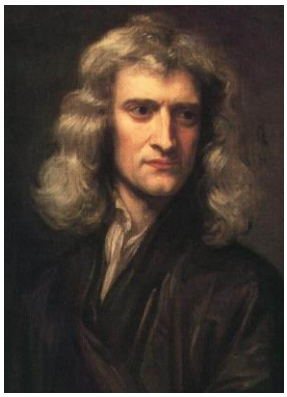
Homework 6

Second Newton's law

We have learned that force can be determined as interaction which makes the interacting object accelerate. Force and acceleration are connected by a simple formula:

$$\vec{F} = m\vec{a}$$

Here *F* is a force applied to an object, *m* is the mass of the object and *a* is the acceleration of the object. Force is measured in newtons (N). 1N is the force required to provide an acceleration of 1m/s^2 to an object with a mass of 1kg.The unit of force is named after Sir Isaac Newton (1643-1727)– one of the brightest genii in human history.



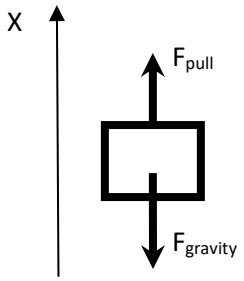
Sir Isaac Newton (www.wikipedia.org)

Arrows over "*F*" and "*a*" remind us that both force and acceleration are vector quantities, which means that they have both magnitude and direction. You can see from the formula that the more mass of the object the more force is needed to provide same acceleration. A heavy object is difficult to accelerate.

However, if an object is not accelerating it does not mean that no forces applied to the object. In most of the cases it just means that forces applied to the object compensate each other. In other words, the sum of all forces applied to the object is zero. So the **force *F* in the formula above is the sum of all the forces applied to the object**. We will call this sum as *total net force*. How we can sum forces?

Example: You pull up a 10kg load with a force of 150N. Is this force enough to lift the load? What is acceleration of the load?

Solution: First, let us make a picture



Let us choose “positive” direction as “down to up”. So the “pulling” force is positive because it looks up and the gravity force is negative because it looks down:

$$F_{pull} - F_{gravity} = ma$$

or

$$F_{pull} - mg = ma$$

We do not know yet what the acceleration (magnitude and sign) is. Let us calculate it:

$$150N - 10kg \cdot 9.8\frac{m}{s^2} = 10kg \cdot a$$

$$a = \left(150N - 10kg \cdot 9.8\frac{m}{s^2}\right) \div 10kg = 5.2\frac{m}{s^2}$$

The acceleration is positive. It means that it is directed up, along our ”positive” axis. It also means that the applied force is enough to lift the load.

Problems:

1. A single force of 10N acts on a mass ***m***. The mass starts from rest and travels in a straight line a distance of 18m in 6 seconds. Find mass ***m***.

2. You push a loaded shopping cart with a force 100N. The mass of the cart is 40kg. Find the velocity of the cart in 2 seconds if the cart was initially at rest.

3. A 40 kg boy is inside the elevator. Elevator goes up with the acceleration of $2m/s^2$. Find the force which is applied to the boy by the elevator.