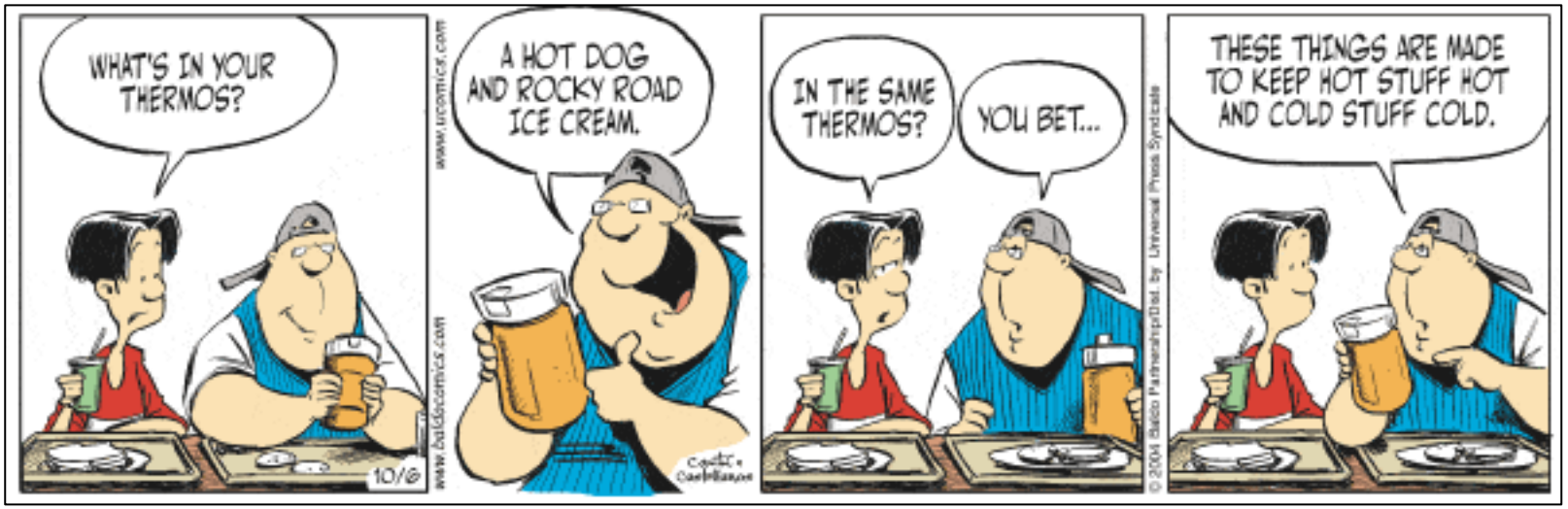
- **Today's Topics:** Thermal Energy
- **Cartoon:** **Hector D. Cantu & Carlos Castellanos**

  Baldo



A book slides across the table. It starts with a kinetic energy $KE_{initial}$. Friction does negative work on the book, making it slide to a halt. What happens to that energy?

A. It is used up stopping the book
B. It is turned into potential energy
C. It is converted to heat in the table and book
D. It is converted into a distortion of the table
E. None of the above

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Energy must be conserved in my system and so if I'm thinking about the table and the book as my system the friction must transfer the KE from one form to another – in this case it would be heat energy.

Announcements

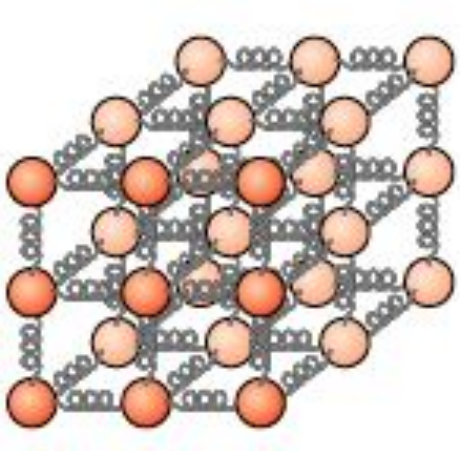
- Reading Questions from Ch14 due tomorrow at midnight
- Homework Ch 13-14 due on Friday
- Exam 3 next Monday, Nov 24th – Ch 10 - 13
  - I will have 2 extra office hours this week: Tuesday 2-3pm, & Wednesday 3:30-4:30pm

