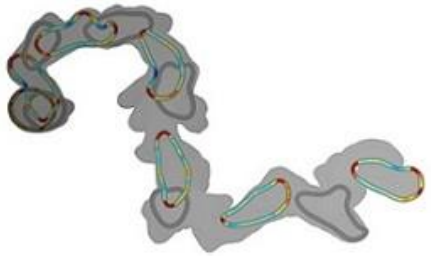
Physics 131- Fundamentals of Physics for Biologists I



Office Hours:

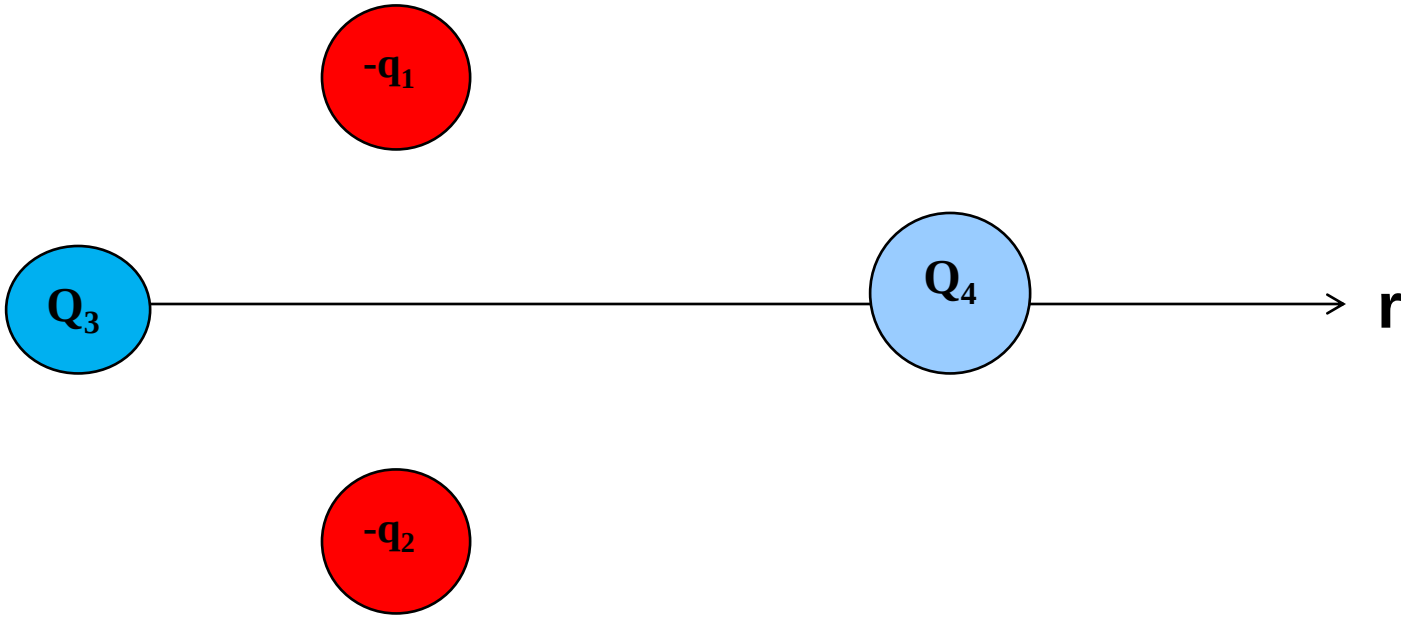
12/6 Friday 5pm-6pm AV Williams 3341

12/9 Monday 3-4pm AV Williams 3341

12/10 Tuesday 1-2pm AV Williams 3341

12/12 Thursday 2pm-3.30pm Course Center

How many interactions in the system hold potential energy?



6 interactions hold potential energies

4 kinetic energies

Whiteboard, TA & LA

Energies between charge clusters

- Atoms and molecules are made up of charges.
- The potential energy between two charges is

$$U_{12}^{elec} = \frac{k_C Q_1 Q_2}{r_{12}}$$

No vectors!

