JAMES CLERK MAXWELL

BY

Sir J. J. Thomson

WE are met to celebrate the centenary of one whose work has had a profound influence on the progress and conceptions of Physical Science; it has moreover been instrumental in harnessing the ether for the service of man and has thereby advanced civilization and increased the safety and happiness of mankind.

Maxwell came of a race, the Clerks of Penycuik in Midlothian, who for two centuries had been prominent in the social life of Scotland; each generation had been remarkable for the talents and accomplishments of some of its members; one of these, Will Clerk, was the intimate friend of Sir Walter Scott and the original of the Darsie Lattimer of *Redgauntlet*. As a race they were remarkable, like Maxwell himself, for strong individuality.

John Clerk Maxwell, Maxwell's father, had added the name of Maxwell to that of Clerk on inheriting the small estate of Middlebie in Dumfriesshire. His main characteristic according to Lewis Campbell

was a persistent practical interest in all useful processes. He was called, like so many of his class, to the Scottish Bar but does not seem to have done much business. His interests were in mechanical contrivances, and his acme of felicity was to attend a meeting of the Royal Society of Edinburgh. He had ways of his own of doing most things, even in designing clothes for himself and his son, which led to disastrous results when the boy went to school. Maxwell's mother was Frances Cay, a member of a well-known Northumbrian family.

Maxwell was born in Edinburgh on June 13, 1831, but spent his infancy and early boyhood at Glenlair, a house built by his father shortly after his marriage. The child took great delight in the happenings of country life and seems to have had more than the usual share of childish inquisitiveness. His cousin Mrs Blackburne said that throughout his childhood his constant question was "What's the go of that?", "What does it do?" and if he was not satisfied with the answer he would ask "But what is the 'particular go' of it?" Besides asking questions he was very fond of making things such as baskets and seals covered with strange devices.

His mother died, when he was in his ninth year,

of the disease which killed him at the same age forty years later. After his mother's death his great delight seems to have been to go about with his father and "help" him when he was doing jobs on the estate. The relations between father and son were extraordinarily intimate. When he was at school his letters to his father were like letters to another schoolboy, and full of the quips and dry humour which were characteristic of him throughout his life.

When he was ten years old he went to the Edinburgh Academy, and was at first anything but a success. There were many reasons for this. He entered at the middle of the term; he had mixed very little with other boys and was naturally shy and awkward; he was not at all well prepared in school subjects and had a very strong Galloway accent, but worst of all he wore clothes designed by his father on what would now be called hygienic principles; he had a lace frill instead of a collar round his neck, a tunic instead of a coat, and square-toed shoes of a novel pattern, with a brass buckle. All these naturally called for vigorous protest, with the result that when he returned home the skirt of his tunic was missing and his frill was rumpled and torn. Things however slowly im-

proved, Professor P. G. Tait who was his junior by one year at the Academy says: "At school he was at first regarded as shy and rather dull. He made no friendships and spent his occasional holidays in reading old ballads, drawing curious diagrams and making rude mechanical models. This absorption in such pursuits, totally unintelligible to his schoolfellows, who were then totally ignorant of mathematics, procured him a not very complimentary nickname.[1] About the middle of his school career however he surprised his companions by suddenly becoming one of the most brilliant among them, gaining prizes and sometimes the highest prizes for scholarship, mathematics, and English verse."

Before he was fifteen he had written a paper on a mechanical method of describing curves of a certain type, which was published in the *Proceedings* of the Royal Society of Edinburgh. It was found afterwards that in this method he had been anticipated by no less famous a mathematician than Descartes. Tait says that at the time the paper was written he had received no instruction in mathematics beyond a few books of Euclid and the merest elements of algebra.

[1] "Dafty."

It was early in his school career that he began to write verses, a practice which he kept up all his life, to the great delight of his friends. Many of these, including two famous in the domestic history of Trinity College, "John Alexander Frere, John" and the ode to the portrait of Cayley, are given in Lewis Campbell's life of Maxwell. The last he ever wrote, "A Paradoxical Ode" to Hermann Stoffkraft, written in 1878, was called forth by the publication of a book, *Paradoxical Philosophy*, by two of his intimate friends P. G. Tait and Balfour Stewart. It has some lines which are a remarkable anticipation of the speculations which are now so common about the destiny of matter and energy:

> Till in the twilight of the Gods,
> When earth and sun are frozen clods,
> When all its energy degraded,
> Matter to ether shall have faded;
> We, that is, all the work we've done
> As waves in ether shall for ever run
> In ever widening spheres through heavens beyond the sun.

