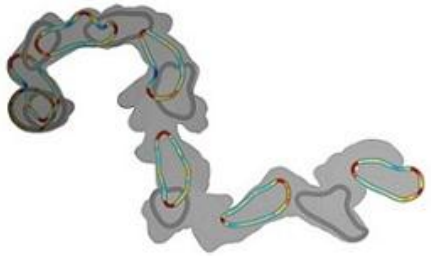
Physics 131- Fundamentals of Physics for Biologists I



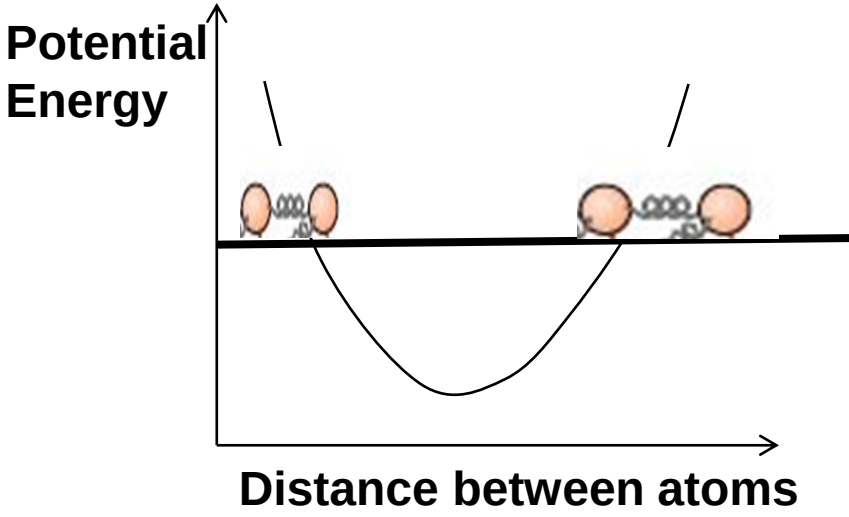
Office Hours:

12/9 Monday 3-4pm AV Williams 3341

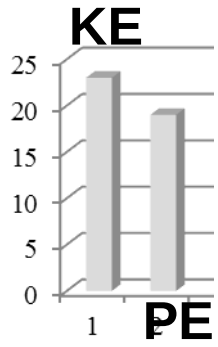
12/10 Tuesday 1-2pm AV Williams 3341

12/12 Thursday 2pm-3.30pm Course Center

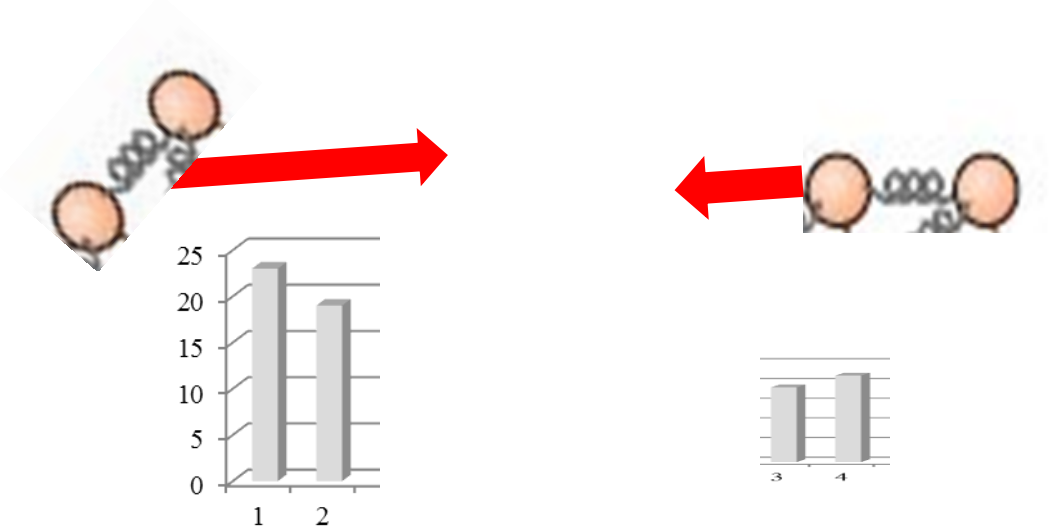
Energy in a Pair of Atoms



- **Let's define the zero of potential energy as the minimum of the Potential Energy Curve.**
- **With this definition, energy is ON AVERAGE the same for both potential and kinetic energy**



