TFY4240

Problemset 6 Autumn 2014

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Problem 1.
Example 7.2, 7.4, 7.7, 7.9 and 7.13 from Griffiths.

Problem 2.
A closed square loop of wire of sides a lies on a table. Its lower section is initially placed a distance $s_0 \ll a$ from an infinitely long straight wire, which carries a current I.
A coordinate system is defined so that the $\hat{\boldsymbol{z}}$-axis coincides with the infinite wire and the look is located in the yz-plane.

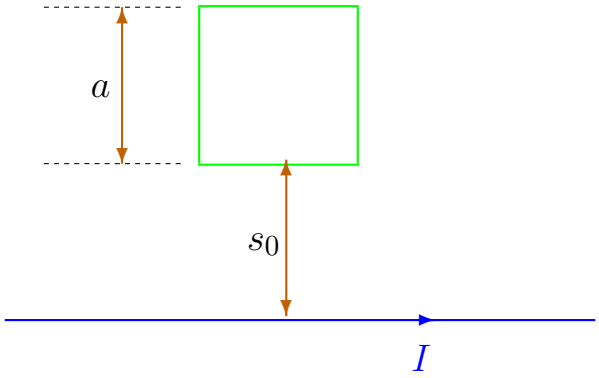

Figure 1: Schematics of the geometry

a) Write down an expression for the current density $\boldsymbol{J}(\boldsymbol{r})$ associated with the infinitely long wire. This expression should be valid for all spatial positions $\boldsymbol{r}$.

b) Use the expression for $\boldsymbol{J}(\boldsymbol{r})$ to obtain the magnetic induction $\boldsymbol{B}(\boldsymbol{r})$ around the long wire.

c) Assume now that someone pulls the square loop directly away from the wire with a (constant) speed $\boldsymbol{v}_1 = v\hat{\boldsymbol{y}}$. What emf is generated? In what direction (clockwise or counterclockwise) does the induced current flow?

d) Make a plot of the induced emf *vs.* time t. Discuss in particular the small and large time limits.

e) What if the loop instead is pulled with the velocity $\boldsymbol{v}_2 = v\hat{\boldsymbol{z}}$. What is then the emf?