Announcement:

Exam 1: 9/30 Thursday 9:00 am-10:20 am

Half of exam will be done on scantron

[show an example scantron sheet on doc cam]

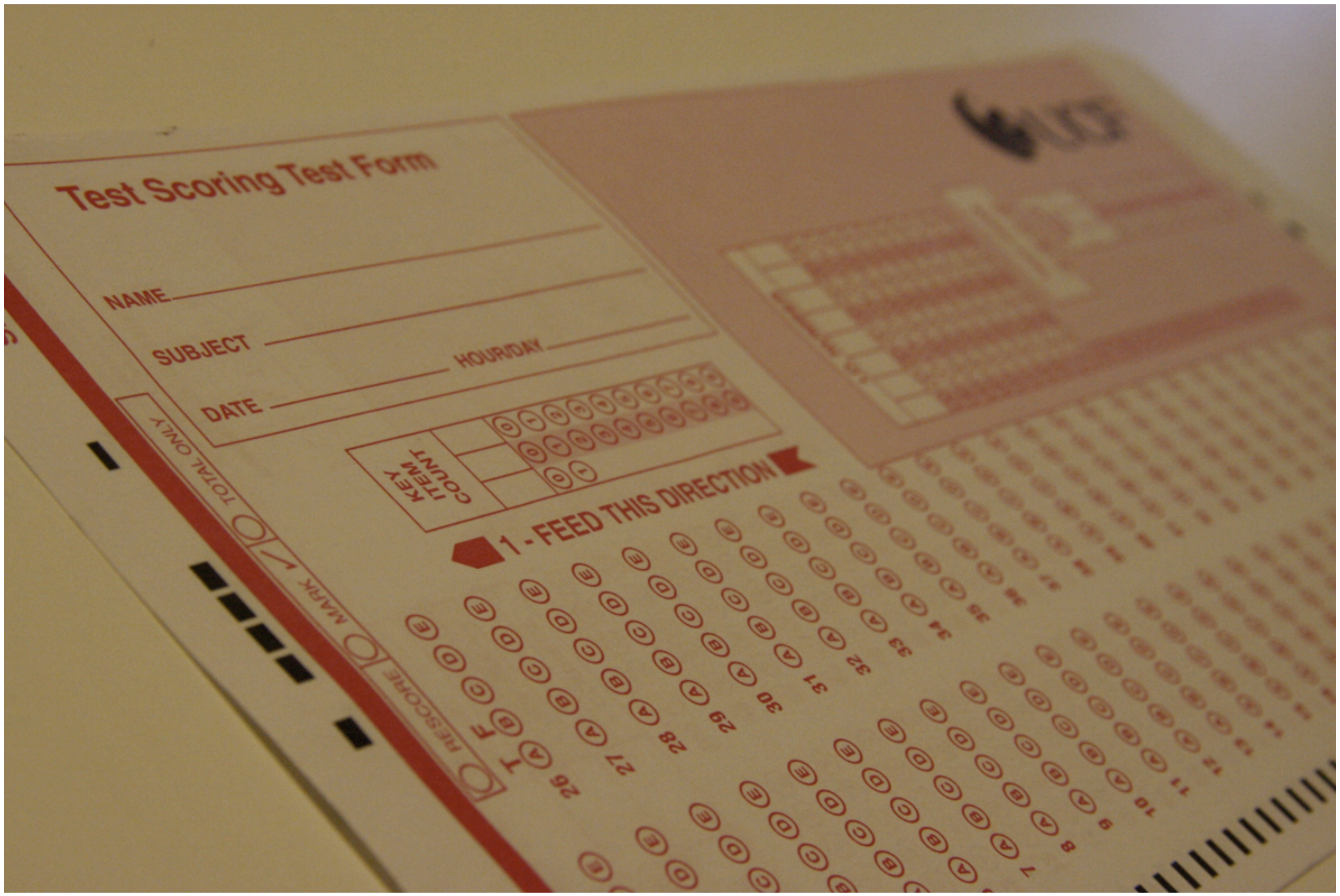
2~3 written questions

Extra review session: 9/27 7 to 9 pm MAP 318 [conference room]