Do you plan to be in class the Wednesday before Thanksgiving? (class is NOT canceled)

A. Yes
B. No
C. Maybe?

Announcements

- No homework due the week of Thanksgiving, but Ch15 reading questions due Tuesday
- No LAs will staff the Help Room the week of Thanksgiving
- Correction problem will still be due by the beginning of class on Wednesday



Ch 13 –
Energy at the atomic level: heat and thermal motion

"The kind of motion we call heat"

- We have a natural sense of hot and cold.
- In the 19th century it was learned that the warmth of an object was a measure of a kind of random internal motion of the object's atoms.
- It was found that there was a surprisingly large amount of "hidden" energy that objects possessed as a result of their temperature –
  and that under the right conditions, this energy could be put to work.

Definitions: Heat energy

- Our model of matter as composed of many small moving particles allows us to extend energy conservation to include resistive forces.
- The energy associated with the motion of a macroscopic object is ***coherent***; all parts of the object move in the same way.
  The object has a net momentum associated with its kinetic energy.
- The internal energy of an object is ***incoherent***. The molecules of the object are moving in all directions randomly. Although the individual molecules have kinetic energy and momentum, the net momentum of the object as a result of its thermal energy is zero.
- The key idea in understanding thermal energy is ***equipartition*** – the equal sharing of energy any place it can go.

When gas particles move at a certain temperature, they….

A. All have same velocity, which is fixed
B. All have different, but fixed, velocities
C. All have different velocities, and those velocities fall into discrete energy bins
D. All have different velocities, and those velocities change

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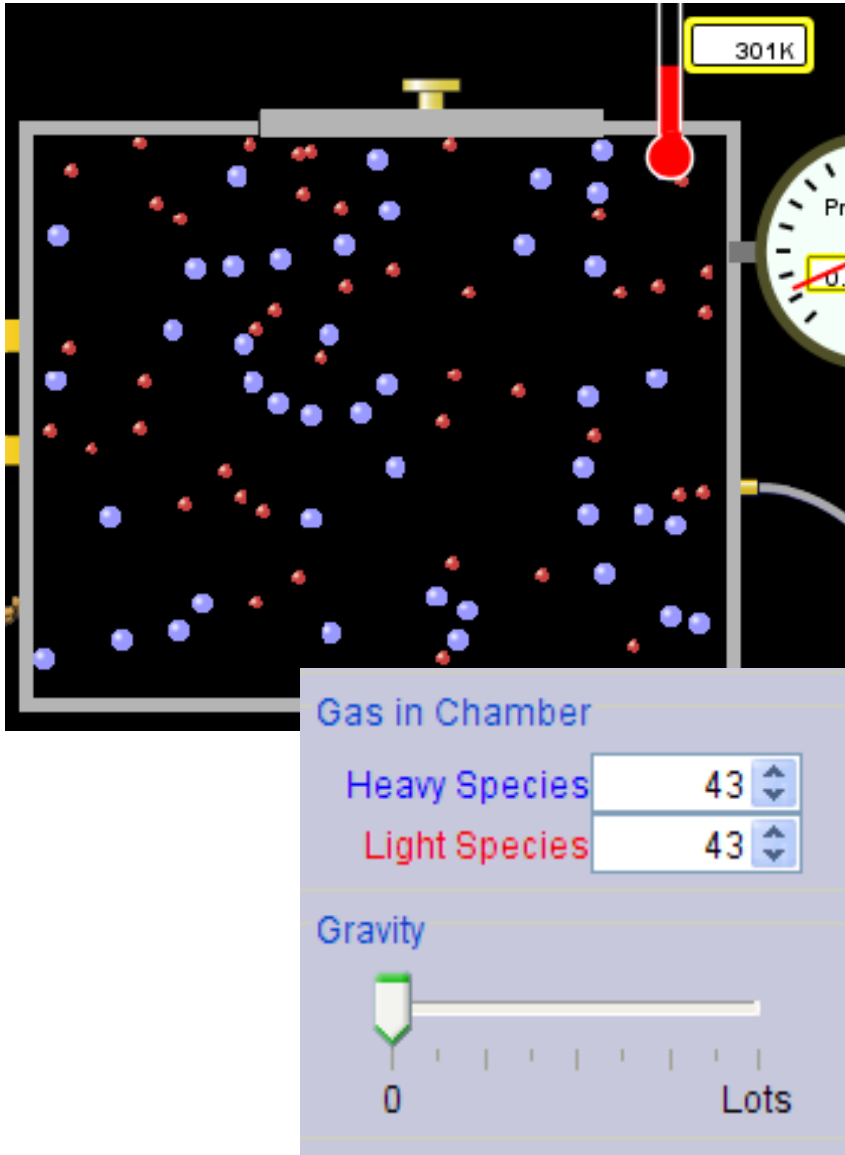
What is important is that the average kinetic energy remains the same. As the particles are moving around they collide with eachother and with the walls, so the velocities are changing, but the average kinetic energy remains the same.

