



Michael Faraday

well as the outside of the books he handles, and young Faraday took advantage of his position, and fed on such intellectual food as Watts's "Improvement of the Mind," Mrs. Marcet's "Conversations on Chemistry," and the article on "Electricity" in the Encyclopedia Britannica, besides such lighter dishes as Miss Burney's "Evelina;" nor can we doubt that when he was binding Lyons's "Experiments on Electricity," and Boyle's "Notes about the Producibleness of Chemical Principles," he looked beyond the covers.¹ And his thirst for knowledge did not stop with reading; he must see whether Mrs. Marcet's statements were correct, and so, to quote his own words, "I made such simple experiments in chemistry as could be defrayed in their expense by a few pence per week, and also constructed an electrical machine, first with a glass phial, and afterward with a real cylinder, as well as other electrical apparatus of a corresponding kind." One day, walking somewhere in the neighborhood of Fleet Street, he saw in a shop-window a bill announcing that lectures on natural philosophy were delivered by Mr. Tatum, at 53 Dorset Street, at eight in the evening; price of admission one shilling. He wanted to hear these lectures. His master's permission was obtained, but where was the money to come from? The needful shillings were given him by his elder brother Robert, who earned them as a black-smith; and so Michael Faraday made his first acquaintance with scientific lectures. And not with lectures only, for Tatum's house was frequented by other earnest students, and lifelong friendships were formed. Among these students was Benjamin Abbott, a young Quaker, who had received a good education, and had then a situation in a City house as confidential clerk. With him Faraday chatted on philosophy or any thing else, and happily for us he chatted on paper, in letters of that fullness and length which the penny post and the telegraph have well-nigh driven out of existence; and happily for us, too, Abbott kept those letters, and Dr. Bence, Jones has published them. They are wonderful letters for a poor bookseller's apprentice; they bear the stamp of an innate gentleman and philosopher. Long afterward, when Benjamin Abbott was an old man, he used to tell how Faraday made his first experiments in the kitchen of his house, and delivered his first lecture from the end of that kitchen table. The electrical machine made by him in those early days came into the possession of Sir James South, and now forms one of the treasures of the Royal Institution. As the eager student drank in the lectures of Tatum, he took notes, and he afterward wrote them out carefully in a clear hand,

made in the chief ray, and then one does not know the state of the atmosphere about a given light-house. Strong lights like that of Cape Grisnez have been invisible when they should have been strong; feeble lights by comparison have risen up in force when one might have expected them to be relatively weak: and after inquiry has not shown a state of the air at the light-house explaining such differences. It is probable that the cause of difference often exists at sea. Besides these difficulties there is that other great one of not seeing the two lights to be compared in the field of view at the same time and same distance. If the eye has to turn 90° from one to the other, I have no confidence in the comparison; and if both be in the field of eight at once, still unexpected and unexplained causes of difference occur. The two lights at the South Foreland are beautifully situated for comparison, and yet sometimes the upper did not equal the lower when it ought to have surpassed it. This I referred at the time to an upper stratum of haze; but on shore they knew nothing of the kind, nor had any such or other reason to expect particular effects.

Ever truly yours,

M. FARADAY."

As an instance of his unwillingness to commit himself to an opinion unless he was sure about it, may be cited a letter he wrote to Mr. Airy, the Astronomer Royal, who asked for his advice in regard to the material of which the national standard of length should be made: "I do not see any reason why & pure metal should be particularly free from internal change of its particles, and, on the whole, should rather incline to the hard alloy than to soft copper, and yet I hardly know why. I suppose the labor would be too great to lay down the standard on different metals and substances; and yet the comparison of them might be very important here-after, for twenty years seem to do or tell a great deal in relation to standard measures." Bronze was finally chosen.

7. De la Rive points this out in his brief notice of Faraday I immediately on receiving the news of his death: "Je n'ai parlé que du savant, je tiens aussi à dire un mot de l'homme. Alliant à une modestie vraie, parcequ'elle provenait de l'élévation de son âme, n'importe à toute épreuve et une caudeur admirable, Faraday n'aimait la science que pour elle-même. Aussi jouissait-il des succès des autres au moins autant que des biens propres; et quant à lui, s'il l'accepte, avec une sincère satisfaction, les honneurs

from time to time by grave-looking gentlemen, many of them white-headed; but often of an afternoon, and always on Friday evening during the season, the quiet street is thronged with carriages and pedestrians, ladies and gentlemen, who flock through these folding doors. Entering with them, we find ourselves in a vestibule, with a large stone staircase in front, and rooms opening on the right and left. The walls of these rooms are lined with myriads of books, and the tables are covered with scientific and other periodicals of the day, and there are cabinets of philosophical apparatus and a small museum. Going up the broad staircase and turning to the right, we pass through an anteroom to the lecture theatre. There stands the large table, horseshoe-shaped, with the necessary appliances for experiments, and behind it a furnace and arrangements for black-board and diagrams; while round the table as a centre range semicircular seats, rising tier above tier, and surmounted by a semicircular gallery, the whole capable of seating 700 persons. On the basement is a new chemical laboratory, fitted up with modern appliances, and beyond it the old laboratory, with its furnaces and sand-bath, its working tables and well-stored shelves, flanked by cellars that look like dark lumber-rooms. A narrow private staircase leads up to the suite of apartments in which resides the Director of the house. Such is the Royal Institution of Great Britain, incorporated by Royal Charter in the year 1800, "for the diffusing knowledge and facilitating the general introduction of useful mechanical inventions and improvements, and for teaching, by courses of philosophical lectures and experiments, the application of science to the common purposes of life"-with the motto, "Illustrans commoda vitae." Fifty or sixty years ago the building was essentially what it is now, except the facade and entrance, and that the laboratory, which was considered a model of perfection, was even darker than at present, and in the place of the modern chemical room there was a small theatre. The side room, too, was fitted up for actual work, though even at mid-day it had to be artificially lighted; and beyond this there was, and still is, a place called the Froggery, from a certain old tradition of frogs having been kept there. The first intention of the founders to exhibit useful inventions had not been found very practicable, but the place was already famous with the memories of Rumford and Young; and at that time the genius of Sir Humphry Davy was entrancing the intellectual world with brilliant discoveries, and drawing fashionable audiences to Albemarle Street to listen to his eloquent expositions. Among the customers of the bookseller in Blandford Street was a Mr. Dance, who, being a member of the Royal

distance apart, and continues to burn, needing little or no attention for three hours and a half, when, the charcoals being consumed, the lamp must be changed, but this is done without extinguishing the light. Again there were inspections, and reports from pilots and other observers, and Faraday propounded lists of questions to the engineer about bolts, and screws, and donkey-engines, while he estimated that at the Varne light-ship, about equidistant from Cape Grisnez and Dungeness, the maximum effect of the revolving French light was equaled by the constant gleam from the English tower. But delays again ensued till intelligent keepers could be found and properly instructed; but on the 6th of June, 1862, Faraday's own light, the baby grown into a giant, shone permanently on the coast of Britain. France, too, was alert. Berlioz's machine, which was displayed at the International Exhibition in London, and which was also examined by Faraday, was approved by the French government, and was soon illuminating the double light-house near Havre. These magneto-electric lights on either side of the Channel have stood the test of years; and for the last twelvemonth there has shone another still more beautiful one at Souter Point, near Tynemouth; while the narrow strait between England and France is now guarded by these "sentinels of peaceful progress," for the revolving light at Grisnez has been lately illuminated on this principle, and on the 1st of January of this year the two lights of the South Foreland flashed forth with the electric flame. **11** In describing thus the valuable applications of Faraday's discoveries of benzol, of specific inductive capacity, and of magneto-electricity, it is not intended to exalt these above other discoveries which as yet have paid no tribute to the material wants of man. The good fruit borne by other researches may not be sufficiently mature, but it doubtless contains the seeds of many useful inventions. Yet, after all, we must not measure the worth of Faraday's discoveries by any standard of practical utility in the present or in the future. His chief merit is that he enlarged so much the boundaries of our knowledge of the physical forces, opened up so many new realms of thought, and won so many heights which have become the starting-points for other explorers.

themselves to her service;" He-promised him the work of the Institution, and his own besides. But shortly afterward the laboratory assistant was discharged for misconduct, and so it happened that one night the inhabitants of quiet Weymouth Street were startled by the unusual apparition of a grand carriage with a footman, which drew up before the house where Faraday lived, when the servant left a note from Sir Humphry Davy. The next morning there was an interview, which resulted in the young aspirant for scientific work being engaged to help the famous philosopher. His engagement dates from March 1, 1813, and he was to get 25s. per week, and a room in the house. The duties had been previously laid down by the managers: " To attend and assist the lecturers and professors in preparing for and during lectures. Where any instruments or apparatus may be required, to attend to their careful removal from the model-room and laboratory to the lecture-room, and to clean and replace them after being used, reporting to the managers such accidents as shall require repair, a constant diary being kept by him for that purpose. That in one day in each week he be employed in keeping clean the models in the repository, and that all the instruments in the glass cases be cleaned and dusted at least once within a month." The young assistant did not confine himself to the mere discharge of these somewhat menial duties. He put in order the mineralogical collection; and from the first we find him occupying a higher position than the minute quoted above would indicate. In the course of a few days he was extracting sugar from beet-root; but all his laboratory proceedings were not so pleasant or so innocent as that, for he had to make one of the worst smelling of all chemical compounds, bisulphide of carbon; and as Davy continued to work on the explosive chloride of nitrogen, his assistant's career stood some chance of being suddenly cut short at its commencement. Indeed, it seems that before the middle of April he had run the gauntlet of four separate explosions. Knowing that the liquid would go off on the slightest provocation, the experimenters wore masks of glass, but this did not save them from injury. In one case Faraday was holding a small tube containing a few grains of it between his finger and thumb, and brought a piece of warm cement near it, when he was suddenly stunned, and on returning to consciousness found himself standing with his hand in the same position, but torn by the shattered tube, and the glass of his mask even cut by the projected fragments. Nor was it easy to say when the compound could be relied on, for it seemed very capricious; for instance, one day it rose quietly in vapor in a tube exhausted by the air-pump, but

rays across the Channel. It was soon inspected by Faraday inside and outside, by land and by sea. His notes terminate in this way: "Went to the hills round, about a mile off, or perhaps more, so as to see both upper and lower light at once. The effect was very fine. The lower light does not come near the upper in its power, and as to color, looks red, while the upper is white. The visible rays proceed from both horizontally, but those from the low light are not half so long as those from the electric light. The radiation from the upper light was beautifully horizontal, going out right and left with intenseness like a horizontal flood of light, with blackness above and blackness below, yet the sky was clear and the stars shining brightly. It seemed as if the lantern only were above the earth, so dark was the part immediately below the lantern, yet the whole tower was visible from the place. As to the shadows of the uprights one could walk into one and across, and see the diminution of the light, and could easily see when the edge of the shadow was passed. They varied in width according to the distance from the lantern. With upright bars their effect is considerable at a distance, as seen last night; but inclining these bars would help in the distance, though not so much as with a light having considerable upright dimension, as is the case with an oil lamp. "The shadows on a white card were very clear on the edge—a watch very distinct and legible. On lowering the head near certain valleys, the feeble shadow of the distant grass and leaves was evident. The light was beautifully steady and bright, with no signs of variation—the appearance was such as to give confidence to the mind—no doubt about its continuance. "As a light it is unexceptionable—as a magneto-electric light wonderful—and seems to have all the adjustments of quality and more than can be applied to a voltaic electric light or a Ruhmkorff coil." The Royal Commissioners and others saw with gratification this beautiful light, and arrangements were made for getting systematic observations of it by the keepers of all the light-houses within view, the masters of the light-vessels that guard the Goodwin Sands, and the crews of pilot cutters; after which Faraday wrote a very favorable report, saying, among other things, "I beg to state that in my opinion Professor Holmes has practically established the fitness and sufficiency of the magneto-electric light for light-house purposes, so far as its nature and management are concerned. The light produced is powerful beyond any other that I have yet seen so applied, and in principle may be accumulated to any degree; its regularity in the lantern is great, its management easy, and its care there may be confided to attentive keepers of the ordinary degree of intellect and

half a dozen persons, chiefly from the City Philosophical Society, who met of an evening to read together, and to criticise, correct, and improve each other's pronunciation and construction of language. The discipline was very sturdy the remarks very plain and open, and the results most valuable. This continued for several years. Seven months after his appointment there began a new passage in Faraday's life, which gave afresh impulse to his mental activity, and largely extended his knowledge of men and things. Sir Humphry Davy, wishing to travel on the Continent, and having received a special pass from the Emperor Napoleon, offered to take him as his amanuensis: he accepted the proposal, and for a year and a half they wandered about France, Italy, and Switzerland, and then they returned rapidly by the Tyrol, Germany, and Holland. From letters written when abroad we can catch some of the impressions made on his mind by these novel scenes. "I have not forgot," he writes to Abbott, "and never shall forget, the ideas that were forced on my mind in the first days. To me, who had lived all my days of remembrance in London, a city surrounded by a flat green country, a hill was a mountain, and a stone a rock; for though I had abstract ideas of the things, and could say rock and mountain, and would talk of them, yet I had no perfect ideas. Conceive then the astonishment, the pleasure, and the information which entered my mind in the varied county of Devonshire, where the foundations of the earth were first exposed to my view, and where I first saw granite, limestone, etc., in those places and in those forms where the ever-working and all wonderful band of nature had placed them. Mr. Ben., it is impossible you can conceive my feelings, and it is as impossible for me to describe them. The sea then presented a new source of information and interest; and on approaching the shore of France, with what eagerness, and how often, were my eyes directed to the south! When arrived there, I thought myself in an uncivilized country; for never before nor since have I seen such wretched beings as at Morlaix." His impression of the people was not improved by the fact of their having arrested the travelers on landing, and having detained them for five days, until they had sent to Paris for verification of their papers. Again, to her toward whom his heart was wont to turn from distant lands with no small longing: "I have said nothing as yet to you, dear mother, about our past journey, which has I been as pleasant and agreeable (a few things excepted, in reality nothing) as it was possible to be. Sir H Davy's high name at Paris gave us free admission into all parts of the French dominions, and our passports were granted

