

7. (a) Equating the magnitude of the electric force ($F = eE$) with that of the magnetic force (Eq. 29-3), we obtain $B = E/v \sin \phi$. The field is smallest when the $\sin \phi$ factor is at its largest value; that is, when $\phi = 90^\circ$. Now, we use $K = \frac{1}{2}mv^2$ to find the speed:

$$v = \sqrt{\frac{2K}{m_e}} = \sqrt{\frac{2(2.5 \times 10^3 \text{ eV})(1.60 \times 10^{-19} \text{ J/eV})}{9.11 \times 10^{-31} \text{ kg}}} = 2.96 \times 10^7 \text{ m/s} .$$

Thus,

$$B = \frac{E}{v} = \frac{10 \times 10^3 \text{ V/m}}{2.96 \times 10^7 \text{ m/s}} = 3.4 \times 10^{-4} \text{ T} .$$

The magnetic field must be perpendicular to both the electric field and the velocity of the electron.

- (b) A proton will pass undeflected if its velocity is the same as that of the electron. Both the electric and magnetic forces reverse direction, but they still cancel.