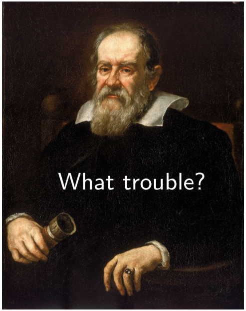
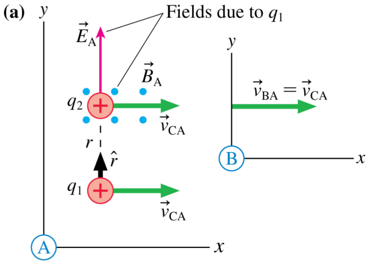
Filling out the Card

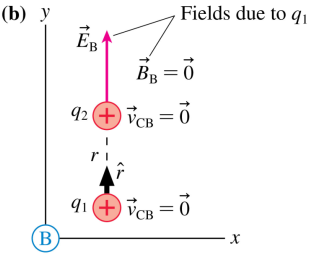
1. List which physics and math courses you have had especially Math Methods, Quantum Mechanics, Classical Mechanics, Statistical Mechanics, Electricity and Magnetism.
2. Do you have experience with *Mathematica*?
3. What are your pronouns?

Consider Figure a. Two positive charges are moving side-by-side in frame A (also called the Home frame) with velocity $\vec{v}_{BA} = \vec{v}_{CA}$. What are the fields $\vec{E}_A$ and $\vec{B}_A$ of charge q_1 at the position of charge q_2 in frame A? In Figure b the B/Other frame is moving with the same velocity as the two charges. What are $\vec{E}_B$ and $\vec{B}_B$ at the position of q_2?





Fields seen in frame A



Fields seen in frame B

Physics is the same in all inertial reference frames (hopefully).

The Galilean Transformations (GT) - 1 4

Galilean
$x' = x - vt$
$y' = y$
$z' = z$
$t' = t$
$v'_x = v_x - v_O$
$v'_y = v_y$
$v'_z = v_z$

primes refer to the frame moving with velocity v_O.

v_O - velocity of moving/Other/B frame.

v_i - i^{th} component of the velocity in the stationary/Home/A frame.

v'_i - i^{th} component of the velocity in the moving/Other/B frame.

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Are Newton's Laws consistent with the Galilean transformations?

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Are Newton's Laws consistent with the Galilean transformations?

Yes! The laws of physics are the same in all inertial frames.

primes refer to the frame moving with velocity v_O.

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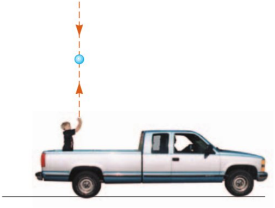
What changes in the trajectory of a tossed ball between the Home frame and the Other frame?



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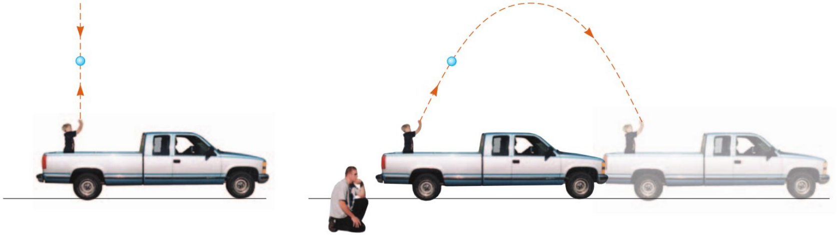

Coulomb's Law

$$d\vec{E} = k_e \frac{dq\hat{r}}{r^2} = \frac{1}{4\pi\epsilon_0}\frac{dq\hat{r}}{r^2}$$

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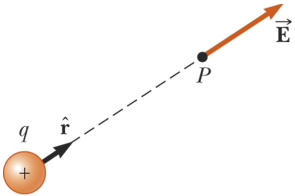

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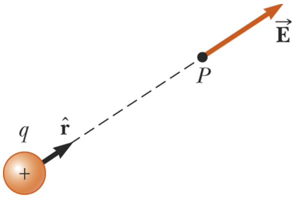
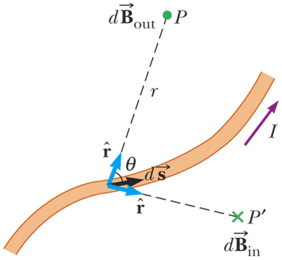


Biot-Savart Law

$$d\vec{B} = k_m \frac{Id\vec{s}\times\hat{r}}{r^2} = \frac{\mu_0}{4\pi}\frac{Id\vec{s}\times\hat{r}}{r^2}$$



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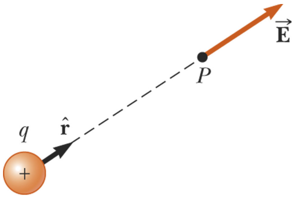

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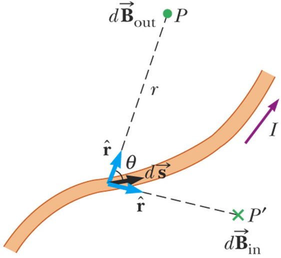

