Energy

OBJECTIVE #1: Differentiate between Kinetic and Potential Energy

A) Kinetic Energy: the energy a substance possesses due to its ____________________

- All types of matter are made up of particles that are moving, therefore …

** ***Temperature*** is a measure of ____ of the particles in a given substance

- The amount of kinetic energy does NOT depend on the amount of substance present

Celsius Scale: Devised by Anders Celsius (~1742): Based on setting the melting point of water as 0°C and the boiling point of water as 100°C.

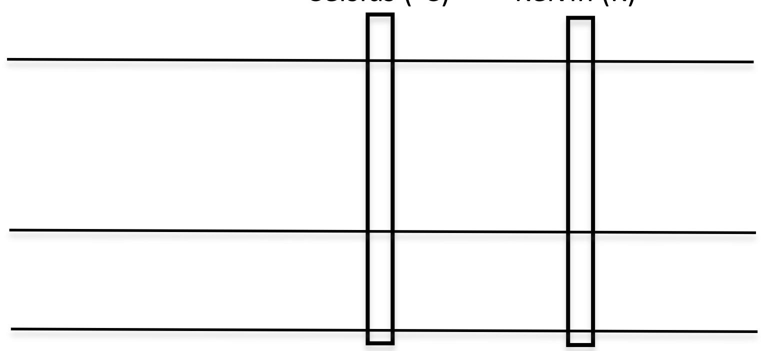
Kelvin Scale: Devised by Lord William Thompson Kelvin: He used the Celsius-sized degree, but he reset the scale so that it starts at 0 Kelvin. At this temperature (which is also -273°C), all particle motion stops.

Celsius (°C) Kelvin (K)

Boiling Point of H_2O

Freezing Point of H_2O

Absolute Zero



The formula to convert between Celsius and Kelvin is found on Reference Table T:

Temperature	K = °C + 273 K = kelvin °C = degree Celsius

1) What unit is used to express the average kinetic energy of a system?
   a) Joule b) Kelvin c) Gram d) Meter

2) Overnight, the temperature drops by 30°C. What is the drop in Kelvin temperature?
   a) 30 K b) 243 K c) 303 K d) 273 K

3) Which of the following samples has the highest average kinetic energy?
   a) 10g of H_2O @ 20°C b) 20g of H_2O @ 20K c) 30g of H_2O @ 70°C d) 40g of H_2O @ 200K

4) What is -22°C expressed in Kelvin?
   a) - 251 K b) 251 K c) 295 K d) 351 K

5) What is 100 K expressed in Celsius?
   a) - 73 °C b) - 173 °C c) - 273 °C d) - 373 °C

6) Which sample has particles with the *lowest* average kinetic energy?
   a) 10.0g of I_2 at 50.°C b) 7.0g of I_2 at 30.°C c) 5.0g of I_2 at 40.°C d) 2.0g of I_2 at 20.°C

B) Potential Energy: known as __________________ energy

- found in the chemical bonds of molecules and substances

When new substances (elements or compounds) are made by breaking bonds between atoms, the energy stored in the bonds is transferred, either to the surroundings or to other substances. The potential energy transferred in this process is known as _____________ or _________________ energy.

- The amount of potential energy DOES depend on the amount of matter and bonds present

- ***Heat*** is the energy transferred from one substance to another, which is measured in ________________or ________________________

  *Heat transfers (flows) from ______________ to ______________

  - heat transfer STOPS when the two substances are at the ____________ temperature

1) What occurs when a 35-gram aluminum cube at 100°C is placed in 90. grams of water at 25°C in an insulated cup?

   a) Heat is transferred from the aluminum to the water, and the temperature of the water decreases.
   b) Heat is transferred from the aluminum to the water, and the temperature of the water increases.
   c) Heat is transferred from the water to the aluminum, and the temperature of the water decreases.
   d) Heat is transferred from the water to the aluminum, and the temperature of the water increases.