29th, 1831, and the letter goes on to describe the great harvest of results which he had gathered since the 29th of August, when he first obtained evidence of an electric current from a magnet. A few days afterward he was at work again on these curious relations of magnetism and electricity in his laboratory, and at the Round Pond in Kensington Gardens; and with Father Thames at Waterloo Bridge. On the 8th of February he entered in his note-book: "This evening, at Woolwich, experimented with magnet, and for the first time got the magnetic spark myself. Connected ends of a helix into two general ends, and then crossed the wires in such a way that a blow at a b would open them a little. Then bringing a b against the poles of a magnet, the ends were disjoined, and bright sparks resulted." Next day he repeated this experiment at home with Mr. Daniell's magnet, and then invited some of his best friends to come and see the tiny speck of light. **8** But what was the use of this little spark between the shaken wires? "What is the use of an infant?" asked Franklin once, when some such question was proposed to him. Faraday said that the experimentalist's answer was, "Endeavor to make it useful." But he passed to other researches in the same field. "I have rather been desirous," he says, "of discovering new facts and new relations dependent on magneto-electric induction than of exalting the force of those already obtained, being assured that the latter would find their full development hereafter." And in this assurance he was not mistaken. Electro-magnetism has been taken advantage of on a large scale by the metallurgist and the telegrapher; and even the photographer and sugar-refiner have attempted to make it their servant; but it is its application as a source of light that is most interesting to us in connection with its discoverer. Many "electric lights" were invented by "practical men," the power being generally derived from a galvanic battery; and it was discovered that by making the terminals of the wires of charcoal, the brilliancy of the spark could be enormously increased. Some of these inventions were proposed for light-houses, and so came officially under the notice of Faraday as scientific adviser to the Trinity House. Thus he was engaged in 1853 and 1854 with the beautiful electric light of Dr. Watson, which he examined most carefully, evidently hoping it might be of service, and at length he wrote an elaborate report pointing out its advantages, but at the same time the difficulties in the way of its practical adoption. The Trinity Corporation passed a special vote of thanks for his report, and hesitated to proceed further in the matter. But Faraday's own spark was destined to be more successful. In 1853 some large magneto-electric machines were set up in

chemist and his scholar as they burn diamonds at Florence by means of the Grand-Duke's gigantic lens, and prove that the invisible result is carbonic acid; or as they study the springs of inflammable gas at Pietra Mala, and the molten minerals of Vesuvius. The whole, too, is interspersed with bits of fun, and this culminates at the Roman Carnival, where he evidently thoroughly enjoyed the follies of the Corso, the pelting with sugar-plums, and the masked balls, to the last of which he went in a nightgown and nightcap, with a lady who knew all his acquaintances; and between the two they puzzled their friends mightily. This year and a half may be considered as the time of Faraday's education; it was the period of his life that best corresponds with the collegiate course of other men who have attained high distinction in the world of thought. But his University was Europe; his professors the master whom he served, and those illustrious men to whom the renown of Davy introduced the travelers. It made him personally known, also, to foreign savants, at a time when there was little intercourse between Great Britain and the Continent; and thus he was associated with the French Academy of Sciences while still young, his works found a welcome all over Europe, and some of the best representatives of foreign science became his most intimate friends. In May, 1815, his engagement at the Royal Institution was renewed, with a somewhat higher position and increased salary, which was again raised in the following year to £100 per annum. The handwriting in the Laboratory Note-book changes in September, 1815, from the large running letters of Brande to the small, neat characters of Faraday, his first entry having reference to an analysis of "Dutch turf ash," and then soon occur investigations into the nature of substances bearing what must have been to him the mysterious names of Paligenetic tincture, and Baphe eugenes chruson. It is to be hoped that the constituents of this golden dye agreed together better than the Greek words of its name. We can imagine the young philosopher taking a deeper interest in the researches on flame which his master was then carrying out, and in the gradual perfection of the safety-lamp that was to bid defiance to the explosive gases of the mine; this at least is certain, that Davy, in the preface to his celebrated paper on the subject, expresses himself indebted to Mr. Michael Faraday for much able assistance, and that the youthful investigator carefully preserved the manuscript given him to copy. Part of his duty, in fact, was to copy such papers; and as Sir Humphry had a habit of destroying them, he begged leave to keep the originals, and in that way collected two large volumes of precious

disturbed. Faraday thought much over this question of "induction," as it is called, and found himself greatly puzzled to comprehend how a body should act where it is not. At length he satisfied himself by experiment that the interposed obstacle is itself affected by the electricity, and acquires an electro-polar state by which it modifies electric action in its neighborhood. The amount varies with the nature of the substance, and Faraday estimated it for such dielectrics as sulphur, shellac, or spermaceti, compared with air. He termed this new property of matter "specific inductive capacity," and figured in his own mind the play of the molecules as they propagated and for a while retained the force. Now these very recondite observations were opposed to the philosophy of the day, and they were not received by some of the leading electricians, especially of the Continent, while those who first tried to extend his experiments blundered over the matter. However, the present Professor Sir William Thomson, then a student at Cambridge, showed that while Faraday's views were rigorously deducible from Coulomb's theory, this discovery was a great advance in the philosophy of the subject. When submarine telegraph wires had to be manufactured, Thomson took "specific inductive capacity" into account in determining the dimensions of the cable: for we have there all the necessary conditions—the copper wire is charged with electricity, the covering of gutta-percha is a "dielectric," and the water outside is ready to have an opposite electric condition induced in it. The result is that, as Faraday himself predicted, the message is somewhat retarded; and of course it becomes a thing of importance so to arrange matters that this retardation may be as small as possible, and the signals may follow one another speedily. Now this must depend not only on the thickness of the covering, but also on the nature of the substance employed, and it was likely enough that gutta-percha was not the best possible substance. In fact, when Professor Fleeming Jenkin came to try the inductive capacity of gutta-percha by means of the Red Sea cable, he found it to be almost double that of shellac, which was the highest that Faraday had determined, and attempts have been made since to obtain some substance which should have less of this objectionable quality, and be as well adapted otherwise for coating a wire. There is Hooper's material, the great merit of which is its low specific inductive capacity, so that it permits of the sending of four signals while gutta-percha will only allow three to pass along; and Mr. Willoughby Smith has made an improved kind of gutta-percha with reduced capacity. Of course no opinion is expressed here on the value of these inventions, as many

will be good enough to deliver. "Mr. Hatchett's letter contained praises of you which were very gratifying to me; and pray believe me there is no one more interested in your success and welfare than your sincere well-wisher and friend,

H. DAVY.

"ROME."

It must not be supposed, however, that he had any astronomical duties, for the parallax he had found was not that of the Dog-star, but of a reputed new metal, Sirius, which was resolved in Faraday's hands into iron, nickel, and sulphur. But the impostor was not to be put down so easily, for he turned up again under the alias of Vestium; but again he was unable to escape the vigilant eye of the young detective, for one known substance after another was removed from it, and then, says Faraday, "my Vestium entirely disappeared." His occupations during this period were multifarious enough. We must picture him to ourselves as a young-looking man of about thirty years of age, well made, and neat in his dress, his cheerfulness of disposition often breaking out in a short, crispy laugh; but thoughtful enough when something important is to be done. He has to prepare the apparatus for Brande's lectures, and when the hour has arrived he stands on the right of the professor, and helps him to produce the strange transformations of the chemical art. And conjurers, indeed, the two appear in the eyes of the youth on the left, who waits upon them, then the "laboratory assistant," now the well known author, Mr. William Bollaert, from whom I have learned many details of this period. When not engaged with the lectures, Faraday is manufacturing rare chemicals, or performing commercial analyses, or giving scientific evidence on trials. One of these was a famous one, arising from the Imperial Insurance Company resisting the claim of Severn and King, sugar-bakers; and in it appeared all the chemists of the day, like knights in the lists, on opposite sides, ready to break a lance with each other. All his spare time Faraday was occupied with original work. Chlorine had a fascination for him, though the yellow choking gas would get out into the room, and he investigated its combinations with carbon, squeezed it into a liquid, and applied it successfully as a disinfectant when fatal fever broke out in the Millbank Penitentiary. Iodine too, another of Davy's elements, was made to join itself to carbon and hydrogen; and naphthaline was tormented with

farewell, telling them that he felt he had been before them too long, and that the experience of that evening showed he was now useless as their public servant, but he would still endeavor to do what he could privately for the Institution. The usual abstract of the lecture appeared, but not from his unaided pen. Inventors, and promoters of useful inventions, frequently benefited by the advice of Faraday, or by his generous help. A remarkable instance of this was told me by Cyrus Field. Near the commencement of his great enterprise, when he wished to unite the Old and the New Worlds by the telegraphic cable, he sought the advice of the great electrician, and Faraday told him that he doubted the possibility of getting a message " across the Atlantic. Mr. Field saw that this fatal objection must be settled at once, and begged Faraday to make the necessary experiments, offering to pay him properly for his services. The philosopher, however, declined all remuneration, but worked away at the question, and presently reported to Mr. Field: "It can be done, but you will not get an instantaneous message." "How long will it take?" was the next inquiry. "Oh, perhaps a second." " Well, that's quick enough for me," was the conclusion of the American; and the enterprise was proceeded with. As to the electric telegraph itself, Faraday does not appear among those who claim its parentage, but he was constantly associated with those who do; his criticisms led Ritchie to develop more fully his early conception, and he was constantly engaged with batteries, and wires, and magnets, while the telegraph was being perfected by others, and especially by his friend Wheatstone, whose name will always be associated with what is perhaps the most wonderful invention of modern times. As to Faraday's own work in applied science, his attempts to improve the manufacture of steel, and afterward of glass for optical purposes, were among the least satisfactory of his researches. He was more successful in the matter of ventilation of lamp-burners. The windows of light-houses were frequently found streaming with water that arose from the combustion of the oil, and in winter this has often converted into thick ice. He devised a plan by which this water was effectually carried away, and the room was also made more healthy for the keepers. At the Athenaeum Club serious complaints were made that the brilliantly-lighted drawing-room became excessively hot, and that headaches were very common, while the bindings of the books were greatly injured by the sulphuric acid that arose from the burnt coal-gas. Faraday cured this by an arrangement of glass cylinders over the ordinary lamp chimneys, and descending tubes which carried off the whole products of combustion without their ever mixing with the air of

transferred the office to his friend Magrath, who held it for a long period. Among the various sects into which Christendom is divided, few are less known than the Sandemanians. About a century and a half ago, when there was little light in the Presbyterian Church of Scotland, a pious minister of the name of John Glas began to 'preach that the Church should be governed only by the teaching of Christ and his apostles, that its connection with the state was an error, and that we ought to believe and to practice no more and no less than what we find from the New Testament that the primitive Church believed and practiced. These principles, which sound very familiar in these days, procured for their asserter much obloquy and a deposition by the Church courts, in consequence of which several separate congregations were formed in different parts of Great Britain, especially by Robert Sandeman, the son-in-law of Mr. Glas, and from him they received their common appellation. In early days they taught a simpler view of faith than was generally held at that time; it was with them a simple assent of the understanding, but produced by the Spirit of God, and its virtue depended not on any thing mystical in the operation itself, but on the grandeur and beauty of the things believed. Now, however, there is little to distinguish them in doctrine from other adherents of the Puritan theology, though they certainly concede a greater deference to their elders, and attach more importance to the Lord's Supper than is usual among the Puritan churches. Their form of worship, too, resembles that of the Presbyterians; but they hold that each congregation should have a plurality of elders, pastors, or bishops, who are unpaid men; that on every first day of the week they are bound to assemble, not only for prayers and preaching, but also for "breaking of bread;" and putting together their weekly offerings; that the love-feast and kiss of charity should continue to be practiced; that "blood and things strangled" are still forbidden as food; and that a disciple of Christ should not charge interest on loans, or lay up wealth for the unknown future, but rather consider all he possesses as at the service of his poorer brethren, and be ready to perform to them such offices of kindness as in the early Church were expressed by washing one another's feet. But what gives the remarkable character to the adherents of this sect is their perfect isolation from all Christian fellowship outside their own community, and from all external religious influence. They have never made missionary efforts to 'v in men from the world, and have long ceased to draw to themselves members from other churches; so they have rarely the advantage of fresh blood, or fresh views of the meaning of Scripture. They constantly

