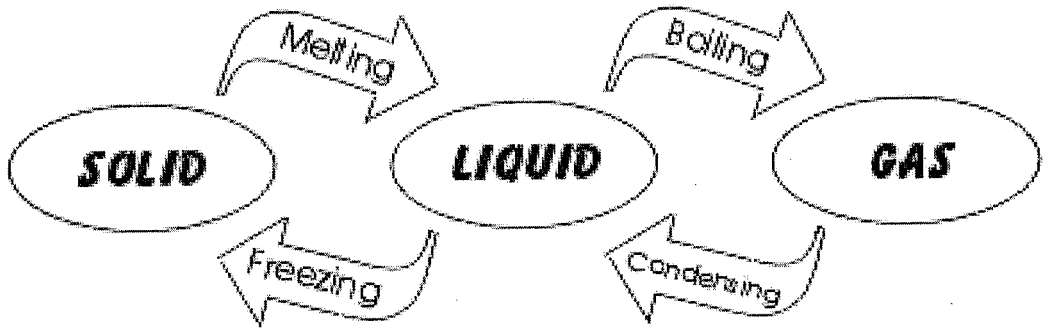
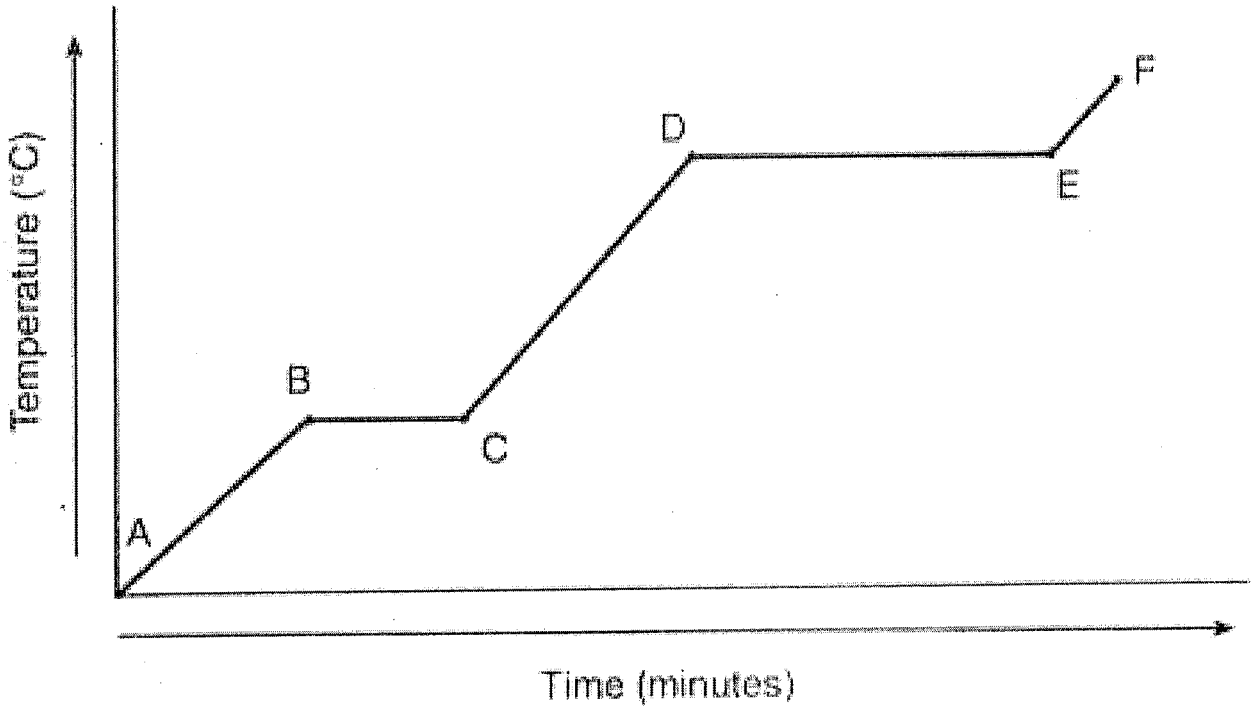
Name_____ Mr. GARDNER

Unit #2: Phases of Matter





Index

1 **Phases of Matter (chapter 13+14)**

2 **Phases of Matter**

- ☐ Dependent on particle arrangement and available space
- ☐ Three phases
  - ■ Solid = particles closely arranged, no free space
  - ■ Liquid = particles spaced out, move freely
  - ■ Gas = particles randomly distributed, far apart

3 **Change of Phase**

- ☐
  - ■ Moving from one phase to another
  - ■ Dependent on:
    - ☐ Temperature
    - ☐ Nature of substance
    - ☐ Pressure of environment (gases only)

4 **Melting/Boiling**

- ☐
- ☐ SOLID LIQUID GAS
  Melting (fusion) boiling (vaporization)
  - ■ Occurs as temperature increases
  - ■ Energy absorbed (endothermic)

5 **Sublimation**

- ☐ SOLID GAS
  Sublimation
  - ■ Occurs as temperature increases
  - ■ Energy absorbed
    - ☐ Example: dry ice

6 **Condensation/Freezing**

- ☐ GAS LIQUID SOLID
  Condensation freezing (solidification)
  - ■ Occurs as temperature decreases
  - ■ Energy released (exothermic)

7 **Deposition**

- ☐ GAS SOLID
  Deposition
  - ■ Occurs as temperature decreases

- Energy released
  - Example: CO_2 fire extinguisher

8 **Endothermic ↑/Exothermic↓ changes**

9 **Kinetic Molecular Theory (KMT)**

- A model of an ideal gas used to explain the behavior of gases
- Important components:
  - Gas moves in a random straight line motion
  - Gas molecules are separated by great distances relative to their size
  - Gas molecules have no attractive forces between them
  - Gas molecules have collisions that result in transfer of energy (law of conservation of energy)

10 **Kinetic Molecular Theory (KMT) continued**

- The average kinetic energy of gas molecules is dependent on temperature
- Equal volumes of gases at the same temperature and pressure have the same number of particles
  - (This is Avogadro's Law)
- Example of Ideal Gases: Noble gases (group 18)

11 **Characteristics of Gases**

- Gases lack definite volume and shape
- Gases have the ability to float in all directions
- Gases are compressible
- Gases spread out and mix with one another
  - Diffusion- movement of molecules from high to low concentration
  - Effusion- movement of molecules under pressure through a small opening (balloons)

12 **Characteristics of Gases continued**

- Most gases are real, not ideal gases
  - Real gases do not follow KMT
  - Real gases can be changed into an ideal gas by either decreasing pressure or increasing temperature
    - Will otherwise liquefy under high pressure or low temperatures

13 **Standard Temperature and Pressure (STP)**

- Reference points when studying gas
- Defined as 1 atmosphere AND 0°C (or 273 K)
- 760mm of Hg or 760 Torr or 101.3 kPa are other standard pressure values that may be used
- Found on Table A in the Chemistry Reference Tables

14 **The Gas Laws MUST USE KELVIN TEMPS!!!**

- Simple mathematical relationships involving:

- -volume
- -temperature
- -pressure
- -number of particles

☐ You will need to convert to K using the formula provided from Table T

- K = °C + 273

15 **Boyle's Law** $P_1V_1=P_2V_2$

- pressure/volume relationship of gases
- volume of a gas is proportional to pressure
- as one variable increases, the other decreases
-

16 **PV = K (where K is a constant)→ $P_1V_1=P_2V_2$**

17 **Boyle's Law example questions**

1) The volume occupied by a gas at STP is 250L. At what pressure in kPa will the gas occupy 1500L? (assume Temperature and # of particles constant)

☐ Given = V_1 = 250L V_2 = 1500L
P_1 = 101.3 kpa P_2 = X

- $(P_1)(V_1) = (P_2)(V_2)$
- (101.3KPa) (250L) = (X) (1500L)
- 25,325KPa*L=(1500L) (X)
- 16.88kpa= P_2
- 17kpa= P_2 (with correct sig figs)

18 **Boyle's Law example questions**

2) A balloon with helium gas has a volume of 500mL at a pressure of 1atm, The balloon reaches an altitude of 6.5km where the pressure is 0.5 atm. Assuming the temperature hasn't changed, what volume does the gas now occupy in the balloon?

