Problem

The largest world accelerator, LHC, is capable of accelerating protons up to the energy of 6.5 TeV, or approximately 7,000 times the rest energy of the proton.

a) Find the difference $c - v \equiv \delta v$ between the velocity v of such a proton and the speed of light $c \approx 3 \times 10^8$m/sec. Find an analytic expression for δv and only then substitute numbers.

In fact, LHC is a collider, in which two protons having this energy in the laboratory frame move towards each other (along, say, x axis).

b) Take the frame in which one of the protons is at rest. What is the velocity v_2 of the second proton in that frame? Since v_2 is very close to the speed of light, represent it as $v_2 = c - \delta v_2$, and find δv_2. Again, find an analytic expression for δv_2 and only then substitute numbers.

c) What is the energy of the second proton in the rest frame of the first one?

d) Imagine that we are in a rocket that leaves the Earth with the speed v equal to the lab frame speed of the LHC protons. How far from the Earth (in light-years) would we find ourselves after spending 1 year of our life on such a rocket?