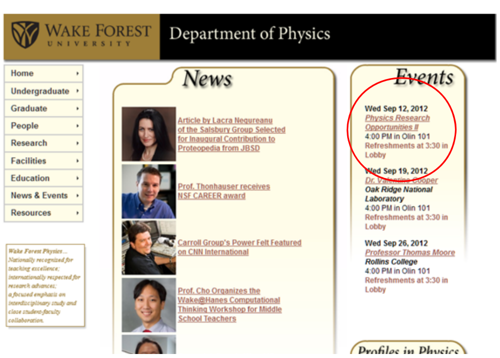
PHY 113 A General Physics I
9-9:50 AM MWF Olin 101

Plan for Lecture 7:

Chapter 5 – NEWTON'S GENIUS

1. Concept of force
2. Relationship between force and acceleration

No.	Lecture Date	Topic	Text Sections	Problem Assignments	Assignment Due Date
1	08/29/2012	Units & measurement	1.1-1.6	1.2,1.6,1.13,1.20	
2	08/31/2012	Motion in 1d -- constant velocity	2.1-2.3	2.1,2.8	09/07/2012
3	09/03/2012	Motion in 1d -- constant acceleration	2.4-2.8	2.13,2.16	09/07/2012
4	09/05/2012	Vectors	3.1-3.4	3.3,3.22	09/07/2012
5	09/07/2012	Motion in 2d	4.1-4.3	4.3,4.50	09/10/2012
6	09/10/2012	Circular motion	4.4-4.6	4.29,4.30	09/12/2012
7	09/12/2012	Newton's laws	5.1-5.6	5.1,5.13	09/14/2012
8	09/14/2012	Newton's laws applied	5.7-5.8	5.20,5.30,5.48	09/17/2012
	09/17/2012	Review	1-5		
	09/19/2012	Exam	1-5		
9	09/21/2012	More applications of Newton's laws	6.1-6.4		09/24/2012
10	09/24/2012	Work	7.1-7.4		09/26/2012



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Department of Physics

WFU Physics Colloquium

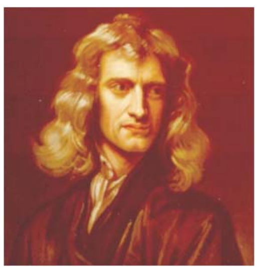
TITLE: "WFU Physics Research -- Part II"
TIME: Wednesday Sept. 12, 2012 at 4:00 PM
PLACE: George P. Williams, Jr. Lecture Hall, (Olin 101)

Refreshments will be served at 3:30 PM in the lounge. All interested persons are cordially invited to attend.

PROGRAM

This colloquium is the second of two which will highlight physics research at Wake Forest University. During the colloquium, Physics Department faculty members will present short overviews of their research programs in the Physics Department. This forum for sharing ideas will hopefully inspire collaborations between students and faculty and between research groups.

Isaac Newton, English physicist and mathematician (1642—1727)



1. **In the absence of a net force, an object remains at constant velocity or at rest.**
2. **In the presence of a net force F, the motion of an object of mass m is described by the form F=ma.**
3. **$F_{12} = - F_{21}$.**

http://www.newton.ac.uk/newton.html

Detail: "Inertial" frame of reference

Strictly speaking, Newton's laws work only in a reference frame (coordinate system) that is stationary or moving at constant velocity. In a non-inertial (accelerating) reference frame, there are some extra contributions.

iclicker question:
Are we (here in Winston-Salem)
- **A. In an inertial frame of reference (exactly)**
- **B. In a non-inertial frame of reference**

Newton's laws are only approximately true in Winston-Salem, but the corrections are very small.

Example force – weight

1 lb = 4.45 N
1 N = 0.225 lb

Gravitational mass versus inertial mass –

The concept of mass ("inertial" mass *m*) is distinct from the concept of weight *mg*. In fact the gravitation "constant" *g* varies slightly throughout the globe. Of course the weight of mass *m* on the surface of the moon is considerable different than its weight on earth.

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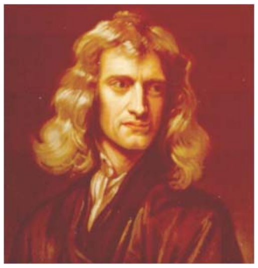

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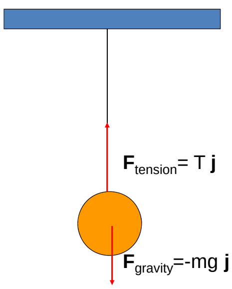
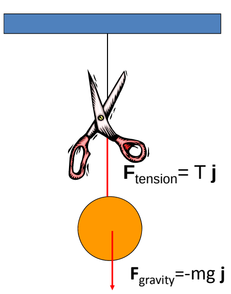
Examples



$\mathbf{F}=\mathbf{F}_{net}=\mathbf{F}_{tension}+\mathbf{F}_{gravity}=(T-mg)\ \mathbf{j} = 0$

Examples



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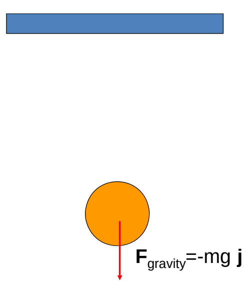


$\mathbf{F}=\mathbf{F}_{net}=\mathbf{F}_{gravity}=(-mg)\ \mathbf{j} = m\mathbf{a}$

→ $\mathbf{a}=-g\mathbf{j}$

iclicker question:

An object having a mass of 2 kg is moving at constant velocity of 3 m/s in the upward direction near the surface of the Earth. What is the net force acting on the object?

