RAFT IDEAS

Topics: Gases, Pressure, Vacuum

Materials List

- ✓ Syringe, plastic, 5 to 20 ml, 1 (**Safety note:** a large syringe, 30+ ml, can snap back with **significant force** when creating a "vacuum".)
- ✓ A (removable) twist-on attachment for the syringe's tip that can make an airtight junction, **or** a second syringe
- ✓ Wood block or equal, 1 or 2
- ✓ Drill and appropriate sized bit
- ✓ Hot glue gun and glue
- ✓ Optional: Scale suitable for force measurements

This activity can be used to teach:
Next Generation Science Standards:

- Atmosphere (Grade 5, Earth and Space Science 2-1)
- Structure of Matter (Grade 5, Physical Science 1-1)
- Forces & Motion (Middle School, Physical Science 2-2, High School, Physical Science 2-1)

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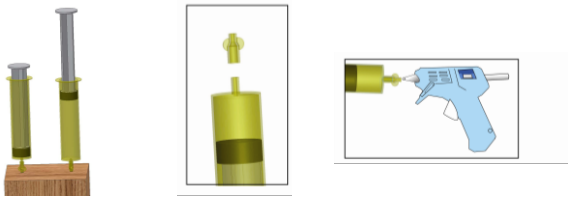
Air under Pressure

What happens when air is squeezed or "pulled"?



Explore a compressed gas and a partial vacuum with this air pressure demonstrator.

Assembly

1. Remove the syringe's dust cover, if present, uncovering the tip.
2. If a twist-on attachment is available, connect it to the syringe. The attachment allows a single syringe to be used for both the compression and vacuum activities.
3. If no twist-on attachment for the tip is available, pull the plunger almost all the way out and use hot glue to plug the tip. Be careful not to force glue into the syringe! This syringe will be the "compression" syringe.
4. To make a "vacuum" syringe push the plunger all the way in on another syringe, and plug the tip in the same way as in step 2.
5. Drill a vertical hole in a wood block for each syringe to be mounted. The hole should be slightly bigger than the tip of the syringe or of the attachment.
6. For a syringe with an attachment, position the plunger in or out and then use hot glue to seal the attachment's tip. Later the syringe can be unscrewed from the attachment and the plunger can be moved in or out as needed (see steps 2 and 3).
7. Add glue to the hole(s) drilled in step 4 and then insert the end of the syringe or attachment into the hole. Allow the glue to cool and harden.

To Do and Notice

1. Push in the plunger of the compression syringe. How does pushing the plunger in halfway compare to pushing the plunger in ¾ of the way? Can the plunger be pushed all the way in? What happens when the plunger is released?
2. Pull the plunger of the vacuum syringe halfway out and then ¾ of the way out. Compare the force needed to hold the plunger in place at each position.
3. Optional: Repeat steps 1 and 2 using a scale to measure and compare the forces.
4. How can the observations be explained?

The Science Behind the Activity

Air pressure at sea level is about 1 kilogram per square centimeter (about 14.7 pounds per square inch). Boyle's law says that when a volume of gas is made smaller the pressure of the gas will increase. When the volume is halved the pressure is doubled. When the volume is reduced to ¼ then the pressure becomes 4 times greater! The geometrically increasing pressure, as the plunger is inserted, makes full insertion, by hand, impossible. Pulling out a fully inserted plunger on a sealed (vacuum) syringe requires overcoming the air pressure pushing the plunger inward. When created, the vacuum syringe contains a little trapped air so only a partial vacuum can be formed. At the ½ and ¾ positions of the plunger the atmospheric force pushing in is almost the same so the pull needed to hold the plunger in place is almost the same. When released, the plunger will move inward, for a vacuum syringe, or outward, for a compression syringe, until the air pressure inside and outside the syringe are equal.

Web Resources (Visit www.raft.net/raft-idea?isid=509 for more resources!)

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