Name:

Regents Chemistry: Dr. Shanzer

Practice Packet

Chapter 3: Matter

Chapter 3 & 4 Vocabulary
Matter & Energy

1. **Absolute Zero** – the lowest possible temperature; the temperature at which all particle movement stops; -273°C or 0 K.
2. **Avogadro's Law** – gases at the same temperature, pressure, & volume have the same number of molecules or particles.
3. **(Normal) Boiling Point** – the temperature at which a phase change between liquid and gas occurs at 1 atm or 101.3 kPa; the temperature at which the vapor pressure of a liquid is equal to the atmospheric pressure.
4. **Compound** – pure substance composed of two or more different elements chemically combined.
5. **Cooling Curve** – diagram showing phase changes for a substance as it loses energy and goes from gas phase all the way to solid phase.
6. **Deposition** – phase change from gas to solid.
7. **Energy** – the capacity to do work.
8. **Element** – pure substance composed of one species of atoms.
9. **Evaporation** – phase change from liquid to gas.
10. **Extensive (property)** – a physical property that depends on sample size or amount (Ex: mass, length).
11. **Heat** – form of energy measured in Joules (J).
12. **Heat of Fusion** – energy required to change 1 g of a substance from solid to liquid.
13. **Heat of Vaporization** – energy required to change 1 g of a substance from liquid to gas.
14. **Heating Curve** – diagram showing phase changes for a substance as it gains energy and goes from solid phase all the way to gas phase.
15. **Heat Transfer** – energy transferred from a substance with more (hotter) to a substance with less (cooler).
16. **Intensive (property)** – a physical property that does NOT depend on sample size or amount (Ex: melting point, boiling point, density)
16. **Kinetic Energy** – energy of motion; energy associated with a change in temperature.
16. **Kinetic Molecular Theory (KMT)** – a model used to explain the behavior of gases in terms of the motion of their particles.
17. **Lattice** – the unique crystal structure associated with any given solid.
18. **Matter** – anything that has mass and takes up space.
19. **Melting Point** – the temperature at which a phase change between solid and liquid occurs.
20. **Mixture** – two or more pure substances physically combined.
21. **Potential (AKA Physical) Energy** – energy of position; energy associated with a phase change.
22. **Sublimation** – phase change from solid to gas.
23. **Temperature** – a measure of average kinetic energy.
24. **Vapor Pressure** – the upward pressure of a vapor in equilibrium with its liquid.

Types of Matter

Chemistry 200
Video Lesson 3.1

Objectives

- Categorize a sample of matter as a substance or mixture.
- Distinguish between homogeneous and heterogeneous samples of matter.
- Describe two ways that components of mixtures can be separated.

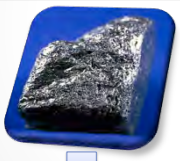
What is Matter?

Anything that has mass and volume

What are pure substances?

- Substances can be identified as either an element or compound
- Cannot be broken down by physical means

Characterized by chemical symbols



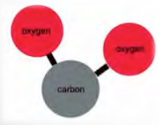
C

Characterized by chemical formulas

NaCl

What is a pure substance?

Compounds	Elements
• Can be broken down by chemical changes • Always in a definite ratio • More than 1 symbol ($NaCl$ or $MgCl_2$)	• Cannot be broken down • 1 symbol ○ Na or C



What is a mixture?

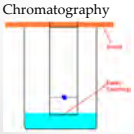
- Mixtures are two or more substances that are NOT chemically combined
  - ○ They can be separated by physical methods
- **Mixtures DO NOT have:**
  - ○ Constant boiling points
  - ○ Constant melting points

Physical Methods to Separate of Mixtures

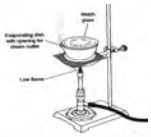
Filtration

Distillation

Chromatography

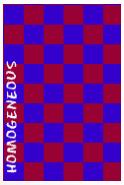


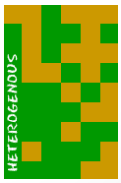
Evaporation/Boiling



Types of Mixtures

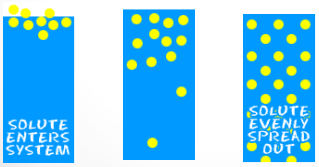
Homogeneous Mixture	Heterogeneous Mixture
• Look the same throughout • Uniform distribution • Salt Water	• Not uniformly mixed • Can see the different components • Ex: Sand and water

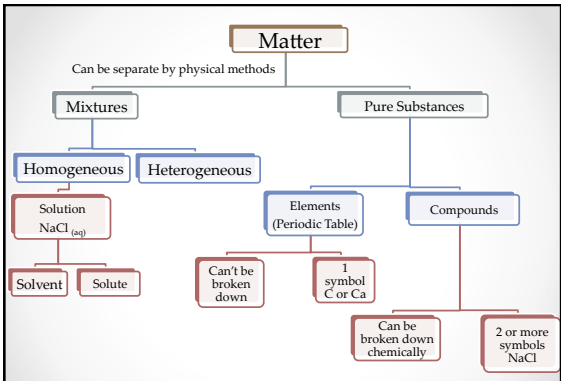




Solutions

- Solutions are homogeneous mixtures
- A substance is completely dissolved by another
  - Solute: substance dissolved
  - Solvent: substance doing the dissolving
- Aqueous – Dissolved in water (aq)
  - **$NaCl_{(aq)}$** **NaCl = solute Water = solvent**





Physical & Chemical changes

Chemistry 200
Video Lesson 3.2

Objective:

How do we determine if a substance is going through a physical or chemical change?

Properties of Matter

- each substance has a **unique set of properties**, this allows us to distinguish it from other substances

Two Categories of Properties:

A. Physical Properties

-characteristics that can be observed or measured ***w/o the production of a new substance***

ex:
color
odor
taste
hardness
density
MP (melting point)
BP (boiling point)
electrical conductivity
solubility

Physical changes -

- a new substance is not formed, only a change in appearance of the starting material.

ex: $H_2O_{(s)} \xrightarrow[\text{heat}]{} H_2O_{(l)} \xrightarrow[\text{heat}]{} H_2O_{(g)}$ all phase changes (Δ's)

B. Chemical Properties

- the ability of a substance to combine w/ or change into one or more other substances

ex: Iron has the ability to rust in the presence of O_2

Chemical change
(chemical reaction)

- the process where 1 or more substances change into new substances

ex: $C_6H_{12}O_6 + O_2 \rightarrow H_2O + CO_2 + ATP$

Key words: explode, rust
oxidize, corrode
tarnish, ferment
burn or rot

Phases of Matter

Chemistry 200
Video Lesson 3.3

Objective:

How do we determine the phase of a substance & if there is a phase change?

Phases (states) of Matter

A. Solid - has a definite shape & volume, rigid form

B. Liquid - indefinite shape (shape of container) & has a definite volume

C. Gas - indefinite shape & volume, confined only by its container

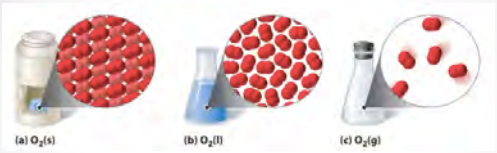
****Aqueous - when H_2O is added to a substance & a solution is formed ****

Phase Change

- when matter changes from one phase or form to another

ex: ice ----------> melts -------> boils to Vapor
solid (s) liquid (l) gas (g)

II. Arrangement of molecules (particles) of matter



Intermolecular Forces

- forces of attraction btwn molecules in solids & liquids

A. Solids - strong intermolecular forces keep the molecules in fixed locations
****no motion*****

B. Liquids (fluid) - intermolecular forces btwn the molecules allow them to move past one another
****no definite shape*****

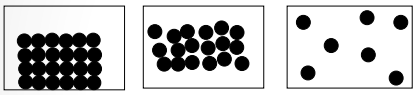
C. Gases (fluid) - no intermolecular forces, molecules spread out & fill its container
****molecules moving fast*****

****Elements H, N, O, Cl, F are gases @ STP(*Standard Temp. & Pressure*)****

Practice!!!!