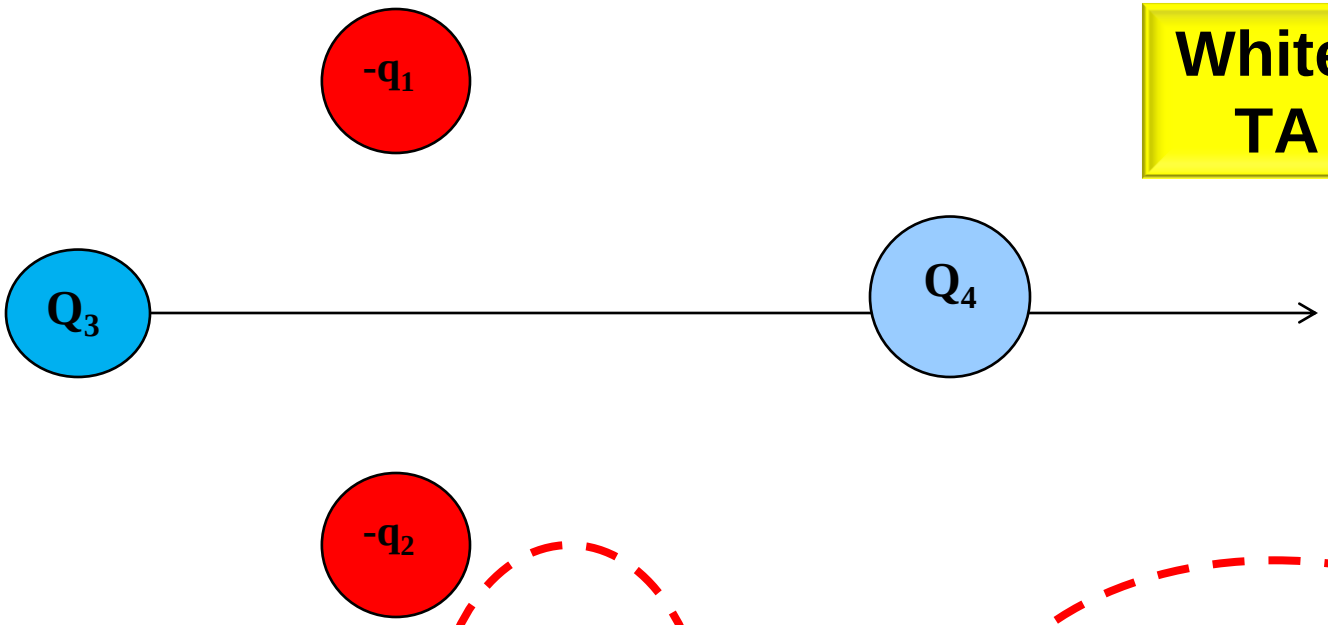
- The potential energy between many charges is

$$U_{12\ldots N}^{elec} = \sum_{i<j=1}^{N} \frac{k_C Q_i Q_j}{r_{ij}}$$

Just add up all pairs!