seemed to break down the barrier between conductors and insulators, and many other barriers besides -when he sent a ray of polarized light through a piece of heavy glass between the poles of an electro-magnet, and on making contact saw that the plane of polarization was rotated, or, as he said, the light was magnetized -and when he watched pieces of bismuth, or crystals of Iceland spar, or bubbles of oxygen, ranging themselves in a definite position in the magnetic field. "I delight in hearing of exact numbers, and the determinations of the equivalents of force when different forms of force are compared one with another," he wrote to Joule in 1845; and no wonder, for these quantitative comparisons have proved many of his speculations to be true, and have made them the creed of the scientific world. When he began to investigate the different sciences, they might be compared to so many separate countries with impassable frontiers, different languages and laws, and various weights and measures ; but when he ceased they resembled rather a brotherhood of states, linked together by a community of interests and of speech, and a federal code; and in bringing about this unification no one had so great a share as himself. .He loved to speculate, too, on Matter and Force, on the nature of atoms and of imponderable agents. "It is these things," says the great German physicist, Professor Helmholtz," that Faraday in his mature works ever seeks to purify more and more from every thing that is theoretical, and is not the direct and simple expression of the fact. For instance, he contended against the action of forces at a distance, and the adoption of two electrical and two magnetic fluids, as well as all hypotheses contrary to the law of the conservation of force, which he early foresaw, though he misunderstood it in its scientific expression. And it is just in this direction that he exercised the most unmistakable influence first of all on the English physicists." While, however, Faraday was pre-eminently an experimental philosopher, he was far from being indifferent to the useful applications of science. His own connection with the practical side of the question was threefold: he undertook some laborious investigations of this nature himself; he was frequently called upon, especially by the Trinity House, to give his opinions on the inventions of others; and he was fond of bringing useful inventions before the members of the Royal Institution in his Friday evening discourses. The first of these, on February 3,1826, was on India-rubber, and was illustrated by an abundance of specimens both in the raw and manufactured states. In this way, also, he continued to throw the magic of his genius around Morden's machinery for manufacturing Bramah's locks,

withdrawing your friendship,. or punish me by aiming to be more than a friend by making me less; and if you can not grant me more, leave me what I possess-but hear me." The lady hesitated, and went to Margate. There he followed her, and they proceeded together to Dover and Shakspeare's Cliff, and he returned to London full of happiness and hope. He loved her with all the ardor of his nature, and in due course, on June 12,1821, they were married. The bridegroom desired that there should be no bustle or noise at the wedding, and that the day should not be specially distinguished; but he calls it himself "an event which more than any other contributed to his happiness and healthful state of mind." As years rolled on the affection between husband and wife became only deeper and deeper; his bearing toward her proved it, and his letters frequently testify to it. Doubtless at any time between their marriage and his final illness he might have written to her as he did from Birmingham, at the time of the British Association: "After all, there is no pleasure like the tranquil pleasures of home, and here -even here-the moment I leave the table, I wish I were with you IN QUIET. Oh! what happiness is ours! My runs into the world in this way only serve to make me esteem that happiness the more." He took his bride home to Albemarle Street, and there they spent their wedded life; but until Mr. Barnard's death it was their custom to go every Saturday to the house of the worthy silversmith, and spend Sunday with him, returning home usually in the evening of that day. His own father died while he was at Riebau's, but his mother, a grand-looking woman, lived long afterward, supported by her son, whom she occasionally visited at the Institution, and of whose growing reputation she was not a little proud. With a mind calmed and strengthened by this beautiful domestic life, he continued with greater and greater enthusiasm to ask questions of Nature, and to interpret her replies to his fellow- men. Just before his marriage he had been appointed at the Royal Institution superintendent of the house and laboratory, and in February, 1825, after a change in the management of the Institution, he was placed as director in a position of greater responsibility and influence. One of his first acts in this capacity was to invite the members to a scientific evening in the laboratory; this took place three or four times in 1825, and in the following years these gatherings were held every week from Feb. 3 to June 9; and though the labor devolved very much upon Faraday, other philosophers sometimes brought forward discoveries or useful inventions. Thus commenced those Friday evening meetings which have done so much to popularize the high achievements of science. Faraday's note-

"As I never looked over one of my papers a year after it was written without believing, both in philosophy and manner, it could have been much better done, I still hope the collection may be of great use to me.

M. FARADAY. ,

"August 18, 1832."

This section may be summed up in the words of Dumas when he gave the first "Faraday Lecture" of the Chemical Society: "Faraday is the type of the most fortunate and the most accomplished of the learned men of our age. His hand in the execution of his conceptions kept pace with his mind in designing them; he never wanted boldness when he undertook an experiment, never lacked resources to insure success, and was full of discretion in interpreting results. His hardihood, which never halted when once he had undertaken a task, and his wariness, which felt its way carefully in adopting a received conclusion, will ever serve as models for the experimentalist,"

SECTION V.

THE VALUE OF HIS DISCOVERIES.

SCIENCE is pursued by different men from different motives.

"To some she is the goddess great;
To some the milch-cow of the field:
Their business is to calculate
The butter she will yield."

Now Faraday had been warned by Davy before he entered his service that Science was a mistress who paid badly; and in 1833 we have seen him

analyses and other professional work, which paid far better than pure science. In 1830 his gains from this source amounted to- £1000, and in 1831 to considerably more; they might easily have been increased, but at that time he made one of his most remarkable discoveries-the evolution of electricity from magnetism ⁴ -and there seemed to lie open before him the solution of the problem how to make one force exhibit at will the phenomena of magnetism, or of common or voltaic electricity. And then he had to face another problem -his own mental force might be turned either to the acquisition of a fortune, or to the following up of those great discoveries; it would not do both: which should he relinquish? The choice was deliberately made Nature revealed , to him more and more of her secrets, but his professional gains sank in 1832 to £155 9s., and during no subsequent year did they amount even -to that. Still his work was not entirely confined to his favorite studies, In a letter to Lord Auckland, long afterward, he says: "I have given up, for the last ten years or more, all professional occupation, and voluntarily resigned a large income, that I might pursue in some degree my own objects of research, But in doing this I have always, as a good subject, held myself ready to assist the government if still in my power-not for pay for, except in one instance (and then only for the sake of the person joined with me), I refused to take it. I have had the honor and pleasure of applications, and that very recently, from the Admiralty, the Ordnance, the Home Office, the Woods and Forests, and other departments, all of which I have replied to, and will reply to as long as strength is left me." He had declined the Professorship of Chemistry at the London University -now University College; but in 1829 he accepted a lectureship at the Royal Academy, Woolwich, and held it for about twenty years. In 1836 he became scientific adviser to the Trinity House, and his letter to the Deputy Master also shows his feelings in reference to such employment: " You have left the title and the sum in pencil. These I look at mainly as regards the character of the appointment; you will believe me to be sincere in this when you remember my indifference to your proposition as a matter of interest, though not as a matter of kindness. In consequence of the good will and confidence of all around me, I can at any moment convert my time into money, but I do not require more of the latter than is sufficient for necessary purposes. The sum, therefore, of £200 is quite enough in itself, but not if it is to be the indicator of the character of the appointment; but I think you do not view it so, : and that you and I understand each other in that respect, and your letter confirms me in

amount of his published researches, is one of those marvels which can be appreciated only by those who are in the habit of describing what they have seen in the mist land that lies beyond the boundaries of previous knowledge. Into this unknown region his mental vision was ever stretched. "I well remember one day," writes Mr. Barrett, a former assistant at the Royal Institution, "when Mr. Faraday was by my side, I happened to be steadying, by means of a magnet, the motion of a magnetic needle under a glass shade. Mr. Faraday suddenly .looked most impressively and earnestly as he said, 'How wonderful and mysterious is that power you have there the more I think over it the less I seem to know;' and yet he who said this knew more of it than any living man." It is easy to imagine with what wonder he would stand before the apples, or leaves, or pieces of meat that swung round into a transverse position between the poles of his gigantic magnet, or the sand that danced and eddied into regular figures on plates of glass touched by the fiddle- bow, or gold so finely divided that it appeared purple, and when diffused in water took a twelve-month to settle. It is easy, too, to imagine how he would long to gain a clear idea of what was taking place behind the phenomena. But it is far from easy to grasp the conceptions of his brain: language is a clumsy vehicle for such thoughts. He strove to get rid of such figurative terms as "currents" and "poles ;" in discussing the mode of propagation of light and radiant heat he endeavored" to dismiss the ether, but not the vibrations;" and in conceiving of atoms, he says: "As to the little solid particles ... I can not form any idea of them apart from the forces, so I neither admit nor deny them. They do not afford me the least help in my endeavor to form an idea of a particle of matter. On the contrary, they greatly embarrass me." Yet he could not himself escape from the tyranny of words or the deceitfulness of metaphors, and it is hard for his readers to comprehend what was his precise idea of those centres of forces that occupy no space, or of those lines of force which he beheld with his mental eye, curving alike round his magnetic needle, and that mightiest of all magnets-the earth. As he was jealous of his own fame, and had learned by experience that discoveries could be stolen, he talked little about them till they were ready for the public; indeed, he has been known to twit a brother electrician for telling his discoveries before printing them, adding with a knowing laugh, "I never do that." He was obliged, however, to explain his results to Professor Whewell, or some other learned friend, if he wished f to christen some new idea with a Greek name. One of Whewell's letters on such an occasion, dated Trinity

reader's imagination' to combine them. Let us watch him on an ordinary day. After eight hours' sleep, he rises in time to breakfast at eight o'clock, goes round the Institution to see that all is .in order, and descends into the laboratory, puts on a large white apron full-of holes, and is busy among his pieces of apparatus. The faithful Anderson, an old soldier, who always did exactly what he was told, and nothing more, **5** is waiting upon him; and as thought flashes after thought through his eager-perhaps impatient- brain, he twists his wires into new shapes, and rearranges his magnets and batteries. Then some conclusion is arrived at which lights up his face with a gleam of satisfaction, but the next minute a doubt comes across that expressive brow-may. the results not be due to something else yet imperfectly conceived? -and a new experiment must be devised to answer that. In the mean time one of his little nieces has been left in his charge. She sits as quiet as a mouse, with her needle-work; but now and then he gives her a nod, or a kind word, and throwing a little piece of potassium on to a basin of water for her amusement, he shows her the metal bursting into purple flame, floating about in fiery eddies, and the crack of the fused globule of potash at the end. Presently there is handed to him the card of some foreign savant, who makes his pilgrimage to the famous Institution and its presiding genius; he puts down his. last result on a slate, comes up stairs, and, disregarding the interruption, chats with his visitor with all cordiality and openness. Then to work again till dinner-time, at half past two. In the afternoon he retires to his study with its plain furniture and the India- rubber tree in the window, and writes a letter full of affection to some friend, after which he goes off to the council meeting of one of the learned bodies. Then back again to the laboratory; but as evening approaches he goes up stairs to his wife and niece, and then there is a game at bagatelle or acting charades and afterward he will read aloud from Shakspeare or Macaulay till it is time for supper and the simple family worship, which now is not liable to the interruptions that generally prevent it in the morning. And so the day closes. Or, if it be a fine summer evening, he takes a stroll with his wife and the little girl to the Zoological Gardens, and looks at all the new arrivals, but especially the monkeys, laughing at their tricks till the tears run down his cheeks. But should it be a Friday evening, :Faraday's place is in the library and theatre of the Institution, to see that all is right and ready, to say an encouraging word to the lecturer, and to welcome his friends as they arrive; then taking his seat on the front bench near the right hand of the speaker, he listens with an animated countenance to his story, **6** sometimes bending

