11.7 Phase Changes

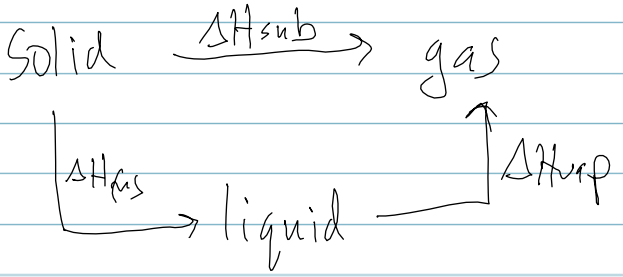
- Vaporization or evaporation: liquid → gas ***endothermic***
- Condensation: gas → liquid ***exothermic***
- Melting (fusing): solid → liquid ***endothermic***
- Freezing: liquid → solid ***exothermic***
- Sublimation: solid → gas ***endothermic***
- Deposition: gas → solid ***exothermic***

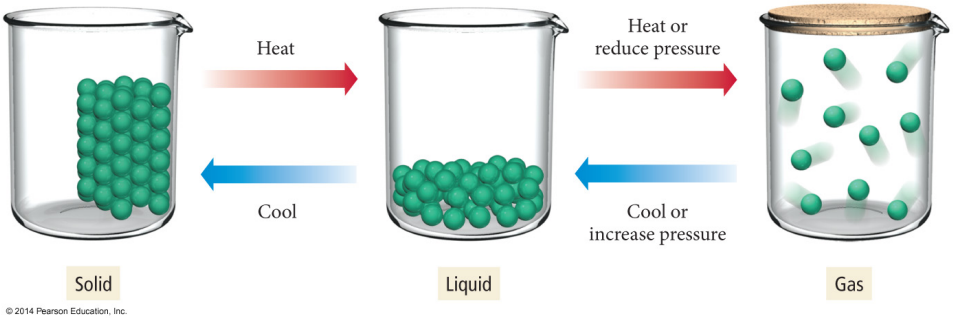
Enthalpy of fusion, ΔH_{fus}: the amount of heat needed to melt 1 mol of a substance.

Enthalpy of vaporization, ΔH_{vap}: the amount of heat needed to vaporize 1 mol of a substance.

- ΔH_{vap} is usually larger than ΔH_{fus}.
- ΔH_{sub}: heat needed to *sublime* 1 mol of a substance

