Point Dipole

Limit $q \to \infty$, $d \to 0$

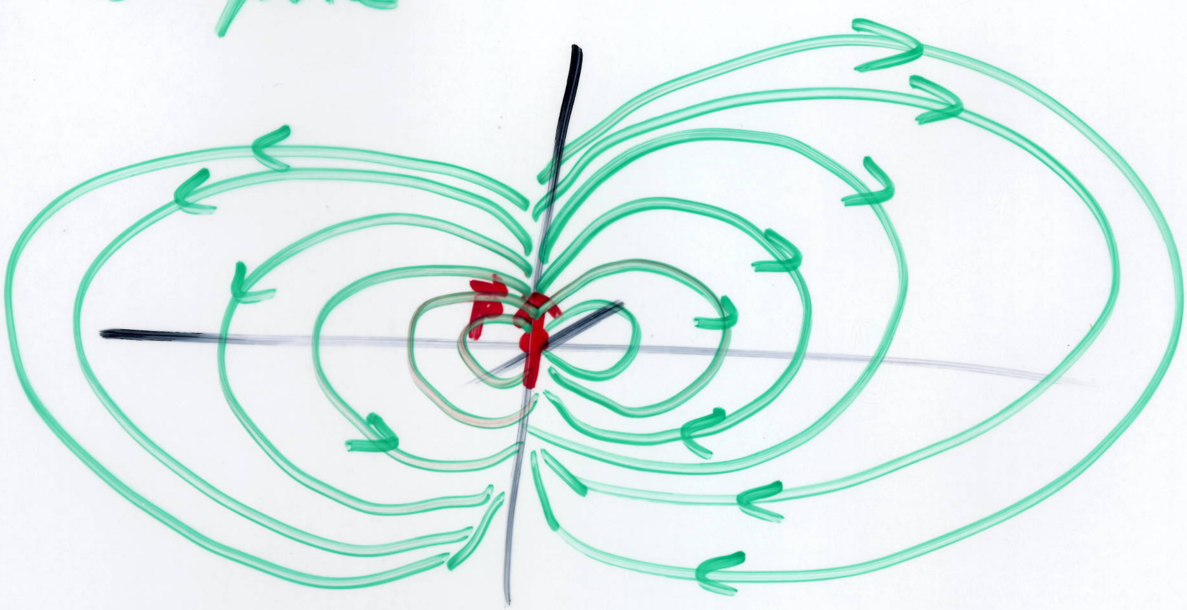
$qd = \text{constant} = p$

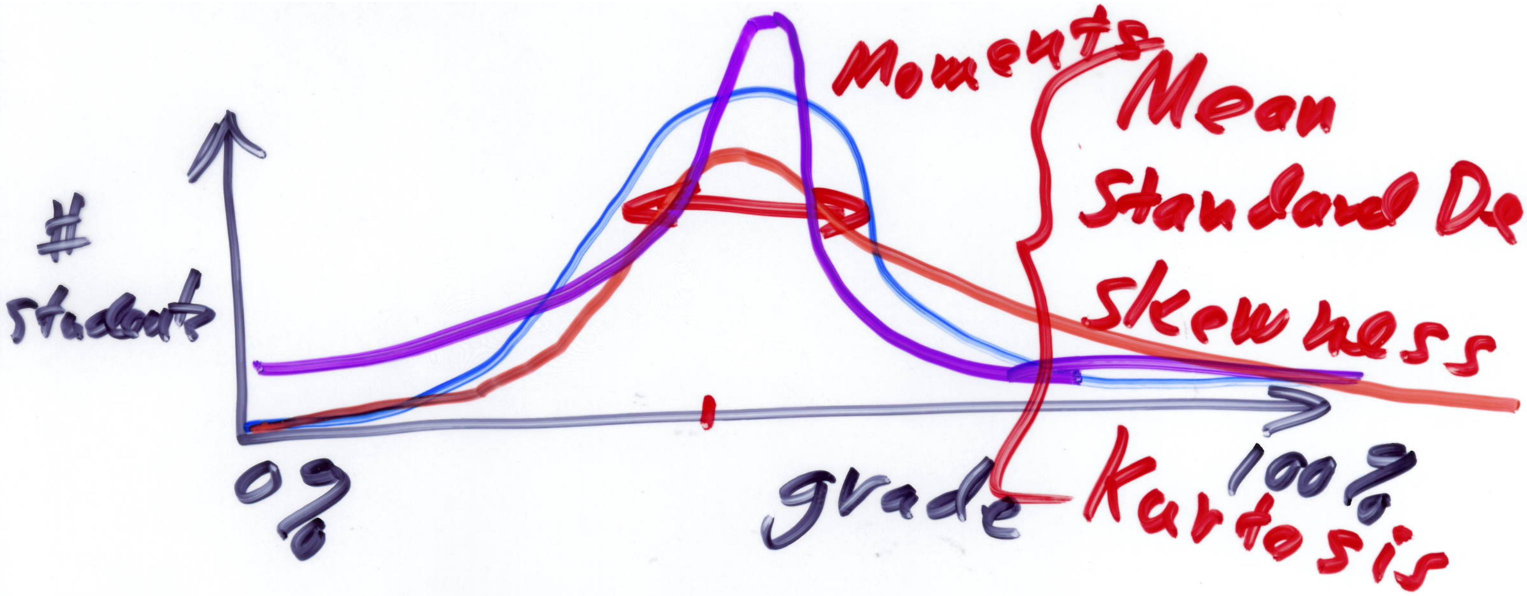
$$V(\vec{r}) = \frac{kp\cos\theta}{r^2}.$$