Unregistered clickers will be posted on the website

physics.ucf.edu/~ishigami/Teaching/fall102049/physics20492010Fall.html

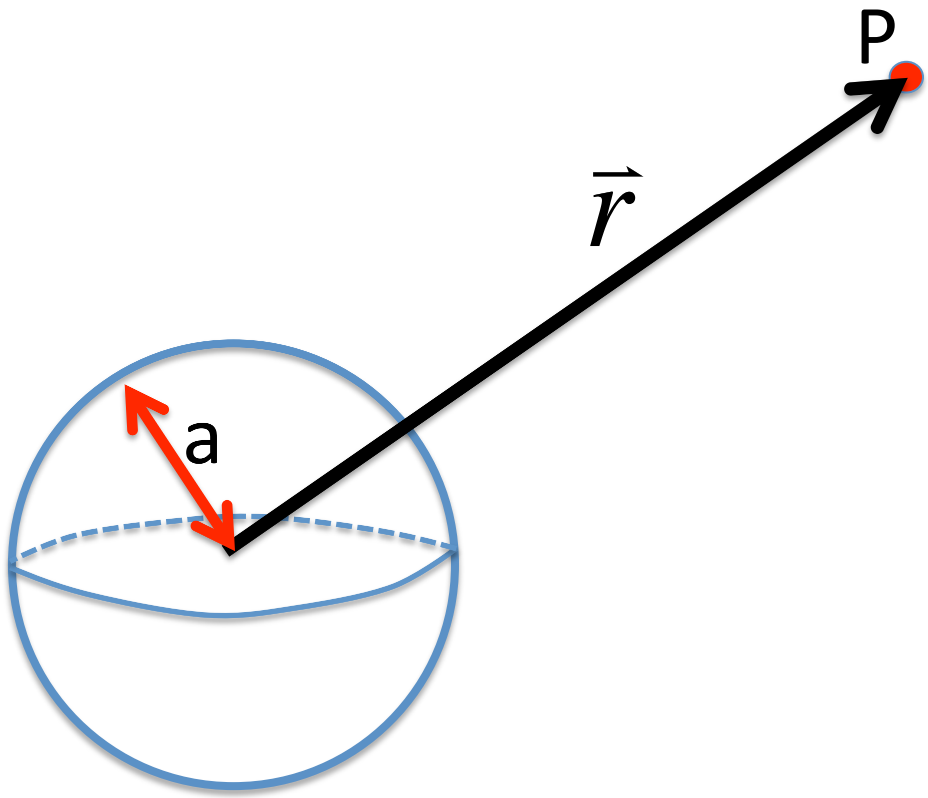
Scantron form to be used



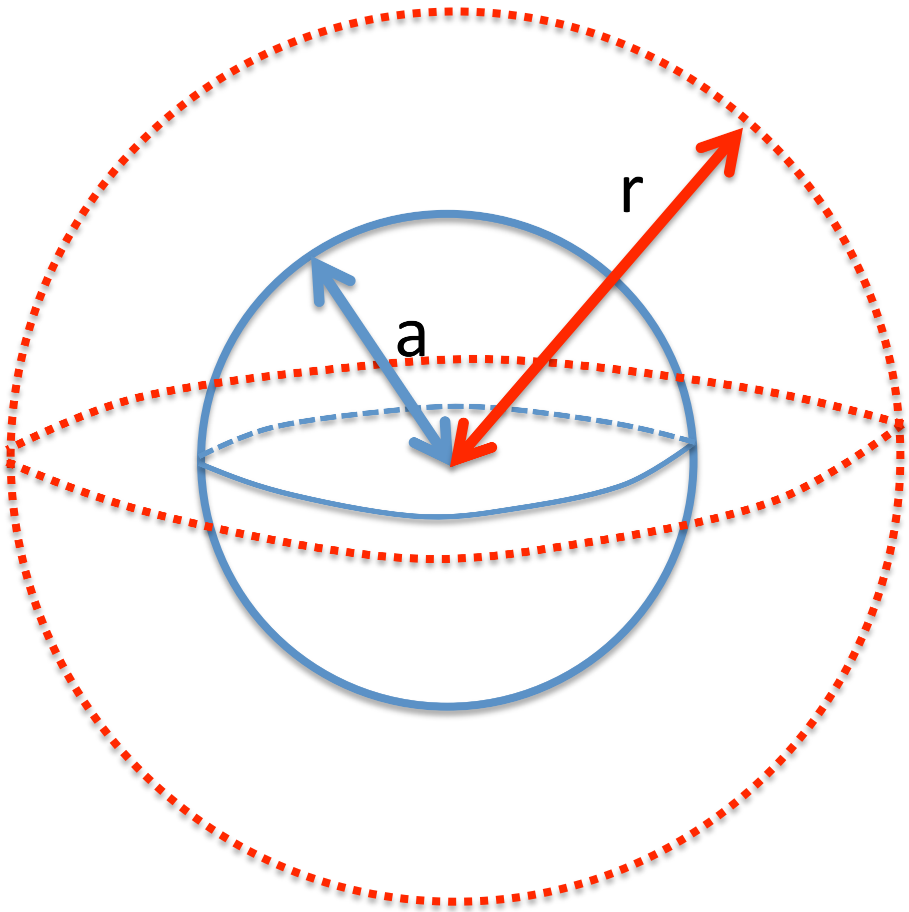
http://www.ucfsga.com/?p=scantrons

Examples of Potential Calculation

Uniformly Charged Sphere with radius a



Electric field outside : Gaussian surface is spherical shell with radius r



