Super Heated Steam

Use a teakettle to create super heated steam

Introduction: Demonstrate how hot a gas can get by heating a coil of steam.

Materials:

- 1 1/ 2 to 2 feet of small diameter copper tubing (1/4 internal diameter)
- Strong pipe or cylinder (1 to 1 1/ 2 external diameter) to wrap the tubing around
- Pipe cutter
- Several pieces of paper and matches
- Safety Goggles
- One holed rubber stopper
- Tea pot or Erlenmeyer flask (The flask is recommended)
- Two heat sources
    - One source must be moveable and be able to achieve very high temperatures - like a propane torch or Bunsen burner.
    - The other may be stationary and only needs to boil water (i.e. a hot plate)

Assembly:

1) Cut copper pipe using the pipe cutter.
2) Carefully and slowly bend the copper tubing around the cylinder into a spiral. Make sure the internal copper tubing passageway is clear and uncrushed (to check this, blow through the tubing. Air should easily pass through the bent tubing). Leave several inches of unbent tubing exposed at each end.
3) Insert one end of tubing into a one holed rubber stopper.
4) Fill a teapot or flask about 1/4 to 1/2 full with water.
5) Insert the stopper with tubing extending from it.
6) Place the kettle on a heating unit and insert the stopper into the top of the kettle. Position the coil of tubing so that a propane torch can easily heat it.

To Do and Notice:

Always wear safety goggle during this experiment. Do not touch any part of this device until it is completely cooled.

1) Heat the water in the kettle until boiling. At the end of the copper tubing a clear gas will emerge, this is steam. A few inches (or centimeters) away from the tubing, the steam will condense into a cloud of water vapor.
2) Hold a sheet of paper or match in the stream of steam (a few millimeters away from the end of the tubing). Your object will get hot and eventually damp.
3) Heat the coil of copper tubing with the torch. Within a few seconds, the copper tubing should begin to glow red-hot.

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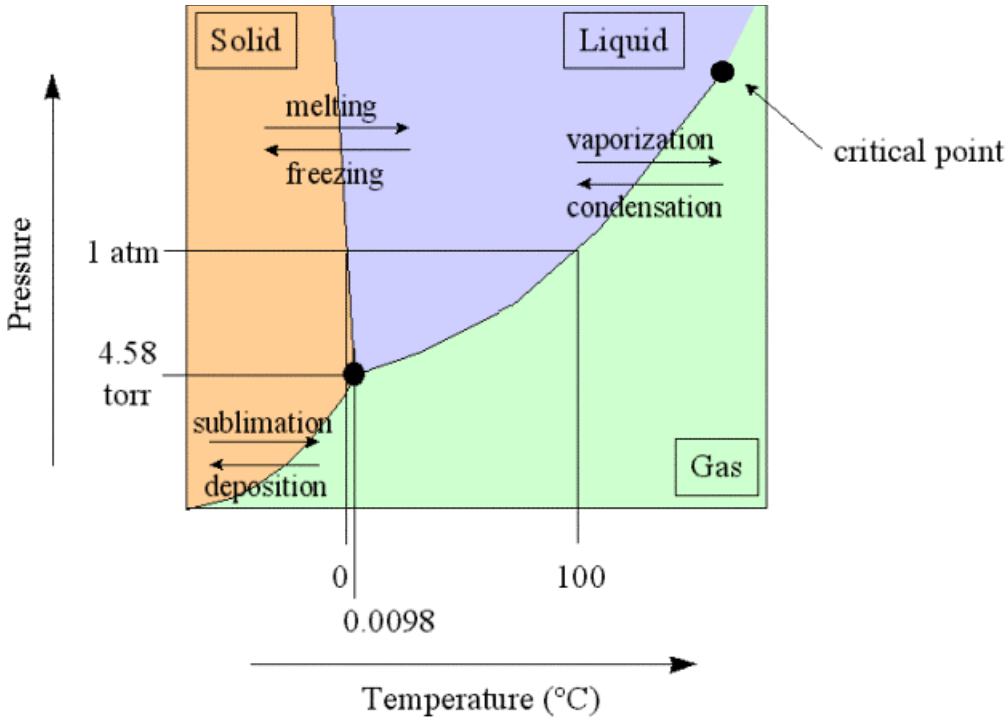
4) Notice that the clear portion of steam has extended much further into the room.
5) Again hold a sheet of paper or match in the stream of steam (a few millimeters away from the end of the tubing). Watch what happens this time - it burns.

What's Going On?

To cause the transition from water to steam at 100° C, you need to add 2260 joules of energy per gram of water (or 540 calories). This energy is added in the kettle as the water boils.

Usually, after the water has converted to steam, the gas leaves the kettle at 100° C, mixes and cools in the air (cooling of the steam is what causes the cloud or vapor just outside of the kettle's mouth). By funneling the steam through a heated pipe, more heat energy can be added to the gas. Instead of being steam at 100 ° C, it can me made several hundred degrees hotter and can possess several hundred more joules per gram of heat energy. This extra energy is what allows the match and paper to be burned.

Water and energy factoids:
Specific Heat of Ice: 2.05 J/g
Heat of Fusion of Ice: 333 J/g at 0°C
Specific Heat of Water: 4.18 J/g
Heat of Vaporization of Water: 2260 J/g at 100°C
Specific Heat of Steam: 2.0 J/g
(to convert from joules to calories divide by 4.18)



Graph from
http://www.its.caltech.edu/~atomic/snowcrystals/ice/h2ophase.gif