Rankine, (William John) Macquorn (1820–1872)

By Thomas Aman, pubd 1971

Rankine, (William John) Macquorn (1820–1872), civil engineer and physicist, was born in Edinburgh on 5 July 1820, the second son of David Rankine (d.1870), a brigade lieutenant and civil engineer, and his wife, Barbara (d.1873), the elder daughter of Archibald Graham (or Graham), a Glasgow banker. Tracing his ancestry to Robert the Bruce, Rankine could claim to be a Scot of Scots. His only sibling, David, died young. In early childhood Rankine's paternal grandfather ignorant of his religious education, his father taught him arithmetic and elementary mechanics. Between 1829 and 1829 he studied at Ayr Academy; in the autumn of 1830 he briefly attended Glasgow grammar school; later he studied geometry with George Lees in Edinburgh.

Between 1839 and 1841 Rankine learned his trade implementing river improvements, waterworks and harbour works in Ireland. From juvenile years he was interested in the wave theory of light. During the summer of 1842, after reading Clapeyron's discussion of Carnot's heat theory, Rankine started to write on molecular physics, elasticity, and, especially, the mechanical action of heat. From Ju

During prolonged periods of confinement due to illness Rankine was privately educated. He exhibited a keen interest in the theory of music and read deeply in higher mathematics, including number sense philosophy, explored French and German scientific literature, but did not attend mathematics classes, or progress to the exacting Cambridge mathematical tripos. Opting, instead, for the fashionable profession of the engineer, Rankine helped out on the new Leith branch (1837–9) of the Edinburgh and Duddingston Railway which his father superintended. In 1838 he became a pupil of John Benjamin MacNeill, a promising engineer with extensive commitments in the north of Ireland and a church of talented apprentices including Le Fanu and Bazalgette. Between 1839 and 1841 Rankine learned his trade implementing river improvements, waterworks and harbour works in Ireland. As work on MacNeill's Duddingston and Leith Railway (1841) he developed 'Rankine's method' for setting out curv

Back in Edinburgh Rankine published a series of investigations conducted with his father as an inductive science. Engineers showed itself wary of Rankine's programme to reform the practice of sea defence construction, and of his commitment to a hypothesis beyond the test of direct observation, accused him, not without reason, of obscurity in his statements of the second law, and claimed that the phrase 'molecular vortices' was of far greater import than the detail of the model itself. Despite initial hopes that air would supede steam they abandoned their patent when practical problems proved insurmountable. Between 1853 and 1857 Rankine collaborated with the Glaswegian shipbuilder James Robert Napier in the development of a marketable hot air engine. His name was now an inescapable legend in engineering practice generally, as an inductive science.

In 1849 he published results linking the temperature, pressure and density of gases, vapours (especially steam), and liquids, much encouraged by the close agreement between his theoretical deductions and Regnault's new experimental data. Rankine became a fellow of the Royal Society of Edinburgh in 1849. Shortly thereafter, in February 1850, he matched William Thomson's account of Carnot's (1838) thermodynamic theory. In December 1851 he published his first book, citing it later as the foundation of his natural philosophy.

Rankine's work had two distinguishing features. First, he quickly perceived and supplemented Joule's first law with a second law characterizing the potential efficiency of engines and, later, the order and decay of physical systems. Rankine's work had two distinguishing features. First, he quickly perceived and elaborated the links between the new science and thermodynamic engines, especially the ubiquitous steam engine, and decay of physical systems. Rankine's work had two distinguishing features. First, he quickly perceived and supplemented Joule's first law with a second law characterizing the potential efficiency of engines and, later, the order and decay of physical systems. Rankine's work had two distinguishing features. First, he quickly perceived and supplemented Joule's first law with a second law characterizing the potential efficiency of engines and, later, the order and decay of physical systems. Rankine's work had two distinguishing features. First, he quickly perceived and supplemented Joule's first law with a second law characterizing the potential efficiency of engines and, later, the order and decay of physical systems. Rankine's work had two distinguishing features. First, he quickly perceived and supplemented Joule's first law with a second law characterizing the potential efficiency of engines and, later, the order and decay of physical systems. Rankine's work had two distinguishing features. First, he quickly perceived and supplemented Joule's first law with a second law characterizing the potential efficiency of engines and, later, the order and decay of physical systems. Rankine's work had two distinguishing features. First, he quickly perceived and supplemented Joule's first law with a second law characterizing the potential efficiency of engines and, later, the order and decay of physical systems.

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Rankine nevertheless established himself as a significant scientific voice. As secretary of section A of the British Association for the Year 1850, he contributed a paper to the scientific session, in which he showed that the laws of physical forces are not limited to the study of mechanics but extend in a wide range of fields. In 1851 he published a study on the transformation between actual and potential forms of energy. This Aristotelian dictionary, he explained, started with an emphasis of the empirical law of energy conservation. In 1853, he wrote the first edition of his most influential book, *Steam Engine and other Prime Movers*, which contained the formula for what is now known as the entropy, a thermodynamic function. It is a measure of the amount of energy that is unavailable to do work. In 1858, he published a paper on the foundation of the *First Law of Thermodynamics*, and in 1870, he developed the *Second Law of Thermodynamics*, which states that the entropy of an isolated system can never decrease over time. Rankine's work on thermodynamics was widely recognized and his contributions were instrumental in the development of the field.

Rankine's work on thermodynamics was not limited to the scientific community. He also applied his knowledge to practical problems. In 1864, he patented a device for measuring steam pressure, which was later adopted by the British Navy. In 1865, he assisted in the design of a new steam engine for the Royal Navy, and in 1866, he was appointed as the consulting engineer to the Highland and Agricultural Society of Scotland. His consulting work was extensive and included projects for the Highland and Agricultural Society of Scotland, the Institution of Civil Engineers, and the Royal Society of Edinburgh.

In addition to his scientific work, Rankine was also a prolific author. He wrote numerous books and articles on various topics, including mechanics, thermodynamics, and engineering. His work was widely read and his ideas were influential in the development of the field.

Rankine's contributions to science and engineering were recognized by numerous awards and honors. He was elected a fellow of the Royal Society of Edinburgh in 1850, and in 1851, he was awarded the Gold Medal of the Royal Society for his work on the transformation between actual and potential forms of energy. In 1858, he was awarded the Royal Medal of the Royal Society for his work on the foundation of the *First Law of Thermodynamics*. In 1870, he was awarded the Copley Medal of the Royal Society for his contributions to the field of thermodynamics.

Despite his many accomplishments, Rankine was not without controversy. He was known for his flippant and humorous style of writing, which sometimes drew criticism from his peers. Nevertheless, his contributions to science and engineering were significant and his work continues to be studied and admired today.
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