$$Q_{enclosed} = Q$$

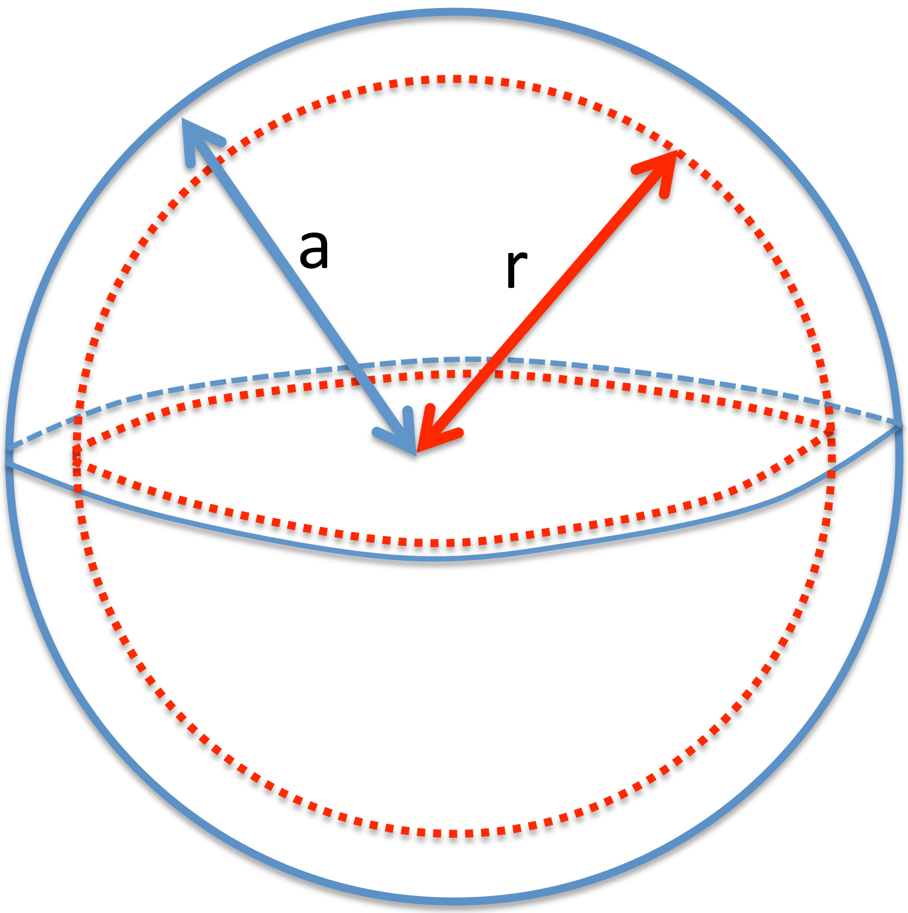
$$\Phi_{total} = \oint E \cdot \hat{n} dS = E \cdot A = 4\pi r^2 E$$

$$\Phi_{total} = \frac{Q_{enclosed}}{\varepsilon_0}$$

$$4\pi r^2 E = \frac{Q}{\varepsilon_0}$$

$$E(r) = \frac{1}{4\pi\varepsilon_0} \frac{Q}{r^2}$$

E inside



$$Q_{enclosed} = Q\frac{\frac{4}{3}\pi r^3}{\frac{4}{3}\pi a^3} = Q\frac{r^3}{a^3}$$

