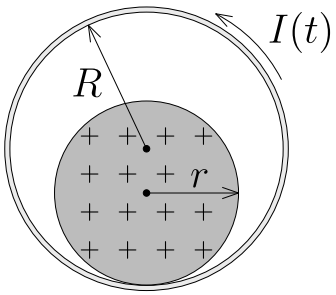
Eötvös 2018

1) A large, sealed cylindrical container is filled with water at room temperature and pressure. It is in zero gravity and contains an air bubble with a volume of $V = 1\,\mathrm{cm}^3$. The container is rotated gently around its axis of symmetry until it reaches a constant angular velocity of $\omega = 300\,\mathrm{rad\,s}^{-1}$. What shape does the air bubble take then? Find the dimensions of the bubble. The surface tension of water is $\alpha = 0.07\,\mathrm{N\,m}^{-1}$.

2) A container contains a mixture of 1 mole of a monoatomic gas and 2 moles of a diatomic gas. The walls of the container allow the atoms of the monoatomic gas to pass through, but not the molecules of the diatomic gas. Initially, the container is in equilibrium with the environment at 20° C. The gas mixture in the container is slowly heated by a heater to 120° C.
   a) Find the change in the internal energy of the gas in the container.
   b) Find the heat the heater transfers to the gas. (Ignore the heat required to heat the container and the heat conduction of the container)

3) A long solenoid has a fixed, horizontal axis, with a circular cross-section of radius R. Inside the solenoid is a solid cylinder of radius r made of (non-magnetic) insulating material. The insulating cylinder is positively charged, with a uniform volume distribution. A current of rapidly increasing strength is applied to the solenoid uniformly over time, in the direction shown in the figure. In what direction does the insulating cylinder start rolling? How does the response depend on the ratio r/R? At what ratio r/R will the charged cylinder remain at rest?



   Static friction is sufficiently large to prevent the cylinder from slipping. Ignore rolling resistance.