Reading: Chapters 1 and 2
Chapter 2: Energy: work and heat.
Chapter 3: Properties of a pure substance.
Work and heat: two primary forms of transferring energy.
Work: form of energy transfer whose sole effect could have been the lifting of a weight.

Thermodynamic analysis is applied:
- Environment (or surroundings): region external to system.
- Boundary: surface separating system and environment.

System types:
- Closed system: Control mass
  - System is a fixed mass
- Open system: Control volume

Open: allows mass transfer
Adiabatic: insulated; no heat transfer across boundary.

System is characterized by properties:
- Mass \( M \), kg
- Volume \( V \), m³
- Temperature \( T \), °C, K = °C + 273.15
- Pressure: \( P \), kPa; \( 10^3 \) Pa; \( 10^5 \) N/m², bar = 100 kPa

\[ \text{Heat: energy transfer that is not work.} \]
\[ \text{More concrete: heat: due to a temperature difference (or a temperature gradient).} \]

Lexicon:
- System: region to which

\[ \text{Pipe} \]
\[ \text{Flow} \]
\[ \text{Heating} \]
\[ \text{Control volume} \]

\[ \text{Heat} \]
\[ \text{Boundary: Closed: no mass transfer} \]

\[ \text{Pressure at sea level = 101.3 kPa} \]

Pressure: force

System in equilibrium: forces are in balance

\[ \text{Environment: } P_o \]

\[ \text{Piston} \]
\[ \text{F_{up} = F_{down}} \]
\[ P \cdot A_p = M \cdot g + P_o \cdot A_p \]
\[ P = \frac{M \cdot g}{A_p} + P_o \]
Column of water

\[
P = \frac{mg}{A} + P_0
\]
M: mass of water column above outlet
\( M = \rho \cdot V \) (kg \cdot m)
\( \rho = \frac{m}{V} \)
\[
P = \rho \cdot h \cdot A
\]
So: \( P = \rho gh + P_0 \): hydrostatic pressure

Water: \( \rho = 1000 \text{ kg/m}^3 \approx 1 \text{ kg/L} \)
\[ g = 9.8 \text{ m/s}^2 = 10 \text{ N/kg} \]
\[
P(h) = 1000 \left( \frac{\text{kg}}{\text{m}^3} \right) \left( \frac{\text{m}^2}{\text{s}^2} \right) h + P_0
\]
\( = 10^4 \text{ Pa} \cdot h + P_0 \)

\( \rightarrow \text{go down 10 m in water, pressure increases by} \ 10^5 \text{ Pa} = 10^2 \text{ kPa} \approx 1 \text{ atm} \)

Temperature: characteristics of the average molecular energy:

range of temperature:

150-250 K: gas liquefaction
270-310 K: typical environmental T

Standard environmental temperature = 298 K = 25°C

350-600°C: typical temperatures of steam in power plants.

\[
\begin{align*}
P, T, V \Rightarrow P_1, T_1, V_1, P_2, T_2, V_2 \\
V: \text{extensive} \\
T, P: \text{intensive}
\end{align*}
\]

\( \rightarrow \) make extensive properties into intensive by dividing by system mass:

\( V = \frac{V}{M} \): specific volume: \( \frac{\text{m}^3}{\text{kg}} \)

1800-2200 K: typical combustion temperatures

\( \approx 6000 \text{ K} \): characteristic radiation T of the sun

properties can be

1) extensive: depend on the extent of the system
2) intensive: independent of extent.