was one of the first cases observed of inseparable elements, of which a number of examples came to light in later years. It was on observations of this character that Soddy later put forward the conception of isotopes which has proved to be of so much significance not only for the radioactive but also for the ordinary elements.

By comparing the rate of growth of radium in the separated ionium with the amount of radium in equilibrium with uranium in the mineral, Boltwood was able for the first time to fix by a direct method the average life of the radium atom. In later researches he was able to show that a genetic relation also existed between actinium and uranium, but that the amount of actinium was only a few per cent of that to be expected if it were in the main line of descent. This work suggested that the actinium must be regarded as a branch product at some point of the uranium-radium series. This is a conclusion we hold to-day, but the exact point of branching is still uncertain.

These investigations, which were carried out with great experimental skill and accuracy, thus yielded results of fundamental importance. Boltwood had not only proved a genetic relation between uranium and radium, but also had isolated the new element which was the immediate parent of radium, and had shown that actinium was also genetically connected with uranium but not in the main line of descent.

I must not omit here to refer to another deduction which has proved to be of great importance. As a result of his own analyses and the analyses of Hillebrand, Boltwood found strong evidence that the amount of lead in old minerals of the same geological age is proportional to their content of uranium and increases with the geologic age. This led him early (1905) to suggest that lead was the final inactive product of the uranium-radium series of transformations. The correctness of this view has been abundantly verified in recent years. We know that the end product of uranium is an isotope of lead of atomic weight 206, and the end product of the thorium series is another isotope of weight 208. These observations have thus supplied a definite method of estimating the age of radioactive minerals and thus of the geological horizons in which they are found.

The importance of Boltwood's work was at once recognised by Yale University, where he was appointed assistant professor of physics in 1906 and professor of radiochemistry in 1910. He took an active part with the late Prof. Bumstead in building the new Physics Laboratory in Yale, and later, in 1918, as professor of chemistry, in building the new chemical laboratories. The labour and detail involved in such undertakings, which he cheerfully undertook, made serious inroads not only on his time for research but also on his energy. He had a breakdown in 1922, and never completely recovered from its effects.

I first made the acquaintance of Boltwood in 1904, when he was carrying out his first radioactive experiments. One could not fail to be impressed by the breadth and accuracy of his scientific knowledge, and by his scrupulous care and accuracy in experimental work. He possessed to an unusual degree the power of anticipating experimental difficulties which were likely to arise and in arranging his apparatus and methods to overcome them. This characteristic feature of Boltwood's work was well illustrated in his investigations with me in the University of Manchester in 1910 on the rate of production of helium by radium and other radioactive bodies. Every detail of the complicated apparatus and arrangements was so carefully thought out beforehand that not a single change was required for the successful conclusion of the measurements.

A man of cosmopolitan tastes, Boltwood was much attracted by many aspects of European life and spent many of his summers on the Continent. He took an active interest in the undergraduate life of his university and had the gift of gaining the interest and confidence of young people. His premature death will be mourned by a wide circle of friends, who held him in high esteem for his personal qualities as well as for his outstanding scientific achievements.

E. RUTHERFORD.

MR. W. H. DINES, F.R.S.

BY the death of Mr. William Henry Dines, meteorology loses an outstanding figure. It is scarcely possible to overrate the importance of his work. He was a meteorologist of the first rank before he began the upper air work for which he is best remembered. Born in 1855, he was the son of George Dines, himself a meteorologist of note. He was educated at Woodcote House School, served an apprenticeship as a railway engineer, and then went to Christ's College, Cambridge; he obtained first class honours in the Mathematical Tripos, and took his B.A. degree in 1881. The bent of his first meteorological work was occasioned by the disaster to the Tay Bridge, which, only recently opened, was destroyed by a gale while a train was crossing it. So George Dines investigated wind pressure and his son helped him. Later, as a result of this work, W. H. Dines designed the pressure tube anemometer. This instrument in its final form records each gust of wind and each transient change of direction, and is the standard recording anemometer for all serious purposes.

Dines's most notable work, that of upper air research, began in 1901 with kite ascents. When possible, Dines always preferred to design and make his own apparatus, and it was his modification of the box kite, his winding gear, and his meteorographs which were used. The meteorograph was simple, efficient, and cheap, a great point for upper air research, when instruments are apt to be lost or broken. Dines took observations at Crinan, on the west coast of Scotland, in the summers of 1902 and 1904, flying kites from a shore station, from a tug in 1902, and from H.M.S. *Seahorse*, lent by the Admiralty for the purpose in 1904. He also used his house at Oxshot in Surrey, and later at Pyrton Hill, near Watlington, as an upper air observatory.

