Six Weeks of **Thermodynamics**

Week 0 - Intro concepts (cover these in a handout/appendix)

- pressure, volume, density, all the units
- moles, molar masses, isotopes, numbers of things
- molecules
- combinatorics and factorials
- large numbers, logarithms
- taylor approximation of log(1+x) for x<<1
- stirling's approximation

Week 1 - Temperature and Gases

1. The Zeroth Law
    a. temperature
    b. thermal equilibrium + the 0th law
    c. absolute temperature
2. Gases
    a. ideal gases and assumptions
    b. real gas models
3. Kinetic Theory
    a. Maxwell-Boltzmann distribution and speeds in a gas
    b. relating pressure to energy
    c. relating energy to temperature

Week 2 - Energy and Processes

4. Thermal energy
    a. degrees of freedom
    b. the equipartition theorem
    c. monatomic/diatomic gas, solids, liquids
5. The First Law
    a. heat, work, energy transfer
    b. heat capacity, specific/molar/molecular
    c. latent heat capacity
    d. enthalpy
6. Ideal Gas Processes
    a. isochoric, isobaric
    b. isothermal
    c. adiabatic

Week 3 - Kinetic Theory and Multiplicity

7. Rates of processes - some more kinetic theory
    a. molecular flux
    b. mean free path
    c. heat conduction
    d. heat conductivity
8. Multiplicity
    a. microstates and macrostates
    b. multiplicity
    c. two state systems
9. Ideal systems
    a. Multiplicity of an Einstein Solid
        i. assumptions
        ii. state variables
        iii. repetitive combinations
        iv. high T limit, low T limit
    b. Multiplicity of an Ideal Gas
        i. assumptions (monatomic, one particle then many particles)
        ii. state variables
        iii. 'momentum' space
        iv. quantising the spaces

Week 4 - Entropy

10. The Second Law
    a. interacting systems
    b. sharpness of multiplicity function
    c. entropy
    d. the second law, reversibility, irreversibility, other implications of entropy
11. Temperature
    a. a true definition of temperature
    b. the reason heat flows from a hotter object to a cooler object
    c. non-standard entropy/energy curves (some interesting shit right there ey)
12. Thermodynamic Identity
    a. (connecting entropy and other state variables - mechanical/diffusive equilibrium)
    b. Pressure and entropy
    c. chemical potential
    d. the differential thermodynamic identity

Week 5 - Heat Engines

13. Heat Engines
    a. cyclic processes
    b. Carnot Cycle
    c. Other, Otto? Stirling?
    d. (maximum) efficiency
14. Reverse Heat Engines
    a. the idea of doing it all in reverse
    b. coefficient of performance
    c. throttling
15. Mid-semester Test on Weeks 1-4
    a. takes place in-lecture
    b. students get full 50 minutes?

Week 6 - Chemical Thermodynamics

16. Chemical Reactions
    a. non-cyclic processes
    b. free energy
    c. free energy from reactions
    d. spontaneity
17. Phase Changes
    a. materials found in the most stable phase
    b. P-T diagrams, critical/triple point
    c. Clausius-Clapeyron relation

Things we didn't get time to treat properly

18. Statistical Distributions
    a. Maxwell-Boltzmann Distribution
    b. Bose-Einstein Distribution
    c. Fermi-Dirac Distribution
    d. Density of States
19.