than truth in this professed innocence of numbers, probably no one acquainted with his electrical researches will doubt that, had he possessed more mathematical ability, he would have been saved much trouble, and would sometimes have expressed his conclusions with greater ease and precision. Yet, as Sir William Thomson has remarked with reference to certain magnetic phenomena, "Faraday, without mathematics, divined the result of the mathematical investigation; and, what has proved of infinite value to the mathematicians themselves, he has given them an articulate language in which to express their results. Indeed, the whole language of the magnetic field and 'lines of force' is Faraday's. It must be said for the mathematicians that they greedily accepted it, and have ever since been most zealous in using it to the best advantage." The peculiarity of his mind was indeed well known to himself. In a letter to Dr. Becker he says: "I was never able to make a fact my own without seeing it; and the descriptions of the best works altogether failed to convey to my mind such a knowledge of things as to allow myself to form a judgment upon them. It was so with new things. If Grove, or Wheatstone, or Gassiot, or any other told me a new fact, and, wanted my opinion either of its value, or the cause, or the evidence it could give on any subject, I never could say anything until I had seen the fact. For the same reason, I never could work, as some professors do most extensively, by students or pupils. All the work had to be my own." The following story by Mr. Robert Mallet serves as an illustration: "It must be now eighteen years ago when I paid him a visit, and brought some slips of flexible and tough Muntz's yellow metal to show him the instantaneous change to complete brittleness with rigidity produced by dipping into permanganate of mercury solution. He got the solution, and I showed him the facts; he obviously did not doubt what he saw me do before and close to him; but a sort of experimental instinct seemed to require he should try it himself. So he took one of the slips, bent it forward and backward, dipped it, and broke it up into short bits between his own fingers. He had not before spoken. Then he said, 'Yes, it is pliable, and it does become instantly brittle.' And after a few moments' pause he added, 'Well, now have you any more facts of the sort?' and seemed a little disappointed when I said 'No; none that are new.' It has often since occurred to me how his mind needed absolute satisfaction that he had grasped a fact, and then instantly rushed to colligate it with another, if possible." But as the professor watched these new facts, new thoughts would shape themselves in his mind, and this would lead to fresh experiments in order to test their truth. The answers so obtained

something about a candle or a kettle that most boys and girls know, then rises to what they had never thought of before, but which now is as clear as possible to their understandings. And with what delight does he watch the performances of Nature in his experiments! One could fancy that he had never seen the experiments before, and that he was about to clap his hands with boyish glee at the unexpected result! Then, with serious face, the lecturer makes some incidental remark that goes far beyond natural philosophy, and is a lesson for life. Some will remember one of these occasions which forms the subject of a painting by Mr. Blaikley. Within the circle of the table stands the lecturer, and waiting behind is the trusty Anderson, while the chair is occupied by the Prince Consort, and beside him are the young Prince of Wales and his brother, the present Duke of Edinburgh; while the Rev. John Barlow and Dr. Bence Jones sit on the left of the princes, Sir James South stands against the door, and Murchison, De la Rue, Mrs. Faraday, and others may be recognized among the eager audience. Let us now suppose that it is a Sunday on which we are watching this prince among the aristocracy of intellect, and we will assume it to be during one of the periods of his eldership, namely, between 1840 and 1844, or after 1860. The first period came to a close through his separation both from his office and from the Church itself. The reason of this is said to have been that one Sunday he was absent from the love-feast, and, on inquiry being made, it appeared not only that he had been the guest of the queen, but that he was ready to justify his own conduct in obeying her commands. He, however, continued to worship among his friends, and was, after a while, restored to the rights of membership, and eventually to the office of elder. In the morning he and his family group find their way down to the plain little meeting-house in Paul's Alley, Redcross Street, since pulled down to make way for the Metropolitan Railway. The day's proceedings commence with a prayer-meeting, during which the worshipers gradually drop in and go to their accustomed seats, Faraday taking his place on the platform devoted to the elders: then the more public service begins; one of a metrical but not rhyming version of the Psalms is sung to a quaint old tune, the Lord's Prayer and another psalm follow; he rises, and reads in a slow, reverent manner the words of one of the evangelists, with a most profound and intelligent appreciation of their meaning; or he offers an extempore prayer, expressing perfect trust and submission to God's will, with deep humility and confession of sin. It may be his turn to preach. On two sides of a card he has previously sketched out his sermon with the illustrative

and the government sent down to the spot as their commissioners Professor Faraday and Sir Charles Lyell. The two gentlemen attended at the coroner's inquest, where they took part in the examination of the witnesses; they inspected the shattered safety-lamps; they descended into the mine, spending the best part of a day in the damaged and therefore dangerous galleries where the catastrophe had occurred, and they did not leave without showing in a practical form their sympathy with the sufferers. When down in the pit, an inspector showed them the way in which the workmen estimated the rapidity of the ventilation draught by throwing a pinch of gunpowder through the flame of a candle, and timing the movement of the little puff of smoke. Faraday, not admiring the free and easy way in which they handled their powder, asked where they kept their store of it, and learned that it was in a large black bag which had been assigned to him as the most comfortable seat they could offer. We may imagine the liveliness with which he sprang to his feet, and expostulated with them on their culpable carelessness. My own opportunities of observing Faraday at work were nearly confined to a series of experiments, which are the better worth describing here as they have escaped the notice of previous biographers. The Royal Commission appointed to inquire into our whole system of Lights, Buoys, and Beacons perceived a great defect that rendered many of our finest shore or harbor lights comparatively ineffective. The great central lamp in a light-house is surrounded by a complicated arrangement of lenses and prisms, with the object of gathering up as many of the rays as possible, and sending them over the surface of the sea toward the horizon. Now it is evident that if this apparatus be adjusted so as to send the beam two or three degrees upward, the light will be lost to the shipping and wasted on the clouds; and if two or three degrees downward, it will only illumine the water in the neighborhood: in either case the beautiful and expensive apparatus would be worse than useless. It is evident, also, that if the eye be placed just above the wick of the lamp, it will see through any particular piece of glass that very portion of the landscape which will be illuminated by a ray starting from the same spot; or the photographic image formed in the place of the flame by anyone of the lenses will tell us the direction in which that lens will throw the luminous rays. This simple principle was applied by the commissioners for testing the adjustment of the apparatus in the different lights, and it was found that few were rightly placed, or rather that no method of adjustment was in use better than the mason's plumb-line. The Royal Commissioners therefore, in 1860, drew the

Jones. His niece, Miss Reid, gives us her recollections of a month spent at Walmer: "How I rejoiced to be allowed to go therewith him! We went on the outside of the coach, in his favorite seat behind the driver. When we reached Shooter's Hill, he was full of fun about Falstaff and the men in buckram, and not a sight nor a sound of interest escaped his quick eye and ear. At Walmer we had a cottage in a field, and my uncle was delighted because a window looked directly into a black-bird's nest built in a cherry-tree. He would go many times in a day to watch the parent birds feeding their young. I remember, too, how much he was interested in the young lambs, after they were sheared at our door, vainly trying to find their own mothers. The ewes, not knowing their shorn lambs, did not make the customary signal. In those days I was eager to see the sun rise, and my uncle desired me always to call him when I was awake. So, as soon as the glow brightened over Pegwell Bay, I stole down stairs and tapped at his door, and he would rise, and a great treat it was to watch the glorious sight with him. How delightful, too, to be his companion at sunset! Once I remember well how we watched the fading light from a hill clothed with wild flowers, and how, as twilight stole on, the sounds of bells from Upper Deal broke upon our ears, and how he watched till all was gray. At such times he would be well pleased if we could repeat a few lines descriptive of his feelings." and then she tells us about their examining the flowers in the fields by the aid of "Galpin's Botany," and how with a candle he showed her a spectre on the white mist outside the window; of reading lessons that ended in laughter, and of sea-anemones and hermit crabs, with the merriment caused by their odd movements as they dragged about the unwieldy shells they tenanted. "But of all things I used to like to hear him read 'Childe Harold;' and never shall I forget the way in which he read the description of the storm on Lake Lemman. He took great pleasure in Byron, and Coleridge's Hymn to Mont Blanc delighted him. When any thing touched his feelings as he read-and it happened not unfrequently-he would show it not only in his voice, but by tears in his eyes also." A few days at Brighton refreshed him for his work. He was in the habit of running down there before his juvenile lectures at Christmas, and at Easter he frequently sought the same sea-breezes. But it was not always that Faraday could run away from London when the mental tension became excessive. A shorter relaxation was procured by his taking up a novel such as "Ivanhoe," or "Jane Eyre," or "Monte Christo." He liked the stirring ones best, "a story I with a thread to it." Or he would go with his wife to see Kean act, or hear Jenny Lind sing, or

a most instructive collection of his experimental apparatus, including the common electrical machine which he made while still an apprentice at Riebau's, and the ring of soft iron, with its twisted coils of wire isolated by calico and tied with common string, by means of which he first obtained electrical effects from a magnet. A lady, calling on his wife, happened to mention that a needle had been once broken into her foot, and she did not know whether it had been all extracted or not. "Oh!" said Faraday, "I will soon tell you that;" and, taking a finely suspended magnetic needle, he held it close to her foot, and it dipped to the concealed iron. "An artist was once maintaining that in natural appearances and in pictures, up and down, and high and low, were find indubitable realities; but Faraday told him that they were merely conventional acceptations, based on standards often arbitrary. The disputant could not be convinced that ideas which he had hitherto never doubted had such shifting foundations. 'Well,' said Faraday, 'hold a walking-stick between your chin and your great toe; look along it and say which is the upper end.' The experiment was tried, and the artist found his idea of perspective at complete variance with his sense of reality; either end of the stick might be called upper-pictorially it was one, physically it was the other." On this subject Schonbein has also some good remarks. "The laboratory of the Institution is indeed efficiently arranged, though any thing but large and elaborately furnished. And yet something extraordinary has happened in this room for the extension of the limits of knowledge, and already more has been done in it than in many other institutions where the greatest luxury in the supply of apparatus prevails, and where there is the greatest command of money. But when men work with the creative genius of a Davy, and the intuitive spirit of investigation and the wealth of ideas of a Faraday, important and great things must come to pass, even though the appliances at command should be of so limited a character. For the experimental investigator of nature, it is especially desirable that, according to the kind of his researches, he should have at command such and such appliances, that he should possess a philosophical apparatus, a laboratory, etc, but for the purpose of producing something important, of greatly widening the sphere of knowledge, it in no way follows that a superfluity of such things is necessary to him. ... He who understands how to put appropriate questions to Nature generally knows how to extract the answers by simple means; and he who wants this capacity will, I fear, obtain no profitable result, even though all conceivable tools and apparatus may be ready to

card, and shot them across the table at his friends. Professional engagements also took him not unfrequently into the country. Some of these will be described in the later sections, that treat of his mode of working and its valuable results. To comprehend a man's life it is necessary to know not merely what he does, but also what he purposely leaves undone. There is a limit to the work that can be got out of a human body or a human brain, and he is a wise man who wastes no energy on pursuits for which he is not fitted; and he is still wiser who, from among the things that he can do well, chooses and resolutely follows the best. Faraday took no part in any of the political or social movements of his time. To politics, indeed, he seems to have been really indifferent. It was during the intensely interesting period of 1814-15 that he was on the Continent with Davy, but he alludes to the taking of Paris by the allied troops simply because of its bearing on the movements of the travelers, and on March 7, 1815, he made this remarkable entry in his journal: "I heard for news that Bonaparte was again at liberty. Being no politician, I did not trouble myself much about it, though I suppose it will, have a strong influence on the affairs of Europe." In later days he seems to have awakened to sufficient interest to read the debates, and to show a Conservative tendency; he became a special constable in 1848, and was disposed generally to support "the powers that be," though that involved some perplexity at a change of government. It is more singular that a man of his benevolent spirit should never have taken a prominent part in any philanthropic movement. During the latter half of his life, he, as a rule, avoided serving on committees even for scientific objects, and was reluctant to hold office in the learned societies with which he was connected. I believe, however, that this arose, not from want of interest, but from a conviction that he was ill suited by natural temperament for joining in discussions on subjects that roused the passions of men, or for calmly weighing the different causes of action, and deciding which was the most judicious. It is remarkable how little even of his scientific work was done in conjunction with others. Neither did he spend time in rural occupations, or in literary or artistic pursuits. Beasts, and birds, and flowers he looked at, but it was for recreation, not for study. Music he was fond of, and occasionally he visited the opera, but he did not allow sweet sounds to charm him away from his work. He stuck closely to his fireside, his laboratory, his lecture-table, and his Church. He lived where he worked, so that he had only to go down stairs to put to the test of experiment any fresh thought that flitted across his brain. He almost

works on." **1** The habit of Faraday was to think out carefully beforehand the subject on which he was working, and to plan his mode of attack. Then, if he saw that some new piece of apparatus was needed, he would describe it fully to the instrument maker with a drawing, and it rarely happened that there was any need of alteration in executing the order. If, however, the means of experiment existed already, he would give Anderson a written list of the things he would require at least a day before-for Anderson was not to be hurried. When all was ready, he would descend into the laboratory, give a quick glance round to see that all was right, take his apron from the drawer, and rub his hands together as he looked at the preparations made for his work. There must be no tool on the table but such as he required. As he began, his face would be exceedingly grave, and during the progress of an experiment all must be perfectly quiet; but if it was proceeding according to his wish, he would commence to hum a tune, and sometimes to rock himself sideways, balancing alternately on either foot. Then, too, he would often talk to his assistant about the result he was expecting. He would put away each tool in its own place as soon as done with, or, at any rate, when the day's work was over, and he would not unnecessarily take a thing away from its place; thus, if he wanted a perforated cork, he would go to the drawer which contained the corks and cork-borers, make there what he wanted, replace the borers, and shut the drawer. No bottle was allowed to remain without its stopper; no open glass might stand for a night without a paper cover; no rubbish was to be left on the floor; bad smells were to be avoided if possible; and machinery in motion was not permitted to grate. In working, also, he was very careful not to employ more force than was wanted to produce the effect. When his experiments were finished and put away, he would leave the laboratory, and think further about them up stairs. This orderliness and this economy of means he not only practiced himself, but he expected them also to be followed by any who worked with him; and it is from conversation with these that I have been enabled to give this sketch of his manner of working. This exactness was also apparent in the accounts he kept with the Royal Institution and Trinity House, in which he entered every little item of expenditure with the greatest minuteness of detail. It was through this lifelong series of experiments that Faraday won his knowledge and mastered the forces of nature. The rare ingenuity of his mind was ably seconded by his manipulative skill, while the quickness of his perceptions was equaled by the calm rapidity of his movements. He had, indeed, a passion for