2) Use an arrow (← or →) to show the direction of heat flow between the substance A and B

Temp of A	Heat Flow	Temp of B		Temp of A	Heat Flow	Temp of B
15˚C		35˚C		30˚C		283 K
30˚C		25˚C		303 K		15˚C
10˚C		293 K		5 K		5˚C

OBJECTIVE #2: Identify the Law of Conservation of Energy

Similar to the law of conservation of matter, energy also cannot be created nor destroyed in an ordinary chemical reaction. It can, however, be converted or transferred from one form of energy into another.

** Common forms of energy are:

- ______________________ -______________________ -______________________
- ______________________ -______________________ -______________________

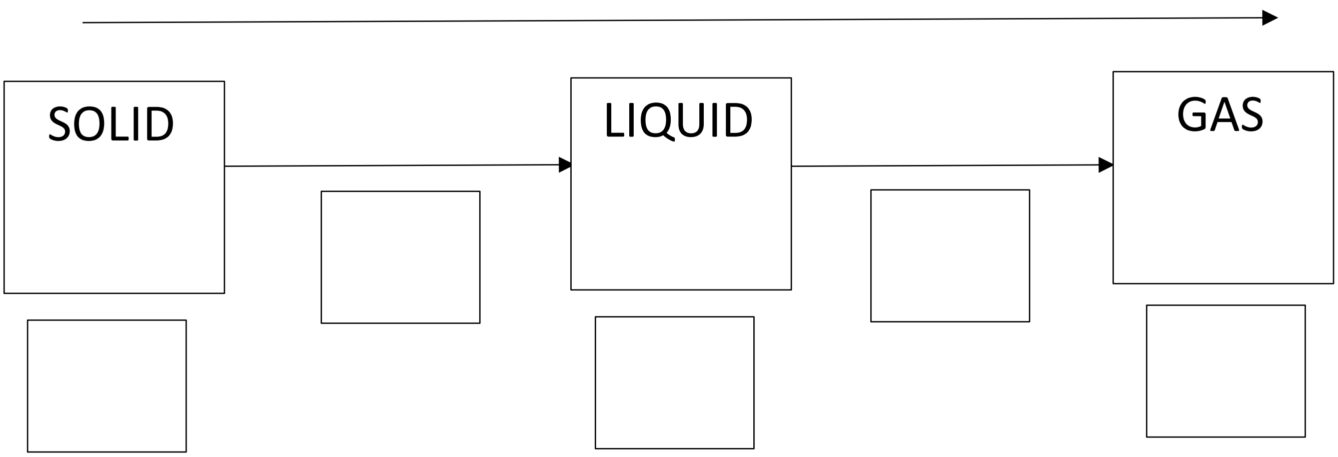
1. Which list includes three forms of energy?

   a) chemical, mechanical, electromagnetic
   b) chemical, mechanical, temperature
   c) thermal, pressure, electromagnetic
   d) thermal, pressure, temperature

OBJECTIVE #3: Identify and Describe Heating and Cooling Curves
During phase changes, the physical state of a substance is altered without changing its identity. These processes can occur when heat is either absorbed (added) or released (removed) from the substance.

