Midterm Sheet

Thursday, October 4, 2018 10:41 PM

Constants

$e = 1.6 * 10^{-19}\ C$

$k = 9.0 * 10^{9}\ N * \frac{m^2}{C^2}$

$\varepsilon_0 = 8.854 \times 10$^-12 F/m

$e^-_{mass} = 9.11E^{-31} kg$

Miscellaneous

$f\lambda = c$

$E_{pt} + E_{shell} = \frac{k(-2Q)}{r^2} + E_{out}$

If r < R then $E_{out} = 0$

Vector Rules -

$|\bar{a}| = \sqrt{x^2 + y^2 + z^2}$

$\hat{a} = \frac{x}{|\bar{a}|} + \frac{y}{|\bar{a}|} + \frac{z}{|\bar{a}|}$

$R_{CD} = D - C$

Dot Product

$a \cdot b = [x_a * x_b + y_a * y_b] = N_{ab}$

Cross Product

$a = x_1, y_1, z_1$

$b = x_2, y_2, z_2$

$$a \ x \ b = \begin{matrix} i & j & k \\ x_1 & y_1 & z_1 \\ x_2 & y_2 & z_2 \end{matrix}$$

$= (y_1 z_2 - z_1 y_2)i + (z_1 x_2 - x_1 z_2)j$

$+ (x_1 y_2 - y_1 x_2)k$

Cylindrical Coordinates

$\rho = \sqrt{x^2 + y^2}$

$\Phi = \tan^{-1}\frac{y}{x}$

$z = z$

$R_C + R_D = R_{CD}$

$R_{CD,\rho} = x\cos(\phi) + y\sin(\phi)$

$R_{CD,\phi} = -x\sin(\phi) + y\cos(\phi)$

$R_{CD,z} = z$

Electric field at p between two points:

$F_p = q\bar{E}$

$\bar{E} = \frac{kq}{r^2}\hat{r}$

$|E| = \sqrt{\left(\frac{kq}{r^2}\hat{\imath}\right)^2 + \left(\frac{kq}{r^2}\hat{\jmath}\right)^2 + \left(\frac{kq}{r^2}\hat{k}\right)^2}$

Field Lines / Gauss

- Every Q has N field lines
- \+ attracted to -

Flux -

$\oint E \cdot dA \cos\theta$

Largest flux is determined by the charge inside the surface (Area does not matter)

On a sphere,

$\oint E * dA = \frac{q_{enclosed}}{\varepsilon_0}$

$\phi = 4\pi r^2 E = EA\cos\theta$

$E = \frac{Qr}{4\pi\epsilon_0 R^3}$ (field inside uniformly charged sphere)

An infinite line of charge

$2\pi r L E = \frac{\lambda L}{\epsilon_0} \rightarrow E = \frac{\lambda}{2\pi\epsilon_0 r}$

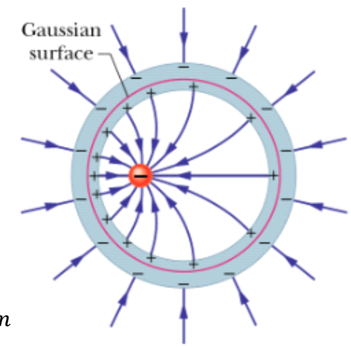
Work:

$\vec{E} = -\frac{dV}{dr}\hat{r} = \frac{V_0}{R}\hat{r}$

$W = \vec{E} \cdot \vec{\delta}$

Shrinking sphere is positive work

Field is doing negative work



Capacitance

$C = \frac{Q}{V} = \frac{\epsilon_0 A}{d}$

In parallel...

$C = C_1 + C_2 \ldots + C_n$

In series...

$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} \ldots \frac{1}{C_N}$

Potential

$\Delta V_{AB} = \frac{\Delta E_{AB}}{q} = \frac{\Delta K_{AB}}{q} = \int_A^B E \cdot dr$

$V = \frac{kq}{r}$

Dipole potential

$V(r,\theta) = \frac{kp\cos\theta}{r^2}$

Where $p = 2aq$

Energy

$KE = \frac{1}{2}mv^2$

$U = \frac{energy}{volume} = \frac{1}{2}\epsilon_0 E^2 = \frac{1}{2}cv^2$

Remember differential breakdown

Different capacitors can't handle different loads

Current

ΔQ

2

$$U = \frac{energy}{volume} = \frac{1}{2}\epsilon_0 E^2 = \frac{1}{2}cv^2$$

$$\Delta V_{AB}(x) = -\int_A^B ax'dx'\left(\hat{i}\cdot\hat{i}\right) = -\int_0^x ax'dx' = -\frac{a}{2}x^2$$

$$V(x) = V(0) + \Delta V_{AB}(x) = -\frac{a}{2}x^2$$

Current

$$I = \frac{\Delta Q}{\Delta t}$$

Drift Velocity

$$I = nAqv_d$$

Continuous Distributions: A Ring and a Disk

- For a uniformly charged ring of total charge Q, integration gives the potential on the ring axis:

$$V(x) = \int \frac{k\,dq}{r} = \frac{k}{r}\int dq = \frac{kQ}{\sqrt{x^2 + a^2}}$$

- Integrating the potentials of charged rings gives the potential of a uniformly charged disk:

$$V(x) = \frac{2kQ}{a^2}\left(\sqrt{x^2 + a^2} - |x|\right)$$

  - This result reduces to the infinite-sheet potential close to the disk, and the point-charge potential far from the disk.