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A Treatise on Electricity and Magnetism

VOLUME ONE

James Clerk Maxwell

A TREATISE ON
ELECTRICITY
AND MAGNETISM

By
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tung in die Elektrostatik, &c.

I have confined myself almost entirely to the mathematical treatment of the subject, but I would recommend the student, after he has learned, experimentally if possible, what are the phenomena to be observed, to read carefully Faraday's *Experimental Researches in Electricity*. He will there find a strictly

at every instant as much must flow out of any given closed surface as flows into it.

It follows from this that every electric current must form a closed circuit. The importance of this result will be seen when we investigate the laws of electro-magnetism.

Since, as we have seen, the theory of direct action at a distance is mathematically identical with that of action by means of a medium, the actual phenomena may be explained by the one theory as well as by the other, provided suitable hypotheses be introduced when any difficulty occurs. Thus, Mossotti has de-

$$+ (9a^2b^{17} + 280a^5b^{14} + 735a^7b^{12} + 192a^8b^{11} + 780a^9b^{10} \\ + 144a^{10}b^9 + 375a^{11}b^8 + 72a^{13}b^6)c^{-19} + \dots \quad (22)$$

$$\begin{aligned} \mathcal{E}_1 = & a^2c^{-2} + 4a^5b^3c^{-8} + (6a^7b^3 + 9a^5b^5)c^{-10} \\ & + (8a^9b^3 + 18a^7b^5 + 16a^5b^7)c^{-12} \\ & + (10a^{11}b^3 + 30a^9b^5 + 16a^8b^6 + 40a^7b^7 + 25a^5b^9)c^{-14} \\ & + (12a^{13}b^3 + 45a^{11}b^5 + 60a^{10}b^6 + 80a^9b^7 \\ & \quad + 72a^8b^8 + 75a^7b^9 + 36a^5b^{11})c^{-16} \\ & + (14a^{15}b^3 + 63a^{13}b^5 + 150a^{12}b^6 + 140a^{11}b^7 + 342a^{10}b^8 \\ & \quad + 175a^9b^9 + 209a^8b^{10} + 126a^7b^{11} + 49a^5b^{13})c^{-18} \\ & + (16a^{17}b^3 + 84a^{15}b^5 + 308a^{14}b^6 + 224a^{13}b^7 + 1050a^{12}b^8 \\ & \quad + 414a^{11}b^9 + 1222a^{10}b^{10} + 336a^9b^{11} + 488a^8b^{12} + 196a^7b^{13} \\ & \quad + 64a^5b^{15})c^{-20} + \dots \quad (23) \end{aligned}$$

$$\begin{aligned} \mathcal{E}_2 = & 3a^3b^3c^{-6} + 6a^3b^5c^{-8} + 10a^3b^7c^{-10} + (12a^6b^6 + 15a^3b^9)c^{-12} \\ & + (27a^8b^6 + 54a^6b^8 + 21a^3b^{11})c^{-14} \\ & + (48a^{10}b^6 + 162a^8b^8 + 158a^6b^{10} + 28a^3b^{13})c^{-16} \\ & + (75a^{12}b^6 + 360a^{10}b^8 + 48a^9b^9 + 606a^8b^{10} \\ & \quad + 372a^6b^{12} + 36a^3b^{15})c^{-18} + \dots \quad (24) \end{aligned}$$

$$\begin{aligned} \mathcal{E}_3 = & a^3c^{-3} + 6a^6b^3c^{-9} + (9a^8b^3 + 18a^6b^5)c^{-11} \\ & + (12a^{10}b^3 + 36a^8b^5 + 40a^6b^7)c^{-13} \\ & + (15a^{12}b^3 + 60a^{10}b^5 + 24a^9b^6 + 100a^8b^7 + 75a^6b^9)c^{-15} \\ & + (18a^{14}b^3 + 90a^{12}b^5 + 90a^{11}b^6 + 200a^{10}b^7 \\ & \quad + 126a^9b^8 + 225a^8b^9 + 126a^6b^{11})c^{-17} \\ & + (21a^{16}b^3 + 126a^{14}b^5 + 225a^{13}b^6 + 350a^{12}b^7 + 594a^{11}b^8 \\ & \quad + 525a^{10}b^9 + 418a^9b^{10} + 441a^8b^{11} + 196a^6b^{13})c^{-19} + \dots \quad (25) \end{aligned}$$

$$\begin{aligned} \mathcal{E}_4 = & 4a^4b^3c^{-7} + 10a^4b^5c^{-9} + 20a^4b^7c^{-11} + (16a^7b^6 + 35a^4b^9)c^{-13} \\ & + (36a^9b^6 + 84a^7b^8 + 56a^4b^{11})c^{-15} \\ & + (64a^{11}b^6 + 252a^9b^8 + 282a^7b^{10} + 84a^4b^{13})c^{-17} + \dots \quad (26) \end{aligned}$$

$$\begin{aligned} \mathcal{E}_5 = & a^4c^{-4} + 8a^7b^3c^{-10} + (12a^9b^3 + 30a^7b^5)c^{-12} \\ & + (16a^{11}b^3 + 60a^9b^5 + 80a^7b^7)c^{-14} \\ & + (20a^{13}b^3 + 100a^{11}b^5 + 32a^{10}b^6 + 200a^9b^7 + 175a^7b^9)c^{-16} \\ & + (24a^{15}b^3 + 150a^{13}b^5 + 120a^{12}b^6 + 400a^{11}b^7 + 192a^{10}b^8 \\ & \quad + 525a^9b^9 + 336a^7b^{11})c^{-18} + \dots \quad (27) \end{aligned}$$