# 2018 Eötvös Competition

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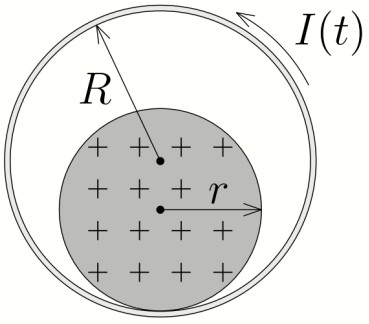
1. There exists an air bubble with a volume $V = 1$ cm$^3$ at normal pressure in a closed, long, cylindrical container filled with water at room temperature. The container is rotated slowly about its central axis of symmetry at a steady state, carefully accelerating it in a state of weightlessness until it reaches an angular velocity of $\omega = 300$ s$^{-1}$ where it is kept rotating at the same constant speed. What shape does the air bubble now take? Give the typical dimensions of the bubble. The surface tension of water is $\alpha = 0.07$ N/m.

2. A tank contains a mixture of 1 mole of monoatomic gas and 2 moles of diatomic gas. The wall of the tank allows monoatomic gas particles to enter, but not diatomic gas particles. Initially, the tank is in equilibrium with the 20° C environment. The gas mixture in the tank is slowly heated by a radiator to 100° C.

   (a) What is the change in internal energy of the gas in the tank?

   (b) How much heat does the radiator give to the gas? (Neglect the heat required to heat the tank and the heat conduction of the tank!)

3. A long solenoid with a fixed, horizontal axis, has a cross-section of a circle with radius $R$. Inside the coil there is a solid cylinder of radius $r$ made of (non-magnetic) insulating material. The insulating cylinder is positively charged in an even volume distribution. A steady, rapidly increasing current is applied to the solenoid over time according to the circumference shown in the figure.




   In what direction does the cylinder start? How does its response depend on the $r/R$ ratio? At what $r/R$ ratio is the cylinder at rest? The adhesive friction is large enough to prevent the cylinder from slipping. Disregard the resistance due to rolling!