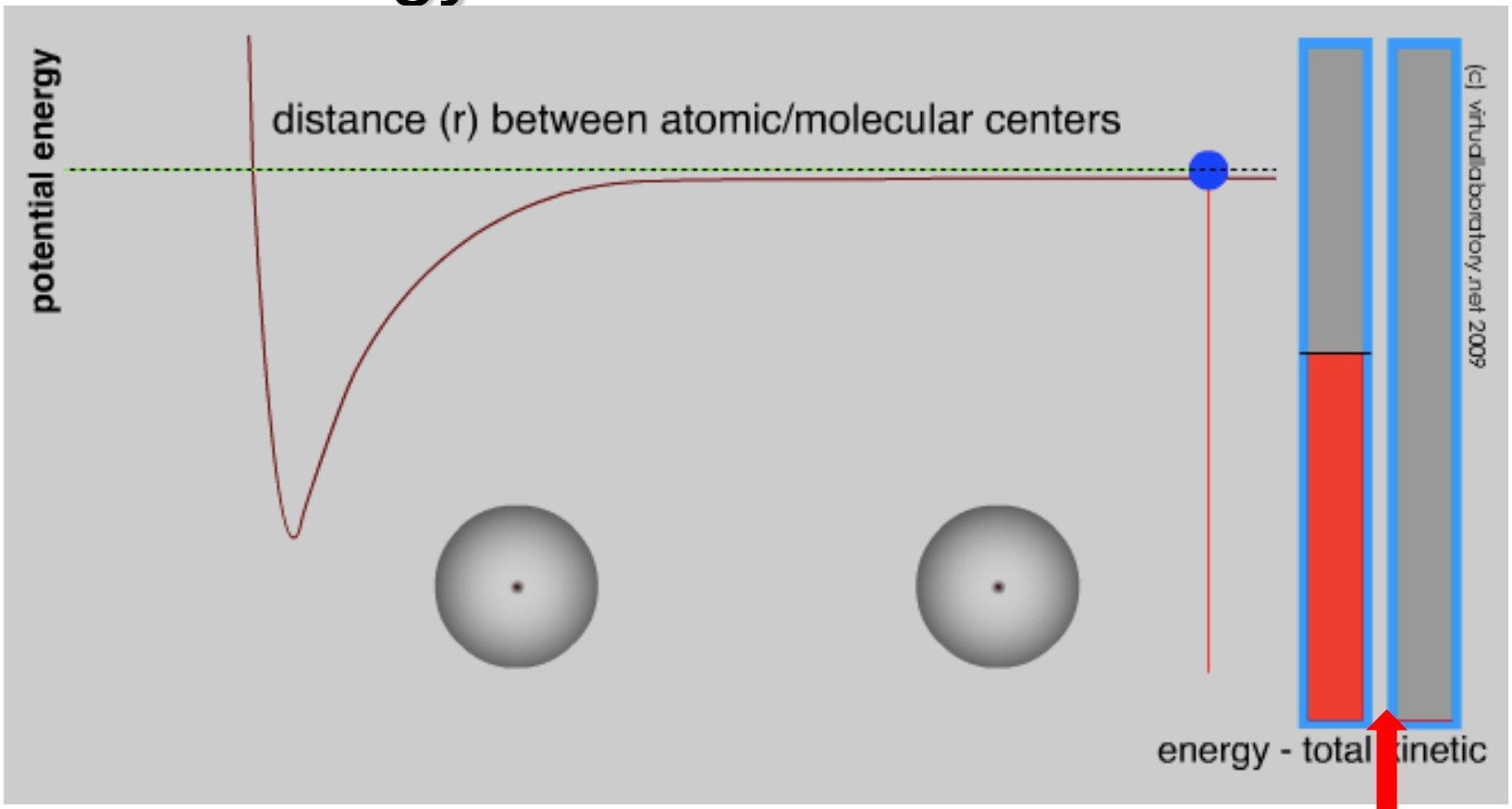
$$U_{tot}^{elec} = \frac{k_C q_1 q_2}{r_{12}} - \frac{k_C q_1 Q_3}{r_{13}} - \frac{k_C q_1 Q_4}{r_{14}} - \frac{k_C q_2 Q_3}{r_{23}} - \frac{k_C q_2 Q_4}{r_{24}} + \frac{k_C Q_3 Q_4}{r_{34}}$$

How many of the energies change when **ONLY** the charge Q_4 moves far to the right, nothing else moves?



$$U_{tot}^{elec} = \frac{k_C q_1 q_2}{r_{12}} - \frac{k_C q_1 Q_3}{r_{13}} + \frac{k_C q_1 Q_4}{r_{14}} + \frac{k_C q_2 Q_3}{r_{23}} + \frac{k_C q_2 Q_4}{r_{24}} + \frac{k_C Q_3 Q_4}{r_{34}}$$

Balance of kinetic and potential energy in a molecule



http://besocratic.colorado.edu/CLUE-Chemistry/activities/LondonDispersionForce/1.2-interactions-0.html

