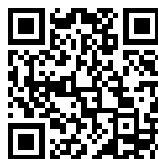

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ELEMENTS OF ELECTRICITY

A PRACTICAL DISCUSSION OF THE FUNDAMENTAL LAWS
AND PHENOMENA OF ELECTRICITY AND THEIR
PRACTICAL APPLICATIONS IN THE BUSI-
NESS AND INDUSTRIAL WORLD

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ELEMENTS OF ELECTRICITY AND MAGNETISM*

PART I

BEGINNINGS OF ELECTRICITY

MAGNETISM

1. **Natural and Artificial Magnets.** It has been known for many centuries that some specimens of the ore known as magnetite (Fe_3O_4) have the property of attracting small bits of iron and steel, Fig. 1. This ore probably received its name from the fact that it is abundant in the province of Magnesia in Thessaly, although the Latin writer Pliny says that the word magnet is derived from the name of the Greek shepherd Magnes, who, on the top of Mount Ida, observed the attraction of a large stone for his iron crook. Pieces of ore which exhibit this attractive property for iron or steel are known as *natural magnets*.

It was also known to the ancients that artificial magnets may be made by stroking pieces of steel with natural magnets, but it was not until the twelfth century that the discovery was made that a suspended magnet would assume a north-and-south position. Because of this property, natural magnets came to be known as lodestones (leading stones); and magnets, either artificial or natural, began to be used for determining directions. The first mention

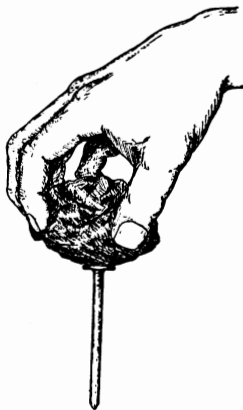


Fig. 1. Natural Magnet or Lodestone

*This article is a modification and extension of the treatment of *Magnetism and Electricity* found in Millikan and Gale's "First Course in Physics" (Ginn & Co., Boston), to which this student is referred for additional problems and applications.

carbon and zinc show an e.m.f. of at least 1.5 volts, while carbon and copper will show an e.m.f. of very much less than a volt. Similarly, by changing the nature of the liquid in which the plates are immersed, we can produce changes in the deflection of the voltmeter. We learn therefore that *the e.m.f. of a galvanic cell depends simply upon the materials of which the cell is composed and not at all upon the shape, size, or distance apart of the plates.*

58. Electrical Resistance. If the terminals of a galvanic cell are connected first to ten feet of No. 30 copper wire, and then to ten feet of No. 30 German-silver wire, it is found that a compass needle placed at a given distance from the copper wire will show a much larger deflection than when placed the same distance from the German-silver wire. A cell, therefore, which is capable of developing a certain fixed electrical pressure is able to force very much more current through a given wire of copper than through an exactly similar wire of German silver. We say, therefore, that German silver offers a higher *resistance* to the passage of electricity than does copper. Similarly, every particular substance has its own characteristic power of transmitting electrical currents. Silver is the best conductor of any of the known substances. The resistances of different substances are commonly referred to silver as a standard, and the ratio between the resistance of a given wire of any substance and the resistance of an exactly similar silver wire is called the *specific resistance* of that substance. The specific resistances of some of the commoner metals are given below:

Silver.....1.00	Soft iron.....7.40	German silver, 18 per cent nickel. .18.0
Copper.....1.13	Nickel.....7.87	Hard steel.....21.0
Aluminum...2.00	Platinum....9.00	Mercury.....62.7

The unit of resistance is the resistance at 0 degrees C of a column of mercury 106.3 cm. long and 1 sq. mm. in cross-section. It is called an ohm, in honor of the great German physicist, Georg Ohm (1789-1854). A length of 9.35 feet of No. 30 copper wire, or 6.2 inches of No. 30 German-silver wire, has a resistance of about one ohm. Copper wire of the size shown in Fig. 71 has a resistance of about 2.62 ohms per mile.



Fig. 71. Copper Conductor

The resistances of all metals increase with a rise in temperature. The resistances of liquid conductors, on the other hand, usually