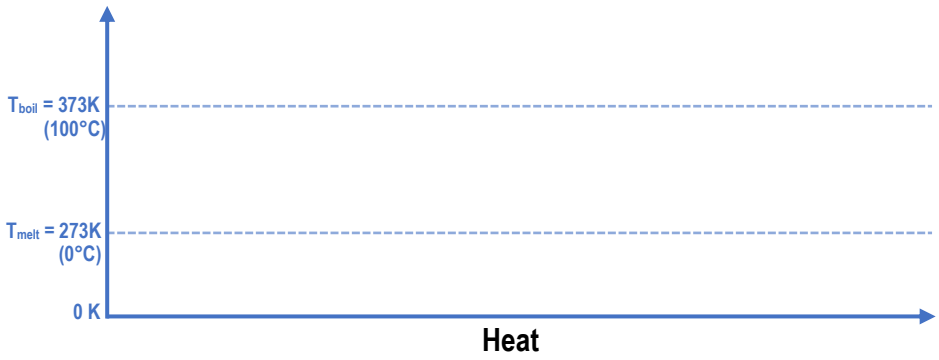
CONCEPT: LATENT HEAT & PHASE CHANGE

● **Phase** of a material = state of matter (e.g. *Ice* = solid; *Water* = liquid; *Steam* = gas), usually depends on temperature.

- **Remember:** When a material *absorbs* or *loses* heat, it changes Temperature OR _____, but not BOTH.

Temperature vs. Heat for Water



Temperature Change

$Q = mc\Delta T$

- **Temperature:** [changing | constant]
- **Phase:** [changing | constant]

PHASE Change

Q = _____

- **Temperature:** [changing | constant]
- **Phase:** [changing | constant]

● **L** = **Latent Heat** or **Heat of Transformation**, depends on material (per kilogram) AND phase change **[** $\frac{J}{kg}$ **]**

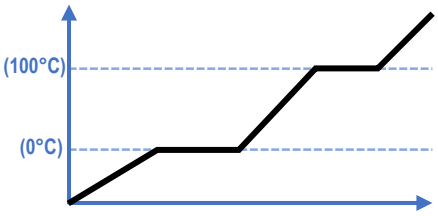
SPECIFIC & LATENT HEAT PROBLEMS

1) Draw T vs. Q graph, identify T_i & T_f
2) Draw "path" from $T_i \rightarrow T_f$
3) Write Q_{TOTAL} EQ
4) Plug in values & solve

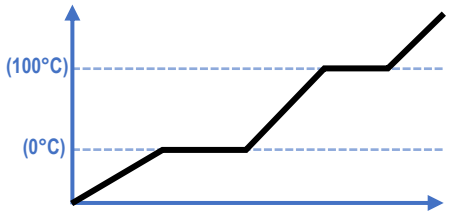
Substance	Heat of Fusion (L_f) (solid ↔ liquid)	Heat of Vaporization (L_v) (liquid ↔ gas)
Hydrogen	5.86×10^4	4.52×10^5
Water	3.34×10^5	2.256×10^6
Lead	2.45×10^4	8.71×10^5

EXAMPLE: Calculate the heat required for the following heating processes for 400g of water. Use c_{water} = 4186 $\frac{J}{K\cdot kg}$

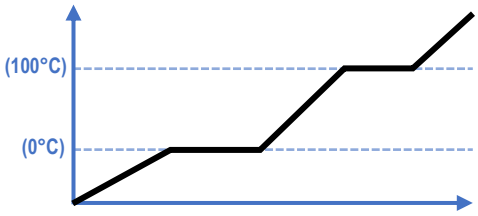
a) Heating from 80°C to 100°C



b) Boiling exactly half of the water, starting from 100°C



c) Completely boiling all the water, starting from 80°C



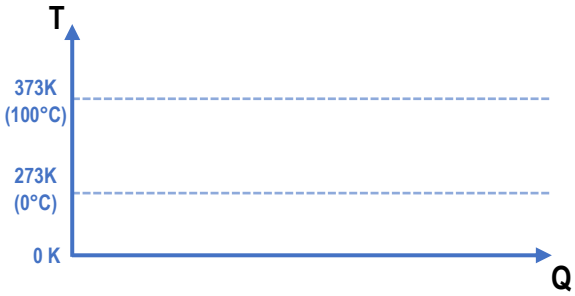
● In problems where T_i isn't the melting/boiling temp, TOTAL Heat = heat required to change **1)** temperature AND **2)** phase.

PROBLEM: How much heat must be removed from 0.7 kg of water at 23°C to cool it to 0°C and completely freeze it?

A) -5.31×10^6 J
B) 1.67×10^5 J
C) -1.65×10^6 J
D) -3.01×10^5 J

SPECIFIC & LATENT HEAT
$Q = mc\Delta T$ (temp change)
$Q = mL$ (phase change)
c_{water} = 4186 J/(kg·K)
$L_{f\ (water)}$ = 3.34×10^5 J/kg
$L_{v\ (water)}$ = 2.256×10^6 J/kg

PROBLEM: If you add 5.89×10^5 J of heat to 0.6kg of liquid water initially at 90°C, how much of the water vaporizes?



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