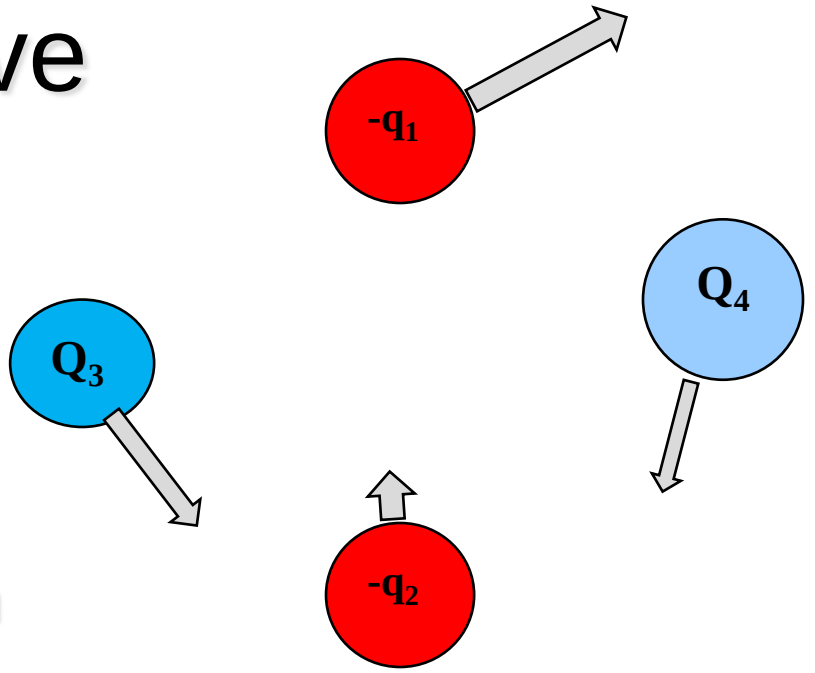
Page 3 of the interactive Demo!

Energy Bargraphs!

Now all four charges are allowed to move

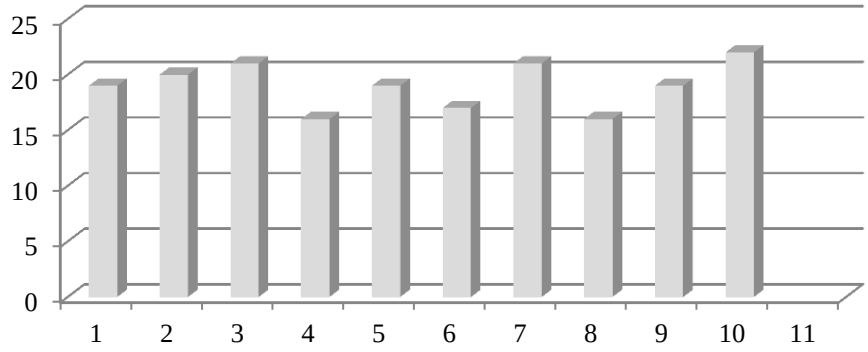
6 potential energies
4 kinetic energies

Energy "bins"



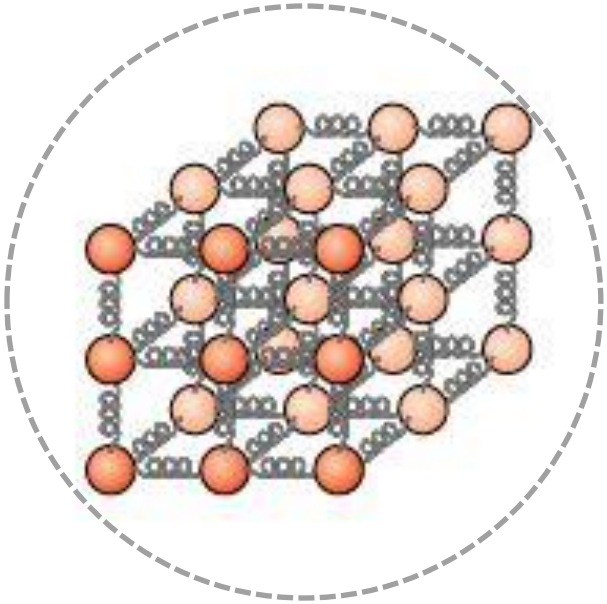
When the charges move, energy is exchanged between ALL 10 "bins"

Total energy is conserved!



