Checkup questions and suggested problems, chpts. $3 - 6$

Chpt. 3 – The Molecular Dance (*Problems* **3.1, 3.2**)

- What does the *ideal gas law* say about the mean kinetic energy?

- What does the *Boltzmann distribution* say in the limits of high/low T?

- Explain the *Arrhenius rate law*.

Chpt. 4 – Random Walks, Friction, and Diffusion (*Problems* **4.1, 4.8**)

- How does the *diffusion law* arise in *random walk* models of Brownian motion?

- How can one use *Stokes' law* to determine the viscosity of a fluid?

- *Einstein* derived a relation between the friction coefficient ζ and the diffusion constant D, for a body in a viscous fluid. What is so remarkable about it?

- What is flux and what does the *continuity eq.* mean?

- Explain *Fick's law* and how it leads to the *Diffusion eq.*

- Show how the *Gaussian sol.* for the diffusive growth of a point-like drop (of e.g. ink) reflects the diffusion law.

Chpt. 5 – Life in the Slow Lane: The Low Reynolds-Number World (*Problems* **5.2, 5.4**)

- Why should one expect the atmosphere to be of the order of 10^4 m high?

- How does a centrifuge work?

- What is required for a situation to yield a low *Reynolds number* $\mathcal{R}$? Give a biological example of the peculiarity of a low $\mathcal{R}$?

Chpt. 6 – Entropy, Temperature, and Free Energy (*Problems* **6.2, 6.5**)

- What does the *Statistical Postulate* say?

- What is the thermodynamical definition of *temperature*?

- State the *Second Law* of thermodynamics.

- A subsystem strives to minimize its (Helmholtz) *Free Energy*. Why is this said to involve a competition between entropy and energy?

- What is *pressure*, thermodynamically?

- A macroscopic system consists of a large number N of identical, non-interacting molecules, each of which can be in either of two states, labelled $+$ and $-$, with resp. energies $E_{\pm} = E_0 \pm \Delta E$. Show that at temperature T, the mean energy per molecule, E/N, will be very close to $E_0 - \Delta E \tanh (\Delta E/kT)$. (tanh is the hyperbolic tangent function; it is increasing and satisfies $|\tanh x| < 1$.)