

commercial work at the same time. To test this conclusion I asked permission to see his accounts, and on my own responsibility, will state the result. In 1832, his professional business income, instead of rising to £5,000, or more, fell from £1,090 4s. to £155 9s. From this it fell, with slight oscillations, to £92 in 1837, and to zero in 1838. Between 1839 and 1845, it never, except in one instance, exceeded £22; being for the most part under this. The exceptional year referred to was that in which he and Sir Charles Lyell were engaged by Government to write a report on the Haswell Colliery explosion, and then his business income rose to £112. From the end of 1845 to the day of his death, Faraday's annual professional business income was exactly zero. Taking the duration of his life into account, this son of a blacksmith, and apprentice to a bookbinder, had to decide between a fortune of £150,000 [\$750,000] on the one side, and his undowered science on the other. He chose the latter and died a poor man. But his was the glory of holding aloft among the nations the scientific name of England for a period of forty years.—PROFESSOR TYNDALL.

FARADAY AND THE PRESIDENCY OF THE ROYAL SOCIETY

The outward and visible signs of fame were of less account to Tyndall than to most men. He had been loaded with scientific honors from all parts of the world. Without, I imagine, a dissentient voice, he was regarded as the prince of the physical investigators of the present age. The highest scientific position in this country he had, however, never filled. When [in 1858—Faraday was then 67 years of age] the late excellent and lamented Lord

Wrottesley resigned the presidency of the Royal Society, a deputation from the council, consisting of his Lordship, Mr. Grove, and Mr. Gassiot, waited upon Faraday, to urge him to accept the president's chair. All that argument or friendly persuasion could do was done to induce him to yield to the wishes of the council, which was also the unanimous wish of scientific men. A knowledge of the quickness of his own nature had induced in Faraday the habit of requiring an interval of reflection, before he decided upon any question of importance. In the present instance he followed his usual habit, and begged for a little time.

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 undertake 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 adverse and I deprecated her decision. "Tyndall," he said at length, "I must remain plain Michael Faraday to the last; and let me now tell you, that if I accepted the honor which the Royal Society desires to confer upon me, I would not answer for

matter in the lines of its motion. By this he enlarged and added to the subjects which he thought naturally possible for experiment to attack; and to experiment he went to test his ideas; and though he failed to realize his imaginations, yet, by his genius, and truthfulness, and handicraft, he filled his experimental researches with new and connected facts, and thus he left to science a monument of himself which will last in all its grandeur for ages.—  
DR. BENICE JONES.

## FARADAY AS A MAN

As a man, the beauty and nobleness of Faraday's character was formed by very many great qualities. Among these the first and greatest was his truthfulness. His noble nature showed itself in his search for truth. He loved truth beyond all other things; and no one ever did or will search for it with more energy than he did.

His second great quality was his kindness (*agapê*). It was born in him, and by his careful culture it grew up to be the rule of his life; kindness to everyone, always—in thought, in word, and in deed.

His third great quality was his energy. This was no strong effort for a short time, but a lifelong lasting strife to seek and say that which he thought was true, and to do that which he thought was kind.

Some will consider that his strong religious feeling was the prime cause of these great qualities; and there is no doubt that one of his natural qualities was greatly strengthened by his religion. It produced what may well be called his marvelous humility.

That one who had been a newspaper boy should receive,

unsought, almost every honor which every republic of science throughout the world could give: that he should for many years be consulted constantly by the different departments of the Government, and other authorities, on questions regarding the good of others; that he should be sought after by the princes of his own and other countries; and that he should be the admiration of every scientific and unscientific person who knew anything of him, was enough to have made him proud; but his religion was a living root of fresh humility, and from first to last it may be seen growing with his fame and reaching its height with his glory, and making him, to the end of his life, certainly the humblest, whilst he was also the most energetic, the truest, and the kindest, of experimental philosophers.

To complete this picture, one word more must be said of his religion. His standard of duty was supernatural. It was not founded upon any intuitive ideas of right and wrong; nor was it fashioned upon any outward expediencies of time and place; but it was formed entirely on what he held to be the revelation of the will of God in the written word; and throughout all his life his faith led him to endeavor to act up to the very letter of it.—DR. BENICE JONES.

## READERS' AND STUDENTS' NOTES

1. The life of Faraday is one of the most popular biographical subjects in literature. Such works as "*Clever Boys of Our Time and How They Became Great Men*," and Sarah K. Bolton's "*Poor Boys Who Became Famous*," are sure to contain accounts

of Faraday. A very excellent account of Faraday, with also a popular explanation of the nature of his physical and chemical discoveries will be found in Dr. William Garnett's "*Heroes of Science—Physicists*" (New York: E. & J. B. Young & Co.). The student will also find that Faraday occupies an important place in Miss Buckley's "*Short History of Natural Science*" (New York: D. Appleton & Co.).

2. The standard "*Life of Faraday*" is the "*Life and Letters*," by his friend, Dr. Bence Jones, the secretary of that "Royal Institution" in which Faraday labored so long. This work however is larger than the ordinary reader will usually have time for. (London: Longmans. 2 vols., 8vo.)

