Tuesday Reading Assessment: Unit 3, Magnetic Forces and Fields

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1 Memory Bank

- $\hat{i} \times \hat{j} = \hat{k}$, $\hat{j} \times \hat{k} = \hat{i}$, $\hat{k} \times \hat{i} = \hat{j}$ ... The direction of the *cross-product* follows this pattern. Reversing the order of any two vectors introduces a minus sign.
- $\hat{i} \times \hat{i} = 0$, $\hat{j} \times \hat{j} = 0$, $\hat{k} \times \hat{k} = 0$ ... The *cross-product* is zero when both vectors are parallel.
- $|\vec{a} \times \vec{b}| = |\vec{a}||\vec{b}| \sin\theta$ ... The magnitude of the cross-product of two vectors $\vec{a}$ and $\vec{b}$, given the angle θ between them.
- $\vec{F} = i\vec{L} \times \vec{B}$ ... The Lorentz force, by a magnetic field $\vec{B}$ on a *current* i of length and direction $\vec{L}$.

2 The Cross-Product

1. Let $\vec{a} = 4\hat{i}$, and $\vec{b} = 4\hat{j}$. (a) Calculate $\vec{a} \times \vec{b}$. (b) What are the magnitude and direction of the result?

2. Let $\vec{a} = 2\hat{i} + 2\hat{j}$, and $\vec{b} = -2\hat{i} - 2\hat{j}$. (a) Calculate $\vec{a} \times \vec{b}$. (b) What are the magnitude and direction of the result?

3. What is the angle between the two vectors in the previous problem?

3 Magnetic Force on a Wire

1. Consider Fig. 1, in which a current passes through a *magnetic field* generated by a permanent magnet. Notice in the Memory Bank the formula for the force on the conductor carrying the current. (a) If the amount of wire in the magnetic field is $L = 10$ cm, the magnetic field is $B = 10^{-1}$ Tesla, the voltage is $V = 24$ Volts, and the effective resistance in the wire is $R = 2\Omega$, what is the force upwards on the wire? (b) If the wire was attached to a scale, and the scale has a mass of $m = 24$ grams on it, what would the scale read if we turn on this current in this magnetic field? (*Hint: it won't say 24 grams*).

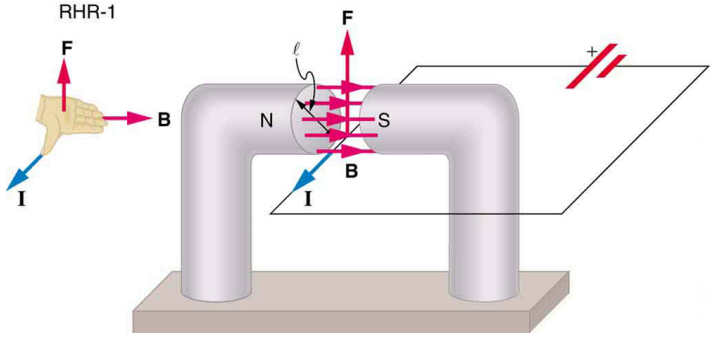

Figure 1: A permanent magnet creates a magnetic field to the *left*, while a voltage pushes a current *out of the page*. The force is measured to occur in the *upward direction*.