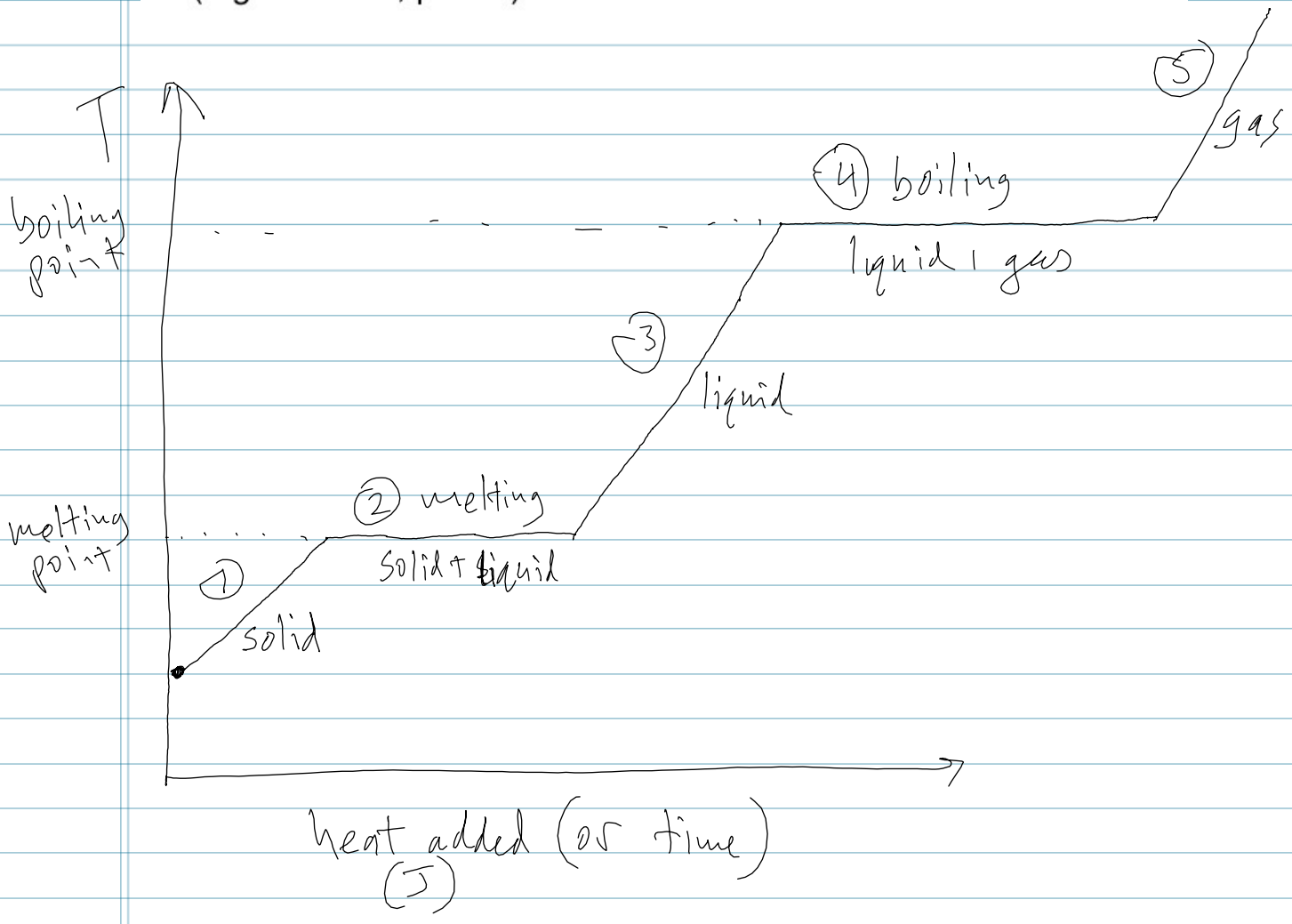
$\Delta H_{sub} = \Delta H_{fus} + \Delta H_{vap}$





Heating Curve

- shows the temperature change as heat is added to a sample (Figure 11.36, p. 511):

