

Holt Physics

Problem 21A**PARTICLE IN A MAGNETIC FIELD****PROBLEM**

A bubble chamber is a device used to make the paths of charged particles visible in collision experiments. Suppose a proton travels in one of these bubble chambers at a speed of 1.9×10^7 m/s. A magnetic force of 4.3×10^{-12} N acts on the proton. What is the magnitude of the magnetic field at right angles to the proton's path?

SOLUTION

Given: $q = 1.60 \times 10^{-19}$ C $v = 1.9 \times 10^7$ m/s

$$F_{\text{magnetic}} = 4.3 \times 10^{-12} \text{ N}$$

Unknown: $B = ?$

Use the equation for the magnetic field from page 773.

$$B = \frac{F_{\text{magnetic}}}{qv} = \frac{4.3 \times 10^{-12} \text{ N}}{(1.60 \times 10^{-19} \text{ C})(1.9 \times 10^7 \text{ m/s})} = \boxed{1.4 \text{ T}}$$

ADDITIONAL PRACTICE

1. An electron in a cathode ray tube (found in many televisions) moving at a speed of 1.2×10^6 m/s has a magnetic force of 1.2×10^{-17} N acting on it. What is the magnitude of the magnetic field perpendicular to the electron's path?
2. Humans emit a magnetic field because ions move through the blood. Suppose an electron whizzes horizontally by a standing person at a speed of 3.9×10^6 m/s. If the electron is affected by a magnetic force of 1.9×10^{-22} N, how much of a magnetic field does this person emit?
3. An electron moves perpendicular to a sunspot at a speed of 7.8×10^6 m/s. A magnetic force of 3.7×10^{-13} N is exerted on the electron. What is the magnitude of the magnetic field emitted by the sunspot?
4. In the Fermilab accelerator, a proton maintains circular motion about a radius of 1.0 km. The proton travels at right angles to a uniform magnetic field of 3.3 T. What is the speed of the proton? (Hint: The magnetic force exerted on the proton is the force that maintains circular motion.)
5. Aurora Borealis, the "northern lights" found at high latitudes, happens when charged particles fall into Earth's atmosphere near the poles. The magnetic field near the poles is 5.0×10^{-5} T. Suppose the particle has a charge of 1.60×10^{-19} C. If the magnetic force exerted on the particle is 6.1×10^{-17} N, at what speed is the particle moving? (Assume that the particle moves perpendicular to Earth's magnetic field.)
6. The magnetic field in the Crab Nebula is about 1×10^{-8} T. If an electron moving perpendicular to this field is affected by a magnetic force of 3.2×10^{-22} N, what is the electron's speed?

7. Suppose an electron moves to the right at a velocity of 6×10^6 m/s at an angle of 45° to a uniform magnetic field. If the magnetic field is 3×10^{-4} T upward, what is the magnitude and direction of the magnetic force exerted on the electron? (Hint: Only the component perpendicular to the magnetic field contributes to the magnetic force.)
8. A proton moves at right angles to a uniform magnetic field of 0.8 T. If the speed of the proton is 3.0×10^7 m/s, what is the magnetic force exerted on the proton?
9. Suppose an electron moves at a speed of 2.2×10^6 m/s on the surface of the Sun. Suppose the Sun has a magnetic field of 1.1×10^{-2} T perpendicular to the electron's path. What is the magnetic force exerted on the electron by the Sun?
10. Suppose an electron moves at a speed of 9.3×10^5 m/s. If it moves at right angles to a uniform magnetic field of 4.1×10^{-10} T in interstellar galactic space, what is the magnetic force exerted on the electron?