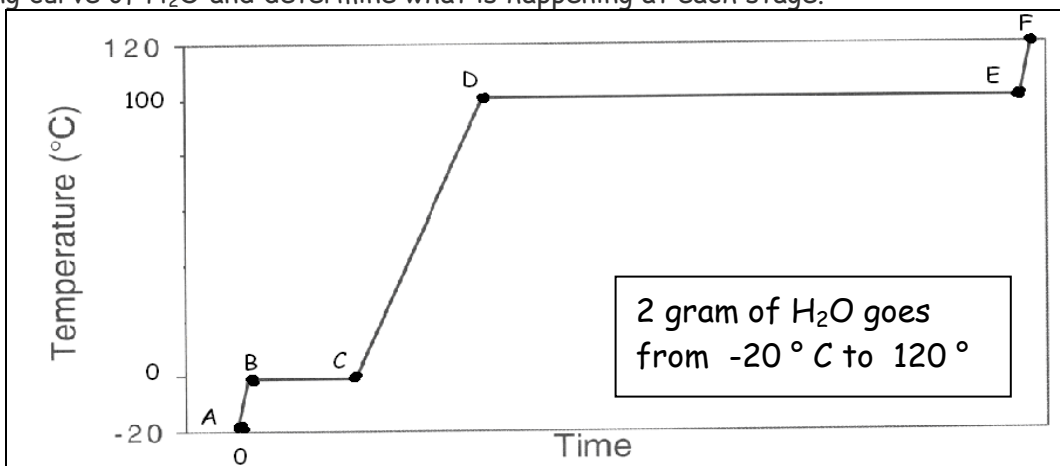


Purpose: Examine the heating curve of H₂O and determine what is happening at each stage.

Heating curve of water

The graph is not to scale but it is drawn to emphasize differences in the amount of time required for each of the 5 steps



1. Point on graph:	Phase of matter (s, l, g)
A	
B	
C	
D	
E	
F	

2. Points on graph:	Phase or Temperature Change?
A → B	
B → C	
C → D	
D → E	
E → F	

- Label the following 4 phase changes in the appropriate location on the diagram above:
 - vaporization
 - condensation
 - fusion (aka melting)
 - freezing
- Label Endothermic or Exothermic on the diagram next to each of the phase changes.
- At what point on the graph (° C):
 - is all of the ice gone?
 - is all of the liquid gone?
- Do you think heating other substances and plotting temperature vs. time would result in a similar heating curve as the graph above? Why or why not?
- Heat and temperature are related, yet different. During phase changes, the water is being heated, yet the temperature does not increase. What is the heat being used to do during these phase changes?
- Looking at the graph above, why does it take so much more time & heat to **boil water completely** than to **melt ice completely**? Explain.
- Identify all the variables in the equations below:
 - $q = m \cdot c \cdot \Delta T$
 - $q = m \Delta H$ vaporization
 - $q = m \Delta H$ fusion
- Calculate the heat required for each change shown in graph at top (2g H₂O goes from -20°C to 120°C)

**Specific heats of H₂O: (solid)= 2.10 J/g°C (liquid) = 4.18 J/g°C (gas)= 1.90 J/g°C **

Points on graph:	Formula to use:	Calculate amount of heat:
A → B		
B → C		
C → D		

Points on graph:	Formula to use:	Calculate amount of heat:
D → E		
E → F		

Calculations Involving Phase Changes DO ON A SEPARATE SHEET OF PAPER!

You must write the equation you are using & show all your work.

Specific heats of H₂O: (solid)= 2.10 J/g°C (liquid) = 4.18 J/g°C (gas)= 1.90 J/g°C

- Identify all the variables in the equations below & when you would know to use them in a problem:
a. $q = m \cdot c \cdot \Delta T$ b. $q = m \Delta H$ vaporization b. $q = m \Delta H$ fusion
- How much heat (Joules) is released when 5.0 g of water vapor condenses to a liquid at 100 °C?
- How much heat (Joules) is needed to get 5.0 g of liquid water to vaporize to a gas at 100 °C?
- A sample of water with a mass of 23.0 grams at a temperature of -46.0°C increases to 40°C.**
 - Make a phase change diagram to indicate the changes water will undergo in this problem & label each step
 - How much total heat (Joules) is needed to do the problem above? (remember, there are to do all the steps)
- Suppose that you are camping in the winter. **You have 30g of ice at 0 °C that you need to melt and heat up so that you'll have some warm drinking water (40 °C).**
 - Make a phase change diagram to indicate the changes water will undergo in this problem & label each step
 - How much total heat (Joules) is needed to do the problem above?
- 10.0 g of steam at 120.0 °C are converted into ice at -20.0°C.**
 - Make a graph to indicate this change.
 - Calculate the total energy released (J) needed to do the problem above.
- You have 2 beakers: one contains 30 g of water (l) at 60°C & the other has 30 g of ethyl alcohol (l) at 60°C.
How many Joules of heat is required to heat each beaker up to 85 °C?
Specific heat of alcohol (l & g): 2.44 J/(g°C), Boiling point = 78.4 °C, Latent heat of Vap. = 841 J/g
 - Make a phase change diagrams for each substance
 - Clearly show each calculation that is needed.

Mixed Thermochemistry Problems DO ON A SEPARATE SHEET OF PAPER!

H₂O's specific heat, latent heat of fusion/ & vaporization can be found on your periodic table.

- How many joules of energy must be absorbed to raise the temperature of 5.0 grams of H₂O from 25°C to 30°C?
- How many joules of energy are needed to melt 5.0 grams of ice into a liquid whose temperature is already at its melting point?
- How much energy must be removed from 5.0 grams of water in order to cool it from 80°C to 40°C?
- How much energy must be absorbed by 5 grams of steam in order to raise its temperature ~~by 100°C~~ to 200°C?
- How much energy is required to vaporize 2.0 grams of liquid H₂O at its boiling point?
- An 50 gram sample of an unknown metal warms from 18° to 58° after absorbing 800 joules. What is the specific heat of the metal?
- How much energy must be removed from 2.0 grams of H₂O in order to cool it from 102°C to 90°C?

