Physics 140 – Fall 2007
lecture 5 : 18 Sep

Mathematics is the language of precise thinking.

– Richard W. Hamming (1915-1998)

Ch 4 topics:

- Newton's laws of motion (I + II)
- dynamics: force and acceleration

Newton's First Law: the Law of Inertia


Source: Undetermined

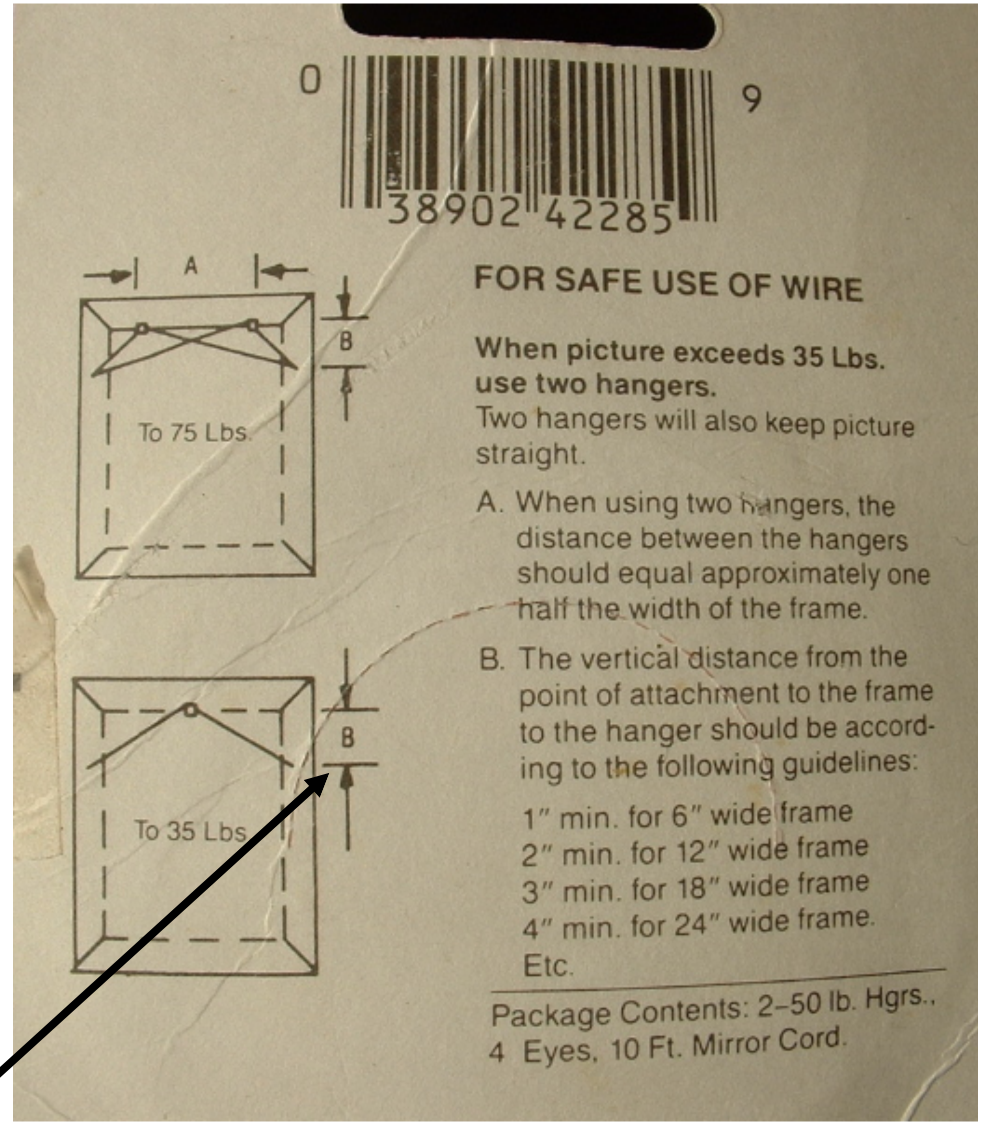
"Every body continues in a state of rest, or uniform motion in a straight line, unless it is compelled to change that state by outside forces impressed upon it."

In the "language of precise thinking", we can say

$$\Sigma \boldsymbol{F} = 0 \quad \Longleftrightarrow \quad \text{velocity } \boldsymbol{v} \text{ is constant}$$

