1. \( \vec{F}_G = mg = (9.11 \times 10^{-31} \text{kg}) \cdot (9.8 \text{m/s}^2) = 8.92 \times 10^{-30} \text{N} \) downward, 
\( \vec{F}_E = qE = (-1.6 \times 10^{-19} \text{C}) \cdot (-100 \text{N/C}) = 1.6 \times 10^{-18} \text{N} \) upward, and 
\( \vec{F}_B = q\vec{v} \times \vec{B} = (-1.6 \times 10^{-19} \text{C}) \cdot [6 \times 10^6 \text{m/s} \text{east} \times 50.0 \mu \text{T} \text{north}] = 4.8 \times 10^{-17} \text{N} \) downward.

2. \( \vec{v} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -4 & 1 \\ 1 & 2 & -3 \end{vmatrix} = \hat{i}(12 - 2) - \hat{j}(-6 - 1) + \hat{k}(4 + 4) = 10\hat{i} + 7\hat{j} + 8\hat{k} \)
\( |\vec{F}_B| = |q\vec{v} \times \vec{B}| = (1.6 \times 10^{-19} \text{C}) \cdot \sqrt{10^2 + 7^2 + 8^2} = 2.34 \times 10^{-18} \text{N}. \)

3. The current must travel to the right to experience an upward force. The force per unit length is \( F/L = BI = 0.04 \text{kg/m} \) so \( I = 0.04 \text{kg/m}/3.60 T = 0.01 A. \)

4. From kinematics, \( v^2 = 2aL = 2 \frac{Bld}{m} L \Rightarrow v = \sqrt{2 \frac{Bld}{m} L}. \)

5. If the plane of the loop makes an angle \( \theta = 30^\circ \) with the x-axis, the normal to the plane makes an angle \( \theta = 60^\circ \) with the x-axis. The magnitude of the torque is \( \tau = NBAI \sin \theta = 100(0.87)(0.4 \times 0.3 \text{m}^2)(1.2A)(\sin 60^\circ) = 9.98 N \cdot m. \) The loop will rotate so as to align the magnetic moment \( \vec{n} \) with the \( \vec{B} \) field. Looking down along the y-axis, the loop will rotate in a clockwise direction.

6. \( E = \frac{1}{2}mv^2 = e(\Delta V) \) and \( evB\sin 90^\circ = m\frac{v^2}{R} \) Thus \( B = \frac{mv}{er} = \frac{m}{eR} \sqrt{\frac{2e(\Delta V)}{m}} = \frac{1}{R} \sqrt{\frac{2m(\Delta V)}{e}} \)
\( = 7.9 \times 10^{-12} T. \)

7. (a) \( R_H = \frac{1}{nq} \) so \( n = \frac{1}{qR_H} = \frac{1}{(1.6 \times 10^{-19} \text{C})(0.84 \times 10^{-10} \text{m}^{-1} \text{C})} = 7.4 \times 10^{28} \text{m}^{-3}. \)
(b) \( \Delta V_H = \frac{nB}{n_q} \rightarrow B = \frac{nq(\Delta V_H)}{IB} = \frac{(7.4 \times 10^{28} \text{m}^{-3})(1.6 \times 10^{-19} \text{C})(0.2 \times 10^{-1} \text{m})}{20 A} = 1.8 T. \)

8. The sodium, consisting of ions and electrons, flows along the pipe transporting no net charge. But inside the section of length \( L \), electrons drift upward to constitute downward electric current \( I = J \times \text{area} = JLw. \) The current then experiences a magnetic force \( \vec{I} \hat{h} \times \vec{B} \) = \( JLwB \sin 90^\circ. \) This force along the pipe will make the fluid move, exerting a pressure \( \frac{F}{\text{area}} = \frac{JLwB}{\text{kw}} = JL. \)