http://phet.colorado.edu/en/simulation/gas-properties

If you have a bottle with Helium & Nitrogen at room temperature, how do the speed of the particles compare?



A. All have same speed
B. The average speeds are the same
C. Helium particles have greater average speed
D. Nitrogen particles have greater average speed

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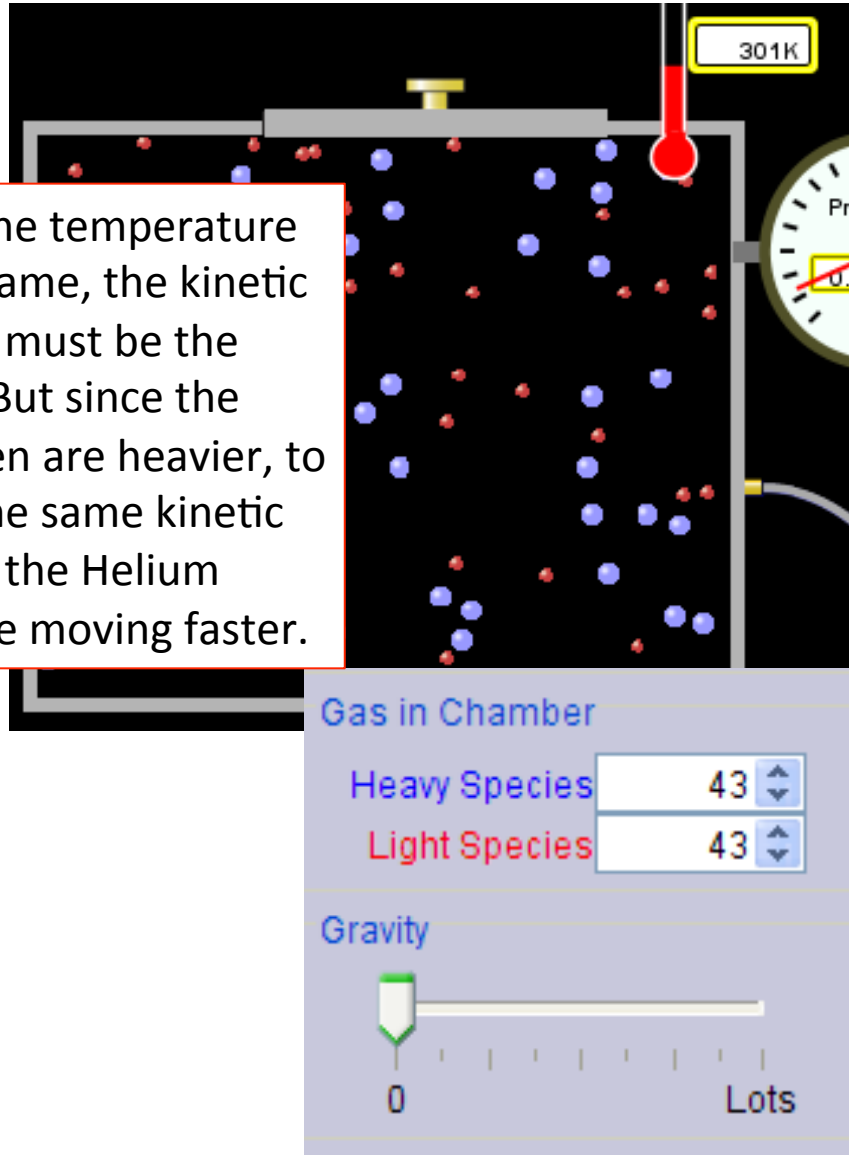
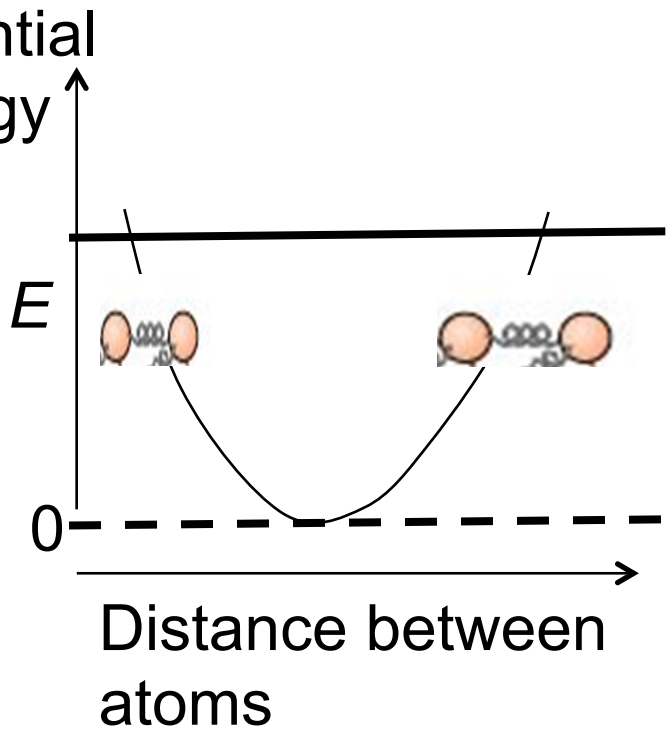
Since the temperature is the same, the kinetic energy must be the same. But since the Nitrogen are heavier, to have the same kinetic energy the Helium must be moving faster.