Illustrate the arrangement of He molecules as a solid, liquid & gas in the containers below:

Key: ● =1 molecule of He (Helium)



solid liquid gas

Particle Diagrams

Chemistry 200
Video Lesson 3.4

Objectives

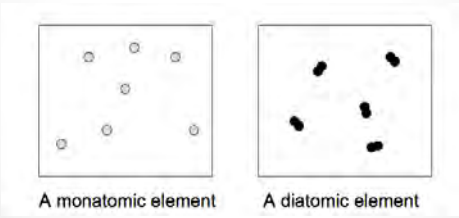
- What do chemists use to represent elements, compounds and mixtures.

Particle Diagrams

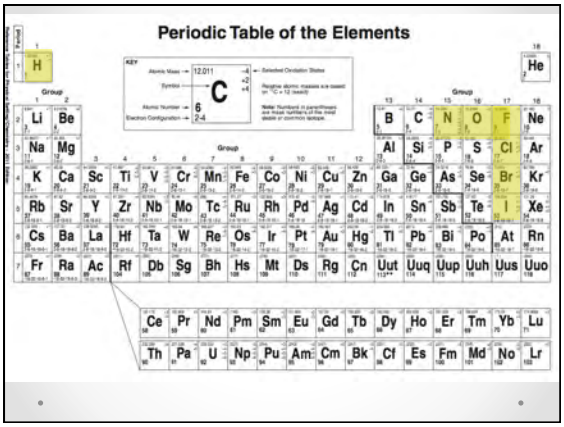
- Elements, Compounds and Mixtures can be represented using particle diagrams
  - A box in which colored circles are drawn to represent atoms or compounds

Elements – 1 Symbol

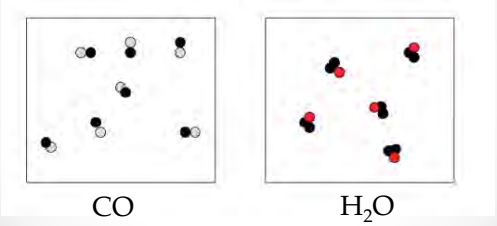
Br_2, I_2, N_2, Cl_2, H_2, O_2, F_2
Or
SEVEN UP



Na F_2

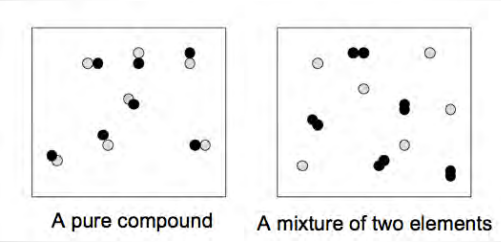


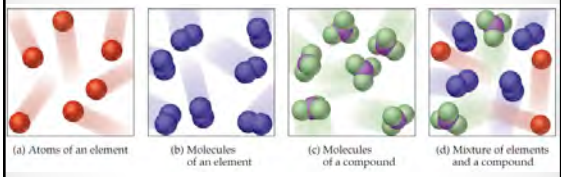
Compounds – 2 or more Symbols

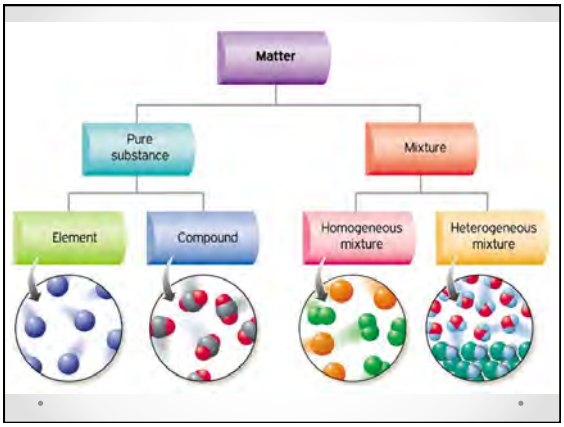


CO H_2O

Mixtures







Heating & Cooling Curves

Chemistry 200
Video Lesson 3.5

Objective:

How do we use heating & cooling curves to determine the phase of a substance & if a phase change has occurred?

I. Heating & Cooling Curves

Sublimation - solid changes directly to a gas

Deposition - gas changes directly to a solid

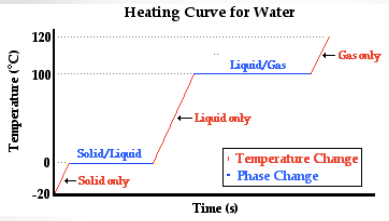
A. Heating Curves

- graph that show phase changes, (s)->(l)->(g), as a solid is heated at a constant rate

Fusion (melting)
- when a solid becomes a liquid

Vaporization (boiling & evaporation)
- when a liquid becomes a gas

Endothermic
- a reaction that requires energy, heat is absorbed



Summary: (all steps endothermic)

Solid only: 1 phase present, K.E. increases

Solid/Liquid: 2 phases present, P.E. increases, K.E. constant

Liquid only: 1 phase present, K.E. increases

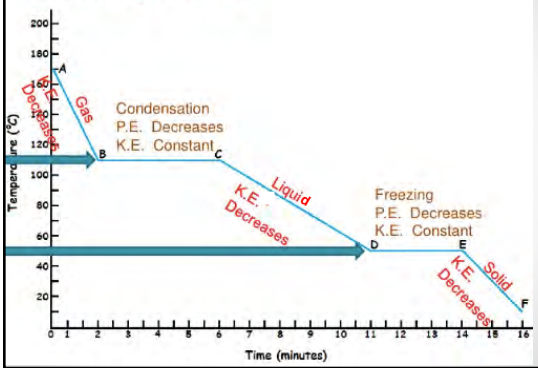
Liquid/Gas: 2 phases present, P.E. increases, K.E. constant

Gas only: 1 phase present, K.E. increases

B. Cooling Curve

1. Graph that shows phase changes, (g)->(l)->(s), as gas cools at a constant rate
2. Condensation - when a gas becomes a liquid (reverse of vaporization)
3. Freezing - when a liquid becomes a solid (reverse of fusion)
4. Exothermic - a reaction that releases energy (heat)

Cooling Curve (all steps exothermic)



Significant Digits & Calculating Density

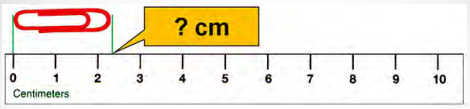
Chemistry 200
Video Lesson 3.6

Objectives

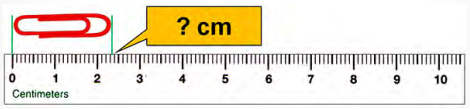
- Determine the number of significant figures in a measurement and in a calculated answer.
- Calculate the density of a material from experimental data.

Significant Figures in Measurement

- Numbers reported in a measurement are limited by the measuring tool.
- Significant figures include known digits in a measurement and one estimated digit.
- Measuring tools differ in the number of significant figures that can be obtained from their use.



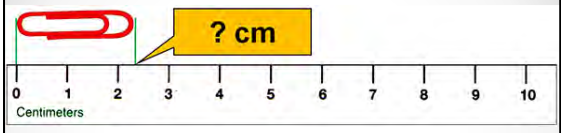
A



B

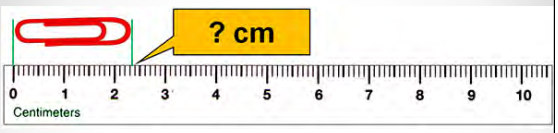
Which ruler is my precise A or B?

A



The only known digit is 2 and a second digit can be estimated
I would estimate this measurement to be 2.3 cm
This tool can report 2 significant figures

B



There are two known digits and a third can be estimated
I would estimate this measurement to be 2.31 cm
This tool can report 3 significant figures

Rules for Count Significant Figures

- All non-zero digits are significant
- Leading zeros in decimal numbers are not significant
- Zeros between nonzero numbers are significant.
- Trailing zeros in numbers without decimals are not significant

A way to Remember

Practice: How many significant digits are in each of the following measurements.

1. 48 cm — 2
2. 306.2 g — 4
3. 3700 mm — 2
4. 400. cm^3 — 3

- **Multiplying & Dividing**: The number of significant figures in a product or quotient is the same as the measurement with the smaller number of sig figs.

