make experiments. But in order to carry out this plan, the experiments to be made by him should be connected with the course of instruction and should be definitely related to the experiments given on the instructor's table. Indeed, the relation should be so close that a knowledge given by the instructor's experiments would be in large measure a guide to the performance of the student's experiments and that without it the successful performance of the practical work by the student would be beyond his power. This insures the closest attention and care on the part of the student to get the professor's instructions; it trains the mind to correct observation, concentration of energies and carefulness in drawing conclusions.

In the beginning of a course in general chemistry and for two or three months, one hour of laboratory work by the student to four hours of such instruction by the professor, as I have outlined, will be a good division of time. As the student's knowledge of the subject increases and his manual dexterity in handling apparatus improves, his working hours should increase. This mode of instruction proceeds on the rational assumption that the pupil needs to be instructed; it will furnish him the largest amount of reliable, systematic, classified knowledge that is attainable in a given time and give him the best foundation for extended scientific study.

Other special advantages of this mode of study will appear by comparison.

Many excellent chemists make laboratory experiments by the student the starting point and the centre of all instruction. Their idea seems to be to make the student do his own work, draw his own conclusions and thus instruct himself: the instructor, according to this method, gives him the fewest practicable hints and directions. In furtherance of this plan of instruction many "laboratory manuals" have been written which contain a great profusion of experiments: in many cases these are poorly arranged. In the preface to one of these "manuals," now open before me, I find these words: "The teacher should be but the guide that points out the right path, calling attention to the by-paths of error." This plainly implies that if only the direction be pointed out, the student can make the trip. This plan puts the student forward to work for unknown truth; it holds out to him the idea that in some sort he is an investigator, when in reality at first his work should be to learn what others have brought to light and how they have done it.

The objections to making the laboratory work of the student in the beginning the leading and independent method of learning chemistry are numerous and strong: 1. It involves an unnecessary consumption of time. 2. It assumes that the student can do properly what, in the very nature of the case, is well-nigh impossible. A certain amount of knowledge is necessary to the acquisition of other knowledge under the best conditions: there is hardly any fact more palpably true than this.

A student of algebra could hardly be expected to solve problems of any degree until he had the preliminary operations and rules that had been established by the patient work of strong, industrious minds. A traveller, ignorant of the topography and history of Rome, her archæology, her classic and Christian art, would not be profited by a visit to the famous city: he would stand unmoved before the ruins, the historic arches and temples and the treasures of her splendid galleries. A man sees what he has eyes to see. This principle applies in the study of chemistry. An untaught youth knows not what to expect, what to look for in an experiment; he sees things and knows not what is essential and important and what incidental and accessory. Many things he fails to see because he knows not what to look for and how to look. This brings him into a hesitating, doubting state of mind which is very unfavorable to definite, strong impressions. He does not know the significance of those actions which he observes, and he is unable to give them scientific interpretation and impression.

Chemistry is a great science, difficult to master: it has risen upon stepping stones of errors and obstacles by the continued efforts of great men. For centuries minds of able and laborious investigators reached out after the truth and battled against error. The advance from the unknown to the known has been very slow.

Glauber's "Sal Mirabile," Shahl's "Phlogiston" and various other propositions and hypotheses, strenuously advocated and rejected, tell us of the intensity of the struggle and how the mists of uncertainty hung over their work. But when Lavoisier availed himself of the labors of others, patiently compared facts with facts and generalized scientifically, he saw a new light, and the birth of modern chemistry was announced; chaos gave place to order; principles became harmonious.

In view of all this, is it not erroneous to require a student in the very outset to make and interpret experiments as the means of getting knowledge and to proceed with the most meagre knowledge to classify phenomena? Students at first should be put in possession of that knowledge which is their just inheritance from the history of the past and should have the opportunity of learning the methods of experimentation adopted by the builders of the science, and from this study of facts and principles and modes of manipulation to acquire the power of orderly thinking and get the key to higher and greater treasures.

When one wishes to enter upon research he carefully inquires what has been done already; he gets the bibliography, and learns the methods of investigation in that line that have been most fruitful of results: not uutil he has come to this point is he ready to enter upon the work which he proposes.

The object of work in the laboratory by the student in the beginning is to learn to use apparatus: his instruction must come mainly from the skillful teacher: the teacher is not merely "a guide" but a positive power in instruction, an intellectual quickener. The work of a student left to himself in the laboratory profits but little.

ORIGIN OF THE HYDROCARBONS.

BY MARCUS E. JONES, SALT LAKE CITY, UTAH.

