They must all feel that they would not have wished him to be other than he was. But if the question must be discussed, it would have to be admitted that by such a training he would have been placed in more thorough rapport with his scientific contemporaries; but mathematical training and mathematical capacity were different things, and it did not follow that Faraday had not a mathematical mind. In Professor Clerk Maxwell's opinion, Faraday had mathematical powers of a very high order, from which, if he had devoted himself to that science, valuable and fertile methods might by him have been discovered.

Sir W. Thomson, in moving a vote of thanks to Lord Rayleigh for his address, said that the Royal Institution was, during the last part of Faraday's life, and during the whole of his scientific career, his home. The splendid results of Faraday's labors contributed in no small degree to the scientific glory of the nineteenth century, and helped to make it one of the most prolific periods in the world's history. Faraday was throughout animated solely by the love of knowledge. He freely gave his discoveries to mankind and left it to others to turn them to practical and profitable account. Faraday pursued science pure and simple, for the sake of increasing natural knowledge. When Mr. Wyld showed him the first great machine for transforming mechanical power into electrical energy, Faraday remarked, "I gave the discovery to you a baby. You bring it back to me a giant."

VELOCITIES OF THE IONS.

By Mr. W. C. D. WHETHAM, B.A.

In studying electrolysis, the question as to whether there is any transference of solvent when a porous wall is absent presented itself to the author. The ordinary methods of testing for transference, such as by increase of pressure or by overflow, not being available when there was no diaphragm, the author used different colored solutions of the same salt, such as cobalt chloride in water and in alcohol, the former of which is red and the latter blue. By putting the solutions into a kind of U-shaped tube, any change in the position of the line of junction of the two liquids could be measured. Two aqueous solutions in which the anion was the same were also tried, one combination being cupric chloride and common salt, and in this case the line of demarcation traversed about seven inches in three hours. The results hitherto obtained by this method agreed fairly with those found by Kohlrausch.

COMPRESSIBILITY OF LIQUIDS.

By Mr. S. SKINNER, M.A.

THE apparatus consisted of a large spherical flask with a long narrow neck containing the liquid to be experimented upon, the lower part of which was in communication through a stop cock and flexible tube with an adjustable reservoir. By raising or lowering the latter, the flask could be easily filled or emptied, or the quantity of liquid adjusted. The flask was inclosed in a bell jar whose interior was in communication with a pump and barometer gauge. So sensitive was the arrangement that the compression of water produced by blowing into the jar caused the liquid to descend about one centimeter in the neck of the flask. This movement corresponded with a change of volume of about half a millionth. The coefficient of compressibility had been tested at different temperatures, and the results were not very different to those obtained by Tait and others. The influence of salts in solution in changing the compressibility had also been tested, and a great difference in this respect found between electrolytes and non-electrolytes.

AN ELECTROLYTIC PROCESS FOR SILVER AND COPPER ORES.

WHEREVER fuel is dear it is certain that the new electrolytic processes for the extraction of metals from their ores will attract considerable attention. In Spain and Chili, for instance, where much copper ore is to be found, most kinds of fuel are far from being cheap, and in such countries the electrolytic processes might well be taken up with advantage.

A recent issue of *Dingler's Polytechnisches Journal* contains a paper on the Höpfner process of extracting silver and copper from their respective ores by means of electrolysis.

Höpfner uses a bath which is separated into compartments by means of diaphragms; generally there are two such compartments, and in one are placed electrolytically insoluble anodes and in the other copper cathodes.

A double salt of cuprous chloride and a halogen salt circulates round the anodes, and a similar solution round the cathodes. On the copper spongy copper is deposited at a rate of 2.38 grammes per ampere hour, and this is double the quantity of metal deposited when a cupric salt is made use of.

If cuprous chloride were not present, then at the anode some free chlorine gas would form, and it would be necessary to have available an electromotive force of 1.8 volt. But in this arrangement the liberated chlorine at once unites with the cuprous chloride, converting it into cupric chloride, equivalent to 1 volt. Hence electrolysis can take place with an electromotive force of 0.8 volt, thus—

$$E.M.F. = 1.8 - 1.0 = 0.8.$$

Theoretically, the electrolysis commences with the consumption of 0.13 volt. This can be deduced by determining the heat of formation of cuprous and cupric chlorides.

