Name:_____**Period:**_____
Ms. Randall
Unit 7: Physical Properties of Matter Workbook

The **bold, underlined** words are **important vocabulary words** that you should be able to define and use properly in explanations. This is a study guide for what you will be tested on throughout the year. The objectives are divided into categories of "**Knowledge**" (**what you have to *know***) and "**Application**" (**what you have to be able to *do***).

	PHYSICAL BEHAVIOR OF MATTER	
	Knowledge	**Application**
1.	○ Physical properties of substances can be explained in terms of chemical bonds and **intermolecular forces**. ○ Intermolecular forces created by an unequal distribution of charge result in varying degrees of attraction between molecules. **Hydrogen bonding** is an example of a strong intermolecular force that occurs in compounds containing H bonded to F, O, or N atoms. ○ Physical properties include malleability, solubility, hardness, melting/freezing point, and boiling point.	○ Predict relative melting and boiling points of compounds given information about its chemical bonds or strength of intermolecular forces ○ Predict relative strength of intermolecular forces of a compound given its melting and boiling points
2.	○ The three **phases of matter** (solids, liquids, and gases) have different properties. ○ The structure and arrangement of particles and their interactions determine the physical state (s, l, or g) of a substance at a given temperature and pressure.	○ Draw and interpret a particle diagram to differentiate among solids, liquids, and gases ○ Explain phase change in terms of the changes in energy and intermolecular distances
3.	○ **Heat** is a transfer of energy (**thermal energy**) from a body of higher temperature to a body of lower temperature. Heat (thermal energy) is associated with the random motion of atoms and molecules. (Heat flows from HOT materials to COLD materials) ○ **Temperature** is a measure of the **average kinetic energy** of the particles in a sample of matter. Temperature is NOT energy – it is a *measure* of heat energy.	○ Distinguish between heat energy and temperature in terms of molecular motion and amount of matter ○ Convert between degrees Celsius and degrees Kelvin (Table T)
4.	○ The concepts of **kinetic** and **potential energy** can be used to explain physical processes that include: **fusion** (melting), **solidification** (freezing), **vaporization** (boiling, evaporation), **condensation**, **sublimation**, and **deposition**. ○ The kinetic and potential energy changes involved in these physical processes can be illustrated in a **heating curve** or **cooling curve**.	○ Identify areas of heating and cooling curves that show changes in kinetic and potential energy, heat of vaporization, heat of fusion, and phase changes ○ Calculate the heat involved in a phase or temperature change of a sample of matter using Tables B & T and/or a given heating or cooling curve
5.	○ Physical processes like phase changes can be **exothermic** or **endothermic**.	○ Distinguish between endothermic and exothermic phase changes
6.	○ **Entropy** is a measure of the randomness or disorder of a system. A system with greater disorder has more entropy.	○ Compare the entropy of different phases of matter
7.	○ The concept of an **ideal gas** is a model to explain behavior of gases. ○ A real gas is most like an ideal gas when the real gas is at low pressure and high temperature.	○ Given a choice of pressure and temperature conditions, identify those under which gases behave *most* ideally and/or *least* ideally

8.	○ **<u>The Kinetic Molecular Theory (KMT)</u>** states that, for an IDEAL gas, all gas particles a. are in random, constant, straight-line motion b. are separated by great distances relative to their size (have negligible volume) c. have no attractive forces between them d. have collisions that may result in a transfer of energy between them, but the total energy of the system remains constant	
9.	○ The Kinetic Molecular Theory (KMT) describes the relationships of pressure, volume, temperature, velocity, frequency, and force of collisions among gas molecules.	○ Explain the gas laws in terms of KMT. ○ Solve problems using the combined gas law (Table T) ○ Recognize and draw graphs showing P vs. T, V vs. T, and P vs. V
10.	○ **Equal volumes of gases at the same temperature and pressure contain an equal number of particles.**	

<u>Goal setting:</u> Based upon your learning style results and the information above list at least two techniques you plan to use to stud during this unit.

1.
2.

What grade would you like to achieve on this unit based on your efforts? _____%

Lesson 1: Chapter Diary 10

Objective: To summarize the concepts related to Physical Properties of Matter

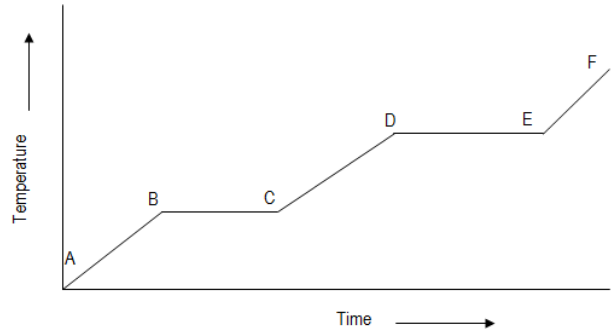
1. Draw particle diagrams for the following:

Solid:	Liquid:	Monoatomic Gas:	Diatomic Gas:

2. What is the Kinetic molecular theory?

3. What is the relationship between temperature and kinetic energy of the particles in a substance?

4. Use the phase change diagram below to answer the questions that follow.



Determine the line segment(s) that represents the information below.

a. Gas, only _____
b. Liquid, only _____
c. Solid, only _____
d. Solid and Liquid, only _____
e. Liquid and Gas, only _____
f. Melting Point _____
g. Boiling Point _____
h. Kinetic energy is increasing _____
i. Potential energy is increasing _____

List 10 facts from the reading

List any questions you may have from your reading:

Lesson 2: Review of Matter Date:_____

Objective: To recall the vocabulary related to types and phases of matter.

