Homework Set #1
(due: Wednesday, January 15, 2003)

1. Consider the motion of a particle with charge q and (relativistic) momentum p in a dipole magnetic field B.

   a) Show that the motion is a circle of radius ρ with p = qρB.

   b) Show that for an elementary particle of charge q(=1.6×10^{-19} Coulombs) the relationship between the particle momentum as measured in GeV/c, the magnetic field as measured in Tesla, and the radius of curvature measured in meter:

   $$p(GeV/c) = (0.3) \times r(meters) \times B(Tesla)$$

   c) Estimate the circumference of an accelerator providing 50 TeV (1 TeV = 10^{12} eV) protons with a magnetic bend field of 10 T.

2. Consider the parameters for two linear collider projects shown in the table (next page). Please complete the table by computing σ_x^* / σ_y^*, beam power, and luminosity.

Beam Parameters

	TESLA	NLC
CM Energy (GeV)	500	500
RF Frequency (GHz)	1.3	11.4
Linac rep rate (Hz)	5	120
# bunches/pulse	2820	190
# particles/bunch (10^{10})	2	0.75
Emittances $\gamma\varepsilon_x/\gamma\varepsilon_y$ (10^{-6} m-rad)	10/0.03	4/0.07
β_x^*/β_y^* (mm)	15/0.4	8/0.125
Bunch length σ_z (μm)	300	125
Beam size σ_x^*/σ_y^* (nm)		
Beam angular divergence $\sigma_{x'}^*/\sigma_{y'}^*$ (μrad)		
Beam power (MW)		
Luminosity (10^{33} cm^{-2}s^{-1})		