THE ESTIMATION OF CARBON DIOXIDE IN MINERALS AND ROCKS.

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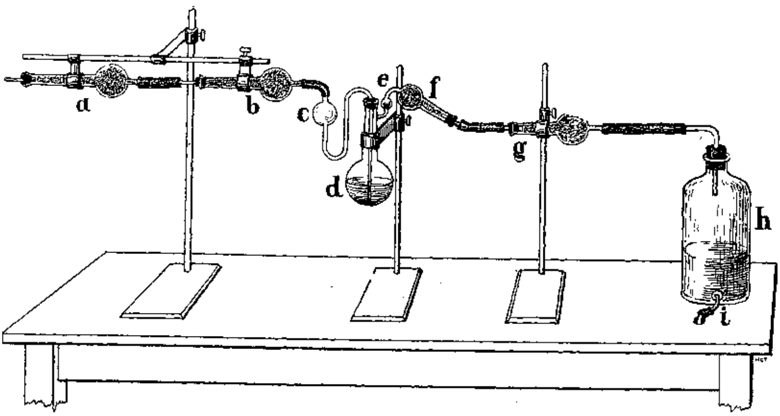
The Fresenius method for the estimation of carbon dioxide in a mineral or rock, the one usually described in the text-books, is somewhat complicated and difficult of manipulation. An undesirable feature is the long series of U-shaped tubes with rubber connections through which it is possible that the carbon dioxide may escape. Everyone who has made ultimate analyses by com-



bustion understands how constant a source of error the joints are and how carefully one must guard losses through the walls of rubber tubing.

A much simpler method was devised by Robert Bunsen, although for some reason it is not usually described in the text-book literature. The essential features are shown in the accompanying illustration. A gram of the finely powdered substance, so fine as not to feel gritty when placed between the teeth, is weighed into the flask *d*. The bulb *c* is nearly filled with a mixture of one part hydrochloric acid and three parts distilled water. The bulb *e* contains cotton which assists in condensing andabsorbing the vapor. Attached to the bulb is a small tube *f* filled with fused calcium chloride. The apparatus from *c* to *f* inclusive is carefully weighed. By means of rubber tube attached to the calcium chloride tube *f*, the dilute acid is started into the flask *d* by suction with the mouth. When all the liquid has passed over, the apparatus is held in the hand and gently warmed until the powder is dissolved or effervescence ceases. The apparatus is then connected with two freshly filled calcium chloride tubes *a* and *b* on one side, and a calcium chloride tube *g* and aspirator *h* on the other side, as shown in the figure. Air is drawn through the apparatus for about twenty minutes, while the flask *d* is immersed in a beaker of distilled water to cool it. The apparatus is carefully wiped with silk and weighed, the loss, of course, representing the amount of carbon dioxide. The apparatus is gently warmed again, and the air aspirated through as before while the flask is in the beaker of distilled water. A weight that is practically constant is readily attained.

It might seem that there would be a tendency to get too high a result on account of the escape of moisture and hydrogen chloride, but such is not the case, providing the rock substance has been sufficiently pulverized and the calcium chloride in tube *f* is of good quality and is changed sufficiently often to keep it in proper condition; besides, the acid becomes further diluted as soon as it begins to act on the powder, and at first the action takes place with very little heat. There is not much difficulty in securing a result that differs not more than one-tenth per cent from the theoretical; indeed, in the majority of determinations, exactly 44 per cent of carbon dioxide is obtained in Iceland spar, or within .02 to .03 per cent of that amount. In the specimen of argillaceous limestone which was the subject of the co-operative analysis, the experts at Washington obtained 30.59 per cent and 30.77 per cent of carbon dioxide respectively; while by the Bunsen method, one of our students obtained 30.76 per cent, before the analysis of the limestone was published in the February number of the *Journal of the American Chemical Society*. We ordinarily use from eight-tenths to a gram of the rock powder. When it is desirable to make a carbon dioxide determination in a sulphide like chalcopyrite or smaltite, it is necessary to prevent the escape of sulphuretted hydrogen as this would give a result too high. This is accomplished by the use of dilute sulphuric acid instead of hydrochloric acid. If there is still an odor of sulphuretted hydrogen, a small quantity of powdered copper sulphate, ferrous sulphate or potassium dichromate is introduced into the bulb with the powdered rock. The carbon dioxide can be easily determined by this means.

After many years of trial, the writer commends this method on account of its simplicity and accuracy; even the student with but little quantitative experience can use it with success. The ability to secure good results increases one's interest in quantitative work. The ordinary high school student who has access to a fairly good analytical balance would have no serious difficulty with this determination. In our laboratory we use this method in the analysis of Iceland spar, dolomite and siderite.

THE INDEX OF REFRACTION. (SNELL'S LAW.)

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In the March number of School Science and Mathematics, Dr. Millikan, in an interesting article on "Tendencies in Physics," gives a list of "bugbears" which beset the pathway of the physics teacher. As bugbear No. 12 he mentions the presentation of the *index* of *refraction* as a *ratio of sines* instead of a *ratio of velocities.* Such a change as he suggests has somewhat to commend it and perhaps ought to be adopted were the teacher limited to a choice between the two.

It must be remembered, however, that definitions and laws, like the one under consideration, have a history that is as truly a part of the science of Physics as are the finished expressions themselves. Sometimes the definitions, in their wording, suggest this history and are an epitome of it, so that on reading them the mind casts a bird's-eye view backward over the sometimes tortuous, but always interesting, historical progress of the subject.

It would surely be a loss to lightly throw aside the historical content of the definition or law merely to make room for a more recent or even more salient expression of the same truth. Will it not better be to frame a second definition which expresses the same truth from the new viewpoint, thereby leaving unmarred th old, and enriching it by the new?

The law in question is one of this class—it bears the name of one of the early workers in Physics, and is in its wording, an epitome of the knowledge of optics up to the time of its framing. To the lover of Physics its story gives the opportunity of engaging the interest of the pupil and of making the subject a living