(16.5) Protons are accelerated to 12 GeV in a synchrotron in which the bending magnets have a maximum field strength of 14.3 T. What is the radius of curvature of the proton orbit?

Begin be defining the units used etc.

$B_{magn} := 14.3 \cdot tesla$ $\quad eV := 1.66021773 \cdot 10^{-19} \cdot joule$ $\quad m_{0p} := 1.672623 \cdot 10^{-27} \cdot kg$

$c_{light} := 299792458 \cdot m \cdot sec^{-1}$ $\quad E_p := 12 \cdot 10^9 \cdot eV$ $\quad q_e := 1.66021773 \cdot 10^{-19} \cdot coul$

Because the high energy implies that the protons have a velocity which is not very small compared to the speed of light (see Fig. 5.2) we should first use eqn. (5.27) to convert energy to kinetic mass.

$\Delta m_p := \dfrac{E_p}{c_{light}^2}$ $\quad m_p := m_{0p} + \Delta m_p$ $\quad m_p = 2.384 \cdot 10^{-26} \cdot \mathrm{kg}$

Then we use eqn (13.6) to calculate *r*.

$z := 1$ $\quad r := \sqrt{\dfrac{E_p \cdot 2 \cdot m_p}{B_{magn}^2 \cdot q_e^2 \cdot z^2}}$ $\quad r = 4.105 \cdot \mathrm{m}$