19 **Boyle's Law example questions**

3) A gas has a pressure of 1.26 atm and occupies 7.40L. If the gas is compressed to 2.93L, what will its new pressure be, assuming constant temp?

20 **Charles Law**

- volume/temperature relationship of gases
- the volume of a fixed mass of a gas at constant pressure is directly related to temperature (K)

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ Where $\frac{V}{T}$=constant

- as one variable increases, so does the other

21 **Charles Law example questions**

1. A sample of neon gas occupies a volume of 752 mL at 25 °C. What volume will the gas occupy at 50 °C?

- 25°C=298K
- 50°C=323K

☐ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\quad \frac{752mL}{298°K} = \frac{V_2}{323°K}$

- (752mL) (323K) = (298K) (V_2)
- 24,896mLK = 298K (V_2)
- 815.08 mL = V_2
- 815mL = V_2

22 **Charles Law example questions**

2. A Balloon filled with oxygen gas occupies a volume of 5.5L at 25 °C. What volume will the gas occupy at 100 °C?

3. A sample of nitrogen gas is contained in a piston with a freely moving cylinder. At 0 °C the volume of gas is 375 mL. At what temperature must the gas be heated to occupy a volume of 500 mL?

23 **Gay-Lussac's Law**

- pressure/temperature relationship of gas
- the pressure of a given gas is directly related to temperature (K)

temp $\quad \frac{P_1}{T_1} = \frac{P_2}{T_2}$

pressure

- as one variable increases, so does the other

24 **Gay-Lussac's Law example questions**

1. The pressure exerted by a gas is 93 kPa at 200K. What pressure does the gas exert at 500K?

$\frac{P_1}{T_1} = \frac{P_2}{T_2}$ $\quad \frac{93Kpa}{200K} = \frac{X}{500K}$

☐ P_2=232.5 kPa → 200kPa (with S.F)

25 **Gay-Lussac's Law example questions**

2. The pressure of a gas is 50,000 pascals at 327 °C. At what temperature will the pressure be 25 kpa?

☐ 50,000 Pa * $\frac{1kPa}{1000Pa}$ → $\frac{50kPa}{600°K} = \frac{25kPa}{X}$

☐ T_2 = 300K or 27°C

26 **Combined Gas Law**

☐ expresses the relationship between pressure, volume, and temperature (K) of a given gas

☐

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

27 **Combined Gas Law example question**

1. A gas occupies 12 cubic decimeters at 0.5 atm and 300 k. At what temperature will the gas occupy 6 cubic decimeters at 0.25 atm?

- $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$ $\frac{(0.5atm)(12dm3)}{300k} = \frac{(0.25atm)(6dm3)}{T_2}$
- 75 K = T_2
- 80 K = T_2

28 **Combined Gas Law example question**

2. A gas occupies a volume of 250mL at 50°C at 99.7kPa. What temperature will be required to change the volume to 300mL if the pressure is increased to 150 kPa?

- $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$
- $\frac{99.7kPa * 250mL}{323K} = \frac{300mL * 150kPa}{X}$
- T_2 = 583K or 310°C

29 **Avogadro's Law**

- at the same temperature and pressure, equal volumes of any given gas contain an equal number of particles
- Molar Volume = 22.4L/mole of any gas at standard temperature and pressure
  - 0°C and 1ATM

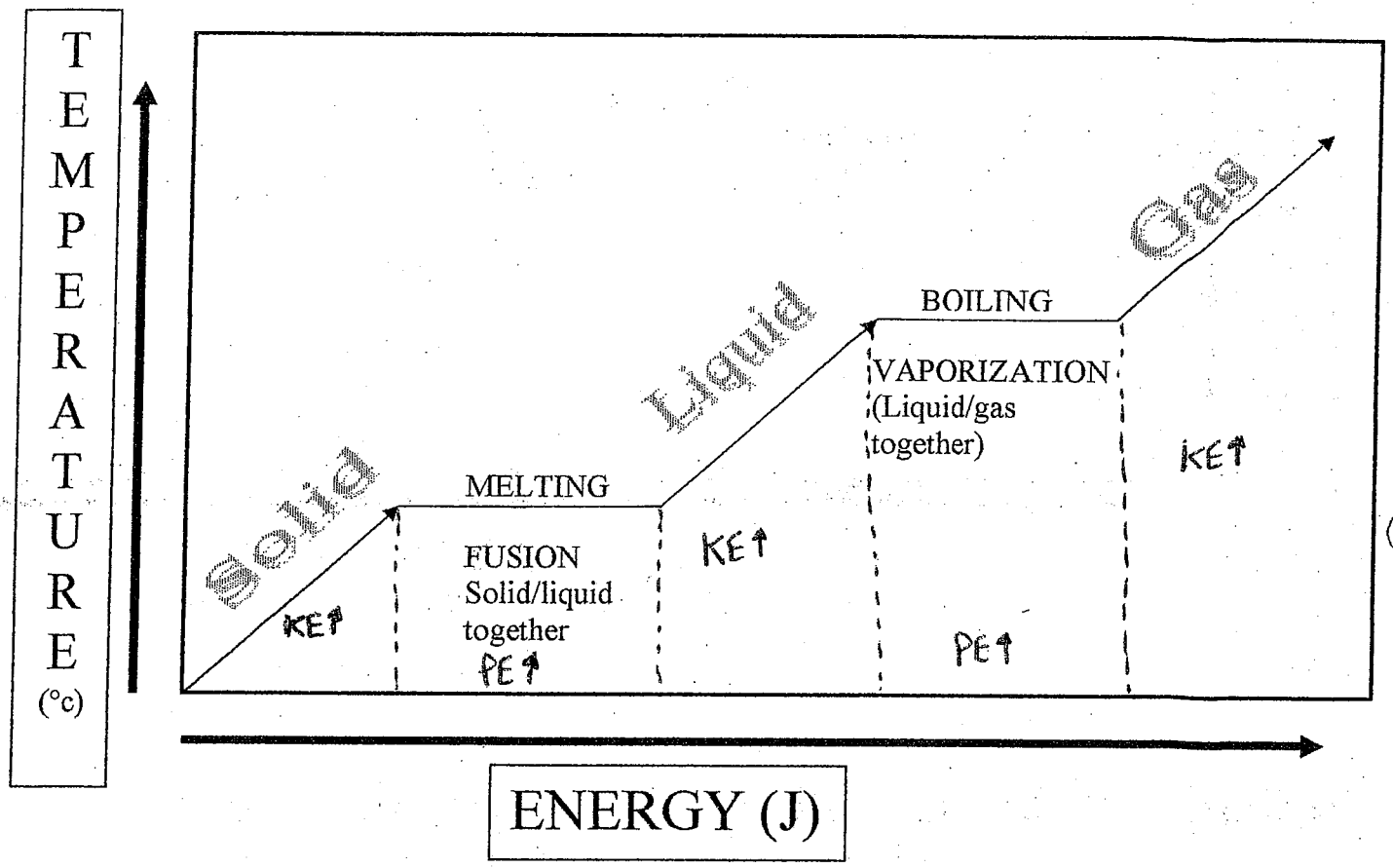
30 **Vapor Pressure**

- pressure exerted by a vapor in equilibrium with it's corresponding liquid at a given temperature
- as temperature of liquid increases, average kinetic energy increases
- as average KE increases, there is an increase of molecules changing to gas
- as number of gas molecules increases, vapor pressure increases