Problem
3.1415 × 2.25 = 7.068375

Correct number of Significant Figures = 3

Solution 7.07

Addition & Subtraction: The number of decimal places in the sum or difference is equal to the number of decimal places in the measured quantity with the smallest number of decimal places.

Problem
6.357 - 2.4 = 3.957

Correct number of Decimal Places = 1

Solution 4.0

Calculating Density

Table T

$d = \frac{m}{V}$

d = density
m = mass
V = volume

Table S
Properties of Selected Elements

Atomic Number	Symbol	Name	First Ionization Energy (kJ/mol)	Electro-negativity	Melting Point (K)	Boiling* Point (K)	Density** (g/cm³)	Atomic Radius (pm)
1	H	hydrogen	1312	2.2	14	20	0.000082	32
2	He	helium	2372	—	—	4	0.000164	37
3	Li	lithium	520.	1.0	454	1615	0.534	130.
4	Be	beryllium	900.	1.6	1560.	2744	1.85	99
5	B	boron	801	2.0	2348	4273	2.34	84

Examples

- A sample of O_2 gas has a mass of 32. 65 g and a volume of 24. 824 L. What is the density of the O_2 gas?

$d = \frac{m}{V}$

d = density
m = mass
V = volume

d = 1.315 g/L

$$d = \frac{32.65\ g}{24.824\ L}$$

4 sig

5 sig

d = 1.315259 g/L

Example

- What is the volume of a 8.52 g sample of boron, expressed to the correct number of significant figures?

$d = \frac{m}{V}$

d = density
m = mass
V = volume

$$2.34\ g/cm^3 = \frac{8.52\ g}{V}$$

$$\frac{(2.34\ g/cm^3)V}{2.34\ g/cm^3} = \frac{8.52\ g}{2.34\ g/cm^3}$$

$V = 3.64102564\ cm^3$

$V = 3.64\ cm^3$

Sketch Notes

Sketch Notes

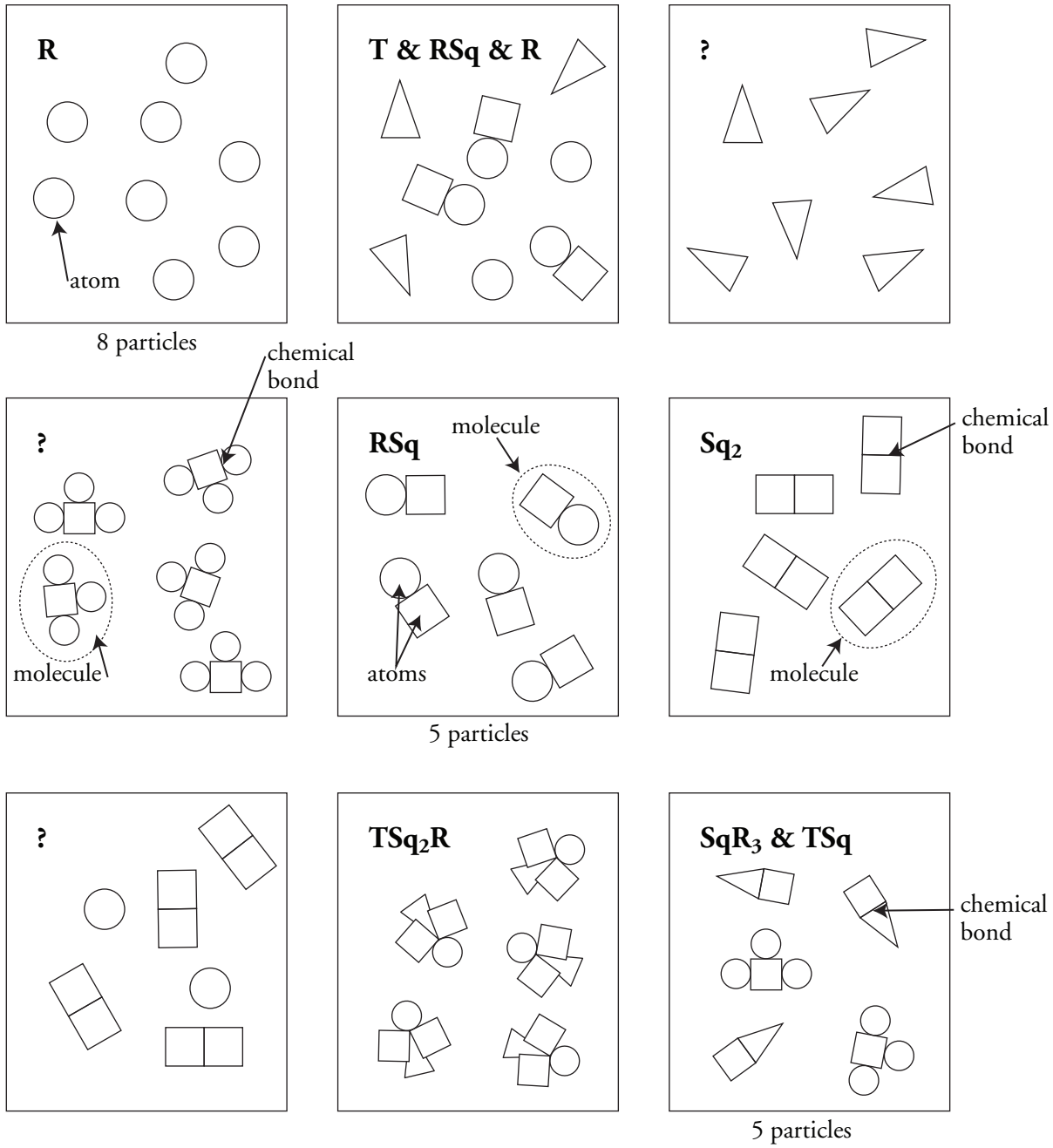
Classification of Matter

How do atoms combine to make different types of matter?

Why?

Look at the things in this room. They are all matter. That matter may be pure or it may be a mixture. Can you tell by looking at it? What if you looked at it under a microscope? Then could you tell? Something that looks pure may not really be pure. It depends on what type of particles an object or substance is made of. In this activity we will explore how the smallest chemical units of matter determine whether something is classified as an element, a compound, or a mixture.

Model 1 — Atoms, Particles, and Molecules



1. Locate the circled molecule of **RSq** in Model 1.
   a. Find a second **RSq** molecule and circle it.
   b. How many atoms are in a molecule of **RSq**?

2. Find and circle a molecule of **TSq_2R** in Model 1.
   a. How many different types of atoms are found in a molecule of **TSq_2R**?

   b. How many Sq atoms are in a molecule of **TSq_2R**?

3. Locate the drawing labeled **SqR_3 & TSq** in Model 1.
   a. How many different types of atoms are found in the sample of **SqR_3 & TSq**?

   b. How many different types of molecules are found in the sample of **SqR_3 & TSq**?

4. When two atoms are touching in the drawings of Model 1, what is holding the atoms together?

5. As a group, discuss the following questions and record your answers:
   a. Can a *particle* be a single atom?

   b. Can a *particle* be a molecule?

   c. How many particles are in the drawing representing **T & RSq & R** in Model 1?

   d. What is your group's definition of the word "particle" as it is used in chemistry?

6. Compare the codes listed at the top of each drawing in Model 1 with the shapes in that box.
   a. What do the letters **R**, **Sq,** and **T** in the codes represent?

   b. What do the small numbers (subscripts) in the codes represent?

   c. When atoms are touching, how is that communicated in the code?

   d. What is the common characteristic of the samples in which an ampersand (&) is used?

   e. In Model 1 there are three drawings that are labeled with a question mark. Write codes to properly label these drawings.

7. Appoint one group member to cut apart Model 1 to separate the nine drawings. As a team, sort the drawings into two groups—one group where all the particles in the drawing are identical, and a second group in which the drawings contain more than one type of particle.

Read This!

Matter is classified as a **pure substance** when all of the particles are identical. Matter is classified as a **mixture** if there are different types of particles present.

8. Identify which drawings from Question 7 are pure substances and which are mixtures. List the codes for the drawings in the appropriate places below.

Pure Substances		Mixtures
_____	_____	_____
_____	_____	_____
_____	_____	_____

9. How are the codes (chemical formulas) for pure substances different from those for mixtures?

10. As a team, take the set of pure substances drawings from Question 8 and sort them into two new groups, those containing only one type of atom and those with two or more types of atoms.

