

Phases Class work Assignment name _____

The concept of phase change is important and complex. The changes in the energy of the substance and the changes physically that occur must be accounted for. We can think about phase changes, and we can graph them as well. Read first, graph and think later.

1. On the back are two data charts of the temperatures of pure water as very cold ice is heated until the H₂O is hot steam, & then the reverse: hot steam cooled down to well below the freezing point for water. The timeline runs 33 minutes for each data set, and the temperatures need to be graphed to show you what happens as the H₂O changes phases. Draw both graphs to show this data. For both, imagine that the heat is being added, or removed, at a steady rate.
The amount of heat in (or out) per minute is constant.
2. We need to explain 2 kinds of energy, kinetic energy which is also called the energy of motion; and potential energy which is thought of as "stored" energy, or as the energy of condition or of position.
3. Temperature is most closely associated with kinetic energy. Lots of motion means particles are moving faster, which is recorded as higher temperature. Slower moving particles have less kinetic energy, or lower temperature. Temperature + kinetic energy do the same thing at the same time.
4. During a phase change, there is no change in temperature, but energy is changing. The energy that changes is the potential energy. Imagine some H₂O at exactly 0°C. The ice part has lower potential energy than the liquid part. The temperature is the same, but their potential energy is different. When something changes phase, temperature is constant until the phase change is complete.
5. As water temperature decreases to 0°C. The particles slow down more and more until the intermolecular forces of attraction begin to lock the liquid water molecules into place as solid ice. The actual temperature of the H₂O does not change during this process of freezing, even if your freezer is set for -10°C. Only when all the liquid is frozen solid, can the solid become colder. As the energy is removed from the water to freeze it, during the phase change, the energy leaving this water is the potential energy, not the kinetic. The reverse is true, when water approaches 100°C the liquid water has lower potential energy than the steam at the same temperature. The liquid water cannot get hotter than the boiling point, and the steam won't get hotter than 100°C until all the liquid is phase changed to steam. Steam can get as hot as you make it.
6. Once frozen, the ice can get colder than 0°C. During all phase changes (hot or cold) there is a steady temperature state, where the potential energy changes, but the kinetic energy (temperature) does not. You'll start to recognize this on your graphs of the heating curve and cooling curve for water.
7. A cooling curve graph (or a heating curve graph) can be drawn for ANY SUBSTANCES as long as you know their freezing + boiling points. The "top" flat line on a graph is always LONGER than the "lower" one. Think about why that might be true, I'll tell you later.

Graph #1: The heating curve for H₂O

Graph #2: The cooling curve for H₂O

time	Temp Kelvin
0	240
1	250
2	260
3	270
4	273
5	273
6	273
7	273
8	280
9	290
10	300
11	310
12	320
12+1	330
14	340
15	350
16	360
17	370
18	373
19	373
20	373
21	373
22	373
23	373
24	373
25	373
26	373
27	373
28	373
29	373
30	373
31	380
32	390
33	400

Make 2 graphs using the titles from above.

Make sensible, big scales, use labels and units.

Label the graph "corners" with the letters: A, B, C, D, E, and F.

Do this so that we can see and then discuss what is happening to the energy of the systems during each line segment of time.

Grading...

2 graphs = 10 points

9 Q = 9 points

2 tables = 11 points

30 points total

time	Temp Kelvin
0	400
1	390
2	380
3	373
4	373
5	373
6	373
7	373
8	373
9	373
10	373
11	373
12	373
12+1	373
14	373
15	373
16	370
17	360
18	350
19	340
20	330
21	320
22	310
23	300
24	290
25	280
26	273
27	273
28	273
29	273
30	270
31	260
32	250
33	240

For Heating Curve: Fill in this chart after graphing
Write in increasing, decreasing, steady, solid, liquid, or gas phase

Line graph segment:	BC	CD	DE
What happens to the mass of the H ₂ O			
What's happening to the temp of the H ₂ O?			
What's happening to the Kinetic Energy of the H ₂ O?			
What's happening to the Potential Energy of the H ₂ O?			
What phase or phases are present?			

For Cooling Curve: Fill in this chart after graphing
Write in increasing, decreasing, steady, solid, liquid, or gas phase

Line graph segment:	BC	CD	DE
What happens to the mass of the H ₂ O			
What's happening to the temp of the H ₂ O?			
What's happening to the Kinetic Energy of the H ₂ O?			
What's happening to the Potential Energy of the H ₂ O?			
What phase or phases are present?			

Questions to ponder (and write the answers to right now).

1. What is the freezing point/melting point for water?
2. What is the Boiling/condensation point?
3. Why do the segments BC + DE both NEED to be parallel to the X axis on the two graphs?
4. What does it mean that freezing + melting point are the same temperature?
5. In the heating curve for water:
 - A. Which line segments show a increasing kinetic energy?
 - B. Which line segments show an increase in potential energy?
6. In the cooling curve for water:
 - A. Which line segments show an decrease in kinetic energy?
 - B. Which line segments show a decrease in potential energy?
7. On the heating curve for water: why is the top flat segment longer than the bottom flat segment?
8. Make a small graph (3 inches square) and draw the *COOLING* curve for sulfur
9. Draw another small graph showing the *HEATING* curve for mercury.

When ever you need to make a graph, like the two in this project: where the temperature is a function of time, the first part of that sentence (the temperature) goes on the Y axis.

The second part, as a function of time, goes onto the X axis.

Always give your graph a nice title and axis labels.

