Chapter 10

PHASES OF MATTER

Gas – total disorder; particles have freedom of motion; particles far apart from one another; no definite shape or volume.
Liquid- disorder, particles are free to move relative to one another, particles are vibrating about moving points, close together; definite volume, no definite shape.
Solid- ordered arrangement; particles are vibrating about a fixed point, much closer together, definite shape and volume.
What determines the physical state of a substance at room temperature?

What keeps the particles in liquids and solids together?

The lower the temperature the slower the movement of the particles. When particles slow down intermolecular forces take affect. **Intermolecular forces** are the attraction *between* molecules. These "bonds" are weaker than ionic or covalent bonds.

Types of intermolecular Forces:

1. **Dispersion**: when electrons orbit around the nucleus temporary polar areas are formed. These polar areas form instantaneous dipoles. The dipoles are attracted to each other, also referred to as Van der Waals forces.
2. **Dipole – Dipole**: (remember your molecular structure) in polar molecules the charged ends form dipoles that are attracted to each other.
3. **Hydrogen bonding**: when hydrogen is bonded to a highly electronegative element (F, O, N). This strong attraction force creates a higher than expected boiling point.

* The larger the molecule, the stronger the force of attraction and a higher boiling point.
** The intermolecular forces of a liquid determine its physical properties.
Review changes in states of matter!!

PROCESSES OF CHANGE

Boiling:

The conversion of a liquid to a vapor when then the vapor pressure of the liquid is equal to the atmospheric pressure. (Boiling point is the temperature at which this occurs.) Normal boiling point – the temperature at which the vapor pressure is equal to standard atmospheric pressure (760mmHg or 101.3 kPa or 1 atm). As altitude *increases*, atmospheric *decreases*, boiling point will also *decrease.*

Location	Altitude	Pressure	Boiling Point (water)
Sea Level	0	760 mmHg	100 C
Mt. Whitney	14495	451 mmHg	86 C
Mt. Everest	29028	240 mmHg	70 C

Pressure cookers increase the pressure above the surface of the liquid. What happens to the boiling point of the liquid?

Freezing and Melting:

The temperature at which a pure liquid changes to a solid is its freezing point. (FP) The reverse is its melting point (MP). It is the same temperature. When a liquid freezes, **it gives off heat to the surroundings.** The amount of heat needed to melt 1 gram of a solid into a liquid is called heat of fusion.

Heat of Fusion: the amount of heat required to convert an amount of solid into a liquid.

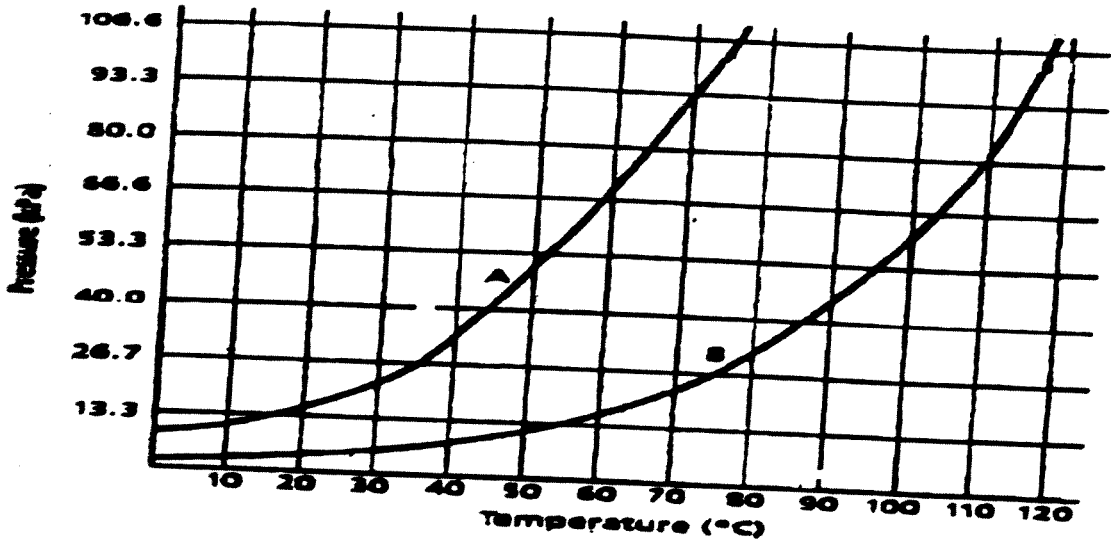
Evaporization:

