

THE LIFE OF FARADAY.

A LECTURE

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THERE are great men who are proud of their descent from a noble ancestry ; there are other great men who are proud of their ascent from an unknown parentage, and take pleasure in talking of how they have become the architects of their own fortunes, and how their present position has been achieved by their own strength of arm or strength of will. If Faraday had been proud of his origin it must have been in the latter sense, for he was the son of a journeyman blacksmith, who worked in London towards the close of the last century. He was one of a very numerous family, and was born on September 22, 1791. Yet no man is, or can be, independent of his parentage, and Michael Faraday was no exception. His father, I have said, was a blacksmith ; but I have, within this last week or two, learned that he was a very clever workman, and long after his death, if his fellow-workmen came upon a piece of iron that was particularly well shaped from the fire, and required little or no dressing with the file, they said it was "Faraday's work." Again, his father was a very industrious man, although he was afflicted with bad health, which brought him to a premature grave. As for his mother, she was a grand woman, they all say, and she was "particularly neat and nice in her household arrangements." We shall see presently that this clever manipulation of the father, and this neatness and orderliness of the mother, were reproduced to an extraordinary degree in the son. And, in other respects, theirs was no common household. For two or three generations, at least, the Faradays

had been an industrious, moral, religious family. They belonged to a peculiar sect of Christians termed the Sandemanians, a sect little known, and with little to distinguish them from many others; but they have kept very much to themselves, and do so still, and this, continued for more than a century, causes in that community a certain separation from what is common or worldly round about them, and produces a peculiar kind of refinement and home affection. It was, therefore, in this atmosphere of poverty, but, at the same time, in an atmosphere of high moral worth, that Michael Faraday was brought up. And he often looked back upon the days of his childhood, and seems to have had no common affection for his home. This often peeped out in after days. For instance, when Noble, the sculptor, was finishing that bust [here the lecturer pointed to a large photograph of the bust of Faraday by Noble], he happened to rattle his chisels together, and, noticing that his sitter had become vacant in look, he said, "I am afraid that the noise disturbs you, or that you are weary." "No, my dear Mr. Noble," said Faraday, and he put his hand upon the sculptor's shoulder—"no, but the jingling of your tools took me back to my father's anvil, and I was among old scenes."

We must, therefore, imagine him as a boy brought up in this industrious home, where, although there was no doubt a severe struggle for the means of life, owing to the increasing number of children and the ill-health of the head of the house, yet, though poverty came in at the door, love did not fly out of the window. We must imagine him to be receiving just the smallest amount of education, first of all at a dame school, and afterwards at something rather better than that. But the instruction which he received at that time was simply the foundation of that education which was growing in all his after life; for, as you and I know, what we learn at school is but a very small part of that which we learn altogether, if we are thinking men. And so it was with Faraday; for as we trace his life we shall find that he constantly went on improving his mind from all the circumstances that were round about him.

We know little of his childhood, but some stories that we have show that he was even at that time something of an experimenter and inquirer. I will give you two of the only stories I know. One is this. He was at his father's workshop, in the upper storey, where there was a large open space just over the anvil or forge; and little Faraday was there amusing himself with pitching halfpence into a pint pot, and when he found he could succeed very well at a certain distance he began to try his ability

at a greater distance, and, stepping backwards, he fell down this hole and nearly killed himself; but, fortunately, he fell upon his father's back, which saved him. Here, then, we find the young philosopher at work trying experiments, as he experimented all his life long; and not content with his first successes, he must try if he could not improve upon them.

Here is another story. He was carrying out some papers to a house, and while waiting at the door to be answered by the servant, he put his head through the iron railings. And then he began to debate within himself this difficult problem—which side of the railings he was on. That was rather a metaphysical inquiry, but it shows the thinking boy at any rate, though like many such questions it was never resolved, because the servant opened the door and he pulled himself back in a hurry, and hurt himself so that he remembered it in after days.