As the liquid flows past the cathode it gradually parts with its copper, and is available for use again; but the copper is, of course, now present as cupric chloride instead of cuprous chloride, and the latter is made to leave the bath in a continuous stream. This solution is employed in an industrial way for extracting the metal from powdered copper and silver ores, special "leaching" vessels being employed.

If the ores are sulphides, then the following reaction takes place, viz.:

The solution of the cuprous chloride is regenerated,

but it is twice as strong now as before, and so it is necessary to dilute it in order to bring it back to its normal condition of concentration; this is effected by mixing it with the waste liquors that come away from the cathodes.

The process, as will readily be seen, may be worked continuously, for the regenerated solution can be used over again as before.

This process would work admirably were it not for the influence of certain natural drawbacks. Sometimes there is present in the ores small quantities—perhaps only traces—of such substances as iron, arsenic, bismuth, antimony, etc., and these will pass into solution instead of the copper. The presence of iron is especially objectionable, since it very sensibly retards the solvent action of the copper salt upon the ore that is being treated.

These adventitious impurities must not be allowed to deposit along with the copper. Fortunately, however, it is by no means difficult to eliminate them, for they can be precipitated by means of copper oxide, and so easily separated off.

In working with silver and copper ores, the former metal, if it be present, is first deposited, and the resulting copper is obtained in a chemically pure condition.

The advantages which are claimed to pertain to the use of Höpfner's process are the following:

1. By electrolyzing cuprous chloride solution, the amount of copper deposited is twice as much as that which would be thrown down from a solution of sulphate of copper when the same intensity of current is employed.

2. Solutions free from iron can be made use of because the alkaline and alkaline earth chlorides possess a great solvent action upon cuprous chloride. In this respect also this process is superior to the copper sulphate process.

3. The most impure ores may be used, yet pure copper may be obtained, and from silver-bearing ores the silver may be deposited at the same time.

4. Forty-four kilogrammes of copper may be obtained by this method in twenty-four hours with an expenditure of one horse power.

5. When reckoning the work of the pumps and the mechanical agitation of the liquor at one quarter, and the electro-dynamic power at three quarters, of the total work necessary to do the operation, then with an expenditure of 30 kilogrammes of coal, 33 kilogrammes of copper may be obtained.

An examination of the figures just quoted will show that the results obtained by the Höpfner process of electrolyzing ores are higher than any which have hitherto been reached—so high, indeed, that the poorest ores may be profitably worked.—*Electrical Review*.

INTERNATIONAL BICYCLE RACE FROM BORDEAUX TO PARIS.

ON the morrow of the international race from Bordeaux to Paris, concerning which the special journals and the daily press have furnished the public with the completest details, it is not without interest to reconsider an occurrence so important in the sport of bicycling.

Retracing in broad lines the various phases of the contest in which our English competitors so splendidly triumphed, we shall point out how, in a not far distant future, this momentary defeat of our fellow countrymen may give way to brilliant victories.

In the first place, let us in a few lines recapitulate the principal incidents of the race, in devoting ourselves more particularly to those from which we wish to draw a lesson. The start from Bordeaux took place on May 23, at 5 o'clock in the morning. Our large engraving (Fig. 3), made from an instantaneous photograph, shows us the grouping of the racers. Twenty-seven cyclists, placed in five rows, signed their road book. The following is an exact list, to which we add a twenty-eighth cyclist, Mr. Exben, who left Bordeaux seven minutes after the others: J. Renault (Paris), H. Gillot (Paris), Jiel-Laval (Bordeaux), P. G. Mills (England), P. Roussel (Bordeaux), H. Tart (Orleans), Mr. Peres (Bordeaux), M. A. Holbein (England), S. F. Edge (England), P. C. Twentymen (England), Mr. Guillet (Blain), Mr. Exben (Bordeaux), A. Duphon (Bordeaux), G. Juzan (Bordeaux), H. Ulrich (Sevres), L. Gebleux (Sevres), Mr. Bates (England), A. Desse (Royan), H. Jules (Paris), Mr. Coulibœuf (Vendome), Mr. Corre (Plestin-les-Greves), E. Pierre (Nancy), Mr. Bailly (Saint Amand), L. Masi (Switzerland), Mr. Issot (Royan), Mr. Huzelstein (Pamiers), J. Jouve (Bordeaux), Mr. Eyquem (Bordeaux). All of these racers were bicyclists, save one, Mr. Roussel, of Bordeaux, their dean, aged fifty-six, who rode a tricycle.

