Fundamentals of X-Ray

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X-rays were first detected in the year of 1895 by the German physicist, William Conrad Roentgen. The discovery occurred during a systematic search for radiation capable of penetrating materials opaque to ordinary light.

Roentgen's original source of X-rays was an exhausted bulb of the type already known as a Crookes tube. Such tubes were at that time relatively common and were used for demonstrating cathode rays, a radiation later identified as a projected beam of electrons. Under ordinary circumstances these cathode ray electrons are completely stopped by the glass walls of the tube, but the spot upon which they fall gives out a faint visible illumination known as fluorescence. The fact that this fluorescence is accompanied by an invisible radiation very different in penetrating properties from ordinary light was left for Roentgen to discover.

X-rays may be defined as an invisible radiation produced by the stopping of rapidly moving electrons. The nature of this radiation is greatly affected by both the velocity of the electrons and by the composition of the target, which is also called the anode, is made of a metallic element of high melting point and high atomic weight. High melting point is necessary to prevent fusion by the heating effect of the cathode ray stream while high atomic weight favors efficient production of X-rays. Tungsten meets both these requirements and is commonly used as an anode material.

The source of electrons in modern X-ray tubes is ordinarily a hot tungsten filament incorporated in a second electrode called a cathode. The space surrounding both cathode and anode is enclosed in a glass bulb from which the air has been very effectively exhausted. A source of high electrical potential such as a transformer is connected across the electrodes of the tube for the purpose of imparting the necessary velocity to the electrons as they traverse the path through the vacuum from cathode to anode.

By nature, X-radiation falls in the same category as light, but by definition the name applies to radiation produced by electron bombardment of a solid target. Although it is true that radiation produced in this manner occupies a more or less definite region in the spectrum, the fact should not be overlooked that there is no essential difference between X-rays of very long wave length and ultra violet light of very short wave length. In other words, X-rays may be regarded as *ultra* ultra violet light.

In both light and X-rays the usual unit of wave length is the angstrom. (1 angstrom = .00000001 cm.) When measured in terms of this unit, the approximate regions of wave length with which certain significant names are associated are as follows:

Visible light	7,000	to	4,000
Ultra violet	4,000	to	100
X-rays	100	to	.01
Gamma-rays	.1	to	.001

The fact should be recognized, however, that the electromagnetic spectrum exists as a continuity through an enormous range of wave lengths and that any division into regions as given in the preceding paragraph is largely arbitrary. Radiation of any particular wave length and intensity produces physical, chemical, or bilogical effects dependent only upon wave length and intensity and in no sense upon the manner in which the radiation is produced.

The effect of velocity of the electrons has already been mentioned. More specifically it may be stated that the kinetic energy, which depends upon the square of the velocity is directly proportional to the voltage and inversely proportional to the minimum wave length of the X-rays. This fact gives the equation:

$$\text{minimum wave length} = \frac{12336}{\text{voltage}}.$$

From this relation it will be seen that 100 kilovolts (100,000 volts) will give a minimum wave length of 0.123 angstroms. The wave length of maximum intensity is about 1.5 times the minimum value or, in this case, about 0.18 angstroms. It will also be observed that very high voltages are capable of producing X-rays comparable in wave length with the gamma-rays of radium.

The unique penetrating properties of X-rays afforded an immediate practical application as a means of investigating the interior of objects opaque to ordinary light It is not true, however, that all X-rays are highly penetrating. This property increases rapidly with decreasing wave length or with increasing voltage. Very long wave lengths (several angstroms) are strongly absorbed by air, even to the extent of fifty per cent in a distance of a few millimeters. The much shorter wavelengths (a few hundredths of an angstrom) are, on the other hand, able to penerate several centimeters of steel.

For X-rays of a given wave length, absorption increases rapidly with increasing atomic number of the absorbing material. This property is in many cases a distinct advantage because in most substances to be examined composition varies more than density. In the case of animal tissues, for example, bone owes its comparative opacity for the most part to its calcium content and not to its greater density.

An understanding of the physiological effects of X-rays developed much more slowly and is yet far fram complete. It is well know that in some case, as in the treament of cancer for example, beneficial effects are obtained, but in general any unnecessary exposure to X-rays should be avoided. Lack of knowledge of the adverse physiological effects resulted in serious injury to many of the early X-ray investigators.

MIXER INITIATES FROSH

A greased pole—a flag—and two scrapping classes. Thus the annual "Vet Mixer" ushered in this year's student A.V.M.A. calendar.

At the word from President Sid Bjornson, the freshman and sophomore classes, lined up at each end of the Meat Lab rushed for the pole and for a full 15 minutes battled to see which class would retrieve the flag at the top. The pole, however, broke loose from its mooring and the fray was then declared officially ended. But class spirit over-rode the official halt, and free-for-alls continued for awhile.

Approximately 100 per cent of the student members were in attendance. Drs. Foust and Benbrook addressed the group for a short time at the beginning of the meeting.

"We have been criticized for sticking too closely together—but such criticism is in reality a compliment," Dr. Benbrook stated. "However," he went on, "we have been inclined to think too little of our profession in the light of its true function—that of protecting the livestock industry."

Prepubic Tendon . . . .

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3. Vary rarely there is a definite history of violence.

Usually the prognosis of complete rupture of the prepubian tendon is very grave, since most mares, along with their foals, perish before the conclusion of the pregnancy during which the rupture occurs.

If the pregnancy existing at the time of the accident is safely determined, the animal may thereafter breed without danger or difficulty, but is so unsightly that her value for this purpose is seriously diminished. She may do ordinary slow work, but here the unsightliness becomes even more serious and few persons are willing to use such an animal.