Problem 1: Two particles, one with charge \( q_p \) and mass \( m_p \), and the other with charge \( 4q_p \) and mass \( 2m_p \), are accelerated from rest through a potential difference \( \Delta V \) and fired at an angle \( \theta \) with respect to the horizontal (the x-axis) in the xy plane into a region with a uniform magnetic field \( \vec{B} = B_0 \hat{x} \), resulting in helical orbits.

(a) What is the ratio of the periods of their orbits?

(b) What is the ratio of the radii of the orbits? Which particle has a larger radius?

(c) What is the ratio of the pitches (distance between spirals) of the helical orbits?

(d) If the initial potential difference used to accelerate the particles is \( \Delta V = 1 \text{ kV} \) and the angle at which they are fired is \( \theta = 30^\circ \), what is the magnitude of the magnetic field needed to spiral the particle of mass \( m_p \) in a helical orbit of radius 4.0 cm? Here \( m_p \) is the proton mass.
Problem 2
A square current loop of side $d = 0.1$ m that carries a current $I = 2$ A is surrounded by a region of uniform magnetic field $B = 2.4$ T pointing in the positive y direction, as shown.

(a) What is the magnetic dipole moment (magnitude and direction) of the loop?

(b) What is the magnetic force (magnitude and direction) on each side of the loop? What is the net force on the loop?

(c) What is the torque acting on the loop? In which direction will the loop rotate?