Department of Physics
Physics 2048 (Rabson) 
Fall semester, 1998

Homework for Week 5
Nominal due date: Friday, 25 September

5.37P, 5.67P, 5.69P
While chapters 5 and 6 cover the phenomenology of friction, the microscopic bases remain subjects of research. The trade journal Physics Today has reported advances in the area of “nanotribology” in recent years; such articles might provide the subject for a term paper for anyone interested. You should in any case be reading the weekly Tuesday science section of the New York Times, another good place to find topics.
6.1Q, 6.2Q, 6.5Q, 6.10Q

Answers for week 3 and 4 problems not in the book
3.1 Let \( R \) be the proton’s radius, the distance to the \( z \) axis about which it twists. We can choose the particle to lie along the \( x \) axis at time \( t = 0 \) with velocity components in the \( y \) and \( z \) directions only. Let \( v_z \) be the particle’s \( z \) component of velocity, and let the its trajectory’s projection into the \( xy \) plane describe a circle with period \( 2\pi/\omega \). Then position \( r = R \cos(\omega t) \hat{x} + R \sin(\omega t) \hat{y} + v_z t \hat{z} \), velocity \( r' = -R \omega \sin(\omega t) \hat{x} + R \omega \cos(\omega t) \hat{y} + v_z \hat{z} \), and acceleration \( r'' = -R \omega^2 \cos(\omega t) \hat{x} - R \omega^2 \sin(\omega t) \hat{y} \).

3.22 If (using the notation of the book) \( v_{PB} = c \), then \( v_{PA} = \frac{c}{1 + v_{PA}/c} = c \). In other words, light goes at the speed of light in any reference frame. This is the fundamental postulate of special relativity and differs violently from the understanding of Galileo and Newton.

4.15 A person riding an elevator accelerating in a uniform gravitational field also accelerates at the same rate as the elevator. So does any apparatus he happens to carry with him. Since everything is accelerating uniformly, the occupant cannot tell he is accelerating at all unless he looks out a window. If the elevator has no window, he simply cannot tell whether he is accelerating or in free space. (More generally, even if he has a window or other way of comparing himself to other frames of reference, the occupant of an elevator has no reason to think his frame any worse than someone else’s.) Nonetheless, Galilean postulates seem to say that his frame is not inertial. Einstein resolved the inconsistency by replacing Galilean and Newtonian mechanics with his General Theory of Relativity, in which gravity is not a force but rather built in to the geometry of space and time. Now a real gravitational field is in general not uniform, and a person in the elevator could in principle measure the differences in acceleration from one side of the elevator to the other.