Read This!

Elements are defined as pure substances made from only one type of atom. **Compounds** are defined as pure substances made from two or more types of atoms.

11. Identify which drawings from Question 10 are elements and which are compounds. List the codes for the drawings in the appropriate places below.

Elements	Compounds
_____	_____
_____	_____
_____	_____

12. How are the codes (chemical formulas) for elements different from those for compounds?

13. Use what you have just learned about chemical formulas to identify each of the following as an element, a compound or a mixture.

a. Br_2 *b.* $NaHCO_3$ *c.* $C_6H_{12}O_6$ & H_2O

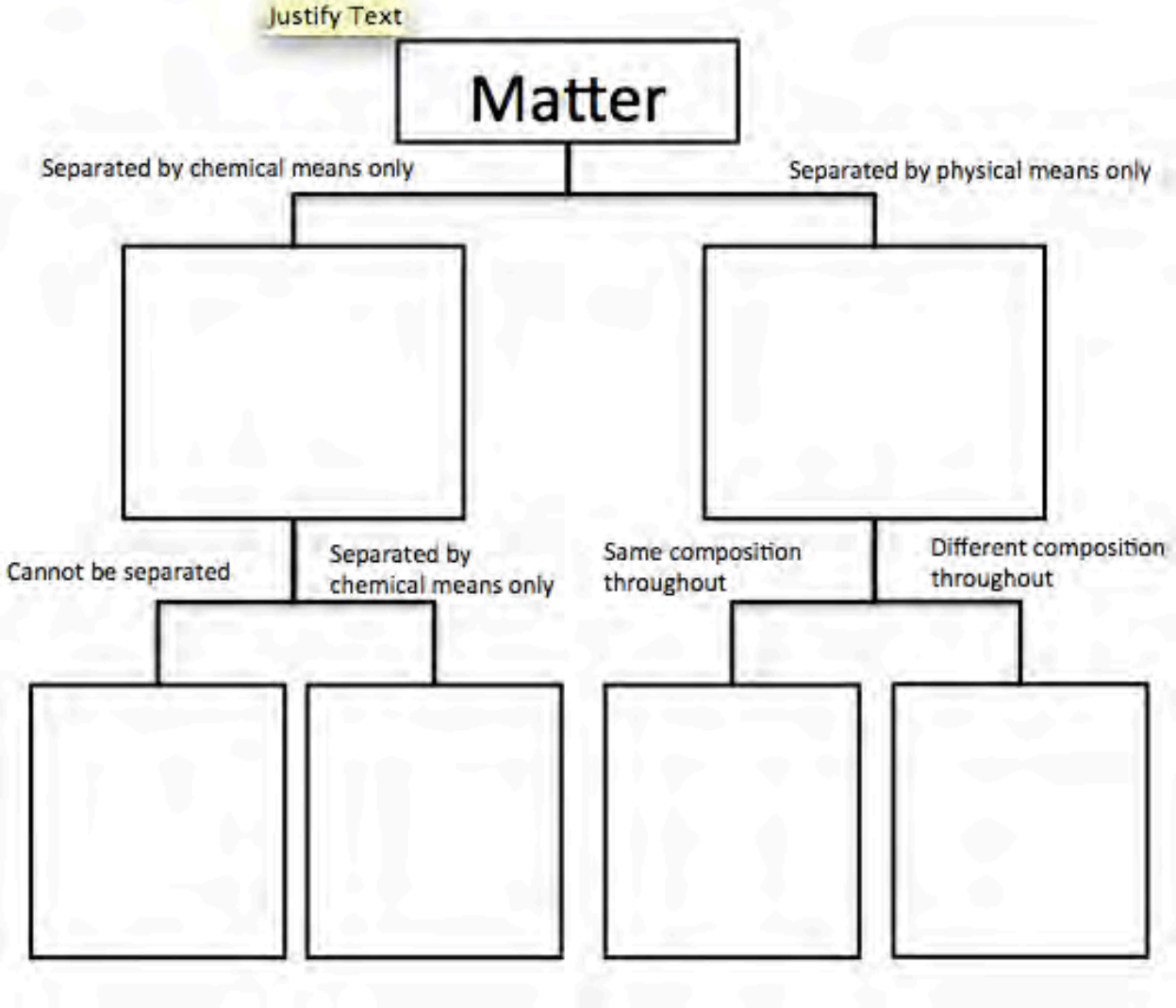
d. Cu & Zn *e.* CO_2 *f.* Al

14. Explain the difference between:

a. An atom and an element.

b. A molecule and a compound.

Video Lesson 1: Types of Matter



On the line provided, record the number of different symbols within the species to the left. Circle all the elements and <u>underline</u> the compounds below.

CO ___	Mg ___	Co ___
C_2H_5OH ___	$Al(CN)_3$ ___	Cl_2 ___
H_2SO_4 ___	He ___	NI_3 ___
O_2 ___	H_2O ___	NaCl ___
C ___	Cu ___	I ___

Questions:

1) Does each compound have the same number of symbols? ____
2) For each **ELEMENT** above, how many total symbols are listed? __
3) What is the minimum number of symbols that must be present in order for a species to be considered a compound? __

Multiple Choice:

1. _____ Copper sulfate can be further subdivided into simpler substances by chemical means only. Therefore, it is:
   1) a mixture
   2) an element
   3) a compound
   4) a solution

2. _____ A pure substance made up of two or more elements that are chemically combined in fixed ratios is:
   1) a mixture
   2) an element
   3) a compound
   4) a solution

3. _____ Which of the following is an element?
   1) Calcium Chloride solution
   2) Calcium Chloride
   3) Calcium
   4) Water

4. _____ Which separation technique uses the property of differences in boiling point to separate the parts making up a mixture?
   1) Filtration
   2) Chromatography
   3) Distillation
   4) Crystallization

5. _____ Anything that has mass and volume is considered:
   1) an element
   2) a compound
   3) a mixture
   4) all of the above

Constructed Response

Base your answers to the next 2 questions on the information below.

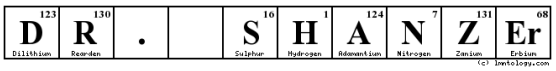
A student prepared two mixtures, each labeled beaker. Enough water is 20.0°C was used to make 100 milliliters of each mixture.

Information about Two Mixtures at 20.°C

	Mixture 1	Mixture 2
Composition	NaCl in H_2O	Fe filings in H_2O
Student Observations	• colorless liquid • no visible solid on bottom of beaker	• colorless liquid • black solid on bottom of beaker
Other Data	• mass of NaCl(s) dissolved = 2.9 g	• mass of Fe(s) = 15.9 g • density of Fe(s) = 7.87 g/cm^3

6. Describe a procedure to physically remove water from mixture 1.

7. Classify each mixture using the terms “homogeneous” or the term “heterogeneous”



Lesson 2: Physical vs. Chemical Change

Identify the following as a chemical (C) or physical property (P):

PHYSICAL PROPERTY	CHEMICAL PROPERTY
1. Observed with the senses 2. Determined without destroying matter	1. indicates how a substance reacts with something else 2. matter will be changed into a new substance after the reaction

_____1. blue color
_____2. density
_____3. flammability (burns)
_____4. solubility (dissolves)
_____5. reacts with acid
_____6. supports combustion
_____7. sour taste
_____8. melting point
_____9. reacts with water
_____10. hardness
_____11. boiling point
_____12. luster
_____13. odor
_____14. reacts with air

PHYSICAL CHANGE	CHEMICAL CHANGE
1. A change in size, shape, or state 2. No new substance is formed	1. A change in the physical and chemical properties 2. A new substance is formed

Identify the following as physical *(P)* or chemical *(C)* changes.

_____1. NaCl (Table Salt) dissolves in water.
_____2. Ag (Silver) tarnishes.
_____3. An apple is cut.
_____4. Heat changes H_2O to steam.
_____5. Baking soda reacts to vinegar.
_____6. Fe (Iron) rusts.
_____7. Alcohol evaporates
_____8. Ice melts.
_____9. Milk sours.
_____10. Sugar dissolves in water.
_____11. Wood rots.
_____12. Pancakes cook.
_____13. Grass grows.
_____14. A tire is inflated.
_____15. Food is digested.
_____16. Paper towel absorbs water.

