4.1 Gas leak hole

(a) Calculate the number of molecules leaving the tank per second and the their kinetic energy by integrating $\vec{p}^2/(2m)$ over Maxwell's distribution and the incident angle with respect to the wall; the average energy is their ratio.
(b) Find the average momentum of molecules leaving the tank similarly to part(a); that only the momentum component perpendicular to the wall is nonzero after averaging.
(c) Using results of part (a), and assuming that kinetic energy is redistributed immediately after any number of molecules leave the tank, find a equation for the temperature $T(t) = E(T)/(\frac{3}{2}N(t))$.

4.2 Chemical equilibrium

Calculate the partition functions of monoatomic gases with molecular masses $m_{1,2}$. Calculate the partition function of a diatomic gas with mass $\approx (m_1 + m_2)$ taking into account the internal rotational degrees of freedom and the different baseline for the internal energy $(-\epsilon_B)$. Write down chemical potentials of all gases and the equilibrium condition for the total Gibbs potential.

4.3 Debye model of crystal vibrations

Calculate the number of atoms per cell and find the atom density (per cm^3); use provided speeds of transverse and longitudinal sound waves to compute Debye frequencies ω_D and temperatures T_D.

4.4 Radiation heat transfer

(a) Use laws of thermodynamics and consider equilibrium of a "gray surface" $(0 < \epsilon < 1)$ with vacuum filled with black-body radiation.
(b) Write equations for the balance for absorbed, reflected, and emitted radiation energy at each surface.
(c) Same as part(b), but now consider the two opposite surfaces of the shield.