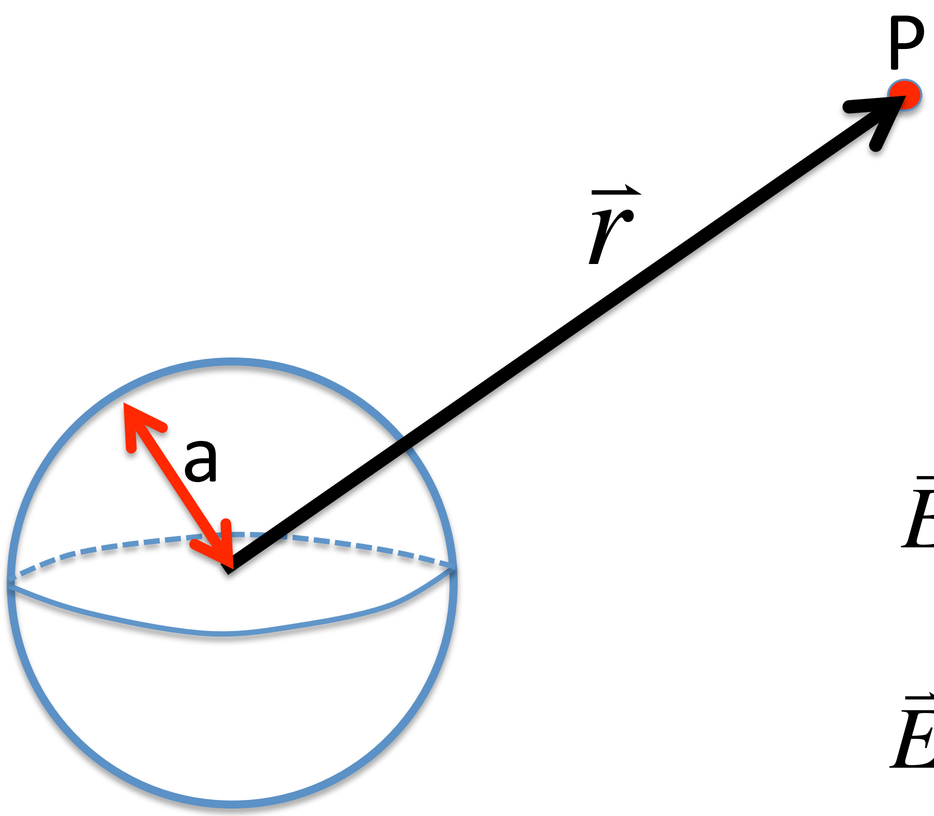
$$\Phi_{total} = \oint E\cdot\hat{n}dS = E\cdot A = 4\pi r^2 E$$

$$\Phi_{total} = \frac{Q_{enclosed}}{\varepsilon_0}$$

$$4\pi r^2 E = \frac{Q\frac{r^3}{a^3}}{\varepsilon_0}$$

$$E(r) = \frac{1}{4\pi\varepsilon_0}\frac{Qr}{a^3}$$

Uniformly Charged Sphere with radius a



Outside (r > a) $E(r) = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$

Inside (r > a) $E(r) = \frac{1}{4\pi\varepsilon_0}\frac{Qr}{a^3}$

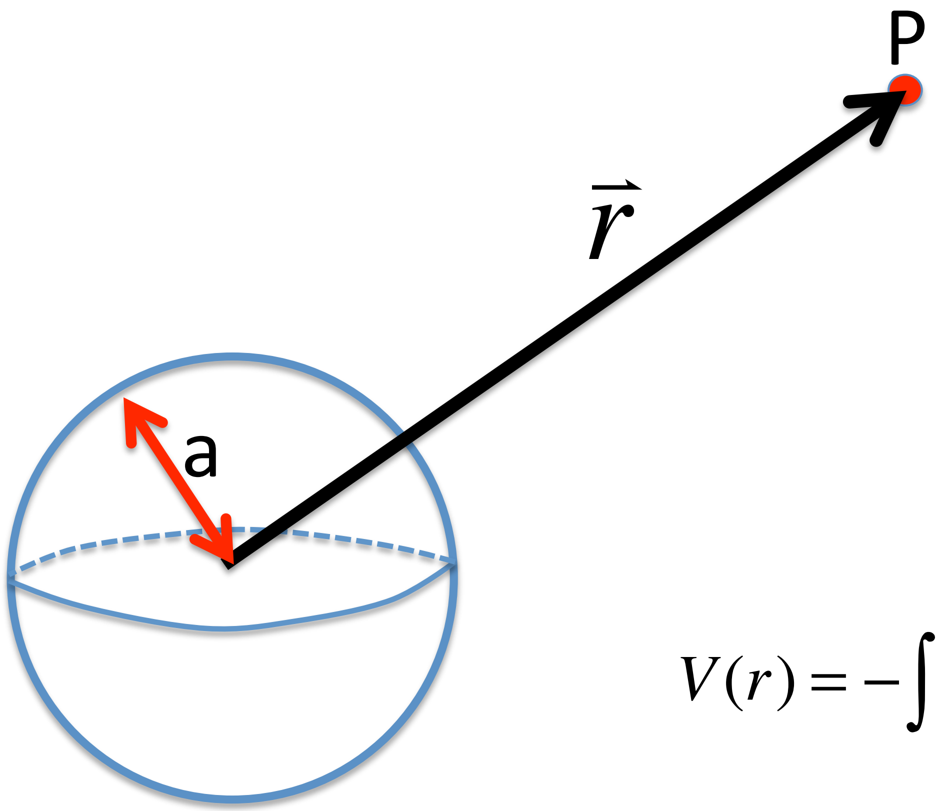
$$\vec{E} = -\vec{\nabla} V$$

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

$$V(r) = -\int E(r)\,dr$$

$$V(\infty) = 0$$

Uniformly Charged Sphere with radius a: potential outside (r > a)



