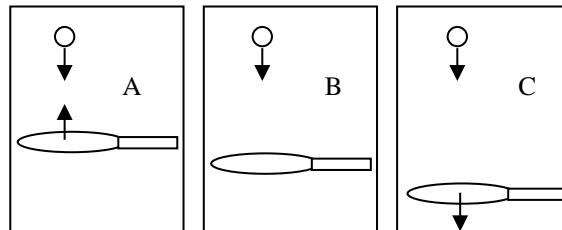


Notes: Heating with Compression – Cooling with Expansion

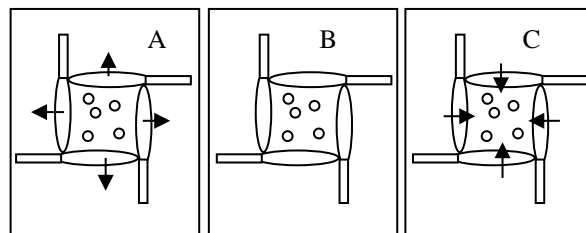
In the three pictures on the right, a “perfectly bouncy” ping pong ball is dropped onto a “perfectly bouncy” ping pong paddle.

1. In which situation will the ball speed up the most (and bounce highest) after being hit by the paddle?
2. In which situation will the ball slow down the most (and bounce the least) after being hit by the paddle?
3. In which situation will the ball’s speed remain approximately the same after hitting the paddle?



The three pictures on the right show “boxes” which have tennis rackets for walls. Inside the boxes, tennis balls are bouncing around. In one box, the walls are pushing inward against the balls. In another box, the rackets are relaxed, allowing the balls to push them out. In a third box the walls are held stationary.

4. In which “box” will the walls’ behavior cause the balls to speed up?
5. In which “box” will the walls behavior cause the balls to slow down?
6. In which “box” will the walls behavior not affect the balls’ speeds?



7. Why does rapidly compressing a gas cause the temperature to increase?

8. Why does allowing a gas to rapidly decompress cause its temperature to decrease?

Make a cloud in a bottle

Complete these steps and then answer the questions that follow:

Get a clear 2-Liter bottle with a cap.

- a. Get the inside of the bottle wet by putting water in it and shaking the water around. Then pour out the water.
- b. Light a match and get it burning well. Blow it out as you place it in the bottle. The point is to get some smoke the bottle. Cap the bottle tightly before the smoke escapes.
- c. Now squeeze the bottle as hard as you can for one second.
- d. Stop squeezing and let the bottle expand for one second.
- e. Squeeze again for another second, with all of your might. But don't jump on the bottle. This should be a steady squeeze.
- f. Release your squeeze.
- g. Squeeze again....
- h. Keep repeating this until you see a cloud forming and disappearing. Pay close attention to when the cloud is appearing and when it is disappearing. Holding the bottle in a bright light with a dark background will make the cloud easier to see.

1. When you squeeze the bottle, does that cause the temperature of the air in the bottle to increase or decrease?
2. When you release the bottle, does that cause the temperature of the air in the bottle to increase or decrease?
3. When the cloud appears in your bottle, the cloud made mostly of water molecules that are _____ (solid, liquid, or gas)
4. When the cloud in your bottle disappears, those water molecules turn to _____ (solid, liquid, or gas).
5. Squeezing the bottle causes _____ (evaporation or condensation) and releasing causes _____ (evaporation or condensation).
6. Clean out your bottle. Remove the air and get fresh air. Will a cloud form if you don't use the smoke?
7. When you make a cloud in a bottle, that cloud is made of water, and it is floating in the air inside your bottle. Where does that water come from, and how does it get in the air?
8. Why does it take a few cycles of squeezing and releasing to make a good cloud?

Cloud formation by Convectional Lifting

The Equator is one of the rainiest parts of the world. At the Equator, the Sun's rays warm the ocean's surface as well as the air near the ocean's surface. Explain how this warming of the ocean and the air above it causes cloud formation at the equator.

The warmth at the ocean's surface transfers heat to the ocean water, causing the speed of water and air molecules to _____ (increase or decrease). Eventually, the water molecules have gained enough energy to _____ (evaporate or condense). Their state of matter turns from _____ (solid, liquid, or gas) to _____ (solid, liquid, or gas), and they leave the ocean to become an invisible part of the warm air near the ocean's surface.

Another effect of this increasing warmth near the ocean's surface is that the volume of the air that is heating at the Earth's surface begins to _____ (increase or decrease). This change in volume causes the air's density to _____ (increase or decrease). This density change causes the air to _____ (rise or sink).

As the rising air gets higher, it encounters _____ (higher or lower) air pressure, because there is _____ (more or less) air above it. This change in air pressure causes the volume of the rising air to _____ (expand or shrink). This _____ (expansion or compression) of the air causes the temperature of the air to _____ (increase or decrease). This new change in the temperature of the air causes the speed of the air molecules to _____ (increase or decrease). The change in molecular motion causes the water molecules to change phase (state) again from _____ (solid, liquid, or gas) to _____ (solid, liquid, or gas). When this happens, tiny droplets of water form around specs of dust, creating clouds. At first the droplets are too small and light to fall to the ground. They fall so slowly that even gentle updrafts keep pushing them back up. Eventually, when enough individual droplets come together, they become big enough to fall fast enough to make it to the ground as rain.