



A solid spherical ball of uniform charge density has total charge $Q_0 = 3.0 \times 10^{-12}$ C and radius $R = 0.010$ m.

As always, we're free to decide the "zero point" of potential energy. Please follow the usual textbook convention of saying a particle has zero potential energy when it is infinitely far away. Mathematically speaking, $V = 0$ at $r = \infty$.

Solve everything symbolically *before* plugging in numbers.

- What is the potential a distance $2R$ from the ball's center? Derive any formulas you use.
- A tiny particle of charge $q_1 = 4.0 \mu\text{C}$ and mass $m_1 = 2.0 \times 10^{-6}$ kg is released from rest from the surface of the ball. What velocity does the particle have when it reaches a distance $2R$ from the ball's center?
- (*Very hard*) What is the potential inside the ball, at radius $r_2 = 0.0075$ m from the ball's center? Remember to solve symbolically before cranking the numbers.
- (*Very hard*) What is the potential at the ball's center?

a) Apply howto to find $V(r)$

Step 1 Find $\vec{E}(r)$: use Gauss' Law howto

$r > R$ spherical symmetry

$$\text{LHS} = \oint \vec{E} \cdot d\vec{A} = E \int dA = E 4\pi r^2$$

$$\text{RHS} = q_{in} / \epsilon_0$$

$$E \cdot 4\pi r^2 = Q / \epsilon_0 \Rightarrow \vec{E} = \frac{Q}{4\pi \epsilon_0 r^2} \hat{r}$$

Step 2 Choose $V = 0$ @ ∞

Step 3

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

where you want $V(r)$

$A \rightarrow \infty$
 $B \rightarrow r$

choose path $\vec{E} \parallel d\vec{r} \Rightarrow \vec{E} \cdot d\vec{s} = E dr$
(radial path)