Exercise 10.4a

Phase Changes & Phase Diagrams - Answers

Name: _____

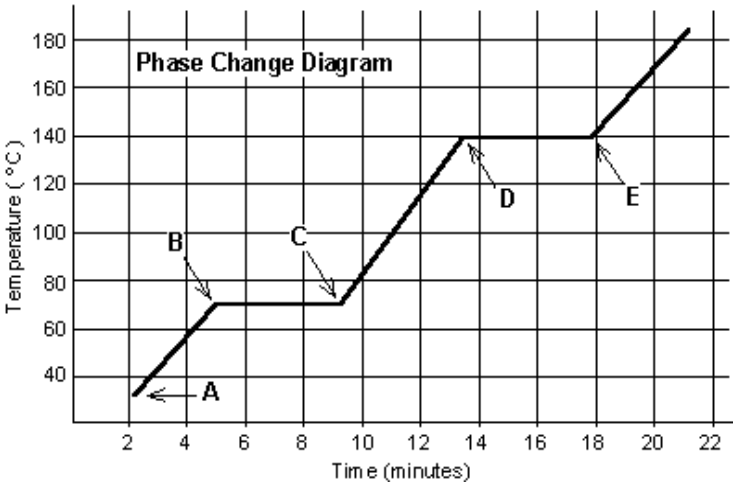
Date:_____ Per:_____

A change in enthalpy (ΔH) is a measurement of energy transfer in the form of heat. Energy may be gained from the surrounding environment by a substance (or system) in an endothermic process (+ΔH), removing heat (i.e., cooling) the surrounding environment. Energy may also be released to the surrounding environment by a substance (or system) in an exothermic process (-ΔH), causing heating of the surrounding environment.

During a phase change the temperature of the substance does not change. Energy is either being absorbed by a substance to overcome intermolecular forces and spread the particles out or is being released as the potential energy of separated particles is converted to motion and particles are drawn together into more condensed arrangements.

Enthalpy of fusion (energy necessary to break solids into liquids) and enthalpy of fusion (energy necessary to separate liquids into gases) may be expressed per gram of substance (kJ/g) or per mole of substance(kJ/mol).

Directions: *The graph was drawn from data collected as a substance was heated at a constant rate. Use the graph to answer the following questions.*



At (**A**) the substance exists in a _____solid_____ state. Material in this phase has ____definite____ volume and _____definite____ shape. As ____heat_____ is added to the substance, the particles of the substance ____vibrate____ more rapidly causing the ___temperature___ to rise. At **(B)** the temperature of the substance is __≈70__°C. This represents the ___melting____ point of the substance. Between **(B)** and **(C)** temperature remains ____constant___ as energy is added to the substance. The energy breaks __intermolecular__ forces and increases the substance's ___potential__ energy. At **(C)** the substance has completely ___melted____ and exists in a ____liquid___ state. Material in this phase has ____definite_____ volume and ____indefinite___ shape. The energy added to the substance between **(B)** and **(C)** was used to convert the substance from a ____solid___ to a ____liquid___. This heat energy is called the ***enthalpy of fusion***. Between **(C)** and **(D),** as heat is added, the ____temperature__ increases indicating an increase in ___kinetic___ energy of the substance. At point **(D)** the temperature of the substance is ___140__ °C and the substance has reached its ____boiling___ point. Additional heat added to the substance after **(D)** breaks ___intermolecular__ forces and increases the substance's _____potential___ energy. The energy involved in the change from **(D)** to **(E)** is __much greater___ than the energy involved in the change from **(B)** to **(C)**. The change between **(D)** and **(E)** is called ___vaporization__. At (**E**), the substance is completely in the _____gaseous____ phase. Material in this phase has ___indefinite____ volume and ___indefinite___ shape. The energy added to the substance between **(D)** and **(E)** converted the substance from a ____liquid____ to a ____gaseous____ state. This energy is called the ***enthalpy of vaporization***. Beyond **(E)**, the substance is in the _____gaseous___ phase and added heat causes the particles to move __more rapidly_ as indicated by the increasing temperature. In summation, the sloped regions of the graph represent changes in ____kinetic____ energy causing particles to ____move more rapidly____, and the level regions of the graph represent changes in ___potential___ energy causing particles to ___separate from one another___.

