- begin video preceding ws07
- This video should be pretty self-contained. Mazur ch07 contains only two new equations worth knowing, but there are some new ideas about the types of interactions that occur in nature, ways in which energy can be transformed, etc.
- After you watch this (pretty short, I hope) video, you may want to skim through the ch07 checkpoints, particularly in the concepts half, to see if any of the discussion interests you.
- Again, chapter 7 is here mainly to prepare your mind, and your intuition, for the force concept. **Force** will be introduced in chapter 8 and then used throughout the rest of the course.

Here are the only two equations worth knowing from Chapter 7.
By contrast, Chapter 8 will have quite a few worth knowing!

(Chapter 7: interactions)

For two objects that form an isolated system (i.e. interacting only with one another), the ratio of accelerations is

$$\frac{a_{1x}}{a_{2x}} = -\frac{m_2}{m_1}$$

When an object near Earth's surface moves a distance Δx in the direction away from Earth's center (i.e. upward), the change in gravitational potential energy of the Earth+object system is

$$\Delta U = mg\Delta x$$

- **Hugely important:** when two objects interact only with one another:

$$\Delta p_{1x} = -\Delta p_{2x}$$

$$\Delta v_{1x}/\Delta v_{2x} = -m_2/m_1$$

$$\boxed{\frac{a_{1x}}{a_{2x}} = -\frac{m_2}{m_1}}$$

- When the medicine ball and I push apart from one another, we both accelerate: in opposite directions, and in inverse proportion to our masses.

- Lifting an object up a height Δx in Earth's gravity changes the gravitational **potential energy** of the object+Earth system by

$$\Delta U^G = mg\Delta x$$

- I usually remember $U = mgh$ where h is height
- Basketball: back & forth between $\frac{1}{2}mv^2$ and mgh
until mechanical energy is dissipated into thermal energy

Problem: I release a 1 kg ball from rest, from an initial height $x_i = +5.0\ \mathrm{m}$ above the ground. (Use $g \approx 10\ \mathrm{m/s^2}$.)

(A) What is the ball+Earth system's initial G.P.E. ?
(Let's define $x = 0$ to be $U^G = 0$.)

(B) What is the ball's initial K.E. ?

(C) What is the ball+Earth system's G.P.E. immediately before it reaches the ground?

(D) What is the ball's K.E. immediately before it reaches the ground?

(E) What is the ball's speed immediately before it reaches the ground?

(F) If the ball bounces elastically off of the floor, what height will it reach after bouncing?

(G) If instead the ball bounces off of the floor with a restitution coefficient $e = 0.9$, what height will it reach after bouncing?

Problem: Suppose your friend's mass is about 50 kg, and she climbs up 30 flights of stairs (that's about 100 m) to check out a great rooftop view of the city's architecture.

(A) By how many joules did climbing the stairs change the G.P.E. of the friend+Earth system?

(B) Where did this gravitational potential energy come from? I mean what source energy was converted into this G.P.E.?

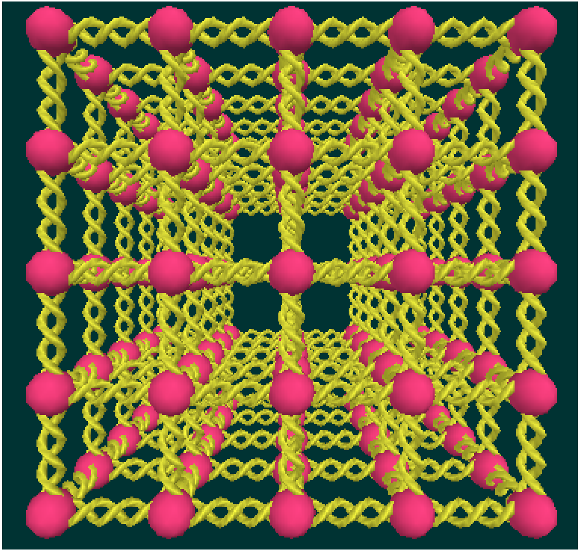
(C) How many food Calories did she burn (assuming, unrealistically, that one's muscles are 100% efficient at converting food into mechanical work)? [Realistically, your metabolism/muscles are very roughly about 20% efficient at turning stored food into mechanical work.]

(Begin digression.)

Dissipative / incoherent / irreversible

A simple ball / spring model of the atoms in a solid.

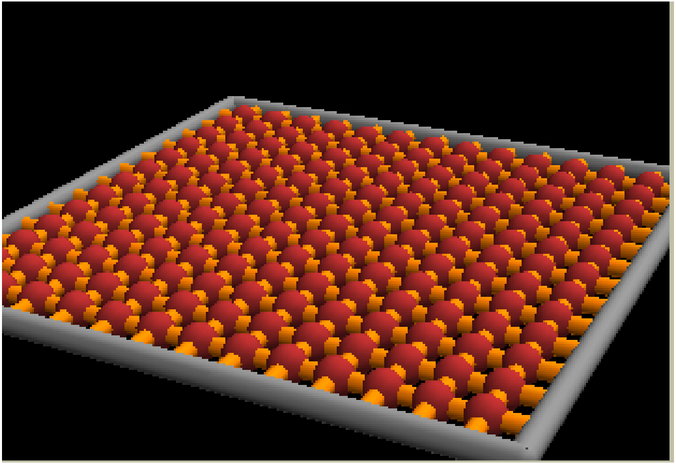
This is sometimes a useful picture to keep in your head.



Dissipative / incoherent / irreversible

2D version for simplicity

illustrate "reversible" and "irreversible" deformation with e.g. marbles and egg crate



Dissipative / incoherent / irreversible

I showed you once before my low-tech animation of two objects in a totally inelastic collision. Collision dissipates coherent motion (kinetic energy) into incoherent vibration of atoms (thermal energy)

`https://youtu.be/SJIKCmg2Uzg`

Here's a high-speed movie of a (mostly) reversible process a golf ball bouncing off of a wall at 150 mph.

https://www.youtube.com/watch?v=AkB81u5IM3I

(End digression.)