$$E(r) = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$$

$$V(r) = -\int E(r)\,dr$$

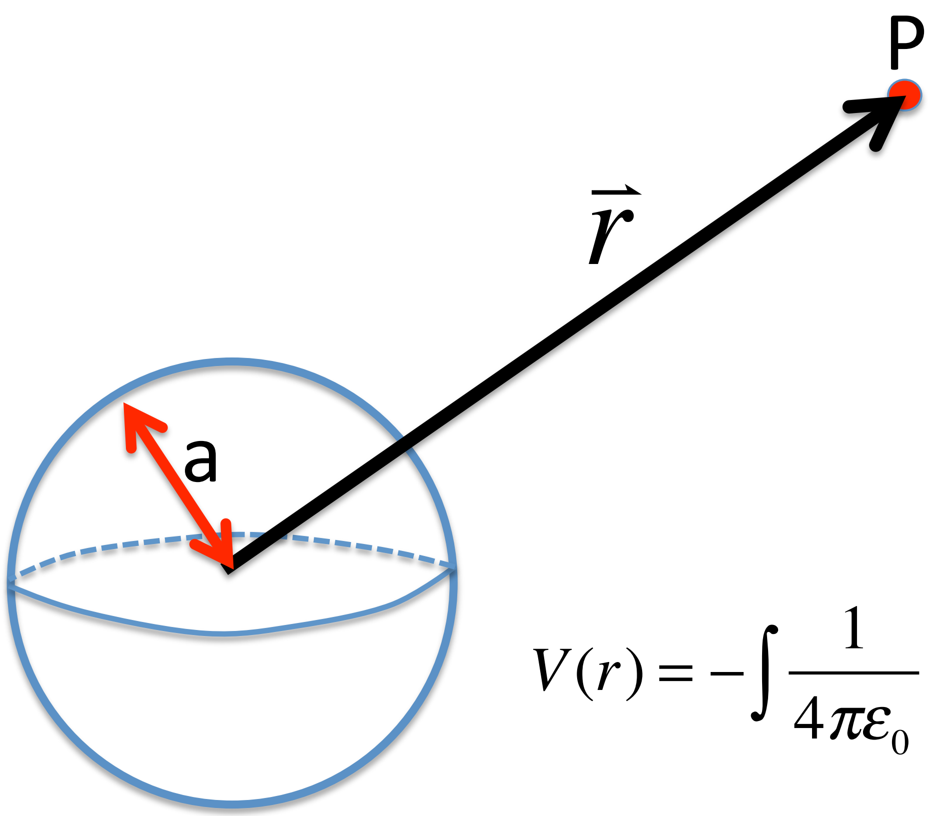
$$V(\infty) = 0$$

$$V(r) = -\int \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}dr = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r} + Constant$$

