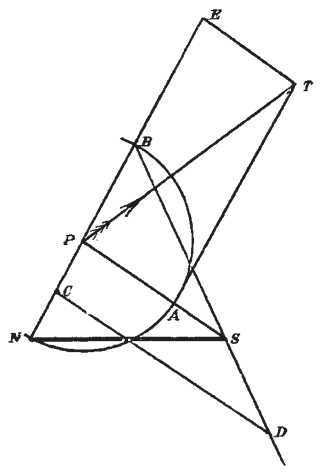
### Construction for the Direction of a Magnetic Line of Force.

IN Prof. Gray's review of Riecke's *Lehrbuch*, a construction for the direction of the line of force at any point, due to a short magnet, is given.

If the magnet be long, then the following construction holds:

Let N and S be the two ends of the magnet and P the point, nearer, say, to N than to S. Take A in PS and B in NP produced, so that PA = PB = PN. Take C in BN, so that BC measured towards N equals PS. Draw CD parallel to PS, D being in the line BS. Measure PE away from N, so that PE = CD. The diagonal PT of the parallelogram AE is the direction required.

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THE determination of the direction of the resultant force, at any point, due to a long, thin magnet, is of some importance as a laboratory exercise, and it is necessary to be able to compare the direction which a small needle takes up in its field with the theoretical direction. For such an exercise the bar should be a long, thin magnet as nearly uniformly magnetised as possible. For this case Mr. Vincent's construction gives the theoretical direction very neatly.

The direction may also be found by dividing the line NS externally, at a point R, say, in the triplicate ratio of NP to SP. The line joining R to P is the direction sought. This construction can be made with only a parallel ruler.

My friend Mr. G. B. Mathews has pointed out to me that this construction may be very conveniently used to draw the whole family of curves. For describe a circle through P dividing NS internally and externally in the ratio of NP to SP. The lines joining any point on this circle with N and S are in this ratio. Hence the direction of the force at each point of the circle is the line joining it with R. Thus, by a succession of circles and corresponding positions of R, the whole series of curves can be laid down.

The following method is perhaps not so good, but is also very easy to remember. A diagram is not necessary. Describe a circle touching the line NP at N, and cutting the line SP produced beyond P in the points H, K, of which H is the nearer to P. From P towards N lay off a distance PL equal to PH, and through L draw a circle touching SP at S and cutting PN, produced, if necessary, in M. The diagonal passing through P of the parallelogram described on PK, PM as adjacent sides is in the direction of the line of force at P.

When either of the angles SNP, NSP is very obtuse, the last construction should be carried out by drawing the circles so as to give equal segments PH, PL both lying on the side of P towards NS. Then a distance PK′ = PK can be laid off along SP produced, and the parallelogram described on PK′, PM as adjacent sides. There are probably a great many ways of solving this problem: I have hit upon three other distinct methods, which I will not take up space with describing here. I may mention also that I have given a simple method of laying down successive points on a line of force in my "Magnetism and Electricity," vol. i. p. 14, figs. 12 and 13.

The construction for the direction of the force due to a short magnet, described in my review of Prof. Riecke's book, was given by Hansteen ("Magnetismus der Erde," s. 208), and again by Gauss ("Vorschriften," &c., Werke Bd. 5, s. 435). It is to be found in Prof. Chrystal's article on "Magnetism" in the "Encyclopaedia Britannica," and in my treatise on "Absolute Measurements," vol. ii. A. GRAY.

## *THE CHEMISTRY OF THE STARS.*[1]

WHEN, on returning from India, I found that you had during my absence done me the honour of unanimously electing me your President, I began to cast about for a subject on which to address you. Curiously enough, shortly afterwards an official inquiry compelled me to make myself acquainted with the early doings of the Royal Commission of the Exhibition of 1851, on which I have lately been elected to serve, and in my reading I found a full account of the establishment of your Institute; of the laying of the foundation-stone by the late Prince Consort in 1855, and of his memorable speech on that occasion. Here, I thought, was my subject; and when I heard that the admirable work done by this and other local institutions had determined the inhabitants of this important city and neighbourhood to crown the edifice by the foundation of a University, I thought the matter settled.

This idea, however, was nipped in the bud by a letter which informed me that the hope had been expressed that I should refer to some branch of astronomical work. I yielded at once, and because I felt that I might thus be able to show cause why the making of knowledge should occupy a large place in your new University, and thus distinguish it from other Universities more or less decadent.

The importance of practical work, the educational value of the seeking after truth by experiment and observation on the part of even young students, are now generally recognised. That battle has been fought and won. But there is a tendency in the official direction of seats of learning to consider what is known to be useful, because it is used, in the first place. The fact that the unknown, that is the unstudied, is the mine from which all scientific knowledge with its million applications has been won is too often forgotten.

Bacon, who was the first to point out the importance of experiment in the physical sciences, and who predicted the applications to which I have referred, warns us that "lucifera experimenta non fructifera quaerenda"; and surely we should highly prize those results which enlarge the domain of human thought and help us to understand the mechanism of the wonderful universe in which our lot is cast, as well as those which add to the comfort and the convenience of our lives.

It would be also easy to show by many instances how researches, considered ideally useless at the time they were made, have been the origin of the most tremendous applications. One instance suffices. Faraday's trifling with wires and magnets has already landed us in one of the greatest revolutions which civilisation has witnessed; and where the triumphs of electrical science will stop, no man can say.

This is a case in which the useless has been rapidly sublimed into utility so far as our material wants are concerned.

I propose to bring to your notice another "useless" observation suggesting a line of inquiry which I believe sooner or later is destined profoundly to influence human thought along many lines.

Fraunhofer at the beginning of this century examined sunlight and starlight through a prism. He found that the light received from the sun differed from that of the stars. So useless did his work appear that we had to wait for half a century till any considerable advance was made. It was found at last that the strange "lines" seen and named by Fraunhofer were precious indications of the chemical substances present in worlds immeasurably remote. We had, after half a century's neglect, the foundation of solar and stellar chemistry, an advance in knowledge equalling any other in its importance.

[1] An inaugural address delivered at the Birmingham and Midland Institute on October 26, by Sir Norman Lockyer, K.C.B., F.R.S., President.