You have mastered this topic when you can:

1) define or describe: **ENERGY**, **POTENTIAL ENERGY**, **KINETIC ENERGY** & **KINETIC MOLECULAR THEORY**.
2) define or describe **HEAT** and **TEMPERATURE.**
3) draw a heating and or cooling curve.
4) describe the energy changes occurring to molecules when they are heated or cooled.
5) describe molecular motions and arrangements for solids, liquids and gasses when they are heated or cooled.
6) relate the heat changes that occur during phase changes to changes in molecular motions and arrangements.
7) define or describe **MELTING**, **BOILING**, **FREEZING** and **CONDENSING POINTS** and **RANGES**.
8) define or describe **PURE SUBSTANCE** and **MIXTURE**.
9) classify matter as a mixture or pure substance given a heating or cooling curve, or **MELTING**, **BOILING**, **FREEZING** or **CONDENSING POINTS** or **RANGES**.

ENERGY IN CHEMISTRY

I) **WHAT IS ENERGY?**

A) ***ENERGY*** _____.

Here are some common forms of ***energy***: heat, light, electrical, nuclear, sound, solar.

B) There are two broad categories of ***energy***: **KINETIC ENERGY** and **POTENTIAL ENERGY**.

1) ***KINETIC ENERGY (KE)*** _____. The ***kinetic energy*** of an object is dependent upon its size and speed. The larger an objects mass the greater its KE. The faster an object's motion the greater is its KE.
2) ***POTENTIAL ENERGY (PE)*** _____. The ***potential energy*** of an object can be converted into ***kinetic energy***: the ***chemical energy*** stored in food is converted by processes in our body to be used as ***kinetic energy*** of our motion and growth.

C) The **KINETIC MOLECULAR THEORY** states that all particles of matter are in constant motion because they have ***kinetic energy***.

II) **THE KINETIC MOLECULAR THEORY AND STATES OF MATTER**

A) The ***kinetic molecular theory*** was developed to explain the properties ***solids***, ***liquids*** and ***gasses*** [See Topic 27.]. According to the ***kinetic molecular theory***, there are three ways that particles can move:

VIBRATIONAL MOTION _____.

ROTATIONAL MOTION _____.

TRANSLATIONAL MOTION _____.

1) ***Solids*** exhibit ***vibrational motion***. ***Solids*** have fixed shape and volume which means their particles are locked in place with very little space between them. This is because the particle in a ***solid*** phase experience ***very strong forces of attraction*** between them. Since all particles have ***kinetic energy*** and particles in the ***solid*** phase are locked in place, the particles of a ***solid*** vibrate within a single space. As a result of this ***vibrational motion***, they are constantly colliding with each other. The collisions between neighbouring particles are not strong enough to cause them to change their position nor the amount of space between them because they are held together by ***very strong attractive forces***. This means large amounts of ***kinetic energy*** are required to cause particles in the ***solid*** phase to change state.

2) ***Liquids*** exhibit ***rotational motion***. ***Liquids*** have variable shape and fixed volume which means their particles move around freely with very little space between them. This is because the particle in a ***liquid*** phase experience ***strong forces of attraction*** between them. Since all particles have ***kinetic energy*** and particles in the ***liquid*** phase are free to move around, the particles of a ***liquid*** spin (rotate) allowing them to slide around each other. As a result of this ***rotational motion***, they are constantly colliding with each other. The collisions between neighbouring particles are strong enough to cause them to change their positions but not the amount of space between them because they are held together by ***strong attractive forces***. This means large amounts of ***kinetic energy*** are required to cause particles in the ***liquid*** phase to change state.

3) ***Gasses*** exhibit ***translational motion***. ***Gasses*** have variable shape and variable volume which means their particles move around freely with large spaces between them. This is because particles in the ***gas*** phase experience very weak attractive forces. Since all particles have ***kinetic energy*** and particles in the ***gas*** phase are free to move around and have very large spaces between them, the particles of a ***gas*** are able to move quickly in straight lines until they collide with another particle or the walls of the container. As a result of this ***translational motion***, they are constantly colliding with each other.

B) **Required Practice 1:** Answer these questions. **{Answers are on page 5.}**

1) Explain how the kinetic energy determines the type of motion of the particles in each state and how the motion of the particles contributes to the spaces between them.

EXPLORING ENERGY CHANGES DURING HEATING OR COOLING A SUBSTANCE

I) ***HEAT*** _____.

Heat energy is dependent on both the kinetic energy of the particles and how many particles are within the substance.