Physical and Chemical Changes

If you change the way something looks, but haven't made a new substance, a **physical change** (P) has occurred. If the substance has been changes into another substance, a **chemical change** (C) has occurred.

1.		An ice cube is placed in the sun. Later there is a puddle of water. Later still, the puddle is gone.
2.		Two chemicals are mixed together and a gas is produced.
3.		A bicycle changes color as it rusts.
4.		A solid is crushed to a powder.
5.		Two substances are mixed and light is produced.

1.) _____ If temperature and pressure remain constant, which physical property of aluminum remains the same from one sample to the next?
   1) mass
   2) density
   3) length
   4) volume

2) _____ Which statement describes a chemical property of bromine?
   1) Bromine dissolves in water
   2) Bromine has a reddish-brown color.
   3) Bromine combines with aluminum to produce $AlBr_3$.
   4) Bromine changes from a liquid to a gas at 59 °C and standard pressure.

3) _____ Which process represents a chemical change?
   1) melting of ice
   2) corrosion of copper
   3) evaporation of water
   4) crystallization of sugar

4) _____ Which equation represents a physical change?
   1) $H_2O_{(s)}$ + energy → $H_2O_{(l)}$
   2) $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$ + energy
   3) $H_{2(g)} + I_{2(g)}$ + energy → $2HI_{(g)}$
   4) $N_{2(g)} + 2O_{2(g)}$ + energy → $2NO_{2(g)}$

5) _____ All of the following are examples chemical properties except:
   1) hydrochloric acid reacts with zinc metal
   2) TNT is explosive
   3) Ethanol is flammable
   4) Lemons taste sour

Base your answers to questions 6-7 on the table below and your knowledge of chemistry

Properties of 4 substances

Substance	Density	Phase at room temperature	Reaction with water	Reaction to flame
Hydrogen Gas	.00009 g/ml	Gas	None	Burns explosively
Sodium	.97 g/ml	Solid	Violent bubbling reaction	Burns explosively
Carbon	2.2 g/ml	Solid	None	Burns slowly
Argon	.002 g/ml	Gas	None	None

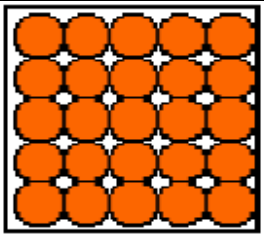
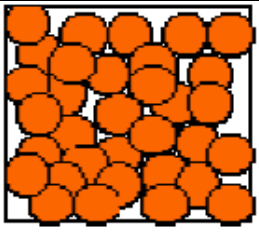
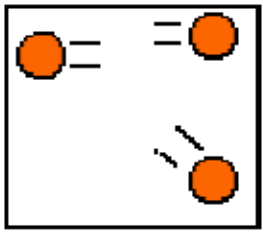
6) _____ Which substance showed no chemical change?
   1) hydrogen
   2) sodium
   3) carbon
   4) argon

7) _____ Which of the tests measured physical properties?
   1) density, reaction to flame
   2) density, phase
   3) reaction to flame and water
   4) phase, reaction to water

Video Lesson 3: Phases of Matter

Matter exists in three forms at STP (_____)

1. _____ (s)
2. _____ (l)
3. _____ (g)

Properties	Solid	Liquid	Gas
Shape			
Volume			
Particle Movement			
Distance between particles			
Intermolecular Forces (Attraction between particles)			
Particle Diagram			

1) ____ Which sample of CO_2 has a indefinite shape and definite volume?
   1) $CO_{2(aq)}$
   2) $CO_{2(g)}$
   3) $CO_{2(l)}$
   4) $CO_{2(s)}$

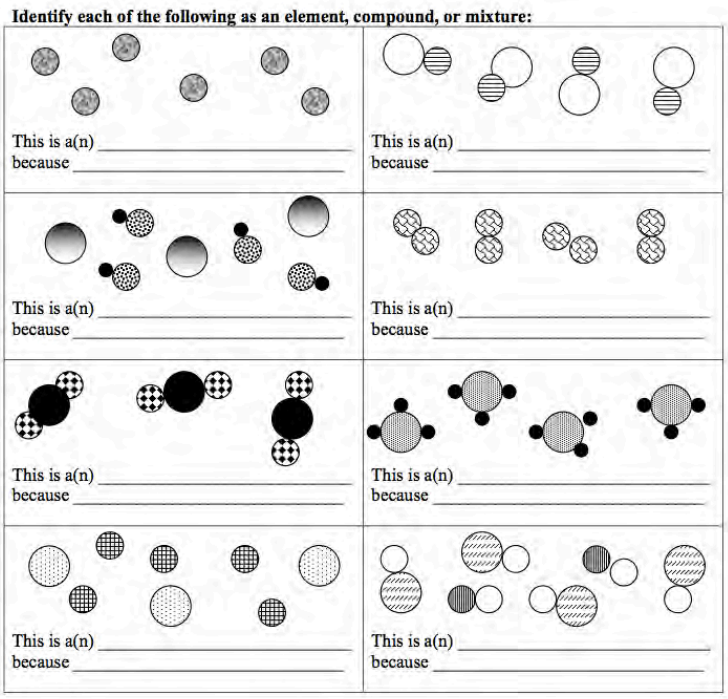
2) ____ Particles are arranged in a crystal structure in a sample of:
   1) $H_{2(g)}$
   2) $Br_{2(l)}$
   3) $Ar_{(g)}$
   4) $Ag_{(s)}$

3) ____ Which statement correctly describes a sample of gas 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 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.

4) ____ When a substance is made up of constantly vibrating particles arranged in a regular geometric pattern, the substance is classified as a
   1) true solid
   2) supercooled liquid
   3) liquid
   4) gas

5) ____ Which statement explains why Br_2 is a liquid at STP (standard temp. & pressure) and I_2 is a solid at STP?
   1) Molecules of Br_2 are polar and molecules of I_2 are nonpolar.
   2) Molecules of I_2 are polar and molecules of Br_2 are nonpolar.
   3) Molecules of Br_2 have stronger intermolecular forces then molecules of I_2.
   4) Molecules of I_2 have stronger intermolecular forces then molecules of Br_2.

Video Lesson 4: Particle Diagrams



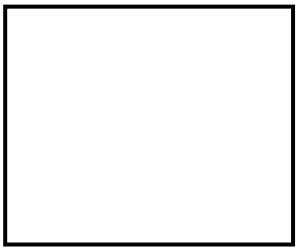
Each circle in a particle diagram represents an atom or particle and each color represents a different kind of atom or particle. If two particles are touching then they are chemically bonded together. Draw particle diagram for the following types of matter using at least 6 particles.