Check your understanding:

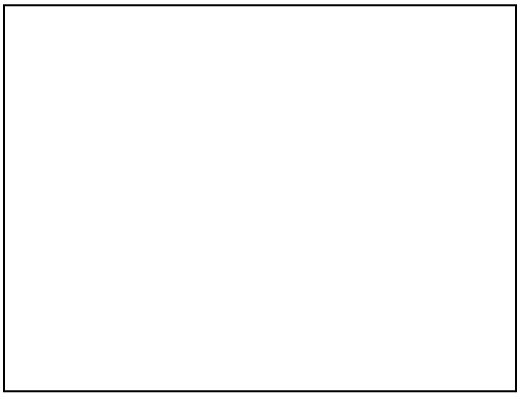
_____1) Which of the following CAN be decomposed by chemical change?
a) SO_2 b) N_2 c) Ne d) Al

_____2) Which of the following substances cannot be decomposed by chemical change?
a) Na b) HNO3 c) ZnCl2 d) C6H12O6

_____3) Which of the following represents a homogeneous mixture?
a) NaCl (s) b) NaCl (l) c) NaCl (aq) d) NaCl (g)

_____4) Which of the following represents a heterogeneous mixture?
a) air b) soil c) salt water d) sugar

5) Draw a particle diagram of a compound of $CaCl_2$, using black solid circles to represent the Ca and empty circles to represent the Cl. Draw at least five molecules of $CaCl_2$ in the box below:



Practice: States of Matter Drill

_____1. Which 5.0-milliliter sample of NH_3 will take the shape of and completely fill a closed 100.0-milliliter container?

(1) $NH_3(s)$ (3) $NH_3(g)$
(2) $NH_3(l)$ (4) $NH_3(aq)$

_____2. Which of the following has the strongest forces of attraction?

(1) $CO_2(s)$ (3) $CO_2(g)$
(2) $CO_2(l)$ (4) $CO_2(aq)$

_____3. Which of the following can be compressed under pressure?

(1) $I_2(s)$ (3) $I_2(g)$
(2) $I_2(l)$ (4) $I_2(aq)$

_____4. Which 1.5-liter sample of salt does *NOT* take the shape of its container?

(1) NaCl(s) (3) NaCl(g)
(2) NaCl(l) (4) NaCl(aq)

_____5. A 25.0 mL sample of water is poured from a 50.0 mL graduated cylinder to a 100.0 mL graduated cylinder. The volume of the water will

(1) increase
(2) decrease
(3) remain the same

_____6.) Which statement correctly describes a sample of gas confined in a sealed container?

(1) It always has a definite volume, and it takes the shape of the container.
(2) It takes the shape and the volume of any container in which it is confined.
(3) It has a crystalline structure.
(4) It consists of particles arranged in a regular geometric pattern.

_____7.) In which material are the particles arranged in a regular geometric pattern?

(1) CO_2 (g) (3) $H_2O(l)$
(2) NaCl(aq) (4) $C_{12}H_{22}O_{11}(s)$

_____8.) Which grouping of the three phases of bromine is listed in order from left to right for increasing distance between bromine molecules?

(1) gas, liquid, solid (3) solid, gas, liquid
(2) liquid, solid, gas (4) solid, liquid, gas

_____9.) Given the particle diagram:

At 101.3 kPa and 298 K, which element could this diagram represent?

(1) Rn (3) Ag

(2) Xe (4) Kr

_____10.) Which statement best describes the shape and volume of an aluminum cylinder at STP?

(1) It has a definite shape and a definite volume.

(2) It has a definite shape and no definite volume.

(3) It has no definite shape and a definite volume.

(4) It has no definite shape and no definite volume.

Lesson 3: Kinetic Molecular Theory (KMT) Basics **Date:_____**

Objective: To relate average kinetic energy and IMF's

Check your understanding:

1. ***In terms of changes in Intermolecular forces of attraction and movement***, what is the relationship between strength of particle attractions and melting point temperature?

2. ***In terms of changes in kinetic and/or potential energy,*** what causes a solid to melt?

3. CO_2 is a substance that sublimes(s→g). What can be inferred about the strength of the attractions between CO_2 molecules, as compared to a substance that melts instead?

Practice:

1. **Kinetic energy** is energy due to the **motion** of the particles in a material. The particles in a sample of matter have three possible ways of moving: **vibrating** in place, **rotating** (spinning), and **sliding** past one another. These are described in terms of kinetic energy.
   What is kinetic energy?

2. How particles are arranged (what phase they are in) is dependent on their energy and the effect this has on their attractions for each other.
   What phase has the most energy and therefore the least attractions?

