\Delta T \qquad \frac{1}{T} \equiv \left(\frac{\partial S}{\partial U}\right)_{N,V} \qquad dS \geq \frac{Q}{T}$$

$$dS = \frac{1}{T}dU + \frac{P}{T}dV - \frac{m}{T}dN \qquad P = T\left(\frac{\partial S}{\partial V}\right)_{U,N} \qquad m = -T\left(\frac{\partial S}{\partial N}\right)_{U,V} \qquad g = \frac{f+2}{f}$$

True under certain conditions

$\Delta U = \frac{f}{2} Nk\Delta T$ where f = # of accessible degrees of freedom.

$$PV = NkT \qquad P_i V_i^{g} = P_f V_f^{g} \qquad W_{s\to} = NkT \ln\left(\frac{V_f}{V_i}\right)$$

k = 1.3 $\times 10^{-23}$ J/K

Name: ______________________

1. **Quickies**
    a. What's the Third Law of Thermodynamics and what's the qualitative rational?

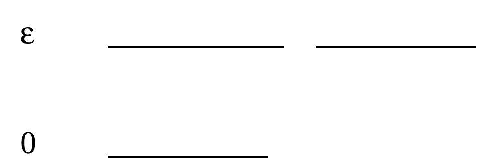
    b. How are multiplicities related to microstates, macrostates, and probabilities?

2. **Calorimetry:** You place 0.25 kg's of ice (initially at 0°C) in 0.75 kg's of water initially at 45°C. The water's latent heat of fusion is 0.333 J/kg. Assuming this system is thermally isolated, what is its final temperature?

3. **Thermodynamic Processes**: A piston of an ideal gas is originally at atmospheric pressure (10^5 Pa) and in thermal equilibrium with the room which is at 298 K. It is then *very slowly* compressed to ¼ of its original volume. How much heating occurs and which way does it flow (gas heats room or room heats gas)?

4. **Multiplicity**
    a. **Coins.** What is the probability is of flipping a coin 10,000 times and getting 5,000 heads?
5. **C:** What's the specific heat for a two-dimensional, monatomic ideal gas? (On a *real* test I'd give you something to start from, but on this practice test, look to your old homework where you've treated such a gas before and start from one of your results).

Each of the problems below involves a system that consists of N distinguishable "atoms." Say you have N three-state "atoms." One state has energy 0 and the other two have energy ε.



Microcanonical approach

1. What is the multiplicity of a macrostate with energy $E=n\varepsilon$? (the answer's on the next page, but try to figure it out before your peek.)

2. Once you've found that, find a relation between the energy and the temperature for the system.

$$\Omega = \binom{N}{n} 2^N$$