Element

Compound

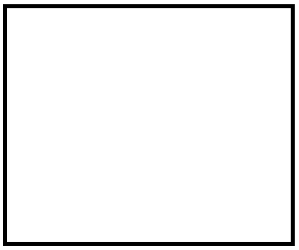
Diatomic element

Mixture of 2 compounds



Mixture of 2 elements

Mixture of a compound and an element



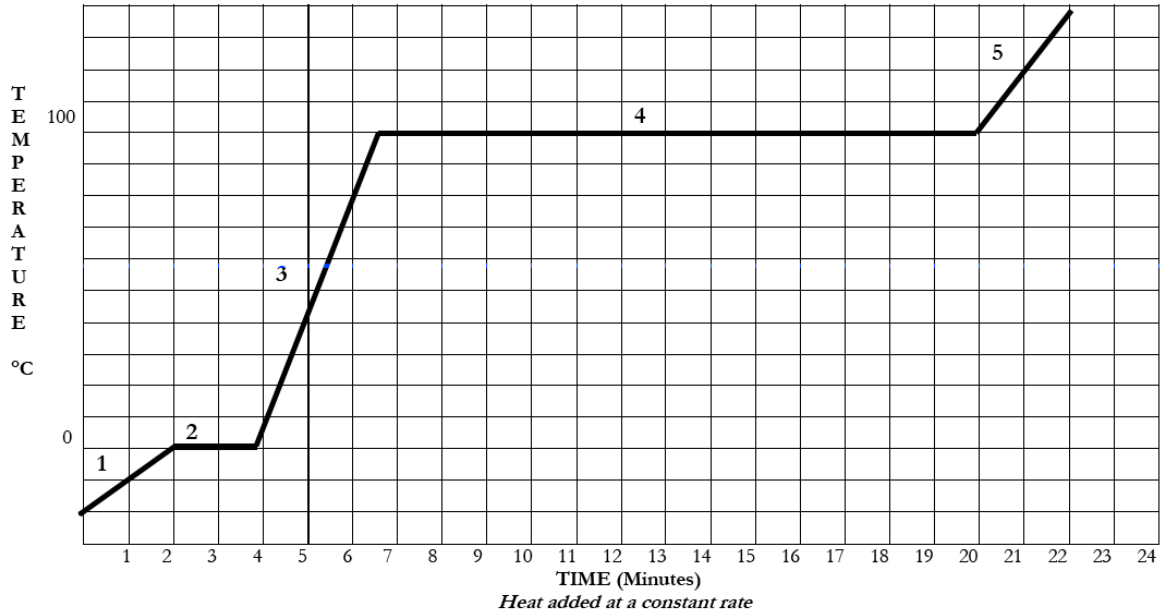
Homogenous mixture of a compound and an element

Heterogeneous mixture of a compound and an element

Video Lesson 5: Heating & Cooling Curves

In the space below are the labels solid, liquid, and gas. Draw arrows between them to represent phase changes. Label each arrow with the name of the phase change it represents. Also, draw an arrow labeled temperature to show the direction in which temperature is increasing.

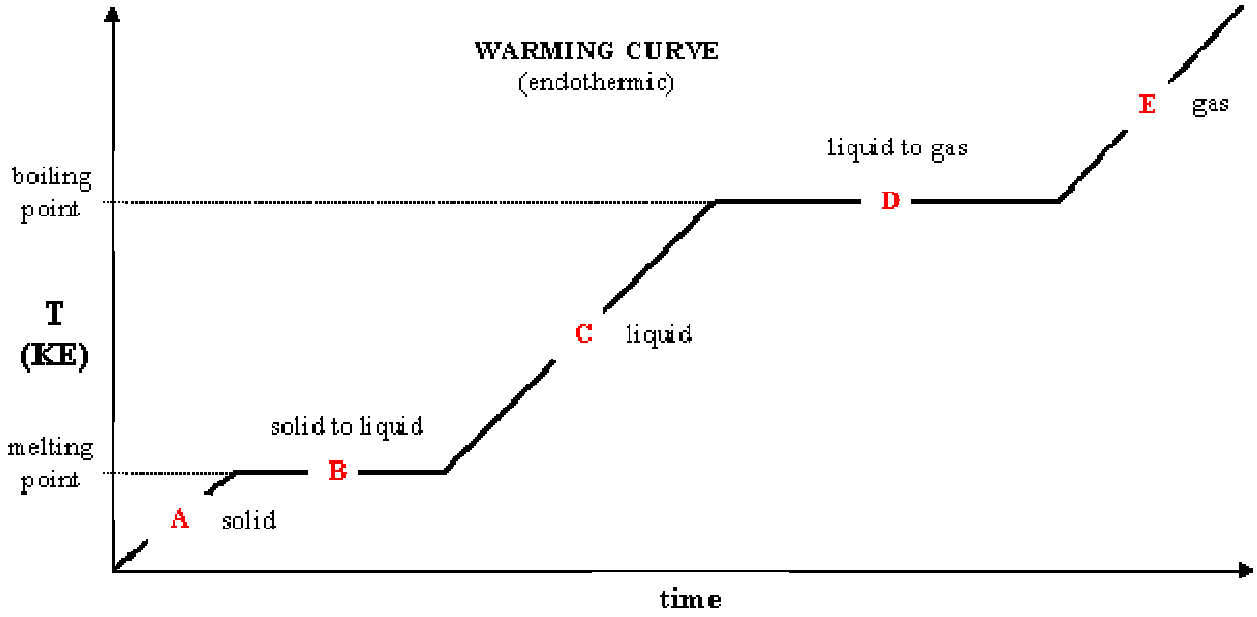
Directions: Answer the following questions based on the heating curve below.



1. At what time does the gas phase first appear? _____
2. How long does it take to completely melt the sample? _____
3. How long does it take to completely vaporize the sample? _____
4. During which segment is the substance in the solid phase? _____
5. During which segment is the substance in the liquid phase? _____
6. During which segment is the substance undergoing fusion? _____
7. During which segment is the substance boiling or vaporizing? _____

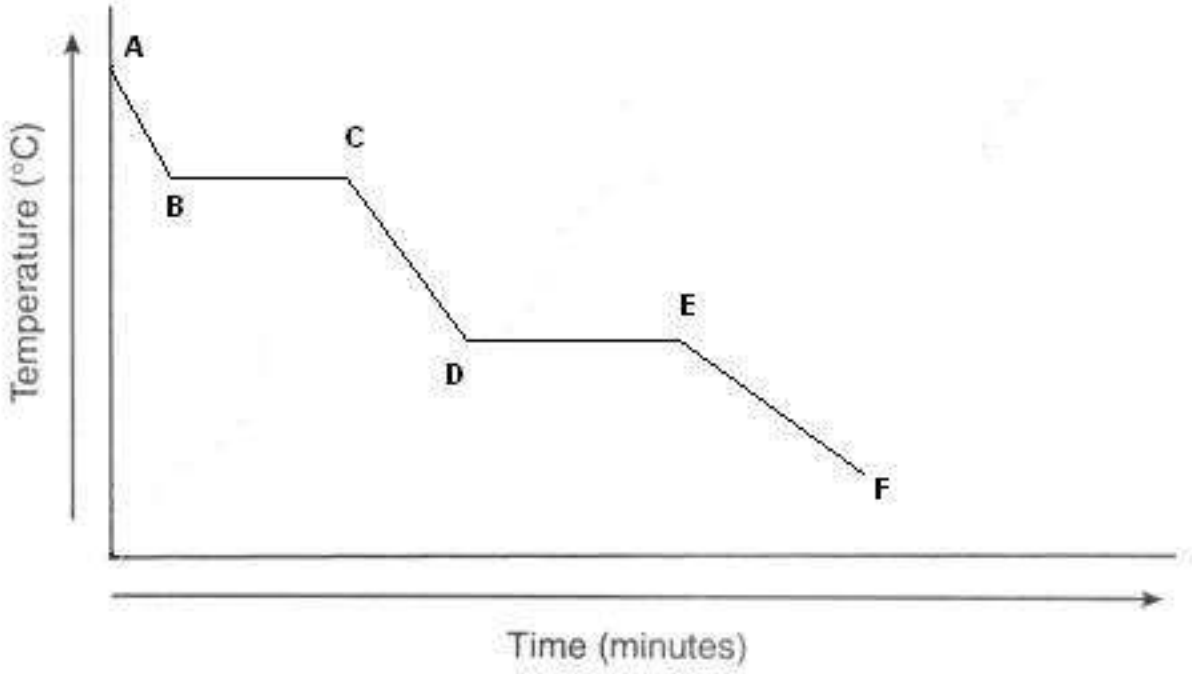
Heating and Cooling Curves: Changes in Matter Physical State

Heating Curves: TEMPERATURE vs. TIME is graphed while a substance is being HEATED at a constant rate.



Section	Phases (# and Name)	Δ T	Δ KE	Δ PE
A				
B				
C				
D				
E				

Cooling Curves: TEMPERATURE vs. TIME is graphed while a substance is being COOLED at a constant rate.