Like boiling, evaproation changes a liquid to a gas. Evaporation occurs at the *surface* of a liquid, boiling occurs **throughout** the liquid. Evaporation takes place **below** the BP. Boiling takes place at the liquid's BP.

Heat of Vaporization: the amount of heat required to vaporize an amount of liquid. For water this is 40.7 kJ/mol

Practice:

We often use graphs to show the correlation between vapor pressure and boiling. The graph below is the **vapor pressure curves** for two different substances. Use this graph to help you answer the questions below.



1. What is the vapor pressure of A at 40°C? _____ Of B at 40°C? _____
2. At what temperature is the vapor pressure of A 93.3 kPa? _____
3. What is the vapor pressure of B at this temperature? _____
4. What is the "normal boiling point" of A? _____ Of B? _____

PHYSICAL PROPERTIES

Kinetic – Molecular Theory: all matter is made up of particles in constant motion.
Gases:

1. gases are composed of tiny particles
2. these particles are in constant motion (theoretically molecular motion ceases at absolute zero.)
3. elastic collisions occur, collisions with no loss of energy or loss of speed
   *gas pressure is a result of the particles colliding with the container wall
4. There are no attractive forces between the particles
5. When the temperature increases the kinetic energy increases

Gases that obey the assumptions of the kinetic theory are said to be **ideal gases**.

Liquids:

1. Viscosity: the friction or resistance to motion that exists between the molecules of a liquid.
2. Surface Tension: the imbalance of forces at the surface of a liquid.

Solid:
A solid's particles are "locked" in position, and can only vibrate.

1. hardness
2. electrical conductivity
3. melting point

Types of Solids:

1. Crystalline: Highly organized, definite, repetitive pattern. Sharp melting point.
   a. metallic: good conductors, ductile
   b. molecular: soft, low melting points
   c. ionic: hard and brittle
   d. covalent-network: good conductors at high temperatures

2. Amorphous Solids: glass, rubber and plastics. Not "true" solids. They have such high viscosities that they appear solid. The have a wide range of softening before melting.

Name: _____ Period: ___ Date: _____
Homework: Properties and Changes in Matter

Complete the following matching. (a choice may be used more than once and there may be more than one correct choice)

____ 1. Particles are in disorder.
____ 2. No definite shape or volume.
____ 3. Particles are "locked" into place
____ 4. Particles undergo "elastic" collisions
____ 5. Has definite volume, no definite shape
____ 6. Has definite shape and volume.

a. Liquid
b. Gas
c. Solid

7. _____molecular forces are forces of attraction between atoms.

8. _____molecular forces are forces of attraction within an atom.

9. The attraction that results from the temporary polar areas formed as electrons orbit is called _____.

10. The _____ point is the temperature at which a liquid converts to a vapor.

11. Substances that are not "true" solids, but behave like solids are called _____.

12. The stronger the intermolecular forces in a liquid, the _____ its boiling point.

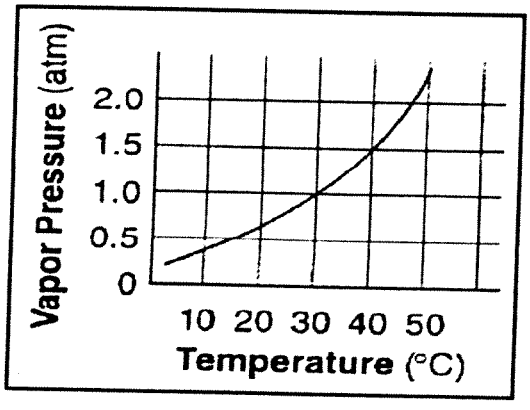
13. _____ - _____ are intermolecular forces created when when the charged ends of polar molecules are attracted to each other.