3. As particles gain energy, the attractions between them decrease. Why does this happen?

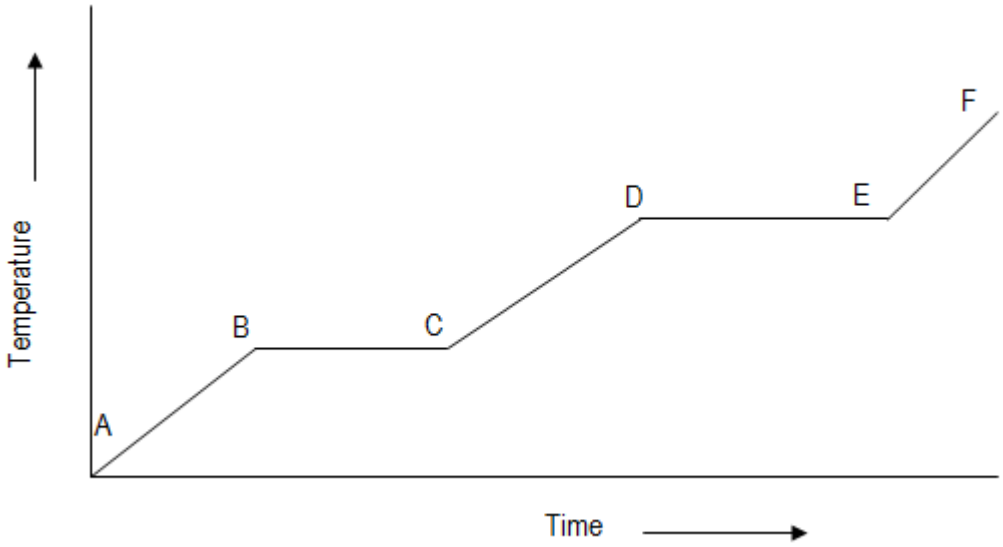
4. The strength of attractions between particles can be evaluated based on properties such as melting and boiling points, heat of fusion and heat of vaporization, and vapor pressure.
   Will a substance with low attractions have a low or high melting/boiling point?

5. The structure and arrangement of particles and their interactions determines the physical state of a substance at a given temperature and pressure.
   What phase are most metals at STP? Nonmetals?

Lesson 4: Heating and Cooling Curves **Date:_____**

Objective: To apply changes in heat and temperature to phase changes

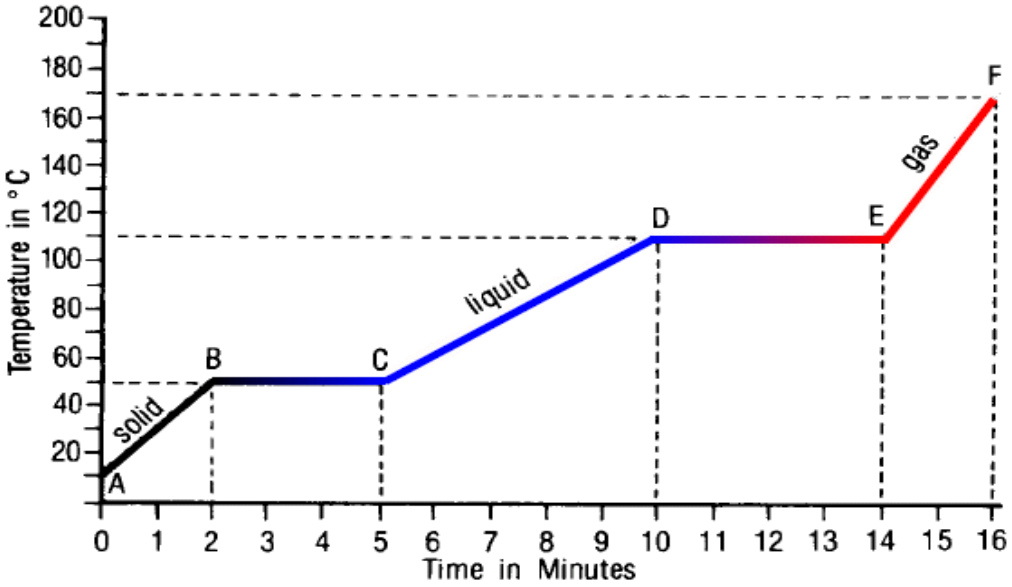
Check your understanding:



Determine the line segment(s) that represents the information below.

a. Gas, only _____
b. Liquid, only _____
c. Solid, only _____
d. Solid and Liquid, only _____
e. Liquid and Gas, only _____
f. Melting Point _____
g. Boiling Point _____
h. Kinetic energy is increasing _____
i. Potential energy is increasing _____

Practice:



From this diagram identify the following:

a. The melting point temperature: _____

b. The boiling point temperature: _____

c. The line segment where heat is being added, causing a change in the temperature of the **solid** phase: _____

d. The segment where heat is being added, causing a change in the kinetic energy of the particles when they are in the **liquid** phase: _____

e. The segment where heat is being added, causing a change in the speed of the particles when they are in the **gas** phase: _____

f. The segment**s** where added heat causes an increase in potential energy: _____ &_____

g. The segment where heat is added, and might be called the "Heat of Fusion": _____

So… Let's compare Potential Energy and Kinetic Energy one more time.
(Answer the following blanks with KE/PE and circle either increasing or decreasing.)

On the flat segments: _____ is constant and _____ is increasing / decreasing.

And on the diagonal segments: _____ is constant and _____ is increasing / decreasing.

_____ 2. As ice melts, its temperature remains at 0°C until it has completely melted. Its potential energy:
(1) decreases (2) increases (3) remains the same

_____ 3. Which change of phase represents fusion?
(1) gas to liquid (2) gas to solid (3) solid to liquid (4) liquid to gas

_____ 4. Which change of phase represents sublimation?
(1) $H_2O(g) \rightarrow H_2O(l)$ (2) $H_2O(l) \rightarrow H_2O(s)$ (3) $CO_2(s) \rightarrow CO_2(g)$ (4) $CO_2(s) \rightarrow CO_2(l)$

_____ 5. Which change of phase is exothermic?
(1) gas to liquid (2) solid to liquid (3) solid to gas (4) liquid to gas

_____ 6. The heat of fusion for ice is 333.6 joules per gram. Adding 333.6 joules of heat to one gram of ice at STP will cause the ice to