attention on the part of the great philosopher would send forward on the journey of life with new energy and hopes. Another day it might be some intellectual chieftain, who could meet the prince of experimenters on equal terms. But these are hardly to be regarded as interruptions-rather as part of his chosen work. Here is one instance in the words of Mr. Robert Mallet. " I was, in the years that followed, never in London without paying him a visit, and on one of those times I ventured to ask him (if not too much engaged) to let me see where he and Davy had worked together. With the most simple graciousness he brought me through the whole of the Royal Institution, Albemarle Street. Brande's furnaces, Davy's battery, the place in the laboratory where he told me he had first observed the liquefaction of chlorine, are all vividly before me-but nothing so clear or vivid as our conversation over a specimen of green (crown) glass, partially devitrified in floating opaque white spheres of radiating crystals: he touched luminously on the obscure relation of the vitreous and crystalloid states; and on the probable nature of the nuclei of the white spheres. My next visit to Faraday that I recollect was not long after my paper 'On the Dynamics of Earthquakes' had appeared in the Transactions of the Royal Irish Academy. He almost at once referred to it in terms of praise that seemed to me so far beyond my due, that even now I recall the very humble way I felt, as the thought of Faraday's own transcendent merits rushed across my mind. I ventured to ask him, had the paper engaged his attention sufficiently that I might ask him-did he consider my explanation of the before supposed vorticose shock sufficient? To my amazement he at once recited nearly word for word the paragraph in which I took some pains to put my views into a demonstrative shape, and ended with, 'It is as plain and certain as a proposition of Euclid!' And yet the subject was one pretty wide away from his own objects of study." Often, too, if some interesting fact was exhibited to him, he would send to his brother savants some such note as this:

"ROYAL INSTITUTION, 4th May, 1852.

"My DEAR WHEATSTONE" - Dr. Dubois-Raymond will be making his experiments here next Thursday, the 6th, from and after 11 o'clock. I wish

reproach; and in knowledge, that man only is to be contemned and despised who is not in a state of transition." "It is not the duty or place of a philosopher to dictate belief and all hypothesis is more or less matter of belief; he has but to give his facts and his conclusions, and so much of the logic which connects the former with the latter as he may think necessary, and then to commit the whole to the scientific world for present, and, as he may sometimes without presumption believe, I for future judgment."

1. Bacon's "Novnm Organum," i.,l.
2. For this anecdote; and some others in inverted commas, I am indebted to Mr. Frank Barnard.
3. In another letter that Lady Burdett Coutts has kindly sent me, Faraday says: " We had your box once before, I remember, for a pantomime, which is always interesting to me because of the immense concentration of means which it requires." In a third he makes admiring comments on Fechter.
4. I myself once heard this advanced by an infidel lecturer I on Paddington Green.
5. "Electrical Researches," Series XV.
6. Analogies in the Progress of Nature and Grace," p. 121.

with his usual vivacity and enthusiasm, and the inter- view is said to have gratified the philosopher as 0" well as the queen. He could not, however, escape the inroads made upon his time by correspondence. People would write and ask him questions. Once a solitary prisoner wrote to tell him, "It is, indeed, in studying the great discoveries which science is indebted to you for that I render my captivity less sad, and make time flow with rapidity"- and then he proceeds to ask," What is the most simple combination to give to a voltaic battery in order to produce a spark capable of setting fire to powder under water or under ground? Up to the present I have only seen employed to that purpose piles of thirty or forty pairs constructed on Dr. Wollaston's principles. They are very large and inconvenient for field service. Could not the same effect be produced by two spiral pairs only? and if so, what can be their smallest dimension ?" And who was the prisoner who thus speculated on the applications of science to war? It was no other than Prince Louis Napoleon, then immured in the fortress of Ham, and now the ex-Emperor of the French. At another time he wrote asking for his advice in the manufacture of an alloy which should be about as soft as lead, but not so fusible-a question which also had evident bearing upon the art of war; and offering, at the same time, to pay the cost of any experiments that might be necessary. Often, too, the correspondents of Faraday thought that they were doing him a kindness. He says somewhere: "The number of suggestions, hints for discovery, and propositions of various kinds, offered to me very freely, and with perfect good will and simplicity on the part of the proposers, for my exclusive investigation and honor, is remarkably great, and it is no less remarkable that but for one exception-that of Mr. Jenkin-they have all been worthless. ... I have, I think, universally found that the man whose mind was by nature or self-education fitted to make good and worthy suggestions, was also the man both able and willing to work them out." Both the askers of questions and the givers of advice expected answers - and the answers came. Most of Faraday's letters, indeed, are of a purely business character: sometimes they are very laconic, as the note in which he announced to Dr. Paris one of his principal discoveries:

and in his writings there sometimes occur such passages as the following: "When I consider the multitude of associated forces which are diffused through nature-when I think of that calm and tranquil balancing of their energies which enables elements most powerful in themselves, most destructive to the world's creatures and economy, to dwell associated together and be made subservient to the wants of creation, I rise from the contemplation more than ever impressed with the wisdom, the beneficence, and grandeur beyond our language to express, of the Great Disposer of all !" Faraday's journals abound with descriptions of " nature and human nature." He had evidently a keen eye for the beauties of scenery, and occasionally the objects around him suggested higher thoughts. Here are two instances taken from his notes of a Swiss tour in 1841 : "Monday, 19th: Very fine day; walk with dear Sarah on the lake side to Oberhofen, through the beautiful vineyards; very busy were the women and men in trimming the vines, stripping off leaves and tendrils from the fruit-bearing branches. The church-yard was beautiful, and the simplicity of the little remembrance-posts set upon the graves very pleasant. One who had been too poor to put up an engraved brass plate, or even a painted board, had written with ink on paper the birth and death of the being whose remains were below, and this had been fastened to a board, and mounted on the top of a stick at the head of the grave, the paper being protected by a little edge and root Such was the simple remembrance; but Nature had added her pathos, for under the shelter by the writing a caterpillar had fastened itself, and passed into its death-like state of chrysalis, and, having ultimately assumed its final state, it had winged its way from ; the spot, and had left the corpse-like relic behind. How old and how beautiful is this figure of the resurrection! Surely it can never appear before 'our eyes without touching the thoughts." "August 12th, Brienz Lake. George and I crossed the lake in a boat to the Giessbach-he to draw, and to saunter. ...This most beautiful fall consists of a fine river, which passes by successive steps down a very deep precipice into the lake. In some of these steps there is a clear leap of water of 100 feet or more, in others most beautiful combinations of leap, cataract, and rap- id, the finest rocks occurring at the sides and bed of the torrent. In one part a bridge passes over it. In another a cavern and a path occur under it. To-day every fall was foaming from the abundance of water, and the current of wind brought down by it was in some parts almost. too strong to stand against. The sun shone brightly, and the rainbows seen from various points were very beautiful. One at the bottom

to the bourn he desires to reach. So perhaps next summer I may think of your house-top again. Many thanks for your kind letter and all your kindnesses usward. My wife had your note yesterday, and I enjoyed the violets, which for a time I appropriated.

"With kindest remembrances and thoughts to all with you and her at Hastings, I am, my dear friend, very faithfully yours,

M. FARADAY."

The following is written to Mr. Frank Barnard, then an Art student in Paris:

"ROYAL INSTITUTION, 9th Nov., 1852.

"My DEAR NEPHEW , -Though I am not a letter-writer, and shall not profess to send you any news, yet I intend to. waste your time with one' sheet of paper, first to thank you for your letter to me, and then to thank you for what I hear of your letters to others. You were very kind to take the trouble of executing my commissions when I know your heart was bent upon the entrance to your studies. Your account of M. Arago was most interesting to me, though I should have been glad if in the matter of health you could have made it better. He has a wonderful mind and spirit. And so you are hard at work and somewhat embarrassed by your position; but no man can do just as he likes, and in many things he has to give way, and may do so honorably, provided he preserve his self respect. Never, my dear Frank, lose that, whatever may be the alternative. Let no one tempt you to it; for nothing can be expedient that is not right; and though some of your companions may tease you at first, they will respect you for your consistency in the end; and if they pretend not to do so, it is of no consequence. However, I trust the hardest part of your probation is over for the earliest is usually the hardest; and that you know how to take all things quietly. Happily for you, there is nothing in your pursuit which need embarrass you in Paris. I think you never cared .for home politics, so that those of another country are not likely to occupy your attention, and a stranger can be but a very poor judge of a new people and their requisites. I think all your family are pretty well, but I

attention. ! "How is it that your name is not signed to the testimony that you give? Are you doubtful even while you publish? I've no evidence that any natural or unnatural power is concerned in the phenomena that requires investigation or deserves it. If I could consult the spirits, or move them to make themselves honestly manifest, I would do it. But I can not, and am weary of them.

"I am, sir, your obedient servant,

"M. FARADAY."

There was once a strange statement put fourth to the effect that Faraday said electricity was life. ⁴ He himself denied it indignantly; but as most falsehoods are perversions of some truth, this one probably originated in his experiments on the Gymnotus. He felt an intense interest in those marine animals that give shocks, and sought "to identify the living power which they possess with that which man can call into action from inert matter, and by him named electricity." ⁵ The most powerful of these is the Gymnotus, or electrical eel, and a live specimen of this creature, forty inches long, was secured by the Adelaide Gallery-a predecessor of the Polytechnic-in the summer of 1838. Four days after its arrival the poor creature lost an eye; for two months it could not be coaxed to eat either meat or fish, worms or frogs; but at last one day it killed and devoured four small fishes, and afterward swallowed about a fish per diem. It was accustomed to swim round and round the tank till a live fish was dropped in, when, in some cases bending round its victim, it would discharge a shock that made the fish float on its back stunned and ready to be sucked into the jaws of its assailant. Faraday examined this eel and the water .around it, both with his hands and with special collectors of electricity, and satisfied himself not merely of the shock, which was easy enough, but of its power to deflect a galvanometer, to make a magnet, to effect chemical decomposition, and to give a spark. His account of the experiments- terminates with some speculations on the connections of this animal electricity with nervous power; but there the matter rested. His own views were thus expressed to his friend Dumas: "As living creatures .produce heat, and a heat certainly identical with that of our hearths, why should they not produce electricity also, arid an electricity in like manner identical with that of our machines? But if the heat produced

bridge had already acknowledged his merits, and the learned academies of Paris and Florence had enrolled him among their corresponding members. Heidelberg and St. Petersburg, Philadelphia and Boston, Copenhagen, Berlin, and Palermo, quickly followed; and as the fame of his researches spread, very many other learned societies in Europe and America, as well as at home, brought to him the tribute of their honorary membership. He thrice received the degree of Doctor, Oxford making him a D.C.L., Prague a Ph.D., and Cambridge an LT..D., besides which he was instituted a Chevalier of the Prussian Order of Merit, a Commander of the Legion of Honor, and a Knight Commander of "the Order of St. Maurice and St.Lazarus. Among the medals which he received were each of those at the disposal of the Royal Society-indeed, the Copley medal was given him twice-and the Grande Medaille d'Honneur at the time of the French Exhibition. Altogether it appears he was decorated with ninety-five titles and marks of merit, ⁹ including the blue ribbon of science, for in 1844 he was chosen one of the eight foreign associates of the French Academy. Though he had never passed through a university career, he was made a member of the Senate of the University of London, which he regarded as one of his chief honors; and he showed his appreciation of the importance of the office by a diligent attendance to its duties. As the recognized prince of investigators, it is no wonder that, on the resignation of Lord Wrottesley, an attempt was made to induce him to become President of the Royal Society. A deputation waited on him and urged the unanimous wish of the council and of scientific men. Faraday begged for time to consider. Tyndall gives us an insight into the reasons that led him to decline. He tells us: "On the following morning I went up to his room, and said, on entering, that I had come to him with some anxiety of mind. He demanded its cause, and I responded, 'Lest you should have decided against the wishes of the deputation that waited on you yesterday.' , You would not urge me to under- take this responsibility,' he said. 'I not only urge you,' was my reply, ' but I consider it your bounden duty to accept it.' He spoke of the labor that it would involve; urged that it was not in his nature to take things easy; and that, if he became president, he would surely have to stir many new questions, and agitate for some changes. I said that in such cases he would find himself supported by the youth and strength of the Royal Society. This, however, did not seem to satisfy him. Mrs. Faraday came into the room, and he appealed to her. Her decision was ad verse, and I deprecated her decision. ' Tyndall,' he said at length, I must remain plain Michael

