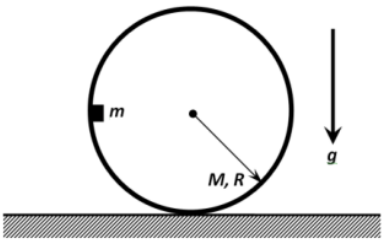
Problem 1 (9 points)

This problem consists of three independent parts.

Part A (3 points)



A small puck of mass m is carefully placed onto the inner surface of the thin hollow thin cylinder of mass M and of radius R. Initially, the cylinder rests on the horizontal plane and the puck is located at the height R above the plane as shown in the figure on the left. Find the interaction force F between the puck and the cylinder at the moment when the puck passes the lowest point of its trajectory. Assume that the friction between the puck and the inner surface of the cylinder is absent, and the cylinder moves on the plane without slipping. The free fall acceleration is g.

Part B (3 points)

A bubble of radius $r = 5.00\,\text{cm}$, containing a diatomic ideal gas, has the soap film of thickness $h = 10.0\,\mu\text{m}$ and is placed in vacuum. The soap film has the surface tension $\sigma = 4.00 \cdot 10^{-2}\,\frac{\text{N}}{\text{m}}$ and the density $\rho = 1.10\,\frac{\text{g}}{\text{cm}^3}$. 1) Find formula for the molar heat capacity of the gas in the bubble for such a process when the gas is heated so slowly that the bubble remains in a mechanical equilibrium and evaluate it; 2) Find formula for the frequency ω of the small radial oscillations of the bubble and evaluate it under the assumption that the heat capacity of the soap film is much greater than the heat capacity of the gas in the bubble. Assume that the thermal equilibrium inside the bubble is reached much faster than the period of oscillations.

Hint: Laplace showed that there is pressure difference between inside and outside of a curved surface, caused by surface tension of the interface between liquid and gas, so that $\Delta p = \frac{2\sigma}{r}$.

Part C (3 points)

Initially, a switch S is unshorted in the circuit shown in the figure on the right, a capacitor of capacitance $2C$ carries the electric charge q_0, a capacitor of capacitance C is uncharged, and there are no electric currents in both coils of inductance L and $2L$, respectively. The capacitor starts to discharge and at the moment when the current in the coils reaches its maximum value, the switch S is instantly shorted. Find the maximum current $I_{\max}$ through the switch S thereafter.

