906.

Problem 56.8 (RHK)

A positive tau $\left(\tau^{+}, \text{ rest energy} = 1784 \text{ MeV}\right)$ *is moving with* 2200 MeV *of kinetic energy in a circular path perpendicular to a uniform* 1.2-T *magnetic field*. (a) *We have to calculate the momentum of the tau in* kg m s^{-1}. (b) *We have to find the radius of the circular path*.

Solution:

(a)

The kinetic energy K of a relativistic particle of rest mass energy mc^2 and momentum p is given by the equation

$$K + mc^2 = \left(p^2c^2 + m^2c^4\right)^{1/2}.$$

The kinetic energy of the τ^{+}, $\text{rest energy} = 1784 \text{ MeV}$, is 2200 MeV. We find the momentum of the particle from the relation

$$\left(p^2c^2 + m^2c^4\right)^{1/2} = K + mc^2$$
$$= 2200 \text{ MeV} + 1784 \text{ MeV}$$
$$= 3984 \text{ MeV}.$$

$$\therefore\ p^2c^2 = \left(3984^2 - 1784^2\right)\ \left(\text{MeV}\right)^2,$$

or

$$pc = 3{,}562.2 \text{ MeV}.$$

Therefore, the momentum of τ^+ is

$$p = \frac{3{,}562.2 \text{ MeV}}{c} = \frac{3{,}562.2 \times 1.6 \times 10^{-13}}{3 \times 10^8} \text{ kg m s}^{-1}$$
$$= 1.899 \times 10^{-18} \text{ kg m s}^{-1}.$$

(b)

The τ^+ particle is moving in a circular orbit of radius R in a uniform magnetic field $B = 1.2$ T, which is perpendicular to the plane of the orbit of the charged particle. For a relativistic particle of momentum p the equation of motion is

$$\frac{p}{R} = eB.$$

Therefore, the radius of the orbit of the τ^+ particle will be equal to

$$R = \frac{p}{eB} = \frac{1.899 \times 10^{-18}}{1.6 \times 10^{-19} \times 1.2} \text{ m} = 9.89 \text{ m}.$$