

widely scattered, but in no case prohibitively so; nor are they expensive. Topographic maps of various regions can be had at five cents apiece (in quantities, three cents) of the director of the U. S. Geologic Survey, Washington, D. C. The Coast Survey harbor charts run from twenty-five to fifty cents and can be purchased of the U. S. Coast and Geodetic Survey, Washington. Weather maps can be obtained daily from the nearest weather bureau station. Rainfall maps and continental relief are in the physical atlas; population, crop, and timber maps are in the commercial atlas. Many good maps of these data can be found in the atlas volume of the census reports.

DETERMINATION OF POLE STRENGTH OF MAGNETS AND THE EARTH'S HORIZONTAL COMPONENT.

BY H. W. HARMON,
Grove City College.

In the March, 1903, SCHOOL SCIENCE AND MATHEMATICS Professor H. D. Stearns gave an extremely clear and simple method of determining pole strengths, and the strength of the earth's field. With the apparatus shown in the cut we are finding the method a practical and surprisingly accurate one. The following is a brief description of the apparatus and theory of the method: A magnetized knitting needle m_1 m , is placed in a brass or tinfoil stirrup, supported by the silk fiber F and placed in the N-S groove, accurately balanced and centered, and the apparatus is then turned until the N-S meridian line is parallel to the needle, as it swings freely. If, now, the needle is lifted out and placed in the E-W groove with its N pole pointing west, the needle will be urged to return to its former position by the action of the earth's horizontal component (H) acting on both of its poles (m_1) with a combined force:

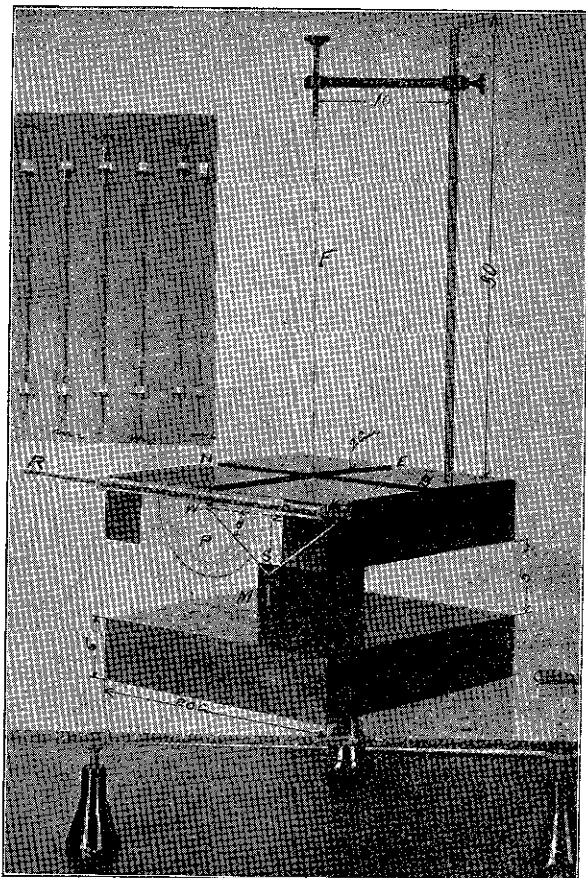
$$F = 2m_1 H \dots \dots \dots \text{No. 1}$$

To neutralize this tendency slip the looped end of the silk fiber (WSK) over the N pole of the magnet which projects through the opening in the center of the protractor and slide the rod (R) right or left until the horizontal component (WZ) of the 10 milligram weight (M) holds the magnet in equilibrium. This equals:

$$F = \frac{\frac{1}{2}M}{\tan \alpha} \dots \dots \dots \text{No. 2.}^1$$

¹M must be reduced to dynes.

where (a) is the angle of the fiber below the horizontal and is read off in degrees or natural tangents from the protractor. M is a 10 milligram weight hung from the middle point of the fiber.