Heating and Cooling Graphs

Represent the change in phase of a substance as temperature increases or decreases

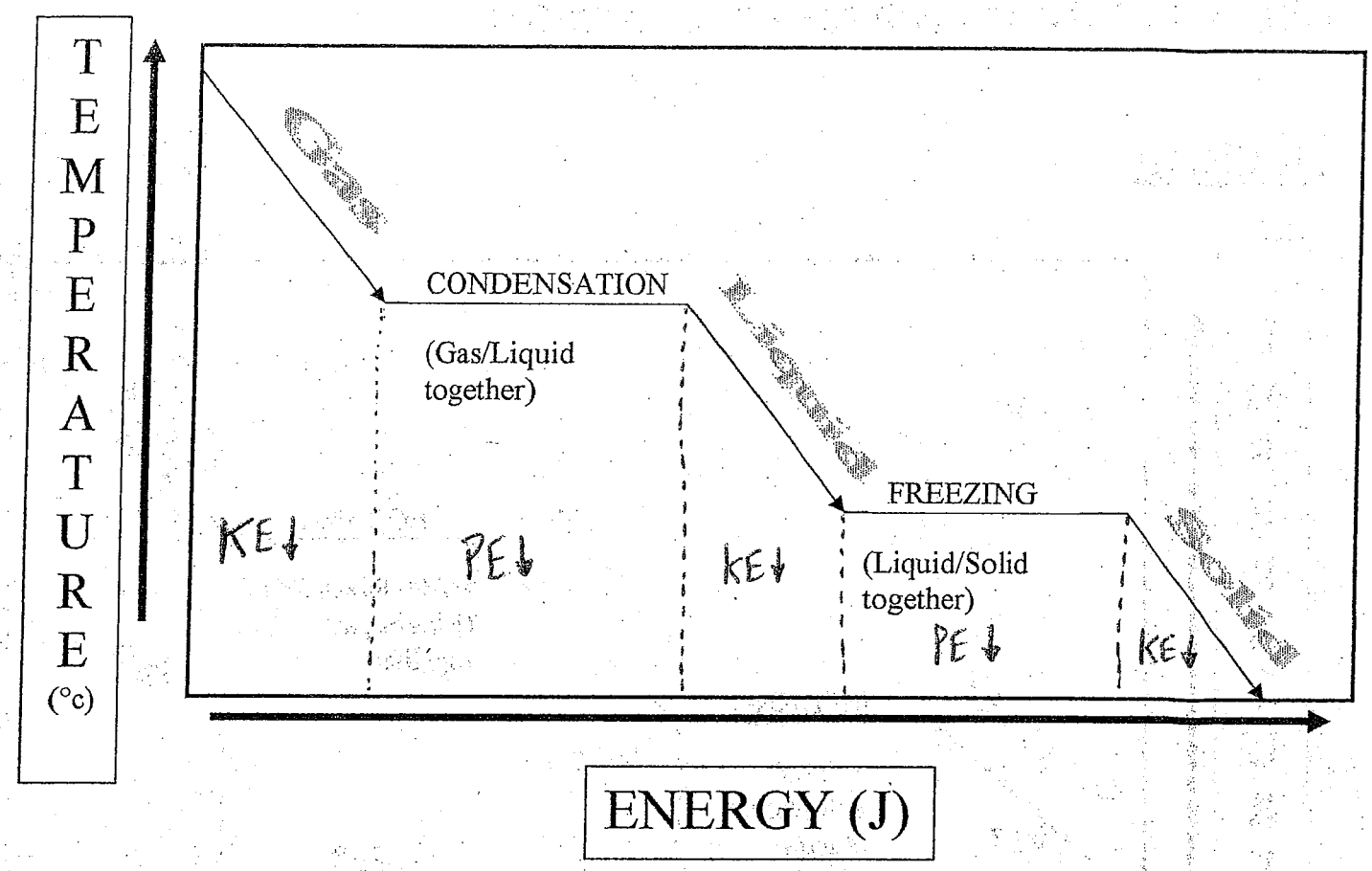
Heating:



Solid/Liquid/Gas
- *Increase in Kinetic Energy
- *no change in Potential Energy

Fusion/Vaporization (melt)/ (boil)
- *Increase in Potential Energy
- *no change in Kinetic Energy

Cooling:



Solid/Liquid/Gas
- *Decrease in Kinetic Energy
- *no change in Potential Energy

Condensation/ Freezing
- *Decrease in Potential Energy
- *no change in Kinetic Energy

