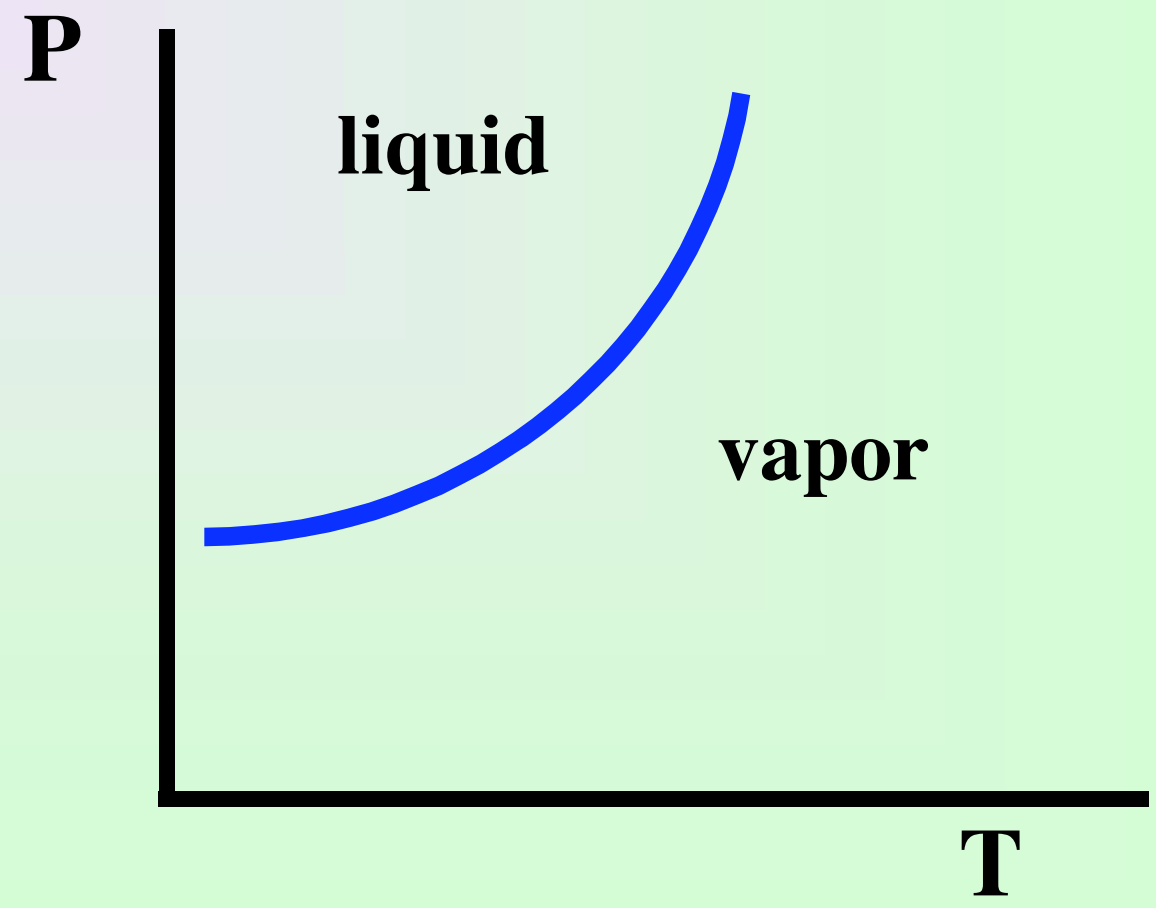
Phase Diagrams

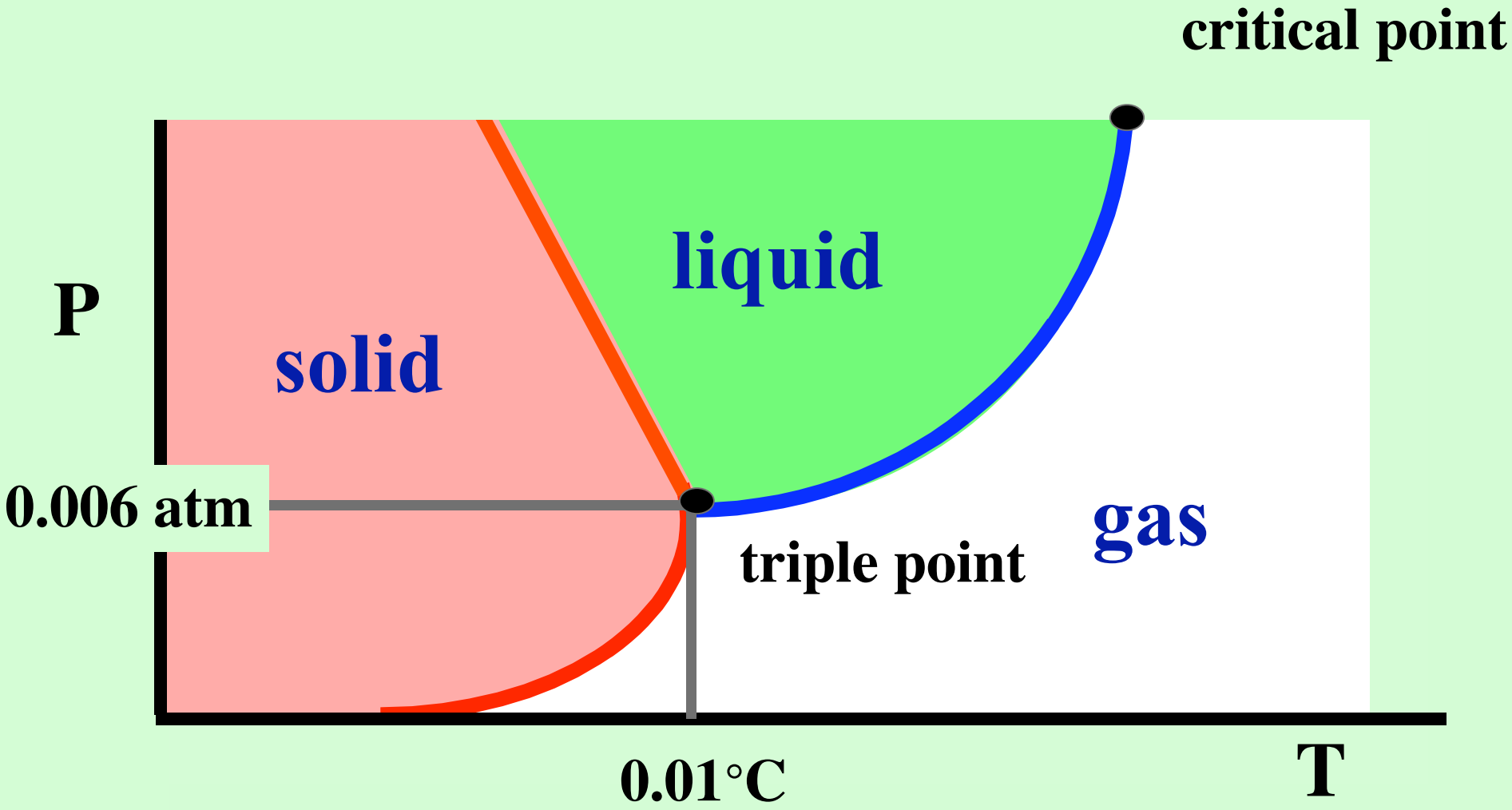
Phase diagrams are graphs that summarize conditions (temperature, pressure) under which a substance exists as a solid, liquid, or gas.

