Departement Physik
Universität Basel
Prof. E. Meyer / PD. T. Glatzel
Contact person: Miguel J. Carballido
miguel.carballido@unibas.ch
Office: 1.12
Tel.: +41 (0)61 207 36 91
http://adam.unibas.ch

Exercises and Complements for the Introduction to Physics II

for Students

of Biology, Pharmacy and Geoscience

Sheet 2 / 11.03.2021 **Solutions**

Exercise 5.

The electrical field of a conducting sphere is:

$$E = \frac{Q}{4\pi\varepsilon_0 r^2}$$
$$Q = E \cdot 4\pi\varepsilon_0 r^2$$

Thus, the total charge of planet Earth ($r = 6371$ km) is obtained by :

$$Q = 130\,\text{V/m} \cdot 4\pi\varepsilon_0 \cdot (6371\ \text{km})^2 = 5.87 \cdot 10^5\ \text{C}$$

Exercise 6.

(a) The total charge is given by the product of the linear charge density and the length:

$$q = \lambda l = 17.5\ \text{nC}$$

(b) The electric field of a line charge at x_0 is given by[1]:

$$E_{x_0} = \frac{1}{4\pi\varepsilon_0} \cdot \frac{q}{x_0(x_0 - l)}$$

At $x_0 = 6$ m we get:

$$E_{6\text{m}} = 8.988 \cdot 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2} \cdot \frac{17.5\ \text{C}}{6\ \text{m} \cdot (6\ \text{m - } 5\ \text{m})} = 26\ \frac{\text{N}}{\text{C}}$$

At $x_0 = 9$ m we get:

$$E_{9\text{m}} = 8.988 \cdot 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2} \cdot \frac{17.5\ \text{C}}{9\ \text{m} \cdot (9\ \text{m - } 5\ \text{m})} = 4.4\ \frac{\text{N}}{\text{C}}$$

[1] The derivation of the following equation is not relevent for the exam but can be reviewed on page 4 of this pdf-document: `https://uni-salzburg.at/fileadmin/oracle_file_imports/513448.PDF`

Exercise 7.

(a) Potential of a point charge:

$$U_P(r) = \frac{1}{4\pi\varepsilon_0}\frac{q_P}{r} = 14.38 \text{ V}$$

(b) An electron volt corresponds to the energy gained by an elementary electric charge when it passes through a voltage of 1 V.

$$1 \text{ eV} = 1.6 \cdot 10^{-19} \text{ C} \cdot 1 \text{ V} = 1.6 \cdot 10^{-19} \text{ J}$$

Electrostatic energy:

$$W = q_E U_P(r = 1 \cdot 10^{-10} \text{ m}) = -14.38 \text{ eV} = -2.3 \cdot 10^{-18} \text{ J}$$

(c) Proton and electron in hydrogen:

$$U_P(r = 5.3 \cdot 10^{-11} \text{ m}) = 27.13 \text{ V}$$

$$W = q_E U_P(r = 5.3 \cdot 10^{-11} \text{ m}) = -27.13 \text{ eV} = -4.3 \cdot 10^{-18} \text{ J}$$

Exercise 8.

(a) The following applies:

$$E = \frac{F}{Q} = \frac{m_e \cdot a}{e} = 11.3 \cdot 10^3 \, \frac{\text{V}}{\text{m}}$$

(b) Because it is a uniformly accelerated motion, the following holds:

$$t = \frac{v}{a} = 1 \text{ ns}$$