Boiling Water at Room Temperature

The boiling point of a liquid is the temperature at which the vapor pressure of the liquid equals the atmospheric pressure.
Water will boil at room temperature if the pressure above it is sufficiently reduced

UPDATE
As of Summer 2015, we have a belt-driven vacuum pump that will boil water at RT. It is kept in EDL, and is on a small cart.

Chemicals and Equipment Needed

- H_2O – drinking fountain
- Bell jar – **M5**
- Vacuum pump – **EDL**
- 1 L dedicated drinking beaker – **on food shelves in office**

Preparation

- Fill the beaker with 500-700 mL d-H_2O and place it inside the bell jar.
  - Get at least 1h before class so it can come to room temperature
- On delivery, connect the vacuum pump hose to the bell jar and plug in the pump.
- Remind the professor that after doing the demo, they **MUST** disconnect the hose before turning the pump off

Presentation

- Turn on the vacuum pump to begin lowering the pressure inside the bell jar. Within a few minutes, the pressure is reduced enough that the water begins to boil. Allow some time for the students to observe the boiling, then disconnect the hose from the bell jar and turn off the vacuum pump.
  - If you turn off the vacuum pump first, oil can get sucked into the hose and interfere with the pump's performance.
- To convince the students that the boiling truly occurred at room temperature, remove the bell jar from its base and plunge your hand into the beaker of water. Many students may gasp, because they have seen the water boil and are still thinking it must be "boiling hot."
- Instead of plunging your hand into the boiling water, you can choose to drink the water after it boils in the bell jar. We have a dedicated, never used for chemicals beaker for this purpose. Let us know, and we'll get water from the drinking fountain and let it sit out to come to room temperature.
- **IMPORTANT** – You must pull the valve for the bell jar and break the vacuum before turning off the vacuum pump. Failure to do this may damage the pump

Discussion

- Many students think of 100°C as **the** boiling point of water, when it is actually the **normal boiling point**. The normal boiling point of a liquid is the temperature at which the vapor pressure of the liquid is 1 atm (760 Torr). At a room temperature of 20°C, the vapor pressure of water is 17.5 Torr; at a room temperature of 25°C, the vapor pressure is 23.8 Torr. The vacuum pump reduces the pressure inside the bell jar sufficiently to cause the water to boil at room temperature.

Clean-Up

- Pour the water down the sink and wash the beaker.

Changing the Pump Oil

- Pump oil should be changed annually
- Run the pump for 15 min with the bell jar attached to warm up and thin the oil (makes it easier to change.
- Connect some tubing to the oil drain spigot and into a container (see pics)
- Drain oil into container (a gallon milk jug works well)
- Flush the pump with oil
    - Fill with 300-400mL fresh oil through the pump outlet (see pics)
    - Take off white septum stopper
    - Use a glass liquid funnel
- Run pump 15 min with bell jar attached, drain again.
    - If the oil still looks chunky, flush it again.
    - If the oil looks ok, refill with 300-400 mL fresh oil for regular use
- For disposal: Contact Don Tong