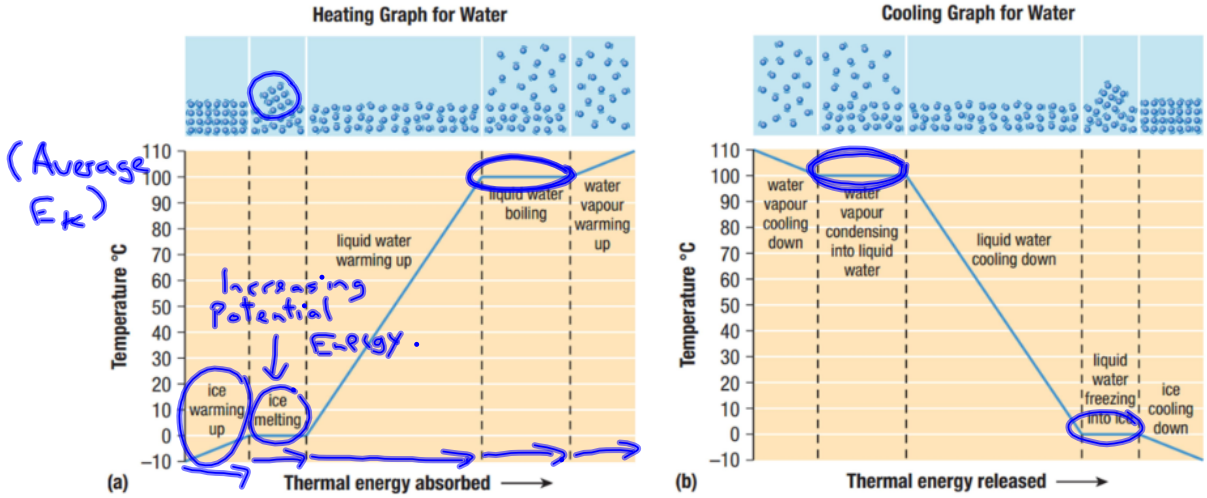
SPH3U 6.4 States of Matter and Changes of State

1. Changes of state

Fusion: (Melting) S → L	Vaporization: L → G	Sublimation: S ⟷ G (skips over L).
Condensation: G → L	Freezing: L → S	

2. Heating and cooling graphs

Thermal Energy = PE + KE.



3. Latent heat

Latent heat:	total thermal energy to change states.
specific latent heat	energy to change 1 kg of a substance from one state to another.

Substance	Specific latent heat of fusion, L_f (J/kg)	Melting point (°C)	Specific latent heat of vaporization, L_v (J/kg)	Boiling point (°C)
aluminum	6.6×10^5	2519	4.0×10^5	10900
ethyl alcohol	1.1×10^5	−114	8.6×10^5	78.3
carbon dioxide	1.8×10^5	−78	5.7×10^5	−57
gold	1.1×10^6	1064	6.4×10^4	2856
lead	2.5×10^4	327.5	8.7×10^5	1750
water	3.4×10^5	0	2.3×10^6	100

Latent heat during a change of state:	Melt/freeze: $Q = mL_F$	Boil/condense: $Q = mL_V$

How much thermal energy is released by 652 g of molten lead when it changes into a solid?

$L_F = 2.5 \times 10^4$ J/kg. $m = 0.652$ kg.

$Q = mL_F = (0.652)(2.5 \times 10^4) = 16.2$ kJ.

Ethyl alcohol is a liquid at room temperature. How much thermal energy is absorbed when 135 g of ethyl alcohol at 21.5 °C is heated until all of it boils and turns into vapour?

① 21.5°C → 78.3°C: $Q = mc\Delta T$, $c = 2.46 \times 10^3 \frac{J}{kg°C}$.

$Q = (0.135\text{kg})(2.46 \times 10^3)(78.3 - 21.5)$

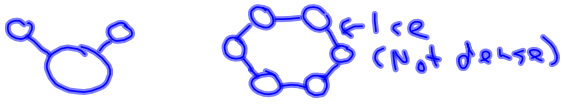
$= 18863$ J.

② L → G: $Q = mL_V$, $L_V = 8.6 \times 10^5 \frac{J}{kg}$.

$Q = (0.135)(8.6 \times 10^5) = 116\,100$ J.

Combined: $Q_1 + Q_2 = 18863 + 116100 = 135$ kJ.

4. Water: A special liquid

Most solids:	Water is more dense than most liquids.	(Sinks)
solid water	(ice) less dense than liquid water.	(Floats)
water molecule shape		

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