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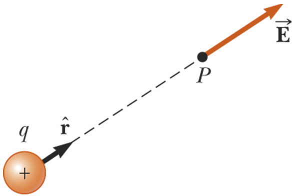

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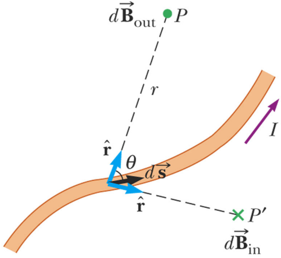
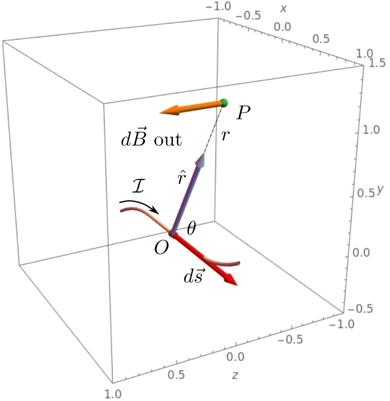
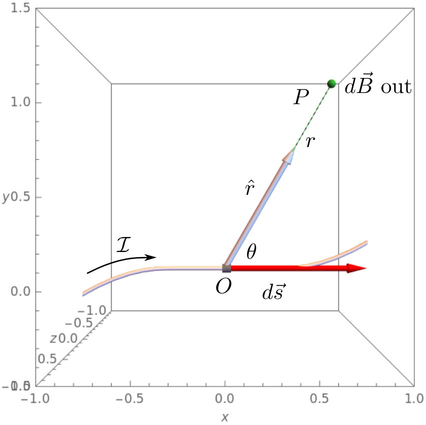


Electromagnetic Force Law

$$\vec{F} = q\left(\vec{E} + \vec{v}\times\vec{B}\right)$$

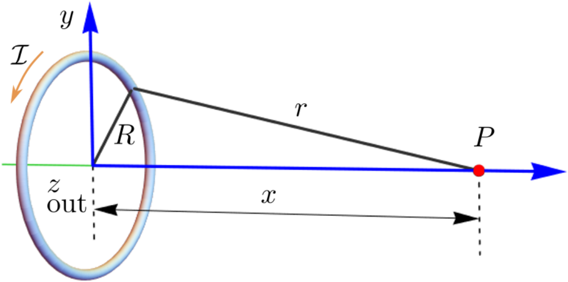
The figures show two views of a segment of a current. What is the magnetic field $d\vec{B}$ at the point P due to the infinitesimal chunk of current at O in terms of the current $\mathcal{I}$, $d\vec{s}$, $\vec{r}$, and the angle θ?



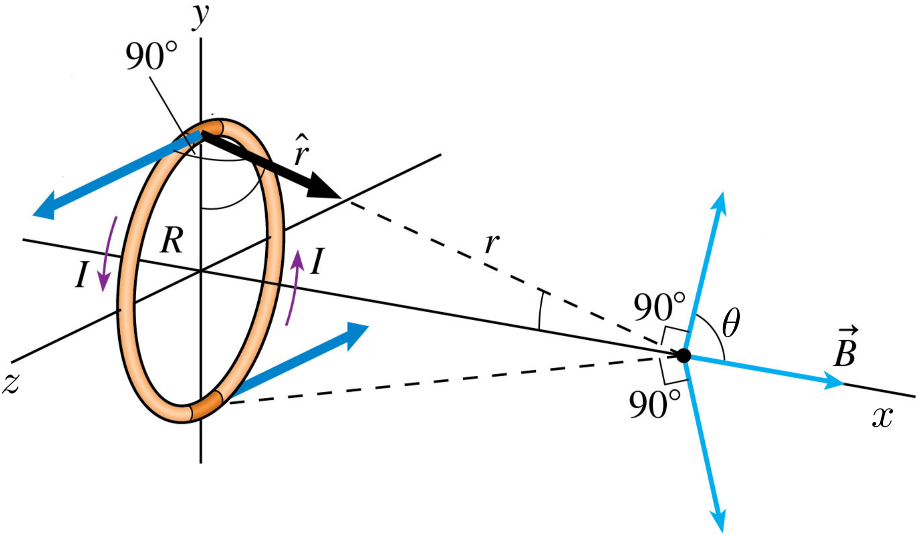


The current $\mathcal{I}$, $\vec{r}$, and $d\vec{s}$ all lie in the same plane.

(1) A ring of radius R as shown in the figure below has a current $\mathcal{I}$. Calculate the magnetic field $\vec{B}$ along the axis of the ring at a point lying a distance x from the center of the ring. Get your answer in terms of R, x, $\mathcal{I}$. (2) In Neils Bohr's 1913 model of the hydrogen atom an electron circles the proton at a distance $R = 5.29 \times 10^{-11}\ m$ with a speed $v = 2.19 \times 10^{6}\ m/s$. What is the magnetic field at the position of the proton created by the electron's orbit?