Section	Phases (# and Name)	Δ T	Δ KE	Δ PE
AB				
BC				
CD				
DE				
EF				

Multiple Choice:

1. _____ Which phase change is endothermic?
   1) gas → solid
   2) gas → liquid
   3) liquid → solid
   4) liquid → gas

2. _____ Which substance takes the shape of and fills the volume of any contain into which it is placed?
   1) $H_2O_{(l)}$
   2) $CO_{2(g)}$
   3) $I_{2(s)}$
   4) $Hg_{(l)}$

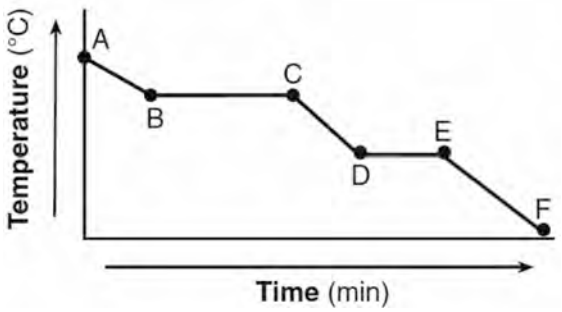
3. _____ As a substance changes from a liquid to a gas, the average distance between molecules:
   1) decreases
   2) increases
   3) remains the same

4. _____ Which phase change is exothermic?
   1) $H_2O_{(s)} \rightarrow H_2O_{(l)}$
   2) $H_2O_{(l)} \rightarrow H_2O_{(s)}$
   3) $H_2O_{(s)} \rightarrow H_2O_{(g)}$
   4) $H_2O_{(l)} \rightarrow H_2O_{(g)}$

5. _____ As ice cools 0 °C → -10 °C, the average kinetic energy of its molecules
   1) decreases
   2) increases
   3) remains the same

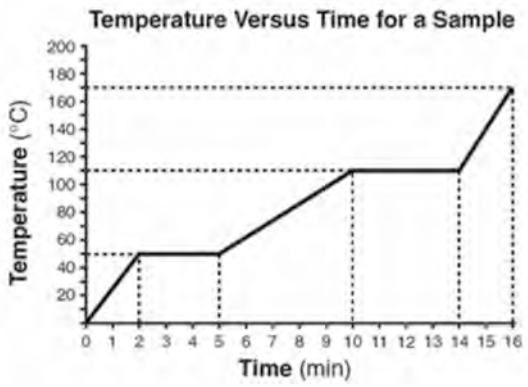
6. _____ Which occurs as a substance melts?
   1) It changes from a solid to a liquid and heat is released
   2) It changes from a liquid to a solid and heat is released
   3) It changes from a liquid to a solid and heat is absorbed
   4) It changes from a solid to a liquid and heat is absorbed

7. _____ The graph below represents the relationship between time and temperature as heat is removed at a constant rate to a sample of a substance.



During interval BC, which energy change occurs for the particles in this sample?
   1) The potential energy of the particles increases.
   2) The potential energy of the particles decreases.
   3) The average kinetic energy of the particles increases.
   4) The average kinetic energy of the particles decreases.

8. _____ 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.

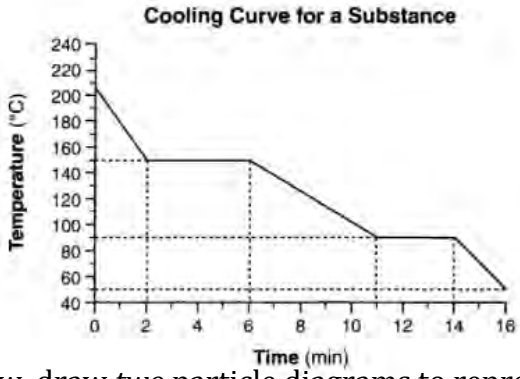


What is the melting point of the sample and the total time required to completely melt the sample after it has reached its melting point?

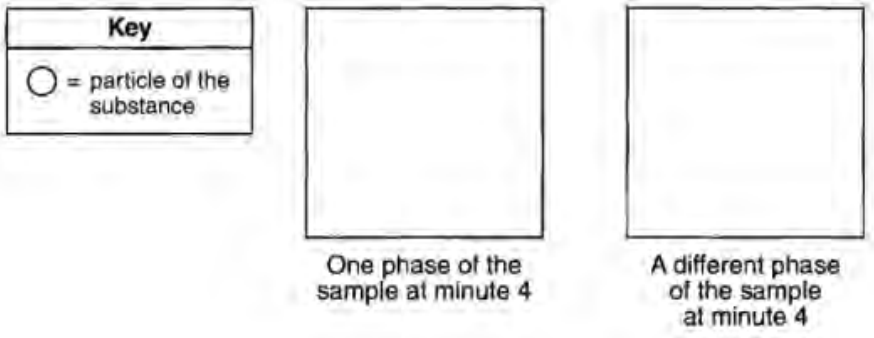
1) 110 °C and 4 mins
2) 110 °C and 14 mins
3) 50 °C and 3 mins
4) 50 °C and 5 mins

Constructed Response

Base your answers to the next 2 questions on the diagram below.



1.) Using the key below, draw *two* particle diagrams to represent the *two* phases of the sample at minute 4. Your response must include *at least six* particles for *each* diagram.



2.) At what time do the particles of this sample have the lowest average kinetic energy?
_____ min

Video Lesson 6: Significant Figures and Calculating Density

An index card is 12. 65 cm long … approximately. The last digit is estimated since the smallest space on the ruler is 0.1 cm. The index card is also 126,500 um long. The 5 is still the estimated digit and the zeros are only placeholders. They are not significant. Significant digits are the ones that are measured and the one (and only one) that is estimated. This all depends on the measurement tool.

Rules:

1. Leading zeros are not significant
2. Trailing zeros are not significant unless they come after a decimal point
3. Everything else is significant

OR: Atlantic-Pacific Rules

1. If decimals are **P**resent, ignore zeros on the **P**acific (left) side.
2. If decimal point is **A**bsent, ignore zeros on the **A**tlantic (right) side.
3. Everything else is significant

Pacific
Decimal Present: Count toward the right from the first nonzero digit

Atlantic
Decimal Absent: Count toward the left from the first nonzero digit

Practice: How many significant digits are in each of the following measurements.

1. 48 cm _____
2. 306.2 g _____
3. 3700 mm _____
4. 400. cm^3 _____

Calculating with Significant Digits

Every measurement has some error associated with it. The best you can do is to estimate the last digit beyond where your measuring tool measures. This causes some trouble with calculations. If you are finding the area of a piece of land, you are multiplying estimates by estimates. You cannot have an answer more accurate than your least accurate tool.

- **Multiplying & Dividing**: The number of significant figures in a product or quotient is the same as the measurement with the smaller number of sig figs.

Problem
3.1415 × 2.25 = 7.068375

Correct number of Significant Figures = 3

Solution 7.07

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- **<u>Addition & Subtraction</u>**: The number of decimal places in the sum or difference is equal to the number of decimal places in the measured quantity with the smallest number of decimal places.

Problem
6.357 - 2.4 = 3.957
Correct number of Decimal Places = 1

Solution 4.0

Practice: *Use the correct number of significant figures.*

1.) A sample of oxygen gas (O_2) has a mass of 32.65 g and a volume of 24.824 L. What is the density of the O_2 gas?

2.) 3. 482 cm + 8.51 cm + 16. 324 cm =

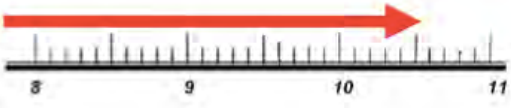
3.) 4.82 m x 1.5 m =

4.) A sample of iron occupies a volume of 15 cm^3. Calculate the mass of the sample.

5.) For the centimeter rulers below, record the length of the arrow shown.

a.

b.



Determine the number of significant digits in each of the following:

1. 23.30 cm _____
2. 1,843.02 L _____
3. 2.00012 km _____
4. 3.65 kg _____
5. 0.5 mL _____
6. 365 kg _____
7. 2000.12 mm _____
8. 704,000 h _____

Report answers to the following using proper significant figures:

9.) 3.414 s + 10.02 s + 58.325 s + 0.00098 s _____

10.) 2.326 h – 0.10408 h _____

11.) 10.19 m x 0.013 m _____

12.) 140.01 cm x 26.042 cm x 0.0159 cm _____

13.) 80.23 m / 2.4 s _____

14.) 4.301 kg / 1.9 cm^3 _____

Practice:

1. A sample of an element has a mass of 34.261 grams and a volume of 3.8 cubic centimeters. To which number of significant figures should be the calculated density of the sample be expressed?

2. The volume of a gas is 22.4 liters at STP. The density of the gas is 1.34 grams per liter. What is the mass of the gas sample, expressed to the correct number of significant figures?

