Exam 1 could include problems from these topics:

- thermal expansion
- ideal gas law
- kinetic theory
- thermal conduction
- calorimetry
- first law of thermodynamics
- pV diagrams
- heat engines, heat pumps and refrigerators

- There will not be any entropy problems on the exam.

The exam will be three pages. The first page will have five short multiple-choice problems. You can solve them any way you like, and then select the correct answer from the given choices. Only the selection of your answer will be graded (i.e. it’s either right or wrong... and you’re welcome to guess if you like.)

The second and third pages will include one problem each; you will be asked to write a complete solution for these two problems.

The list of equations shown below will be included with the exam.

I will provide scratch paper; all you will need is a calculator, a straightedge and something to write with. You’re welcome to use color for highlighting, if you wish.

You will have 85 minutes (i.e. entire class period for the morning section, half the class period for the evening section) to work on the exam, although I expect some of you will finish in about an hour or so. I cannot extend the time: I have to get to my next class in the morning, and in the evening... well, we have other stuff to do. If you’re concerned that 85 minutes might not be enough, direct that concern into more study time. Although...

If you feel like you know how to do the homework problems, you should be just fine for the exam.

The “reference number”: I will include on the exam a line for you to provide me with a five-digit number of your choosing. This is optional, but if you want to give me a number I will use it in place of your name on a score sheet that I will post to the class website and update after each exam. If you do not wish to be included on the sheet, you can leave the REF# line on your exam blank. If you give me a number with greater or fewer than five digits, it will be treated as if you left the line blank.

Please email questions if you have them.
Thermal Expansion

solids: \( \Delta L = L_i \alpha \Delta T \) \( \Delta A = A_i 2 \alpha \Delta T \) \( \Delta V = V_i 3 \alpha \Delta T \)

liquids: \( \Delta V = V_i \beta \Delta T \)

Conduction: \( \Delta T = RH \)

For a “wall”: \( R = \frac{x}{kA} \)
cylindrical shell: \( R = \frac{\ln(b/a)}{2\pi \cdot kL} \)
in series: \( R_{\text{tot}} = R_1 + R_2 \)

Calorimetry: temperature change: \( Q = mc \Delta T \) phase change: \( Q = \pm mL \)

For water: \( c = 1.00 \text{ cal/g} \cdot \text{C} = 4.19 \text{ J/g} \cdot \text{C} \) \( L_t = 79.7 \text{ cal/g} = 333 \text{ J/g} \) \( L_v = 540 \text{ cal/g} = 2260 \text{ J/g} \)

Ideal Gas Law: \( pV = nRT \) \( pM = \rho RT \)

Kinetic Theory: \( K_{\text{avg}} = \frac{3}{2} kT \) \( v_{\text{rms}} = \sqrt{\frac{3kT}{m}} = \sqrt{\frac{3RT}{M}} \)

Useful constants:
\( R = 8.314 \text{ J/mol-K} = 0.08206 \text{ atm-L/mol-K} \) \( k = 1.38 \times 10^{-23} \text{ J/K} \) \( 1 \text{ atm-L} = 101.3 \text{ J} \)

First Law of Thermodynamics: \( \Delta E = Q - W \)

monatomic ideal gas \( \gamma = 5/3 \) \( \Delta E = \frac{3}{2} nR \Delta T = \frac{3}{2} (pV_f - pV_i) \)

diatomic ideal gas \( \gamma = 7/5 \) \( \Delta E = \frac{5}{2} nR \Delta T = \frac{5}{2} (pV_f - pV_i) \)

isobaric process: \( W = p(V_f - V_i) \) isothermal process: \( W = nRT \ln\left(\frac{V_f}{V_i}\right) \)

adiabatic process: \( p_i V_i^\gamma = p_f V_f^\gamma \)

heat engine: \( e = \frac{W}{Q_i} \) heat pump: \( COP = \frac{Q_h}{W} \) refrigerator: \( COP = \frac{Q_c}{W} \)

Carnot cycle: \( e = 1 - \frac{T_c}{T_h} \)