Science Bulletin

Volume 2 | Number 8 Article 6

4-1930

Magnetism

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Recommended Citation

Begeman, L. (1930) "Magnetism," *Science Bulletin*: Vol. 2: No. 8, Article 6.
Available at: https://scholarworks.uni.edu/science_bulletin/vol2/iss8/6

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answers from the number of right ones to find the percent you know of the answers. This method of scoring assumes that for each wrong answer you make without knowing it you by chance get one right without knowing it.)

E. O. Finkenbinder.

SUGGESTIONS FOR HEALTH CLASSES

Health

(Continued from March)

a. If one has been exposed to smallpox should he be vaccinated at once? Smallpox, I; Smallpox, III.

b. What factors should one look for in buying a new pair of shoes? Shoes, I.

c. A child has been bitten by a dog which is suspected of being mad. How can it be determined if the dog really has rabies? What should be done with the dog? What should be done with the child? Rabies, III; Rules and Regulations of the State Board of Health, III.

d. Who is most responsible for a person's first set of teeth? His second set of teeth? Good Teeth, I; Children's Teeth, V; Building Baby's Teeth, V; Save Those Baby Teeth, V; Caring for Teeth, V; Eating for Teeth, V; Prevent Tooth Decay, V; Spare the Sweets and Save the Teeth, V.

e. One of the boys in high school went home one noon because he was so sick that he did not feel like staying longer. He was so ill the next morning that a physician was called. The physician diagnosed the case as diphtheria and had a placard put on the house. The physician stated that there must be a carrier in town, as there had been no recent case of. diphtheria. What is a carrier? How can one be detected? What type of placard was placed on the house and how long would it have to be there? Can the father go from the home to his work daily, and can the brother in the eighth grade and the sister in the kindergarten keep going to school? Can diphtheria be prevented? Diphtheria, I; Chart of Communicable Diseases Among School Children, III; Does the Giving of Toxin-antitoxin Pay in Iowa? III; What is Diphtheria? III; Diphtheria is Preventable, III; Rules and Regulations of the State Board of Health, III.

These few concrete illustrations of the use that can be made of the material listed will suffice to show its value for the health classes. An ingenious teacher will find many more ways than those suggested in this article for making the work in the health classes interesting by the use of such reference material.

BELVA L. SWALWELL.

MAGNETISM

Physics

Interstellar space is characterized by the existence of three all pervading fields of force denoted respectively as gravitational, electric, and magnetic. Einstein in his general theory of relativity demonstrates mathematically that these three force fields are but different aspects of one universal field. To the average man, however, these three natural forces will always appear as separate distinct entities.

In the high school texts on physics the subject of magnetism is approached from the standpoint of ferromagnetism. The subject of electro-magnetism is treated later as one of the most striking properties of an electric current. Our remarks on magnetism, accordingly, will be limited to magnetism as manifested by different forms of iron. It should be recognized, however, that there are other metals; such as, nickel and cobalt and even quite a number of metallic alloys that can be used to illustrate the simple phenomena of magnetism. According to the electro-magnetic theory of matter all forms of molecular substances possess in their fundamental structures the properties of magnetism.

In taking up the subject of magnetism for instruction, we usually begin with the natural magnet. A natural magnet consists of a piece of block iron ore whose molecular composition consists of three atoms of iron and four atoms of oxygen. Such magnets were known to the ancients long before the Christian era. During the early middle ages they were used as compass needles to point the way for ships upon the seas. A small natural magnet can be obtained at a trifling cost from any apparatus firm.

Artificial magnets are usually made of tempered steel. They are sold by apparatus firms in two forms,—namely, bar magnets and horse shoe magnets. The instructor can obtain a supply of such magnets at small cost in his own community. All that is necessary is to purchase a bar of tool steel at the hardware store. This can be cut up into pieces about eight inches long at the blacksmith shop. The blacksmith can also shape some of the pieces of appropriate length into horseshoe forms. These bars should be about one-half to one inch in width and a quarter of an inch in thickness. After the bars are shaped up in form they should be tempered by heating them to a dull red and then plunging them into cold water. To magnetize the bars, it is necessary to construct a small electro-magnet. This is quickly done by wrapping some twenty or thirty turns of insulated copper wire around a soft iron bolt about six inches long. Finally connect the electro-magnet in circuit with two dry cells. The circuit should possess a key for its control. To magnetize the tool steel bars, their ends must be drawn repeatedly from their middle points out across the core ends of the electro-magnet when the circuit is closed. In doing this one end of the bar magnet should be drawn over the south seeking pole of the electro-magnet and the other end of the bar magnet over the north seeking pole of the electro-magnet. Having a supply of bar and horseshoe magnets, the necessary incidentals for experimental work, such as iron filings and cardboards, are easily obtained at no cost whatever. In every community there are machinists in automobile shops who will gladly supply iron filings free of cost.

