[Cheng P.3-43] Prove that Eqs (3-180) for stored electrostatic energy hold true for any two-conductor capacitor.

*Solution:* Two conductors at potentials $V_1$ and $V_2$ carrying charges $Q$ and $-Q$:

$$W_e = \frac{1}{2}V_1 \int_{S_1} \rho_{si}\, dS + \frac{1}{2}V_2 \int_{S_2} \rho_{s2}\, dS = \frac{1}{2}Q(V_1 - V_2) = \frac{1}{2}CV^2\,, \qquad V = V_1 - V2\,.$$

*Answer:*

$$W_e = \frac{1}{2}Q(V_1 - V_2)$$