Knight-hoods and baronetcies are sometimes conferred with such intentions, but I think them utterly unfit for that purpose. Instead of conferring distinction, they confound the man who is one of twenty, or perhaps fifty, with hundreds of others. They depress rather than exalt him, for they tend to lower the especial distinction of mind to the commonplaces of society. An intelligent country ought to recognize the scientific men among its people as a class. If honors are conferred upon eminence in any class, as that of the law or the army, they should be in this also. The aristocracy of the class should have other distinctions than those of lowly and highborn, rich and poor, yet they should be such as to be worthy of those whom the sovereign and the country should delight to honor, and, being rendered very desirable and even enviable in the eyes of the aristocracy by birth, should be unattainable except to that of science. Thus much I think the government and the country ought to do, for their own sake and the good of science, more than for the sake of the men who might be thought worthy of such distinction. The latter have attained to their fit place, whether the community at large recognize it or not. " But besides that, and as a matter of reward and encouragement to those who have not yet risen to great distinction, I think the government should, in the very many cases which come before it having a relation to scientific knowledge, employ men who pursue science, provided they are also men of business. This is perhaps now done to some extent, but to nothing like the degree which is practicable with advantage to all parties. The right means can not have occurred to a government which has not yet learned to approach and distinguish the class as a whole. "At the same time, I am free to confess that I am unable to advise how that which I think should be may come to pass. I believe I have written the expression of feelings rather than the conclusions of judgment, and I would wish your lordship to consider this letter as private rather than as one addressed to the chairman of a committee. "I have the honor to be, my lord, your very faithful servant,

M. FARADAY."

In this day, when so many allow their names to be used for offices of which they never intended to discharge the duties, the following letter I may convey an appropriate lesson:

share of health free from pain is granted with it; and while memory and certain other faculties of the mind diminish, my good spirits and cheerfulness do not diminish with them." When he could no longer discharge effectually his duties at the Trinity House, the Corporation quietly made their arrangements for transferring them, and, with the concurrence of the Board of Trade, determined that his salary of £200 per annum should continue as long as he lived. Sir Frederick Arrow called upon him at Albemarle Street, and explained how the matter stood, but he found it hard to persuade the professor that there was no injustice in his continuing to receive the money; then, taking hold of Sir Frederick by one hand and Dr. Tyndall by the other, Faraday, with swimming eyes, passed over his office to his successor. Gradually, but surely, the end approached. The loss of memory was followed by other symptoms of declining power. The fastenings of his earthly tabernacle were removed one by one, and he looked forward to "the house not made with hands, eternal in the heavens." This was no new anticipation. Calling on the friend who had long directed with him the affairs of the Institution, but who was then half paralyzed, he had said, " Barlow, you and I are waiting; that is what we have to do now; and we must try to do it patiently." He had written to his niece, Mrs. Deacon: " can not think that death has to the Christian any thing in it that should make it a rare, or other than a constant thought; out of the view of death comes the view of the life beyond the grave, as out of the view of sin (that true -and real view which the Holy Spirit alone can give to a man) comes the glorious hope. My worldly faculties are slipping away day by day. Happy is it for all of us that the true good lies not in them. As they ebb, may they leave us as little children trusting in the Father of Mercies, and accepting his unspeakable gift." .And when the dark shadow was creeping over him, he wrote to the Comte de Paris: "I bow before him who is the Lord of all, and hope to be kept waiting patiently for his time and mode of releasing me according to his divine Word, and the great and precious promises where by his people are made partakers of the divine nature." His niece, Miss Jane Barnard, who tended him with most devoted care, thus wrote from Hampton Court on the 27th of June: "The kind feelings shown on every side toward my dear uncle, and the ready offers of help, are most soothing. I am thankful to say that we are going on very quietly; he keeps his bed and sleeps much, and we think that the paralysis gains on him, but between whiles he speaks most pleasant words, showing his comfort and trust in the finished work of our Lord. The other day he repeated some verses of the

sent away their carriages, and perhaps put off other engagements. On this the whole audience rose as by a single impulse, and a number of persons surrounded Faraday, who now yielded to the general desire to spare him the pain and inconvenience of lecturing." A fortnight elapsed before he could again make his appearance, but he continued his course later than usual, in order not to deprive his audience of any of the eight lectures he had undertaken to give them. Prince Albert came to one of these extra lectures. Faraday's opinion as to the honors due to scientific men from society or from government may be gathered from the following extract from a letter written me by his private friend Mr. Blaikley: "On one occasion, when making some remark in reference to a movement on behalf of science, I inadvertently spoke of the proper honor due to science. He at once remarked, 'I am not one who considers that science can be honored.' I at once saw the point. His views of the grandeur of truth, when once apprehended, raised it far beyond any honor that man could give it; but man might honor him self by respecting and acknowledging it.." Professor George Wilson, of Edinburg, has thus described his first visit to the philosopher: "Faraday was very kind, showed me his whole laboratory with labors going on, and talked frankly and kindly; but to the usual question of something to do, gave the usual round answer, and treated me to a just, but not very cheering animadversion on the government of this country, which, unlike that of every other civilized country, will give no help to scientific inquiry, and will afford no aid or means of study for young chemists." "Take care of your money," was his advice to Mr. Joule, then another-young aspirant to scientific honors, but who has since rendered the highest service to science, without "leaning on any hopes of government help or public support. But the impressions given in conversation may not be always correct. Happily there exist his written opinions on this subject. In a letter addressed to Professor Andrews, of Belfast, and dated 2d February, 1843, there occurs this passage: "As to the particular point of your letter about which you honor me by asking my advice, I have no advice to give; but I have a strong feeling in the matter, and will tell you what I should do. I have always felt that there is something degrading in offering rewards for intellectual exertion, and that societies or academies, or even kings and emperors, should mingle in the matter does not remove the degradation, for the feeling which is hurt is a point above their condition, and belongs to the respect which a man owes to himself: With this feeling, I have never, since I was a boy, aimed at

in science. These were the gift of his widow, in accordance with his own desire.

2. This seems probable from some remarks of Faraday to Lady Burdett Coutts.
3. Sir Roderick Murchison used to tell how he was attending Brande's lectures, when one day, the professor being absent, his assistant took his place, and lectured with so much ease that he won the complete approval of the audience. This, he said, was Faraday's first lecture at the Royal Institution.
4. The laboratory note-book shows that at this very time he was making a long series of commercial analyses of salt-petre for Mr. Brande.
5. The following anecdote has been sent me on the authority of Mr. Benjamin Abbott: "Sergeant Anderson was engaged to attend to the furnaces in Mr. Faraday's researches on optical glass in 1828, and was chosen simply because of the habits of strict obedience his military training had given him. His duty was to keep the furnaces always at the same heat, and the water in the ash-pit always at the same level. In the evening he was released, but one night Faraday forgot to tell Anderson he could go home, and early next morning he found his faithful servant still stoking the glowing furnace, as he had been doing all night long."
6. One evening, when the Rev. A. J. D'Orsey was lecturing "On the Study of the English Language," he mentioned as a common vulgarism that of using "don't" in the third person singular, as "He don't pay his debts." Faraday exclaimed aloud, "That's very wrong."
7. The St. Paul's Magazine, June, 1870.

that he is in their presence." He allows a lecturer to prepare his discourse in writing, but not to read it before the audience, and points out how necessary it is "to raise their interest at the commencement of the lecture, and by a series of imperceptible gradations, unnoticed by the company, keep it alive as long as the subject demands it." This, of course, forbids breaks in the argument, or digressions foreign to the main purpose, and limits the length of the lecture to a period during which the listeners can pay unwearied attention. He castigates those speakers who descend so low as "to angle for claps," or who throw out hints for commendation, and shows that apologies should be made as seldom as possible. Experiments should be to the point, clear, and easily understood: "they should rather approach to simplicity, and explain the established principles of the subject, than be elaborate, and apply to minute phenomena only. ... 'Tis well, too, when the lecturer has the ready wit and the presence of mind to turn any casual circumstance to an illustration of his subject." But experiments should be explained by a satisfactory theory; or, if the scientific world is divided in opinion, both sides of the question ought to be stated with the strongest arguments for each, that justice may be, done and honor satisfied. Often in later days was his experience in lecturing made use of for the benefit of others. "If," he once remarked to a young lecturer, "I said to my audience, 'This stone will fall to the ground if I open my hand,' I should open my hand and let it fall. Take nothing for granted as known; inform the eye at the same time as you address the ear." I remember him once giving me hints on the laying of the lecture table at the Institution, and telling me that, where possible, he was accustomed to arrange the apparatus in such a way as to suggest the order of the experiments. An incident told me by Dr. Carpenter will illustrate some of the foregoing points. The first time he heard Faraday lecture at the Royal Institution, the Professor was explaining the researches of Melloni on radiant heat. During the discourse he touched on the refraction and polarization of heat; and to explain refraction, he showed the simple experiment of fixing some colored wafers at the bottom of a basin, and then pouring in water so as to make them apparently rise. Dr. Carpenter, who had come from Bristol with grand ideas of the lectures at Albemarle Street, wondered greatly at the introduction of so commonplace an experiment. Of course there were many other illustrations, and beautiful ones too. He went down, however, after the lecture, to the table, and among the crowd chatting there was an old gentleman, who remarked, "I think the best experiment tonight was

acknowledged, too, that he was endowed with a naturally clear understanding and an unusual power of looking below the surface of things. The first element of success that we meet with in his biography is the faithfulness with which he did his work. This led the bookseller to take his poor errand-boy as an apprentice; and this enabled his father to write, when he was 18: "Michael is bookbinder and stationer, and is very active at learning his business. He has been most part of four years of his time out of seven. He has a very good master and mistress, and likes his place well. He had a hard time for some while at first going; but, as the old saying goes, he has rather got the head above water, as there is two other boys under him." This faithful industry marked also his relations with Davy and Brande, and the whole of his subsequent life, and at last, when he found that he could no longer discharge his duties, it made him repeatedly press his resignation on the managers of the Royal Institution, and beg to be relieved of his eldership in the Church. His love of study, and hunger after knowledge, led him to the particular career which he pursued, and that power of imagination, which reveals itself in his early letters, grew and grew, till it gave him such a familiarity with the unseen forces of nature as has never been vouchsafed to any other mortal. As a source of success there stands out also his enthusiasm. A new fact seemed to charge him with an energy that gleamed from his eyes and quivered through his limbs, and, as by induction, charged for the time those in his presence with the same vigor of interest. Plucker, of Bonn, was showing him one day in the laboratory at Albemarle Street his experiments on the action of a magnet on the electric discharge in vacuum tubes. Faraday danced round them; and as he saw the moving arches of light, he cried, "Oh! to live always in it!" Mr. James Heywood once met him in the thick of a tremendous storm at Eastbourne, rubbing his hands with delight because he had been fortunate enough to see the lightning strike the church tower. This enthusiasm led him to throw all his heart into his work. Nor was the energy spasmodic, or wasted on unworthy objects; for, in the words of Bence Jones, his was "a lifelong strife to seek and say that which he thought was true, and to do that which he thought was kind." Indeed, his perseverance in a noble strife was another of the grand elements in his success. His tenacity of purpose showed itself equally in little and in great things. Arranging some apparatus one day with a philosophical instrument maker, he let fall on the floor a small piece of glass: he made several ineffectual attempts to pick it up. "Never mind," said his companion, "it is not worth the trouble." "Well, but, Murray, I

ought to be overcome I have not the least doubt in the world." Lord Clarendon asked him: "You think it is now knocking at the door, and there is a prospect of the door being opened?" "Yes," answered Faraday, "and it will make its way, or we shall stay behind other nations in our mode of education." He had been led to the conviction that the exclusive attention to literary studies created a tendency to regard other things as nonsense, or belonging only to the artisan, and so the mind is positively injured for the reception of real knowledge. He says: "It is the highly educated man that we find coming to us again and again, and asking the most simple question in chemistry or mechanics; and when we speak of such things as the conservation of force, the permanency of matter, and the unchangeability of the laws of nature, they are far from comprehending them, though they have relation to us in every action of our lives. Many of these instructed persons are as far from having the power of judging of these things as if their minds had never been trained." He gives his own opinion as to the precise course to be pursued with great diffidence; but it is evident that he would begin the education in natural science at a pretty early age, and in all cases carry it up to a certain point. One fifth of a boy's time might be devoted to this purpose at present, though in less than half a century he thinks science will deserve and obtain a far larger share. Supposing a boy of eleven years of age and of ordinary intelligence at one of our public schools: "I would teach him," he says, "all those things that come before classics in the programme of the London University -mechanics, hydrostatics, hydraulics, pneumatics, acoustics, and optics. They are very simple and easily understood when they are looked at with attention by both man and boy. With a candle, a lamp, and a lens or two, an intelligent instructor might teach optics in a very short time; and so with chemistry. I should desire all these." Much would depend on the competency and earnestness of the teacher. "Good lectures might do a great deal. They would, at all events, remove the absolute ignorance which sometimes now appears, but would give a very poor knowledge of natural things." Perhaps these opinions of one whose lips are now silent will yet have their weight in the discussion of this question both in our highest seats of learning and in those educational parliaments which have been just called into existence in almost every town and district of our country. From the somewhat disparaging remarks about lectures quoted above, it must not be supposed that this prince of lecturers depreciated his office. "Lectures," he said, "depend entirely for their value upon the manner in which they are given. It is not the matter,

