Physics Practice Test

Time: 20 minutes for part A, 45 minutes in all

Part A: Short Questions

Remarks:

- No aids (calculator, FoTa, formula sheet) allowed
- Always express numerical results as rounded decimal numbers (except in ratios)
- Derivation required for numerical results

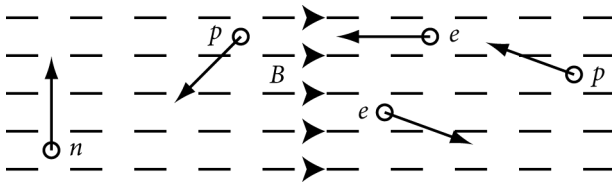
1. On the reverse side of the sheet, describe and explain a method to determine the direction and the magnitude of a magnetic field.
2. Which of the following statements are true?

   ☐ A helix is the most general path of a proton in a homogeneous magnetic field.

   ☐ When a current flows through a helical spring, the spring contracts.

   ☐ Charged particles cannot move parallel to a current carrying wire.

   ☐ Electrons are accelerated in an inhomogeneous magnetic field.
3. Protons (p), electrons (e) and a neutron (n) move through a homogeneous magnetic field (see figure). For each particle, determine the direction of the force it experiences.



4. Give realistic numerical values for the parameters of a solenoid producing a magnetic field of 50 mT.

5. A proton flies through an inhomogeneous magnetic field whose magnitude increases from 12 mT to 15 mT. Calculate the percentage change of the force acting on the proton.

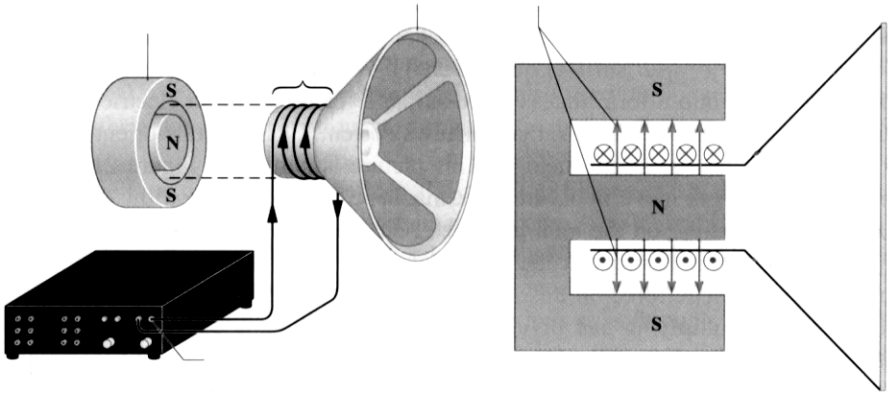
Numerical Solutions: 2. ☑☑☑☐; 5. + 25 %

Part B: Problems

Remarks:

- Write you solutions to the problems on the answer sheet. Start a new page for every problem.
- An algebraic solution and all values used in calculations are required to get the full mark.
- Results must be rounded to at most three significant figures.

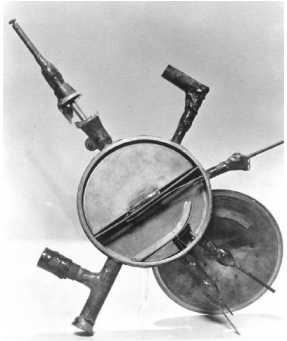
1. The figure shows a typical loudspeaker. The magnitude of the magnetic field at the position of the loudspeaker coil is 480 mT.

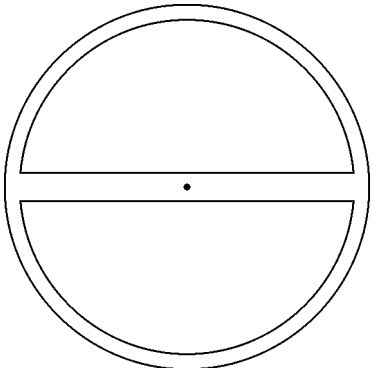


   a) Label the different parts in the figure. Determine the direction of the force acting on the loudspeaker coil for the directions given in the figure.

   b) The coil experiences accelerations of up to several km/s². Calculate the required current for a coil with 24 turns, a radius of 2.3 cm and a mass of 3.7 g.

2. The American physicist Ernest O. Lawrence built the first cyclotron in 1929 (see left figure). The diameter of this first circular accelerator was only 10 cm. The magnitude of the applied magnetic field was 730 mT.





   a) In the schematic drawing (right figure), sketch the path of a proton starting at the centre. Determine the direction of the corresponding magnetic field.

      Where and how are the protons accelerated?

   b) Calculate the speed of the protons just before they leave the cyclotron. Express the result as a fraction of the speed of light.

      What speed would you expect for electrons accelerated in the same cyclotron? Is this realistic?

   c) Discuss similarities, differences, advantages and disadvantages of synchrotrons and cyclotrons.

Numerical Solutions: 1. 2.2 A for 1 km/s²; 2. 0.012 *c*, 21 *c* (impossible)