As the investigation progressed, greater heights were required than could be attained by kites, and Dines used sounding balloons. His balloon meteorograph with its metal case weighed only two ounces, and cost only about one-twentieth of the price of instruments used on the Continent and in the United States. Being so light it allowed much smaller balloons to be used. The whole cost and difficulty of sounding balloons were so much reduced that the Department of Physics at the University of Manchester was able on two occasions to send up a balloon every hour for twenty-four hours. He designed also a very ingenious apparatus for calibrating the meteorographs. Accounts of these and many other instruments, and many papers on meteorology, especially on wind pressure, upper air research, and, later, on radiation, are to be found in the publications of the Royal Society, the Royal Meteorological Society, the Meteorological Office, and elsewhere.

Dines had a wonderful insight as to what was necessary in an instrument. He could design it, make it himself in many cases, use it to the best advantage, and afterwards discuss the results obtained. It was the possession of these qualities, seldom all united in one person, that marks the genius that he applied to meteorology. It was as an amateur that he worked. Most sciences have been started by amateurs, but by degrees they have grown out of the stage when an amateur can usefully apply himself to their problems. Meteorology has possibly reached this stage. Dines was the last and the greatest of the amateurs who built up the science, and he has left it in a very different condition from that in which he found it. Now it is recognised as a real science worthy of study by mathematicians and physicists of the first rank. He had a great share in bringing it to this stage.

Most of the sounding balloon work was done by Dines at Benson, near Wallingford, where he went from Pyrton Hill. It was chosen as being in a part of England most favourable for balloon ascents. Dines himself hoped that Benson would become ultimately a permanent aerological observatory, and indeed at one time this was to have been its destiny. Fate, however, intervened, and to the regret of many the dream will not come true.

Dines joined the Royal Meteorological Society in 1881; he was for a number of years a member of council; he was president in 1901 and 1902; and in 1914 he received the Symons Gold Medal of the Society. In 1905 he was elected a fellow of the Royal Society. From 1905 until 1922 he was Director of Experiments on the Upper Air for the Meteorological Office, and a small annual grant was made for the maintenance of the establishment, first at Pyrton Hill, afterwards at Benson; but Dines received no personal emolument; so far as his own services went, his position was an honorary one. Perhaps because he was never in the employment of any Government office, or the holder of any public post, perhaps because he was of a very modest and retiring nature, and would never have dreamt of pushing himself into public notice, he received no public honour of any kind. Probably in no country but Great Britain would such eminence in a science which has become of such great practical importance have passed unrecognised.

Dines was a real student, wrapped up in his work, and in the subject he had made his own. He was singularly retiring, and had the constitutional shyness which not seldom goes with genius. But those who penetrated his reserve found that he could have, and maintain, strong opinions, and that he had a quiet but very real sense of humour. He was ever ready to help others who were working on the same lines as his own, and took infinite pains in this way, as the writer can testify from the experience of many years. He is survived by a widow, and by two sons who carry on the family tradition of meteorology into the third generation, for they both have posts in the Meteorological Office.

The early years of the century will stand out by reason of great advances made in many sciences, especially in physics and astronomy. Meteorology advanced rapidly at the same time, and in Great Britain it was Dines who led the way. Physics and astronomy are still in the period of rapid advance. Meteorology shows signs of decreasing acceleration. Can we look forward to a further advance, which only research can ensure? Given the will, it is possible; but we shall not so easily find again the genius of a Dines.

C. J. P. CAVE.

DR. HERMANN KAST, well known for his work on explosives, died on Sept. 6, 1927, aged fifty-eight years. After a period of study in A. W. Hofmann's laboratory in Berlin, Kast graduated in 1893. For many years he was a member of the council and deputy-president of the Berlin Bezirksverein deutscher Chemiker. In addition to numerous original scientific publications, Kast published two comprehensive works dealing with explosive materials.

WE regret to announce the following deaths:

General Henry L. Abbot, the distinguished U.S. Army engineer, who was elected a member of the National Academy of Sciences in 1872, on Oct. 2, aged ninety-five years.

Mr. Leon Gaster, honorary secretary of the Illuminating Engineers' Society, on Jan. 7, aged fifty-five years.

Prof. H. W. Mackintosh, formerly professor of zoology and comparative zoology in the University of Dublin, a post which he held for nearly fifty years, on Jan. 8.

Dr. Frederick C. Newcombe, emeritus professor of botany in the University of Michigan, and secretary in 1897 of Section G of the American Association for the Advancement of Science, who worked particularly on the sensitive reactions of plants, on Oct. 1, aged sixty-nine years.

Dr. Geo. A. Osborne, emeritus professor of mathematics at the Massachusetts Institute of Technology, on Nov. 20, aged eighty-eight years.

Prof. F. W. Very, director of the Westwood Astrophysical Observatory at Westwood, Mass., since 1906, on Nov. 23, aged seventy-five years.