gentleman wearing his hat in the drawing-room." This produced a laugh, which the professor joined in, bowed, and retired, This faithful discharge of duty, this almost intuitive insight into natural phenomena, and this persevering enthusiasm in the pursuit of truth, might alone have secured a great position in the scientific world, but they alone could never have won for him that large inheritance of respect and love. His contemporaries might have gazed upon him with an interest and admiration akin to that with which he watched a thunder-storm; but who feels his affections drawn out toward a mere intellectual Jupiter; we must look deeper into his character to understand this. There is a law well recognized in the science of light and heat, that a body can absorb only the same sort of rays which it is capable of emitting. Just so is it in the moral world. The respect and love of his generation were given to Faraday because his own nature was full of love and respect for others. Each of these qualities, his respect for and love to others, or, more generally, his reverence and kindness deserves careful examination. Throughout his life, Michael Faraday appeared as though standing in a reverential attitude toward Nature, Man, and God. Toward Nature, for he regarded the universe as a vast congeries of facts which would not bend to human theories. Speaking of his own early life, he says: "I was a very lively, imaginative person. and could believe in the Arabian Nights' as easily as in the 'Encyclopaedia;' but facts were important to me, and saved me. I could trust a fact, and always cross-examined an assertion." He was, indeed, a true disciple of that philosophy which says, "Man, who is the servant and interpreter of Nature, can act and understand no farther than he has, either in operation or in contemplation, observed of the method and order of Nature." ¹ And verily Nature admitted her servant into her secret chambers, and showed him marvels to interpret to his fellow-men more wonderful and beautiful than the phantasmagoria of Eastern romance. His reverence toward Man showed itself in the respect he uniformly paid to others and to himself Thoroughly genuine and simple-hearted himself, he was wont to credit his fellow-men with high motives and good reasons. This was rather uncomfortable when one was conscious of no such merit, and I at least have felt ashamed in his presence of the poor commonplace grounds of my words and actions. To be in his company "as in fact a moral tonic. As he had learned the difficult art of honoring all men, he was not likely to run after those whom the world counted great. " We must get Garibaldi to come some Friday evening," said a member of the Institution during the visit of the Italian hero to London. " Well, if

stimulate him to the requisite exertion; and to those who reflect upon the many hours and days devoted by a lover of sweet sounds to gain a moderate facility upon a mere mechanical instrument, it ought to bring a correcting blush of shame if they feel; convicted of neglecting the beautiful living instrument wherein play all the powers of the mind." At the commencement of this discourse the lecturer felt called upon to limit the range of his remarks: "High as man is placed above the creatures around him, there is a higher and far more exalted position within his view; and the ways are infinite in which he occupies his thoughts about the fears, or hopes, or expectations of a future life. I believe that the truth of that future can not be brought to his knowledge by any exertion of his mental powers, however exalted they may be; that it is made known to him by other teaching than his own, and is received through simple belief of the testimony given. Let no one suppose for a moment that the self-education I am about to commend in respect of the things of this life extends to any considerations of the hope set before us, as if man by reasoning could find out God. It would be improper here to enter upon this subject further than to claim an absolute distinction between religious and ordinary belief I shall be reproached with the weakness of refusing to apply those mental operations which I think good in respect of high things to the very highest. I am content to bear the reproach.. Yet, even in earthly matters, I believe that 'the invisible things of Him from the creation of the world are clearly seen, being understood by the things that are made, even his eternal power and Godhead; and I have never seen any thing incompatible between those things of man which can be known by the spirit of man which is within him, and those higher things concerning his future which he can not know by that spirit.'" There is, of course, a certain truth in this passage; spiritual discernment is a real thing possessed by some, and not by others; yet is there this absolute distinction between religious and ordinary belief? Surely there is the same opportunity and the same necessity for careful judgment, and for resistance to prejudice or preference, when we are weighing the credentials of any thing that may come before us purporting to be a revelation from above; surely, too, if we have satisfied ourselves that we possess such a revelation, we must seek for the same clearness of ideas, and must exercise the same patience and labor of thought if we would understand it aright. That mental discipline which fits us to interpret the works of God can not but be akin to the intellectual training required for interpreting his word. Since Faraday thought and wrote, the question of

combined with his delicate regard for the feelings of others, struck me forcibly in the following incident; At Mr. Barlow's one Friday evening after the discourse, two or three other chemists and myself were commenting unfavorably on a public act of Faraday, when suddenly he appeared beside us. I did not hesitate to tell him my opinion. He gave me a short answer, and joined others of the company. A few days afterward he found me in the laboratory preparing for a lecture, and, without referring directly to what I had said, he gave me a full history of the transaction in such away as to show that he could not have acted otherwise, and at the same time to render any apology on my part unnecessary. Intimately connected with his respect for Man as well as reverence for truth was the flash of his indignation against any injustice, and his hot anger against any whom he discovered to be pretenders. When, for instance, he had convinced himself that the reputed facts of table-turning and spiritualism were false, his severe denunciation of the whole thing followed as a matter of course. Thus, too, a story is told of his once taking the side of the injured in a street quarrel by the pump in Savile Row. One evening also at my house, a young man who has since acquired a scientific renown was showing specimens of some new compounds he had made. A well-known chemist objected that, after all, they were mere products of the laboratory; but Faraday came to the help of the young experimenter, and contended that they were chemical substances worthy of attention, just as much as though they occurred in nature. His reverence for God was shown not merely by that homage which every religious man must pay to his Creator and Redeemer, but by the enfolding of the words of Scripture and similar expressions in such a robe of sacredness that he rarely allowed them to pass his lips or flow from his pen unless he was convinced of the full sympathy of the person with whom he was holding intercourse. This characteristic reverence was united to an equally characteristic kindness. This word does not exactly express the quality intended; but unselfishness is negative, goodness is too general, love is commonly used with special applications; kindness, friendship, geniality, and benevolence are only single aspects of the quality. Let the reader add these terms all together, and the resultant will be about what is meant. Faraday's love to children was one way in which this kindness was shown. Having no children of his own, he surrounded himself usually with his nieces: -we have already had a glimpse of him heartily entering into their play, and we are told how a word or two from uncle would clear away all the trouble from a difficult lesson, that a long

from the first are given by Dr. Bence Jones; the second was published at the time. In the early lecture, which is "On the Forms of Matter," he points out the advantages and dangers of systematizing, and winds up his remarks with " Nothing is more difficult and requires more care than philosophical deduction, nor is there any thing more adverse to its accuracy than fixidity of opinion. The man who is certain he is right is almost sure to be wrong, and he has the additional misfortune of inevitably remaining so. All our theories are fixed upon uncertain data, and all of them want alteration and support. Ever since the world began opinion has changed with the progress of things, and it is something more than absurd to suppose that we have a sure claim to perfection, or that we are in possession of the highest stretch of intellect which has or can result from human thought. Why our successors should not displace us in our opinions as well as in our persons it is difficult to say; it ever has been so, and from analogy would be supposed to continue so; and yet, with all this practical evidence of the fallibility of our opinions, all, and none more than philosophers, are ready to assert the real truth of their opinions." In his discourse entitled "Observations on Mental Education," like a skillful physician he first determines what is the great intellectual disease from which the community suffers-"deficiency of judgment"-and then he lays down rules by which each man may attempt his own cure. For this self-education, cc it is necessary that a man examine himself, and that not carelessly. ...A first result of this habit of mind will be an internal conviction of ignorance in many things respecting which his neighbors are taught, and that his opinions and conclusions on such matters ought to be advanced with reservation. A mind so disciplined will be open to correction upon good grounds in all things, even in those it is best acquainted with, and should familiarize itself with the idea of such being the case. It is right that we should stand by and act on our principles, but not right to hold them in obstinate blindness, or retain them when proved to be erroneous." And then he gives cases from his own mental history: "I remember the time when I believed a spark was produced between voltaic metals as they approached to contact (and the reasons why it might be possible yet remain); but others doubted the fact and denied the proofs, and on re-examination I found reason to admit their corrections were well-founded. Years ago I believed that electrolites could conduct electricity by a conduction proper; that has also been denied by . many through long time: though I believed my-self right, yet circumstances have induced me to pay that respect to criticism as to reinvestigate the

returned to the village I bade her good-night, and she bade me farewell, both by her actions, and, I have no doubt, her language too." In a letter which Mr. Abel, the Director of the Chemical Department of the War Establishment, has sent me, occur the following remarks: "Early in 1849 I was appointed, partly through the kind recommendation of Faraday, to instruct the senior cadets and a class of artillery officers in the Arsenal in practical chemistry. On the occasion of my first attendance at Woolwich, when; having just reached manhood, I was about to deliver my first lecture as a recognized teacher, I was naturally nervous, and was therefore dismayed when, on entering the class-room, I perceived Faraday, who, having come to Woolwich as usual, to prepare for his next morning's lecture at the Military Academy, had been prompted by his kindly feelings to lend me the support of his presence upon my first appearance among his old pupils. In a moment Faraday put me completely at my ease; he greeted me heartily, saying, 'Well, Abel, I have come to see .whether I can assist you;' and, suiting action to word, he bustled about, persisting in helping me ' in the arrangement of my lecture-table, and at the close of my demonstration he followed me from pupil to pupil, aiding each in his first attempt at manipulation, and evidently enjoying most heartily the self-imposed duty of assistant to his young protege." Another scientific friend, Mr. W. F. Barrett, writes: "My first interview with Mr. Faraday ten years ago left an impression upon me I can never forget. Young student as I then was, thinking chiefly of present work and little of future prospects, and till then unknown to Mr. Faraday judge of my feelings when, taking my hand in both of his, he said, 'I congratulate you upon choosing to be a philosopher: it is an arduous life, but a noble and a glorious one. Work hard, and work carefully, and you will have success.' The sweet yet serious way he said this made the earnestness of work become a very vivid reality, and led me to doubt whether I had not dared to undertake too lofty a pursuit. After this Mr. Faraday never forgot to remember me in a number of thoughtful and delicate ways. He would ask me up stairs to his room to describe or show him the results of any little investigation I might have made: taking the greatest interest in it all, his pleasure would seem to equal and thus heighten mine, and then. he would add words of kind suggestion and encouragement. In the same kindly spirit he has invited me to his house at Hampton Court, or would ask me to join him at supper after the Friday evening's lecture. His kindness is further shown by his giving me a volume of his researches on Chemistry and Physics, writing therein,

kindred spirits, he would turn naturally enough from scientific to religious thoughts, and back again to natural philosophy, but he generally kept these two departments of his mental activity strangely distinct, though of course it was well known that the professor at Albemarle Street was one of that long line of scientific men, beginning with the savants of the East, who have brought to the Redeemer the gold, frankincense, and myrrh of their adoration. But the peculiar features of Faraday's spiritual life are matters of minor importance: the genuineness of his religious character is acknowledged by all. We have admired his faithfulness, his amiability of disposition, and his love of justice and truth: how far these qualities were natural gifts, like his clearness of intellect, we can not precisely tell; but that he exercised constant self control without becoming hard, ascended the pathway of fame without ever losing his balance, and shed around himself a peculiar halo of love and joyousness, must be attributed in no small degree to a heart at-peace with God, and to the consciousness of a higher life.

SECTION III

FRUITS OF HIS EXPERIENCE

THOSE who loved Faraday would treasure every word that he wrote, and to them the life and letters which Bence Jones has given to the world will be inestimable; but from the multitude who knew him only at a distance, we can expect no enthusiasm of admiration. Yet all will readily believe that through the writings of such a genius there must be scattered nuggets of intellectual gold, even when he is not treating directly of scientific subjects. Some of these relate to questions of permanent interest, and such nuggets it is my aim to separate and lay before the reader. When quite a young man he drew the following ideal portrait: "The philosopher should be a man willing to listen to every suggestion, but determined to judge for himself. He should not be biased by appearances, have no favorite 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." This ideal he must steadily have kept before him, and not unfrequently in after days he gave utterance to

for him. His charities were very numerous-not to beg-gars; for them he had the Mendicity Society's tickets-but to those whose need he knew. The porter of the Royal Institution has shown me, among his treasured memorials, a large number of forms for post-office orders for sums varying from 5s. to £5, which Faraday was in the habit of sending in that way to different recipients of his thoughtful bounty. Two or three instances have come to my knowledge of his having given more considerable sums of money-say £20-to" persons who he thought would be benefited by them. In some instances the gift was called a loan, but he lent" not expecting again," and entered into the spirit of the injunction, "When thou doest alms, let not thy left hand know what thy right hand doeth."