$$Constant = 0$$

$$V(r) = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$$

Uniformly Charged Sphere with radius a: Potential Inside r < a



$$E(r) = \frac{1}{4\pi\varepsilon_0}\frac{Qr}{a^3}$$

$$V(r) = -\int E(r)\,dr$$

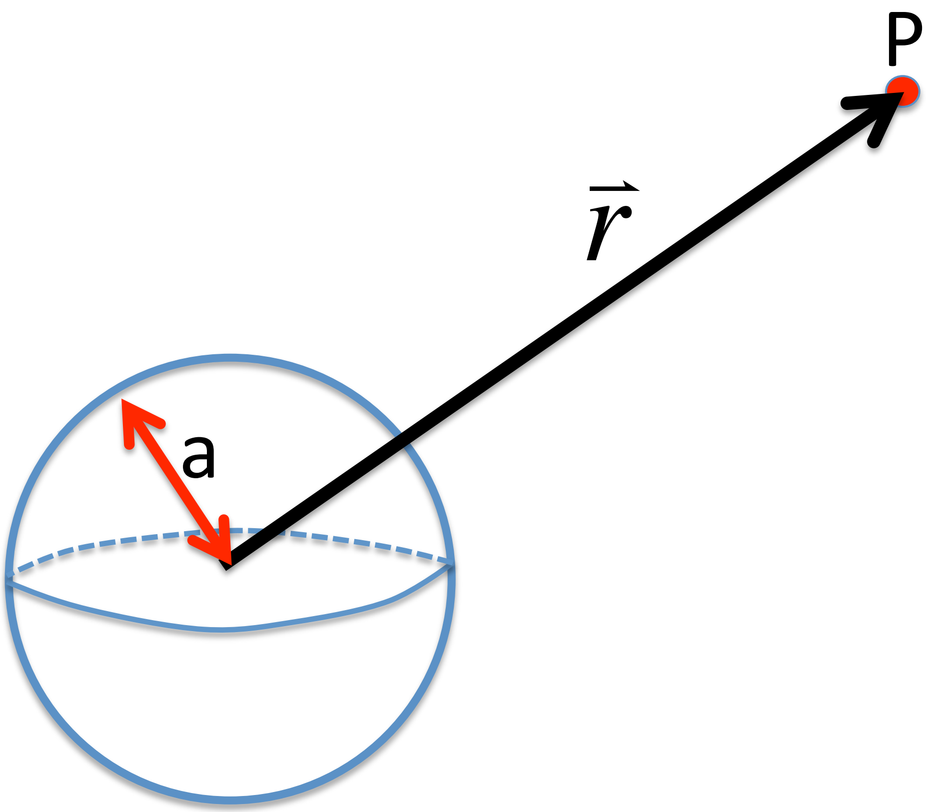
$$V(a) = \frac{1}{4\pi\varepsilon_0}\frac{Q}{a}$$

$$V(r) = -\int \frac{1}{4\pi\varepsilon_0}\frac{Qr}{a^3}dr = -\frac{1}{8\pi\varepsilon_0}\frac{Qr^2}{a^3} + Constant$$

$$V(a) = \frac{1}{4\pi\varepsilon_0}\frac{Q}{a} = -\frac{1}{8\pi\varepsilon_0}\frac{Qa^2}{a^3} + Constant$$

$$Constant = \frac{1}{4\pi\varepsilon_0}\frac{Q}{a} + \frac{1}{8\pi\varepsilon_0}\frac{Q}{a} = \frac{1}{4\pi\varepsilon_0}\frac{3}{2}\frac{Q}{a}$$

