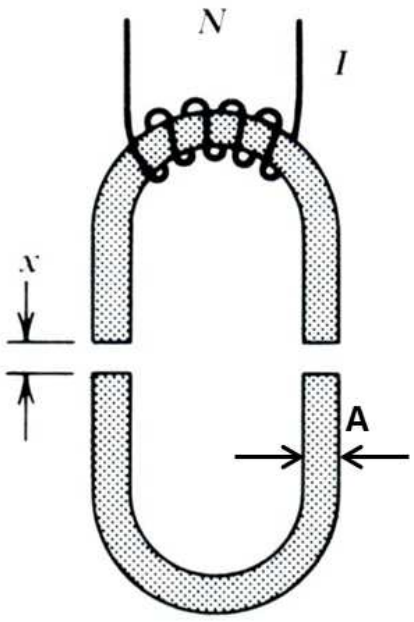
EM Consider an electromagnet made of iron as shown in the figure. The iron in the two parts has a total length L, cross-sectional area A, and permeability $\mu = 5000\mu_0$ where μ_0 is the permeability of free space. The two halves of the magnet are separated by a small distance $x \ll L$. The magnet is activated by a coil of N turns carrying a constant current I. Neglect any flux leakage.



a) Write down the boundary conditions at the iron-air gap interfaces for the fields H and B and the flux Φ.
b) Determine the magnetic fields in the iron when $x = 0$ (*i.e* the gap is closed): $H_0 = H(x = 0)$ and $B_0 = B(x = 0)$.
c) Determine the fields H and B when x is non-zero but small.
d) Determine the total magnetic field energy as a function of $x \ll L$.
e) Use your result from part (d) to compute the force holding the two halves of the magnet together when $x = 0$. (**Hint**: Is the force between the two halves attractive or repulsive? If your answer for the force has the wrong sign, what contribution to the work that must be done to separate the halves have you accidently omitted?).