A) The more particles within a substance, the greater the ***heat*** energy of the substance.

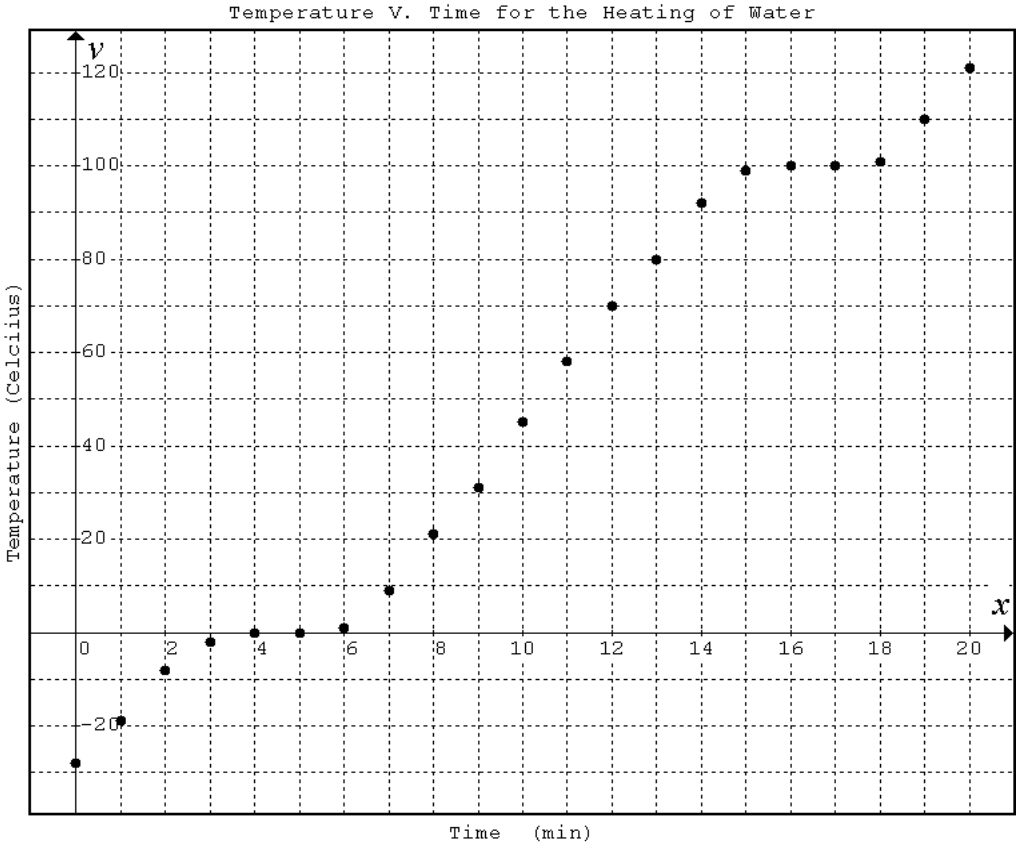
B) The more kinetic energy each particle of a substance has, the greater the ***heat*** energy of the substance.

II) ***TEMPERATURE*** _____.

Temperature is dependent upon the kinetic energy of each particle of a substance, not the potential energy of the particles or how many particles within the substance. Since ***temperature*** is a measure of the average kinetic energy of each particle in a substance, it is not affected by the number of particles in the substance. This means that we cannot use ***temperature*** as an indication of the exact amount of ***heat*** in a sample, rather, it can be used as an approximation of the amount of heat within a sample. **IN GENERAL:** *The greater the **temperature** of a substance, the greater the amount of **heat** the substance contains. The lower the **temperature** of a substance, the lower the amount of **heat** the substance contains.*

III) **EXPLORING ENERGY CHANGES WHEN HEATING WATER**

A) Consider this graph.



1) Describe the energy changes and changes in molecular motion that are occurring at each time period.

0 → 3 min: _____

_____

_____

3 → 6 min: _____

_____

_____

6 → 15 min: _____

_____

_____

15 → 18 min: _____

_____

_____

18 → ∞ min: _____

_____

_____

B) ***MEMORIZE THESE DEFINITIONS!!***

1) ***MELTING POINT*** _____

_____.

2) ***FREEZING POINT*** _____

_____.

3) ***BOILING POINT*** _____

_____.

4) ***CONDENSATION POINT*** _____

_____.

5) ***MELTING RANGE*** _____

_____.

6) ***FREEZING RANGE*** _____

_____.

7) ***BOILING RANGE*** _____

_____.

8) ***CONDENSATION RANGE*** _____

_____.

IV) **RECALL** that ***pure substances*** are composed of many copies of one kind of particle having an identical set of properties while ***mixtures*** are composed of two or more different kinds of particles each having its own set of unique properties. Because ***mixtures*** are composed of two or more substances each with its own unique set of properties while ***pure substances*** are composed of only one kind of particle all sharing the same properties, the heating and cooling curves for ***mixtures*** and ***pure substances*** have different characteristics.

