

7.2 James Prescott Joule

James Joule was known for the accuracy and precision of his work in a time when exactness of measurements was not held in high regard. He demonstrated that heat is a form of energy. He studied the nature of heat and the relationship of heat to mechanical work. Joule has also been credited with finding the relationship between the flow of electricity through a resistance, such as a wire, and the heat given off from it. This is now known as Joule's Law. He is remembered for his work that led to the First Law of Thermodynamics (Law of Conservation of Energy).

The young student

James Joule was born near Manchester, England on December 24, 1818. His father was a wealthy brewery owner. James injured his spine when he was young and as a result he spent a great deal of time indoors, reading and studying. When he became interested in science, his father built him a lab in the basement.

When James was fifteen years old, his father hired John Dalton, a leading scientist at the time, to tutor James and his brother, Benjamin. Dalton believed that a scientist needed a strong math background. He spent four years teaching the boys Euclidian mathematics. He also taught them the importance of taking exact measurements, a skill that strongly influenced James in his scientific endeavors.

Brewer first, scientist second

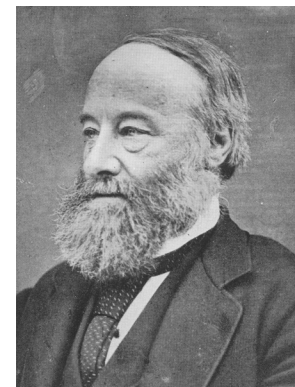
After their father became ill, James and Benjamin ran the family brewery. James loved the brewery, but he also loved science. He continued to perform experiments as a serious hobby. In his lab, he tried to make a better electric motor using electromagnets. James wanted to replace the old steam engines in the brewery with these new motors.

Though he learned a lot about magnets, heat, motion, and work, he was not able to change the steam engines in the brewery. The cost of the zinc needed to make the batteries for the electric motors was much too high. Steam engines fired by coal were more cost efficient.

The young scientist

In 1840, when he was only twenty-two years old, Joule wrote what would later be known as Joule's Law. This law explained that electricity produces heat when it travels through a wire due to the resistance of the wire. Joule's Law is still used today to calculate the amount of heat produced from electricity.

By 1841, Joule focused most of his attention on the concept of heat. He disagreed with most of his peers who believed that heat was a fluid called caloric. Joule argued that heat was a state of vibration caused by the collision of molecules. He showed that no matter what kind of mechanical work was done, a given amount of mechanical work always produced the same amount of heat. Thus, he concluded, heat was a form of energy. He established this kinetic theory nearly 100 years before others truly accepted that molecules and atoms existed.



On his honeymoon

In 1847, Joule married Amelia Grimes, and the couple spent their honeymoon in the Alps. Joule had always been fascinated by waterfalls. He had observed that water was warmer at the bottom of a waterfall than at the top. He believed that the energy of the falling water was transformed into heat energy. While he and his new bride were in the Alps, he tried to prove his theory. His experiment failed because there was too much spray from the waterfall, and the water did not fall the correct distance for his calculations to work.

From 1847–1854, Joule worked with a scientist named William Thomson. Together they studied thermodynamics and the expansion of gases. They learned how gases react under different conditions. Their law, named the Joule-Thomson effect, explains that compressed gases cool when they are allowed to expand under the right conditions. Their work later led to the invention of refrigeration.

James Joule died on October 11, 1889. The international unit of energy is called the Joule in his honor.



Reading reflection

1. Why do you think that Joule's father built him a science lab when he was young?
2. What evidence is there that Joule had an exceptional education?
3. Why was Joule so interested in electromagnets?
4. Why would you consider Joule's early experiments with electric motors important even though he did not achieve his goal?
5. Explain Joule's Law in your own words.
6. Describe something Joule believed that contradicted the beliefs of his peers.
7. Describe the experiment that Joule tried to conduct on his honeymoon.
8. Name one thing that we use today that was invented as a result of his research.
9. What unit of measurement is named after him?
10. **Research:** Find out more information about one of Joule's more well-known experiments, and share your findings with the class. Try to find a picture of some of the apparatus that he used in his experiments. Suggested topics: galvanometer, heat energy, kinetic energy, mechanical work, conservation of energy, Kelvin scale of temperature, thermodynamics, Joule-Thomson Effect, electric welding, electromagnets, resistance in wires.