14. The temperature at which a liquid changes to a solid is its _____ point.

15. When hydrogen is bonded to a highly electronegative element a strong intermolecular attraction is formed called _____ _____.

Use the graph below to answer questions 16-20.

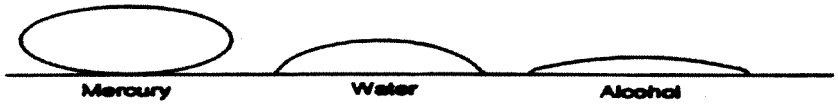
16. What is the "normal boiling point" of this liquid? _____
17. What is the vapor pressure at 30°C? _____
18. What is the temperature at which the vapor pressure is 1.5 atm? _____
19. What is the temperature at which the vapor pressure is 2.0 atm? _____
20. What is the vapor pressure at 10°C? _____



Complete the following short answer questions.

21. What effect does an increase in temperature have on viscosity? Why?

22. A drop of mercury on a glass surface beads into a tighter sphere than a drop of water. A drop of alcohol hardly beads at all. What can you say about the surface tension of these liquids? What can you infer about the intermolecular forces in these liquids?



23. List the properties of a crystalline solid.

24. Discuss the Kinetic-Molecular Theory.

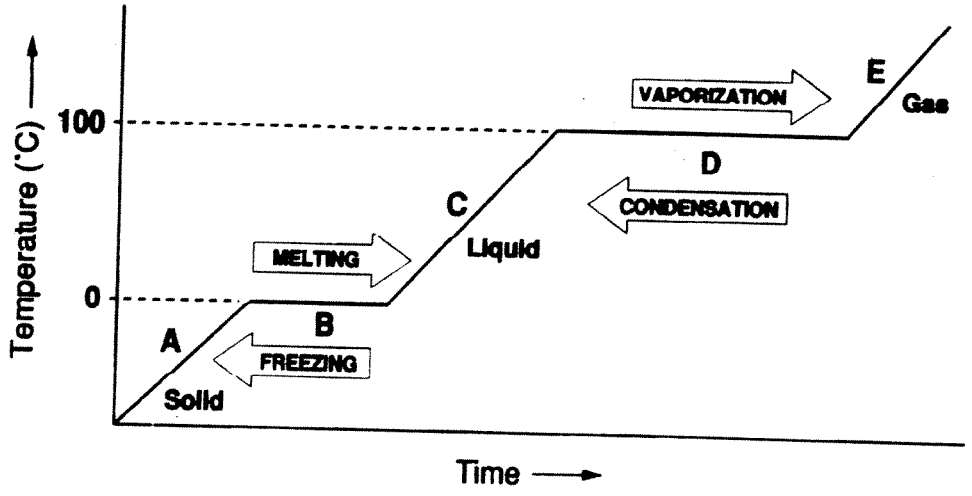
PROPERTIES OF WATER

1. Bent or angular shape
2. Forms hydrogen bonds
3. Liquid at room temperature
4. Requires a great amount of energy to raise or lower water temperature
5. Solid form is less dense (more organized, spaces molecules farther apart)
6. High boiling point
7. Relatively high surface tension
8. High heat of vaporization
9. Excellent solvent

Heating Curve: (text pg 487)