Well, so he went on till he was thirteen years of age, and then he must do something for his living. He went first of all as an errand boy to a book shop; and he behaved with such industry, perseverance, and propriety there for twelve months, that when he was fourteen, his master, Mr. Riebau, took him as an apprentice without a premium, and he remained at this book shop for seven years. During that time he learned the art of bookbinding. During the latter part of his apprenticeship also he was frequently reading the books which came into his hands; and at the same time he took opportunities to hear lectures. Penny lectures there were not I think in those days, but he got his elder brother, Robert, to give him shillings, so that he went to hear some lectures on science at a shilling, and he wrote them out afterwards. I have looked over the notes which he took of these lectures in those very early days; they are very interesting, and are now among the treasures of the Royal Institution in London. He learned, too, to draw from a French artist of eminence, who happened to be lodging at his master's house. He got acquainted with a good number of young men of like tastes with himself, and they carried on a mutual improvement society, which afterwards was called the City Philosophical Society, and developed in various ways, until it formed to a certain extent the nucleus of the present Society of Arts. But the young man's mind was set upon a more scientific employment than that of selling or of binding books. At that time Sir Humphrey Davy was a man of great eminence in the scientific world; his discoveries resounded throughout Europe, and his lectures were the resort of the most fashionable audiences. Young Faraday was entranced with the

fame of Davy ; and having read a good deal that Davy had written, he got the opportunity of hearing the last four lectures which that philosopher ever delivered at the Royal Institution in London. He wrote these lectures out very carefully, making little drawings of the apparatus ; and circumstances led him some months afterwards to send this book to Davy, with a letter explaining his desire for some scientific employment. This was well received by the great philosopher of Albemarle Street, and eventually Davy employed the young aspirant as his assistant in the laboratory, at 25s. a week, with two rooms at the top of the house. This was on the 1st March, 1813. Here the young Michael Faraday found himself in a congenial occupation. His work was hard, no doubt, and among explosions and noxious gases he ran some risk probably in Davy's laboratory ; but still he worked on with an honest intention and with a cheerful heart, solacing himself occasionally with a song, or with playing upon his flute, and found very little time to write to some of his old friends, with whom he had corresponded largely before. But shortly afterwards there was an event which did very much for Faraday's education—that was his going on the continent. 1813, as you may remember, was a time of much political disturbance in Europe ; but the philosopher Davy, with his wife, and young Faraday as his secretary, travelled about in various places, and visited the most eminent men of science upon the continent. Faraday's mind was, of course, enlarged greatly during this process. In those days, you know, postal communication was rather difficult, especially when there was war in various parts of Europe. Here is a letter which Faraday wrote at that time from Rome. It cost 3s. 10d., I see by the postmark. It is dated "Rome, Dec. 21, 1814," but was mostly written the day before Christmas Day. It is addressed to his eldest sister, and is full of all kinds of familiar chit-chat, and inquiries about the babies—there had been a fresh baby in the establishment. There is also an allusion to his eldest brother having got engaged to be married, and various other little matters of a private character, with descriptions of his first impressions of Rome, and the Carnival that was to be, and so on, along with occasionally a warm-hearted expression such as this—just before Christmas Day : "Hail to the season ! may it bring every blessing down upon you. May it fill your hearts with gladness and your minds with contentment. May it come smiling as the morn which ushers in the glorious light of a summer's day ; and may it never return to see you in sorrow or trouble.

My heart expands to the idea that Christmas is come, for I know that my friends, in the midst of their pleasures, will think of me," &c.

He came back to England, and was engaged again in the laboratory of the Royal Institution, where he worked and eventually lectured, for gradually the assistant became the lecturer. Professor Brande was the Professor of Chemistry at that time, and a very good lecturer he was, but Faraday occasionally took his place. I was talking lately with a lady who in those days was a girl, and she told me that she remembered being taken along with her sister to hear the lectures of Brande; and when they went into the room she said they were rather apt to inquire whether Brande or Faraday was to lecture that day, because they decidedly preferred the lively young assistant to the staid Professor. In this industrious, intelligent way, he went on for some years making inquiries of nature, and constantly ascertaining fresh and fresh facts—of which more hereafter,—and then came some changes in his life.