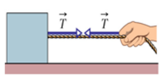
A. 0 N.

B. 6 N in the upward direction.

C. 25.6 N in the upward direction.

D. 19.6 N in the downward direction.

Example: (assume surface is frictionless)



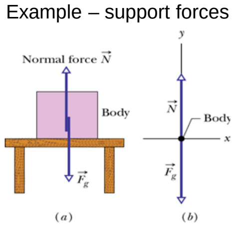
Suppose **T** measured

a observed & measured

T = m **a**

$$T = 5\text{N};\ a = 0.1\,\text{m/s}^2$$
$$m = \frac{T}{a} = \frac{5\text{N}}{0.1\text{m/s}^2} = 50\text{kg}$$

Example – support forces



$$\mathbf{F}_g = -mg\hat{\mathbf{y}}$$
$$\mathbf{F}_{\text{support}} = -\mathbf{F}_{\text{applied}}$$

➔$\mathbf{F}_{\text{support}}$ acts in direction ⊥ to surface

(in direction of surface "normal")

Newton's second law

F = m **a**

Types of forces:

Fundamental	Approximate	Empirical
Gravitational	F=-mg **j**	Friction
Electrical		Support
Magnetic		Elastic
Elementary particles		

$$\mathbf{F} = m\mathbf{a} = m\frac{d\mathbf{v}}{dt} = m\frac{d^2\mathbf{r}}{dt^2}$$

Examples (one dimension):

$F = F_0$ (constant) => $x(t) = x_0 + v_0 t + \frac{1}{2}\frac{F_0}{m}t^2$

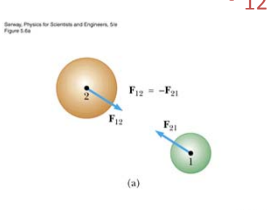
$F = F_0 \sin\omega t$ => $x(t) = x_0 + v_0 t - \frac{F_0}{m\omega^2}\sin\omega t$

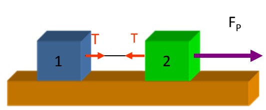
$F = -kx$ => $x(t) = x_0 \cos\sqrt{\frac{k}{m}}t$

$F = F_0 - mbv$ => $v(t) = -\frac{g}{b} + \frac{g}{b}e^{-bt}$

Newton's third law

$$\mathbf{F}_{12} = -\mathbf{F}_{21}$$





$T = m_1 a$ $a = F_P/(m_1+m_2)$

$F_P - T = m_2 a$ $T = F_P\,(m_1/(m_1+m_2))$

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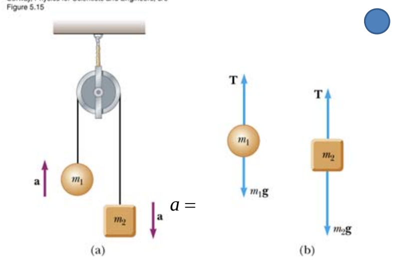
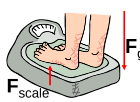
Figure 5.15



$T - m_1 g = m_1 a$ $\quad T - m_2 g = -m_2 a$ $\quad$ => after some algebra:

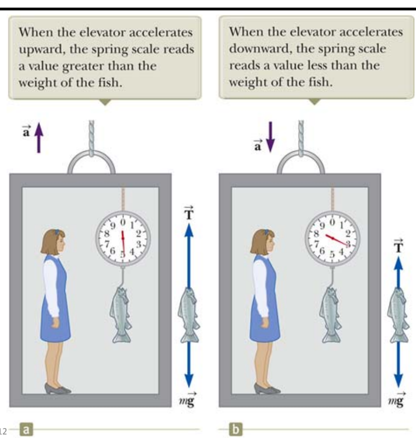
$$a = \frac{m_2 - m_1}{m_2 + m_1} g \qquad T = \frac{2 m_1 m_2}{m_2 + m_1} g$$

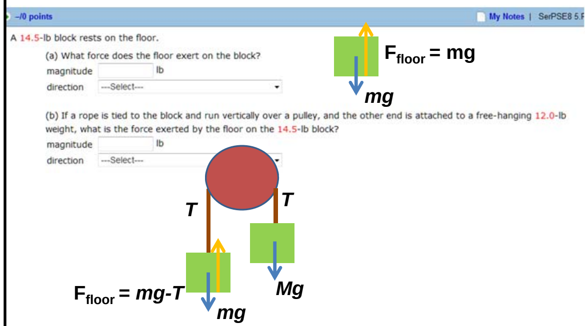


$\mathbf{F}_{scale} + \mathbf{F}_{gravity} = \mathbf{0}$; $F_{scale} = mg$

Question: What if you step on the scale in the elevator?

$\mathbf{F}_{scale} + \mathbf{F}_{gravity} = m\,\mathbf{a}$; $\quad F_{scale} = mg + m\,a$





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Exercise

For this exercise, you should ride the elevator from the first floor of Olin Physical Laboratory up to the second or third floor. While in the elevator, stand on the scale and record the scale readings to answer the following questions.

1. What is the scale reading when the elevator is stationary? x
2. What is the scale reading when the elevator just starts moving upward? >x
3. What is the scale reading when the elevator is coming to a stop just before your destination floor? <x

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