

Problem 2

a) First the electron velocity is calculated from the current I:

$$I = jS = ne_0vbc, \quad v = \frac{I}{ne_0bc} = 25 \text{ m/s}.$$

The components of the electric field are obtained from the electron velocity. The component in the direction of the current is

$$E_{\parallel} = \frac{v}{\mu} = 3.2 \text{ V/m}. \quad (0.5\text{p.})$$

The component of the electric field in the direction b is equal to the Lorentz force on the electron divided by its charge:

$$E_{\perp} = vB = 2.5 \text{ V/m}. \quad (1\text{p.})$$

The magnitude of the electric field is

$$E = \sqrt{E_{\parallel}^2 + E_{\perp}^2} = 4.06 \text{ V/m}. \quad (0.5\text{p.})$$

while its direction is shown in Fig. 5 (Note that the electron velocity is in the opposite direction with respect to the current.) (1.5 p.)

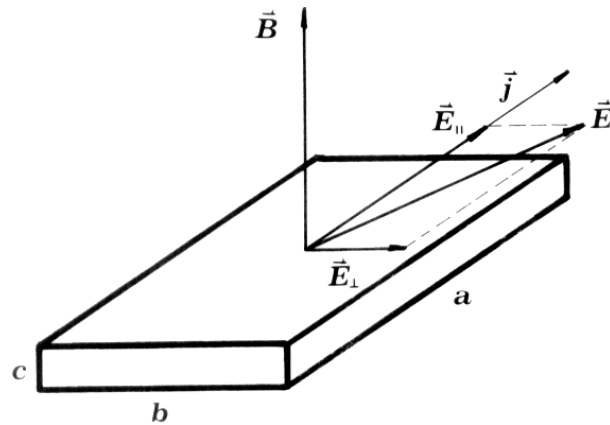


Fig. 5

b) The potential difference is

$$U_H = E_{\perp}b = 25 \text{ mV} \quad (1\text{p.})$$

c) The potential difference U_H is now time dependent:

$$U_H = \frac{IBb}{ne_0bc} = \frac{I_0B_0}{ne_0c} \sin \omega t \sin(\omega t + \delta).$$

The DC component of U_H is

$$\bar{U}_H = \frac{I_0B_0}{2ne_0c} \cos \delta. \quad (3p.)$$

d) A possible experimental setup is shown in Fig. 6

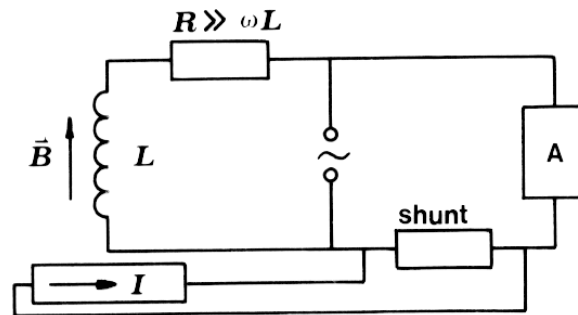


Fig. 6

(2 p.)