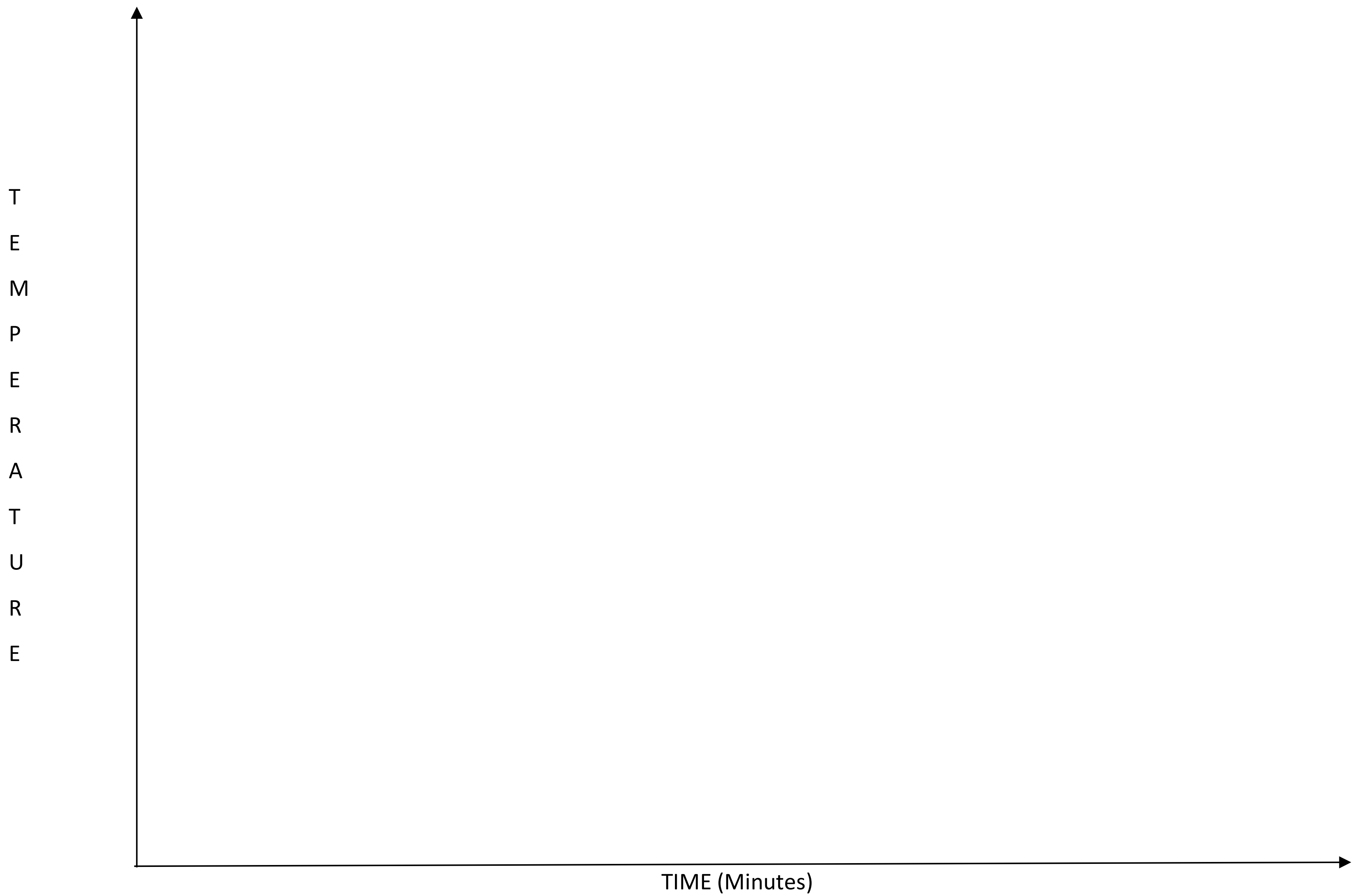
A) Heating Curve

A heating curve shows the changes of matter a substance undergoes as it absorbs heat. Such a process is called an ___________________________ process.



