Phase Changes

Phases of Water

- Water exists in all three phases:
  - Solid:

Ice

  - Liquid:

Water

  - Gas:

Steam

Water Changes Phase

Why Phase Changes

- Heating a substance in a given phase causes the temperature to increase.
- Increasing the temperature causes particles to move faster and collide harder.
- Harder faster collisions cause particles to rebound harder moving them further apart.
- Larger distances between particles weakens the forces of attraction between them.
- When the forces of attraction are weak enough, the distance between the particles increases markedly and the phase changes.
  - Solid melts
  - Liquid evaporates
- The reverse happens when a substance cools.
  - Gas condenses
  - Liquid freezes

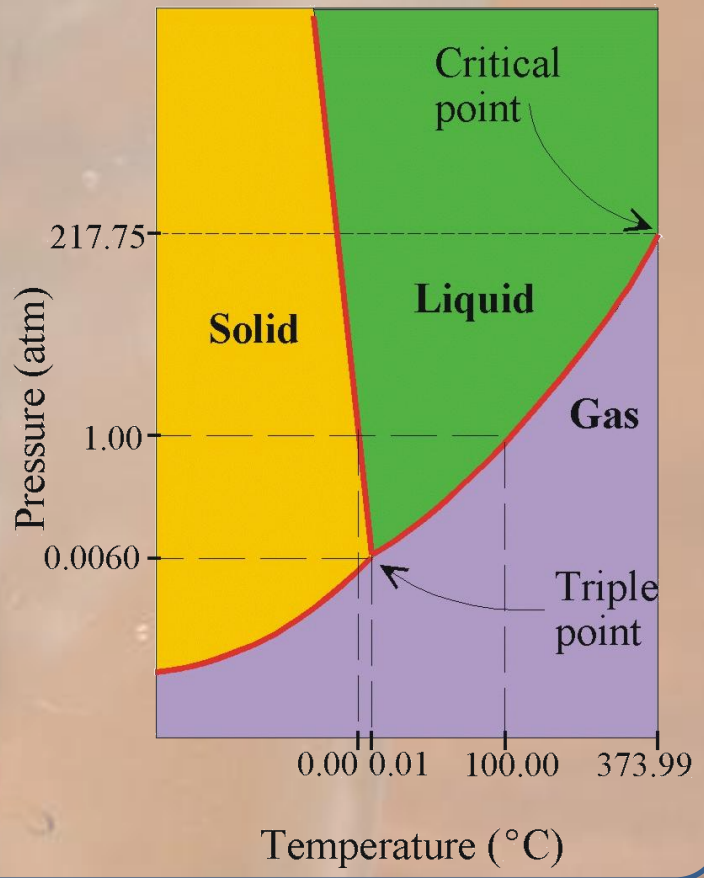
Pressure and Phase

- The liquid in a butane lighter is normally a gas at room temperature.
- When the valve is open, the butane comes out as a gas.
- **What makes it a liquid in the lighter?**
- Gases can be compressed under pressure.
- When the molecules of gas come closer together the attraction between them increases.
- This causes them to turn into a liquid.

Phase Diagram

WRITE DOWN

- A *phase diagram* shows the relationship between temperature, pressure, and phase.
- Terms
  - Triple point – temperature and pressure at which a substance can coexist as a solid, a liquid, and a gas.
  - Critical point – pressure above which a gas cannot exist at any temperature.



Reading a Phase Diagram

- Below is a phase diagram for carbon dioxide (*NOTE:* the *y*-axis is logarithmic)
  - What would have to be done to make CO_2 a liquid at room temperature (20°C)?

    Raise the pressure.
  - At what temperature and pressure does CO_2 coexist as a solid, a liquid, and a gas?

    5.2 atm and −56°C