PHYSICS 208 EXAM I: Spring 2004
Formula/Information Sheet

- Basic constants:

Gravitational acceleration	g	$=$	9.8 m/sec^2
Permittivity of free space	ϵ_0	$=$	8.8542×10^{-12} C^2/N·m^2 [$k = 1/4\pi\epsilon_0 = 8.9875 \times 10^9$ N·m^2/C^2]
Permeability of free space	μ_0	$=$	$4\pi \times 10^{-7}$ T·m/A [$k_m = \mu_0/4\pi = 10^{-7}$ Wb/A·m]
Elementary charge	e	$=$	1.60×10^{-19} C
Unit of energy: electron volt	1 eV	$=$	1.60×10^{-19} J
Unit of energy: kilowatt-hour	1 kWh	$=$	3.6×10^6 J

- Properties of some particles:

Particle	Mass [kg]	Charge [C]
Proton	1.67×10^{-27}	$+1.60 \times 10^{-19}$
Electron	9.11×10^{-31}	-1.60×10^{-19}
Neutron	1.67×10^{-27}	0

- Some indefinite integrals:

$$\int \frac{dx}{x} = \ln x \qquad \int \frac{dx}{a+bx} = \frac{1}{b}\ln(a+bx)$$

$$\int \frac{dx}{(x^2+a^2)^{3/2}} = \frac{x}{a^2\sqrt{x^2+a^2}} \qquad \int \frac{x\,dx}{(x^2+a^2)^{3/2}} = -\frac{1}{\sqrt{x^2+a^2}}$$

$$\int \frac{dx}{\sqrt{x^2 \pm a^2}} = \ln\left(x + \sqrt{x^2 \pm a^2}\right) \qquad \int \frac{x\,dx}{\sqrt{x^2 \pm a^2}} = \sqrt{x^2 \pm a^2}$$

Coulomb's law: $|\vec{F}| = k\,\frac{|q_1||q_2|}{r^2}$

Electric field [N/C = V/m]

(point charge q): $\vec{E}(r) = k\,\frac{q}{r^2}\,\hat{r}$ ($\hat{r}$ = unit vector radially from q)

(group of charges): $\vec{E} = \sum \vec{E}_i = k \sum \frac{q_i}{r_i^2}\,\hat{r}_i$

(continuous charge distribution): $\vec{E} = k \int \frac{dq}{r^2}\,\hat{r}$ ($\hat{r}$ = unit vector radially from dq)

Electric force [N] (on q in $\vec{E}$): $\vec{F} = q\,\vec{E}$

Electric flux

(through a small area ΔA_i): $\Delta\Phi_i = \vec{E}_i \cdot \Delta\vec{A}_i = E_i\,\Delta A_i\,\cos\theta_i$

(through an entire surface area): $\Phi_{surface} = \lim_{\Delta A \to 0} \sum \Delta\Phi_i = \int \vec{E} \cdot d\vec{A}$

Gauss' law (through a closed surface area): $\Phi_{closed} \equiv \oint \vec{E} \cdot d\vec{A} = \frac{Q_{in}}{\epsilon_0}$

Electric potential [V = J/C]

(definition): $\Delta V = V_B - V_A = -\int_A^B \vec{E} \cdot d\vec{s}$

($\vec{E}$ = constant): $\Delta V = -\vec{E} \cdot (\vec{r}_B - \vec{r}_A)$

(point charge q): $V(r) = k\,\frac{q}{r}$ (with $V(\infty) = 0$)

(group of charges): $V(\vec{r}) = \sum V_i(|\vec{r}_i - \vec{r}|) = k \sum \frac{q_i}{|\vec{r}_i - \vec{r}|}$ ($V_i(\infty) = 0$)

(continuous charge distribution): $V(\vec{r}) = k \int \frac{dq}{|\vec{r}\,' - \vec{r}|}$ ($V(\infty) = 0$)

Electric potential energy [J] (definition): $\Delta U = U_B - U_A = -q_0 \int_A^B \vec{E} \cdot d\vec{s} = q_0\,(V_B - V_A)$

$\vec{E}$ from V: $\vec{E} = -\vec{\nabla} V$ ($\vec{\nabla}$ = gradient operator)

Electric potential energy of two-charge system: $U_{12} = k\,\frac{q_1 q_2}{r_{12}}$