A long solenoid of radius $a$, carrying $n$ turns per unit length, is looped by a wire with resistance $R$.

1. If a current in the solenoid is increasing at a constant rate ($\frac{dI}{dt} = k$), what current flows in the loop, and which way (left or right) does it pass through the resistor?

   [Solution: The flux through the loop due to the field in the solenoid is
   \[ \Phi = \mu_0 n I \pi a^2 \]
   and
   \[ \mathcal{E} = -\frac{d\Phi}{dt} = -\mu_0 n k \pi a^2 \]
   \[ I = \frac{\mathcal{E}}{R} = \frac{\mu_0 k n \pi a^2}{R} \]
   It passes from left to right through the resistor, opposite the direction of the current in the solenoid.]

2. If the current $I$ in the solenoid is constant but the solenoid is pulled out of the loop (toward the left, to a place far from the loop), what total charge passes through the resistor?

   [Solution:
   \[ I = \frac{dQ}{dt} = -\frac{d\Phi}{dt} \frac{1}{R} \rightarrow \Delta Q = -\frac{\Delta \Phi}{R} = \frac{\mu_0 n I \pi a^2}{R} \]