6. Magnets (6 pts)

1) Each permanent magnet can be considered as a solenoidal molecular current at the surface of the magnets. Suppose that each magnet has net surface current I. Consider triangular contour going through the interiors of the magnets A, B, C. According to the circulation theorem for that contour, the circulation $B_A l + B_B l + B_C l$ is proportional to the overall molecular current through that contour: $B_A l + B_B l + B_C l = 3kI$. Here, B_A designates magnetic inductance inside the magnet A; B_B and B_C are defined analogously. For a single magnet attached to a massive U-shaped ferromagnetic, the circulation theorem yields $B_0 l = kI$ (where B_0 is the magnetic inductance inside the magnet; the contribution to the circulation inside a massive U-shaped ferromagnetic can be neglected, because the magnetic field there is much smaller than inside the magnet). So, $B_A + B_B + B_C = 3B_0$ and $\Phi_A + \Phi_B + \Phi_C = 3\Phi$.

2) There are no sources of magnetic field lines (and hence of the flux), so $\Phi_A = \Phi_B + \Phi_F$.

3) Due to symmetry, $\Phi_F/\Phi_C = 1$.

4) Upon using symmetry, $\Phi_F = \Phi_C$ and $\Phi_D = \Phi_B$. From the circulation theorem for the triangle CDE, $\Phi_C + \Phi_E - \Phi_B = \Phi$. From the no-flux-source condition for the vertex with magnets E, C, B we obtain $\Phi_E = \Phi_C - \Phi_B$. Together with the equations form questions 1 and 2, $\Phi_A = \frac{3}{2}\Phi$, $\Phi_C = \Phi_F = \Phi$, $\Phi_B = \Phi_D = \Phi_E = \frac{1}{2}\Phi$.

5) The larger the flux, the more difficult to remove a magnet, because the magnetic flux needs to go through the air gap which will be formed (enlarging the magnetic energy), when starting the removal. So, the answer is "A".