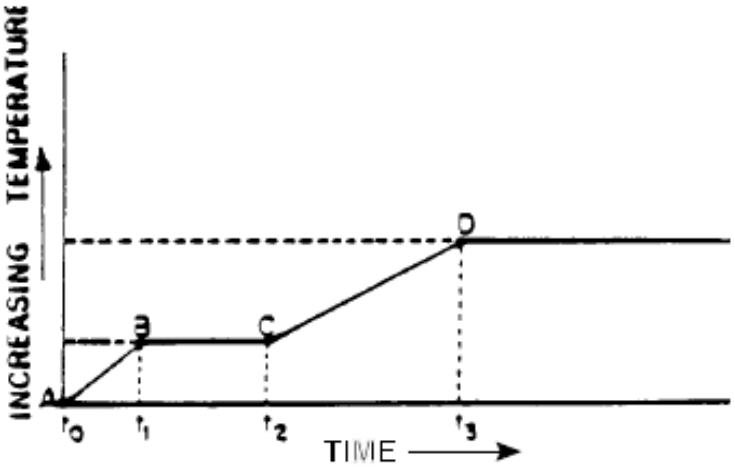
(1) increase in temperature
(2) decrease in temperature
(3) change to liquid water at a higher temperature
(4) change to liquid water at the same temperature

_____ 7. Which term can be used to describe the change of a substance from the solid phase to the liquid phase?
(1) condensation (2) vaporization (3) evaporation (4) fusion

_____ 8. Which sample contains particles arranged in regular geometric pattern?
(1) $CO_2(l)$ (2) $CO_2(s)$ (3) $CO_2(g)$ (4) $CO_2(aq)$

9. The energy required to change 1 gram of a solid to a liquid at constant temperature is called its "heat of _____" value. It is a _____ property.
(physical or chemical?)

Base your answers to questions 10 and 11 on the diagram below which represents a substance being from a solid to a gas, the pressure remaining constant



_____ 10. The substance begins to boil at point
(1) E (3) C
(2) B (4) D

_____ 11. Between points B and C the substance exists in
(1) the solid state, only
(2) the liquid state, only
(3) both the solid and liquid states
(4) neither the solid nor the liquid state

Lesson 5: Measurement of Heat Energy(Potential energy): **Date:_____**

Objective: To calculate heat during phase changes and temperature changes

Check your understanding:

1. What is the specific heat of silver if a 93.9 g sample cools from 215.0°C to 196.0°C with the loss of 428 J of energy?

2. If 100.0 J are added to 20.0 g of water at 30.0°C, what will be the **final** temperature of the water?

3. What is the total number of kilojoules of heat needed to change 15.0 g of ice to water at 0°C?

4. In question 3 is heat being absorbed or released? Is this process endothermic or exothermic?

Practice: Use the Heat Equations on Table T and the Physical Constants for Water on Table B in your reference to complete the following problems. **SHOW ALL WORK.**

1. A 5.00 gram sample of water is heated so that its temperature increases from 10.0°C to 15.0°C. What is the total amount of energy absorbed by the water?

2. When a sample of 25.0 g of water is cooled from 20.0°C to 10.0°C, what is the number of Joules of energy released?

3. What is the total number of kilojoules of heat needed to change 150. grams of ice to liquid water at 0ºC?

4. How much energy is required to vaporize 10.00 grams of water at its boiling point?

5. How many joules of heat energy are released when 50.0 grams of water are cooled from 70.0 °C to 60.0 °C?

6. What is the total number of joules of heat energy absorbed when the temperature of 200.0 grams of water is raised from 10.0 °C to 40.0 °C?

7. The temperature of a sample of water in the liquid phase is raised 30.0 °C by the addition of 3762 J. What is the mass of the water?

8. When 418. Joules of heat energy are added to 10.0 grams of water at 20.0 °C, what will the final temperature of the water be?

9. When 20.0 grams of a substance is completely melted at 0˚C, 3444 J is absorbed. What is the heat of fusion of this substance?

10. What would be the temperature change if 3.0 grams of water absorbed 15 Joules of heat?

Challenge: Calculate the amount of heat needed to heat a 20g piece of ice at -10˚C. to water vapor at 115˚C. (Hint: refer to heating curve and formulas)

Practice: Heat Calculations Drill

_____1) Which substance has the highest melting point?

a) Cl_2 (s) b) H_2S (s) c) KCl (s) d) H_2O (s)

_____2) How many joules are required to melt 10.0 grams of water at 0°C?

a) 334 J b) 3340 J c) 2260 J d) 22 600 J

_____3) Which of the following phase changes requires heat of fusion to accomplish?

a) H_2O (s) → H_2O (g) b) H_2O (g) → H_2O (l) c) H_2O (l) → H_2O (g) d) H_2O (s) → H_2O(l)

_____4) Which of the following phase changes is endothermic?

a) H_2O (s) → H_2O (l) b) H_2O (g) → H2O (l) c) H_2O (l) → H_2O (s) d) H_2O (g) → H_2O (s)

5) A mixture of 50.0 g of ice (H2O (s)) and 30.0 g of water (H2O (l)) sits in a sealed flask at 0°C.