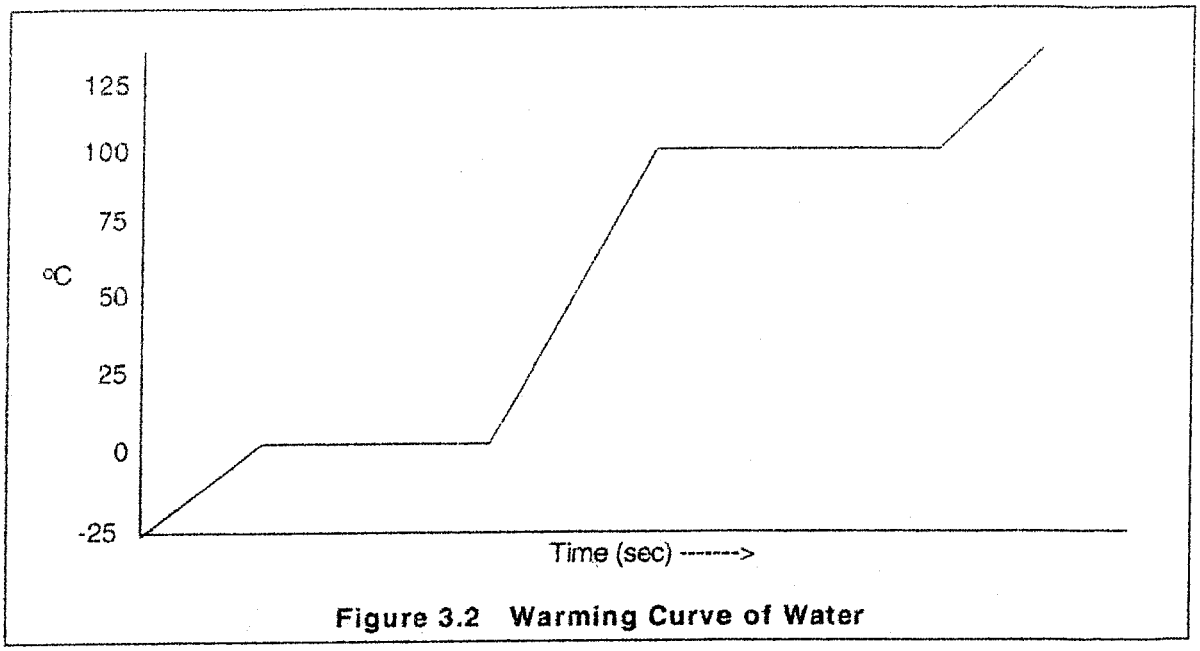


Figure 3.2 Warming Curve of Water

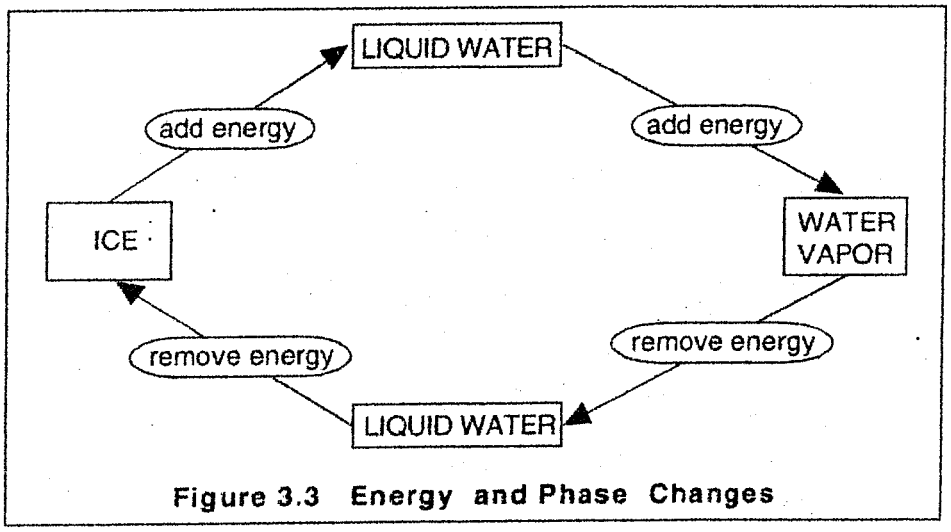
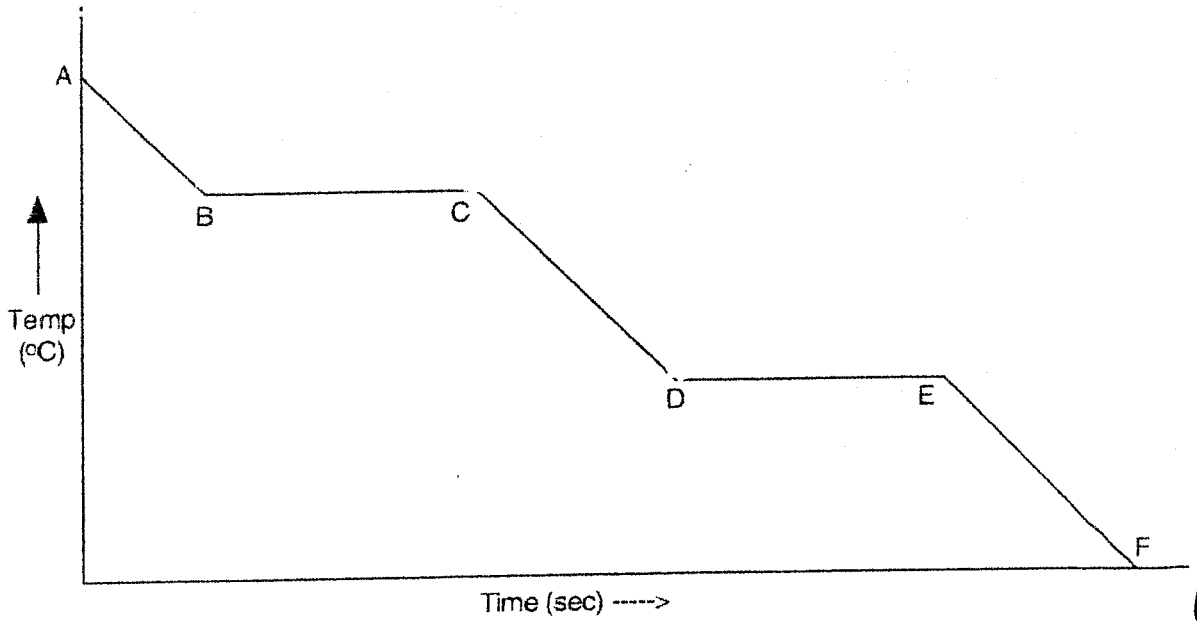


Figure 3.3 Energy and Phase Changes



Name _____ Period _____ Date _____

Unit 4

A.5 SUPPLEMENT: BOYLE'S LAW

In this activity you will solve the following problems using Boyle's law. Show your setup for all problems.

1. A sample of 100.0 mL of oxygen has a pressure of 10.50 kPa. If the pressure is changed to 9.91 kPa, what is the new volume of the gas?

_____

2. A flask containing 95.0 cm^3 of hydrogen was collected under a pressure of 731 mm of mercury. At what pressure would the volume be 70.0 cm^3?

_____

3. A gas has a volume of 50.0 m^3. What volume would the gas occupy

a. if the pressure is doubled? _____

b. if the pressure is cut in half? _____

c. if the pressure is tripled? _____

4. A scuba diver inflates a balloon at a depth of 99 ft (about 4 atm) to .25 ft^3. In the ascent will the balloon increase or decrease in volume?

What will the volume be at the surface (1.0 atm)? _____

_____

5. If the pressure of a gas is 3.0 atm and the volume of the gas doubles, what will the new pressure of the gas become?

_____

6. A gas is confined in a cylinder with a movable piston at one end. When the volume of the cylinder is 760.0 cm^3 the pressure of the gas is 125.0 kPa. When the cylinder volume is reduced to 450.0 cm^3, what is the pressure in psi?

_____

_____

_____

Name _____ Period _____ Date _____

Unit 4

A.7 SUPPLEMENT: CHARLES' LAW

Use Charles' law to solve the following problems.
Show your setup on all problems.

1. If the temperature of a gas is 0.0 °C and the temperature is changed so that the gas volume doubles, what is the new temperature of the gas?

_____

2. A gas has a volume of 10.0 m^3 at standard temperature (273 K). What will the volume of the gas occupy if

a. the Kelvin temperature is doubled? _____

b. the Kelvin temperature is reduced to one-fourth of its original value?

_____

3. Suppose 500.0 mL of oxygen is collected at 25 °C. What will the volume be if the temperature is increased to 50 °C?

_____

4. A gas occupies a volume of 560.0 cm^3 at a temperature of 120 °C. In °C, to what temperature must the gas be lowered if it is to occupy 400.0 cm^3?

_____

5. Suppose 100.0 mL of nitrogen is collected at −10.0 °C. If the temperature of the gas is increased to 60.0 °C, how much will the gas increase in volume?

_____

6. A helium-filled balloon has a volume of 2.75 L at 20.0 °C. The volume of the balloon decreases to 2.46 L after it is taken outside on a winter day.

What is the outside temperature? _____

10

Name _____ Period _____ Date _____

Unit 4

A.8 SUPPLEMENT: TEMPERATURE-PRESSURE RELATIONSHIPS

Solve the following problems. Show your set up on all problems.

1. An automobile tire has a pressure of 199 kPa at 20.0 °C. What will be the pressure after driving, if the tire temperature rises to 80.0 °C?

_____

2. A cylinder of helium outside in the sun has a pressure of 2000.0 psi and a temperature of 51.0 °C. If the cylinder is taken indoors and cooled to 20.0 °C, what will its new pressure be?

_____

3. To what temperature must a sample of nitrogen gas at 22.0 °C and 0.700 atm be heated so that its pressure increases to 1.25 atm?

_____

4. The gaseous contents in an aerosol can are under a pressure of 3.00 atm at 25 °C. If the can pressure cannot exceed 4.00 atm without bursting, what is the highest Celsius temperature it can be exposed to?

_____

5. An empty gasoline can, which still has gasoline vapors in it, has been stored in a garage since the summer when the temperature was 86.0 °F and the pressure was 29.92 in Hg. What would the pressure of the gas in the can be during the winter, when the temperature was 32.0 °F? Explain how this might effect the opening of the can.

_____

_____

_____

6. A can of tennis balls are pressurized to 1.75 atm in a factory at 86.0 °F. If taken out on a wintry day of 10.0 °C, how much would the pressure change?

_____

_____

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Name_____ Gardner

Questions 1-13: Show all work using the combined gas law formula. Answers must show units, and must be rounded to the correct number of significant digits.

1. A sample of neon is collected at 2.7 atm and 12.0 °C. It has a volume of 2.25 L. What would be the volume of this gas at STP?

2. A sample of argon has a volume of 205 cm^3 when its temperature is -44.0 °C and its pressure is 712 mm of Hg. What would be the volume of the argon at STP?