Which of these three substances was likely used in this phase change experiment? _Z_

Substance	Melting point	Boiling point
X	20 °C	100 °C
Y	40 °C	140 °C
Z	70 °C	140 °C

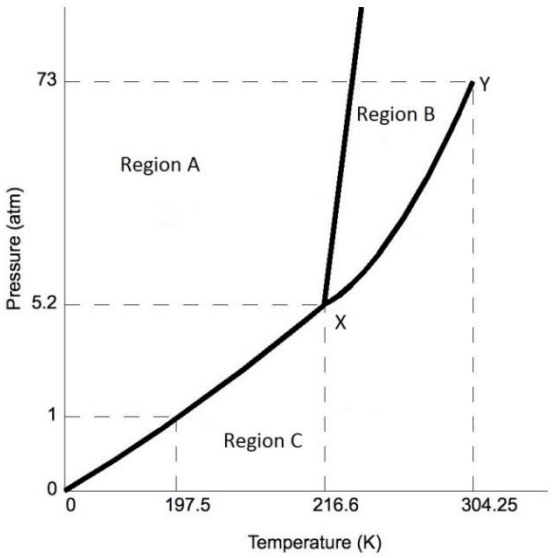
Exercise 10.4a

Phase Changes & Phase Diagrams - Answers

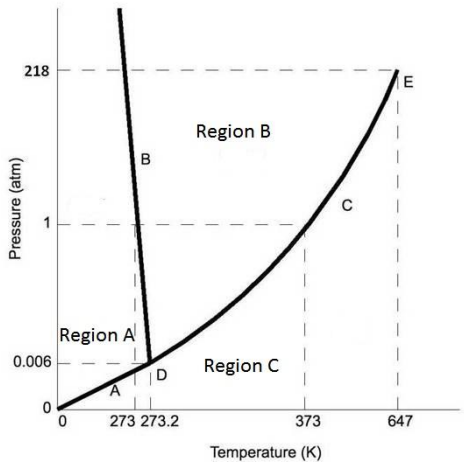
Name: _____

Date: _____ Per: _____

DIRECTIONS: Use the graph at right to answer questions 1-9.



1. Which region of the diagram represents the solid phase? A
2. Which region of the diagram represents the liquid phase? B
3. Which region of the diagram represents the gaseous phase? C
4. What is occurring along the line between Region A and Region B? melting & freezing as IMFs are broken or form
5. What is occurring along the line between Region A and Region C? sublimation & deposition as IMFs are broken or form
6. What is occurring along the line between Region B and Region C? vaporization & condensation as IMFs are broken or form
7. What is occurring at 1 atm and 197.5 K?
   sublimation & deposition equilibrium
8. Describe the triple point of this substance. What point represents the triple point and what is occurring at those conditions?
   The triple point exists at 5.2 atm & 216.6°C. All three phases would be present and all six phase changes would be occurring at equilibrium.
9. Describe the critical point of this substance. What point represents the critical point and what is occurring at those conditions?
   The critical point exists at 73 atm and 304.25°C. Beyond that pressure, the particles cannot separate into gas. Beyond that temperature, the particles are moving too fast to attract into liquid. A supercritical fluid exists.



DIRECTIONS: Use the graph at left to answer questions 10-16.

10. Which region of the diagram represents the solid phase? A
11. Which region of the diagram represents the liquid phase? B
12. Which region of the diagram represents the gaseous phase? C
13. What is the boiling point of this substance at 1 atm? _____
14. What is happening at 1 atm and 273 K? Melting & freezing are in equilibrium (simultaneous melting & freezing).
15. At a constant temperature, what could be done to cause a liquid to gas phase change? The pressure may be reduced until the vapor pressure of the liquid is equal to the pressure of the atmosphere.
16. At what point(s) on the graph do multiple phases exist? along any of the lines
17. Which of the two substances described by these phase diagrams exhibits higher intermolecular forces? Explain your reasoning. The bottom substance has higher IMF. At 1 atm, the bottom substance changes from solid to liquid at 273 °C. The top substance will change from solid directly to gas at a temperature lower than that (197.5 °C) indicating that its IMF are weaker and the particles are easier to separate.