_____a) What will happen to the amount of ice in the flask if the mixture is left alone at 0°C?
a) increase b) decrease c) remain the same

_____b) What will happen to the amount of ice in the flask if the temperature of the flask is lowered to –10°C?
a) increase b) decrease c) remain the same

_____6) Which of the following elements is a solid at standard temperature and pressure?
a) Ne b) Hg c) Br d) Zn

_____7) Which of the following elements is a metallic liquid at standard temperature and pressure?
a) Ne b) Hg c) Br d) Zn

_____8) Which of the following elements is a gas at standard temperature and pressure?
a) Ne b) Hg c) Br d) Zn

_____9) How many joules are required to boil 10.0 grams of water at 100°C?
a) 334 J b) 3340 J c) 2260 J d) 22 600 J

Lesson 6: Calorimetry **Date:_____**

Objective: To calculate the transfer of heat between substances using the calorimetry formula

Check your understanding: SHOW ALL WORK!

1. A small pebble is heated and placed in a foam cup calorimeter containing 25.0 g of water at 25.0°C. The water reaches a final temperature of 26.4°C. How many joules of heat were released by the pebble?
   (*Hint:* $q_{water} = -q_{pebble}$)

2. A sample of silver with a mass of 63.3 g and a specific heat of 0.240J/g*°C is heated to a temperature of 111.3°C and placed in a container of water at 16.85°C. The final temperature of the silver and water is 19.25°C. Assuming no heat loss, what mass of water was in the container?
   Remember: $(mC\Delta T)_{lost} = (mC\Delta T)_{gained}$

Practice:

1. A 2.50 g sample of zinc is heated, and then placed in a calorimeter containing 65.0 g of water. Temperature of water increases from 20.00 ^{o}C to 22.50 ^{o}C. The specific heat of zinc is 0.390 J/g^{o}C. What was the initial temperature of the zinc metal sample? (final temperatures of zinc and water are the same)

2. A 13.5 g sample of gold is heated, and then placed in a calorimeter containing 60.0 g of water. Temperature of water increases from 19.00 ^{o}C to 20.00 ^{o}C. The specific heat of gold is 0.130 J/g^{o}C. What was the initial temperature of the gold metal sample?

3. A 28.4 g sample of aluminum is heated to 39.4 ^{o}C, then is placed in a calorimeter containing 50.0 g of water. Temperature of water increases from 21.00 ^{o}C to 23.00 ^{o}C. What is the specific heat of aluminum?

Lesson 7: **Vapor Pressure & Boiling Point Temperature** **Date:**_____

Objective: To relate vapor pressure to boiling points. To determine the boiling point of a substances using reference table H

Check your Understanding:

Refer to the *Table H* to answer these questions.

_____ **1.** Which substance has the lowest normal boiling point?

_____ **2.** Which substance evaporates most easily at any temperature?

_____ **3.** Which of the substances has the highest boiling point?

_____ **4.** Which of the substances has the highest vapor pressure at 40°C?

_____**5.** Which substance boils at 79°C?

Practice: Refer to the *Table H* to answer these questions.

_____ 1. At what temperature will ethanol boil when the atmospheric pressure is 50 kPa?

_____2. What atmospheric pressure will allow propanone to boil at 20°C?

_____3. What atmospheric pressure will allow water to boil at 90°C?

_____ _4. As the atmospheric pressure decreases, the boiling point of water will

(a) increase
(b) decrease
(c) remain the same

5. What is the boiling point of water in Denver, where atmospheric pressure averages about 90 kPa, due to elevation?

6**.** Based on the boiling point information in Table H, which of the four substances has the greatest attractions between particles? **Explain how you know!**

7. At 65˚C, which compound has a vapor pressure of 58 kPa?

a. ethanoic acid b. propanone
c. ethanol d. water

8. Which liquid has the lowest vapor pressure at 65˚C?

a. ethanoic acid b. propanone
c. ethanol d. water

9. At which temperature is the vapor pressure of ethanol equal to the vapor pressuer of propanone at 35˚C?

a. 35˚C b. 82˚C
c. 60˚C d. 95˚C

Lesson 8: Real vs. Ideal gases **Date:_____**

Objective: To compare the properties of real and ideal gases

Check your understanding:

Ideal gas conditions

1. A gas is composed of very tiny particles which are in a continuous, random _____ motion.
   (curved/straight line)
2. Collisions between particles may result in a transfer of energy between particles but the net total kinetic energy of the system remains constant.
   - These are called "Elastic Collisions"

3. The volume of the gas particles themselves is ignored in comparison with the volume of space in which they are contained.
   - This is because the particles are very _____.
     (tiny/large)

4. Gas particles are considered as having no attraction for each other.
   - This is most true for _____ molecules/particles.
     (small/large)
5. High Temperature and Low Pressure
   - The higher the temperature, the _____ the particles move.
     (slower/faster)
   - The lower the pressure, the _____ spacing between particles.
     (more/less)

Real Gas Conditions (Deviations from Ideal Gases):

1. Gases do have volume.
2. Gases do exert some attraction for each other.

These deviations become significant when the space between particles is reduced due to:

1) Low Temperature
   - The lower the temperature, the _____ the particles move.
     (slower/faster)
2) High Pressure
   - The higher the pressure, the _____(more/less) spacing between particles.

3) Large molecules

4) Gas particles have a greater attraction for each other.

Practice:

Fill in the blanks below, using the word bank. Use text p. 413 – 429 if you need to.
(Words can be used more than once!)

Attractions	**Colliding**	**Compressed**
Faster	**Slower**	**Increase**
Decrease	**Less**	**More**
Pressure	**Volume**	**Temperature**

1. The particles or molecules in a sample of gas are spread very far apart from each other. As a result they feel no _____ for each other.

2. The molecules in a gas can be forced closer together without changing back to the liquid state, in other words they are able to be _____ into a smaller volume.