3. A student collects a 3.00×10^2 cm^3 sample of hydrogen at 22.0 °C and 91.9 kPa. What volume would the hydrogen occupy at STP?

4. A 350 cm^3 sample of helium gas is collected at 22.0 °C and 99.3 kPa. What volume would this gas occupy at STP?

5. If I initially have a gas at a pressure of 12 atm, a volume of 23 liters, and a temperature of 200 K, and then I raise the pressure to 14 atm and increase the temperature to 300 K, what is the new volume of the gas?

6. A gas takes up a volume of 17 liters, has a pressure of 2.3 atm, and a temperature of 299 K. If I raise the temperature to 350 K and lower the pressure to 1.5 atm, what is the new volume of the gas?

7. 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 decreased to 35 ^{0}C. If I measure the pressure after the change to be 2.0 atm, what was the original pressure of the gas?

12

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

8. A gas has a temperature of 14 ^{0}C, and a volume of 4.5 liters. If the temperature is raised to 29 ^{0}C and the pressure is not changed, what is the new volume of the gas?

9. I have an unknown volume of gas at a pressure of 0.5 atm and a temperature of 325 K. If I raise the pressure to 1.2 atm, decrease the temperature to 320 K, and measure the final volume to be 48 liters, what was the initial volume of the gas?

10. If I have 21 liters of gas held at a pressure of 78 atm and a temperature of 900 K, what will be the volume of the gas if I decrease the pressure to 45 atm and decrease the temperature to 750 K?

11. If I have 2.9 L of gas at a pressure of 5 atm and a temperature of 50 ^{0}C, what will be the temperature of the gas if I decrease the volume of the gas to 2.4 L and decrease the pressure to 3 atm?

12. I have an unknown volume of gas held at a temperature of 115 K in a container with a pressure of 60 atm. If by increasing the temperature to 225 K and decreasing the pressure to 30 atm causes the volume of the gas to be 29 liters, how many liters of gas did I start with?

13. If I have 17 liters of gas at a temperature of 67 ^{0}C and a pressure of 88.89 atm, what will be the pressure of the gas if I raise the temperature to 94 ^{0}C and decrease the volume to 12 liters?

Name_____

Hot Air Balloons

Extra Credit Opportunity

Topic Area Buoyancy

Materials

- tissue paper - approximately 20" x 30" (7 sheets per balloon)
- rubber cement, glue sticks or white glue
- scissors and tape
- paper clips or pennies (for ballast)
- marking pens (optional)
- propane camp stove
- large cans with tops and bottoms cut out

Key Question What causes a hot air balloon to rise?

Background Information

Hot air balloons are a rich part of aviation history and are as fascinating today as they were two hundred years ago. The first successful manned flight carried two Frenchmen aloft on November 21, 1783, in a hot air balloon constructed of paper and linen. Hot air balloons demonstrate Archimedes' principle. A hot air balloon rises because of the buoyancy imparted by the surrounding air which is more dense than the hot air inside the balloon. This buoyant force is equal to the weight of the air displaced by the balloon. If the weight of the air displaced by the hot air balloon is greater than the total weight of the balloon and its cargo, the balloon will rise. The greater the temperature difference between the inside air and the surrounding air, the greater the difference in their densities, which produces more lift. Hot air balloons work best on cool, still days.

Discussion Questions

1. Why does a hot air balloon rise?

2. Why is it better to launch a hot air balloon on a cold day than on a warm day?

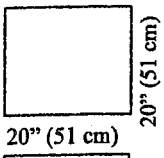
3. Why is hot air less dense than cold air?

4. Why does the hot air balloon fly differently with ballast added?

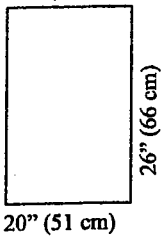
5. Why do hot air balloon pilots avoid windy days?

Hot Air Balloons

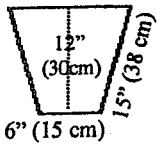
Make one square:



Make four rectangles:



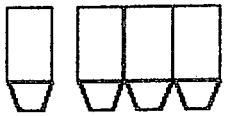
Make four trapezoids:



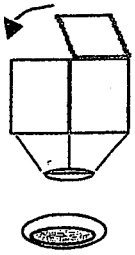
Materials:

- tissue paper (9 sheets)
- construction paper strip
- glue stick, scissors, ruler, pencil
- hot air popcorn popper (~1440 watts)

Glue the rectangles and trapezoids into panels. Glue the panels together.



Glue the square on top.



Make a construction paper ring. Glue it on to the bottom edge of the balloon.

1/2" (1 cm) 26" (64 cm)

Hold the balloon over the hot air popper.

How high does the balloon go when it is filled with hot air for a short time? a long time?

How can you tell when it's ready to fly?

Many things influence how well a balloon floats: the temperature and density of the air (both inside *and* outside the balloon), the mass of the balloon materials, and the distribution of weight.
To learn more, check out *Air Travelers,*
http://www.omsi.edu/sln/air

OMSI

Hot Air Balloons

Make one square:

Make four rectangles:

Make four trapezoids:

Materials:

- tissue paper (9 sheets)
- construction paper strip
- glue stick, scissors, ruler, pencil
- hot air popcorn popper (~1440 watts)

Glue the rectangles and trapezoids into panels. Glue the panels together.

Glue the square on top.

Make a construction paper ring. Glue it on to the bottom edge of the balloon.

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OMSI

Chemistry Review – Unit 2 Name_____
Section_____

Give the definitions for the following terms (use your notes or text). Answer all short answer problems on the lines provided.

1. Pressure –

Standard pressure = _____atm = _____kPa

2. Ideal Gas –

Give the 4 assumptions (postulates) of the Kinetic Theory of gases:

a.

b.

c.

d.

What two real gases behave most like an ideal gas? _____ and _____
Any real gas will behave more like an ideal gas at _____temperature and _____pressure

3. Direct proportion –

Sketch the graph of a direct proportion.

Give the general equation of a direct proportion.

4. Inverse proportion –

Sketch the graph of an inverse proportion.

Give the general equation of an inverse proportion.

5. Charles Law –

Give the equation of Charles law: What unit must temperature be in? _____

What must be kept constant?_____

6. Boyles Law –

Give the equation of Boyles law: What must be kept constant?_____

16

7. Give the equation of the Combined gas law:

8. Phases of matter – to define each phase, fill in the following table. For volume and shape, write definite or indefinite. For spacing, write close together or far apart. For arrangement, write random or ordered.

Phase	Solid	Liquid	Gas
Volume			
Shape			
Particle Spacing			
Particle Arrangement			
Sketch the phase using ○ for the particle.			

9. Intermolecular forces of attraction –

A substance with strong intermolecular attractions would have relatively high/low melting and boiling points and relatively high/low vapor pressures.

10. Evaporation –

11. Vapor pressure –

Explain why vapor pressure increases when temperature increases but not when the amount of liquid increases.

12. Boiling point –

At the boiling point, the vapor pressure of the liquid equals _____.

13. Normal boiling point –

At the normal boiling point, the vapor pressure of the liquid equals _____.

14. Heating curve –

15. Fusion –

16. Vaporization –

17. Sublimation –

Name two substances that readily sublime at room temperature. _____

Name_____ Chem Matter/Gas Law Quiz

Matching:

___ 1) To make something	A. Gay-Lussac's Law
___ 2) Burning in the presence of oxygen	B. Effusion
___ 3) A reaction in which one element is switched	C. Boyle's Law
___ 4) A Reaction is which both elements are switched	D. Diffusion
___ 5) To break something	E. Single Replacement
___ 6) Relationship between pressure and temperature	F. Synthesis
___ 7) Relationship between volume and temperature	G. Double replacement
___ 8) Relationship between pressure and volume	H. Charles' Law
___ 9) Movement of molecules through small openings	I. Combustion
___10) Movement of molecules from high to low	J. Decomposition

Short Answer:

11) Is going from solid to liquid to gas an exothermic process or endothermic one?

