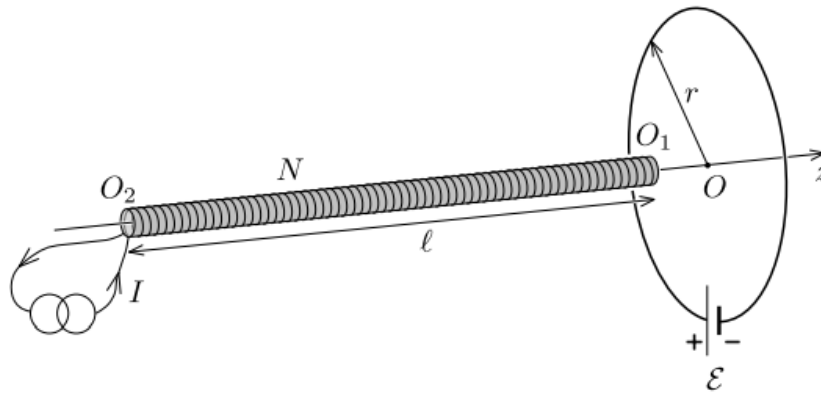


## Solenoid and loop

A closed circular loop of radius  $r$  consists of an ideal battery of electromotive force  $\xi$  and a wire of resistance  $R$ . A long thin air-core solenoid is aligned with the axis of the loop ( $z$ -axis). Its length is  $l \gg r$ , cross-sectional area is  $A$  ( $r \gg \sqrt{A}$ ), and the number of turns is  $N$ . The solenoid is powered by a constant current  $I$  provided by an ideal current source. The directions of the currents in the solenoid and in the loop are the same (clockwise in the figure).



- Find the force  $F_1$  acting on the solenoid when its head  $O_1$  is positioned in the loop centre  $O$ . What is the force  $F_2$  acting on the solenoid when its tail  $O_2$  is located in the centre of the loop?
- Suppose now, that the solenoid is moving slowly with a constant velocity  $v$  along  $z$ -axis starting far away from the loop, going past its centre, and proceeding further to the right in positive  $z$ -direction. Plot the current  $J$  flowing in the loop as a function of time. Highlight important features and values on the graph. The velocity  $v$  is so small that self inductance of the loop can be neglected.