EE Ph.D. Qualifying Exam, January 2012 Question

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Energy in charging and discharging capacitors

Notes:

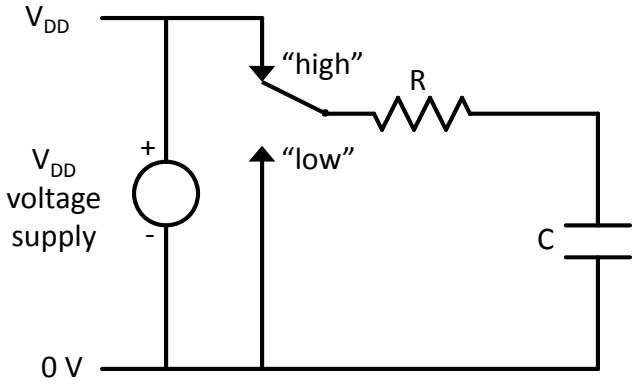
There may not be single "correct" answer to parts of this question. The goal of this question is to see how you think about it.

If you finish the question on this sheet, subsequent questions will be asked.

[In the exam, most students got through the main question, possibly with some help. Most of those then got through the first supplementary question. A fair fraction got to the second supplementary question, though only a few had time to finish that. Those that did finish mostly also got through the third supplementary question.]

Question:

In the circuit below, the switch has initially been connected in the "low" position for a long time; at the start of our experiment, therefore, the capacitor C is completely discharged. Then we move the switch to the "high" position and leave it there for a long time, charging the capacitor up to a voltage V_{DD}.



(i) What electrostatic energy is now stored in the capacitor C?

(ii) What energy has been dissipated in the resistor R during the charging process?

(iii) What total energy has been provided by the V_{DD} power supply?