During his school-days we first hear of a game which he played throughout his life and which all his friends associate with him. One name for it is "diabolo", but it was usually called the "devil on two sticks". The devil consists of a double cone,

the narrow part resting on a string, whose ends are attached to the ends of two sticks which are held in the hands of the player; by moving the ends of the sticks in opposite directions it is possible to give very considerable rotation to the devil; in fact it is a home-made gyroscope with all the paradoxical properties of that instrument. He attained great skill with it, and no doubt it led him to the construction of his dynamical top, by which he demonstrated in a striking way the properties of bodies in rotation. Another toy which attracted him in boyhood and to which later on he also gave a scientific application was the zoetrope or wheel of life. Long afterwards he used it to represent the way two circular vortex rings play at leap-frog with each other. This is I think the first application of the principle of the cinematograph to scientific purposes.

Maxwell spent six years at the Academy and then went for three years to the University of Edinburgh, and was allowed by Professor Forbes to use the lecture apparatus for his own experiments. He read widely, though not systematically, in Mathematical Physics and published two papers in the *Transactions* of the Royal Society of Edinburgh. On leaving Edinburgh in 1850 he pro-

ceeded to Cambridge, entering first at Peterhouse where Tait had preceded him, but migrating after one term to Trinity, the principal reason being that there was at that time a number of very able mathematicians at Peterhouse and the chance of a mathematician obtaining a Fellowship there seemed less than at Trinity. He brought to Cambridge a range of mathematical knowledge extraordinary for so young a man, but in a state of disorder which Tait said appalled his private tutor Hopkins. Early in his second year of residence he was elected to a Scholarship at Trinity. At that time, and indeed for long afterwards, the Scholars dined together at one table. This brought Maxwell into daily contact with the most intellectual set in the College, among whom were many who attained distinction in later life. These in spite of his shyness and some eccentricities recognized his exceptional powers. He was made one of the "Apostles", a club limited to 12 members, who in the opinion of the Club were the men of most outstanding ability in the University.

Dr Butler, who later became Master of Trinity, says: "When I came up to Trinity, James Clerk Maxwell was just beginning his second year. His position among us was unique. He was the one

acknowledged man of genius among the Undergraduates". The impression of power which Maxwell produced on all he met was remarkable; it was often much more due to his personality than to what he said, for many found it difficult to follow him in his quick changes from one subject to another, his lively imagination started so many hares that before he had run one down he was off after another. I was told by Dr Butler that he remembered going for a walk with Maxwell without understanding one word of what he said though he talked the whole of the time, and yet, said Dr Butler, "I would not have missed it for anything". We have evidence of the charm of his conversation in the diary of a great friend of his, a Mathematical Scholar of his year, who writes: "Maxwell as usual showing himself acquainted with every subject on which the conversation turned. I never met a man like him. I do believe there is no subject on which he cannot talk and talk well too, displaying always the most curious and out of the way information". Another friend writes: "Among his friends he was the most genial and amusing of companions, the propounder of many a strange theory, the composer of many a poetic *jeu d'esprit*".

At the beginning of his second year at Cambridge he began his serious preparation for the Mathematical Tripos. Though he had read much more widely than his contemporaries it had been in a very desultory fashion and was not likely to show to advantage in any examination where speed was a factor of considerable importance. He set himself resolutely to remedy this defect. Although preparing for an examination is regarded as almost degrading by some who are keenly conscious of their own superiority, Maxwell in his correspondence at this time never expresses any irritation, though he followed loyally and closely the normal course for the best men. He became a pupil of Hopkins, a man of great scientific distinction, as well as the most successful mathematical teacher of his time, and who had had Stokes and William Thomson among his pupils, and was careful to do all the work Hopkins set. There are references in letters of this period to his breaking away from parties to go and do "old Hop's props". The term before the Tripos was spent in revising subjects read before. Many find this distasteful, but Maxwell writes: "If any one asks how I am getting on in Mathematics say that I am busy arranging everything so as to be able to

express all distinctly so that examiners may be satisfied now and pupils edified hereafter. It is pleasant work and very strengthening but not nearly finished".

Besides reading with Hopkins he attended Stokes' lectures. He took the Mathematical Tripos in January 1854 and was Second Wrangler, Routh of Peterhouse, who became a most successful teacher of Mathematics with twenty-seven Senior Wranglers to his credit, and who also made original contributions to Mathematics of a very high order, being Senior. In the examination for the Smith's Prize, where the papers are confined to the higher subjects, the two were bracketed.

It is interesting that in the paper set by Stokes in this examination there was published for the first time the fundamentally important theorem known as Stokes' theorem, connecting a line with a surface integral; this was to prove of vital importance in the development of Maxwell's electric theory.

Hopkins is reported to have said that Maxwell was unquestionably the most extraordinary man he had met with in the whole course of his experience; that it appeared impossible for him to think wrongly on any physical subject, but that in analysis he was far more deficient. Maxwell's