today:

§ 6.4 - work
quiz: §§ 6.1, 6.2

wednesday:

mslc webwork workshop @ 11:30, 12:30, 1:30, 2:30, 3:30 in SEL 040
webwork 3 due @ 11:55 pm
project 1 help session 5:30 - 7:30 in EA 285

thursday:

homework 3 due (6.2.16, 6.2.22, 6.2.60, 6.3.20, 6.3.28, 6.3.46b)
§ 7.1 - integration by parts
§ 7.2 - trig integrals
mslc - trig review workshop @ 12:30 and 3:30 in CH 042

monday:

webwork extra credit project 1 due @ 6:00 am

tuesday, 27 october:

homework 4 due (6.4.10, 6.4.16, 7.1.28, 7.1.56, 7.2.44, 7.2.66)
quiz: §§ 6.4, 7.1

wednesday, 28 october:

webwork 4 due @ 11:55 pm
mslc midterm review @ 7:30 pm in HI 131

thursday, 29 october:

midterm: §§ 6.2-6.4, 7.1-7.3

Newton's second law

"*Mutationem motus proportionalem esse vi motrici impressae, et fieri secundum lineam rectam qua vis illa imprimitur.*"
- Isaac Newton, *Principia Mathematica* 1687

Newton phrased the law in terms of changes of momentum, which is equivalent to what we will use.

Principia published in 1687, wasn't knighted until 1705.

http://upload.wikimedia.org/wikipedia/commons/9/9d/Principia_Mathematica_title.gif

Newton's second law

$$\text{force} = (\text{mass})(\text{acceleration})$$

Since the SI unit for mass is kg and acceleration is m/s^2, force is measured using the newton (N),

$$\text{N} = \text{kg m}/\text{s}^2$$

A pound (lb) is a unit of force, not mass.

This is why you would have a different weight but the same mass on the moon.

http://upload.wikimedia.org/wikipedia/commons/9/9d/Principia_Mathematica_title.gif

work

For constant acceleration, work is the product of force and distance:

$$\text{work} = (\text{force})(\text{distance})$$

In SI, work has units of N m, which we define to be a Joule (J). That is,

$$\text{J} = \text{N m} = \text{kg m}^2/\text{s}^2$$

In English units, work is measured in "lb ft"

example

How much work does it take to raise a one kilogram object by one meter?

Recall: $g = 9.8 \text{ m/s}^2$.

Here g is the acceleration due to gravity.

Answer: 9.8 N

example

How much work does it take to raise a two pound object by three feet?

Answer: 6 lb ft

(We don't multiply by g because 2 pounds is a unit of force)

work

When acceleration is not constant, we divide the distance into small sections over which the acceleration is approximately constant. We then define work to be

$$W = \lim_{n \to \infty} \sum_{i=1}^{n} f(x_i)\, \Delta x = \int_a^b f(x)\, \mathrm{d}x$$

example

A spaceship at a distance x away from a very small black hole of a certain size is acted on by a force of $1000\ x^{-2}$ Newtons. How much work is done by a rescue ship pulling the spaceship from a distance of $1\ \mathrm{m}$ to a distance of $1\ \mathrm{km}$?

example

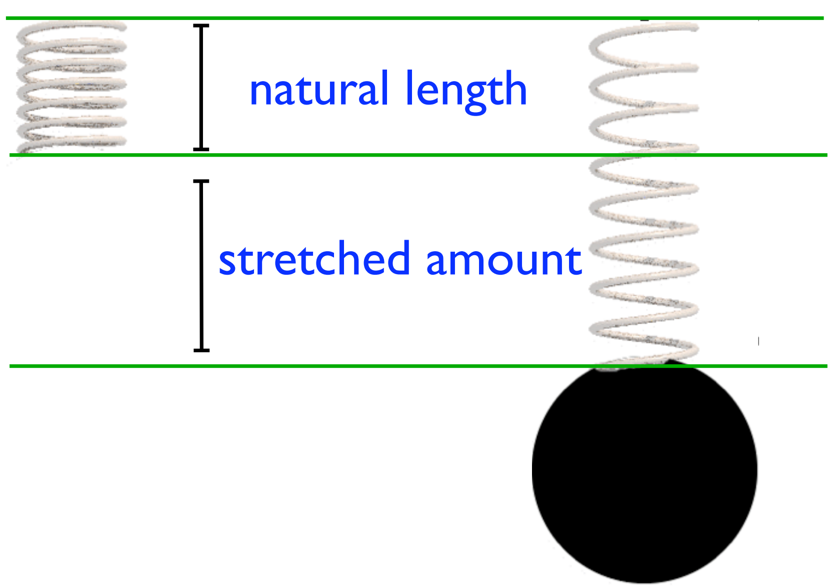
Note: Units matter.

1 km = 1000 m.

A spaceship at a distance x away from a very small black hole of a certain size is acted on by a force of $1000\ x^{-2}$ Newtons. How much work is done by a rescue ship pulling the spaceship from a distance of $1\ \mathrm{m}$ to a distance of $1\ \mathrm{km}$?

$$\begin{aligned} W &= \int_1^{1000} 1000\, x^{-2} \mathrm{d}x = -\frac{1000}{x}\bigg|_1^{1000} \\ &= -1 + 1000 = 999\ \text{Joules} \end{aligned}$$

springs



Hooke's Law

The force f required to maintain a spring stretched x units beyond its natural length is proportional to x:

$$f = k\,x$$

for some constant k.

coming soon

- webwork 3 due wednesday at 11:55 pm
- webwork project 1 (extra credit) due monday at 6 am
- homework 3 due thursday
- start homework 4 (due tuesday)