Quiz 4A

PHYSICS 208, WINTER 2016

SECTION: NAME:

The Spherical Capacitor: Two concentric spherical conducting shells are separated by vacuum. The inner shell has total charge $+Q$ and outer radius r_a, and the outer shell has charge $-Q$ and inner radius r_b.

(10 pts) **Problem 1:** Find the capacitance for the spherical capacitor.

Electric Field

(1 pt)(i) By considering a spherical Gaussian surface, you can obtain the electric field for the region between the two spherical shells. What is Q_{enc} for the constructed surface?

(3 pts)(ii) Integrate $\oint \vec{E} \cdot d\vec{a}$, which runs over the entire Gaussian surface.
Note: $\vec{E}$ is uniform, $\oint da$ is the total area of the Gaussian surface when $\vec{E}$ is parallel to the surface normal $\hat{n}$.

(1 pt)(iii) What is $\vec{E}$ (with direction $\hat{r}$)?

Potential Difference

(3 pts)(i) Using $V_{ab} = \int_{r_a}^{r_b} E(r)\, dr$, find the potential difference between the concentric shells by integrating the electric field previously found.

Capacitance

(1 pt)(i) What is the equation for the capacitance in terms of the potential difference V_{ab} and charge Q?

(1 pt)(ii) Using the value of V_{ab} you obtained, write the capacitance of the spherical capacitor.

(5 pts) **Problem 2:** Find the energy stored in the spherical capacitor.

The work dW needed to put a charge of dq on the capacitor is given by $dW = V dq$.

(1 pt)(i) Write the potential V in terms of Q and C.

(2 pts)(ii) The total work is given by $W = \int_0^W dW$. Integrate this expression to find W.

(1 pt)(iii) What is the electrical potential energy U stored for the spherical capacitor?

(1 pt)(iv) Using the value obtained for the capacitance in problem 1, write the potential energy stored for the spherical capacitor.

[BONUS (2 pts)]**Conceptual Question : Circle the correct choices to complete the statement.**
The capacitance of a spherical capacitor *INCREASES/DECREASES* with increasing radial difference $r_b - r_a$ between the two shells, and *DOUBLES/HALVES* if r_a is doubled.