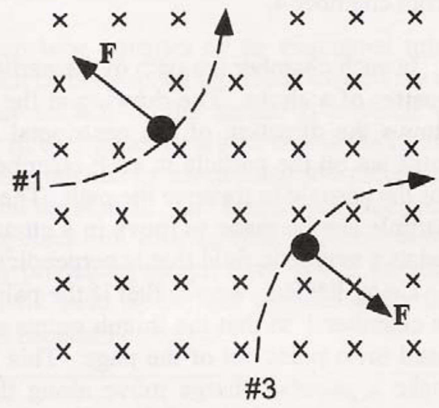
5. ***REASONING AND SOLUTION*** Since the paths of the particles are perpendicular to the magnetic field, we know that the velocities of the particles are perpendicular to the field. Since the velocity of particle #2 is perpendicular to the magnetic field and it passes through the field undeflected, we can conclude that particle #2 is neutral.



Particles #1 and #3 move in circular paths. The figure at the right shows the direction of the (centripetal) magnetic force that acts on the particles. If the fingers of the right hand are pointed into the page so that the thumb points in the direction of motion of particle #1, the palm of the hand points toward the center of the circular path traversed by the particle. We can conclude, therefore, from RHR-1 that particle #1 is positively charged. If the fingers of the right hand are pointed into the page so that the thumb points in the direction of motion of particle #3, the palm of the hand points away from the center of the circular path traversed by the particle. We conclude, therefore, from RHR-1 that particle #3 is negatively charged.

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2. ***REASONING AND SOLUTION*** The magnitude of the force can be determined using Equation 21.1, $F = qvB \sin\theta$, where θ is the angle between the velocity and the magnetic field. The direction of the force is determined by using Right-Hand Rule No. 1.

a. $F = qvB \sin 30.0° = (8.4 \times 10^{-6}\ \text{C})(45\ \text{m/s})(0.30\ \text{T}) \sin 30.0° = \boxed{5.7 \times 10^{-5}\ \text{N}}$,

directed $\boxed{\text{into the paper}}$.

b. $F = qvB \sin 90.0° = (8.4 \times 10^{-6}\ \text{C})(45\ \text{m/s})(0.30\ \text{T}) \sin 90.0° = \boxed{1.1 \times 10^{-4}\ \text{N}}$,

directed $\boxed{\text{into the paper}}$.

c. $F = qvB \sin 150° = (8.4 \times 10^{-6}\ \text{C})(45\ \text{m/s})(0.30\ \text{T}) \sin 150° = \boxed{5.7 \times 10^{-5}\ \text{N}}$, directed $\boxed{\text{into the paper}}$.

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8. ***REASONING*** The positive plate has a charge q and is moving downward with a speed v at right angles to a magnetic field of magnitude B. The magnitude F of the magnetic force exerted on the positive plate is $F = qvB \sin 90.0°$. The charge on the positive plate is related to the magnitude E of the electric field that exists between the plates by (see Equation 18.4) $q = \varepsilon_0 AE$, where A is the area of the positive plate. Substituting this expression for q into the expression for the magnetic force gives the answer in terms of known quantities.

SOLUTION

$$F = (\varepsilon_0 AE)vB$$

$$= \left[8.85 \times 10^{-12}\ \text{C}^2/(\text{N}\cdot\text{m}^2)\right]\left(7.5 \times 10^{-4}\ \text{m}^2\right)(170\ \text{N/C})(32\ \text{m/s})(3.6\ \text{T})$$

$$= \boxed{1.3 \times 10^{-10}\ \text{N}}$$

An application of Right-Hand Rule No. 1 shows that the magnetic force is perpendicular to the plane of the page and $\boxed{\text{directed out of the page}}$, toward the reader.

18. ***REASONING*** The radius of the circular path is given by Equation 21.2 as $r = mv/(qB)$, where m is the mass of the species, v is the speed, q is the magnitude of the charge, and B is the magnitude of the magnetic field. To use this expression, we must know something about the speed. Information about the speed can be obtained by applying the conservation of energy principle. The electric potential energy lost as a charged particle "falls" from a higher to a lower electric potential is gained by the particle as kinetic energy.

SOLUTION For an electric potential difference V and a charge q, the electric potential energy lost is qV, according to Equation 19.4. The kinetic energy gained is $\frac{1}{2}mv^2$. Thus, energy conservation dictates that

$$qV = \tfrac{1}{2}mv^2 \quad \text{or} \quad v = \sqrt{\frac{2qV}{m}}$$

Substituting this result into Equation 21.2 for the radius gives

$$r = \frac{mv}{qB} = \frac{m}{qB}\sqrt{\frac{2qV}{m}} = \frac{1}{B}\sqrt{\frac{2mV}{q}}$$

Using e to denote the magnitude of the charge on an electron, we note that the charge for species X^+ is $+e$, while the charge for species X^{2+} is $+2e$. With this in mind, we find for the ratio of the radii that

$$\frac{r_1}{r_2} = \frac{\frac{1}{B}\sqrt{\frac{2mV}{e}}}{\frac{1}{B}\sqrt{\frac{2mV}{2e}}} = \sqrt{2} = \boxed{1.41}$$

29. ***REASONING AND SOLUTION*** The force on each side can be found from $F = ILB \sin\theta$. For the top side, $\theta = 90.0°$, so

$$F = (12\text{ A})(0.32\text{ m})(0.25\text{ T})\sin 90.0° = \boxed{0.96\text{ N}}$$

The force on the bottom side ($\theta = 90.0°$) is the same as that on the top side, $F = \boxed{0.96\text{ N}}$.

For each of the other two sides $\theta = 0°$, so that the force is $F = \boxed{0\text{ N}}$.

53. ***REASONING AND SOLUTION*** The magnetic field due to the circular loop alone is $B_1 = \frac{\mu_0 I_1}{2R}$. The field due to the straight wire is $B_2 = \frac{\mu_0 I_2}{2\pi H}$. These two fields cancel at the center of the loop, so that their magnitudes must be equal:

$$\frac{\mu_0 I_1}{2R} = \frac{\mu_0(6.6\, I_1)}{2\pi H} \quad \text{or} \quad \boxed{H = 2.1\, R}$$