Exam solutions are posted on the class website:
http://faculty.washington.edu/storm/121C/

Graded exams will be returned at the end of class. If you feel a grading error has been made on your exam, you may submit a request for regrading. (Form on class website.) If you plan this, do not write anything more on your exam. If you request regrading, your entire exam will be regraded.

Homework assignment #4 is due by midnight tonight.
HW #5 is due next Wed by midnight. It is relatively short.

Office hours today: 4:00 – 5:30pm…

Exam grades posted on Tycho. If there is a "_" entered for a question, that means you didn't put your name on the page or didn't hand it in. See Helen Gribble in PAB C136 to identify your page. (She will want ID, your student number, and a handwriting sample.)

Human horsepower:

In the demo, Bristin ran up the stairs in 3.6 s
There are 10 rows of height 9” = ¾’ each
so her vertical displacement was 7.5’
with an estimated weight (mg) of 110 pounds,
Bristin produced power = mgh/t
= 110x7.5/3.6 = 230 ft-lb/s
since a horse power is 550 ft-lb/s, this was
230/550 = 0.42 horse power.

My recollection that a human can produce 1/6 horsepower for a short period was incorrect. This is the value for fairly long period.

I find (web search) that a person can produce 1.2 hp for short periods and 0.1 hp for long periods. Since the stairs are not set up for maximum power, we shouldn’t expect Bristin to be able to produce the maximum 1.2 hp, but we see that she is quite fit and the result is reasonable.

Scientific method:

Test beliefs or hypotheses with repeatable experiments. Make sure experiments are right. Be prepared to revise your beliefs or hypotheses.

Chapter 7.2-7.3 Conservation of energy

Now we consider a system of particles.
(e.g 2 masses on the ends of a spring)
Work on the system: $W_{\text{total}} = \sum \Delta K_i = \Delta K_{\text{system}}$

Internal forces (between the members of the system) can be conservative or not. And there are External forces. So consider 3 kinds of work $W_{\text{total}} = W_{\text{ext}} + W_{\text{int,nc}} + W_{\text{int,c}}$

$W_{\text{int,c}} = -\Delta U_{\text{system}}$ **Put the "system" things into the above equation, rearrange:**

$$W_{\text{ext}} + W_{\text{int,nc}} = \Delta(K_{\text{system}} + U_{\text{system}})$$

define $E_{\text{mech}} = K_{\text{system}} + U_{\text{system}}$

so $\Delta E_{\text{mech}} = W_{\text{ext}} + W_{\text{int,nc}}$

This equation says E_{mech} is only changed by external work and internal, non-conservative (dissipative) work. Those kinds of work come from the corresponding forces.

E_{mech} is conserved if

1. **there is no external work on the system (the system is isolated)**

2. ***and* there is no internal dissipation.**

I.e. E_{mech} is conserved if

1. **there are no external forces on the system (can also have ones doing no work)**

2. **and no internal non-conservative forces.**

Examples:

two masses on the ends of a spring
the Moon-Earth system
a pendulum and the Earth….

Examples of external force or internal dissipation

We now have "conservation of MECHANICAL energy" -- what about general "conservation of energy"?

Can't get around "external work" – you add energy to a system (or take it out) and its energy changes.

What about internal dissipation?

it produces heat, which is also energy. (experimentally demonstrated by Joule.)

Define

$E_{sys} = E_{mech} + E_{therm} + E_{chem} + E_{other}$

that covers it.

Then $\Delta E_{mech} = W_{ext} + W_{int,nc}$ becomes

$W_{ext} = \Delta E_{sys} = \Delta E_{mech} + \Delta E_{therm} + \Delta E_{chem} + \Delta E_{other}$

Work – Energy theorem in general form.

Energy of system is conserved if no external forces. Or

Energy of isolated system is conserved

(note – could have $W_{ext} = 0$ even if $\vec{F}_{ext} \neq 0$ so the statements are overly restrictive.)

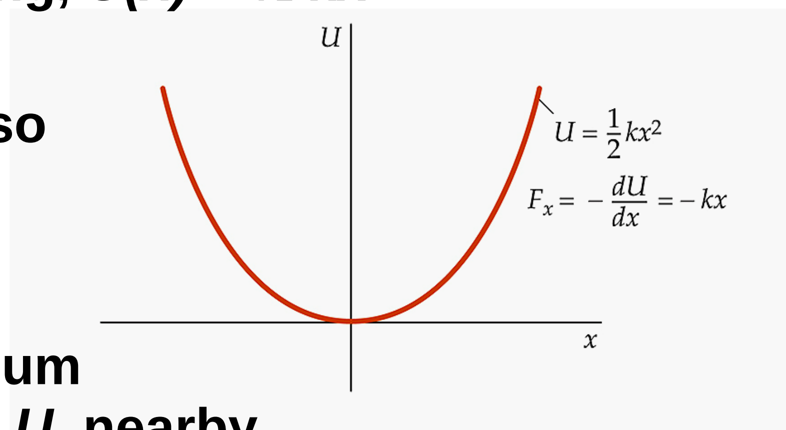
Examples of inelastic collisions – E_{mech} is converted to E_{therm}

Potential Energy Functions – Equilibrium

Example of a spring, *U(x)* = ½ *kx*^{2}
one dimension:

$$U(x) = -\int F_x dx$$ **so**

$$F_x = -\frac{dU}{dx}$$



***F* = 0 at an extremum**

at a minimum in *U*, nearby forces push back toward min. So a particle put there will stay. Stable Equilibrium.

But, at a maximum, nearby forces push away. So a particle exactly at a max in *U* has no *F*, but any tiny displacement will produce an *F* that pushes the particle away. Unstable Equilibrium

Examples