

Name \_\_\_\_\_

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Date \_\_\_\_\_

## Phase Changes and Heating/Cooling Curves

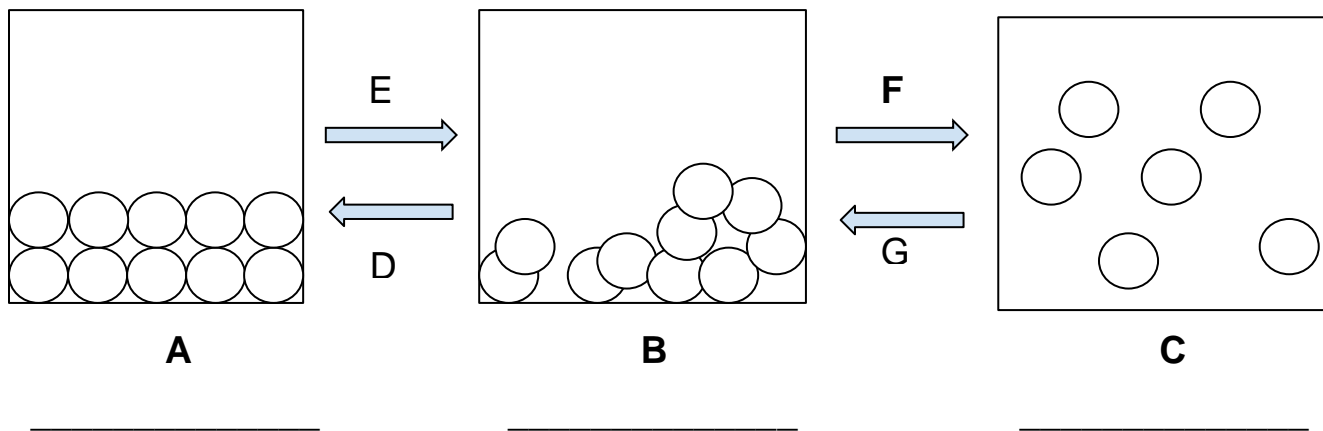
### Why?

Most substances go through a phase change when heated or cooled. Molecules of a substance are held together in either the solid, liquid, or gaseous phase by intermolecular forces. It is necessary to discuss what is occurring at the molecular level in order to explain how an ice cube is melted or how water is boiled.

### Learning Objectives

- To determine what is occurring on the molecular level during a phase change

### Model 1: Representations of Molecules in Three Phases



- 1.) Label each arrow (D, E, F, G) in Model 1 with the appropriate phase change (melting, freezing, boiling, condensation).
- 2.) Which arrows in Model 1 indicate the addition of energy? \_\_\_\_\_
- 3.) Which term, endothermic or exothermic, is used to describe the situation when energy is added into a system from the surroundings? \_\_\_\_\_
- 4.) Which arrows in Model 1 indicate the release of energy? \_\_\_\_\_ Are the “bonds” between the molecules being broken or formed? \_\_\_\_\_
- 5.) Which term, endothermic or exothermic, is used to describe the situation when energy is released into the surroundings by the system? \_\_\_\_\_
- 6.) Which arrows in Model 1 indicate the absorption of energy? \_\_\_\_\_ Are the “bonds” between the molecules being broken or formed? \_\_\_\_\_

- You can use the acronym BARF to help you remember!