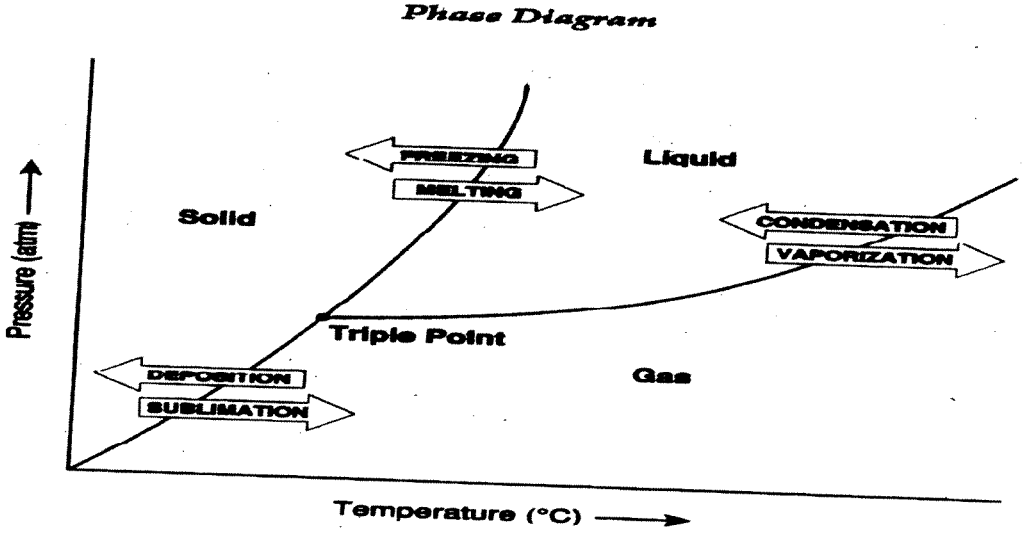
A plot of the temperature of a substance over time.

The Heating Curve of Water



(be prepared to label a heating curve and interpret the information it contains)

Phase Diagrams: the state of matter in relation to pressure and temperature.
-shows the relationship among temperature, pressure, and physical state (phase) of a substance.



1. vertical axis plots **pressure**
   horizontal axis plots **temperature**
2. There are 3 regions for solid, liquid, and gas: each is divided by *solid-liquid, liquid-vapor, and solid-vapor* phase boundaries.
3. The **triple point** represents the temperature and pressure at which all 3 phases of a substance are in equilibrium (where are 3 lines meet).
4. At the top of the liquid-vapor line there is the **critical point** (above which there is no vapor pressure curve.) The critical point represents the **critical temperature** and **critical pressure.** (You can't liquefy a gas above the critical point- no matter how much pressure you put on it!)
5. Normal boiling point and Normal Melting Point can be found by finding standard atm. Pressure on the vertical axis and drawing a straight line across the liquid-vapor line and solid liquid line. Find the corresponding temp.

* Standard atm. Pressure – 760mmHg, 1 atm, 101.3 KPa

(be prepared to label a phase diagram and answer questions about the information it contains)

Name: _____ Period: ___ Date: _____
Homework: Properties of water, heating curves and phase diagrams.