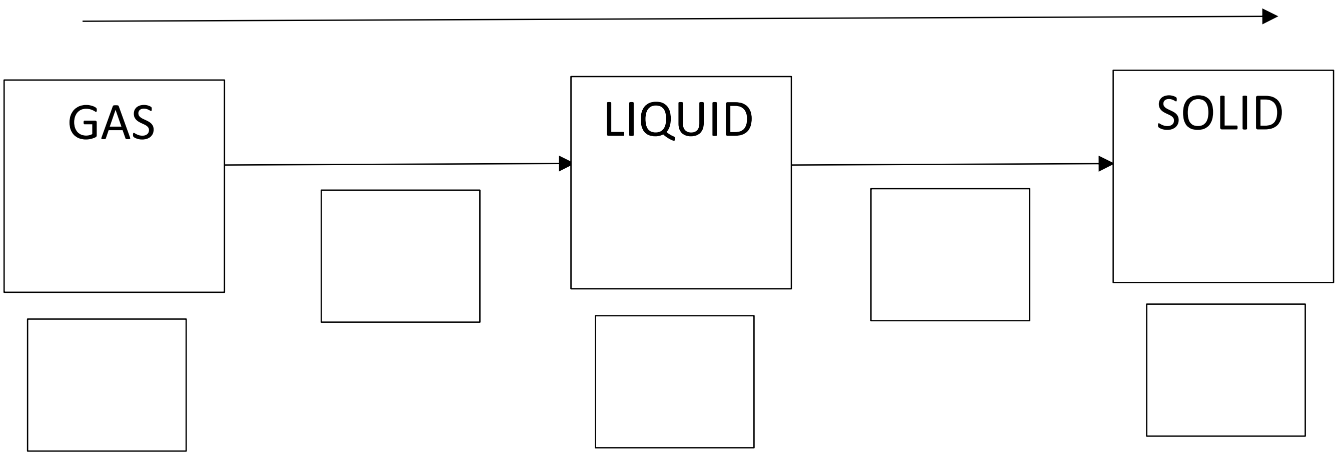
- As heat is added to a substance completely in the solid phase, the heat absorbed is used to increase the ___________________________, and particles begin moving __________________ until the melting point temperature is reached
    - Once the substance's MELTING POINT temperature has been reached, the temperature _____________________________________, and the particles now ______________________________________ until completely in the liquid phase
- As heat is then added to a substance completely in the liquid phase, the heat absorbed is used to increase the ___________________________ again, and particles move even ______________________ until the boiling point temperature is reached
    - Once the substance's BOILING POINT temperature has been reached, the temperature _____________________________________, and the particles now _____________________________ even further until completely in the gas phase
- If heat continues to be added to the gas phase, the heat absorbed is used to increase the ___________________________ again, and particles move _________________ again

