

Phase Changes

Constant Pressure

- _____ temps gases have _____ behavior
- _____, volume drops and forms _____
- Colder yet, _____ drops and forms _____

Constant Temperature (_____ diagram)

- Critical Point - _____ above which _____ cannot exist
- _____ pressure needed for _____

Constant Volume (phase diagram)

- Critical point - Above this temp, no _____
- Triple point - All 3 phases _____
- Lines - 2 phases _____

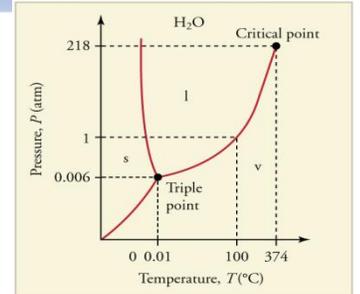
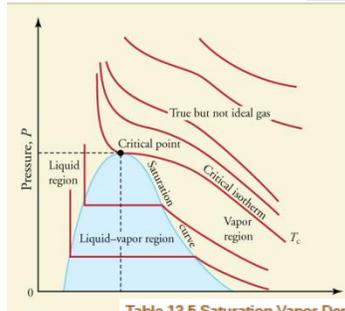
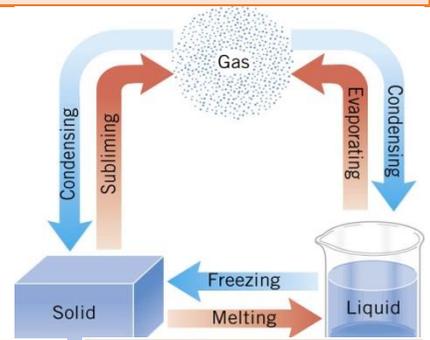
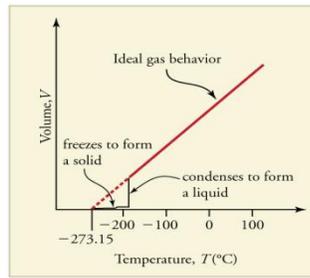


Table 13.5 Saturation Vapor Density of Water

Temperature (°C)	Vapor pressure (Pa)	Saturation vapor density (gm ³)
-50	4.0	0.039
-20	1.04×10 ²	0.89
-10	2.60×10 ²	2.36
0	6.10×10 ²	4.84
5	8.68×10 ²	6.80
10	1.19×10 ³	9.40
15	1.69×10 ³	12.8
20	2.33×10 ³	17.2
25	3.17×10 ³	23.0
30	4.24×10 ³	30.4
37	6.31×10 ³	44.0
40	7.34×10 ³	51.1
50	1.23×10 ⁴	82.4
60	1.99×10 ⁴	130
70	3.12×10 ⁴	197
80	4.73×10 ⁴	294
90	7.01×10 ⁴	418
95	8.59×10 ⁴	505
100	1.01×10 ⁵	598
120	1.99×10 ⁵	1095
150	4.76×10 ⁵	2430
200	1.55×10 ⁶	7090
220	2.32×10 ⁶	10,200

Humidity

Vapor Pressure

- The pressure at which a gas _____ with its _____ or _____ phase.
- _____ molecules break away from liquid or solid to form _____

Partial Pressure

- The _____ a gas would create if there were _____ gases present.

Total Pressure

- _____ of all _____ pressures of all gases present

Relative Humidity

- How much _____ vapor is in air
 - At 100% humidity, partial _____ of water = _____ pressure
 - If partial pressure < vapor pressure → _____
 - If partial pressure > vapor pressure → _____
- _____ means _____ partial pressure of water
 - Hot air can hold more water
- Saturation Vapor Density - _____ amount of water _____ that air can hold at _____ temp
- Percent Humidity

$$\% \text{ Relative Humidity} = \frac{\text{vapor density}}{\text{saturation vapor density}} \times 100\%$$

What pressure is necessary to raise the boiling point of water to 150°C?
If this was a sealed container, what would the gauge pressure be?

Late on an autumn day, the relative humidity is 45.0% and the temperature is 20.0 °C. What will the relative humidity be that evening when the temperature has dropped to 10.0 °C, assuming constant water vapor density?

Homework

1. A camping stove is used to boil water on a mountain. Does it necessarily follow that the same stove can boil water at lower altitudes, such as at sea level? Provide a reason for your answer.
2. Medical instruments are sterilized under the hottest possible temperatures. Explain why they are sterilized in an autoclave, which is a device that is essentially a pressure cooker and heats the instruments in water under a pressure greater than one atmosphere.
3. A bottle of carbonated soda is left outside in subfreezing temperatures, although it remains in the liquid form. When the soda is brought inside and opened, it immediately freezes. Explain why this could happen.
4. What is the vapor pressure of solid carbon dioxide (dry ice) at -78.5°C?
5. Why does a beaker of 40.0°C water placed in a vacuum chamber start to boil as the chamber is evacuated (air is pumped out of the chamber)? At what pressure does the boiling begin? Would food cook any faster in such a beaker?
6. Pressure cookers increase cooking speed by raising the boiling temperature of water above its value at atmospheric pressure. (a) What pressure is necessary to raise the boiling point to 120.0°C? (b) What gauge pressure does this correspond to? (OpenStax 13.51) **1.99 × 10⁵ Pa, 9.8 × 10⁴ Pa**
7. (a) At what temperature does water boil at an altitude of 1500 m (about 5000 ft) on a day when atmospheric pressure is 8.59 × 10⁴ N/m²? (b) What about at an altitude of 3000 m (about 10,000 ft) when atmospheric pressure is 7.00 × 10⁴ N/m²? (OpenStax 13.52) **95°C, 90°C**
8. What is the atmospheric pressure on top of Mt. Everest on a day when water boils there at a temperature of 70.0°C? (OpenStax 13.53) **3.12 × 10⁴ Pa**
9. What is the relative humidity on a 25.0°C day when the air contains 18.0 g/m³ of water vapor? (OpenStax 13.55) **78.3%**
10. What is the density of water vapor in g/m³ on a hot dry day in the desert when the temperature is 40.0°C and the relative humidity is 6.00%? (OpenStax 13.56) **3.07 g/m³**
11. If the relative humidity is 90.0% on a muggy summer morning when the temperature is 20.0°C, what will it be later in the day when the temperature is 30.0°C, assuming the water vapor density remains constant? (OpenStax 13.60) **50.9%**
12. What is the dew point (the temperature at which 100% relative humidity would occur) on a day when relative humidity is 39.0% at a temperature of 20.0°C? (OpenStax 13.63) **4.77°C**
13. Find the partial pressure of water vapor on a day when the weather forecast gives the relative humidity as 56.0% and the temperature as 30.0°C. (Cutnell 12.71) **2400 Pa**