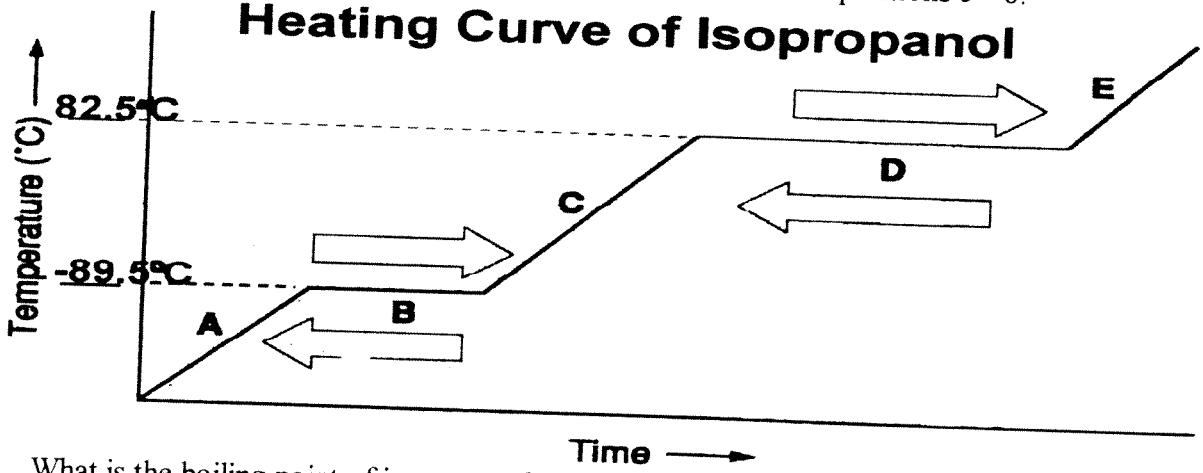
1. Which of the following statements could be used to explain why water has an unusually high boiling point. Check all that apply.
   ___ a. water molecules have a strong intermolecular force
   ___ b. there are no nitrogen atoms in water
   ___ c. oxygen is more electronegative than hydrogen
   ___ d. water is a bent molecule
   ___ e. oxygen atoms are smaller than hydrogen atoms
   ___ f. water does not contain metallic bonds
   ___ g. water molecules are polar

2. Why is water an excellent solvent?

3. What quality about water allows it to rise in the stems and roots of a plant? (Hint: define cohesion, adhesion and capillary action)

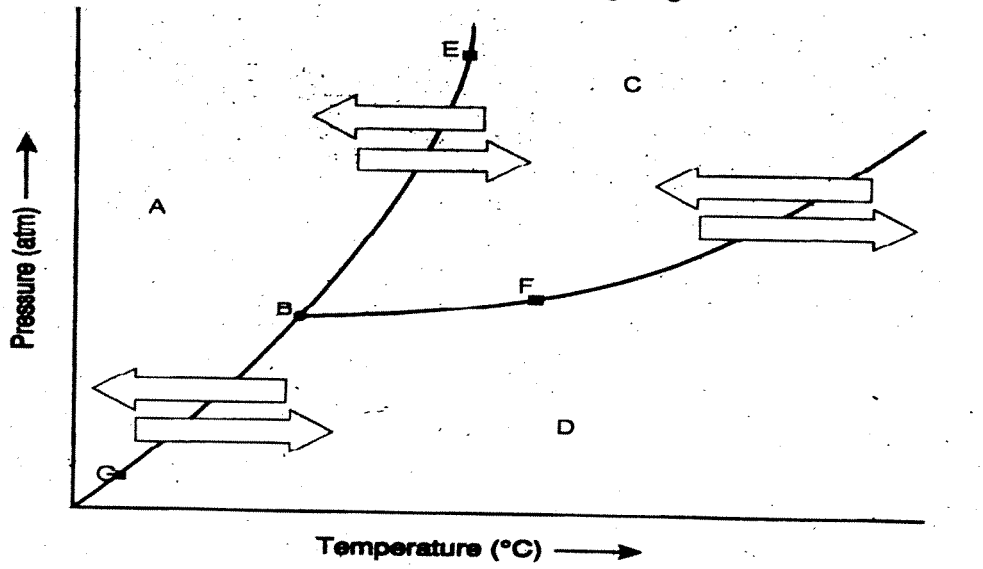
4. Explain why large bodies of water act as climate moderators.

Label the following phase changes on the diagram below and answer questions 5 - 8.



5. What is the boiling point of isopropanol? _____
6. What is the freezing point of isopropanol? _____
7. What phase is the substance in at "A"? _____
8. Why is there a plateau at point "D" as the substance changes from phase "C" to "E"?

9. Label the changes in phase for the following diagram.



10. At which point would you find the triple point? ____ What is the triple point?

11. At which point would you measure the heat of fusion? ____

12. At which point would you find a liquid boiling? ____

13. Label the phases of the substance at "A", "C", and "D".

14. Define the critical temperature.

15. Why would you receive a more severe burn from steam at 100°C than from water at 100°C?