Physics 425 Homework 1

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Due: 9/11/02 by 430 pm

Problem 1.

Using binomial expansions to terms of order $\frac{v^2}{c^2}$, compare the three Doppler shift formulas:

a) $f' = f(1 \mp \frac{v}{c})^{-1}$ moving source

b) $f' = f(1 \pm \frac{v}{c})$ moving observer

c) $f' = f(1 \pm \frac{v}{c})(l - \frac{v^2}{c^2})^{-1/2}$ relativistic

What is f' using these formulas if $v/c = 0.1?$ $= 0.5?$ $= 0.9?$ When does the binomial expansion fail?

Problem 2.

The potential between two atoms is sometimes given by the Leonard-Jones potential:

$$V(r) = \frac{A}{r^{12}} - \frac{B}{r^6}$$

where A and B are constants. See attached figure.

a) Eliminate A and B and rewrite $V(r)$ in terms of the well depth ϵ, and equilibrium separation r_o.

b) Find the frequency of oscillation near equilibrium of a particle with effective m moving in the Leonard-Jones potential. Hint: Taylor expand the rewritten $V(r)$ around r_o.

Problem 3.

If you are at the top of a tower of height h above the surface of the earth, show that the distance you can see along the surface of the earth is approximately $s = \sqrt{2Rh}$, where R is the radius of the Earth. With R in miles and h in feet, show that s is given (in miles) by $(3h/2)^{1/2}$. See attached figure. Hints: Express $\frac{h}{R}$ as a $f(\sec\theta)$, do a Taylor expansion of $\sec\theta$ and use $s = R\theta$.