body, whereas among the summer herrings a large percentage have it behind the centre. In the immature fish, however, the fin-centre is generally anterior to the body-centre. The anal and pelvic fins show a corresponding difference in position. As regards the pelvic fin, however, this condition is limited to the adult and larger young herring, the pelvic fin being found, like that of the sprat, anterior to the dorsal fin in young herring below 60 millimetres in length. The pectoral fin varies very slightly in its relative position on the winter and summer herring. The relative basal length of both the dorsal and anal fins conveys no indication of racial distinction between the summer and winter fish. The dorsal fin is in all the herrings generally longer than the anal; only about 1½ per cent. of the summer herrings, and 7½ per cent. of the winter, having the anal fin longer than the dorsal. Further details are given respecting the number of fin-rays, keeled scales, circumstances of spawning, &c., but which scarcely affect the question of racial distinction. The inquiry, so far as it has gone, tends to prove that there is no racial distinction between the herrings found in the various localities around the Scottish coast. Judging, however, from the more backward position of the dorsal pelvic and anal fins, the doubtfully smaller head, and the slightly lesser size of the summer herrings, more minute inquiries may indicate a slight difference between the winter and summer herrings.

Mr. Brook reports on the herring-fishery of Loch Fyne and the adjacent districts during 1885, and under his "Ichthyological Notes" gives a short account of the rare fishes met with during the year.

Naturalists and fishermen alike have long felt the absence of accurate information as to the spawning period of fishes. In order to have a basis on which to found further investigations, Mr. Brook has prepared a provisional list of the spawning period of various food-fishes. This list brings out the great lack of accurate information on the subject, but gives an idea of the opinions as to the spawning periods held by fishermen and others around our coast. These opinions are in many cases conflicting, and in most cases they will require to be altered. Prof. McIntosh contributes an account of the work undertaken at St. Andrews since the last Report, including notes on the eggs and young of fishes studied during the past year. Recently considerable attention has been devoted by Mr. Wilson to the development of the common mussel, and an account of his investigations up to the present time will be found in the appendix. During the summer and early autumn several attempts were made to fertilise the eggs artificially at St. Andrews. The early stages of development were studied from ova obtained in this manner, while the free-swimming embryos were frequently obtained in pools amongst the mussel beds in the Eden and in other localities. In the Board's last Report it was mentioned that Prof. Greenfield had undertaken to investigate the lower organisms met with in some of our more important salmon-rivers. This investigation has been advanced a step, and numerous forms have been isolated and cultivated by the methods previously described.

Mr. Brook and Mr. Calderwood give the further results of examination of the food of these "useful" fishes, the herring, the cod, and the haddock. Mr. Calderwood also sends notes on the Copepods of Loch Fyne, and on the Greenland shark; Canon Norman reports on a Crangon, some Schizopoda, a member of the order Cumacea, new to, or rare in, the British seas; Dr. Stirling, on red and pale muscles in fishes, and on economic products from fish and corresponding vegetable products; Mr. Haliburton, on the blood of *Nephrops norwegicus*; Dr. John Gibson, on physical observations made for the Fishery Board in the Moray Firth during the autumn of 1883.

Ten plates accompany the appendix. It is greatly to be regretted that the Board has not yet been able to survey some of the fishing-banks, more especially those which are supposed to extend along the western shores of the Hebrides, and that the part of the Report dealing with scientific work is not published separately.

THE ELECTRIC CHARGE ON THE ATOM

ALTHOUGH considerable attention has been given of late to electrolysis and the subjects connected therewith by English chemists, more especially since the Helmholtz Faraday Lecture of 1881, yet some of Prof. Helmholtz's deductions from Faraday's experiments have been curiously neglected.

I refer more especially to the bearing of the facts on the true nature of valency, and I purpose in this paper to point out one or two fairly obvious consequences which follow from the results of Faraday's researches, but which have not, I believe, been stated before.