All higher-order terms go to zero

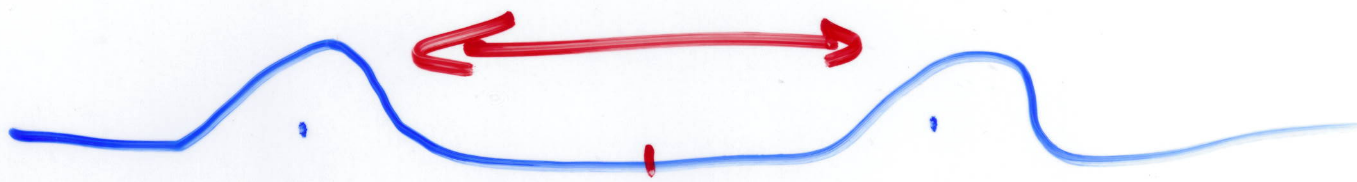
$$V(\vec{r}) = \frac{kp\cos\theta\, r}{r^3} = \frac{k\,\vec{p}\cdot\vec{r}}{r^3}$$

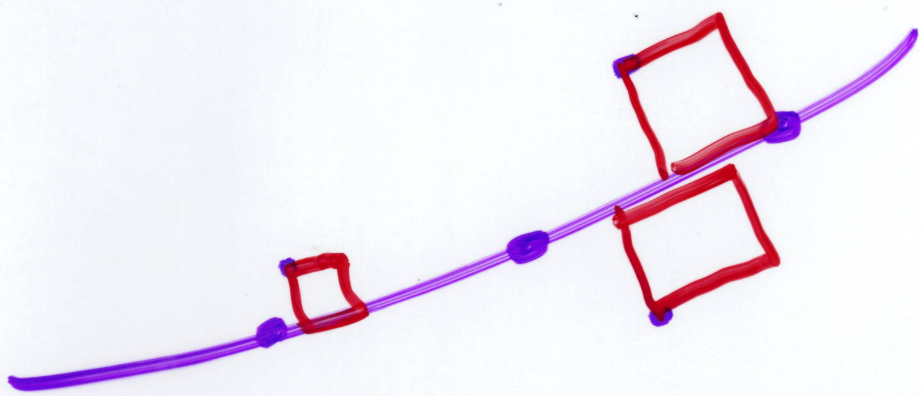
Electric field from a point dipole





Moments
Mean
Mean
Standard Dev.
Skewness
Kurtosis
students
0%
grade
100%





Mechanics

Described by volume mass density

$\rho(\vec{r})$

Total Mass $M = \iiint \rho(\vec{r})\,dV$

~ Total Charge (scalar)

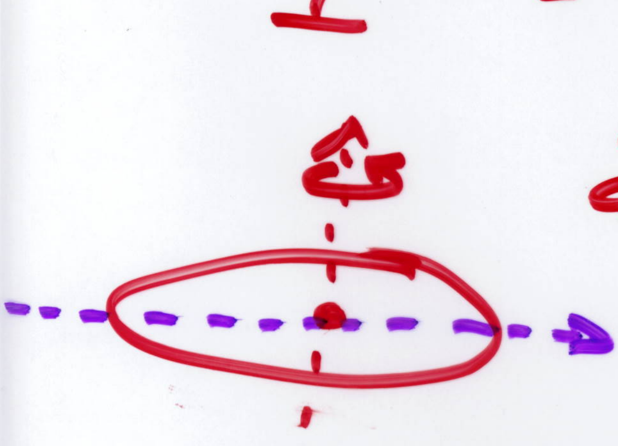
Center of Mass Vector $\vec{R}_{cm} = \dfrac{\iiint \vec{r}\,\rho(\vec{r})\,dV}{M}$

~ Dipole Moment Vector

Moment of inertia ~ Quadrupole Moment tensor

$$I = \iiint r^2 \rho(\vec{r})\,dV$$

distance from the axis of rotation



Not really a scalar

rank-2 tensor $I_{11} = I_{xx} / I_{22} = I_{y\ldots}$

16-3

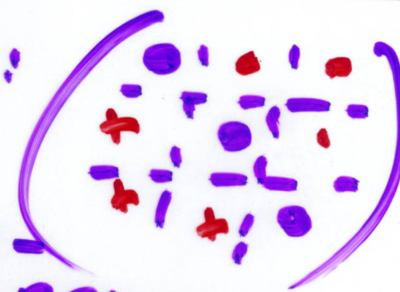
Calculating the vector components of $\vec{P}$:

$$P_1 = P_x = \iiint x \, \rho(\vec{r}) \, dV$$

$$P_2 = P_y = \iiint y \, \rho(\vec{r}) \, dV$$

$$P_3 = P_z = \iiint z \, \rho(\vec{r}) \, dV$$

Quadrupole Moments:



symmetric $\rightarrow$ 6 independent components

$$Q_{11} = Q_{xx} = \iiint x^2 \, \rho(\vec{r}) \, dV$$

$$Q_{12} = Q_{xy} = \iiint xy \, \rho(\vec{r}) \, dV$$

$$\vdots$$

$$Q_{33} = Q_{zz} = \iiint z^2 \, \rho(\vec{r}) \, dV$$