A RECENT review of the paper of Dr. Engler on this subject in *Science* is an interesting one, as it is in the line with my own observations on that subject in Utah. The time-worn theory of the origin of our Utah hydrocarbons from coal has been repeated by several persons in *Science* during the past year, but unfortunately there is hardly a particle of evidence of such origin. I do not know of a single deposit near our coal beds in Utah, with perhaps the exception of one bed of impure asphalt, which seems to be close to the Dakota group, but may have come down from above, as it is not certainly interstratified with the Cretaceous beds. With this exception I do not know of any deposits of our hydrocarbons that are earlier than the Miocene Tertiary. There are some places where it is not possible to certainly tell whether some sandstones are Eocene or Miocene where asphalt has collected from adjacent beds of shale or clay. In using the word "near" it is used in a geological sense, i. e., stratigraphically near. There are some hydrocarbon beds which are within perhaps one-half a mile of the upper coal beds but separated from them by the whole thickness of the Eocene and considerable of the Cretaceous. Again these deposits are always in the immediate vicinity of large deposits of bituminous shales or clays quite full of fish bones and the like but showing few or no vegetable remains. That a distillate should have come up from the far underlying Cretaceous coal beds through fissures and have spread out in certain beds only of the Miocene, while exactly the same conditions as to permeability prevail throughout the upper Cretaceous and Eocene with no hydrocarbons, would of itself preclude the supposed origin even if there were great fissures through which the material could come. In addition, however, there are no fissures cutting the formations where the deposits occur; the beds lie almost and often quite horizontally and show no signs of disturbance for the most part. Here and there are little irregular seams very rarely more than a foot wide, though in one case four feet wide, into which the hydrodarbon has oozed from the surrounding clays and made a deposit of the pure article. Were these fissures, which are evidently only local and shallow, the source and not the receptacle of the hydrocarbons, then the surrounding shales and clays would be saturated most at the point of contact and less and less as the distance from them increased, but the fact of the case is they are if anything less saturated at the point of contact and fully as much impregnated miles away from any fissures. Wherever we find even a seam the thickness of a knife-edge in these beds we find hydrocarbons, and where they are absent we find no deposits of hydrocarbons at all. The only beds which show a thinning out of their contained asphalts are the sandstones, which are nowhere evenly impregnated but are full of asphalt only where there is a crack or fissure leading up or down to the bituminous beds in the immediate vicinity. There are also several places where crude asphalt has oozed out of the sandstones and formed from a thousand to a million tons of matter more or less pure, assaying from 11 per cent to 75 per cent crude asphalt; the larger deposits are still flowing slowly, perhaps a barrel a day or the like. This material when it first comes out carries a large percentage of the more volatile hydrocarbons and considerable of the paraffine series, while the fixed carbons are low. To my mind these have the same origin as the other deposits, the connection with the overlying bituminous beds being very extensive through the small seams in the sandstones and the means of exit being the gentle slope of the beds. That the asphalt is composite is due either to the quantity and its wide origin or to lack of facilities for the volatilization of the lighter elements. Another remarkable feature in our hydrocarbons is that no two deposits so far discovered in Utah are alike in their chemical composition excepting the asphalts just mentioned. The so-called ozokerite at Pleasant Valley Junction is black and somewhat flaky, containing an excess of fixed carbon for one of the paraffines. Some fifty miles south is a deposit a few inches wide, containing a paraffine as pure as beeswax and of the same color, approaching closely to the typical ozokerite. At a place near Pleasant Valley Junction there are quite a number of seams of the asphalt series and one place where it oozes very slowly out of a layer in the bituminous shales and forms little balls which at length break off and roll down the slope. These have about the appearance of pure Trinidad asphalt and go low in the paraffines and contain small percentages of the lighter hydrocarbons. In the same region are several seams of the pure asphalt, none of them workable, in which the matter is as pure as the Uintahite or Gilsonite of commerce and has a fracture varying in the various seams from cubical to conchoidal, according to quantity of contained paraffine. A few miles farther north, but in the same geological horizon, are the only known deposits of what has recently been called Wurtzellite, which is an asphalt with an excess of paraffine. Some 100 miles farther, but in the same horizon, are the great deposits of Uintahite or Gilsonite, which has become so well known as a varnish and insulator. In my judgment these variances in composition are due to local causes, affecting the matter as it has oozed out of the shales into the crevices which have received it, such as exposure to the air, oxidation, etc.

Though the theory of the animal origin of our hydrocarbons, which was long ago ably advocated by Professor Newberry, seems to be the only tenable one, it must not be taken as proved by any means, for I have never yet seen sufficient remains of animals to account for the quantity of our hydrocarbons, though there may be sufficient in the beds as a whole. A significant fact is that these beds contain multitudes of tracks of birds and mud cracks indicating their being nearly on a level with the water. It is possible that many of the bones have disappeared by decay; this is plausible, since I have never found the bones of any animal intact but always scattered, broken and tangled in wild confusion, and yet plentiful.

The above remaks apply to the hydrocarbons of which mention has been made in *Science* and other journals. They are not the only ones in Utah, however. At the base of the Cretaceous, or at least as low as the base of the Colorado of Emmons, are other hydrocarbons wholly different from those mentioned above, which are nearly identical with the petroleum of the east, containing more paraffine only. So far they are not known to be extensive. In one locality there seems to be natural gas, but with what pressure is not definitely known,

In Salt Lake Valley is quite an extensive local deposit of natural gas of Pliocene age giving a pressure of at least 200 pounds to the inch. Its composition does not vary materially from that of the east, though it seems to give more heat and less flame.

BIRDS SELDOM SEEN IN SOUTH CAROLINA.

BY PROF. J. C. HARTZELL, JR., B. S., M. A. O. U., ORANGEBURG, S. C.

FOR some time the writer has been endeavoring to make a list of those birds that are uncommon in South Carolina. The undertaking has proved a very arduous task. The following is a partial list as the result of the undertaking. A fuller list is not given on account of the unsatisfactory data of a few species observed. The majority of the species noted below are in the writer's possession:

Clangula hyemalis; A. O. U. 154. Bays and coast in fall and winter. Food, shell-fish. Nest in long grass. Eggs bluish-white.

Grus americana; A. O. U. 204. Salt marshes and swamps. Food, Indian corn and sometimes mice. Nest on the ground. Eggs pale blue, spotted with brown,

Bonasa umbellus; A. O. U. 300. Hills, northwestern part of state. Nest under fallen log. Eggs white.

Aquila chrysætos; A. O. U. 349. Food, mammals and birds. Mountains in northern part of state. Nest on ledge of rocks. Eggs whitish.

Archibuteo lagopus sancti-johannis; A. O. U. 347a. Open fields. Nest in tree. Eggs whitish and drab. Food, field-mice.

Strix partincola; A. O. U. 365. Marsh lands and meadows. Food, rodents. Nest in old building. Eggs whitish.