task_5efsj705cf97jxga_with_calculation

Student Group

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lorentz force, magnetic field, exam ee2 SS2024

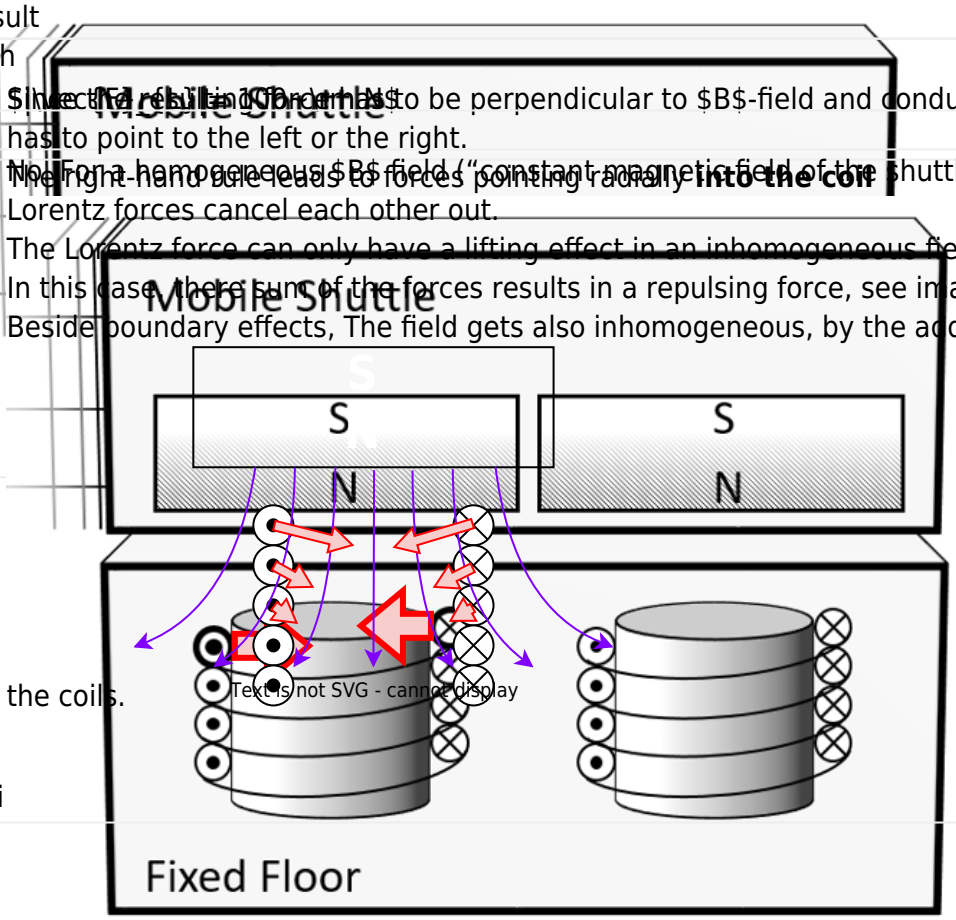
Exercise E1 Lorentz Force
(written test, approx. 8 % of a 120-minute written test, SS2024)

2. Determine the direction of the force on the shuttle if the magnetic field of the coils is switched off and explain, why this is the case.
3. Determine the direction of the force on the shuttle if the magnetic field of the coils is switched off and the shuttle is moved to the left. Explain, why this is the case.

Result

Path

Since the resulting force has to be perpendicular to B-field and conductor, the force has to point to the left or the right.
For a homogeneous B field (“constant magnetic field of the shuttle”), the Lorentz forces cancel each other out.
The Lorentz force can only have a lifting effect in an inhomogeneous field.
In this case, the sum of the forces results in a repulsing force, see image.
Beside boundary effects, The field gets also inhomogeneous, by the additional field of the coils.



- current $I = 1.6 ~\rm A$
- magnetic field of the shuttle of is homogeneous with $B=0.5 ~\rm T$

1. Calculate the magnitude of the resulting force on one coil!

Path

The Lorentz force on a conductor the length l and the current I in a B-field is $$\begin{align*} |\vec{F}_{L}| &= I \cdot l \cdot B \cdot \cos(\angle \vec{B}, \vec{l}) \\ &= I \cdot (N \cdot 2\pi r) \cdot B \cdot \cos(\angle \vec{B}, \vec{l}) \\ &= \rm 1.6 ~A \cdot (500 \cdot 2\pi 40\cdot 10^{-3}~m) \cdot 0.5 ~T \cdot \cos 90° \end{align*}$$