Hidden Energy Inside Objects

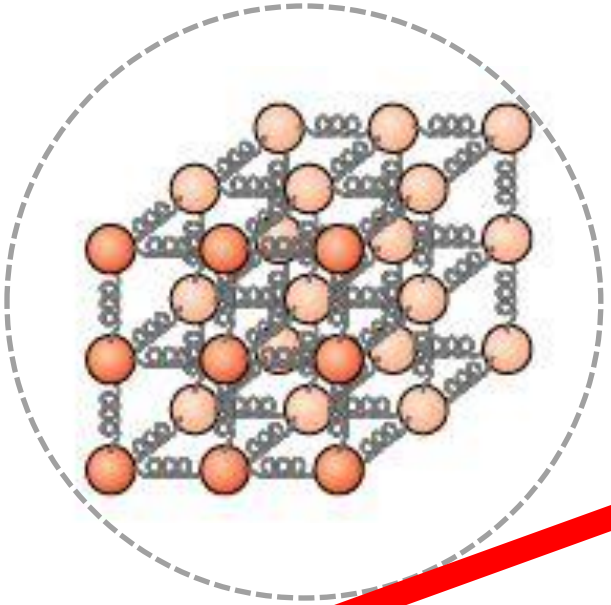
Object A

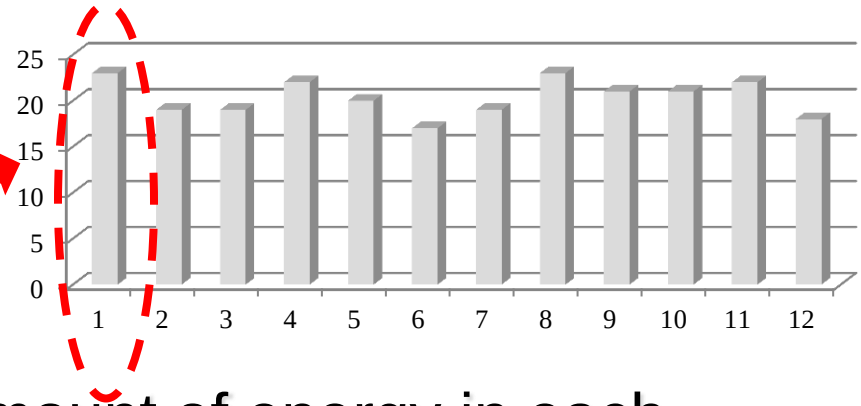


- Each atom can have kinetic energy
- Each interaction between atoms can store potential energy
  - Interactions between atoms can be modeled as springs
  - More realistic: Lenard-Jones Potential

Temperature

Object A

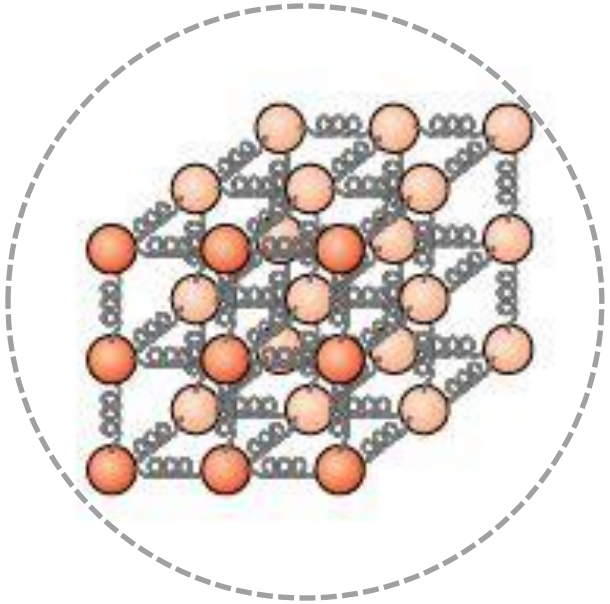


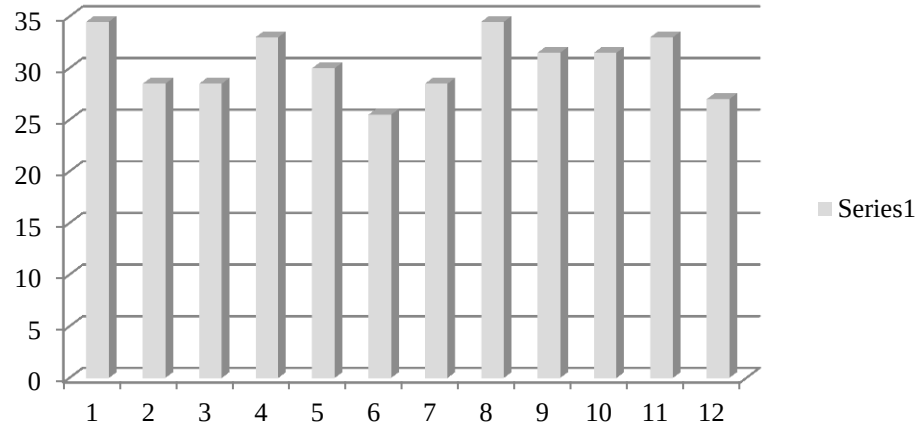


- **Temperature:** Measures the amount of energy in each atom or interaction – the key concept is that thermal energy is **on average** equally distributed among all these possible "bins" where energy could reside.

