Physics 1BH, Midterm #3 “cheat sheet”
Winter 2016, Prof. Saltzberg

This will be handed out with the exam. Let me know if you think something should be added.

A few things are deliberately **not** on here so you memorize them forever. These are things physicists and engineers are expected to know without looking up.

- value of μ_0
- value of c
- Magnetic field from an infinitely long line of current
- Ampere’s Law (in differential and integral forms)
- Gauss’s law for magnetism (in differential and integral forms)
- The Lorentz force on a moving particle with velocity **v** in an **E** and **B** field

Lorentz Transformation:

$$
\begin{aligned}
x' &= \gamma(x - vt) \\
y' &= y \\
z' &= z \\
t' &= \gamma(t - \frac{vx}{c^2})
\end{aligned}
$$

Time dilation & Length contraction:
$\Delta t = \gamma \Delta t'$ where $\Delta t'$ is the time between events in the rest frame.
$L = L'/\gamma$ where L' is the time between events in the rest frame.

$$E_{\parallel}^{\text{lab}} = E_{\parallel}^{\text{source}} \qquad \text{and} \qquad E_{\perp}^{\text{lab}} = \gamma E_{\perp}^{\text{source}}$$

Velocity addition rule:

$$u = \frac{u' + v}{1 + \frac{u'v}{c^2}}$$

The field of a point charge moving with constant velocity $v = \beta c$ is radial and has magnitude

$$E = \frac{Q}{4\pi\epsilon_0 r^2} \frac{1 - \beta^2}{(1 - \beta^2 \sin^2\theta)^{3/2}}. \qquad (5.31)$$

$$
\boxed{\begin{array}{ll} \mathbf{E}'_{\parallel} = \mathbf{E}_{\parallel} & \mathbf{E}'_{\perp} = \gamma\big(\mathbf{E}_{\perp} + \mathbf{v} \times \mathbf{B}_{\perp}\big) \\ \mathbf{B}'_{\parallel} = \mathbf{B}_{\parallel} & \mathbf{B}'_{\perp} = \gamma\big(\mathbf{B}_{\perp} - (\mathbf{v}/c^2) \times \mathbf{E}_{\perp}\big) \\ \multicolumn{2}{l}{(\mathbf{v} \text{ is the velocity of } F' \text{ with respect to } F)} \end{array}} \tag{6.76}
$$

$$
\boxed{d\mathbf{B} = \frac{\mu_0 I}{4\pi} \frac{d\mathbf{l} \times \hat{\mathbf{r}}}{r^2}}
$$

- The *vector potential* $\mathbf{A}$ is defined by

$$
\mathbf{B} = \operatorname{curl} \mathbf{A}, \tag{6.90}
$$

which leads to $\operatorname{div} \mathbf{B} = 0$ being identically true. Given the current density $\mathbf{J}$, the vector potential can be found via

$$
\mathbf{A} = \frac{\mu_0}{4\pi} \int \frac{\mathbf{J}\, dv}{r} \qquad \text{or} \qquad \mathbf{A} = \frac{\mu_0 I}{4\pi} \int \frac{d\mathbf{l}}{r} \quad \text{(for a thin wire)}. \tag{6.91}
$$