1. **Chapter 1: Equilibrium, Energy, Conservation, and Temperature**
   1. Thermal Equilibrium and the Laws of Thermodynamics
      1. Laws of Thermodynamics
         1. Interchanges between various forms of energy
         2. First Law: Energy is conserved
            1. Conversion is possible between different energy types
            2. Sum remains constant
         3. Second Law: Total entropy of a system plus surroundings never decreases
            1. Heat spontaneously flows from a body of higher temperature to one at lower temperature
      2. Thermal Equilibrium
         1. Two systems are in equilibrium when temperatures are equal.
         2. AKA steady state
         3. Temperature does not change with time
         4. No heat flow
      3. Energy Conservation
         1. First Law of Thermodynamics
         2. Rate of Energy In - Rate of Energy Out + Rate of Energy Generation = Rate of Energy Storage
   2. Non-Equilibrium Thermodynamics and the Transport of Energy
      1. Laws of thermodynamics only deal with final or equilibrium state
      2. No data about interaction or rate
      3. Energy transfer is non-equilibrium thermodynamics
      4. Need additional rate laws
         1. Fourier’s Law of energy diffusion
         2. Fick’s Law of mass diffusion
   3. Temperature in Living Systems
      1. Temperature Response to Human Body
         1. 98.6°F
         2. Narrow range of temperature for effective bio function
      2. Temperature Sensation in Humans
         1. Heat and cold receptors to perceive gradations of temperature
         2. Pain receptors for extreme heat and cold
         3. Temperature alters intracellular chemical reaction rates >2x for each 10°C change
         4. Freezing cold and burning hot feels the same pain
         5. Rapid adaptation to temperature
            1. Feel changes and steady state
      3. Thermal Comfort of Humans and Animals
         1. Human balances temperature with environment with minor physiological changes
         2. Animals use thermoregulation to gain and lose heat to maintain a constant temperature
            1. Heat loss: convection, evaporation, radiation
         3. Design buildings
         4. Humidity tolerance greater than temperature tolerance
   4. Temperature in the Environment
      1. The Greenhouse Effect
         1. Energy from the sun can enter earth, but energy cannot escape back into space
         2. More gases in atmosphere, higher temperature of earth
         3. Real warming
            1. Ask how much, not what is cause
         4. A few degrees of warming raises sea level between 0.2 and 1.5 meters (polar icecaps)
   5. Temperature Scales
      1. Celsius
      2. Kelvin
         1. T(K) = T(C) + 273.15
         2. Change in T(K) = change in T(C)
      3. Fahrenheit
         1. T(F) = 1.8T(C) + 32
         2. Change in T(F) = Change in T(R)
         3. Change in T(F) = 1.8 \* Change in T(C)
      4. Rankine
         1. T(R) = T(F) + 459.67