I. Grad-B drift

Consider a particle in magnetic field given by:

$$\vec{B} = (B_0 + \alpha y) \cdot \vec{z}^0 \tag{1}$$

with initial velocity $\vec{v}_0 = 10 \cdot \vec{x}^0$ and mass to charge ratio $m/q = 10^3$ kg/C.
Determine the Larmor radius, cyclotron frequency and drift velocity for these parameters:

- $B_0 = 100$ T, $\alpha = 0.01$ m^{-1}T
- $B_0 = 1$ T, $\alpha = 1$ m^{-1}T

II. Magnetic mirror

A magnetic field given by:

$$\vec{B} = B_0 \left([0, 0, 1] - \frac{z}{L^2} [x, y, -z] \right) \tag{2}$$

is an example of a magnetic mirror.

- Verify that $\nabla \cdot \vec{B} = 0$
- Calculate B at the point where the particle is reflected given that the velocity vector at $r(0) = [0, 0, 0]$ m is $v(0) = [0.0, v_y, v_z]$ m/s.

Use these parameters:
$B_0 = 1.0$ T, $L = 1000$ m, $v_y = 1.0$ m/s, $v_z = 8.0$ m/s

Can you calculate the field for $L = 1$ m using the same method?