This principle was in fact stated in one of his letters to a friend: "As a case of distress, I shall be very happy to help you as far as my means allow me in such cases; but then I never let my name go to such acts, and very rarely even the initials of my name." His contributions to the general funds of his Church were kept equally secret. From all these circumstances, therefore, it is impossible to gauge the amount of his charitable gifts; but when it is remembered that for many years his income from different sources must have been £1000 or £1200, that he and Mrs. Faraday lived in a simple manner-comfortably, it is true, but not luxuriously-and that his whole income ..was disposed of in some way, there can be little doubt that his gifts amounted to several hundred pounds per annum. But it was not in monetary gifts alone that his kindness to the distressed was shown. Time was spent as freely as money, and an engrossing scientific research would not be allowed to stand in the way of his succoring the sorrowful. Many persons have told me of his self-denying deeds on behalf of those who were ill, and of his encouraging words. He had, indeed, a heart ever ready to sympathize. Thus, meeting once in the neighborhood of Hampton Court an old friend who had retired there invalided and was being drawn about in a Bath chair, he is said to have burst into tears. When eight years ago my wife and my only son were taken away together " and I lay ill of the same fatal disease, he called at my house, and, ill spite of demonstrances, found his way into the infected chamber. He would have taken me by the hand if I had allowed him; and then he sat a while by my bedside consoling me with his sympathy and cheering me with the Christian hope. It is no wonder that this kindness took the hearts of men captive; and this quality was, like mercy, "twice blessed; it blesseth him that gives, and him that takes." The

your position and with your pursuits, which elevate you entirely out of the meaner -aspects and lower aims of common life," "He shook his head, and with that wonderful mobility of countenance which was characteristic, his expression of joyousness changed to one of profound sadness, and he replied: 'When I quitted business, and took to science as a career, I thought I had left behind me all the petty meannesses and small jealousies which hinder man in his moral progress; but I found myself raised into another sphere only to find poor human nature just the same every where-subject to the same weaknesses and the same self-seeking, however exalted the intellect, These were his words as well as I can recollect; and, looking at that good and great man, I thought I had never seen a countenance which so impressed me with the characteristic of perfect unworldliness. We know how his life "proved that this rare qualification was indeed his." "Childlike simplicity:" "unworldliness." Where was the tree rooted that bore such beautiful blossoms? Far a day had learned in the school of Christ to become "a little child," and he loved not the world because the love of the Father was in him. We have a charming glimpse of this in an extract which Professor Tyndall has given from an old paper in which he wrote his impressions after one of his earliest dinners with the philosopher: "At two o'clock he came down for me. He, his niece, and myself formed the party. 'I never give dinners,' he said; 'I don't know how to give dinners; and I never dine out. But I should not like my friends to attribute this to a I wrong cause. I act thus for the sake of securing time for work, and not through religious motives, as some imagine.' He said grace. I am almost ashamed to call his prayer a 'saying' of grace. In the language of Scripture, it might be described as the petition of a son into whose heart God had sent the Spirit of his Son, and who with absolute trust asked a blessing from his father. We dined on roast beef, Yorkshire pudding, and potatoes, drank sherry, talked of research and its requirements, and of his habit of keeping himself free from the distractions of society. He was bright and joyful-boy-like, in fact, though he is now sixty-two. His work excites admiration, but contact with him warms and elevates the heart. Here, surely, is a strong man. I love strength, but let me not forget the example of its union with modesty, tenderness, and sweetness, in the character of Faraday." But his religion deserves a closer attention. When an errand-boy, we find him hurrying the delivery of his newspapers on a Sunday morning so as to get home in time to make himself neat to go with his parents to chapel: his letters when abroad indicate the same disposition; yet he did not make any

House. In that case I shall hear from him through the Trinity House. He has, however, certain inquiries (which have no I doubt have gone to him long ago through the Trinity House) to answer before I shall think it necessary to take any further steps in the matter. With these, however, I suppose you have nothing to do. "Are you aware that many years ago our Institution was lighted up for months, if not for years together, by oil gas (or, as you call it, olefiant gas), compressed into cylinders to the extent of thirty atmospheres, and brought to us from a distance? I have no idea that the patent referred to at the bottom of page 9 could stand for an hour in a court of law. I think, too, you are wrong in misapplying the word olefiant. It already belongs to a particular gas, and can not, without confusion, be used as you use it.

"I am, sir, your obedient servant,

"M.FARADAY."

"SIR,-Thanks for your letter. At the close of it you ask me privately and confidingly for the encouragement my opinion might give you if this power gas-light is fit for light-houses. I am unable to assent to your request, as my position at the Trinity House requires that I should be able to take up any subject, applications, or documents they may bring before me in a perfectly unbiased condition of mind.

"I am, sir, yours very truly,

M.FABADAY."

The kindness which shed its genial radiance on every object around glowed most warmly on the domestic hearth. Little expressions in his writings often reveal it, as when we read in his Swiss journal about Interlachen: "Cloutnail making goes on here rather considerably, and is a neat and pretty operation to observe. I love a smith's shop, and any thing relating to smithery. My father was a smith." When he was sitting to Noble for his bust, it happened one day that the sculptor, in giving the finishing touches to the marble, made a clattering with his chisels: noticing that his sitter-appeared distraught, he said that he feared the jingling

brought up: it is certain that he was restrained by the desire to give all the time and energy he could to scientific research. Yet pleasant stories are told of his occasional appearances at social gatherings. Thus he liked to attend the Royal Academy dinners, and in earlier days he enjoyed the artistic and musical conversaciones at Hullmandel's, where Stanfield Turner and Landseer met Garcia and Malibran; and sometimes he joined this pleasant company at supper and charades, at others in their excursions up the river in an eight-oared cutter. Captain Close has described to me how, when the French light-house authorities put up the screw-pile light on the sands near Calais, they invited the Trinity House officers and Faraday to inspect it. A dinner was arranged for them after the inspection, and M. Reynaud proposed the health of the stranger celeberrime. A young engineer took exception to Faraday being called a stranger--since he had been at St. Cyr he had known the great Englishman well by his works. The professor replied to the compliment in the language of his hosts, with a few of his happy and kindly remarks. A gentleman high in the diplomatic service, who was present, remarked that Faraday had said many things which were not French, but not a word which ought not to be so. More unrestricted was Faraday's sympathy with Nature. He felt the poetry of the changing seasons, but there were two aspects of Nature that especially seemed to claim communion with his spirit: he delighted in a thunder-storm, and he experienced a pleasurable sadness as the orange sunset faded into the evening twilight. There are other minds to which both these sensations are familiar, but they seem to have been felt with great intensity by him. No doubt his electrical knowledge added much to his interest in the grand discharges from the thunder-clouds, but it will hardly account for his standing long at a window watching the vivid flashes, a stranger to fear, with his mind full of lofty thoughts, or perhaps of high communings. Sometimes, too, if the storm was at a little distance, he would summon a cab, and, in spite of the pelting rain, drive to the scene of awful beauty. One clear starry night Captain Close quoted to him the words of Lorenzo in the "Merchant of Venice":

On the character of Faraday, these two qualities of reverence and kindness have appeared to me singularly influential. Among the ways in which they manifested themselves was that beautiful combination of firmness and gentleness which has been frequently remarked: intimately associated with them also were his simplicity and truthfulness. These points must have made themselves evident already, but they deserve further illustration. In his early days, "one Sabbath morning, his swift and sober steps were carrying him along the Holborn pavement toward his meeting-house when some small missile struck him smartly on the hat. He would have thought it an accident and passed on, when a second and a third rap I caused him to turn and look just in time to perceive a face hastily withdrawn from a window the upper story of a closed linen-drapery's establishment. Roused by the affront, he marched up to the door and rapped. The servant, opening it, said there was no one at home; but Faraday declared he knew better, and desired to be shown up stairs. Opposition still being made, he pushed on, made his way up through the house, opened the door of an upper room, discovering a party of young drapers' assistants, who at once professed they knew nothing of the motive of this sudden visit. But the hunter had now run his game to earth: he taxed them sharply with their annoyance of wayfarers on the Sabbath, and said that unless an apology were made at once, they should hear from their employer of something much to their disadvantage. An apology was made forthwith." Long, long after this event, Dr. and Mrs. Faraday, with Dr. Tyndall, were returning one evening from Mr. Gassiot's, on Clapham Common: a dense fog came on, and they did not know where they were. The two gentlemen got out of their vehicle, and walked to a house and knocked. A man appeared, first at a window and afterward at the door, very angry indeed at the disturbance, and demanding to know their business. Faraday, in his calm, irresistible manner, explained the situation and their object in knocking. The man instantly changed his tone, looked foolish, and muttered something about being in a fright lest his house of business was on fire. As to simplicity of character: when, in the course of writing this book, I have spoken to his acquaintances about Faraday, the most frequent comment has been in such words as, "Oh! he was a beautiful character, and so simple-minded." I have tried to ascertain the cause of this simple-mindedness, and I believe it was the consciousness that he was meaning to do right himself, and the belief that others whom he addressed meant to do right too, and so he could just let them see every thing that was passing through his

mind. And while he knew no reason for concealment, there was no trace of self-conceit about him, nor any pretense at being what he was not. To illustrate this quality is not so easy; the indications of it, like his humor, were generally too delicate to be transferred to paper; but perhaps the following letter will do as well as any thing else, for there are few philosophers who could have written so naturally about the pleasures of a pantomime and then about his highest hopes:

"ROYAL INSTITUTION, LONDON, W.,
1st Jan., 1857.

"My DEAR MISS Coutts,-You are very kind to think of our pleasure and send us entrance to your box for to-morrow night. We thank you very sincerely, and I mean to enjoy it, for I still have a sympathy with children, and all their thoughts and pleasure. Permit me to wish you very sincerely a happy year; and also to Mrs. Brown. With some of us our greatest happiness will be content mingled with patience; but there is much happiness in that and the expected end. Ever your obliged servant,

"M. FARADAY." 3

As to truthfulness: he was not only truthful in the common acceptation of the word, but he did not allow, either in himself or others, hasty conclusions, random assertions, or slippery logic. "At such times he had a way of repeating the suspicious statement very slowly and distinctly, with an air of wondering scrutiny as if it had astonished him. His irony was then irresistible, and always produced a modification of the objectionable phrase." "An acquaintance rather given to inflict tedious narratives on his friends was descanting to Faraday on the iniquity of some coachman who had set him down the previous night in the middle of a dark and miry road-'in fact,' said the 'irksome drawler, 'in a perfect morass; and there I was, as you may imagine, half the night, plunging and struggling to get out of this dreadful morass.' 'More ass you rapped out the philosopher at the top of his scale of laughter." This was a rare instance, for it was only when much provoked that he would perpetrate a pun, or depart from the kind courtesy of his habitual talk. That he was quite ready to give up a statement or view when it was proved by others to be incorrect, is shown by the Preface to the volumes in which are reprinted his "Experimental Researches." "In giving advice," says Miss

Reid, "he always went back to first principles, to the true right and wrong of questions, never allowing deviations from the simple straight-forward path of duty to be justified by custom or precedent; and he judged himself strictly by the same rule which he laid down for others." These beauties of character were not marred by serious defects or opposing faults. "He could not be too closely approached. There were no shabby places or ugly corners in his mind." Yet he was very far from being one of those passionless men who resemble a cold statue rather than throbbing flesh and blood. He was no "model of all the virtues," dreadfully uninteresting, and discouraging to those who feel such calm perfection out of their reach. 'His inner life was a battle, with its wounds as well as its victory. Proud by nature, and quick-tempered, he must have found the curb often necessary; but, notwithstanding the rapidity of his actions and thoughts, he knew how to keep a tight rein on that fiery spirit. I have listened attentively to every remark in disparagement of Faraday's character, but the only serious ones have appeared to me to arise from a misunderstanding of the man-a misunderstanding the more easy because his standard of right and wrong often differed from the notions current around him. Still, it may be true that his extreme sensitiveness led him sometimes to do scant justice to those who he imagined were treading too closely in his own foot-steps; as, for instance, when Nobili brought out some beautiful experiments on magnetism, just after the short notice of his own discoveries in 1831 which Faraday had sent to M. Hachette, and which was communicated to the Academie des Sciences. It is true also that, with his great caution and his repugnance to moral evil, he was more disposed to turn away in disgust from an erring companion than to endeavor to reclaim him. It has also been imputed to him as a fault that he founded no school, and took no young man by the hand as Davy had taken him. That this was rather his misfortune than his fault would appear from words he once wrote to Miss Moore: "I have often endeavored to discover a genius, but have not been very successful, though many cases seemed promising at first." The world would doubtless have been the gainer if he had stamped his own image on the minds of a group of disciples; but a man can not do every thing; and had Faraday been more of a teacher, he would perhaps have been less of an investigator. It has been previously remarked that Faraday took little part in social movements, and went little into society, but it must not be supposed that he was by any means unsocial. It seems probable that his freedom in this matter was somewhat hampered by the principles in which he had been