3. When you pump up a soccer ball with an air pump, the ball gets harder. This is because you are taking the same amount of space and filling it with _____ gas molecules. As a result, the _____ inside the ball increases. This is because there are more molecules _____ with the inside surface of the ball.

4. _____is a measure of the average kinetic energy of the molecules in a sample. In a hotter sample, the molecules are moving _____ on average compared to a colder sample.

5. When working with gases, it is important to realize that the variables of pressure, _____, temperature, and number of molecules are all inter-related. In other words, changing one of these variables for a gas system will change at least one of the others.

    - In a flexible container (one that can change volume, like a balloon), increasing the pressure on a gas will cause the volume to _____.
    - In a flexible container, increasing the temperature on a gas will cause volume to _____.
    - In a rigid container (one that cannot change volume, like an aerosol can), increasing the temperature will cause the pressure inside the container to _____.
    - In a rigid container, increasing the amount of gas inside the container will cause the pressure inside it to _____.

Lesson 9: Gas Laws **Date:_____**

Objective: To select and apply the proper formula to calculate pressure, temperature or volume changes in a gas.

Check your understanding:

1. The volume of a 5.0 mL syringe is changed to 4.5 mL. If the starting pressure was 101.3 kPa, what is the new pressure?

(Temperature is constant.)

Make a "shopping list" below!

V_1 = _____ V_2 = _____

P_1 = _____ P_2 = _____

T_1 = _____ T_2 = _____

Practice:

1. The volume of a balloon is increased by a factor of 4 . What is the new pressure if the starting pressure is 1 atm?
Make a "shopping list" below!

2. A 2.0 Liter balloon at 273K is heated to 373K. In order to keep pressure constant, what must be the new volume of the balloon?
Make a "shopping list" below!

3. A 2.36 Liter balloon at a temperature of 17˚C is heated to 25˚C. What is the balloon's new volume?
Make a "shopping list" below!

4. A rigid metal cannister is filled with gas at room temperature (300K) and 1 atmosphere of pressure. The temperature of the cannister is raised to 400K. What is the pressure in atmospheres?
Make a "shopping list" below!

5. A 5.0 Liter container is filled with hydrogen gas at a temperature of 21˚C. The pressure in the container is 246 kPa. The temperature is lowered to 13˚C. What is the new pressure?
Make a "shopping list" below!

Lesson 10: Combined Gas Laws **Date:_____**

Objective: To apply the combined gas law to calculate changes in temperature, pressure or volume of a gas.

Check your Understanding:

1. A gas has a volume of 2.00 L at 323 K and 3.00 atm. What will be the new volume if the temperature is changed to 273 K and the pressure is changed to 1.00 atm?

2. A gas has a volume of 100 mL at a temperature of 20. K and a pressure of 760 mm Hg. What will be the new volume when the temperature is changed to 40.0 K and the pressure is changed to 380 mm Hg?

Practice:

1. A 10.0 L sample of argon gas is stored in a cylinder at room temperature of 23.8 °C and a pressure of 78.6 psi. The sample is completely transferred to another 2.80 L cylinder. Several hours after the transfer, the second cylinder has also attained room temperature. What is the pressure in the second cylinder?

2. A tank of compressed CO_2 has a temperature of 20.0°C and a volume of 31.4 L. The CO_2 is completely transferred into a smaller tank with a volume of 25.0 L. Assuming none of the CO_2 escapes during the transfer, what does the temperature of the gas in the smaller tank need to be to have the pressure be the same as it was in the larger tank?

3. A tank of compressed oxygen has a volume of 3.00 L and a pressure of 400. kPa at room temperature (21.0°C). The tank is accidentally thrown into a fire and the temperature increases to 200.°C. What is the pressure inside the tank?

4. At 75.0°C a gas has a volume of 2.20 L and exerts a pressure of 1.30 atm on the walls of the container. If the gas is compressed to a volume of 1.00 L and temperature is reduced to 10.0°C, what is the new pressure on the walls of the container?

5. A gas at STP occupies a volume of 34.0 liters. What is the temperature of the gas if it is compressed to 20.0 liters by increasing the pressure to 250. kPa?

6. A gas that has a volume of 28 liters, a temperature of 45 ^{0}C, and an unknown pressure has its volume increased to 34 liters and its temperature remains constant. If I measure the pressure after the change to be 2.0 atm, what was the original pressure of the gas?

Practice: Gas Laws Drill

_____ 1. If the temperature is held constant, what will happen to the pressure exerted by a gas if the volume of the container is decreased?

(1) increase
(2) decrease
(3) remain the same
(4) increase, or decrease (it depends)

_____ 2. Which of the following is NOT true about pressure?

(1) pressure is exerted equally in all directions
(2) pressure is defined as force per unit area
(3) gas pressure can only be measured in units of mm of mercury
(4) atmospheric pressure decreases with increasing altitude

_____ 3. The pressure of a sample of gas is 500. mm Hg and the volume is 30.0 L. If the volume is changed to 50.0 L, what is the new pressure?

(1) 833 mm Hg (2) 300 mm Hg (3) 7500 mm Hg (4) 3000 mm Hg

_____ 4. If the temperature of a sample of gas is decreased at constant pressure, the volume of the gas will:

(1) increase
(2) decrease
(3) remain the same
(4) increase, or decrease (it depends)

_____ 5. Standard temperature and pressure, STP, refers to:

(1) 100^{o}C and zero atmosphere
(2) absolute zero and one atmosphere
(3) 0^{o}C and a pressure of one atmosphere
(4) 0^{o}C and zero atmosphere

_____ 6. A sample of gas in a rigid container (constant volume) is at a temperature of 25.0^{o}C. If the temperature of the gas is increased to 50.0^{o}C, what will happen to the pressure exerted by the gas?