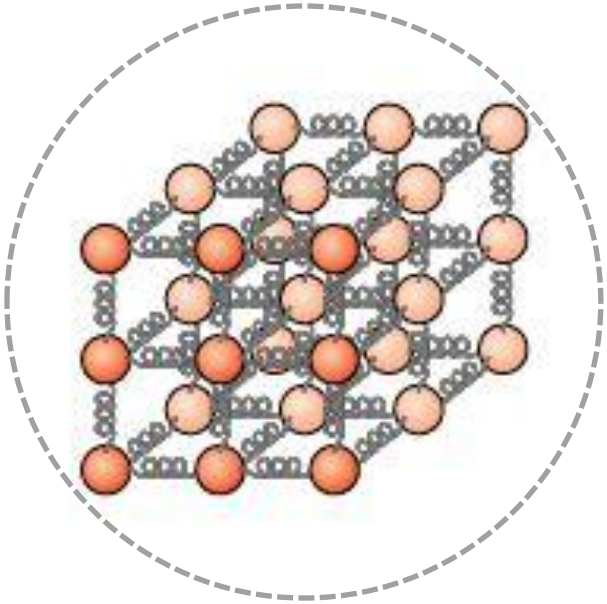
Interaction between two pairs of atoms



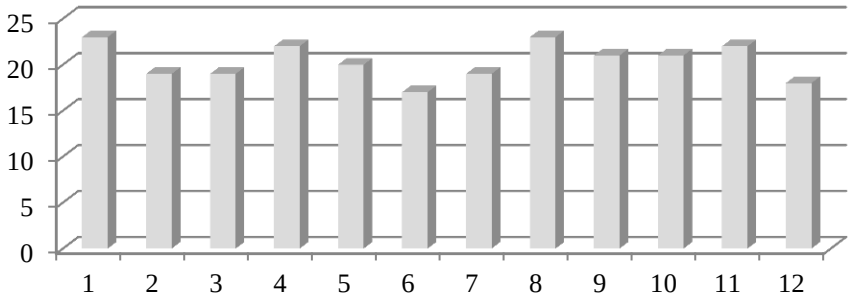
- **After many random collisions, energy is ON AVERAGE the same for**
  - **Kinetic energy of motion of both pairs of atoms**
  - **Kinetic energy of vibration of atom pair**
  - **Potential energy of interaction (relative to potential minimum)**

Temperature

Object A



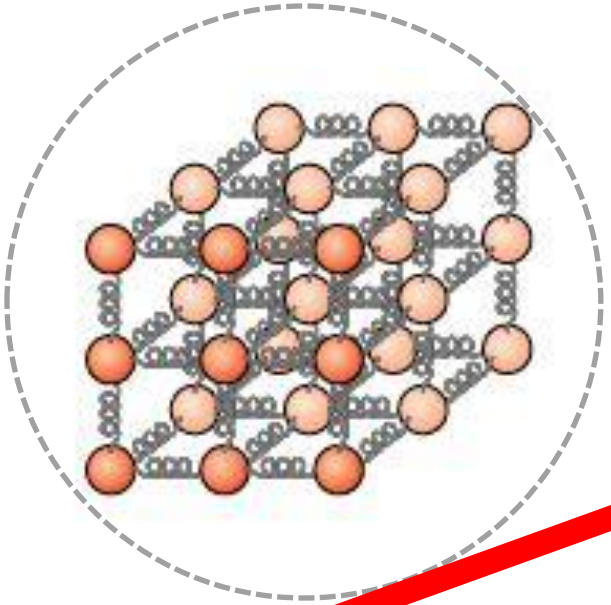
Object contains MANY **atoms (kinetic energy)** *and* **interactions (potential energy**)

