

CENTRIPETAL FORCE ON MOVING CHARGES

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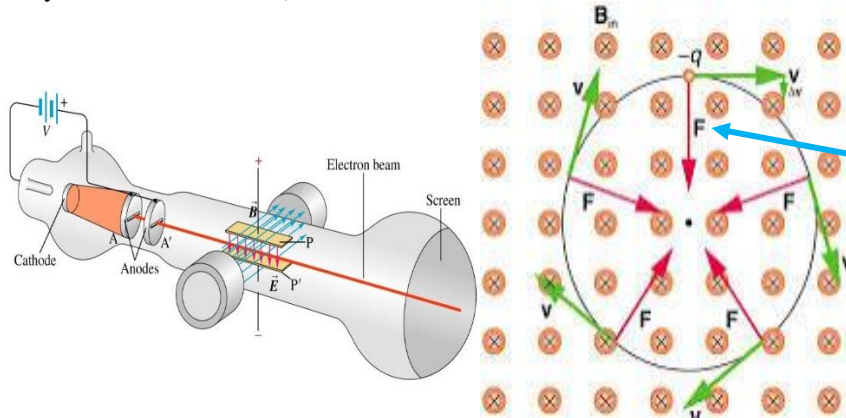
Stephen Hawking to Be Interred at Westminster Abbey

By DENNIS OVERBYE MARCH 21, 2018



Stephen Hawking will be interred at Westminster Abbey in London, keeping company with the likes of Charles Darwin and Isaac Newton.

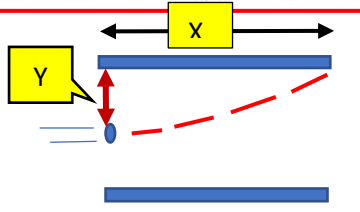
They played poker together on [Star Trek: The Next Generation](#). Now [Stephen Hawking, the English cosmologist and black hole maven who died last week](#), and Sir Isaac Newton, the Englishman who founded modern physics, will rest together for eternity, or at least for its practical equivalent: the lifetime of the stones that make up Westminster Abbey in London. The Abbey announced Wednesday that Dr. Hawking would be given the ultimate tribute. His ashes will be interred in the Abbey in a ceremony “of thanksgiving” to be held later this year. “We believe it to be vital that science and religion work together to seek to answer the great questions of the mystery of life and of the universe,” said the Very Rev. Dr. John Hall, dean of the abbey, Hawking will be in good company. [Sir Isaac Newton](#) was buried in the Abbey in 1727. [Charles Darwin](#) was buried beside him in 1882. **More recently**, the physicists [Ernest Rutherford](#) in 1937 and **Joseph John Thomson in 1940 have been interred there.** “We believe it to be vital that science and religion work together to seek to answer the great questions of the mystery of life and of the universe,” the dean of Westminster, the Very Rev. Dr. John Hall, said in a statement.



INTRODUCTION: JJ Thomson in 1887 found ratio of electron charge to mass e/m by balancing electric field force UP (qE) with magnetic field force DOWN (qvB) on electrons. As you can see in cathode ray tube (at far left) the electrons are moving left to right toward screen. The magnetic field (perpendicular into page) causes negative electrons to experience a **Centripetal force DOWN** (see middle graphic) Thus, $qE = qvB$ or $E/B = v$ With magnetic field OFF the charge experiences ONLY a

Force UP $E q = F$. See graphic in middle bottom Thus, from Newton's second law $a = F/m$ and displacement vertical $y = \frac{1}{2} at^2 = \frac{1}{2} (F/m)t^2$, but since $F = E q$, $y = \frac{1}{2}(q E/m)t^2$ [eq. 1]. Now lets look at horizontal motion of charge. since $v = E/B$, $X = vt$, $X = (E/B)t$ [eq.2]. Solve eq.1 for t and insert in Eq.2 yields: $q/m = 2yE/X^2B^2$ eq. 3

FINAL COMMENT: The author's focus is classical physics and Hawking's work is quite modern physics cosmology. But, J J Thomson's work was at the start of modern physics. **Thomson and Hawking are buried together at Westminster Abby.** $q/m = 1.758 \times 10^{11} \text{ C/kg}$. In 1907 Robert Millikan's oil drop experiment found $q = 1.602 \times 10^{-19} \text{ C}$ and thus m_{ELECTRON} found.



The motion of the electron in just above electric field $E = F/q$ is similar to motion of a projectile in the earth's gravitational field.

QUESTIONS: (a) Solve eq. 1 for t and insert into eq. 2 to yield eq. 3 for q/m ?, (b) Show after units for: y, E, X , & B are inserted into Eq. 3 the final yielding units are Coulombs/kg.?

HINTS: X & Y have units of meters (m), Units of E are same as $v B$ since $v = E/B$