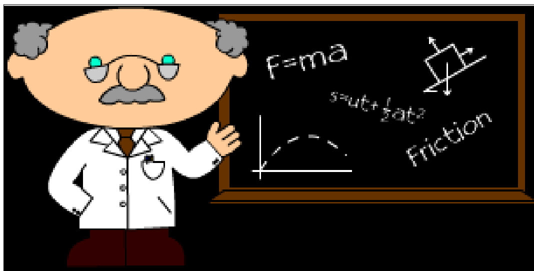
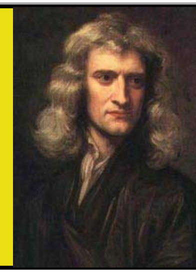


Unit 2: Dynamics



2.12 Mass and Elevators

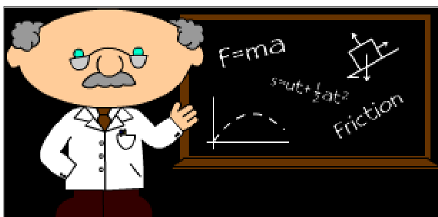
We now have two methods to determine mass of an object:

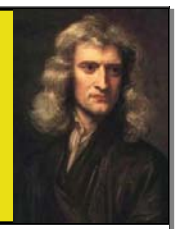
Method 1: Inertial Mass

Mass found by measuring the force needed to accelerate an object according to: **$F = ma$.**

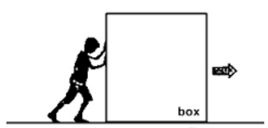
Method 2: Gravitational Mass

Mass is found by measuring the gravitational force between two objects according to: **$F = Gm_1m_2/r^2$**

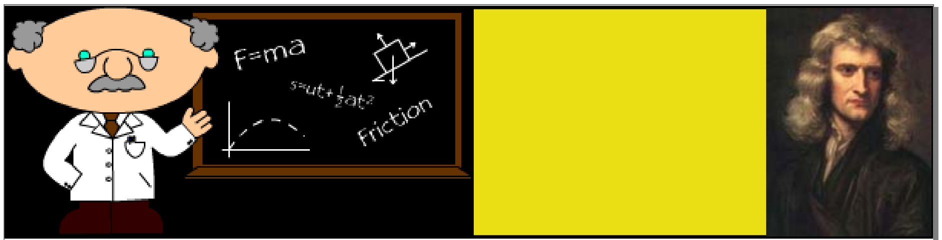




Inertial mass is measured when we, say, push a box on the floor. If we measure the acceleration of the box we can find the boxes' mass. Notice, this has nothing to do with gravity.

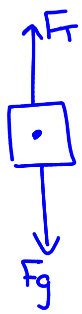


Gravitational mass is measured when we, say, weigh an object in a double-pan balance. When it is balanced, the force of gravity between the object and the Earth is equal.



It is important to know that it has been shown that inertial mass is equivalent to gravitational mass.

Ex.) (Pg. 151) A person and an elevator have a combined mass of 6.00 x 10² kg. The cable exerts a tension of 6.50 x 10³ N up on the elevator. What is the acceleration on the person?



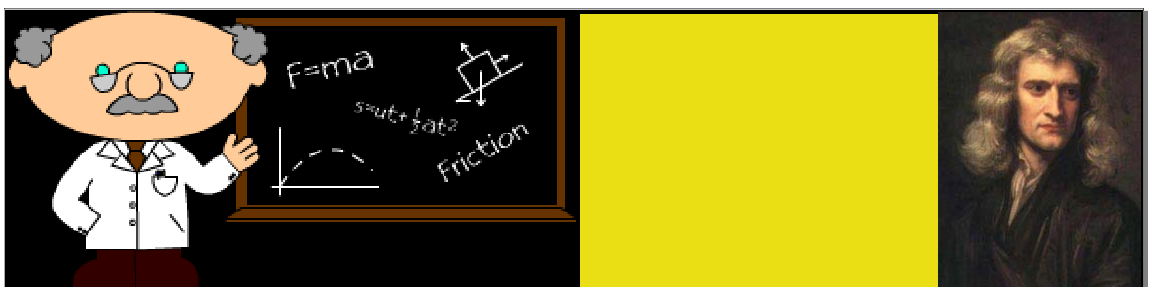
$F_{net} = F_T + F_g$ * use - 9.81

$F_{net} = F_T - F_g$ *use 9.81

$m\vec{a} = F_T - mg$

$\vec{a} = \frac{F_T - mg}{m} = \frac{6.50 \times 10^3 - (600)(9.81)}{600}$

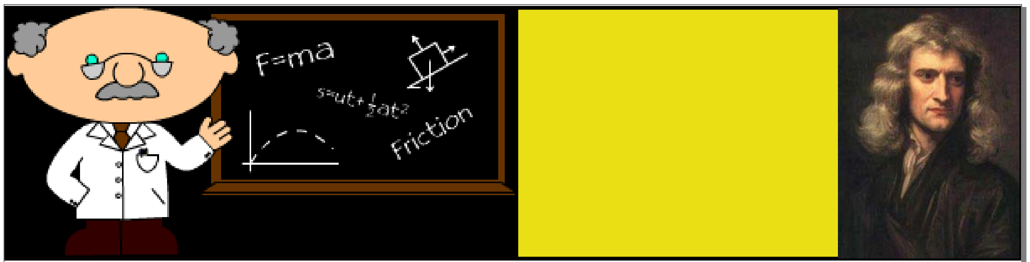
$\boxed{\vec{a} = 1.02 m/s^2 \text{ [up]}}$



This type of analysis will work for many other situations when more then one force is acting on a body.