If now the first needle (m_1, m_1) be replaced by another needle (m_2, m_2) as before in the (E-W) direction, its tendency to return will be different and equal to:

$$F_1 = 2m_2H \dots \dots \dots \text{No. 3}$$

If this tendency to return (N-S) be neutralized by placing the N pole of the first needle (m_1, m_1) with its axis east and west at a suitable distance (d) to the left of (W) and this distance measured, we will have:

$$F_1 = \frac{m_1 m_2}{d^2} \dots \dots \dots \text{No. 4}$$

by their equality in No. 3 and No. 4

$$\frac{m_1 m_2}{d^2} = 2m_2 H \text{ or}$$

m_2 canceling out

$$H = \frac{m_1}{2d^2} \dots\dots\dots \text{No. 5}$$

also by their equality in No. 1 and No. 2

$$2m_1 H = \frac{\frac{1}{2} M}{\tan \alpha} = F \text{ or}$$

$$H = \frac{F}{2m_1} \dots\dots\dots \text{No. 6}$$

Now by combining No. 5 and No. 6 and solving for m_1

$$m_1 = d\sqrt{F} \dots\dots\dots \text{No. 7}$$

H is now computed by the use of either No. 5 or No. 6.

We are using three different sizes of needles, large, medium, and fine; as shown in cut they are mounted on a cardboard holder to avoid mixing them.

Trial	Magnet Combina- tions	Angle		Restoring Force F	Polar Distance d	Pole Strength m	Earth's Horizontal Component		Error
		α	Tangent				Observed H	Correct H	
1	m_1 & m_2	35°	.7002	7.00 dynes	7.5 cm.	19.82	.1768 dynes	.184 Dynes	.0072
2	m_2 & m_1	33.5°	.6619	7.41 "	7.6	20.70	.1791 "	"	.0049
3	m_3 & m_4	48°	1.1106	4.41 "	5.85	12.27	.1795 "	"	.0045
4	m_4 & m_3	51°	1.2349	3.962 "	5.8	11.53	.1718 "	"	.0122
5	m_5 & m_6	66°	2.2460	2.262 "	4.0	6.02	.1880 "	"	.004
6	m_6 & m_5	65°	2.1445	2.283 "	4.05	6.12	.1866 "	"	.0026
7	m_1 & m_3	35°	.7002	7.00 "	7.7	20.3	.1723 "	"	.0147
8	m_3 & m_1	48°	1.1106	4.41 "	5.9	12.40	.1772 "	"	.0068
9	m_2 & m_5	33.5°	.6619	7.41 "	7.8	21.23	.1747 "	"	.0093
10	m_5 & m_2	66°	2.2460	2.262 "	3.95	5.935	.1882 "	"	.0042
AVERAGE =							.1798 "	"	.0031

By referring to the data table, the pole strengths of these vary from about 6 to 21 unit poles. With the three pairs of needles a large number of combinations for making different trials are possible.

Examination of the (H) and (m) columns in the data table will show the accuracy of the apparatus; pole strengths being determined to within $\frac{1}{2}$ unit pole and earth's field to within .01 of a dyne or about .01 milligram.

The experiment gives us a realizing sense of the value of a unit pole, and that the earth's field urging a compass needle into the (N-S) direction is less than one fifth of a dyne. From this latter we can infer that a compass needle must be mounted on a good point else this feeble force will not be able to overcome the friction on it.

This experiment is not beyond the good high school student taking physics, for he has the definitions of unit pole and unit field and from his knowledge of resolution of forces into components the diagramming of the triangle WZS to scale gives him the component WZ, which is equal to (F) ; or if they understand the meaning of tangent, the natural tangents can be read off directly from the protractor, or looked up.

The dimensions of the apparatus are given in the cut. The leveling screws may be omitted. The grooves, cut 2 cms. square, are for the purpose of avoiding air currents.

AN EXPERIMENT IN ORGANIZING A COURSE IN GENERAL SCIENCE.

BY E. D. HUNTINGTON.

An investigation of what science matter, is essential in the first year of the high school was made by the writer during 1910-1911. Theoretical investigation was paralleled by experimentation with a first year class in a rural high school, extending over a period of nearly six months. The results of these investigations are briefly summarized below. In addition, a further investigation was carried on as a special problem in connection with a class in the University of Chicago.

It being generally conceded that there should be some science course at this point, the vital question becomes what science or sciences should be selected. Botany, zoölogy, physical geography, physics, and of late agriculture, have all been tried, and usually have proved unsatisfactory. Among the reasons assigned for their failures, the following seem the most pertinent: The first two are too specialized and formal, and if presented successfully at this point must be largely handled in an extremely elementary and superficial way; the third has become the specialized and technical physiography, which precludes its most effective use in the first year of the high school; physics as a differentiated science is too technical for first year stu-