We arrive at the period of 1821, when Faraday's position was rather improved at the Royal Institution. He was acquainted with a goldsmith in Paternoster Row who had some daughters, and his visits to that house became more and more frequent; at last he wrote a beautiful letter, that has been preserved, to one of these daughters, asking her if she could not be more than a friend to him, but hoping that at any rate he might retain the friendship which he had, saying that she had corrected him of some bad habits, and he hoped she would correct him of more, and so on. The lady hesitated, and went to Margate; but he followed her there; and then they went together to Dover and to Shakespere's Cliff, and he returned a supremely happy man. Shortly afterwards they were married, and thus commenced one of the most beautiful domestic lives of which we have a record. They lived together united in an affection which we have heard described by one of her relations as romantic. They never had any children; but Faraday was very fond of children, and he generally had some of his nieces staying with him; in fact, three of them were in a great measure brought up by him. There was another important event also which occurred in the same year. His parents being Christian people, there are indications even in his early letters that his mind was directed sometimes to religious things. We have evidence that he thought seriously over these matters about this time, and he publicly professed his faith in Christ by joining the church of his fathers shortly after his marriage. And he was

constantly attached to it, joining most regularly in its services, and afterwards becoming one of its elders and preachers. This quiet life continued long—he living at the Royal Institution, working in the laboratory, making fresh discoveries, and frequently giving lectures.

We may pass over another ten years, and come to 1831. There was now the great question before him—what was to be the object of his life? At that time he was making a very considerable income by commercial or analytical chemistry, and he was much sought after in various directions. The question came—to what should he devote himself? Just then he was making some of his most important discoveries respecting the connection between magnetism and other forms of electricity. At last he determined that his life should be devoted to these matters of research, and that he would be an experimental inquirer into scientific truth, and a revealer of that truth to others. For this purpose he gave up the pursuit of wealth. His receipts for commercial analyses had latterly been about £1,000 a year; they dropped down to little more than £100 in that year, and afterwards he scarcely made anything at all in that way. He gave up also the pursuit of position and renown in society. But we cannot say that money and honour gave him up. Although he did not pursue wealth, still we must not suppose, as has frequently been said, that he was a poor man, for there were several appointments which he held, and which brought him in always a fair income, and the Government gave him £300 a year. Then as to honours, all sorts of scientific honours were showered down upon him by nearly all the learned societies in Europe; but he did not care for those that brought with them serious obligations, and he declined some of the highest that he was capable of receiving; for instance, the Presidentship of the Royal Society; and when once he was sounded as to whether a knighthood would be acceptable to him, he declined the proffered honour, saying that he must “remain plain Michael Faraday to the last.” For the pursuit of this one great purpose in life—that of an experimental inquirer into truth, he gave up therefore a great deal that men esteem most precious in life. He also did not intermix himself with many things which we cannot but suppose he was interested in, such as the great social questions of the day. It is probably difficult for us to understand why Faraday, with his large and loving sympathy with men, did not engage more, or rather did not engage at all, in any of the philanthropic movements of the time. Every man must of course be judged according to his own conscience in this respect; but one could almost have wished that

he had not so exclusively kept himself apart, but that he had given some of his time, or at any rate the strength of his name, to some of these movements for the improvement of the condition of his fellow men. However, he kept himself to his laboratory, his home, and his church.

Faraday had indeed a passion for experimenting. Without going so far back as to refer again to his childhood, we might speak of the simple experiments he made at the end of his friend Abbott's kitchen table before ever he was employed by Davy. Faraday's first original research was published in 1816; it was merely an analysis of some caustic lime; but that was the first of an extensive and beautiful series of investigations, so numerous that the Royal Society's catalogue contains the titles of 158 papers. A good experiment seems to have filled him with the most intense pleasure; but he always liked to have his own fingers in the experiment. That manipulative skill to which I have referred was manifest throughout all his life, and the order and neatness of all his arrangements were remarkable. If you had gone to see him in his laboratory, you would have found him wearing a large apron, with just the apparatus he wanted, and no more, arranged before him on the table, and this apparatus generally of the simplest kind that would serve his purpose; and then he would begin with those wonderful broad-ended fingers of his, twisting about wires, blowing glass, or working skilfully with corks and cards, and other things, to produce the contrivances that he wanted, and all the time balancing himself on one foot and then on the other, and swinging himself from side to side while he observed what took place; and then if nature gave him an affirmative reply to his questions, his face would brighten with pleasure; but if there came a negative reply, still that was information. Sometimes there would be a doubt as to what the nature of the result actually was, and then he would modify his experiment, so as to arrive at the truth. Everything must be neat and orderly; every bottle must have its stopper in, and every basin or glass, if put away, must have a nice paper cover put upon it; and there must be no dust or dirt about that could possibly be avoided. In this way he was constantly working; and no small part of his time was passed in inventing and perfecting his apparatus. He started generally with very simple things. I will show you a little of his apparatus. Here is a box which Faraday took about with him in his lighthouse expeditions, and which was kindly lent me for these lectures by the Trinity House of London. I will take out of that box this little one. Sir Frederick Arrow, the deputy master of the

