1.a. E_y @ $+d/2$ $= \frac{q}{4\pi\varepsilon_0 d^2}$

$\Rightarrow$ $F = \frac{q^2}{4\pi\varepsilon_0 d^2}$ outward

1.b. $u = -v$

$E_y' = \gamma E_y$, $B_z' = \frac{\gamma v}{c^2} E_y$

$F_y' = qE_y' - qv B_z'$

$= \frac{q^2}{4\pi\varepsilon_0 d^2} \gamma \cdot (1 - \frac{v^2}{c^2}) = \frac{1}{\gamma} \frac{q^2}{4\pi\varepsilon_0 d^2}$

1.c. $K^\mu = (0, 0, \frac{q^2}{4\pi\varepsilon_0 d^2}, 0)$

($\gamma = 1$ initially)

$K^{\mu'} = K^\mu$ since y component of 4-vector doesn't change

But $K^{\mu'} = \gamma (\frac{1}{c} dE'/dt, F_x', F_y', F_z')$

$\Rightarrow$ $F_y' = 1/\gamma K^{2'} = \frac{1}{\gamma} \frac{q^2}{4\pi\varepsilon_0 d^2}$

2.a. Use Lorentz transformation w/ $u = -v$

$$E_z' = \gamma E_z = \gamma \sigma / 2\varepsilon_0$$

$$B_y' = \gamma u/c^2 E_z = -\gamma v/c^2 E_z = \frac{-\gamma v \sigma}{2\varepsilon_0 c^2}$$

$$F^{\mu\nu} = \begin{pmatrix} 0 & 0 & 0 & \gamma\sigma/2\varepsilon_0 c \\ 0 & 0 & 0 & \gamma v \sigma / 2\varepsilon_0 c^2 \\ 0 & 0 & 0 & 0 \\ -\frac{\gamma\sigma}{2\varepsilon_0 c} & -\frac{\gamma v \sigma}{2\varepsilon_0 c^2} & 0 & 0 \end{pmatrix}$$

2.b.

$$K^\mu = q \eta_\nu F^{\mu\nu}$$

$$\eta_\nu = (-c, 0, 0, v_p) / \sqrt{1 - v_p^2/c^2}$$

$$= \gamma_p (-c, 0, 0, v_p)$$

$$K^0 = q \gamma_p v_p \cdot \gamma \sigma / 2\varepsilon_0 c = \gamma_p / c \, dE/dt$$

$$K^1 = q \gamma_p v_p \cdot \gamma v \sigma / 2\varepsilon_0 c^2 = \gamma_p F_x$$

$$K^2 = 0$$

$$K^3 = -q \gamma_p c \cdot -\frac{\gamma\sigma}{2\varepsilon_0 c} = \gamma_p F_z$$

F_x due to $\vec{B}$, F_z due to $\vec{E}$

dE/dt due to motion through $\vec{E}$

3. $A^\mu = \left(\frac{K}{rc}, 0, 0, 0\right)$

$$= \left(\frac{K}{c}\frac{1}{\sqrt{x^2+y^2+z^2}}, 0, 0, 0\right)$$

$$F^{\mu\nu} = \partial A^\nu / \partial x_\mu - \partial A^\mu / \partial x_\nu$$

only non-zero derivatives are

$$\partial A^0/\partial x = \frac{K}{c}\frac{-x}{(x^2+y^2+z^2)^{3/2}} = \frac{-Kx}{cr^3}$$

$$\partial A^0/\partial y = -Ky/cr^3$$

$$\partial A^0/\partial z = -Kz/cr^3$$

$$F^{\mu\nu} = \frac{K}{cr^3}\begin{pmatrix} 0 & x & y & z \\ -x & 0 & 0 & 0 \\ -y & 0 & 0 & 0 \\ -z & 0 & 0 & 0 \end{pmatrix}$$