TABLE 1. AVERAGE SUMMER AND WINTER GAINS IN LIVE WEIGHT (LB.)

Group	Number of heifers in group	Summer	Winter	Summer	Winter
1	7	229	47	212	−38
2	5	218	85	143	−58
3	7	171	89	126	+61
Mean	–	206	74	160	−12

This variation is further illustrated by the daily gain for each month The average daily gain of sixteen groups of heifers consisting of fifty head in all, during the year 1927–31, are given in Table 2.

TABLE 2. AVERAGE DAILY GAIN PER MONTH (LB.)

July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June
1·54	0·93	0·75	1·06	0·36	0·85	0·38	0·48	0·13	−0·30	1·66	1·32

The rate of growth in late winter is low, and in April there is actually a loss in weight.

(2) The season of birth has an influence on live-weight gains during subsequent growth. The computed live-weight gains per 100 days according to season of birth is given in Table 3.

This table indicates the advantage that calves born during the autumn have over those born at other times. At 300 days of age, such calves weighed 53·5 lb. more, and at 600 days they weighed 101·5 lb. more, than the others. This may have been due partly to a higher pre-natal level of nutrition, as their dams were on grass during the last stages of pregnancy, and partly to the fact that autumn milk is usually richer in fat, and considerably richer in carotene, than April milk. The autumn-born calves were out on grass during their first summer, whereas the spring-born calves were kept indoors during their first summer.

TABLE 3. COMPUTED LIVE-WEIGHT GAIN IN LB. PER 100 DAYS

Season of birth	1st 100 days	2nd 100 days	3rd 100 days	4th 100 days	5th 100 days	6th 100 days	7th 100 days	1st 300 days	1st 700 days
Jan., Feb. and Mar.	125	121	110	98	112	85	12·5	356	663
April, May and June	118·5	127·5	105	96	109	35·5	14·5	351	606
July, Aug. and Sept.	116	131	107	107	60	46	73	354	640
Oct., Nov. and Dec.	136	141	129·5	84	105	77·5	64·5	406·5	737·5
Mean, Jan. to Sept.	120	126	107	100	94	55·5	33	353	636
In favour of Oct. to Dec.	16	15	22·5	−16	11	22	31·5	53·5	101·5

These figures are consistent with the practical farmers' view that it is easier to rear calves born in autumn than those born in spring, with the data of Jordan[8] on the relative mortality of autumn and of spring calves, with data collected here[9] on the seasonal variation in wastage among dairy stock and with observations on other species[10,11,12]. Full details will be published elsewhere.

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Electricity for Engineers

DR. HUGHES was on the whole very generous in his review[1] of my "Elementary Electric-Circuit Theory", but since he thinks that I have Ohm's law wrong, I should like to come to terms with him on that point.

I take no exception to Dr. Hughes's statement to the effect that Ohm's law merely expresses the fact that the ratio V/I is substantially constant for certain materials under certain conditions. On the other hand, Joule's law says in effect that the ratio P/I^2 is substantially constant for these same materials. In my derivation I specify a wire, and hence can use Joule's law. Use of the principle of conservation of energy in the form $P = VI$ gives Ohm's law from Joule's law or vice versa. The former is done on p. 20 of my book. In the preface I specify as a prerequisite a course in basic physics, in which Joule's law presumably should be learned; hence I do not expand upon it. I am very hard put to ascertain Dr. Hughes's difficulty with my statement on p. 21, that Ohm's and Joule's laws are interdependent, one being derivable from the other, unless he would have me add there, "through the principle of conservation of energy". However, I stated the use of this principle at the outset (p. 20) and feel that the repetition is scarcely necessary.

Lest this view of the interdependence of Ohm's and Joule's laws still may seem novel to Dr. Hughes, I refer him to p. 557 of the article by Prof. W. Thomson in the *Philosophical Magazine*, iv, **2** (1851), where the situation is explained, probably for the first time. If we call that ancient history, I then refer to "A Treatise on Electricity and Magnetism", by Mascart and Joubert (translated by Atkinson), **1**, 238 (1883), for a restatement of this view in the middle ages, and to the *American Journal of Physics*, **11**, 351 (1943), for a modern restatement.

Though the idea of potential was introduced into electrostatics by Poisson (1812) and named and developed by Green (1828), its application to current-carrying conductors was not clearly understood at the time Ohm discovered his law (1827) nor even by the time Joule discovered his law (1841), nor was the equivalence of work and heat firmly established. Hence the relation between Ohm's and Joule's laws could not become immediately apparent. However, this relation has been known for nearly one hundred years, and we now know that (aside from the commendable desire to be doubly sure) either Ohm or Joule might have been spared his trouble. Their laws are merely alternate ways of describing the same property of certain materials.

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[1] *Nature*, **157**, 4 (1946).

THERE appears to be nothing fundamentally different in what Prof. Frazier and I say, only the method of approach, his from the historical scientific and mine from what I conceive to be the modern educational, especially for electrical engineers.

From time to time it becomes necessary to examine the routine of establishing the most complete and compact description of Nature, particularly for educational purposes. There are many historical aspects which in my view are unnecessary for educational purposes but are merely retained because they fit into a syllabus and can be examined and can usefully fill out an examination paper. They receive names, such as Kirchhoff, so that their form and use are retained under a label which can be easily remembered. I contend that a so-called law should describe Nature in a way which cannot be anticipated but is only revealed by experiment. In this instance we know what current electricity is, so there is no need to define it. Because current can convey power, the definition of potential difference is required. Current cannot escape, therefore Kirchhoff's first law tells us nothing, and the second law is simply an extension of the previous definition of potential and does not have to be discovered: similarly with Joule's law. These become scientific when verified with suitable accuracy by experiment, but are not independent descriptions of Nature. I am in favour of reducing the subject to the minimum, consistent with a rigorous adherence to definitions, so that those practising applications can be certain of their background without unnecessary excursions into history.

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John Tyndall's Radiation Experiment

IN the recently published "Life and Work of John Tyndall" no alteration has been made in his explanation of his experiment on radiation through a solution of iodine in carbon disulphide, rendering platinized platinum foil white hot.

The English translation of Clausius on "The Mechanical Theory of Heat" was published in 1879, with a preface by Tyndall; in the chapter "On the Concentration of Rays of Light and Heat", Clausius showed that in no circumstances could optical means produce an image hotter than the source of radiation. Tyndall supposed that the iodine solution transmitted infra-red rays only; if so, the source in effect was of infra-red only. But in Wood's "Physical Optics" (1934), p. 15, it is stated that, while bromine vapour stops all visible light, it passes so much ultra-violet that it gives good results as a screen for photography by ultra-violet light. The curve 23 in Plate 1 of that book, for a solution of iodine in carbon tetrachloride, shows absorption in the middle of the spectrum only, from green to violet; and so it appears that Tyndall's result was actually due to ultra-violet radiation, through the iodine screen.

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