PHY 127, Midterm 1, useful formulas

1. Coulomb's law:
$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r} \tag{1}$$
with $\hat{r} = \vec{r}/r$ and $r = |\vec{r}|$. Also
$$\vec{F} = q\vec{E} \tag{2}$$

2. Gauss's law:
$$\Phi = \int_{surf} \vec{E}\cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0} \tag{3}$$

3. Work
$$W_{a\to b} = U_a - U_b = \int \vec{F}\cdot d\vec{r} \tag{4}$$
Potential difference
$$V_a - V_b = \int \vec{E}\cdot d\vec{r} \tag{5}$$
Potential due to a collection of point charges
$$V = \frac{1}{4\pi\epsilon_0}\left(\frac{q_1}{r_1} + \frac{q_2}{r_2} + \frac{q_3}{r_3} + \ldots\right) \tag{6}$$
where r_1 is the distance to q_1 etc. Also $\vec{E} = -\vec{\nabla}V$.

4. Useful numbers
$$k = \frac{1}{4\pi\epsilon_0} = 9\cdot 10^9\,\mathrm{Nm^2/C^2} \tag{7}$$
$$e = 1.6\cdot 10^{-19}\mathrm{C} \tag{8}$$
$$m_e = 9.1\cdot 10^{-31}\mathrm{kg} \tag{9}$$
$$m_p = 1.7\cdot 10^{-27}\mathrm{kg} \tag{10}$$