

VIII) Heat Transfer & Changes of State

$S \equiv$ specific heat ($\frac{J}{g \cdot ^\circ C}$)

$C \equiv$ molar heat capacity ($\frac{J}{mol \cdot ^\circ C}$)

Heat transfer w/in a state

$$q = m \cdot S \cdot \Delta T$$

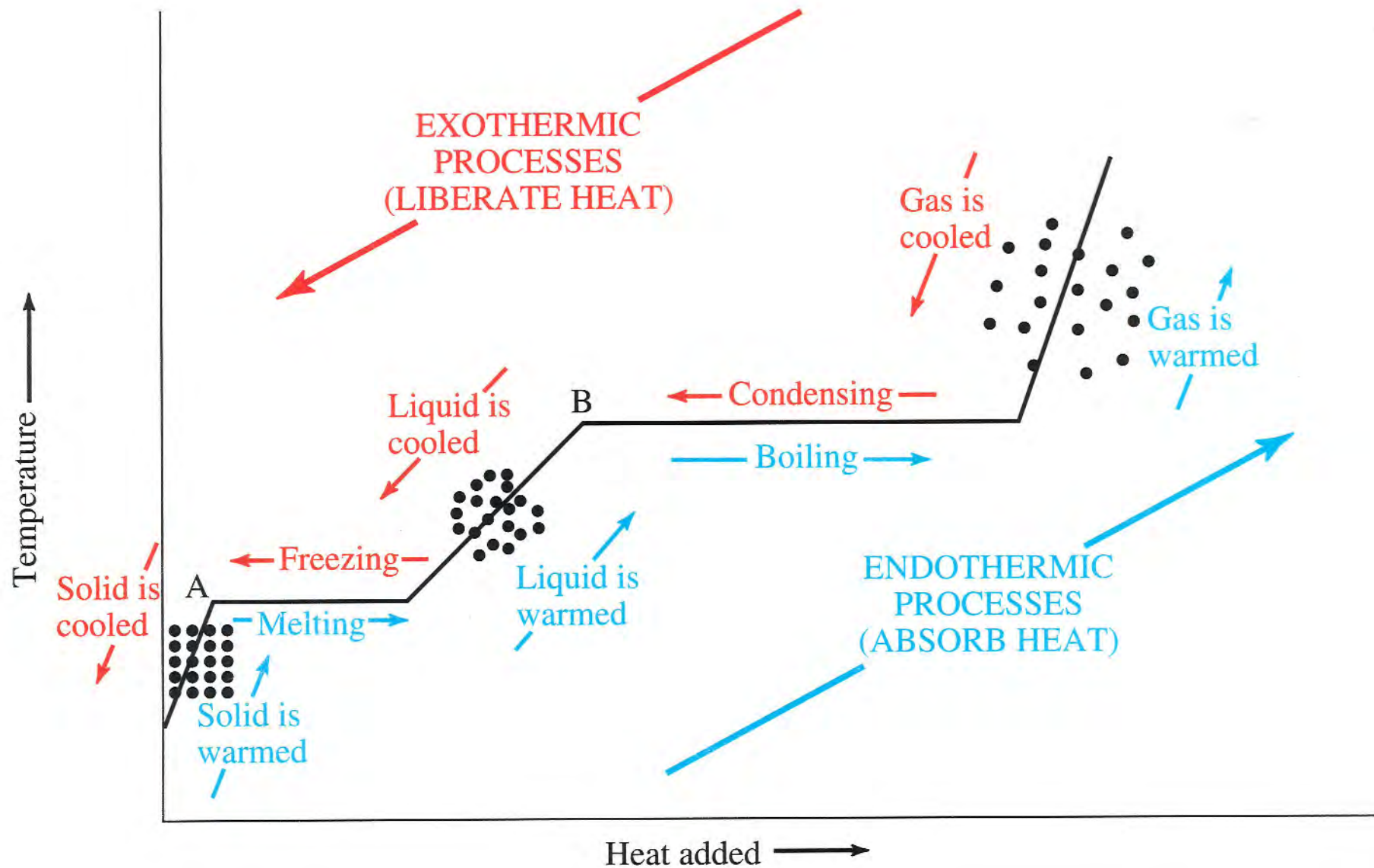
$$q = n \cdot C \cdot \Delta T$$

Heat transfer for Phase Changes

$$q = n \cdot \Delta H$$

Note

$$q_{\text{gained}} = -q_{\text{lost}}$$



A) Ex: Calc. the heat energy req. to convert 1.00 mol of ice at -25°C to liquid water at 90°C .

