GEOL4714/5714
Equations to remember

When working in the field, it is often helpful to be able to make a few simple calculations so that you have some idea of what you are doing. Here are some equations that can make collection of data far more reliable.

Seismic refraction:
The crossover distance formula:

$$x_c = 2h\left(\frac{v_2 + v_1}{v_2 - v_1}\right)^{1/2}$$

where x_c is the crossover distance for a layer over a halfspace, h is the thickness of the layer, v_1 and v_2 are the velocities in the top layer and halfspace, respectively. We use this to estimate to be sure our geophone spacing isn't too large and our line length isn't too short. You should also keep in mind the relationship between apparent velocity and dip.

Electrical resistivity:

Unfortunately the full equations are too complex to really tote about, but some simple rules of thumb will serve. For a layer over a halfspace, you will usually start to see the apparent resistivity change as the electrode spacing in a Wenner array reaches about ½ the thickness of the layer; the apparent resistivity won't reach the resistivity of the halfspace until the electrode spacing reaches somewhere between about 10 and 100 times the thickness of the layer, depending on the resistivity contrast. The other concept to keep in mind (we get two since we don't have a real equation) is that for thin conductors in a resistive medium, you can decrease the resistivity below the observed minimum apparent resistivity and still fit the data if you keep the resistivity divided by the thickness constant. Similarly, for thin resistors, it is the resistivity times the thickness that stays needs to stay constant.

Gravity:
The gravity from an infinite slab formula:

$$\Delta g = 2\pi G h \Delta\rho$$

$$\cong 0.04193 h \Delta\rho \ (\Delta g \text{ in mGal}, h \text{ in meters}, \Delta\rho \text{ in g/cc})$$

This is the gravity anomaly from an infinite flat slab. This is the basis for the Bouguer correction (which is generally about 0.1 mGal/m) and estimating about how large an anomaly you might expect from a simple flat slab approximation. It is also helpful in the field to know the free-air correction, which is about 0.3 mGal/m.

Magnetics:

One of the more useful half-anomaly formulae:

$$z_{\text{sphere}} \approx x_{1/2}$$

where $x_{1/2}$ here is the **total** width of the anomaly (either total field or vertical component) at half the anomaly peak and z_{sphere} is the depth of the center of a sphere or horizontal rod were that creating the anomaly. (A related equation for an infinite rod (a monopole) is that the depth to the top is $x_{1/2}$ / 1.5). This is mainly a helpful reminder to decide when to fill in magnetics data. [Slope methods are frequently better for getting the depth to the top of a prism; see pp. 485-7 of text].

GPR/seismic reflection:

Travel time from a diffractor:

$$t = \frac{2}{v}\sqrt{x^2 + z^2 + \frac{d^2}{4}}$$

where t is the time as a function of position x horizontal from the diffractor, z is the diffractor depth, d is the distance between source and receiver, and v is the velocity of the medium. This can be helpful in the field when trying to determine the origin of a diffraction on a GPR profile. It is also applicable to some seismic reflection signals.