(1) it will double
(2) it will halve
(3) it will increase by a small amount
(4) it will decrease by a small amount

_____ 7. A gas occupies a volume of 444 mL at 273 K and 79.0 kPa. What is the final Kelvin temperature when the volume of the gas is changed to 1880 mL and the pressure is changed to 38.7 kPa?

(1) 31.5 K (2) 566 K (3) 292 K (4) 2360 K

_____ 8. A sample of gas is held at constant pressure. Increasing the Kelvin temperature of this gas sample causes the average kinetic energy of its molecules to

(1) decrease and the volume of the gas sample to decrease
(2) decrease and the volume of the gas sample to increase
(3) increase and the volume of the gas sample to decrease
(4) increase and the volume of the gas sample to increase

_____ 9. A gas occupies a volume of 40.0 milliliters at 20°C. If the volume is increased to 80.0 milliliters at constant pressure, the resulting temperature will be equal to

(1) $20°\text{C} \times \frac{80.0\text{ mL}}{40.0\text{ mL}}$

(2) $20°\text{C} \times \frac{40.0\text{ mL}}{80.0\text{ mL}}$

(3) $293\text{ K} \times \frac{80.0\text{ mL}}{40.0\text{ mL}}$

(4) $293\text{ K} \times \frac{40.0\text{ mL}}{80.0\text{ mL}}$

_____ 10. The volume of a gas is 4.00 liters at 293 K and constant pressure. For the volume of the gas to become 3.00 liters, the Kelvin temperature must be equal to

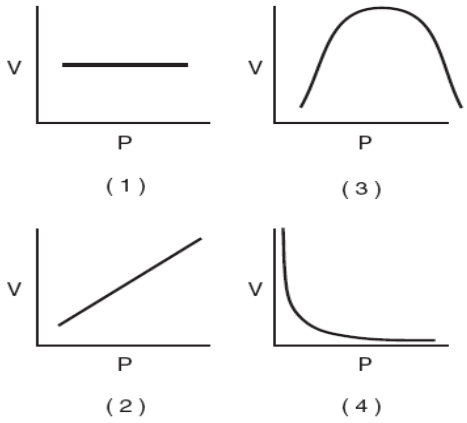
(1) $\frac{3.00 \times 293}{4.00}$

(2) $\frac{4.00 \times 293}{3.00}$

(3) $\frac{3.00 \times 4.00}{293}$

(4) $\frac{293}{3.00 \times 4.00}$

_____ 11. Which graph best represents the pressure - volume relationship for an ideal gas at constant temperature?



_____ 12. A sample of helium gas has a volume of 900. milliliters and a pressure of 2.50 atm at 298 K. What is the new pressure when the temperature is changed to 336 K and the volume is decreased to 450. milliliters?

(1) 0.177 atm (2) 4.43 atm (3) 5.64 atm (4) 14.1 atm

Challenge:

Try to explain what happened to the tanker car shown in the picture below, in terms of gas particle behavior. The situation happened when some workers cleaned the tanker out with a hot water flush and then sealed the tanker car lid after doing their work in the middle of the day. That night, the air temperature dropped down to the 35^{o}F range. The car did this sometime during the night.

Unit Study Guide

Law, Theories, BIG ideas	**Equations, Calculations, Reference Tables**
Laws:	Equation: (When to use & units)
Theories:	Calculations (When to use)
BIG ideas:	Reference Table (Hints & tricks)

Helpful tips, sayings, shortcuts

Things I always forget…

Unit Review: ***Physical Behavior of Matter***

Place a checkmark next to each item that you can do! If a sample problem is given, complete it as evidence.

_____1. I can still do everything from Unit 1.	
_____2. I can still do everything from Unit 2.	
_____3. I can still do everything from Unit 3.	
_____4. I can still do everything from Unit 4.	
_____5. I can still do everything from Unit 5.	
_____6. I can still do everything from Unit 6.	
_____7. I can define kinetic energy, potential energy, temperature, heat, endothermic, and exothermic.	**Definitions:** kinetic energy potential energy temperature heat endothermic exothermic
____8. I can use particle diagrams to show the arrangement and spacing of atoms/molecules in different phases.	Draw a particle diagram to represent atoms of Li in each phase. **Solid** | **Liquid** | **Gas**

_____9. I can compare solids, liquids, and gases in terms of their relative kinetic energy, type of molecular motion, ability to completely fill a container, ability to change shape.

	Solid	Liquid	Gas
Relative Kinetic Energy			
Type of Molecular Motion	vibrations, only	vibration and rotation	vibration, rotation, and translation
Ability to Completely Fill a Container			
Ability to Change Shape			

_____10. I can state the change of phase occurring in fusion, solidification, condensation, vaporization, melting, boiling, sublimation, deposition, and freezing.

During fusion a substance changes from _____ to _____.

During solidification a substance changes from _____ to _____.

During condensation a substance changes from _____ to _____.

During vaporization a substance changes from _____ to _____.

