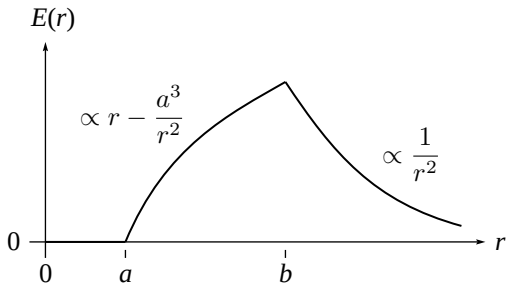
The thick shell of charge

From the class discussion about "onions" of charge,

$$E(r) = \frac{1}{4\pi\epsilon_0}\frac{Q_{\text{[inside r]}}}{r^2}.$$

So

$$E(r) = \begin{cases} 0 & r < a \\ \dfrac{1}{4\pi\epsilon_0}\dfrac{4}{3}\pi(r^3 - a^3)\dfrac{\rho}{r^2} & a < r < b \\ \dfrac{1}{4\pi\epsilon_0}\dfrac{4}{3}\pi(b^3 - a^3)\dfrac{\rho}{r^2} & b < r \end{cases}$$



The graphs of the left-most and right-most parts of the function are straightforward. For the middle portion ($a < r < b$) note that the slope is proportional to

$$\text{slope} \propto 1 + 2\frac{a^3}{r^3}$$

so that (i) the slope is always postive — never zero or negative — and (ii) as r increases, the slope decreases.

Grading: 2 points for each part of answer equation ($r < a$, $a < r < b$, and $b < r$); 4 points for graph.