Trinity House, told me a story about this small box, relating to a period of Faraday's life when he went round our coast to make observations and comparisons of the different lighthouses. The persons composing the expedition took all the photometers they had for the purposes of observation. Producing this little card box, Faraday said, humorously, "I must take particular care of this, because it contains my special photometer;" and when they were all prepared for making their experiments he produced his special photometer—and there it is. You see that it is merely a little shawl-pin with a black bead of glass at the head; and an admirable photometer it is, because, instead of attempting to compare the different lights by looking at them separately, you have only to get them reflected upon that bead, and you are at once able to compare the brilliancy of the lights. Here, then, is Faraday's "special photometer." But he did not stop with the first idea. Here is a whole heap of curious contrivances of the kind; little silvered glass beads stuck upon corks, stands upon which they were to be placed, made of wood and steadied with lead. These things are all, I believe, intended for improvements upon the original shawl-pin. The wooden box which contains the whole was originally, you see, a cigar-box, and one of the card boxes inside, now filled with glass apparatus, bears still the label "Improved Seidlitz Powders." Here are some of Faraday's standard candles; and here is his candlestick in three different stages of development. There is first the simplest idea of a candlestick—only a round flat piece of lead; you see you can stick the candle upon it, and there it is. Only that is a little awkward to carry. The next form is this; it is much the same, only it has a little handle which you can catch hold of—that is more advanced. But *the* candlestick is this, and it is, I believe, of his own making—a piece of solder poured out upon a plate, in somewhat the shape of a pear. You can stand the candle upon that, and I believe if you heat it the candle will stick very well. It is turned up at one end so as to form a thumb rest; and what better candlestick can you possibly have than that? At any rate, that was the candlestick which was made and used by the greatest philosopher of the day. These things are of the more interest to me because I was associated with him at one time in these examinations of lighthouses, for I happened to be appointed a member of the Royal Commission which reported upon our lighthouse system, and as Faraday was scientific adviser to the Trinity House, we worked together upon this matter. This is one of Faraday's drawings of a lighthouse flame. There is the wick, and here is

the flame rising from it. I have not time to enter into a description of the beautiful optical apparatus which is put round the lighthouse lamp. We generally found the lamp and the lenses and prisms badly adjusted; or rather there was no proper means of adjustment. But we devised a means, and brought it under the attention of Faraday, and Faraday elaborated it, and contrived a little apparatus, of which he made this drawing for the instrument-maker. You will see by that how well he could draw out a plan for a piece of apparatus, for the instrument-maker, Mr. Ladd, had no occasion to vary from the drawing, excepting in some minute proportions. At the same time he supplied a model of the apparatus made from a cork, cut into the proper shape, with two lucifer matches stuck through it. I cannot enter into a full description of the whole matter, but I just show you the apparatus because I want you to see the simple way in which he worked out his ideas and planned his apparatus, making drawings and rough models for the instrument-maker to work from. That apparatus, I believe, has been used for examining the lights all round the coasts of this kingdom, and has thus aided in improving the illumination of our shores, and securing the safety of our mariners.

I have brought with me this other piece of apparatus which Mr. Ladd has lent me, and which is connected with the same inquiry, though it was never used. It affords the means of making a brilliant spark in any part of the space usually occupied by the flame of a lighthouse lamp, and the direction of the rays from that particular point can be ascertained from outside the apparatus. The main interest connected with this instrument arises from the fact that it is about the last piece of apparatus that Faraday ever devised.