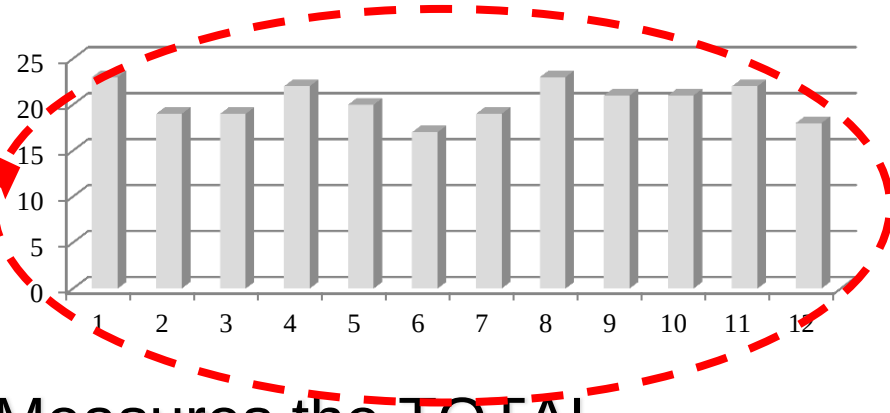


- **Temperature:** Measures the amount of energy in each atom or interaction – the key concept is that thermal energy is **on average** equally distributed among all these possible "bins" where energy could reside.
- **Note: Potential energy of each bin is here defined relative to each minimum of the Potential Energy Curve.**

Thermal Energy

Object A



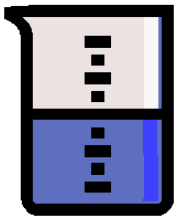


- **Thermal energy of object A :** Measures the TOTAL energy in the whole object. Depends on temperature and the number of “bins” where energy could reside.
- Energy in each bin: ½ kT

Experiment 2

If we have unequal amounts of the same kinds of materials at different temperatures and put them together, what happens?

100 g of water at 80 ° C



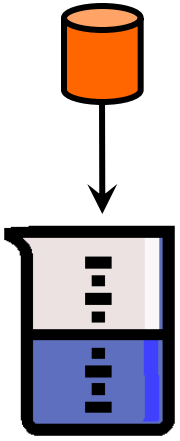
200 g of water at 20 ° C

1. pretty close to 40 C
2. pretty close to 80 C
3. pretty close to 20 C
4. greater than 60 C
5. something else

Quick Answer

Experiment 3

If we have equal masses of different kinds of materials at different temperatures and put them together, what happens?



200 g of copper at 80 ° C

200 g of water at 20 ° C

1. pretty close to 50 C
2. pretty close to 80 C
3. pretty close to 20 C
4. greater than 80 C
5. less than 20 C

Whiteboard, TA & LA

Why does copper block heat the water less than water itself?

Whiteboard, TA & LA

Specific Heat and Heat Capacity

- The amount of thermal energy Q needed to produce one degree of temperature change is an object is called its heat capacity C.

$$Q = C\Delta T$$

- The amount of thermal energy per unit mass needed to produce one degree of temperature change in an object is called its specific heat.

$$C = mc$$

Scales and Units

- 1 cal = the amount of thermal energy needed to change the temperature of 1gram of water by 1 degree C (from 14.5^{o} to 15.5^{o}) (by definition)
- 1 Cal = 1000 cal
- 1 Cal = 4184 J

Can we feel the temperature?

– If we have a cup of hot water and a cup of cold water, can we feel the difference?

– If you touch the plastic part of your chair and the metal part, which feels warmer?

Whiteboard, TA & LA