Magnetic Field of a Current Loop - 3



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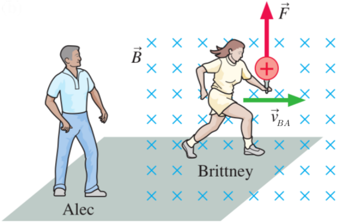
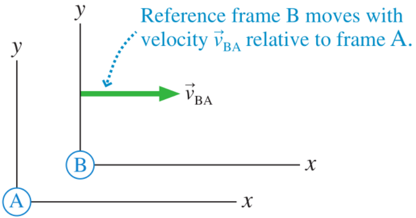


Charge q moves through a magnetic field established by Alec.

1. primes - in frame with velocity v_O.
2. v_O - velocity of moving/Other/B frame.
3. v_i - velocity component in stationary/Home/A frame.
4. v_i' - velocity component in moving/Other/B frame.



$$\vec{E}_B = \vec{E}_A + \vec{v}_{BA} \times \vec{B}_A$$

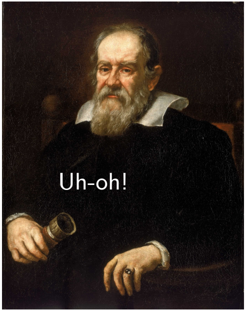
$$\vec{B}_B = \vec{B}_A - \mu_0 \epsilon_0 \vec{v}_{BA} \times \vec{E}_A$$

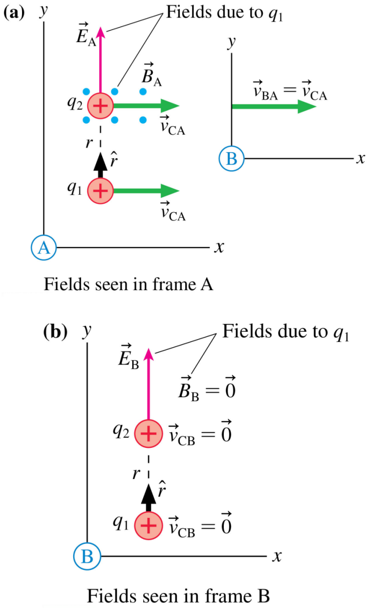
$$\mu_0 \epsilon_0 = \frac{1}{c^2}$$

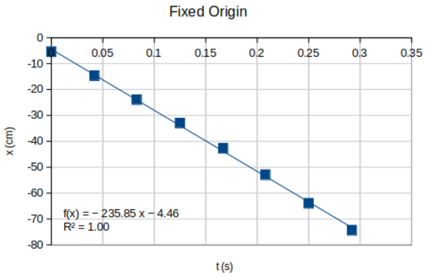
The vector $\vec{v}_{BA}$ is the velocity of the Other frame.

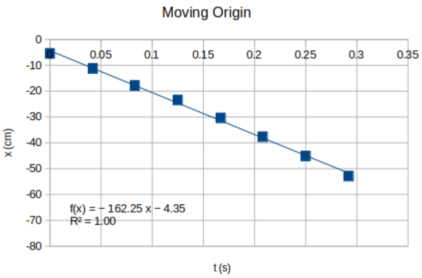
* *Classical electromagnetism and special relativity*, https://en.wikipedia.org/wiki/Classical_electromagnetism_and_special_relativity

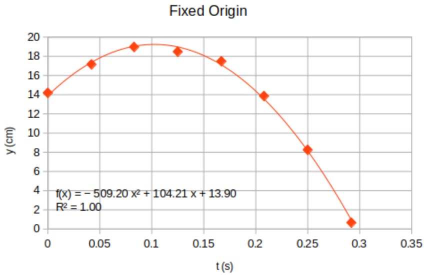
Consider Figure a. Two positive charges move side-by-side through frame A (the Home frame) with velocity $\vec{v}_{BA} = \vec{v}_{CA}$. What are the fields $\vec{E}_A$ and $\vec{B}_A$ of charge q_1 at the position of charge q_2 in frame A? In Figure b the B/Other frame moves with the same velocity as the two charges. What are $\vec{E}_B$ and $\vec{B}_B$ at the position of q_2?

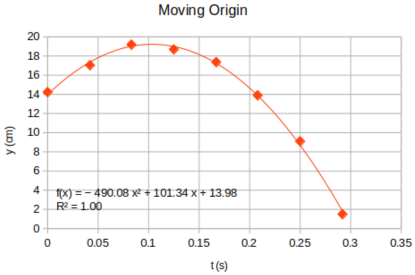





Fixed Origin
f(x) = − 235.85 x − 4.46
R² = 1.00
x (cm)
t (s)


Moving Origin
f(x) = − 162.25 x − 4.35
R² = 1.00
x (cm)
t (s)


Fixed Origin
f(x) = − 509.20 x² + 104.21 x + 13.90
R² = 1.00
y (cm)
t (s)


Moving Origin
f(x) = − 490.08 x² + 101.34 x + 13.98
R² = 1.00
y (cm)
t (s)