This power of adapting simple means to produce the end required was exhibited by him in various other ways, and even in the common concerns of life. For instance, on one occasion a flower was given to him when he was away from home, and which he wished to take with him without its fading. I will show you how he managed this: Here is a flower which I brought from Professor Roscoe's dinner table just now. Well, Faraday first took a piece of ordinary letter paper, rolled it round the cork of a medicine phial, thus, and tied it with a string. There you have a little tube, into which you may pour water and stick your flower. There is Faraday's bouquet-holder, and what more perfect bouquet-holder can you have? Any of you may make one like it, and it will hold water for many hours.

Faraday liked to show the boys and girls to whom he lectured at Christmas time, in the Royal Institution, in what a simple way he could produce his experiments. I must show you one of his contrivances—his electrophorus. You know the piece of apparatus called an electrophorus. It consists of a plate of resinous matter, which is rubbed with a catskin to excite electricity, and a brass plate, to which is attached a glass handle, so that it can be laid on the resinous plate, and removed from it when charged, without discharging itself through the experimenter's hands. Such an apparatus you can buy at an instrument-maker's ; but Faraday wished to show that he could produce an electrophorus without going to the instrument-maker. He liked to show boys and girls that these effects could be produced by means which they could find at their fathers' houses, or could buy at the cost of a few pence. Here is a piece of indiarubber cloth, and a piece of tinfoil ; it is a rough piece I found in my laboratory, but that does not matter much ; at any rate we must take what means we can get hold of without going far to look for them. I will press it down to make it more flat ; and now I put a plate or saucer upon it. The object is to lift up the tinfoil. I take some strings of silk, and make a sort of cradle. I first put the tinfoil on the table, and the silk cradle on top of it ; then I put down the plate upside down, and I can turn up the ends of the tinfoil over the plate, so that it will hold the sheet of metal. Now we want to excite the piece of indiarubber. How shall it be done ? I can do it by simply beating it with a piece of flannel, which is more easily got than a catskin. I have not taken any precautions to warm this, as lecturers usually do with their electrical apparatus. Now, by means of the silk threads I will lift up this tinfoil and plate and put it on the indiarubber, and then touching it for an instant with my finger, and raising it again, you perceive I can get a considerable spark on my knuckle. Those of you who are near will plainly see or hear the spark. That is the simple way in which Faraday made an electrophorus.

But this passion for experimenting and this manipulative skill would never have made him the great philosopher he was. If he had worked constantly, of course he must have made some discoveries ; but if a man merely makes apparatus, sets that apparatus working, and watches what happens, without any particular view, nature is not likely to give him very satisfactory or very instructive answers. If he carries out more fully, as some do, the experiments of others, amassing new data, for instance, that is a most valuable service, but it is the work rather of an apprentice than of a master.

Faraday did not do that. He usually had some idea or conception in his mind, and then the experiments were devised so as to prove the truth or falsity of that idea. There were about him two valuable qualities from the very beginning. He says, speaking of his own early life: "I was a very lively, imaginative person, and could believe in the 'Arabian Nights' as easily as in the 'Encyclopædia'; but facts were important to me, and saved me. I could trust a fact, but always cross-examined an assertion." And in later life he was greatly indebted to his wonderful imagination, and at the same time his great love of truth, his loyalty to truth; so that while his imagination carried him along and opened up fresh vistas of thought and experiment, his love of truth prevented him from being carried away or misled by this power of imagination, while always obeying the indications of nature; and those who have worked upon the confines of human knowledge know how very difficult indeed it is not to be misled by preconceived ideas.

We must bear in mind, also, that with this great imagination and loyalty to truth, Faraday had the advantage, for it was an advantage to him—I believe—of being free from any system to begin with; he was ready to follow Truth wherever she led.

And now what can I say as to the results of his scientific work? Through the kindness of Mr. Harrison, I am able to show you just a few experiments that may illustrate here and there something of his discoveries; but I must refer you to the book of Tyndall on Faraday as a Discoverer for any real account of his labours. The work of a lifetime cannot be condensed, of course, into one lecture, much less into a small fraction of a lecture. Faraday's experiments extended through many different regions, and to understand and appreciate his labours fairly it would be necessary to go back into the position of science at the time in which he commenced, and that would be difficult for any of us to do. It was as a chemist that he began. His discoveries of chemical substances, however, were not numerous, or perhaps generally important; but here is one—benzine—which has acquired considerable importance since. You know that benzine is used in many of the arts. One of the children of benzine also is aniline, and the children of aniline, and therefore the grandchildren of benzine, are many beautiful colouring matters, which I need not put upon the table, for some of my lady auditors, I dare say, have brought specimens with them—the mauve and magenta dyes: all that branch of industry has sprung from Faraday's discovery of benzine. At the time that he began experimenting