Example: Conducting Sphere with total charge Q

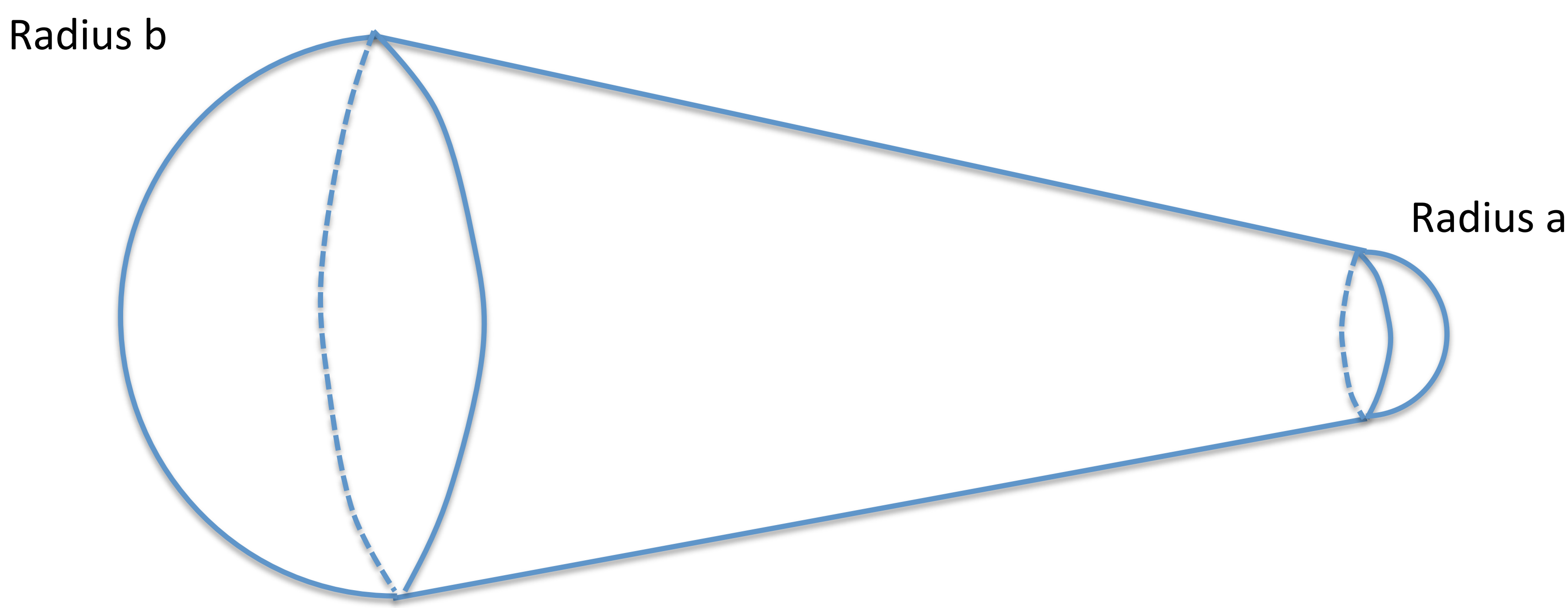


$$V(r) = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}, r > a$$

$$V(r) = \frac{1}{4\pi\varepsilon_0}\frac{Q}{a}, r < a$$

What about a non-traditional objects?

Conducting irregular shaped object

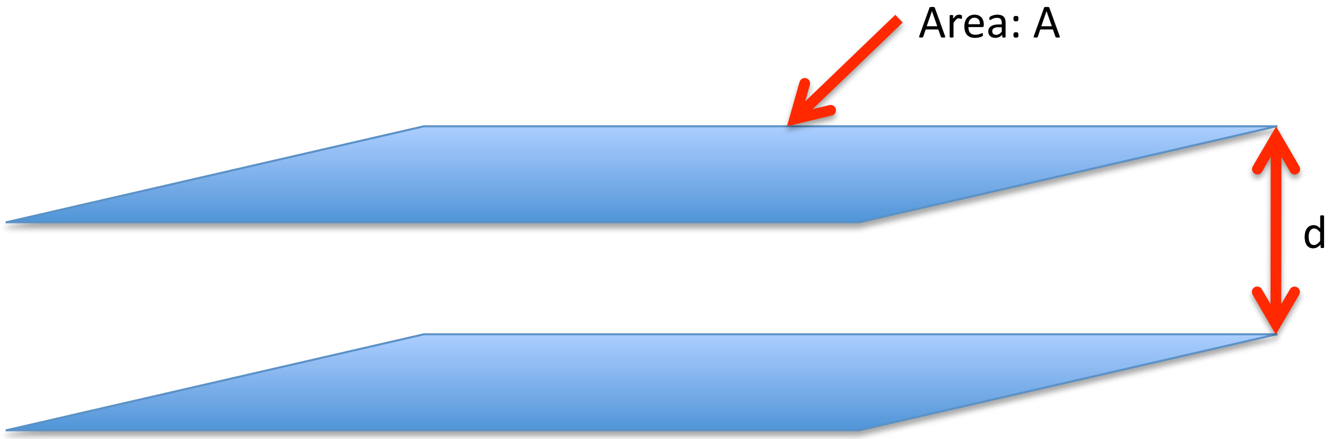


Capacitance

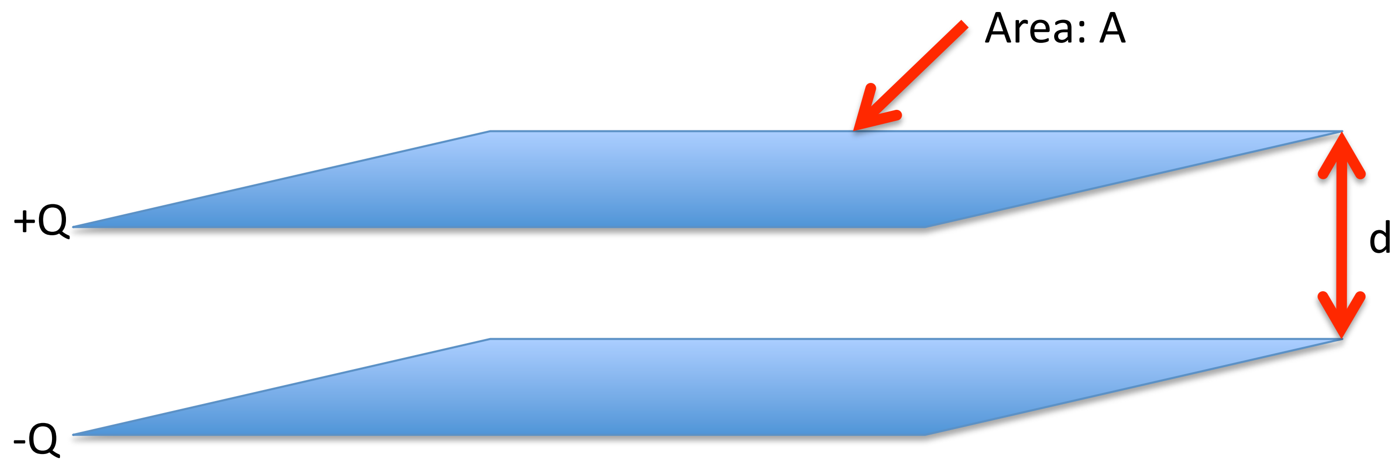
$$C = \frac{Q}{|\Delta V|}$$

Units: Farads (Coulomb per Volt)

