Measurement of particle momentum (from curvature of its path in a magnetic field)

A particle of charge *q* travelling at right-angles to a magnetic field *B* with a speed *v* experiences a force *Bqv* at right angles to its motion.

This makes the particle follow a circular path of radius *r* and the motion is described by

$$Bqv = mv^2/r \rightarrow p = (Bq)\, r$$

This tells us that for a fixed field *B*, and charge q, the momentum *p* is proportional to the radius of curvature *r*. Here, nature has been kind: all charged particles that live long enough to travel a measurable distance have a charge equal or opposite to the charge on the electron e = 1.6×10^{-19} C.

In units used by nuclear and particle physicists, the relation $p = Bqr$ becomes $p = 0.3r$, where *p* is measured in GeV/*c*, B in tesla (*T*) and *r* in metres.

For the CERN 2 metre bubble chamber, B was 1.78 *T*; for the Fermilab 15-foot bubble chamber, it was 3 T. (At the magnetic north pole, the magnetic field at the earth's surface is 6.2×10^{-5} *T*.)

Exercise Show, using $p = 0.3Br$, that a particle of momentum 1 GeV/c, moving in the Fermilab 15-foot bubble chamber, has a track with a radius of curvature of about 1 metre.