12) List 2 sets of values for STP

Pressure		
Temperature		

13) A balloon filled with gas occupies a volume of 7L at 27°C. What will the volume be at 100°C?

14) List three properties or characteristics of gases

A)
B)
C)

15) Using the formula for heat, $Q=MC\Delta T$ determine how much energy is required to warm up 200mL of water from 20°C to 55°C.

18

Phases of Matter

Name: _____

___ 1) Which 5.0-milliliter sample of NH_3 will take the shape of and completely fill a closed 100.0-milliliter container?

A) $NH_3(aq)$ C) $NH_3(l)$
B) $NH_3(g)$ D) $NH_3(s)$

___ 2) Which kelvin temperature is equivalent to -24DC?

A) 297 K C) 249 K
B) 273 K D) 226 K

___ 3) The solid and liquid phases of water can exist in a state of equilibrium at 1 atmosphere of pressure and a temperature of

A) 373DC C) 100DC
B) 0DC D) 273DC

___ 4) How much heat energy must be absorbed to completely melt 35.0 grams of $H_2O(s)$ at 0°C?

A) 9.54 J C) 11,700 J
B) 79,100 J D) 146 J

___ 5) In which process does a solid change directly into a vapor?

A) condensation
B) solidification
C) sublimation
D) deposition

___ 6) As the temperature of a liquid increases, its vapor pressure

A) remains the same
B) decreases
C) increases

___ 7) Based on the *Vapor Pressure of Four Liquids* chemistry reference table, which substance has the *weakest* intermolecular forces?

A) ethanoic acid
B) water
C) propanone
D) ethanol

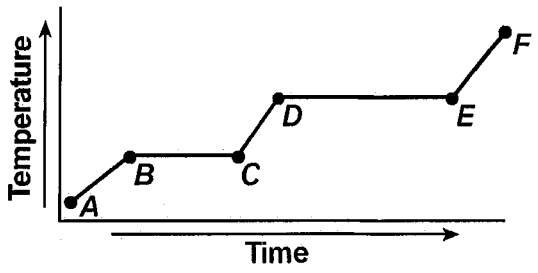
___ 8) According to *Vapor Pressure of Four Liquids* chemistry reference table, what is the vapor pressure of propanone at 45DC?

A) 22 kPa C) 98 kPa
B) 70. kPa D) 33 kPa

___ 9) Which phase change results in the release of energy?

A) $H_2O(l)$ □, $H_2O(g)$
B) $H_2O(s)$ □, $H_2O(g)$
C) $H_2O(s)$ □, $H_2O(l)$
D) $H_2O(g)$ □, $H_2O(l)$

___ 10) The graph below represents the uniform heating of a substance, starting with the substance as a solid below its melting point.

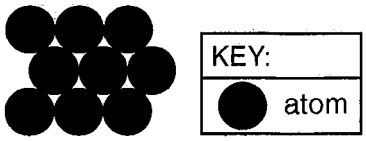


Which line segment represents an increase in potential energy and *no* change in average kinetic energy?

A) *BC* C) *AB*
B) *EF* D) *CD*

___ 11) The density of hydrogen at STP is 0.0899 gram per liter. Express this density to *two* significant figures.

___ 12) Given the particle diagram:



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

A) Ag C) Rn
B) Kr D) Xe

___ 13) A student calculates the density of an unknown solid. The mass is 10.04 grams, and the volume is 8.21 cubic centimeters. How many significant figures should appear in the final answer?

A) 1 C) 3
B) 2 D) 4

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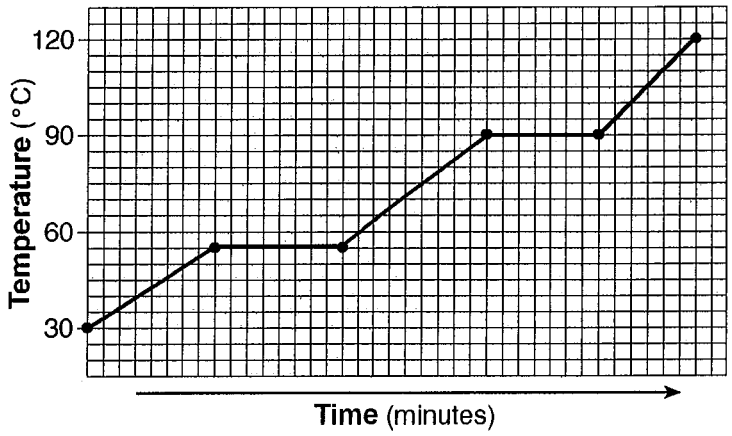
___ 14) The graph below represents the heating curve of a substance that starts as a solid below its freezing point.

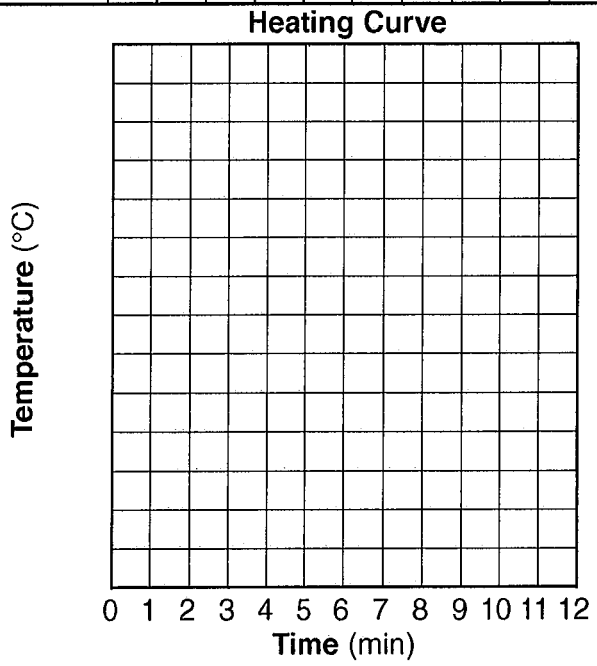


What is the melting point of this substance?

A) 120DC B) 90DC C) 30DC D) 55DC

___ 15) A substance is a solid at 15DC. A student heated a sample of the solid substance and recorded the temperature at one-minute intervals in the data table below.

Time (min)	0	1	2	3	4	5	6	7	8	9	10	11	12
Temperature (°C)	15	32	46	53	53	53	53	53	53	53	53	60	65



(a) On the grid provided, mark an appropriate scale on the axis labeled "Temperature (DC)." An appropriate scale is one that allows a trend to be seen.

(b) Plot the data from the data table. Circle and connect the points.

EXAMPLE:

(c) What is the evidence that the average kinetic energy of the particles of this substance is increasing during the first three minutes?

20

Name: _____ Class: _____ Date: _____ ID: A

Phases of Matter-Gas Laws

Matching

Match each item with the correct statement below.

a. activity series of metals
b. single-replacement reaction
c. combustion reaction
d. decomposition reaction

____ 1. a reaction in which a single compound is broken down into simpler substances
____ 2. a reaction in which oxygen reacts with another substance, often producing heat or light
____ 3. a reaction in which the atoms of one element replace the atoms of a second element in a compound

Match each item with the correct statement below.

a. Boyle's law
b. Charles's law
c. Dalton's law
d. Graham's law
e. Gay-Lussac's law
f. ideal gas law

____ 4. For a given mass of gas at constant temperature, the volume of the gas varies inversely with pressure.
____ 5. The pressure of a gas is directly proportional to its Kelvin temperature if the volume is kept constant.

Match each item with the correct statement below.

a. effusion
b. compressibility
c. diffusion
d. partial pressure

____ 6. the escape of gas through a small hole in a container
____ 7. tendency of molecules to move to regions of lower concentration

Multiple Choice

Identify the letter of the choice that best completes the statement or answers the question.