Prof. Helmholtz has shown that it follows from Faraday's experiments on electrolysis that while a monovalent atom carries to the electrode one charge of electricity a divalent atom carries two charges of electricity. For instance, when we electrolyse potassium chloride, we have each potassium atom delivering a charge of electricity at the one electrode, and each chlorine atom delivering an equal charge of electricity at the other electrode, all monovalent atoms, carrying with them an equal charge of electricity, which we may call the unit charge.

When, however, we electrolyse magnesium chloride, we have two atoms of chlorine set free for one of magnesium, and consequently while each chlorine atom carries its unit charge with it, the magnesium atom carries two units of electricity to the electrode. In fact electrolysis proves that differences of valency mean differences in the electrical charge on the atom. All this is so familiar to us now that I have perhaps repeated it at unnecessary length.

But we have many elements which vary in valency. For instance, copper is capable of forming two series of compounds, in one of which it is monovalent, and in the other divalent, that is, in one of which the copper atom carries one unit charge of electricity, and in the other carries two units of electricity.

We are able, then, under certain conditions to alter the electrical charge on an atom, increasing it by some simple multiple.

There are therefore a special group of chemical reactions, such as the oxidation of the cuprous salts, in which we have not merely combinations between two or more substances, or ordinary double decomposition, but in which, besides such changes, an additional electrical charge is given to, or removed from, an atom. I think it follows from this that all such reactions are of very special interest, and deserve careful study.

For instance, take the case of the saturation of an olefine by chlorine. We must look on this reaction from one of two points of view. Either on the addition of chlorine an additional charge is supplied to the carbon atom, in which case by-products of less saturation are probably formed; or the carbon atom is already fully charged, in which case the double bond is not merely a shorthand statement of a possible reaction, but expresses a physical fact.

There is also another point worthy of note in connection with this addition of electricity to the atom. If we take the case of the two copper chlorides—cuprous and cupric chloride—we find that their heat of formation per chlorine atom is not very different. Now it is well known that the heat of formation of a salt approximates to the heat of formation as calculated from the electromotive force developed when that salt is formed in a voltaic cell.

To put this in other words, we can obtain from the heat of formation of cuprous chloride, or of cupric chloride, an approximate calculation of the difference of electric potential between the copper atom and the chlorine atom in the two salts.

Now, as already stated, the heat of formation per chlorine atom is nearly the same; that is, the difference of potential between the copper and chlorine is nearly the same in both salts. What follows from this?

It follows that, in doubling the electric charge on the copper atom, the potential is not also doubled. This means, therefore, that the capacity for electricity of the atom is increased at the same time. This conclusion is not quite certain, as our information is still too scanty on the actual differences of potential in the case of these two salts; and, further, we do not know what fraction of it belongs to the chlorine atom; but, on the whole, the facts we have point to the above conclusion, and it is at any rate a subject well worthy of study to determine whether the capacity of the atom for electricity can vary or not.

Passing from this, I wish to point out another very obvious but nevertheless important deduction to be made from the facts of electrolysis.

We have recognised that the difference between monovalent and divalent copper consists in the doubling of the charge upon the atom. This again may be due to some profound change in the atom itself, but it is at any rate the obvious and marked distinction; we have copper in both cases, but double the electrical charge in one case over that in the other.

If we searched among the elements, could we find two series of salts more completely different in their nature and properties than the cuprous and cupric salts?

I venture to say that, if we did not know we could derive the same element from both, we should assume them to be derived from two different elements, and assign them very different places in Mendelejeff's table. Many other examples of the same thing will occur to everybody, namely, that alteration of the electrical charge on the atom is accompanied by profound alteration in the nature of its compounds, and is therefore probably the cause of this alteration.

Up to this point I think my deductions are fair and obvious deductions from the facts of electrolysis. I wish now to suggest a possibility, I can call it no more, which if true will considerably alter our views of the facts of chemistry. We have found the importance of alterations of electrical charge in altering the properties of an atom as shown in its compounds.

