

Quiz 4C

PHYSICS 208, WINTER 2016

SECTION:

NAME:

The Parallel-Plate Capacitor: Consider a parallel-plate capacitor with plate separation d and charge $+Q$ and $-Q$ on the top and bottom plates respectively. The positive \hat{z} direction is pointing downwards.

(10 pts) **Problem 1:** Find the capacitance for the parallel-plate capacitor.

Electric Field

(1 pt)(i) By considering a rectangular Gaussian surface (with one end embedded inside of a plate), you can obtain the electric field for the region between the two plates. 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{z})?

Potential Difference

(3 pts)(i) Using $\Delta V = \int_0^d E(z) dz$, find the potential difference between the parallel plates by integrating the electric field previously found.

Capacitance

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

(1 pt)(ii) Using the value of ΔV you obtained, write the capacitance of the parallel-plate capacitor.

(5 pts) **Problem 2:** Find the energy stored in the parallel-plate capacitor.

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

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

(2 pt)(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 parallel-plate capacitor?

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

[BONUS (2 pts)] **Conceptual Question : Circle the correct choices to complete the statement.**

The capacitance of a parallel-plate capacitor *INCREASES/DECREASES* with increasing plate separation d and *INCREASES/DECREASES* with increasing charge held on the plates (by the capacitor).