Oersted, Hans Christian (ör’stō), 1777–1851, Danish physicist and chemist. His discovery that a magnetic needle is deflected by a conductor carrying an electric current showed a relation between ELECTRICITY and MAGNETISM and initiated the study of electromagnetism. (One of the) unit(s) of magnetic field strength, the oersted, is named for him. Oersted was the first to isolate ALUMINUM.

Energy, 1819
Danish physicist Hans Christian Oersted, 42, advances knowledge of electromagnetic energy. He notices that a compass needle located close to a wire carrying an electric current will swing wildly but will finally settle at right angles to the wire. He suspects that the current in the wire must set up a magnetic field around it, and his observation will be the starting point for others (see ROMAGNOSI, 1802; AMPÈRE, 1820; FARADAY, 1821; ELECTROMAGNET, 1823).

\[ \mu_0 = 4 \pi \times 10^{-7} \ T \cdot m / A \]
(e) An RC circuit consists of a 625 kΩ resistor and a 625 μF capacitor. Find the time $t$ in seconds it takes for the fully charged capacitor to discharge to half its initial value, i.e. $q = 0.500 Q_{\text{max}}$.

$$t = RC = (625\Omega)(625 \times 10^{-6} F) = 0.3906 \text{ sec}$$

$$q = Q_0 e^{-t/RC} ; \quad q = 0.500Q$$

$$0.500Q = Q_0 e^{-t/RC}$$

$$0.500 = e^{-t/RC}$$

$$\ln(e^{-t/RC}) = \ln(0.500)$$

$$-\frac{t}{RC} = -0.6931$$

$$t = (0.6931)RC = (0.6931)(0.3906 \text{ sec})$$

$$t = 0.2707 \text{ sec}$$

**Wait A Second! How’d Oersted Do It?** SEE COVER SHEET (50,000 points)

2.) Yesterday afternoon, after PHYS-115 class, after my 4pm appointment, after the rest of the Physics Dept. meeting, one of my colleagues came in and showed me a problem in a Physics Education book and he didn’t understand how they could get the answer they did. I looked at it, at first agreed with him, and then realized that Real Life isn’t as simple as we make it in class sometimes. Consider: Oersted runs a current through a wire and a compass needle changes its direction. The North end of a compass needle points in the same direction as a magnetic field points (N points towards S). (a) A current carrying wire is shown below, in two views. Show by R.H.R. which way the magnetic field from the wire points at the P in both views.

View From Above

View Looking From Right Side

(b) A compass needle points to the LEFT while you are sitting in 1104 Rood Hall. But from part (a), there’s no way that the B-field from the wire could deflect the needle at point P. But... a real compass is thick. The needle would sit ABOVE the wire – and there WOULD be a magnetic field. Okay, okay. Enough of Dr. Phil marveling at the wonder of Physics... Suppose the compass sits directly ON TOP of the wire. For a wire carrying a current of 1.00 A, find the distance $d$ where the magnetic field measures $B = 0.000100 T$. (This is 1/10,000th of a Tesla or 1.00 Gauss, the same strength as the Earth’s magnetic field here on the surface.)

$$B = \frac{\mu_0 I}{2\pi r} = \frac{\mu_0 I}{2\pi d}$$

$$d = \frac{\mu_0 I}{2\pi B} = \frac{(4\pi \times 10^{-7} T \cdot m / A)(1.00 A)}{2\pi (0.000100 T)}$$

$$d = 0.002000m = (2,000 \text{ mm})$$

(c) A coil consists of 10,500 turns of wire in a length of 15.0 cm and a diameter of 8.00 cm. The B-field in the solenoid measures $B = 0.00135 T$, as shown. Find the magnitude of the current $I$ in the coil and indicate whether the current comes out the LEFT or the RIGHT of the coil.

$$B = \frac{\mu_0 NI}{l}$$

$$I = Bl/\mu_0 N = \frac{(0.00135T)(0.150 m)}{(4\pi \times 10^{-7} T \cdot m / A)(10,500)}$$

$$I = 0.01535 A$$

(d) For the same solenoid coil as in (c), with $B = 0.00135 T$, a second wire is inserted down the center of the coil. If the current in this second wire is $i = 0.500 A$ as shown, find the magnitude and direction of the magnetic force, $F_B$, on this second wire. Use the length of the coil as the length of the second wire.

(Alternately, the second current, $i_2$, is everywhere in the coil perpendicular to the first current, $i_1$, and therefore there is no magnetic force between perpendicular wires.)

$$\vec{B} \text{ and } i \text{ are anti - parallel}$$

$$\vec{F}_B = 0$$

(e) The E-field part of a velocity selector consists of two parallel plates, separated by a gap $d = 0.100 m$ and with a potential difference $\Delta V = 1500$ volts. If the B-field part uses the same solenoid coil with $B = 0.00135 T$ as above, find the “design speed” $v$ for this velocity selector, using any charged particle.

$$\Delta V = Ed$$

$$E = \frac{\Delta V}{d} = \frac{1500 \text{ volts}}{0.100m} = 15,000 V / m$$

$$v = \frac{E}{B} = \frac{15,000 V / m}{0.00135T} = 1,111 \times 10^3 m / s = 11,110,000 m / s$$