PHYS1022 Electricity and Magnetism

Problem Sheet 5 – for workshop

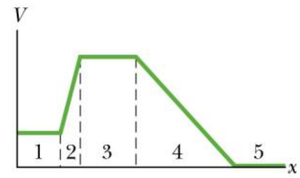
1. Calculate
   (a) the electric potential established by the nucleus of a hydrogen atom at the average distance ($r = 5.29 \times 10^{-11}$ m) of the atom's electron (take $V = 0$ at infinite distance),
   (b) the electrical potential energy of the atom when the electron is at this radius, and
   (c) the kinetic energy of the electron, assuming it to be moving in a circular orbit of this radius, centred on the nucleus.
   (d) How much energy is required to ionise the hydrogen atom (that is, to remove the electron from the nucleus so that the separation is effectively infinite)? Express all energies in electron-volts.

2. Two positive charges $+q$ are on the x-axis at $x = +a$ and $x = -a$.
   (a) Find the potential $V(x)$ as a function of x for points on the x-axis.
   (b) Sketch $V(x)$ versus x.
   (c) What is the significance of the minimum on your curve?

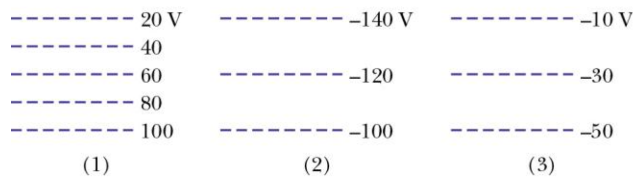
3. (a) Derive an expression for the distance of closest approach of an α particle with kinetic energy E to a massive nucleus of charge Ze. Assume that the nucleus is fixed in space.
   (b) Find the distance of closest approach of a 5.0- and a 9.0-MeV α particle to a gold nucleus; the charge of the gold nucleus is $79e$. (Neglect the recoil of the gold nucleus.)

PHYS1022 Electricity and Magnetism
Problem Sheet 4 – for tutorials

1. The figure gives the electric potential V as a function of x.
(a) Rank the five regions according to the magnitude of the x component of the electric field within them, greatest first. Is the field along the x axis positive or negative in
(b) region 2 and
(c) region 4?



2. The figure shows three sets of cross sections of equipotential surfaces; all three cover the same size region of space.
(a) Rank the arrangements according to the magnitude of the electric field present in the region, greatest first.
(b) In which is the electric field directed down the page?



3. The electric potential difference between the ground and a cloud in a particular thunderstorm is 1.2×10^9 V. What is the magnitude of the change in potential energy of an electron that moves between the ground and the cloud?

4. Define what is meant by potential at a point. Two point charges q and q' are separated by a distance a. At a point $a/3$ from q on the line between the two charges the potential is zero. Find the ratio q/q'.