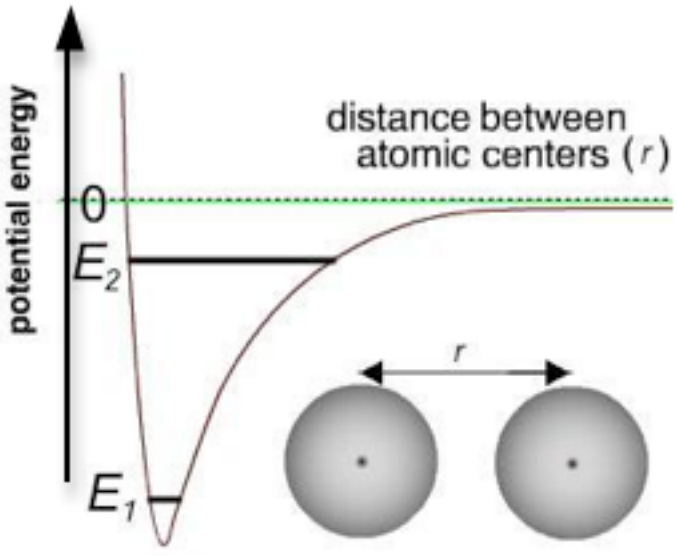
Energy in a 2-Atom Molecule



- For small displacements around the bond length, the PE of a pair of bound atoms can be modeled as a spring.
- Define the zero of potential energy as the <u>minimum</u> of the Potential Energy curve.
- With this definition, in a gas of these molecules, **ON AVERAGE** the energy is <u>the same</u> for both potential and kinetic energy

While wandering around their environment,
a molecule winds up being shifted to the state with a total energy E_2 as shown on the figure.
What could be responsible for this shift from E_1 to E_2?

A. The temperature of the system was increased.
B. The temperature of the system was decreased.
C. The molecule collided with another molecule and lost kinetic energy.
D. The molecule collided with another molecule and gained kinetic energy.
E. More than one is true.



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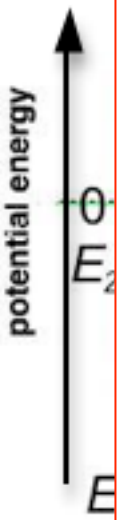

Either A or C is possible. Moving from total energy, E_1 to total energy, E_2 means that the maximum kinetic energy has increased (which we can see if we stand at the bottom of the potential well). Increasing the kinetic energy of the system could also correspond to increasing the temperature.