Newton’s Laws

1. At takeoff, the combined actions of engines and wings on a plane produce a force of $9 \times 10^4$ N at an angle of $60^\circ$ above the horizontal. The plane rises at a constant velocity in the vertical direction while continuing to accelerate in the horizontal direction.

   (a) What is the mass of the plane?
   (b) What is the plane’s horizontal acceleration?

2. Suppose a nonzero net force $\vec{F}$ acts on an object of mass $m_1$, causing it to accelerate. When the object eats another object of mass $m_2$, the same force produces an acceleration that is $k$ times less than before (for $k > 1$).

   (a) Find the ratio of the masses ($m_1/m_2$) in terms of $k$.
   (b) What would happen if $k$ was less than 1? Is this realistic?

3. A stationary circle of mass $m$ is wedged between two walls, one of which is slanted at an angle of $\theta$, as shown below. The circle touches each wall at only one point. Let $F_a$ be the magnitude of the normal force exerted by the slanted wall and let $F_b$ be the magnitude of the normal force exerted by the vertical wall. Find $F_a$ and $F_b$ in terms of $m$, $g$, and $\theta$.

4. **Super Fun Question:** A rope of length $L = 2$ m and uniform mass density $\lambda = 1$ kg/m is hanging from the ceiling. (It does not reach the floor.) Find an expression for the tension in the rope at an arbitrary point on the rope that is located $x$ meters from its top. (Hint: draw a free-body diagram.)