ENDOTHERMIC HEATING CURVE



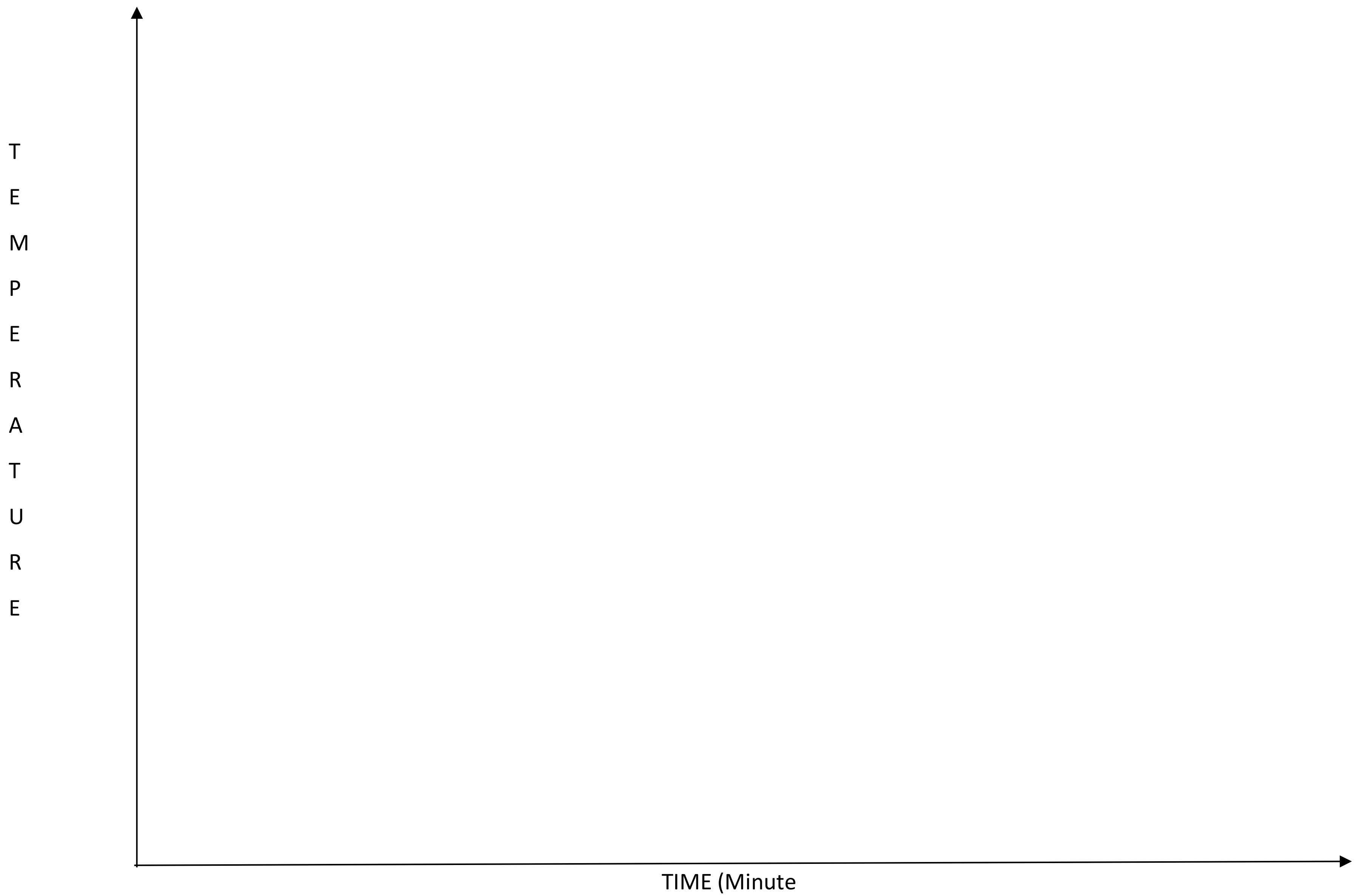
B) Cooling Curve

A cooling curve shows the changes of matter a substance undergoes as heat is removed. Such a process is called an ___________________________ process.



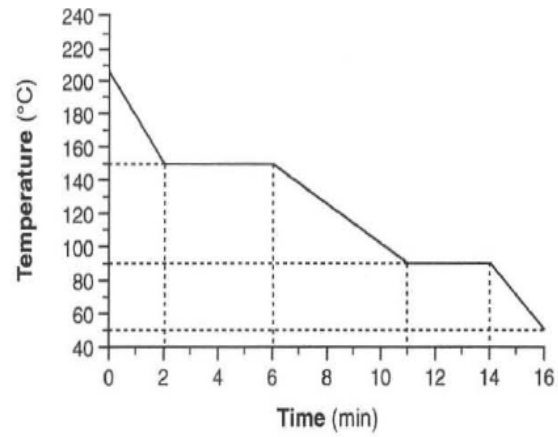
- As heat is removed from a substance completely in the gas phase, the temperature ___________________________, and particles begin moving ____________________ until the condensation point temperature is reached
    - Once the substance's CONDENSATION POINT temperature has been reached, the temperature _____________________________________, and the particles move ______________________________________ until completely in the liquid phase
- As heat is then removed from a substance completely in the liquid phase, temperature ___________________________ again, and particles move even _____________________ until the freezing point temperature is reached
    - Once the substance's FREEZING POINT temperature has been reached, the temperature _____________________________________, and the particles now move ____ until completely in the solid phase
- If heat continues to be removed from the solid phase, the temperature continues to ___________________________, and particles move ____________________________