A) **ACTIVITY:** In this activity you will explore the difference in behavior of ***mixtures*** and ***pure substances*** when heated or cooled. Two substances, A and B, are heated resulting in the data listed below.

Title: Exploring phase change temperatures of pure substances and mixtures.

Object: To determine the difference between pure substances and mixtures during phase changes.

Materials: The data tables given on the next page.

Procedure: Graph each the data on separate graphs then answer the questions given below. Be sure you label each axis and give a title to each graph.

Data:

Substance A		Substance B	
Time (min)	Temp (°C)	Time (min)	Temp (°C)
0	20	0	-25
1	30	1	-20
2	37	2	-16
3	44	3	-14
4	51	4	-12
5	51	5	-10
6	51	6	0
7	60	7	12
8	70	8	25
9	81	9	38
10	91	10	49
11	103	11	55
12	111	12	57
13	122	13	59
14	133	14	63
15	133	15	70
16	133	16	80
17	133	17	91
18	142	18	110
19	153	19	122
20	163	20	136

Analysis: Answer these questions. **{Answers are on page 5.}**

1. Does Substance A's have a melting point or melting range? What is it?
2. Does Substance A's have a boiling point or boiling range? What is it?
3. Is Substance A mixture or a pure substance? How do you know?
4. What range of temperatures is Substance A present as a solid only?
5. What range of temperatures is Substance A present as a liquid only?
6. Does Substance B's have a melting point or melting range? What is it?
7. Does Substance B's have a boiling point or boiling range? What is it?
8. Is Substance B a mixture or a pure substance? How do you know?
9. What range of temperatures is Substance B present as a solid only?
10. What range of temperatures is Substance B present as a liquid only?

Continued on the next page.

2) **Conclusions**.

a) ***Pure substances*** _____

_____

_____

_____

_____

a) ***Mixtures*** _____

_____

_____

_____

_____

1. Use your knowledge of ***pure substances*** to explain why they change phase at a single ***temperature***.
2. Use your knowledge of ***mixtures*** to explain why they change phase at a range of ***temperatures***.

ANSWERS TO THE REQUIRED PRACTICE

Required Practice 1 from page 2

1. Particles in the solid state exhibit vibrational motion because they have very low kinetic energy. Because their kinetic energy is low they are unable to move so they vibrate in a single space within the solid. Because they vibrate in a single place within the solid, they are very tightly packed together resulting in very little space between the particles. Particles in the liquid state exhibit rotational motion because they have enough kinetic energy to slide past one another. Because the particles slide past one another, they are very tightly packed together resulting in very little space between the particles. Particles in the gas state exhibit translational motion because they have large amounts of kinetic energy, which means they are moving very fast. As a result there are large spaces between particles in a gas.

Analysis from page 4

1. Substance A has a melting point of 51°C. **2.** Substance A has a boiling point of 133°C. **3.** Substance A is a pure substance because it has a melting point and a boiling point. **4.** Substance A exists as a solid below 51°C. **5.** Substance A exists as a liquid between the temperatures 51°C and 133°C. **6.** Substance B has a melting range of approximately ¯16°C – ¯10°C. **7.** Substance B has a boiling range of approximately 55°C – 63°C. **8.** Substance B is a mixture substance because it has a melting range and a boiling range. **9.** Substance B exists as a solid below ¯16°C. **10.** Substance B exists as a liquid between the temperatures ¯10°C and 55°C.

Required Practice 2 from page 5

1. Pure substances change phase at a single temperature because they are composed of identical particles each having the same properties. This means that each must obtain same amount of kinetic energy in order to change phase.
2. Mixtures change phase at a range of temperature because they are composed of different kinds of particles, each having a unique melting and boiling point. This means that during a phase change one kind of particle maintains constant kinetic energy while its potential energy changes at the same time as the other kind of particle continues to maintain potential energy while its kinetic energy changes. Because one part of the substance experiences changing kinetic energy while the other part does not, the temperature of the substance will continue to increase if the substance is being heated or decrease if the substance is being cooled.