____ 8. Which of the following is NOT an example of matter?
a. air b. heat c. smoke d. water vapor

____ 9. An example of an extensive property of matter is ____.

a. temperature b. pressure c. mass d. hardness

____ 10. All of the following are physical properties of matter EXCEPT ____.
a. mass b. color c. melting point d. ability to rust

____ 11. A vapor is which state of matter?
a. solid b. liquid c. gas d. all of the above

____ 12. Which state of matter has a definite volume and takes the shape of its container?
a. solid b. liquid c. gas d. both b and c

____ 13. Which state of matter expands when heated and is easy to compress?
a. gas b. liquid c. solid d. all of the above

____ 14. Which of the following is a physical change?
a. corrosion b. explosion c. evaporation d. rotting of food

____ 15. Which of the following is a heterogeneous mixture?
a. air b. salt water c. steel d. soil

____ 16. What is one difference between a mixture and a compound?
a. A compound consists of more than one phase. b. A compound can only be separated into its components by chemical means. c. A mixture can only be separated into its components by chemical means. d. A mixture must be uniform in composition.

____ 17. What must occur for a change to be a chemical reaction?
a. There must be a change in chemical properties. b. There must be a change in physical properties.
c. The change must involve a change in mass. d. The change must involve a change in volume.

____ 18. Which of the following is NOT a physical change?
a. grating cheese b. melting cheese c. fermenting of cheese d. mixing two cheeses in a bowl

____ 19. When paper turns yellow-brown upon exposure to sunlight, what type of change is likely taking place?
a. a physical change b. a chemical change c. neither a physical change nor a chemical change d. both a physical change and a chemical change

____ 20. Which of the following is true for all chemical reactions?
a. The total mass of the reactants increases. b. The total mass of the products is greater than the total mass of the reactants. c. The total mass of the products is less than the total mass of the reactants. d. The total mass of the reactants equals the total mass of the products.

____ 21. When an iron nail is ground into powder, its mass ____.
a. stays the same b. decreases c. increases d. cannot be determined

____ 22. According to the kinetic theory, collisions between molecules in a gas ____.
a. are perfectly elastic b. are inelastic c. never occur d. cause a loss of total kinetic energy

____ 23. Which of the following statements is part of the kinetic theory?
a. The particles of a gas move independently of each other. b. The particles in a gas move rapidly.
c. The particles in a gas are relatively far apart. d. all of the above

____ 24. What is the SI unit of pressure?
a. candela b. mole c. pascal d. newton

____ 25. What is one standard atmosphere of pressure in kilopascals?
a. 0 kPa b. 760 kPa c. 101.3 kPa d. 1 kPa

____ 26. How does the atmospheric pressure at altitudes below sea level compare with atmospheric pressure at sea level?
a. The atmospheric pressure below sea level is higher. b. The atmospheric pressure below sea level is lower. c. The pressures are the same. d. Differences in pressures cannot be determined.

____ 27. What causes gas pressure in a container such as a helium balloon?
a. the walls of the container b. the vacuum maintained in the container c. the simultaneous collisions of fast-moving particles in the container d. atmospheric pressure acting on the outside walls of the container

____ 28. The temperature at which the motion of particles theoretically ceases is ____.
a. –273 K b. 0 K c. 0°C d. 273°C

____ 29. What happens to the average kinetic energy of the particles in a sample of matter as the temperature of the sample is increased?
a. The average kinetic energy decreases. b. The average kinetic energy increases. c. The average kinetic energy does not change. d. The change in average kinetic energy cannot be determined.

____ 30. With which temperature scale is temperature directly proportional to average kinetic energy?
a. Celsius b. Fahrenheit c. Kelvin d. centigrade

____ 31. Consider an iron cube and an aluminum cube. If the two cubes were at the same temperature, how would the average kinetic energy of the particles in iron compare with the average kinetic energy of the particles in aluminum?
a. The average kinetic energy of the iron particles would be greater. b. The average kinetic energy of the aluminum particles would be greater. c. There would be no difference in the average kinetic energies. d. No determination can be made based on the information given.

____ 32. If a liquid is sealed in a container and kept at constant temperature, how does its vapor pressure change over time?
a. It continues to steadily increase. b. It increases at first, then remains constant. c. It increases at first, then decreases. d. It continues to steadily decrease.

____ 33. Which of the following best describes the motion of the particles in a piece of steel?
a. None are moving. b. A few are moving. c. All are moving. d. Most are moving.

____ 34. The direct change of a substance from a solid to a gas is called ____.
a. evaporation b. sublimation c. condensation d. solidification

____ 35. Why does the pressure inside a container of gas increase if more gas is added to the container?
a. There is an increase in the number of collisions between particles and the walls of the container.
b. There is an increase in the temperature of the gas. c. There is a decrease in the volume of the gas.
d. There is an increase in the force of the collisions between the particles and the walls of the container.

____ 36. If a balloon is squeezed, what happens to the pressure of the gas inside the balloon?
a. It increases. b. It stays the same. c. It decreases. d. The pressure depends on the type of gas in the balloon.

____ 37. What happens to the temperature of a gas when it is compressed?
a. The temperature increases. b. The temperature does not change. c. The temperature decreases.
d. The temperature becomes unpredictable.

____ 38. What happens to the pressure of a gas inside a container if the temperature of the gas decreases?
a. The pressure increases. b. The pressure does not change. c. The pressure decreases. d. The pressure cannot be predicted.

____ 39. When the Kelvin temperature of an enclosed gas doubles, the particles of the gas ____.
a. move faster b. strike the walls of the container with less force c. decrease in average kinetic energy
d. decrease in volume

____ 40. The volume of a gas is doubled while the temperature is held constant. How does the gas pressure change?
a. It is reduced by one half. b. It does not change. c. It is doubled. d. It varies depending on the type of gas.

____ 41. If a balloon is heated, what happens to the volume of the air in the balloon if the pressure is constant?
a. It increases. b. It stays the same. c. It decreases. d. The change cannot be predicted.

____ 42. If a sealed syringe is plunged into cold water, in which direction will the syringe piston slide?
a. in b. out c. No movement will occur. d. The direction cannot be predicted.

____ 43. A gas occupies a volume of 2.4 L at 14.1 kPa. What volume will the gas occupy at 84.6 kPa?
a. 497 L b. 2.5 L c. 14 L d. 0.40 L

____ 44. The combined gas law relates which of the following?
a. pressure and volume only b. temperature and pressure only c. volume and temperature only
d. temperature, pressure, and volume

____ 45. At a certain temperature and pressure, 0.20 mol of carbon dioxide has a volume of 3.1 L. A 3.1-L sample of hydrogen at the same temperature and pressure ____.
a. has the same mass b. contains the same number of atoms c. has a higher density d. contains the same number of molecules

____ 46. Under what conditions of temperature and pressure is the behavior of real gases most like that of ideal gases?
a. low temperature and low pressure b. low temperature and high pressure c. high temperature and low pressure d. high temperature and high pressure

____ 47. Which of the following gases will effuse the most rapidly?
a. bromine b. chlorine c. ammonia d. hydrogen

Short Answer

48. The volume of a gas is 250 mL at 340.0 kPa pressure. What will the volume be when the pressure is reduced to 50.0 kPa, assuming the temperature remains constant?

