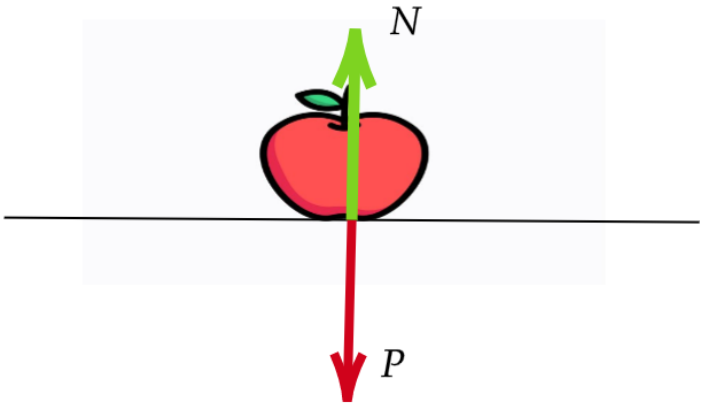
NORMAL FORCE AND WEIGHT CONTINUED.

DECEMBER 1, 2022

Theory recap

Newton's third law tells us that when the table acts with normal force $\vec{N}$ on the apple, the apple acts on the table with force $\vec{P} = -\vec{N}$. This force $\vec{P}$ is called **weight**. Weight is the force with which an object acts on its support. From the above equation we see that when the apple is at rest, its weight is equal to the gravitational force: $P = mg$. However, it is important not to confuse weight and gravitational force because they act on two different objects. Gravitational force mg acts on the apple. Weight P acts on the table. You need to always keep this distinction in mind in order to avoid confusion.



If an object is moving with acceleration, normal force (and therefore weight) change compared to when it is at rest. Let us assume that the same apple is in an elevator which is moving with acceleration a directed up. The net force up in terms of normal and gravitational forces is $F_{net} = N - mg$, and by Newton's second law for the apple:

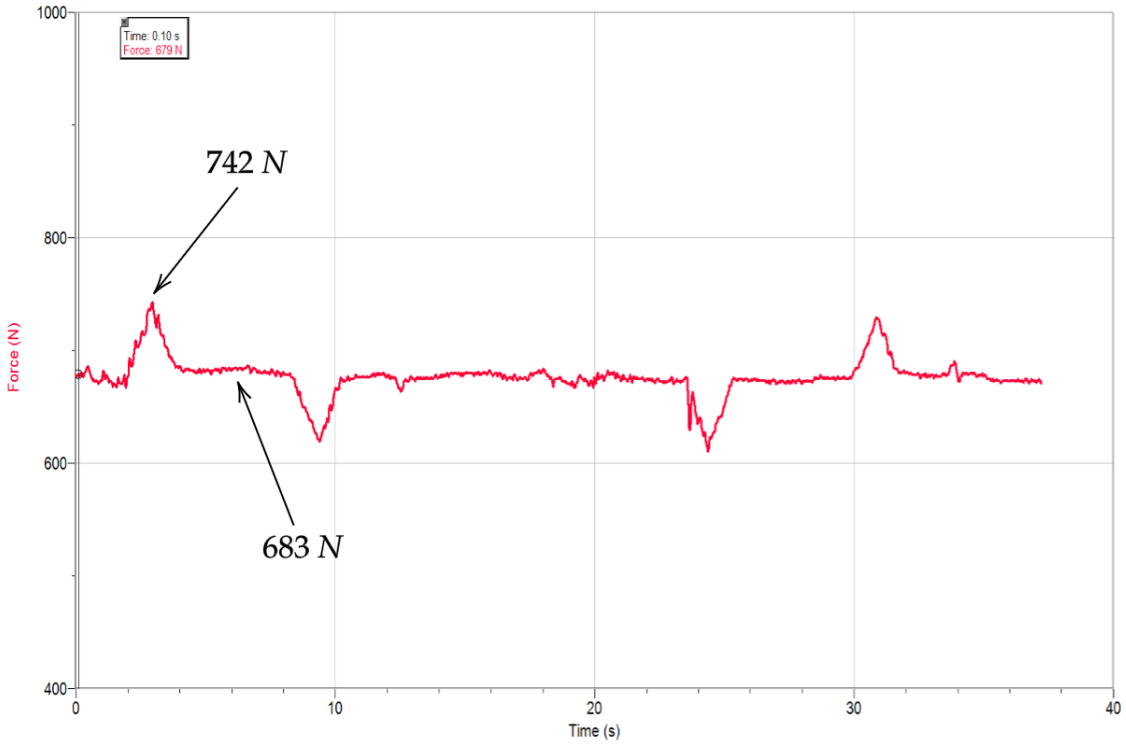
$$F_{net} = N - mg = ma \Longrightarrow N = mg + ma \Longrightarrow \boxed{P = mg + ma}$$

For the last equation we used Newton's third law relating absolute values of weight and normal force: $P = N$. We see that for positive a (acceleration up) weight is increased and for negative a (acceleration down) weight is decreased.

Homework

1. In this problem using the data obtained in our elevator experiment you will need to calculate the maximal upwards acceleration of the elevator. On the next page there is the plot (which is the result of our experiment) of how weight of a person riding an elevator changes with time. It has the relevant data points provided. In order to find the person's mass, use the fact that when there is no acceleration, weight measured by the scales is equal to the gravitational force acting on the person. Knowing the

mass and weight for the moment of maximal upward acceleration, you will **find the maximal upward acceleration**. You could use 10 $\frac{\text{m}}{\text{s}^2}$ for the free fall acceleration.



The problem below is a bonus problem.

***2.** Find the force with which a 1 kg block attracts the Earth due to gravity. What is Earth's acceleration due to this force (assuming this was the one and only force acting on the Earth)? Earth's mass is approximately $6 \cdot 10^{24}$ kg.