$$s_{\text{ice}} = 2.09 \frac{\text{J}}{\text{g}\cdot^{\circ}\text{C}} \quad s_{\text{water}} = 4.18 \frac{\text{J}}{\text{g}\cdot^{\circ}\text{C}}$$

$$\Delta H_{\text{fus}} = 6.01 \frac{\text{kJ}}{\text{mol}}$$

Heat req. to raise temp. of a substance,

$$q = m \cdot s \cdot \Delta T$$

$$q_{\text{Total}} = q_{\text{ice}} + q_{\text{fus}} + q_{\text{water}}$$

$$\begin{aligned}q_a &= (18.0\text{g}) (2.09 \frac{\text{J}}{\text{g}\cdot^\circ\text{C}}) [0^\circ\text{C} - (-25^\circ\text{C})] \\ &= 940.5 \text{ J} \\ &= 0.9405 \text{ kJ}\end{aligned}$$

$$\begin{aligned}q_{\text{fus}} &= (1.00 \text{ mol}) (6.01 \frac{\text{kJ}}{\text{mol}}) \\ &= 6.01 \text{ kJ}\end{aligned}$$

$$\begin{aligned}q_l &= (18.0\text{g}) (4.18 \frac{\text{J}}{\text{g}\cdot^\circ\text{C}}) [90^\circ\text{C} - 0^\circ\text{C}] \\ &= 6771.6 \text{ J} \\ &= 6.772 \text{ kJ}\end{aligned}$$

$$\begin{aligned}q_{\text{Total}} &= 0.9405 + 6.01 + 6.772 \\ &= 13.72 \text{ kJ}\end{aligned}$$

VI) Phase Diagrams

shows relationship between
solid, liquid, & gas phases
on a single graph

Fig. 11.27

Line CA - V.P. curve of solid

Line AB - V.P. curve of liquid

Line AD - solid \rightleftharpoons liq. equil.

Point A - Triple Point

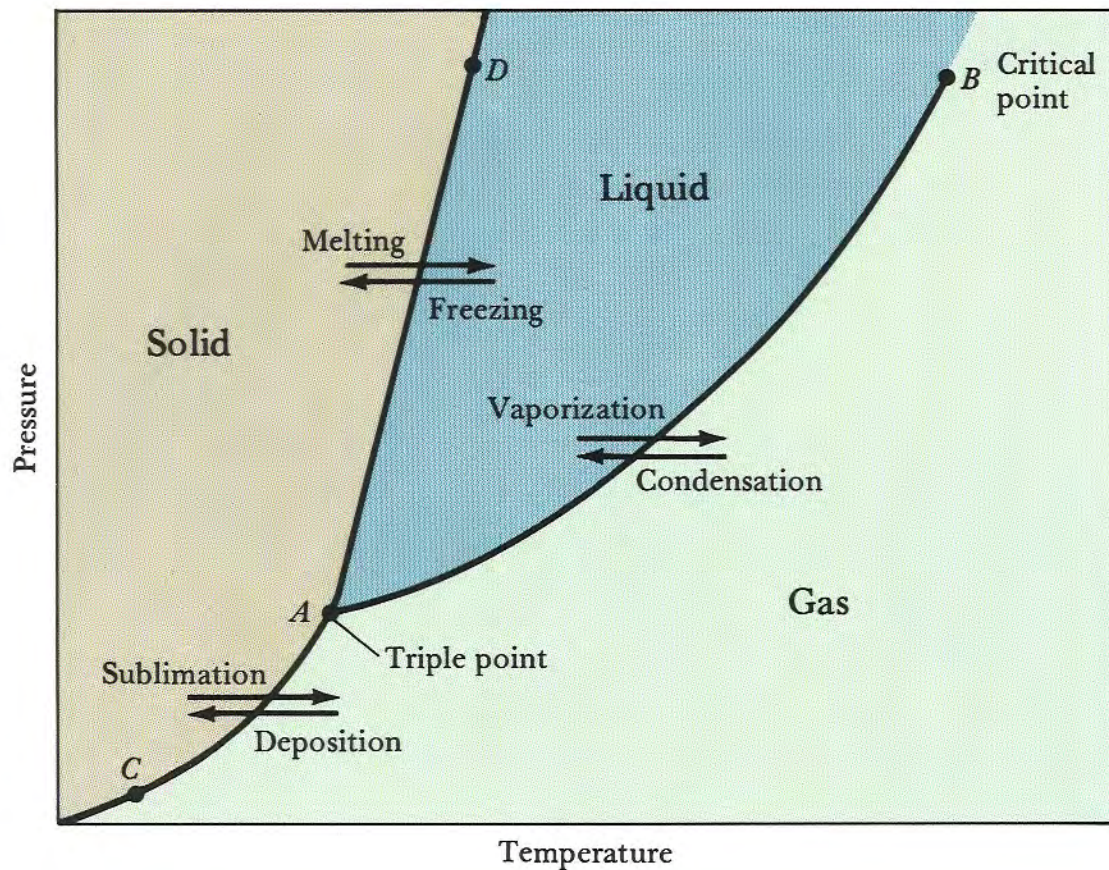
- ALL 3 states exist
in equil.