it was supposed that gases were very different things from vapours ; but he showed that it was merely a question of temperature whether any body, not decomposable by heat, should exist as a solid, a liquid, or a gas. Then, again, he showed the connection of chemistry with galvanism ; that the chemical action in the battery was the measure of the galvanic electricity that was produced. But the greatest series of Faraday's researches were those which showed the connection between one form of electricity and another—that the same great force was capable of manifesting itself under various aspects. One or two illustrations I may give you. There is a battery below the table, and the chemical action is going on unseen, and the power is being carried through these wires, and now it is proceeding forth, not as chemical action, but as light. You see the intensity of that light between the charcoal points. [Illustration of the electrical light.] Here we have the transformation of one force into another. Of course, I need not say that along with the light there is a great deal of heat. But we will take something which was more especially Faraday's. The next experiment is to illustrate his induction coil. I had hoped that the lecture preceding mine would have been by my friend Mr. Barrett, who has been prevented, as you are aware, by illness, from giving an account of Faraday's electrical discoveries. If Mr. Barrett had lectured, I should have drawn upon your knowledge of his lecture for these illustrations. But we will have one or two. Again we start with the chemical power, again we have galvanic action, and now we find the production of magnetism, and induced currents of electricity, giving rise to the lightning flash between these two points. You hear the loud report and see the light. The flash is much the same as that produced from an ordinary electrical machine, where it originates in friction. We shall now pass it through some vacuum tubes, and you will see other luminous appearances. I may repeat that the same power is here presenting itself in different parts of the apparatus in different forms. Commencing with the solution of a metal in an acid, we get finally this beautiful hydrogen light. It is only near at hand that we can see the extreme beauty of the forms, and the bending of the light in various directions, and its division into luminous strata. Here we have a large tube of the same kind, with a fluorescent solution, and here one with cups of uranium glass. [These and other experiments were ably performed by Mr. Harrison.] One of Faraday's greatest discoveries, and a very prolific one it was, consisted in making a magnet rotate, by which he was able to produce any electrical effect,

including the spark which was afterwards exalted into the brightest of all lights. Faraday also showed the connection of magnetism with light by causing it to rotate the plane of a polarised ray. It seems a pity we have not time for more of these beautiful illustrations which Mr. Harrison has kindly prepared and brought before us, but we ought to have this little apparatus, in which electricity is set to do mechanical work. Here is a small pump, and the water is to be pumped up by means of these magnets. The power is brought from the galvanic battery below, and we have an arrangement for converting this chemical and electrical force into a simple mechanical force. There you see the stream of water raised by the electric pump.

Faraday's work consisted in a great measure of the overthrowing of idols. There were many false opinions prevalent about the forces of nature at the time when he started his investigations; and he did much good service in overthrowing them, and trying to get rid of the false notions that attached themselves to such words as "poles" and "currents." We cannot say that he always got rid of erroneous opinions himself, because so difficult is it to separate our notions from the words we employ, so difficult is it to clarify our intellects, that no man—Faraday or any other—can become altogether independent of the tyrannical influence which words exercise over his ideas. A still more important service which Faraday rendered was in the breaking down of barriers. When he started his investigations all the different sciences seemed to stand aloof from one another; but he gradually showed the connection of one with the other, and exemplified how force was capable of appearing sometimes in one form and sometimes in another—while the same amount of force was continually present. Other philosophers, including our chairman, have rendered inestimable service in carrying out more fully the same ideas, with mathematical knowledge that Faraday did not possess. These barriers between the different sciences Faraday broke down, and showed that the whole of nature was a commonwealth, and he tried to demonstrate that there was one great law pervading the whole. And not only did he break down the barriers that had been set up by men, but he enlarged the boundaries of science, and added a great deal to the wealth of our previous knowledge, making known to us a great number of new facts, which others have taken as starting points to make additional discoveries. Not only did he thus overthrow idols, break down barriers, and enlarge the boundaries of natural knowledge, but he often raised an enthusiasm for science. It is

true that he had no disciples, properly speaking, that he had no body of young men whom he trained in the paths of research. That did not seem to be within his power; but he lectured as very few indeed have ever lectured, and he imparted his own enthusiasm to the audiences that hung upon his lips. At the same time he raised the popular conception of science. In his early days he wrote thus:—

