Physics 21 Fall, 2004 — Equation Sheet for Exam-1

Physical Constants:

speed of light *in vacuo*	c	3.00×10^{8} m/s
Gravitational constant	G	6.67×10^{-11} N m^2/kg^2
Avogadro's Number	N_A	6.02×10^{23} mol^{-1}
Gas constant	R	8.315 J/mol K
Boltzmann's constant	$k_{\rm B}$	1.38×10^{-23} J/K
charge on electron	e	1.60×10^{-19} C
free space permittivity	ϵ_0	8.85×10^{-12} C^2/N m^2
free space permeability	μ_0	$4\pi \times 10^{-7}$ T m/A
Planck's constant	h	6.63×10^{-34} J s
electron rest mass	$m_{\rm e}$	9.11×10^{-31} kg
proton rest mass	$m_{\rm p}$	1.6726×10^{-27} kg
neutron rest mass	$m_{\rm n}$	1.6749×10^{-27} kg
atomic mass unit	u	1.6605×10^{-27} kg
$1/(4\pi\epsilon_0)$	k	8.99×10^{9} N m^2/C^2

Various and Sundry Equations:

$$\mathbf{F}_{12} = \frac{1}{4\pi\epsilon_0}\frac{Q_1 Q_2}{r_{21}^3}(\mathbf{r}_1 - \mathbf{r}_2) \qquad \text{(Coulomb's Law)}$$

$$\mathbf{E} = \frac{1}{4\pi\epsilon_0}\frac{Q}{r^2}\hat{\mathbf{r}} = \frac{1}{4\pi\epsilon_0}\frac{Q}{r^3}\mathbf{r} \quad \text{(field of point charge)}$$

$$\mathbf{F} = q\mathbf{E}$$

$$\oint \mathbf{E}\cdot d\mathbf{A} = \frac{Q_{\rm encl}}{\epsilon_0}$$

$$V_b - V_a = -\int_a^b \mathbf{E}\cdot d\mathbf{l}$$

$$\mathbf{E} = -\nabla V$$

$$\mathbf{E} = -\left(\hat{\mathbf{i}}\frac{\partial V}{\partial x} + \hat{\mathbf{j}}\frac{\partial V}{\partial y} + \hat{\mathbf{k}}\frac{\partial V}{\partial z}\right)$$

$$V = \frac{1}{4\pi\epsilon_0}\frac{Q}{r}$$

$$Q = CV$$

$$U = \tfrac{1}{2}CV^2$$

$$U = \tfrac{1}{2}Q^2/C$$

$$u = \tfrac{1}{2}\epsilon_0 E^2$$

$$C = \epsilon_0 K\frac{A}{d} = \epsilon\frac{A}{d}$$

$$V = IR \quad \text{or} \quad V - IR = 0$$

$$R = \rho\frac{l}{A}$$

$$\sigma = \frac{1}{\rho}$$

$$P = IV$$

$$P = I^2 R$$

$$I = \frac{dQ}{dt}$$

C's in series or R's in parallel:

$$\frac{1}{C_{\rm eff}} = \frac{1}{C_1} + \frac{1}{C_2}, \qquad \frac{1}{R_{\rm eff}} = \frac{1}{R_1} + \frac{1}{R_2}$$

C's in parallel or R's in series:

$$C_{\rm eff} = C_1 + C_2, \qquad R_{\rm eff} = R_1 + R_2$$

Useful Integrals:

$$\int \frac{du}{\sqrt{a^2+u^2}} = \ln\left(u + \sqrt{a^2+u^2}\right)$$

$$\int \frac{u\,du}{\sqrt{a^2+u^2}} = \sqrt{a^2+u^2}$$

$$\int \frac{du}{a^2+u^2} = \frac{1}{a}\tan^{-1}\left(\frac{u}{a}\right)$$

$$\int \frac{u\,du}{a^2+u^2} = \tfrac{1}{2}\ln\left(a^2+u^2\right)$$

$$\int \frac{du}{(a^2+u^2)^{3/2}} = \frac{u}{a^2\sqrt{a^2+u^2}}$$

$$\int \frac{u\,du}{(a^2+u^2)^{3/2}} = -\frac{1}{\sqrt{a^2+u^2}}$$

$$\int e^{au}\,du = \frac{1}{a}e^{au}$$

$$\int \sin\theta\,d\theta = -\cos\theta$$

$$\int \cos\theta\,d\theta = \sin\theta$$

$$\int \ln u\,du = u\ln u - u$$

$$\int u^n\,du = \frac{1}{n+1}u^{n+1}$$

$$\int \frac{du}{a+bu} = \frac{1}{b}\ln(a+bu)$$

$$\int \frac{du}{u} = \ln u$$

Lengths, Areas and Volumes:

$C = 2\pi r$	circumference of circle
$C = \pi d$	circumference of circle
$A = \pi r^2$	area of circle
$A = 4\pi r^2$	surface area of sphere
$V = \frac{4}{3}\pi r^3$	volume of sphere

Quadratic Formula:

$$ax^2 + bx + c = 0 \Rightarrow x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

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