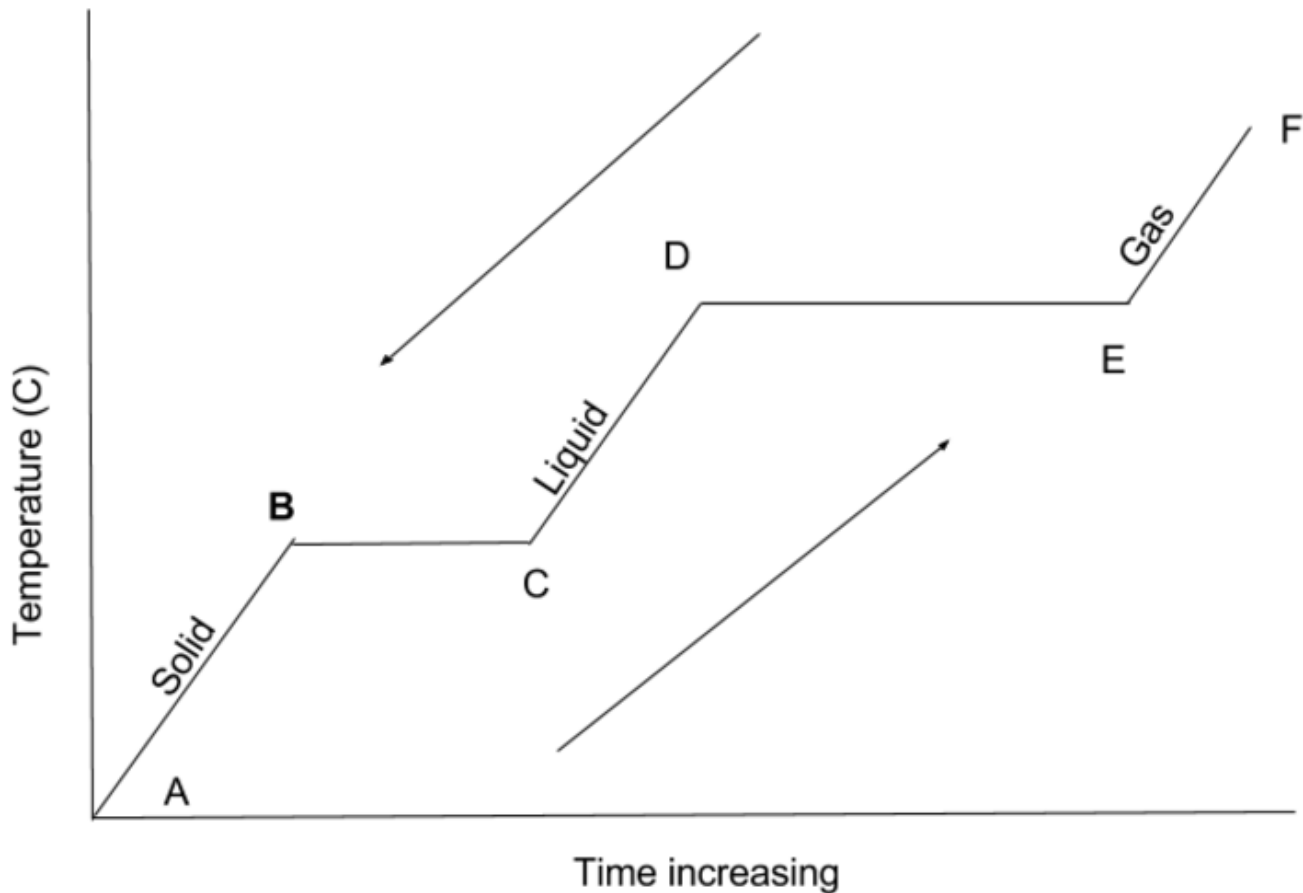
**B**reaking

**A**bsorbing

**R**elease

**F**orm

## Model 2: Temperature of a Substance as Heat is Added Over Time



1. What is plotted on the x-axis? \_\_\_\_\_
2. What is plotted on the y-axis? \_\_\_\_\_
3. a.) During which line segments does temperature increase? \_\_\_\_\_  
b.) What kind of energy (kinetic or potential) is associated with temperature? \_\_\_\_\_
4. a.) During which line segments is there no change in temperature? \_\_\_\_\_  
b.) What type of energy is associated with the points in the graph where temperature is NOT changing?  
\_\_\_\_\_
- 5.) A phase change is defined as a change in state (solid, liquid, or gas) for a specific substance. During a phase change the distance between the molecules changes. In which phase are the molecules closest together? \_\_\_\_\_ Furthest apart? \_\_\_\_\_
- 6.) Phase changes occur on the plateaus in the heating curve. Write a statement that relates a phase change and the change in temperature while it is occurring.  
\_\_\_\_\_
- 7.) The phases that exist during the heating process are labeled on three of the line segments. During a phase change, does the substance change from one phase to another immediately (all at once) or is it gradual?  
\_\_\_\_\_.

8.) During a phase change TWO phase of matter exist until the phase change is 100% complete. *On each of the plateaus on the graph, write in the two phases of matter that will exist.*

9. a.) If heat was being added (absorbed by the substance), list the name of the phase change that would occur on the following segments: BC \_\_\_\_\_ DE \_\_\_\_\_

b.) If heat is being removed (released by the substance), list the name of the phase change that would occur on the following segments: ED \_\_\_\_\_ CB \_\_\_\_\_

10.) Moving from point A to point F is considered an endothermic process. *Label the arrow pointing up the curve as endothermic.* Explain why this makes sense in terms of energy and distance between the particles.

11.) Moving from point F to point A is considered an exothermic process. *Label the arrow pointing down the curve as exothermic.* Explain why this makes sense in terms of energy and distance between the particles.

12.) If this substance were water, at what temperature would segment B – C occur? \_\_\_\_\_ *Label point B as the melting point on the curve.*

13.) If this substance were water, at what temperature would segment D – E occur? \_\_\_\_\_ *Label point D as the boiling point on the curve.*

14.) Comparing segments B – C and D – E, what information is conveyed by the observation that segment D – E is longer?

## Exercise

A sample of a mythical substance is cooled from a temperature of  $250^{\circ}\text{C}$  to  $10^{\circ}\text{C}$  in two hours. The boiling point of the substance is  $175^{\circ}\text{C}$  and the melting point is  $22^{\circ}\text{C}$ . Using this information, clearly label the following items in the appropriate locations (use arrows as needed to indicate direction or exact location on the curve. Some terms may be used more than once, as needed.):

Solid	Freezing Point temperature (mark it on the y axis)
Liquid	Condensation Point temperature (mark it on the y axis)
Gas	KE changing, PE stays same
Condensation	PE changing, KE stays same
Evaporation	Direction of endothermic changes
Melting	Direction of exothermic changes
Freezing	