3. Perhaps the one best book for the ordinary reader to get in order to obtain a good idea of Faraday's life and work is "*Michael Faraday*," by J. H. Gladstone, Ph. D., F. R. S. (son of William Ewart Gladstone). It is only of 172 pages, and is exceedingly interesting from beginning to end. (London: The Macmillan Co.)

4. Professor Tyndall's "*Faraday as a Discoverer*" was "a labor of love." Tyndall was Faraday's assistant, and afterwards his successor. He considered Faraday the greatest man in physical science in the century. The work is peculiarly valuable from its clear and easily understood exposition of the nature of Faraday's discoveries. (New York: D. Appleton & Co., \$1.00.)

Sir Charles Lyell

the integrity of my intellect for a single year." I urged him no more, and Lord Wrottesley had a most worthy successor in Sir Benjamin Brodie.—PROFESSOR TYNDALL.

#### FARADAY'S WORK FOR THE UNIFICATION OF SCIENCE

Faraday was pre-eminently a discoverer; he liked the name of "philosopher." His favorite paths of study seem to wander far enough from the common abodes of human thought or the requirements of ordinary life. He became familiar, as no other man ever was, with the varied forces of magnetism and electricity, heat and light, gravitation and galvanism, chemical affinity and mechanical motion; but he did not seek to "harness the lightnings," or to chain those giants and make them grind like Samson in the prisonhouse. His way of treating them reminds us rather of the old fable of Proteus, who would transform himself into a whirlwind, or a dragon, a flame of fire, or a rushing stream, in order to elude his pursuer; but if the wary inquirer could catch him asleep in his cave, he might be constrained to utter all his secret knowledge; for the favorite thought of Faraday seems to have been that these various forces were the changing forms of a Proteus, and his great desire seems to have been to learn the secret of their origin and their transformations.

"I delight in hearing of exact numbers, and the determination 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.—DR. J. H. GLADSTONE.

#### FARADAY'S HONORS

When a comparatively young man Faraday was naturally desirous of appending the mystic letters "F. R. S." to his name, and he was balloted into the Royal Society in January, 1824, not without strong opposition from his master, Sir Humphry Davy, then president. He paid the fees, and never sought another distinction of the kind. But they were showered down upon him. The Philosophical Society of Cambridge had already acknowledged his merits, and the learned Academies of Paris and Florence had enrolled him amongst 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. No wonder the celebrated electrician, P. Riess, of Berlin, once addressed a long letter to him as "Professor Michael Faraday, Member of all Academies of Science, London." He thrice received the degree of Doctor, Oxford making him a D. C. L., Prague a Ph. D., and Cambridge an LL. D., besides which he

was instituted a Chevalier of the Prussian Order of Merit, a Commander of the Legion of Honour, 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 Médaille d'Honneur at the time of the French Exhibition. Altogether, it appears he was decorated with ninety-five titles and marks of merit, including the blue ribbon of science, for in 1844 he was chosen one of the eight foreign associates of the French Academy [of Sciences].—DR. J. H. GLADSTONE.

PROFESSOR TYNDALL'S FINAL ESTIMATE OF FARADAY

Taking him for all and all, I think it will be conceded that Michael Faraday was the greatest experimental philosopher the world has ever seen; and I will add the opinion, that the progress of future research will tend, not to dim or to diminish, but to enhance and glorify the labors of this mighty investigator.—From "*Faraday as a Discoverer*."

FARADAY AS A PHILOSOPHER

As a philosopher, Faraday's first great characteristic was the trust which he put in facts. He said of himself, "In early life I was a very lively imaginative person, who could believe in the '*Arabian Nights*' as easily as in the '*Encyclopædia*.' But facts were important to me, and saved me. I could trust a fact." Over and over again he showed his love of experiments in his writings and lectures: "Without experiment I am nothing," "But

still try, for who knows what is possible?" "All our theories are fixed upon uncertain data, and all of them want alteration and support from facts." "One thing, however, is fortunate, which is, that whatever our opinions, they do not alter nor derange the laws of nature."

His second great characteristic was his imagination. It rose sometimes to divination, or scientific second sight, and led him to anticipate results that he or others afterwards proved to be true.

Throughout his life his idea of force and of matter differed from those held by others; thereby he was led to form plans for the broadest and newest, as well as the exactest experiments. In one of his first lectures he spoke of realizing "the once absurd notion of the transmutation of the elements," and obtaining "the basis of the metals."

The discoveries of Davy and Oersted led him into more connected ideas of force, and he imagined that there might be one great universal principle from which gravity, heat, light, electricity, magnetism, even life itself, might come.

He hoped to prove by experiment that there was more than a connection between the imponderable agents. He worked to find more even than a relationship, more than a common origin, for the forces of nature. He wanted to establish an actual identity among them, and in his search for the unity of all force he made all his great discoveries.

Later in life a new image of matter came into his mind. He immaterialized matter into "centers of force," and he materialized the directions in which matter tends to move into "physical lines of force." What he took from matter at its centers and gave to force he partly gave back to