Stories of Science: Mr and Mrs Joule's Honeymoon

The story about the English Scientist and his wife.

A typical Georgian Scientist

James Joule was born in 1818 into a wealthy family as his father owned a brewery. His father could therefore afford a quality education for his sons and James and his brother. James' tutors included John Dalton the chemist who had proposed the Atomic Theory of matter.

James enjoyed science and he and his brother particularly liked playing around with electricity and we often told off for giving minor electric shocks to people.

Although he loved science, during the Georgian era science was not really a profession, merely a hobby so he took over his father's Brewing business, but looked to apply his scientific hobby to making his brewery make him more money. He considered replacing the coal-burning steam engines with new electric motors, but in order to judge which was better Joule needed a way to quantify how much better the electric motors were than the steam engines, so came up with the idea of a measurement called a "foot-pound". The foot-pound was many pounds of mass could be lifted a certain number of feet in height by each method. He later realised that he also needed to be able to quantify energy in heated liquids and took careful measurements of temperature of stirred liquids, noticing that the temperature was dependent on how much it was stirred. He called this property the "mechanical equivalent of heat".

This led Joule to propose the convertibility of energy between different stores, rather than of "heat" as a substance itself that flowed from object to object, which was the prevailing view at the time. When Joule first presented his ideas at a meeting of the British Assocation for the Advancement of Science, he was met with silence. Joule kept experimenting and developing his ideas about energy. Joule also found a relationship between the current flowing in a conductor, its resistance and the heat transferrred per second (the power), which gives us the equation you use in your GCSEs, $P=I^2R$.

Always experimenting

Joule's theory suggested that water at the bottom of a waterfall would be slightly warmer than the top, as gravitational potential energy is converted into heat. But that a fall of 800 feet (243 meter) would be required for a difference of 1°F (0.6 °C). His later collaborator William Thompson, the Lord Kelvin used to apocryphally say that James and his wife Amelia were out for a romantic walk in the Alps on honeymoon when they came across a beautiful waterfall, but rather than admire the beautiful scenery James whipped a thermometer out his pocket and began to take measurements of the temperature of the water! Even if this story is not true, it likely that it reflects the personality of James Joule a man who was seriously dedicated to his scientific work. James and Amelia has two children, but sadly Amelia died during the birth of their third child who then died three weeks later.

What Joule and Lord Kelvin did next

Joule's work began to be more and more accepted by other scientists and it was William Thompson the Lord Kelvin who was one of the first to accept Joule's ideas and work in collaboration together. Together they found that when a gas expands its temperature falls, and conversely when a gas is compressed its temperature rises. This is the basis for how refridgeratures work now, compressing and expanding refridgerant gases to keep the contents cool. Joules ideas became so widely accepted in the end that he was elected President of the British Association for the Advancement of Science in 1872. The same society that had met his ideas origanlly with such stoney silence.

James Joule and William Thompson the Lord Kelvin worked together on an absolute temperature scale which would be more related to the energy of a substance. This scale would be called the Kelvin scale. While Joule's name would eventually be given to the SI unit of Energy, the Joule. Joule died in 1889, and on his gravestone is carved "772.55", which is the "foot-pounds" of work needed to increase the temperature of one pound of water from 60°F to 61°F.

Comprehension and Reflection Questions

1. List three things you find out about James Joule as a person

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2. What does "quantify" mean?

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3. Why did Joule need to quantify his experiments?

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4. What is the definition of a foot-pound, and why do you think this unit is no longer commonly used today?

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5. 1 foot = 30.48cm, 1 pound = 435.6g. Convert 772.55 foot-pounds into kgm (SI units)

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6. What does it mean to be "met with silence"?

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7. Why do you think Joule's ideas were "met with silence" at the time?

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8. How did Joule persuade other scientists that his ideas were correct?

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9. If the density of water is 1000kg/m^3, the temperature at the top is 20°C and the specific heat capacity of water is 4200J/kg°C, what is the final temperature of 1m^3 of water at the bottom of a 10m waterfall?

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Extension Activities

Ideas for things to do next:

Find out about The Kelvin Scale. Why is it used. How is it different/similar to other temperature scales?

Can you recreate Joule's experiment, using a falling mass to spin a paddle to stir some water?

Can you experimentally test the "Joule-Thompson effect" for contracting/expanding gases?

Why not visit the Science & Industry Museum in Manchester, to see their collections of Joule's equipment?

Further Reading

Ideas for things to read next:

The scientific papers of James Prescott Joule (1884) – annotated by Joule

Smith, C. (1998). The Science of Energy: A Cultural History of Energy Physics in Victorian Britain. London: Heinemann.

Memoir of James Prescott Joule by Osborne Reynolds, 1892