“A philosopher should be a man willing to listen to every suggestion, but determined to judge for himself. He should not be biassed by appearances, have no favourite hypothesis, be of no school, and in doctrine have no master. He should not be a respecter of persons, but of things. Truth should be his primary object. If to these qualities be added industry, he may, indeed, hope to walk within the veil of the temple of nature.”

And what he laid down then as the characteristic of a philosopher, he carried out in his future life and taught to others. Faraday also did good service in promoting scientific education, for so impressed was he with the importance of our knowing about the various forces which are constantly influencing us throughout this beautiful Nature which is spread around us—the handiwork of God—that he claimed for the study of nature a place in the education of all men. I do not know that I need speak so much about that here in Manchester as in some other places; but without in any way depreciating other kinds of study which are perfectly necessary, I think we may well say that a man whose knowledge of the world around him, whose knowledge of nature, has not been properly drawn out and trained, is only a partially educated man. And so, ladies and gentlemen, I would claim in Faraday's name—as I think he would if he were standing here—an honoured place for science in the education of every Englishman and every Englishwoman.

Now will you go back with me again to Faraday's personal character for a little? We have seen something of the great work that he achieved, the mighty results that sprang from his diligent, constant labours down in the laboratory in the basement of the Royal Institution in London; but in the evening he would go into the upper part of the house and be with his wife and nieces, or he would be enjoying himself with various other friends in a social way, inviting them to supper—nice pleasant little suppers they were, nothing extravagant or pretentious about them, but everything good, for Faraday was no ascetic; and what was far better than the things on the table was the geniality that was round about the table. Then there was the kindness that

pervaded all his intercourse with others, and his love for children too. I remember how he played with my own children. One of his nieces gave me this the other day ; it is a copy of a letter he sent to her daughter, then a little damsel five years of age. I think I may read the whole of it ; it is short and sweet, as well as characteristic :—

TO CONSTANCE DEACON.

Royal Institution, 19th May, 1852.

My dear Constance,—First a kiss, p—p—p—ph ; next thank you for your good letter—very well written, and very pleasant ; and now thanks for the letter you are going to write to me, in which you must tell me how Papa and Mamma do, and what you are about.

I went this morning to see a fish like a great eel take his breakfast. This morning he had three frogs for breakfast ; yesterday he ate nine fish in the course of the day, each as large as a sprat, and the day before fourteen. When the fish are put into the water he electrifies and kills them, and then swallows them up ; and if a man happens to have his hands in the water at the same time, the fish—that is, the eel—electrifies the man too. The eel is now above twelve years old, and is heavier, I think, than you are.

Yesterday I saw the Royal children, the Prince of Wales, and the Duke of York—such nice children ! they would make famous playmates for you ; but I do not know whether princes do play much. I do not think they can be as happy in their play as you are.

As to the magnic*, when you and I meet we will have a long talk about it, and make some *experiments*. And so, with my love to Papa and Mamma, and curious Constance, with a kiss for each, I am your loving old uncle,

M. FARADAY.

You may form a fair idea of the appearance and expression of the good man's face by looking at these different portraits, and combining them together in your mind. [Here the lecturer showed the portraits of Faraday in the memoirs written by Dr. Bence Jones and Prof. Tyndall, and some other engravings and photographs, especially commending one by Watkins.]

We may imagine the genial philosopher also at his various amusements, for he was fond of seeing all the sights of London, all the shilling shows, the Zoological Gardens, or the opera ; and his enjoyment was the greater if his wife or niece was with him. Then there was a remarkable playfulness which pervaded his whole nature, and relieved his work, a playfulness which it is difficult to describe, because it depended mainly upon his manner ; but a playfulness sometimes rising into a little practical joke of a harmless nature, though generally stopping short of that, and diffusing a kind of pleasant halo over one's intercourse with him. And under his playfulness there were deeper feelings.