EXOTHERMIC COOLING CURVE



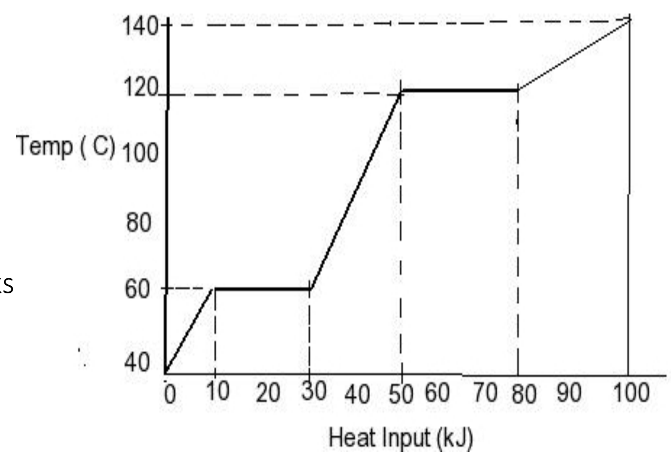
Heating and Cooling Curves Practice:

1. Label the line segments with their phase(s).
2. What is this substance's melting point? _________
3. What is this substance's boiling point? _________



4. Does this represent an endothermic or exothermic reaction?
5. How many minutes does it take the substance to freeze?
6. Label the point with the most kinetic energy with a star.

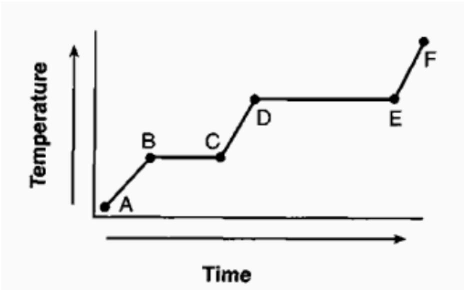
7. Draw six particles of this substance as it looks for the first line segment in the box below.
8. Draw six particles of this substance as it looks for the last line segment in the box below.



9. At which point is the potential energy the highest? Label it with a star.
10. What is the boiling point of this substance? _____________
11. What is the melting point of this substance? _____________
12. What would you expect the graph to do if the substance continued to be heated?

Heating and Cooling Curves Practice:

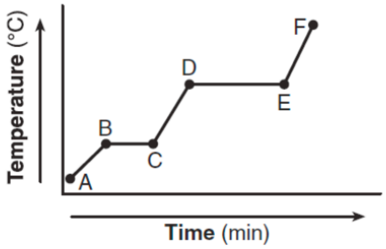
1) The graph below represents the uniform heating of a substance, starting below its melting point, when the substance is solid.



Which line segments represent an increase in average kinetic energy?

1) A-B and B-C 2) A-B and C-D 3) B-C and D-E 4) D-E and E-F

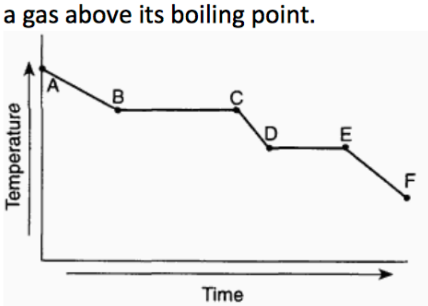
2) The graph below represents the uniform heating of a sample of a substance starting as a solid below its melting point.



Which statement describes what happens to the energy of the particles of the sample during time interval *DE*?

1) Average kinetic energy increases, and potential energy remains the same.
2) Average kinetic energy decreases, and potential energy remains the same.
3) Average kinetic energy remains the same, and potential energy increases.
4) Average kinetic energy remains the same, and potential energy decreases

3) The graph below represents the uniform cooling of a substance, starting with the substance as a gas above its boiling point.



During which interval is the substance completely in the liquid phase?

1) *AB* 2) *BC* 3) *CD* 4) *DE*

4) The table below shows the data collected by a student as heat was applied at a constant rate to a solid below its freezing point.

Time (min)	Temperature (°C)	Time (min)	Temperature (°C)
0	20	18	44
2	24	20	47
4	28	22	51
6	32	24	54
8	32	26	54
10	32	28	54
12	35	30	54
14	38	32	58
16	41	34	62

What is the boiling point of this substance?