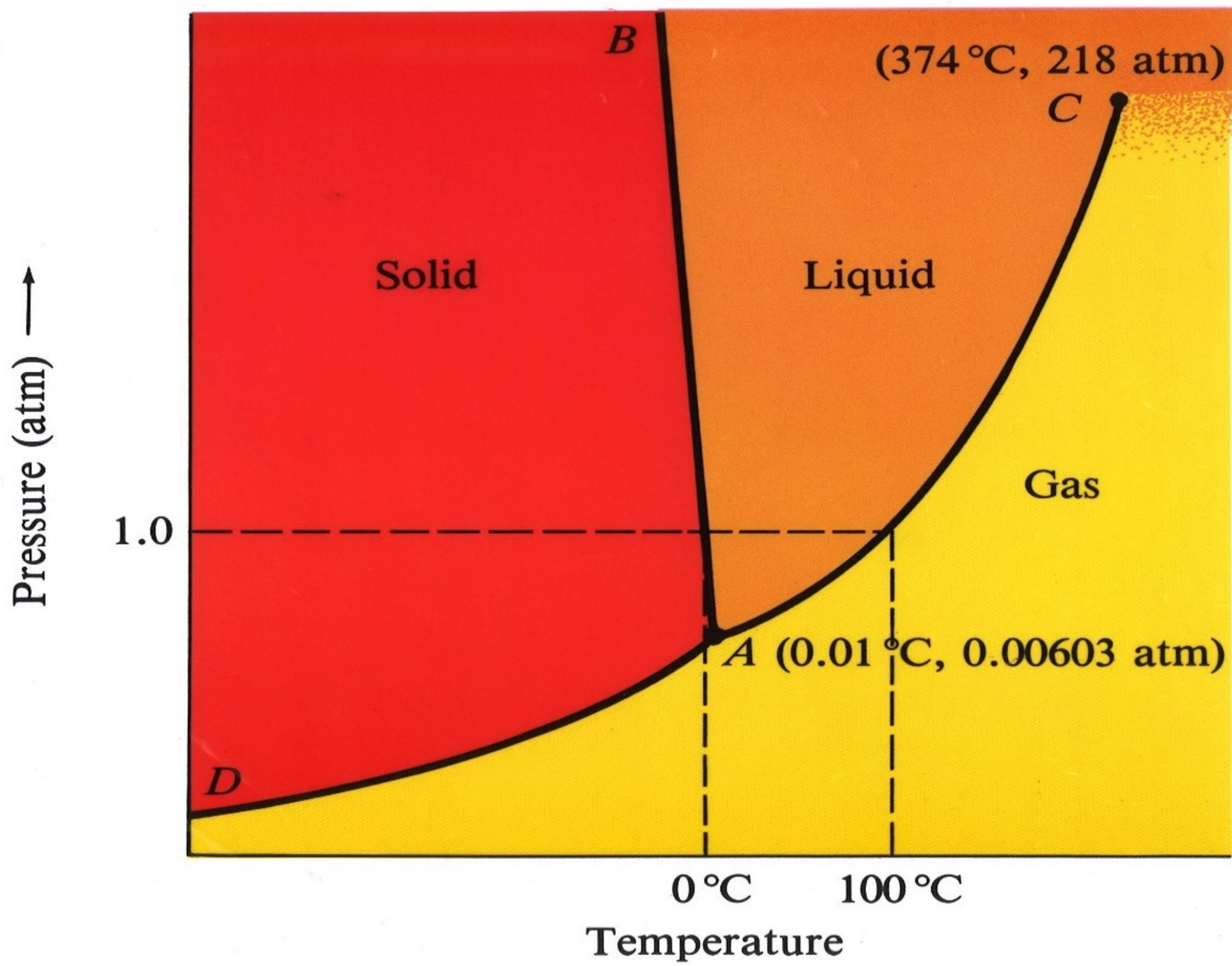
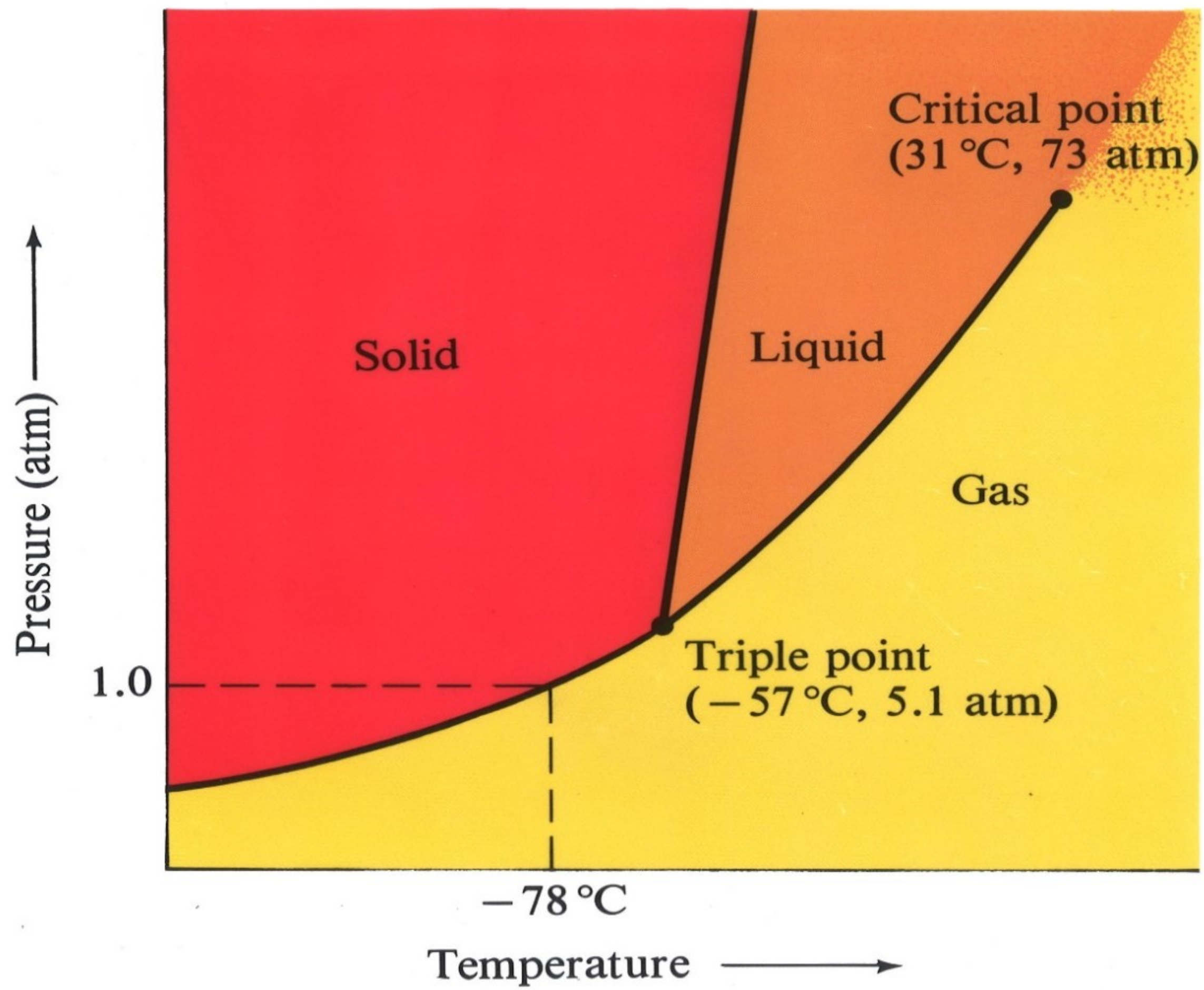
Point B - Critical Point

- beyond B liq. & gas

phases are indistinguishable

Figure 11.20 General phase diagram





Direction of vertical depends on relative densities of solid & liquid

In general:

$$D_s > D_l$$

inc. $P \Rightarrow$ smaller Vol.
get solid

$s \rightleftharpoons l$ line slants right

Exception: H_2O

$$D_l > D_{ice}$$

inc. $P \Rightarrow$ smaller Vol.
get liquid

$s \rightleftharpoons l$ line slants left

D) Critical Temp. & Pressure

Can liquefy a gas by compressing it at a suitable temp.

Critical Temp.

Highest temp. at which a gas can be liquefied, regardless of pressure

Critical Pressure

Pressure req. to cause liquefaction at the critical temp.

He	5.3 K	2.26 atm
O ₂	154.4 K	49.7 atm
H ₂ O	647.2 K	217.7 atm