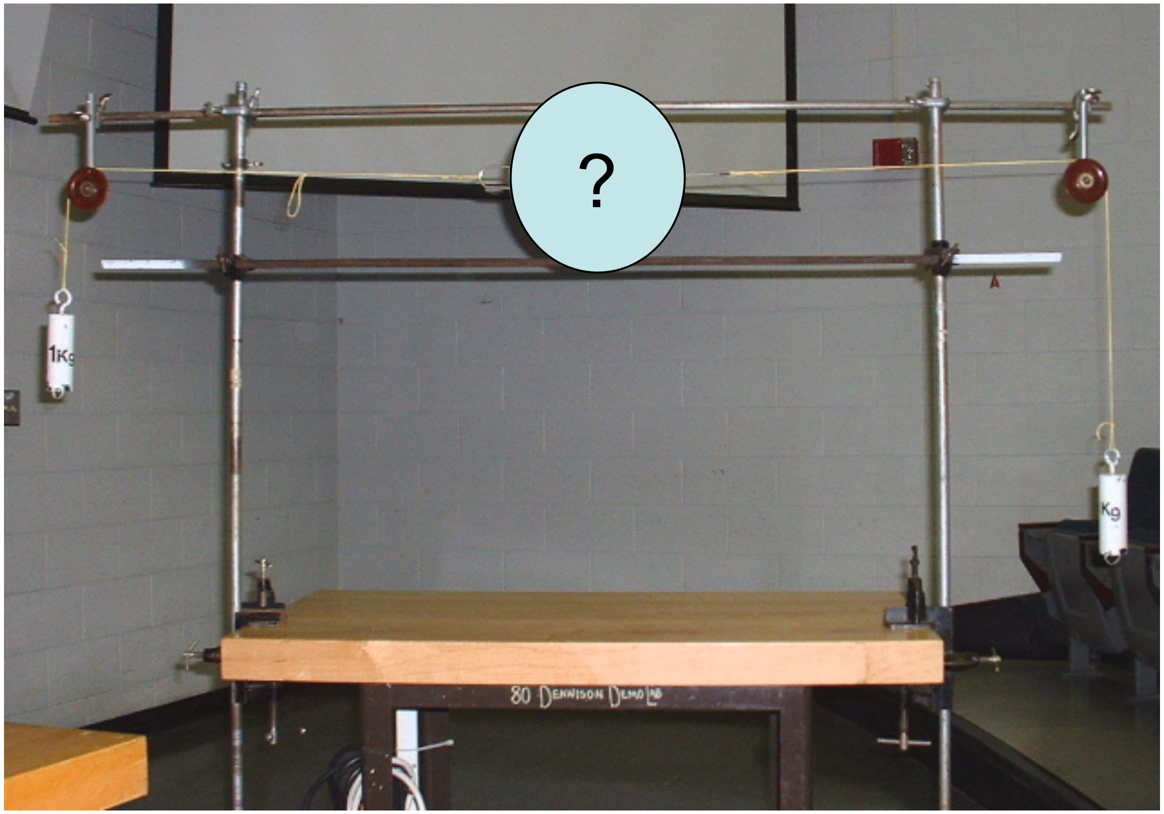
where $\Sigma \boldsymbol{F}$ represents the sum of **all external forces** acting on an object with velocity $\boldsymbol{v}$.

A valid ***inertial reference frame*** is one in which objects move at constant velocity unless forced to do otherwise.



Why is there a minimum vertical distance (called B in the figure) when hanging a frame by wire?

What will happen to the tension measured by the spring scale when I attach the opposite end of the string to the other, identical “salami”?



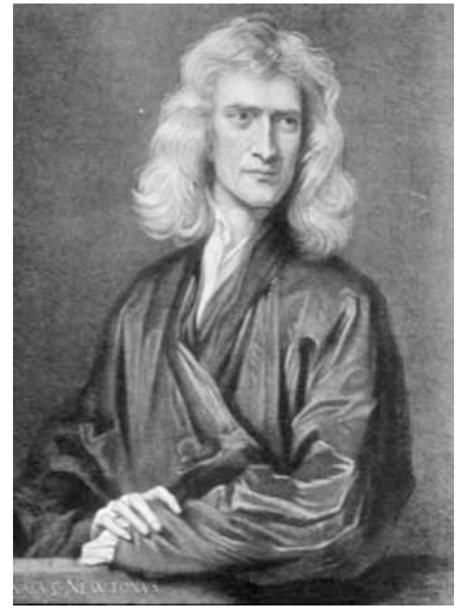
A. The tension will stay the same.

B. It will double.

C. It will be halved.

D. It will change by a factor different from two.

Newton's Second Law: Force and Acceleration



"The change in the quantity of motion is proportional to the motive force impressed and is made in the direction of the line in which that force is impressed."

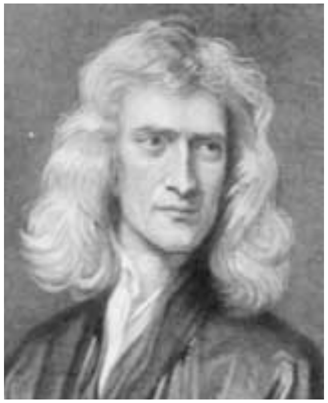
In short, $\boxed{\Sigma \boldsymbol{F} = m\, \boldsymbol{a}}$

(Unit: 1 Newton (N) = 1 kg m/s^2)

The vector sum of forces $\Sigma \boldsymbol{F}$ acting on a body cause it to accelerate in the direction of $\Sigma \boldsymbol{F}$.