1) 32°C 2) 54°C 3) 62°C 4) 100°C

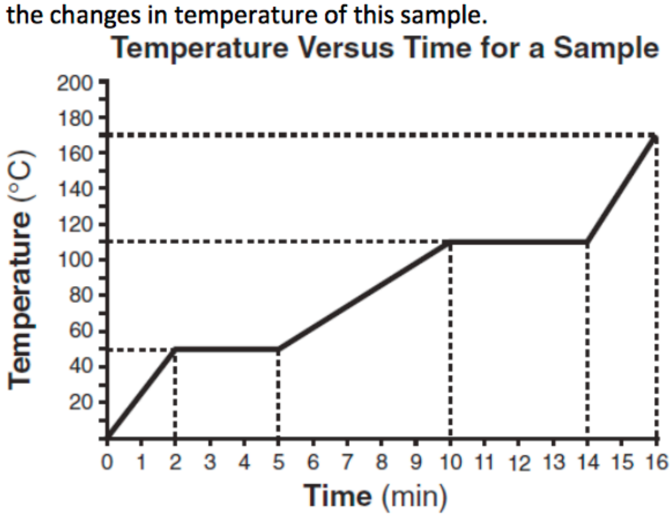
5) A student obtained the following data while cooling a substance. The substance was originally in the liquid phase at a temperature below its boiling point.

Time (minutes)	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
Temperature (°C)	70.	63	57	54	53	53	53	53	53	52	51	48

What is the freezing point of the substance?

1) 70.°C 2) 59°C 3) 53°C 4) 48°C

6) Starting as a solid, a sample of a substance is heated at a constant rate. The graph below shows the changes in temperature of this sample.



What is the melting point of the sample and the total time required to completely melt the sample after it has reached its melting point?

1) 50°C and 3 min
2) 50°C and 5 min
3) 110°C and 4 min
4) 110°C and 14 min

OBJECTIVE #4: Solve Calorimetry Problems

Calorimetry: measurement of __________________ energy into or out of a system for chemical and physical processes.

- Calorimeter: a device used to measure the absorption or release of energy in chemical or physical processes

- Heat flow is measured in two common units, the _______________________ and the ____________________.
    - The Joule is the standard international (SI) unit of heat energy

Reference Table T has the three equations that are used to determine the amount of HEAT given off or absorbed during a chemical reaction. <u>When you solve for heat, or for the variable "q", your unit will be Joule, or J.</u>

Heat	$q = mC\Delta T$ $q = mH_f$ $q = mH_v$	q = heat m = mass C = specific heat capacity ΔT = change in temperature	H_f = heat of fusion H_v = heat of vaporization

You will use Reference Table B to obtain the values of C, H_f and H_v

Table B
Physical Constants for Water

These values are ONLY for water (H_2O)!!

H_f →	Heat of Fusion	334 J/g
H_v →	Heat of Vaporization	2260 J/g
C →	Specific Heat Capacity of $H_2O(\ell)$	4.18 J/g•K

Formula	When to use:
$q = mC\Delta T$	
$q = mH_f$	
$q = mH_v$	

Practice Calorimetry Problems

a) How many joules are absorbed when 50.00 grams of water are heated from 32.0°Cto 58.6°C?

b) A sample of water absorbs 175. Joules of energy when the temperature increases from 24.0°C to 29.8°C. What is the mass of the sample?

c) The temperature of 15.00 grams of a liquid changes from 23.0°C to 55.0°C. The specific heat capacity for this liquid is 2.9 g/J°C. Calculate how much heat has been absorbed by this liquid. (*Hint- the liquid is NOT water)

d) When 418.0 joules of heat energy are added to 10.00 grams of water at 20.0°C, what will the final temperature of the water be?

e) Calculate the amount of heat needed to melt 100. grams of water.

f) How much energy is needed to vaporize 255 g of water?

g) What is the heat change for a 55.0 gram sample of liquid water to freeze back into a liquid at 0º C?