A Familiar Phase Diagram

Vapor pressure curve for water

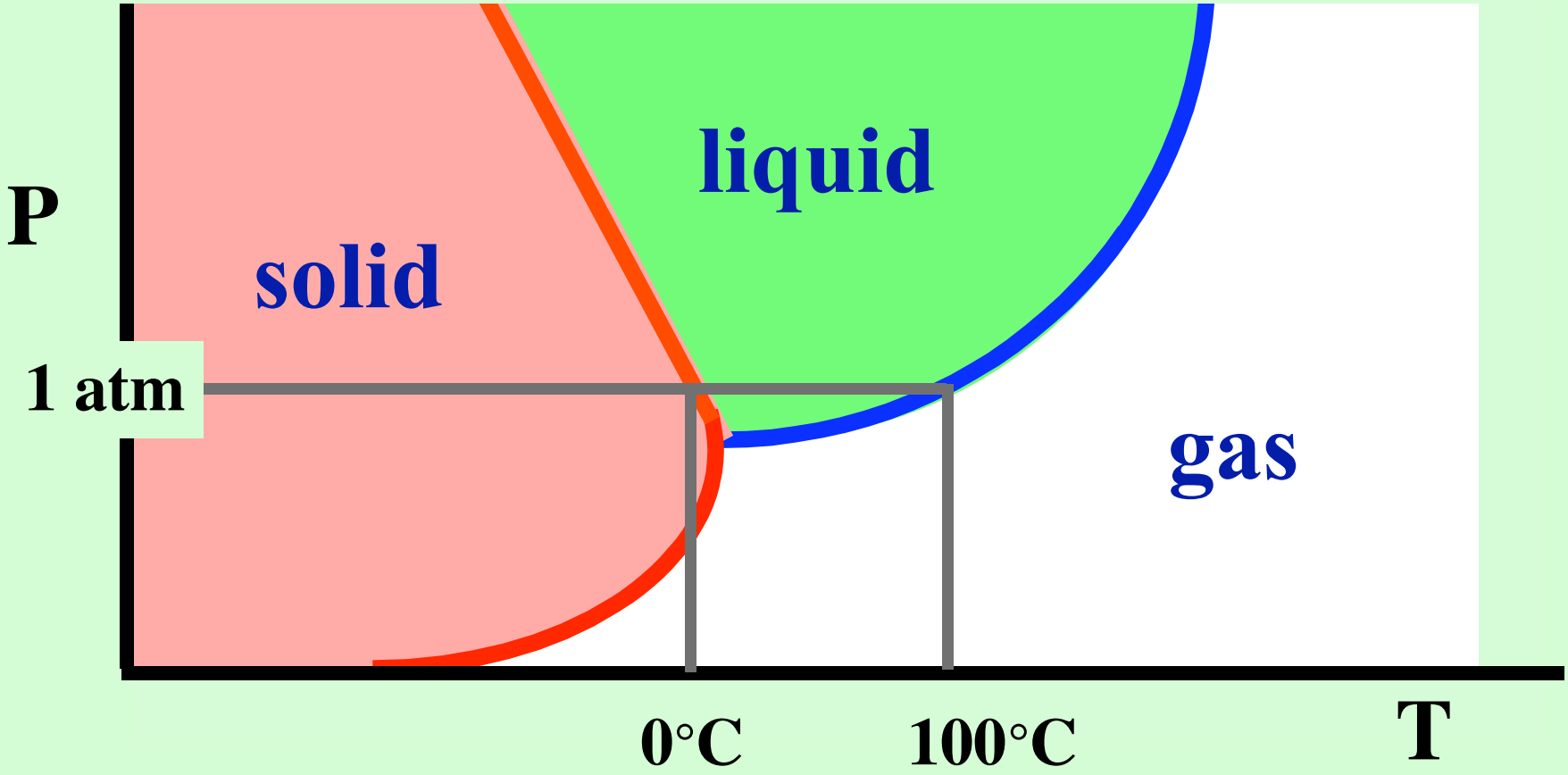


Including the Solid Phase

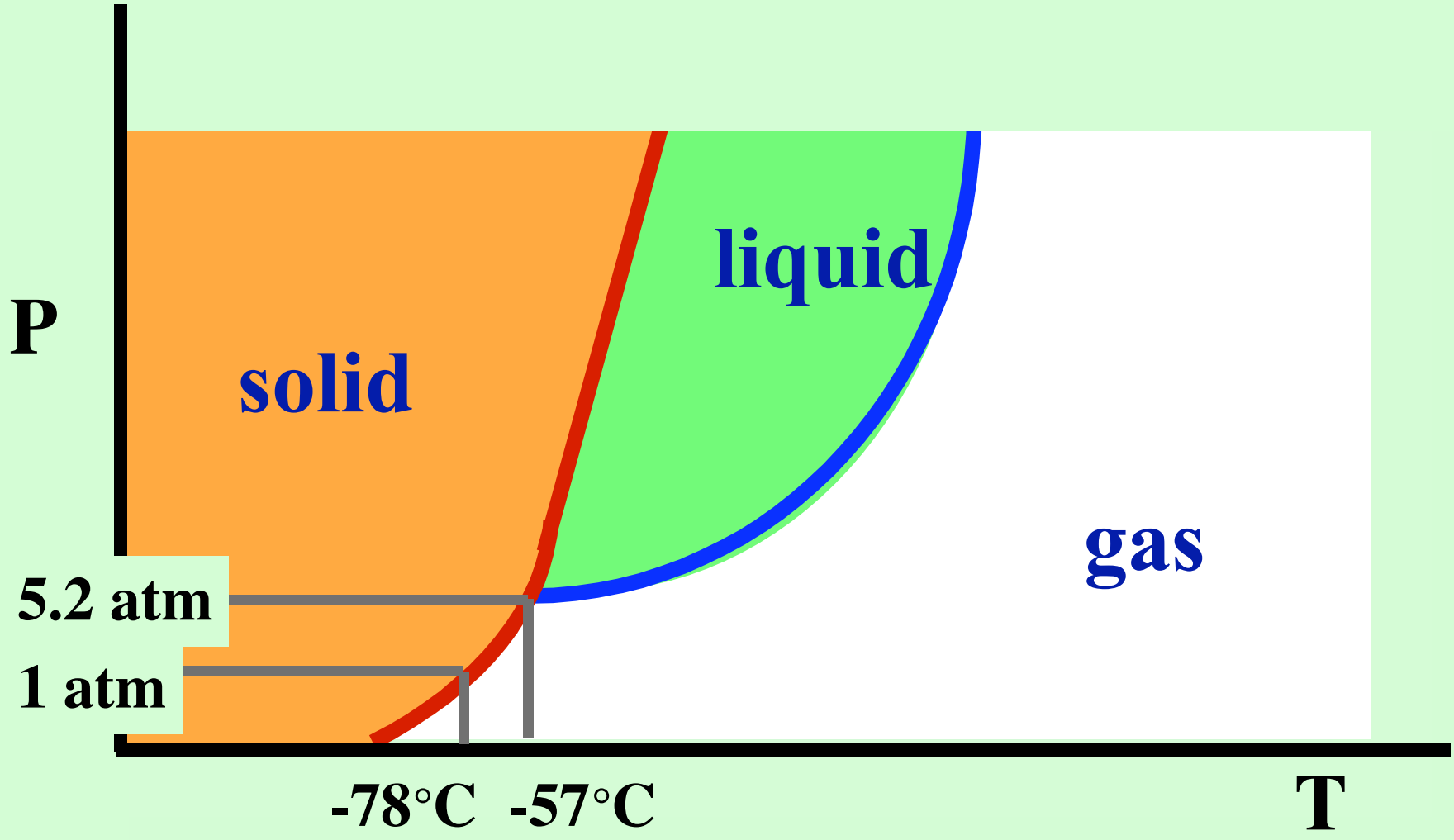


Normal melting and boiling point of water

Pressure = 1 atm



Carbon dioxide phase diagram



kinetic-molecular theory

the absolute temperature of a gas is a measure of the average kinetic energy of the molecules

$$(KE)_{ave} \propto T \qquad (KE)_{ave} \propto \frac{1}{2} m\overline{u^2}$$

average mean square value of molecular speed

$$\overline{u^2} = \frac{u_1^2 + u_2^2 + \ldots u_N^2}{N_A}$$

number of molecules in a mole

$$(KE)_{ave} = \frac{3}{2} RT \qquad (KE)_{ave} = N_A \left(\frac{1}{2} m\overline{u^2} \right)$$

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$$N_A \left(\frac{1}{2} m\overline{u^2} \right) = \frac{3}{2} RT \qquad \overline{u^2} = \frac{3\ RT}{N_A m}$$

$$\sqrt{\overline{u^2}} = \sqrt{\frac{3RT}{N_A m}}$$

Root -mean-square speed

$$u_{rms} = \sqrt{\overline{u^2}} = \sqrt{\frac{3RT}{M}}$$

Where M is the molar mass

Root -mean-square speed is directly proportional to the square root kelvin temperature and inversely proportional to the square root of the molar mass (molecular weight)

Distribution of molecular speeds as a function of temperature.

$$f(u) = 4\pi \left(\frac{m}{2\pi k_B T} \right)^{3/2} u^2 e^{-mu/2k_B T}$$