Numeric Response

49. In how many physical states does water commonly exist?

50. How many grams of liquid water are produced when 60 grams of ice melt?

Gases
Mr. Gardner

Name_____

1. According to the kinetic theory of gases, which assumption is correct?

1. Gas particles strongly attract each other.

2. Gas particles travel in curved paths.

3. The volume of gas particles prevents random motion.

4. Energy may be transferred between colliding particles.

2. As the temperature of $H_2O(l)$ in a closed system decreases, the vapor pressure of the $H_2O(l)$

1. decreases

2. increases

3. remains the same

3. Given the equilibrium at 101.3 kPa
At what temperature does this equilibrium occur?

$$H_2O\,(s) \rightleftharpoons H_2O(\ell)$$

1. 100 K

2. 273 K

3. 298 K

4. 373 K

4. At 1 atmosphere of pressure, the steam-water equilibrium occurs at a temperature of

1. 0 K

2. 100 K

3. 273 K

4. 373 K

5. What volume will a 300.-milliliter sample of a gas at STP occupy when the pressure is doubled at constant temperature?

1. 150. mL

2. 450. mL

3. 300. mL

4. 600. mL

6. As the pressure of a gas at 760 torr is changed to 380 torr at constant temperature, the volume ot the gas

1. decreases

2. increases

3. remains the same

7. The volume of a sample of a gas at 273°C is 200. liters. If the volume is decreased to 100. liters at constant pressure, what will be the new temperature of the gas?

1. 0 K

2. 100. K

3. 273 K

4. 546 K

8. Based on Reference Table *H*, which sample has the highest vapor pressure?

1. water at 20°C

2. water at 80°C

3. ethanol at 50°C

4. ethanol at 65°C

9. What is the equilibrium temperature of an ice-water mixture at a pressure of 1 atmosphere?

1. 0°C

2. 32°C

3. 100°C

4. 273°C

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10. As the temperature of a gas increases at constant pressure, the volume of the gas

1. decreases
2. increases
3. remains the same

11. Standard temperature and a pressure of 0.5 atmosphere are equal to

1. 0°C and 380 torr
2. 32°C and 380 torr
3. 0°C and 760 torr
4. 32°C and 760 torr

12. What will be the new volume of a 1.00-mole sample of a gas at STP if the pressure remains constant and the Kelvin temperature is halved?

1. 11.2 L
2. 22.4 L
3. 33.6 L
4. 44.8 L

13. At constant temperature, the relationship between the volume (V) of a given mass of gas and its pressure (P) is

1. $V = kP$
2. $P = kV$
3. $PV = k$
4. $V/P = k$

14. The particles in a crystalline solid are arranged

1. randomly and far apart
2. randomly and close together
3. regularly and far apart
4. regularly and close together

15. If the pressure on a given mass of gas in a closed system is increased and the temperature remains constant, the volume of the gas will

1. decrease
2. increase
3. remain the same

16. Compared to the average kinetic energy of 1 mole of water at O°C, the average kinetic energy of 1 mole of water at 298 K is

1. the same, and the number of molecules is the same
2. the same, but the number of molecules is greater
3. greater, and the number of molecules is greater
4. greater, but the number of molecules is the same

17. Under which condition does a real gas behave most nearly like an ideal gas?

1. high pressure and low temperature
2. high pressure and high temperature
3. low pressure and low temperature
4. low pressure and high temperature

18. Which property of a sample of mercury is different at 320 K than at 300 K?

1. atomic mass
2. atomic radius
3. vapor pressure
4. melting point

19. The volume of a given mass of an ideal gas at constant pressure is

1. directly proportional to the Kelvin temperature
2. directly proportional to the Celsius temperature
3. inversely proportional to the Kelvin temperature
4. inversely proportional to the Celsius temperature

20. A gas has a volume of 1,400 milliliters at a temperature of 20. K and a pressure of 760 mmHg. What will be the new volume when the temperature is changed to 40. K and the pressure is changed to 380 mmHg?

1. 350 mL
2. 750 mL
3. 1,400 mL
4. 5,600 mL

21. At a temperature of 273 K, a 400. milliliter gas sample has a pressure of 760. millimeters of mercury. If the pressure is changed to 380. milliliters of mercury, at which temperature will this gas sample have a volume of 551 milliliters?

1. 100 K
2. 188 K
3. 273 K
4. 546 K

22. The volume of a 1.00-mole sample of an ideal gas will decrease when the

1. pressure decreases and the temperature decreases
2. pressure decreases and the temperature increases
3. pressure increases and the temperature decreases
4. pressure increases and the temperature increases

23. Which temperature change would cause the volume of a sample of an ideal gas to double when the pressure of the sample remains the same?

1. from 200°C to 400°C
2. from 400°C to 200°C
3. from 200 K to 400 K
4. from 400 K to 200 K

24. A 3.00-liter sample of gas is at 288 K and 1.00 atm. If the pressure of the gas is increased to 2.00 atm and its volume is decreased to 1.50 liters, the Kelvin temperature of the sample will be

1. 144 K
2. 288 K
3. 432 K
4. 576 K

25. At the same temperature and pressure, which sample contains the same number of moles of particles as 1 liter of $O_2(g)$?

1. 1 L Ne(g)
2. 2 L $N_2(g)$
3. 0.5 L $SO_2(g)$
4. 1 L $H_2O(l)$

26. A closed container holds 3.0 moles of CO_2 gas at STP. What is the total number of moles of Ne(g) that can be placed in a container of the same size at STP?

1. 1.0 mole
2. 1.5 moles
3. 3.0 moles
4. 0.0 moles

27. According to Reference Table *H*, what is the vapor pressure of propanone at 45°C?

1. 22 kPa
2. 33 kPa
3. 70. kPa
4. 98 kPa

28. 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.

29. The solid and liquid phases of water can exist in a state of equilibrium at 1 atmosphere of pressure and a temperature of

1. 0°C
2. 100°C
3. 273°C
4. 373°C

30. As the temperature of a liquid increases, its vapor pressure

1. decreases
2. increases
3. remains the same

31. At the same temperature and pressure, 1.0 liter of CO(g) and 1.0 liter of CO_2(g) have

1. equal masses and the same number of molecules
2. different masses and a different number of molecules
3. equal volumes and the same number of molecules
4. different volumes and a different number of molecules

32. The temperature of a 2.0-liter sample of helium gas at STP is increased to 27°C and the pressure is decreased to 80. kPa. What is the new volume of the helium sample?

1. 1.4 L
2. 2.0 L
3. 2.8 L
4. 4.0 L

33. A real gas differs from an ideal gas because the molecules of real gas have

1. some volume and no attraction for each other
2. some volume and some attraction for each other
3. no volume and no attraction for each other
4. no volume and some attraction for each other

34. A sealed flask containing 1.0 mole of H_2(g) and a sealed flask containing 2.0 moles of He(g) are at the same temperature. The two gases must have equal

1. masses
2. volumes
3. average kinetic energies
4. numbers of molecules

35. Two basic properties of the gas phase are

1. a definite shape and a definite volume
2. a definite shape but no definite volume
3. no definite shape but a definite volume
4. no definite shape and no definite volume

BONUS: List <u>both</u> parts/views/answers of each illusion (possible 2.5 pts each or 10 points total)

Teacher: Why did you not study?

Me: A year has 365 days for you to study. After taking away 52 Sundays, there are only 313 days left. There are 50 days in the summer that is way too hot to work so there are only 263 days left. We sleep 8 hours a day, in a year, that counts up to 122 days so now we're left with 141 days. If we fooled around for only 1 hour a day, 15 days are gone, so we are left with 126 days. We spend 2 hours eating each day, 30 days are used in this way in the year, and we are left with 96 days in our year. We spend 1 hour a day speaking to friends and family, that takes away 15 days more and we are left with 81 days. Exams and tests take up at least 35 days in your year, hence you are only left with 46 days. Taking off approximately 40 days of holidays, you are only left with 6 days. Say you are sick for a minimum of 3 days, you're left with 3 days in the year to study! Let's say you only go out for 2 days, You're left with 1 day! But that 1 day is your birthday.

NOTE: Be sure you actually do study this year...Each night, put some time in and you will see the exponential growth of your knowledge that will help you on upcoming exams in this class.