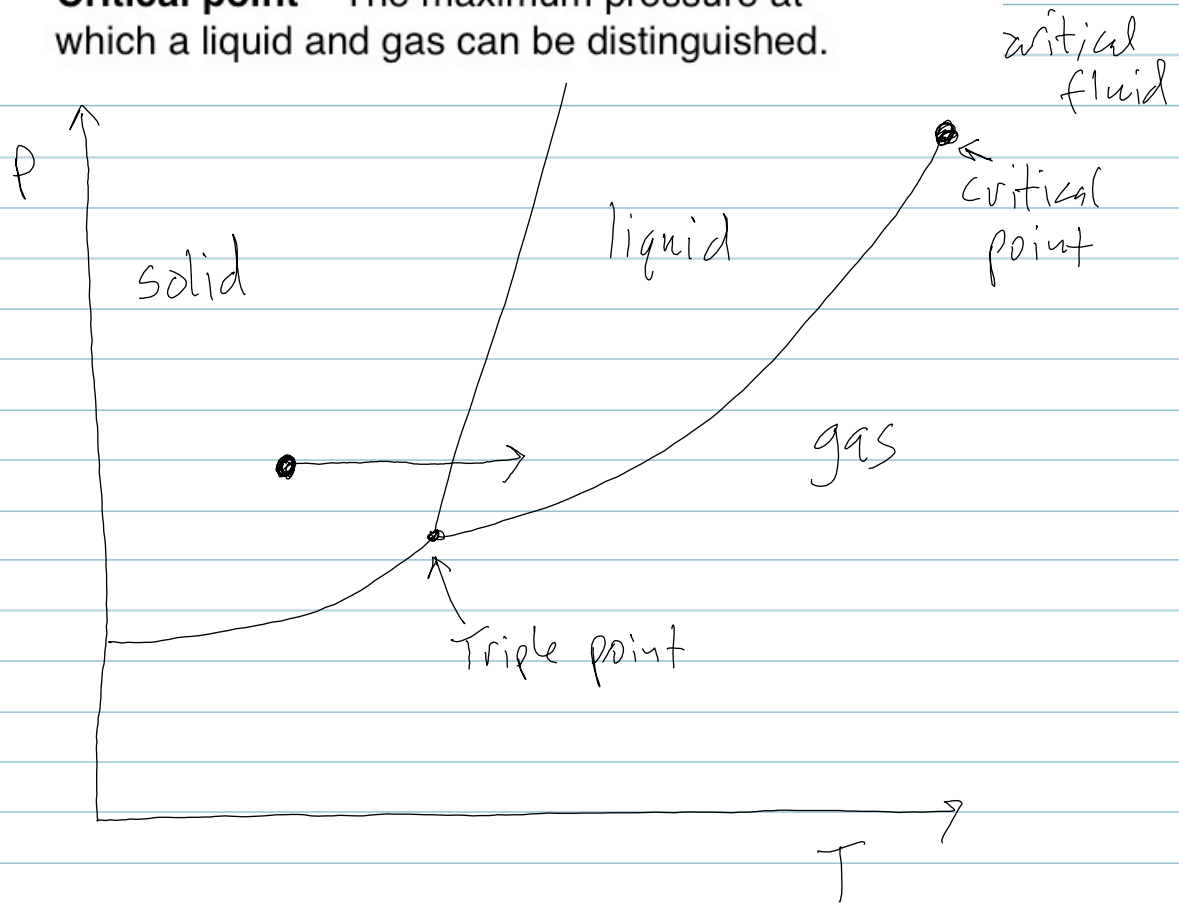


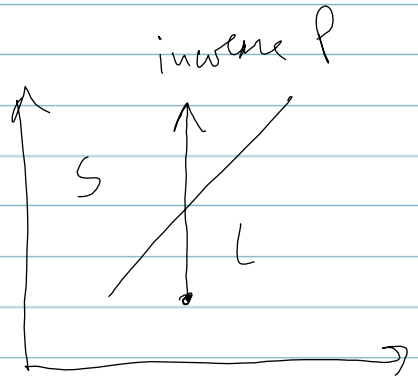
1) Solid heating: $q = \text{m}\ C_{\text{s(solid)}}\ \Delta\text{T}$
2) Solid melting: $q = \text{n}\ \Delta H_{\text{fus}}$
3) Liquid heating: $q = \text{m}\ C_{\text{s(liquid)}}\ \Delta\text{T}$
4) Liquid vaporizing: $q = \text{n}\ \Delta H_{\text{vap}}$
5) Gas heating: $q = \text{m}\ C_{\text{s(gas)}}\ \Delta\text{T}$

- So if a temperature change also involves a phase change, to calculate the total amount of heat transferred, you have to sum the heat for each stage.

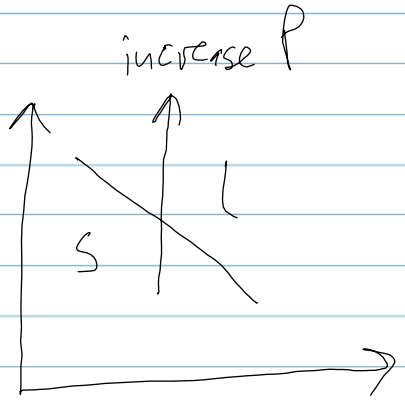
11.8 Phase Diagram

- Shows what phase of a substance is the most stable at a certain temperature and pressure.
- **Triple Point** – A specific T and P at which solid, liquid and gas are all in equilibrium.
- **Critical point** – The maximum pressure at which a liquid and gas can be distinguished.





solid more dense than liquid



water: solid is less dense than liquid