Pg. 152 # 1, 2.

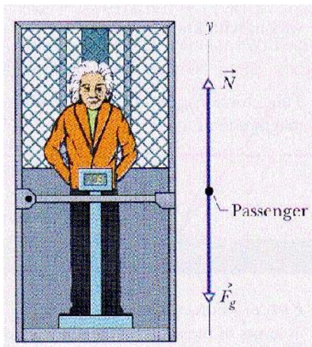
Pg. 153 # 1, 2(top of page)



When an elevator accelerates up, there are two weights to consider:

1. **True weight**: the force of gravity acting downwards.

2. **Apparent weight**: the opposite of the normal force, which makes the rider "feel" lighter or heavier.



What forces are acting on the rider?

F_g acting down

F_N acting up

F_{net} acting up

(Disregard tension as that does not act directly on the rider)

- The rider has a true weight, F_g acting downwards. This weight stays the same throughout the problem.

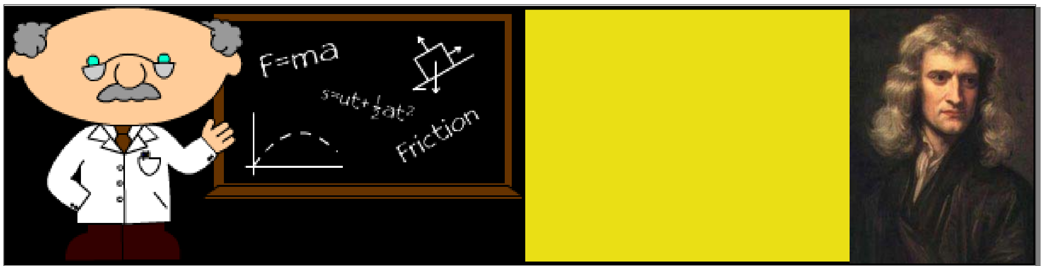
- The rider is on a scale which will measure his apparent weight, which varies depending on the direction the elevator moves in.

Finding Apparent Weight:

Step 1: Write the total force statement.

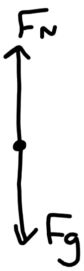
$$F_{net} = F_g + F_N$$

where the normal force is the apparent weight (except going up instead of down)



Ex.) A elevator has an upwards acceleration of 3.5 m/s². What is the true and apparent weight of a rider with mass of 75 kg.

$\vec{w} = mg$



$F_{net} = F_N - F_g$

$m\vec{a} = F_N - mg$

$F_N = m\vec{a} + m\vec{g}$

$= (75)(+3.5) + (75)(9.81)$

$= 998 = \boxed{1.0 \times 10^3\ N}$

So, this 75 kg person feels 102 kg.

*Note: You will need to reverse the sign of the normal force in order for the apparent weight to make sense. (Hint: Be careful of your signs on the acceleration.)

What about acceleration downwards?

Ex.) An elevator has a downwards acceleration of -8.5 m/s². What is the true and apparent weight of a rider with mass of 75 kg?

$F_{net} = F_N - F_g$

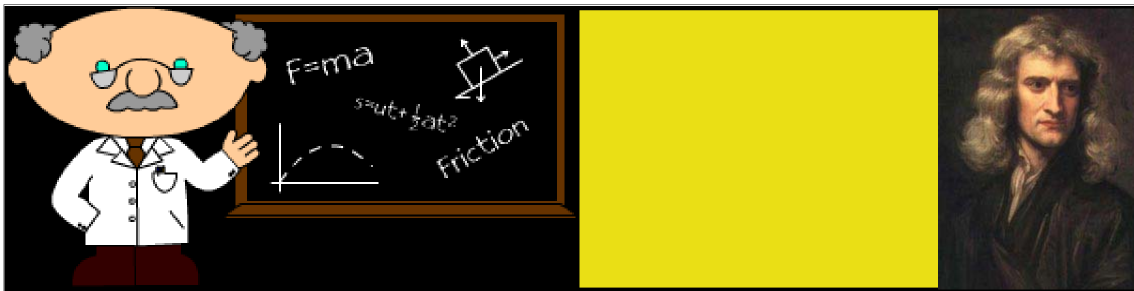
$ma = F_n - mg$

$F_N = ma + mg$

$= (75)(-8.5) + (75)(9.81)$

$= \boxed{98 N}$

So, 75 kg rider feels 10 kg.



Free Fall:

Free fall occurs when there is no balancing normal force present.

Without a normal force, there is no apparent weight, and the rider experiences "weightlessness"(this is what happens to astronauts in orbit or on the Vomit Comet).

Pg. 225 # 1-2 and 1-2.