Electromagnetism I – Problem sheet 5

Problem 1.

N charged raindrops each with radius a all have the the same potential. Assume that they are far enough apart so that the charge distribution on each is not affected by the others (that is, each are spherically symmetric).

1. What is the total capacitance of the system? **[1]**
2. If there is a total charge Q on the raindrops, what is the potential of each of them? **[1]**
3. How does the capacitance compare with the capacitance in the case where the drops are combined into one big drop? (the total volume of water does not change) **[1]**

Problem 2.

1. Make a rough estimate of the capacitance of an isolated human body. It must lie somewhere between that of an inscribed sphere and that of a circumscribed sphere. **[1]**
2. By shuffling over a nylon rug on a dry winter day, you can easily charge yourself up to ≈ 2 kV, as shown by the spark when your hand comes too close to a grounded conductor. How much energy would be dissipated in such a spark? **[1]**

Problem 3.

A spherical conducting shell has radius R and potential ϕ. (If you wish, you may consider it to be part of a capacitor with the other shell at infinity.) You compress the shell down to zero size (always keeping it spherical), while a battery holds the potential constant at ϕ.

1. What are the initial and final energies stored in the system? **[2]**
2. What is the final charge on the shell? **[1]**
3. What is the work done *by or on* the battery? **[1]**
4. What is the work done *by or on* you? **[1]**

[Be sure to specify clearly what your conservation-of-energy statement is, paying careful attention to the signs of the various quantities]