We already believe that variations in atomic weight are closely allied with the variations in the properties of the atom as shown in its compounds.

Are there, then, two things which condition the chemical properties of an atom, or is there only one?

Let us look again for an instant at the facts of electrolysis, and let us take the electrolysis of hydrochloric acid as our example.

At present we state the facts thus:—Every molecule of hydrochloric acid consists of one atom of chlorine and one atom of hydrogen, the chlorine atom weighing 35·5, the hydrogen atom weighing 1. On passing a current, each molecule is split into these two atoms, each atom carrying a unit charge of electricity.

Is it not just possible that we may some day state the facts thus:—A molecule of hydrochloric acid consists of one molecule of hydrogen weighing 1 combined with 35·5 molecules of chlorine each weighing 1. On electrolysis, the chlorine atoms are split from the hydrogen atom, the chlorine atoms each carrying unit charge of electricity, and the hydrogen atom carrying 35·5 charges of electricity.[1]

If this is the truth, then all the atoms of the elements are of the same weight, and probably are made of the same "stuff," and we have two, and only two, things which condition the properties of the atom—namely, its electrical charge and its electric potential, and Mendelejeff's table becomes a statement of the periodic relationship between these.

[1] No one need quibble about the 35·5.

In suggesting this vague possibility, I do not wish to obscure the first part of the paper, which consists, I believe, of perfectly legitimate deductions from the facts of electrolysis.

I have purposely avoided giving many examples, as I have been dealing with such familiar and common-place chemical reactions that plenty of examples will at once occur to every reader; and sufficient has, I think, been said to show at any rate the importance of experimental inquiry into this subject, and the probability of considerable modifications of our views of chemical facts in the near future.

The new way of looking on valency, which we owe to Prof. Helmholtz, may, as I have already pointed out, completely alter our conception of the nature of an unsaturated carbon compound, and of the process by which saturation takes place; and probably as investigation proceeds in this department it will become necessary to re-dissolve our chemical facts and crystallise them out in completely new mental concepts, while doubtless the ideas associated with the graphic formula pass away and leave not a wrack behind. A. P. LAURIE

MUSIC AND MATHEMATICS

YESTERDAY afternoon meeting at a friend's house a lady visitor to Oxford who was to sing that evening at one of the hebdomadal concerts in Balliol College, and the conversation happening to turn on the gifted mathematical lady Professor in the University of Stockholm, my thoughts shaped themselves, as I was walking home, into the following lines, which, if likely to interest any of your readers, I shall be happy to see appear in the world-wide-diffused columns of NATURE.

New College, November 15 J. J. SYLVESTER

SONNET

To a Young Lady about to sing at a Sunday Evening Concert in Balliol College

Fair maid! whose voice calls Music from the skies
Weaving amidst pale glimpses of the moon
Tones with fresh hues of glowing fancy strewn
And soft as dew that falls from pitying eyes–
Let from their virgin fount those accents rise
That bid sad Philomel suspend her tune,
Thinking the lark doth chant his lay too soon–
Whose else that trill which with her own note vies!
To her whose star shines bright o'er Maelar lake
And thee who beautifi'st glad Isis' shore
Grant! I one joint harmonious garland bind:
Thou canst with sounds our senses captive take–
She the true Muse, fond poets feigned of yore,
Strike Heaven's own lyre, Nature's o'erruling mind.

NOTES

MR. HAROLD B. DIXON has been appointed Professor of Chemistry and Director of the Chemical Laboratories at Owens College, Manchester.

THE *Oxford Magazine* announces that Prof. Burdon Sanderson and Mr. Gotch are going to spend their Christmas vacation at Arcachon, where there is awaiting them a large tank full of torpedoes. It looks forward with interest to the publication of the results of the Oxford physiologists' holiday, remarking that "to the research will be added the pleasing excitement of danger; for if incautiously handled these torpedoes will give the physiologist a shock, compared with which the agonies of scores of vivisected rabbits are as nothing." Of course this is not true.