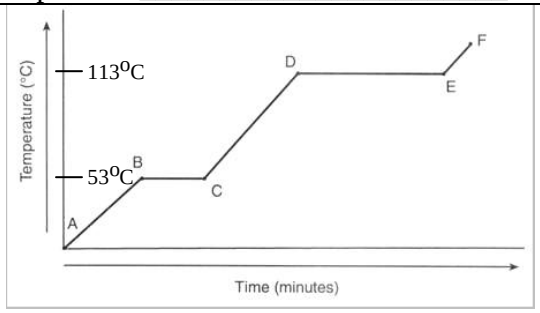
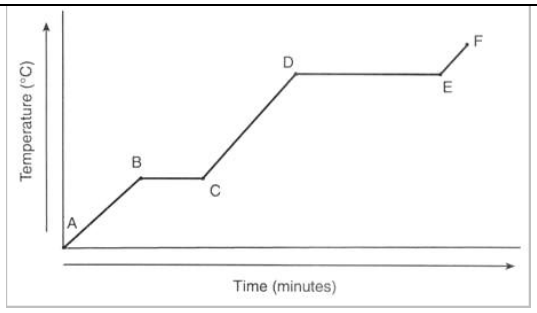
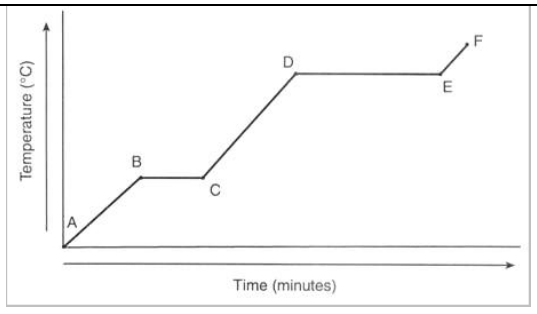
During melting a substance changes from _____ to _____.

During boiling a substance changes from _____ to _____.

During sublimation a substance changes from _____ to _____.

During deposition a substance changes from _____ to _____.

During freezing a substance changes from _____ to _____.

_____11. I can indicate if a phase change is exothermic or endothermic.	For each phase change listed, indicate whether the change is exothermic or endothermic. fusion/melting_____ solidification/freezing_____ condensation_____ vaporization/boiling_____ sublimation_____ deposition_____
_____12. Given a heating/cooling curve, I can determine the temperature at which a substance freezes/melts or condenses/vaporizes.	 What is the freezing point of this substance? What is the boiling point of this substance?
_____13. Given a heating/cooling curve, I can determine which sections of the curve show changes in potential energy.	 On the graph, circle the sections that show a change in potential energy.
_____14. Given a heating/cooling curve, I can determine which sections of the curve show changes in kinetic energy.	 On the graph, circle the sections that show a change in kinetic energy.
_____15. I can state the temperature at which water freezes in °C and K.	What is the freezing point of water in °C and K?

_____16. I can state the temperature at which water melts in ^{O}C and K.	What is the melting point of water in ^{O}C and K?
_____17. I can state the temperature at which water vaporizes/boils in ^{O}C and K.	What is the boiling point of water in ^{O}C and K?
_____18. I can state the temperature at which water condenses in ^{O}C and K.	What is the condensing point of water in ^{O}C and K?
_____19. I can use Reference Table T to determine which "heat" equation is needed for a given problem.	Which heat equation should be used in each of the following: a. How much heat is needed to vaporize 100.0 g of water at 100^{O}C? b. How much heat is needed to raise the temperature of 100.0 g of water by 35^{O}C? c. How much heat is needed to melt 100.0 g of ice at 0^{O}C?
_____20. I can define specific heat capacity, heat of fusion, heat of vaporization.	**<u>Definitions:</u>** specific heat capacity heat of fusion heat of vaporization
_____21. I can use the "heat" equations to solve for any variable, if I am given the other variables.	How many grams of water can be heated by 15.0 ^{O}C using 13,500 J of heat? It takes 5210 J of heat to melt 50.0 g of ethanol at its melting point. What is the heat of fusion of ethanol?

_____22. I can state the 4 parts of the Kinetic Molecular Theory.	The four parts of the Kinetic Molecular Theory are: a. b. c. d.
_____23. I can define an ideal gas.	**<u>Definition:</u>** ideal gas
_____24. I can state the conditions of pressure and temperature under which a gas will act "ideally".	A gas will act most "ideally" under the conditions of _____ pressure and _____ temperature.
_____25. I can state the two elements that act ideally most of the time.	The two elements that act ideally most of the time are _____ & _____.
_____26. I can explain how pressure is created by a gas.	What causes gas molecules to create pressure?
_____27. I can state the relationship between pressure and volume for gases (assuming constant temperature).	At constant temperature, as the pressure on a gas increases, the volume _____.
_____28. I can state the relationship between temperature and volume for gases (assuming constant pressure).	At constant pressure, as the temperature on a gas increases, the volume _____.
_____29. I can state the relationship between temperature and pressure for gases (assuming constant volume).	In a fixed container (AKA "has constant volume), as the temperature on a gas increases, the pressure_____.

_____30. I can state Avogadro's Hypothesis.	Avogadro's Hypothesis says_____ _____ _
_____31. I can remember to convert ^{O}C to K when using the Combined Gas Law to determine changes in V, P, or T of a gas.	A gas originally occupies 2.3L at 56^{O}C and 101.3 kPa. What will its volume be at 100^{O}C and 105.7 kPa?
_____32. I can define boiling point and vapor pressure.	**Definition:** boiling point vapor pressure
_____33. I can state the condition of pressure that is used for "normal" boiling points.	The normal boiling point of a substance occurs at a pressure of _____atm/_____kPa.
_____34. I can state the relationship between atmospheric pressure and boiling point.	As the atmospheric pressure increases, the boiling point _____.