Chapter 10 Problems

1. Using conservation of energy and momentum perpendicular to the surface, derive the classical expression for the energy exchange ΔE (Eq. 10.8)) when a gas phase species, mass m_g, strikes a surface cube, of mass m_s, where $\mu = m_g/m_s$, with a translational energy E_i along the surface normal.
2. Assuming a physisorption well can be represented by an attractive well of depth W followed by a hard repulsive wall, show that the classical condition for trapping is given by $E_i = 4\mu W/(1-\mu)^2$ (Eq. (10.9)).
3. Assuming that a molecule can be adsorbed only when its translational energy towards the surface is greater than some critical value E_0, *i.e.* $S = 0$ for $E<E_0$ and $S = 1$ for $E \geq E_0$, derive an expression for the average energy release along the surface normal $\langle E_z \rangle$ (Eq. (10.15)). Hence find the limiting behaviour for a sticking threshold $E_0 = 0$ or $E_0 \gg k_B T$. Hint: use Eq. (10.13) to calculate $\langle EP(E) \rangle / \langle P(E) \rangle$.
4. Assuming the adsorption probability $S(E, \theta)$ is unity above some critical normal energy $E_0 \cos^2\theta$, derive the expression for the anticipated angular distribution $P(\theta, T)$ (Eq. (10.17)). Hint: this requires integrating Eq. (10.16) with appropriate limits for $E(\theta)$.