<u>Topic</u>: Electromagnetism

1.1 Capacitors and capacitance

<u>Writing extended definitions</u>

A. Read the following two excerpts and using information from the texts write an extended definition of *<u>capacitor</u>* (not more than 90 words). Remember to use your own words!

Excerpt 1

Two insulated conductors of any arbitrary shape adjacent to each other, as depicted in Figure 3.35, form a *capacitor*. By applying an external energy, we can transfer charges from one conductor to another. In other words, we are charging the capacitor using an external source. At all times during the charging process, the two conductors will have equal but opposite charges. This separation of charges establishes an electric field in the dielectric medium and thereby a potential difference between the conductors. As we continue the charging process it becomes apparent that the more we transfer charge from one conductor to another, the higher is the potential difference between them. Simply put, the potential difference between the two conductors is proportional to the charge transferred. Such an understanding enables us to define the *capacitance* as the ratio of the charge on one conductor to its potential with respect to the other. Capacitance is expressed mathematically as

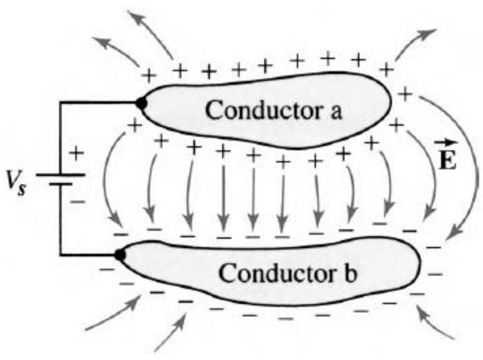

Figure 3.35 A charged capacitor

$$C = \frac{Q_a}{V_{ab}} \qquad (3.74)$$

where *C* is the capacitance in farads (F), *Qa* is the charge on conductor *a* in coulombs (C), and *Vab* is the potential of conductor *a* with respect to conductor *b* in volts (V).

You may have already used capacitors in the design of tuned circuits in electronics and power factor correction networks in power systems. However, you may not have realized that capacitance also exists, even when it is not being sought, between the conductors of a transmission line and at the pn junction of a diode.

Excerpt 2

Capacitors store electrical energy on the surfaces of two conducting plates separated by an insulating layer. Because they release energy more quickly than chemical batteries, they are good for providing a sudden burst of power.

In large-scale devices, the layers are usually rolled up into a cylinder to make the device more compact. Now Carlos César Bof' Bufon and his team at the Leibniz Institute for Solid State and Materials Research in Dresden, Germany, have created nanoscale capacitors in a similar way. They begin by depositing thin layers of metal and insulating material on top of a host substrate. The lowest metal layer of titanium and chromium is placed under strain, so once the substrate is removed, the layers roll themselves up (*Nano Letters*, DOI: 10.1021/nl1010367).

Shrinking the nanoscale capacitors allows more electrical power to be stored in a small space. The rolled-up device provides a capacitance of 200 microfarads per square centimetre of chip surface. That's at least twice what is possible with other capacitors using the same material, says team member Oliver Schmidt.