If you lower the temperature of object A, what happens to the energy?

Object A

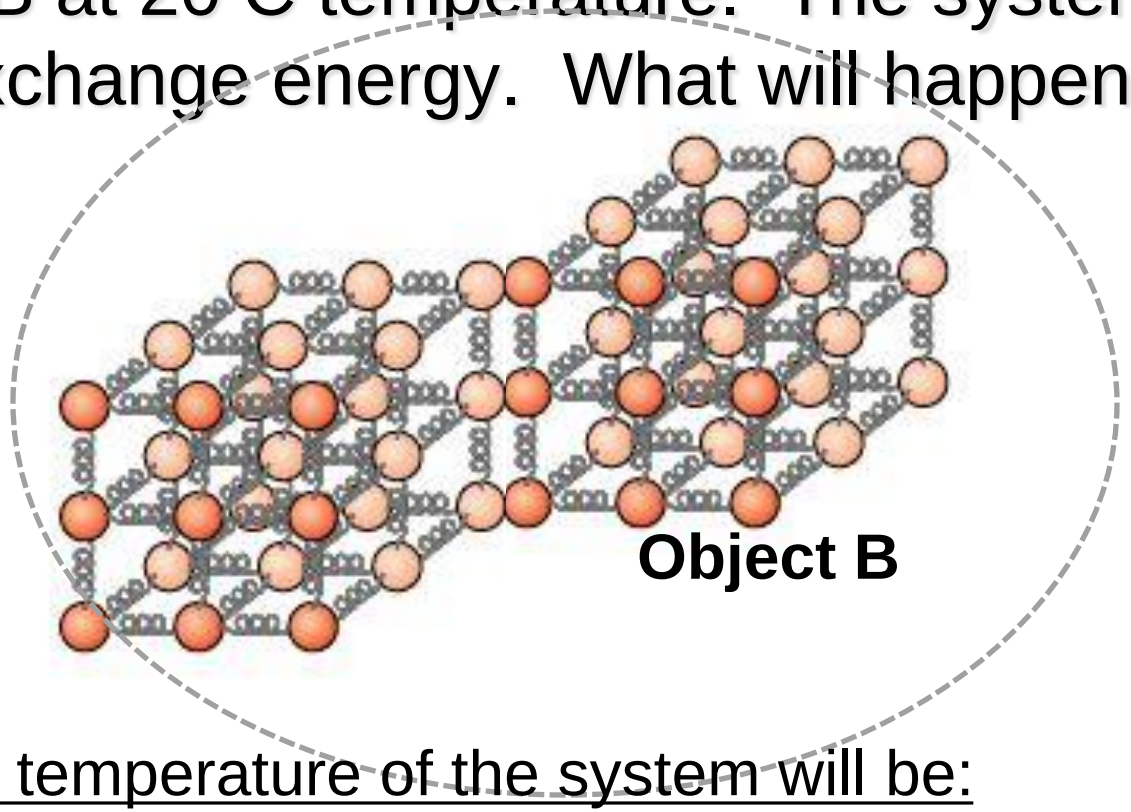




1. Fewer “bins”, but each carries same energy independent of temperature
2. **Smaller amount of energy in each bin**
3. Both fewer “bins” and smaller amount of energy in each bin

Whiteboard, TA & LA

Object A at 80 C temperature, touches object B at 20 C temperature. The system will exchange energy. What will happen



The temperature of the system will be:

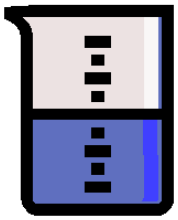
1. **pretty close to 50 C**
2. pretty close to 80 C
3. pretty close to 20 C
4. greater than 80 C
5. less than 20 C

Whiteboard, TA & LA

Critical Experiment 1

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

200 g of water 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