Physics 820 homework VI, due Mon Oct 11

Reading: Chapter 3, 4.1-3

Problems:

1. Goldstein, Problem 3-18.

2. Goldstein, Problem 3-31.

3. A proton of energy 4 MeV scatters off a second proton at rest. One proton comes off at an angle of 30° in the lab system. What is its energy? What is the energy and scattering angle of the second proton?

4. From the Aug '02 subject exam: Two skaters *G*eorge and *H*arry, both of mass $M = 70$ kg, are approaching one another, each moving at the speed of $v_0 = 2$ m/s. G carries a bowling ball with a mass of $m = 10$ kg.

(i) G tosses the ball toward H at $u = 4$ m/s (relative to the thrower), when G and H are $D_0 = 30$ m apart.

(i.a) While the *B*all is in the air, what are the velocities (magnitudes and signs) of G, B and H (v_1^G, v_1^B and v_1^H)?

(i.b) Show graphically the time development of the positions of G, B and H (i.e. plot the positions $x_{G,B,H}$ vs. t); let $x_{G,H}(t = 0) = \mp 15$ m respectively.

(ii) H catches the ball and immediately tosses it back toward G with the same relative speed u (with respect to the thrower).

(ii.a) What are the velocities of G, B and H when the ball is in the air this time (v_2^G, v_2^B, v_2^H)?

(ii.b) Plot this motion on the above graph (i.b). Assuming the two skaters continue to throw the ball back and forth, how will their motion develop according to this graph? (Will they ever collide?)

(This example is often used as a model of a repulsive exchange force between two objects (G and H) mediated by a third particle (B)).