To illustrate the law of polarity which states that "like poles repel and unlike poles attract", two knitting needles, properly magnetized by means of a bar magnet, should be suspended side by side from a horizontal support, so that the pupil can see which are the north seeking and south seeking poles of each needle. The demonstration thus becomes clear and simple when the poles of the needles are brought into mutual interaction.

The pupil readily grasps the meaning of the qualitative law of polar interaction but seldom understands fully the quantitative law,—namely, "the force between two poles varies directly as the product of the pole strengths and inversely as the square of the distance between them." It would be very difficult to demonstrate this principle with any degree of accuracy. However, it is not so difficult to give concreteness to its concepts if the instructor is careful to analyze it properly. It is not difficult to explain to a pupil that the force between two magnetic poles at a given distance from each other would be four times as great if each of their pole strengths were doubled and nine times as great when each pole strength is trebled and so on for increasing pole strengths.

The difficulty with the law comes in the discussions of the variations of force intensity between poles at different distances from each other. To explain this phase of the law clearly it is well to call the attention of the pupil to the fact that the "law of inverse squares" is fundamental in nature when energy is distributed. The force exerted by a sound wave upon the tympanum of the ear varies inversely as to the square of its distance from the sounding source. All other conditions remaining constant, one can hear a speaker four times as well at a distance of ten feet as when at a distance of twenty feet from him. The intensity of light upon the retina of the eye varies inversely as the square of its distance from the light source. Conditions remaining constant, we can see four times as well two feet from a light as when we are four feet from it. By such simple illustrations, one is able to create some interest in a principle which is basic to the three all-pervading natural forces,—namely, gravitation, electricity, and magnetism.

The most important phenomenon of a magnet is found in its field of force. The value of a magnet is wholly dependent upon the intensity of its field. The magnetic field of a magnet consists of the immediate space surrounding it filled with magnetic lines of force. A concrete notion of these lines of force is usually obtained by first laying a piece of stiff cardboard about one foot square upon the magnet. Fine iron filings are then sifted over the surface of the cardboard. Finally, the cardboard is tapped gently causing the filings to arrange themselves into a series of curved lines emanating from one of the magnet's poles and passing around in space into the other. These lines form a complete magnetic circuit. The conception of a magnetic field in terms of lines of force was originated by the great English scientist, Faraday. To him these lines passing through the air from pole to pole were concrete entities possessing tension and exerting lateral repulsion upon each other. The total number of lines of force coming out of the north seeking end of a magnet constitutes its flux. Each single line is capable of exerting a force of one dyne upon a unit magnetic pole. Just as an electric circuit possesses current, electromotive force and resistance so a magnetic circuit possesses flux, magnetomotive force, and reluctance.

The most striking property of a magnetic field is not its lifting or mechanical action but rather its power of induction. The instructor should stress particularly this property of induction of a magnetic field. This property is simply illustrated by bringing a short piece of a wrought iron rod about two inches long into the field of a permanent magnet near one of its poles. When in this position the wrought iron rod becomes polarized, possessing a north seeking and a south seeking pole, and will pick up tacks or iron filings. When the rod is taken out of the field, it loses its polarity. The experiment also illustrates what we mean by a temporary magnet. For maximum effect the wrought iron rod should be brought in contact with the pole end of the magnet.

The inductive effect of a magnetic field is most interestingly illustrated by having a pupil test out all the iron objects in the schoolroom with a compass. It will be found that all of them are polarized; one end of each attracting the north seeking pole of the compass needle and the other end attracting the south seeking end. If the object tested is in an upright position, the top end of it will attract the north seeking end of the needle, showing that it possesses a south seeking pole. The experiment might be extended by having a pupil test out iron objects in the surrounding neighborhood outside of the building. They will all be found to be magnets possessing polarity. If this same experiment were tried out in the southern hemisphere of the earth it would be found that any upright iron objects there would possess a north seeking pole in its top end which would attract the south seeking end of a compass needle.

We have evidence that the earth is a magnet because whenever we suspend a magnetic needle anywhere upon the earth's surface it generally takes a north and south direction. Of course this would not be the case directly over the earth's magnetic poles. The earth's magnetic poles do not coincide with the geographical poles and hence one would not expect a compass needle to point exactly north and south at many points of the earth's surface. Now, if the earth is a magnet, then like every other magnet, it must possess a magnetic field of force which passes through the atmosphere from one magnetic pole to the other. Knowing this, it becomes clear that it is the inductive influence of the earth's magnetic field that gives polarity to all iron objects upon the earth's surface.

Finally, before leaving such an interesting subject as magnetism, the instructor should not fail to impress the pupil with the universal aspect of magnetism in nature. Space throughout the universe, it seems, is permeated by magnetic lines of force as well as gravitational lines of force. Magnetism is one of the fundamental entities of nature and helps to give one an enlarged vision of this universe in which we live.

L. Begeman.