Example 1: Parallel Plate Capacitor



Calculate the capacitance of parallel plate capacitor



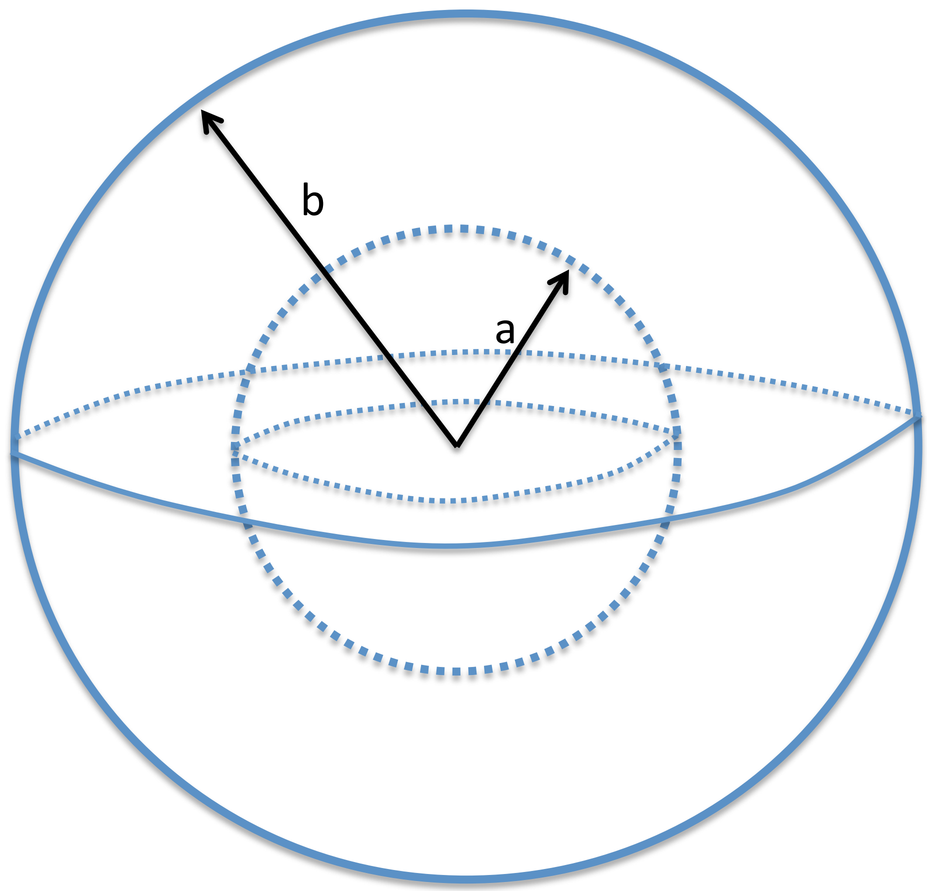
1. Put equal and opposite charge on each plate (imagine)

2. Calculate the voltage difference between the plates

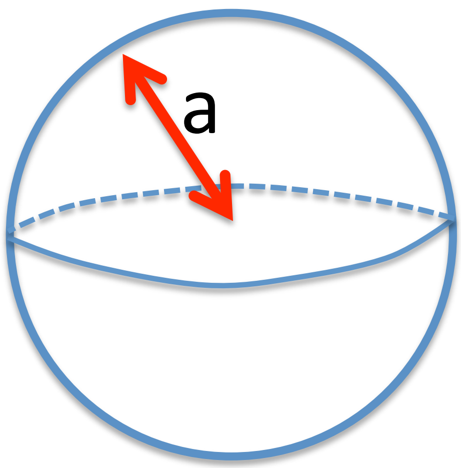
3. Apply $C = \dfrac{Q}{|\Delta V|}$

Proceed on Blackboard

Spherical capacitor



Example: Conducting sphere with charge Q and radius a



$$V(a) = \frac{1}{4\pi\varepsilon_0}\frac{Q}{a}$$

$$Q = CV(a)$$

$$C = 4\pi\varepsilon_0 a$$