

obtained an apparent blackening in the first case, which did not appear when the crucible was empty. This first experiment showed definitely that it is possible to get X-rays from a gas.

Later, I started to work with sulphur instead of sodium, and then I placed the crucible in front of the slit of a vacuum spectrograph in order to get a spectrum of the X-radiation. Using a gypsum crystal as a grating, and a strong electron current (about 60 milliamperes), I obtained a very weak line on the part of the plate corresponding to the $K\alpha$ -line for sulphur. So far as I know, this is the first time an X-ray spectrum has been obtained with a gas as radiator. In order to be able to control the conditions better, I rearranged the apparatus. A small electric heater was fixed round the upper part of the crucible, and in this way the beam of vapour could be regulated independently of the electron current. The latter one was coming from the side at right angles to the stream of vapour. Using an electron current of 90 ma., a tension of about 6000 volts, and a slit 0.6 mm. wide, I obtained 5 lines on the plate after 2 hours exposure. The strongest two correspond to the $k\alpha$ and $k\beta$ lines. The three others, which are the most interesting, are so weak, though, that it is impossible to determine their wave-lengths. The work is being continued, and by some improvements of the apparatus I hope very soon to be able to increase the intensity so that the weaker lines as well will be measureable.

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Animal Diseases in Elizabethan Times.

WHILE looking up certain references for a paper now in course of preparation, I recently came upon some interesting data in Prof. E. A. Lewis's "The Welsh Port Books" (London, 1927), with regard to live-stock epizooties in Ireland in the time of Queen Elizabeth.

As is to be expected, the Welsh Port Books record numerous importations of animals and animal produce from Ireland—plough-horses, cattle, wool, hides, etc., and of course considerable quantities of fish. But the most interesting items are those relating to the import of "murrain sheep skins." Totalling up these items for the period Michaelmas 1593 to Michaelmas 1594 (Port Book K.R. 1299/5), we find that no less than 15,100 "morkins" or "murren sheepskins" were imported from Ireland to the port of Milford. Again, we have a single cargo containing "2000 morkins being murren sheep skins"—that of the *Rioll Defence* of Milford, trading to that port from Ireland in May 1599. In March 1601 there were imported from Waterford to Milford 300 murrain sheep skins, and in July 1602, from Wexford to Milford, "100 murrain sheep skins and 250 murrain lambfell and kidfell." Altogether, therefore, during the ten years 1593-1602 there are records of the import of 17,750 "murrain skins" from Ireland.

The term 'murrain' has always covered a variety of epizooties, including probably anthrax, foot-and-mouth disease, etc., and if in the present instance it includes cases of microbic diseases, the above figures throw an interesting light on possible means of dissemination. But from the heavy incidence on sheep, and the absence of any reference to diseased cattle or other livestock, one may perhaps suggest that *Fasciola hepatica*, the sheep liver-fluke, was the main source of the damage. This parasite would of course always tend to flourish in such a wet country as Ireland, and especially in such a marshy and un-

drained Ireland as that of the sixteenth century. One of the earliest epidemics mentioned in history is that which appeared in Holland in 1552, and which Gemma called "lues infanda pecoris."

The matter is being investigated further, as it would seem to be of some importance in the history of animal diseases in Great Britain.

COLIN MATHESON.

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Cardiff, June 16.

Square Roots and the Decimal System.

IN NATURE of June 9, a correspondent, A. R., gives a method of James Thomson's for obtaining a series of convergents to a square root in the form of vulgar fractions.

A much more rapidly convergent set of values can be found by making use of the principle that if n is an approximation to the value of \sqrt{N} , then the expression

$$\frac{1}{2} \left(n + \frac{N}{n} \right)$$

is a much closer approximation. Thus we should find

$$\begin{aligned} \sqrt{6} &= \frac{1}{2} \left(2 + \frac{6}{2} \right) = \frac{5}{2} \text{ approx.} \\ &= \frac{1}{2} \left(\frac{5}{2} + \frac{6}{\frac{5}{2}} \right) = \frac{17}{5} \text{ approx.} \\ &= \frac{1}{2} \left(\frac{17}{5} + \frac{6}{\frac{17}{5}} \right) = \frac{41}{11} \text{ approx.} \end{aligned}$$

We thus get the series of convergents

$$2, \frac{5}{2}, \frac{17}{5}, \frac{41}{11}, \dots$$

as compared to the series

$$2, \frac{5}{2}, \frac{2^2}{2^2}, \frac{4^2}{2^2}, \frac{2^2 \cdot 3}{2^2 \cdot 3}, \frac{4^2 \cdot 3}{2^2 \cdot 3}, \dots$$

given by A. R.

The error in the value $\frac{41}{11}$ is less than 1 part in 18 million, and this is obtained direct from the mere slide rule approximation of $\frac{4}{2}$ or 2.45. I have in practice found this to be much the most convenient way of finding a square root when the accuracy given by a slide rule is insufficient.

For cube roots the form

$$\frac{1}{3} \left(2n + \frac{N}{n^2} \right)$$

can be used in a similar manner.

From its simplicity one would have imagined that this method would have occurred to everybody who had often to extract roots, but except in Egypt (where I taught it myself) I have never met anybody who made use of it.

C. E. WOLFF.

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June 10.

Can Crocodiles swallow their Food under Water?

RECENTLY I was touring the east coast of Lake Albert. At sunset one evening I saw a crocodile of medium size about 100 yards from the shore, very quietly and stealthily making its way toward the sandy beach. Having a telescope, I watched attentively, but to my surprise, when it grounded about 100 yards from me, it did not crawl out. It opened its mouth, disclosing a fish which I judged would weigh some 5 or 6 pounds, and proceeded to give it several vigorous bites before swallowing it head-first. This observation seems to suggest that the crocodile could not swallow the fish when submerged, else why did it take the trouble to swim to the shore with it?

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May 14.