The magnitude of the body's acceleration depends *inversely* on its ***inertial mass*** m.

***Mass* is a measure of *inertia* (resistance to change in motion).**



Source: Undetermined

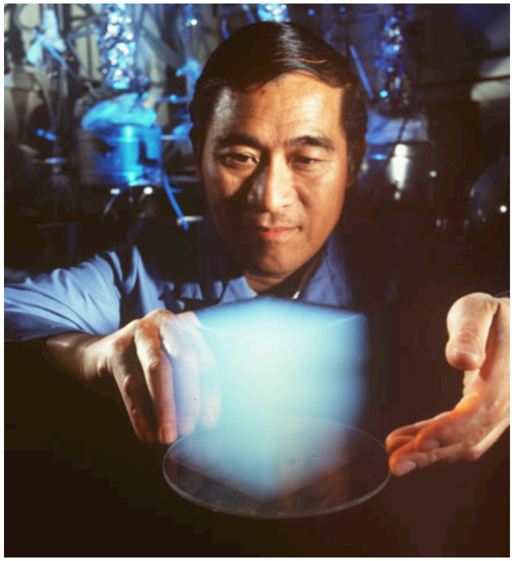
Inertia

$F = ma$

density

ρ = mass/volume

*google **aerogel** to find out what this funny stuff is*



Source: NASA

? mass ?

Energy

$E = mc^2$

Source: The Scientific Monthly (1921)

Higgs particle

CC: BY University of Michigan

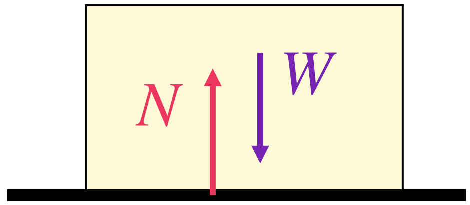
some common forces

Weight from near-Earth gravity, *W*

- magnitude W=mg
- directed to Earth's center (defines downward)

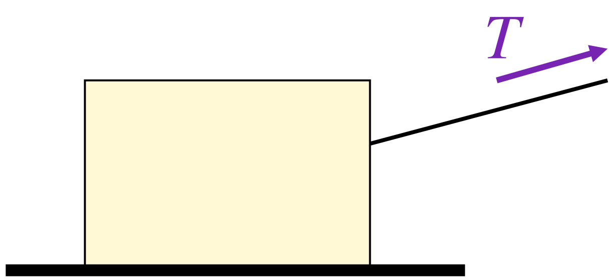
Normal/contact Force, *N*

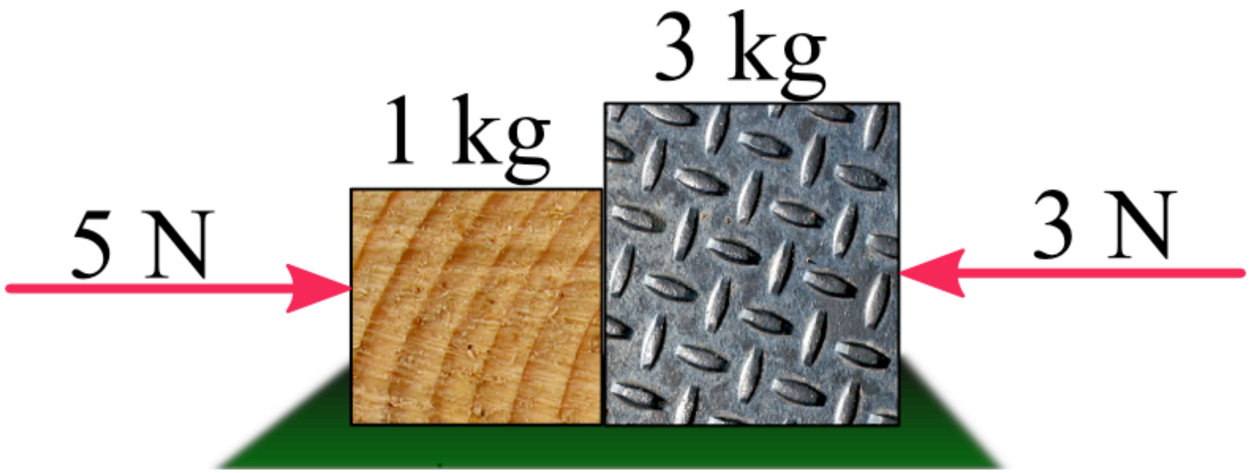
- occur at interfaces
- act perpendicular to interface (come in pairs)
- situation-dependent magnitude



Tension in rope or string, *T*

- acts at contact point
- directed along rope/string
- light ("massless") strings have constant tension along their lengths (act as *force conduits*)





On a horizontal, frictionless surface, the blocks above are being acted upon by two opposing horizontal forces, as shown. What is the magnitude of the **net force** acting on the 3kg block?

A. zero

B. 2N

C. 1.5 N

D. 1N

E. More information is needed.