26 Electromagnetism

1. A beam of electrons travels an undeflected path in a Thomson tube. $E = 8.0 \times 10^3$ N/C. $B = 4.5 \times 10^{-2}$ T. What is the speed of the electrons as they travel through the tube?

2. An electron moving at 2.0×10^6 m/s moves through a magnetic field of 8.0×10^{-2} T. What is the radius of the electron's path. The mass of an electron is 9.11×10^{-31} kg. $q = 1.6 \times 10^{-19}$.

3. A magnetic field and an electric field are perpendicular to each other in a Thomson tube. The electric field intensity is 5.0×10^4 N/C, and the intensity of the magnetic field is 3.0×10^{-2} T. What is the speed of the moving particles?

4. A charged particle is accelerated from rest through a potential difference of 8.0×10^2 V. It enters a magnetic field of 5.0×10^{-2} T. The radius of curvature is 6.0×10^{-2} m.

a. Calculate the m/q ratio.

b. If the particle has a charge of 1.6×10^{-19} C, what is its mass?

5. Alpha particles are accelerated through a potential difference of 8.0×10^2 V. The particles have a mass of 6.68×10^{-27} kg and a charge of twice that of an electron. If the magnetic field is 0.30 T, what is the radius of the path of the particles?

6. A proton moves with the speed of 9.0×10^3 m/s through a magnetic field of 4.5×10^{-2} T. The charge on the proton is equal to the charge on the electron only positive. The mass of the proton is 1.67×10^{-27} kg. What is the radius of the circular path?

7. A beam of electrons is bent in a circular path with a radius of 3.0 cm by a magnetic field of 5.0×10^{-4} T. What is the speed of the electrons?

8. A proton moves across a 3.0-T magnetic field. The radius of curvature of the path is 1.5×10^{-2} m.

a. What is the speed of the proton?

b. The proton follows a straight line when an electric field is applied at right angles to the magnetic field. What is the strength of the electric field?

9. A lithium ion with a speed of 7.0×10^5 m/s and a charge of 1.6×10^{-19} C enters the magnetic field of a mass spectrometer. The magnetic field is 0.28 T, and the radius of the ion path is 0.30 m. Find the mass of the lithium ion.

10. An electron and a proton move at the same speed as they enter a 3.0×10^{-2} T magnetic field. The electron moves in a circular path of radius 8.0×10^{-3} m. Calculate the radius of the path of the proton.

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11. A mass spectrometer produces a beam of doubly ionized calcium ions. They are first accelerated by a potential difference of 82 V. The magnetic field is 0.090 T. The radius of the path is 6.5×10^{-2} m. Find the mass of the calcium atom as a whole number of proton masses.

12. With an accelerating voltage of 73.5 V, a mass spectrometer produces ions with masses of 6.8×10^{-26} kg that move in a circular path with radius of 8.6×10^{-2} m in a 6.5×10^{-2} T magnetic field.

a. What is the charge on one ion?

b. How many electrons have been removed by the spectrometer to provide the ion?

13. A beam of singly ionized chlorine ions is sent through a mass spectrometer. The values are $B = 0.10$ T, $r = 4.9 \times 10^{-2}$ m, $q = 1.6 \times 10^{-19}$ C, and $V = 33$ V. Find the mass of the chlorine as a whole number of protons.

14. In Problem 13 you found the mass of a chlorine isotope. Another chlorine isotope has 37 proton masses. How far from the first isotope would these ions land on the photographic film in the spectrometer?

15. What length antenna would be best to transmit microwaves of wavelength of 2.4 cm?

16. The radio wave generated by Heinrich Hertz to demonstrate the transmission of radio waves had a frequency of 1.0×10^9 Hz. What length antenna would you use to detect this frequency?