* I believe this was the little girl's way of pronouncing "magnet."

There was a great reverence which seemed to characterise the man—a reverence for everything that was about him that deserved respect; a reverence not for God only, not for nature only, but for man, for all men, unless he knew them to be bad. This reverence appeared also in the form of self-respect. It was difficult to take any liberties with him. It was strange, too, how, in talking with him, you felt that he was giving you credit for high motives and for noble aims, while perhaps you felt ashamed of yourself, being aware that your own aims were not as high as those which Faraday was imputing to you. And so the general effect of intercourse with him—at any rate I felt it to be so—was that of a moral tonic, and one went away from the good man feeling braced and stronger for the various duties of life.

And, in addition to this, there was a peculiar amiability in his character—a gentleness combined with firmness, an unselfish kindness in all his relations with others. He loved his friends with a rare love; but he was ready to do acts of service to strangers. [Here the lecturer repeated some of the illustrative anecdotes that are printed in his book on “Michael Faraday,” and elsewhere.] This kindness showed itself unconsciously in a thousand little loving actions. It caused him to give away large sums of money, and to spend time in visiting the sick, without taking note of the outlay, and it won the hearts and the confidence of all who came into his company.

Yet when I speak of Faraday’s moral excellence, you must not suppose that he was always perfect, or had no need of that self-control which every true man must exercise. The beauty of his character does not lie in its being faultless, but we should rather admire him for having learnt to curb those risings of pride or irritability which might otherwise have marred his nobility and unselfishness.

We must think of him, also, not only on the ordinary working days of life, but also on Sundays. I will not enter into the peculiarities of the small religious body to which he belonged, but simply mention, that, as an elder, he took his turn in preaching among them. His sermons, however, were not to be compared to his lectures. One could, perhaps, have wished that he had thought it right to apply to his interpretation of the word of God some of those great principles that had been so productive in his own hands in the investigation of natural science. But he did not do so, and his preaching was of the simplest and plainest order—chiefly a collection of texts illustrating some central thought, such as the following, which I quote from one of his sermons: “The plan

of salvation is so simple that every one can understand it—love to Christ springing from the love He bears us, and which made Him undertake our salvation.”

But I must hasten on to the close of his life. His was a gradual decline. I have not time to read letters in which he speaks of how happy his life had been. And yet with all that, he was not loth to depart, but said, if asked how he was—“I am as well as I expect or wish to be, for I cannot expect or desire to be here any longer, as now I am only a burden to my friends.” And gradually old age and the failing of his faculties crept over him. He retired more and more to the house which the Queen had given him near Hampton Court, and there he mainly spent the last few years of his life. His niece and constant kind attendant, Miss Barnard, told me lately an affecting story, how one day in 1864 he brought her a copy of the *Athenæum*, in which was narrated an incident of the great Duke of Marlborough wishing toward the end of his career never to be consulted upon any important matter of state again, because he felt that his powers were failing. Faraday, with tears in his eyes, wished her to copy out the passage, and remind him of it if the need arose. Some time afterwards, when he was very feeble, he proposed to her a journey to Paris. On his persisting in the idea she asked if he remembered the story of the Duke of Marlborough. At his request she fetched the paper, and read it to him. He thanked her, and said nothing more about the Paris visit. Gradually decay came on; his memory and other faculties failed; silently and slowly he sank to rest; and on August 25, 1867, this beautiful spirit passed beyond our earthly horizon.

But although his bodily presence is gone he lives still amongst us by his works, ever fruitful in fresh applications. He lives also in the enthusiasm which he has engendered in the hearts of very many for natural science. He lives, moreover, by the example which he showed of the combination of intellectual and moral greatness. In him could be seen a living instance of how a man may unite nobility and strength of character with perfect gentleness and love; how he may cherish a beautiful domestic life, and yet at the same time be one of the princes of intellect; and how this lovable, simple-minded, honest, upright godly life may be one which the present age and succeeding ages will delight most to honour. When Faraday passed away the world mourned him, and it still mourns him, because it has lost not only a teacher, but a friend; and yet at the same time the world feels itself richer, not only for the work, but for the example of this Christian gentleman and philosopher.