The five Englishmen took the lead from the start, so

FIG. 2.—MAP OF THE ROUTE, GIVING MILLS' HOURS OF PASSING THE DIFFERENT LOCALITIES.

as to leave their competitors immediately behind them. The hours of passage were verified at various points of the route, the cyclists having to dismount in order to sign a register prepared for the purpose. They took advantage of this to refresh themselves in haste, and then started off again for the following registering station.

In the accompanying map (Fig. 2) our readers may very clearly see the principal points of the itinerary, with the hours of passage of Mr. Mills, the first to reach Paris. The details of the hours of passage of the various competitors would lead us too far; it is the incidents of the route that we wish to note here, in accompanying them with some reflections that they have suggested to us. The first of these occurred at the 17th mile, at Libourne. One of the best cyclists,

Mr. Masi, of Switzerland, got a fall through the fault of a dog, and had his left arm badly bruised. Beyond Libourne, another dog crossed the road in front of the French cyclist Jiel-Laval, who, in endeavoring to steer clear of him, collided with Mr. Mills, whom he overthrew. Mills had his wrist and side skinned and his bicycle bent, but was still able, on his damaged machine, to make 12 miles, at the end of which a trainer furnished him with one that was in a good state. I have noted these two accidents, which were due to dogs, and which, seeing the speed of the cyclists, might have turned to tragedy, in order to point out the difference that exists in this respect between English and French dogs. In our country, horses and dogs are not yet sufficiently used to seeing bicycles, and many horses take fright at the sight of the rolling machine.

FIG. 1.—MR. MILLS, THE VICTOR IN THE BORDEAUX-PARIS BICYCLE RACE.

The duty of the cyclist in such a case is to dismount and wait until the animal has passed on or been quieted. As for dogs, a large number of them rush in front of the machine and bark at it, just as they do in the case of carriages; but they have no suspicion of the difference in speed between the two kinds of vehicle. The bicycle passes over their body and is upset and the rider gets a fall that is often very serious, while the dog gets off very lightly, especially if he is of a strong build. Contrary to what occurs with carriages, it is the one run over that receives the least harm; as for the rider, he may be killed instantly. So the French dog is the terror of cyclists, who are further fortunate when it is not the owner of the animal that excites the latter against them, as this has been too often done. "Le chien, viola l'ennemi," exclaims our confrere of the *Velee-Sport*. "French dogs are devils!" writes Mr. Duncan, a cyclist correspondent, to an English journal. We are told by this writer that in England a complaint would be at once lodged against a dog that jumped upon a cyclist, and its owner would be compelled to pay a heavy fine. In France, the cyclist, in this respect, does not receive all the protection to which he is entitled, and complaints, save in cases of very serious accidents, are rarely listened to. So the discouraged cyclist contents himself with suspending a horsewhip near his hand, the protection offered by which is very often but illusory.

The machines employed were, for the most part, of the type intermediate between the light racing machine and the road machine, which is lighter, but not so strong. It was found with patriotic satisfaction that those that came from French houses were capable of contesting advantageously with the machines put forth by English manufacturers. We must state that the pneumatic rubber tires, which seemed as if they were to revolutionize the construction of the bicycle and tricycle, have not performed what they apparently promised. They prevent jolting, and permit of using light wheels, while at the same time presenting a wide rolling surface on the ground; but, excellent as they are

upon a well leveled track, they are difficult to use upon roads. The Bordeaux-Paris race showed that it is necessary to improve them greatly in order to render them practical. In fact, most of them split on the way, and put the machines with which they were provided out of use. Our skillful manufacturers will evidently set themselves to work to give us something stronger. They will also have to seek a means of preventing lateral sliding, either through stræ or otherwise. The best of our cyclists, Mr. Jiel-Laval, fell, in fact, at the start, in consequence of a sliding upon viscous earth. As well known, the race was made in very bad weather, and over roads softened by rain.

Let us now return to the race and follow the group of English cyclists, who reached Angoulême in the following order, Mills, Holbein, Edge, Bates, at thirty.