3. What is the volume of an 8.52 gram sample of boron?

Name _____ **Matter Review** **Date** _____

1. **OMIT**

2. Compared to a 26-gram sample of NaCl(s) at STP, a 52-gram sample of NaCl(s) at STP has

   A) a different density
   B) a different gram-formula mass
   C) the same chemical properties
   D) the same volume

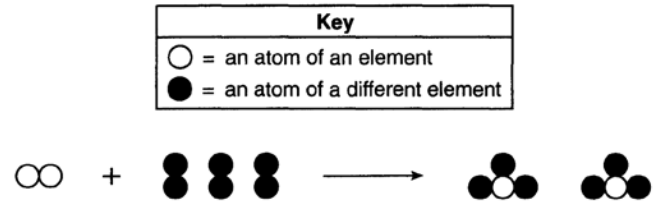
3. At STP, which physical property of aluminum always remains the same from sample to sample?

   A) mass B) density
   C) length D) volume

4. Which sample of CO_2 has a definite shape and a definite volume?

   A) $CO_2(aq)$ B) $CO_2(g)$
   C) $CO_2(\ell)$ D) $CO_2(s)$

5. Given the balanced particle-diagram equation:



   Which statement describes the type of change and the chemical properties of the product and reactants?

   A) The equation represents a physical change, with the product and reactants having different chemical properties.
   B) The equation represents a physical change, with the product and reactants having identical chemical properties.
   C) The equation represents a chemical change, with the product and reactants having different chemical properties.
   D) The equation represents a chemical change, with the product and reactants having identical chemical properties.

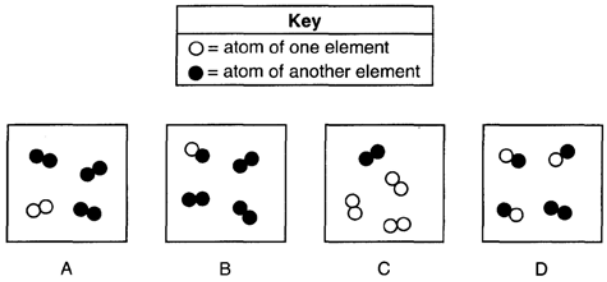
6. Particles are arranged in a crystal structure in a sample of

   A) $H_2(g)$ B) $Br_2(l)$ C) Ar(g) D) Ag(s)

7. Which substance can be broken down by chemical means?

   A) CO B) Ce C) Ca D) Cu

8. Which two particle diagrams represent mixtures of diatomic elements?



   A) *A* and *B* B) *A* and *C*
   C) *B* and *C* D) *B* and *D*

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

   A) gas, liquid, solid B) liquid, solid, gas
   C) solid, gas, liquid D) solid, liquid, gas

10.

BLANK

11. Which phase change results in the release of energy?

   A) $H_2O(s) \rightarrow H_2O(\ell)$ B) $H_2O(s) \rightarrow H_2O(g)$
   C) $H_2O(\ell) \rightarrow H_2O(g)$ D) $H_2O(g) \rightarrow H_2O(\ell)$

12. Which process is exothermic?

   A) boiling of water
   B) melting of copper
   C) condensation of ethanol vapor
   D) sublimation of iodine

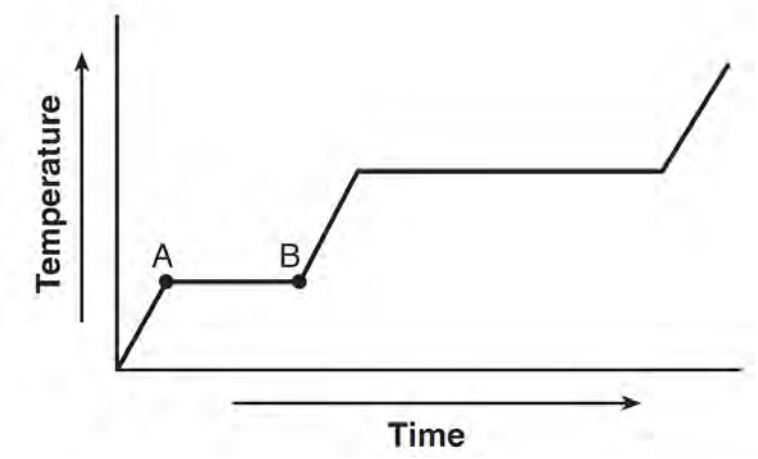
13. Which statement defines the temperature of a sample of matter?

   A) Temperature is a measure of the total electromagnetic energy of the particles.
   B) Temperature is a measure of the total thermal energy of the particles.
   C) Temperature is a measure of the average potential energy of the particles.
   D) Temperature is a measure of the average kinetic energy of a particles.

14. A gas changes directly to a solid during

   A) fusion B) deposition
   C) saponification D) decomposition

15. The graph below represents the relationship between time and temperature as heat is added at a constant rate to a sample of a substance.



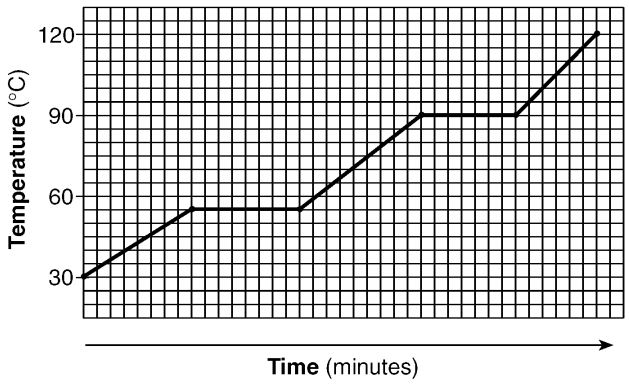
During interval *AB* which energy change occurs for the particles in this sample?

A) The potential energy of the particles increases.
B) The potential energy of the particles decreases.
C) The average kinetic energy of the particles increases.
D) The average kinetic energy of the particles decreases.

16. Which sample of water contains particles having the highest average kinetic energy?

A) 25 mL of water at 95°C
B) 45 mL of water at 75°C
C) 75 mL of water at 75°C
D) 95 mL of water at 25°C

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



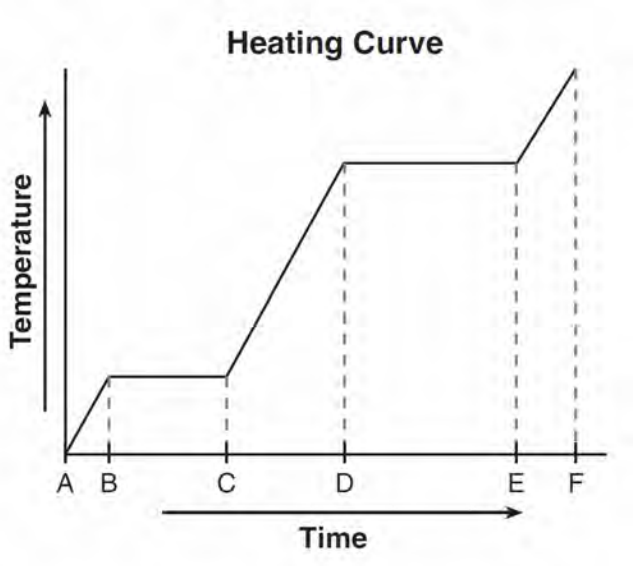
What is the melting point of this substance?

A) 30°C B) 55°C C) 90°C D) 120°C

18.

BLANK

19. Given the diagram representing a heating curve for a substance:

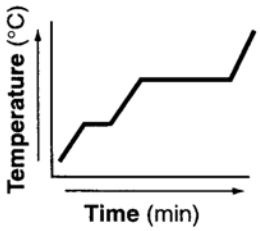


During which time interval is the average kinetic energy of the particles of the substance constant while the potential energy of the particles increases?

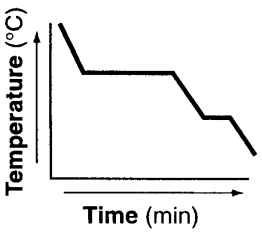
A) *AC* B) *BC* C) *CD* D) *DF*

20. Which graph could represent the uniform cooling of a substance, starting with the gaseous phase and ending with the solid phase?

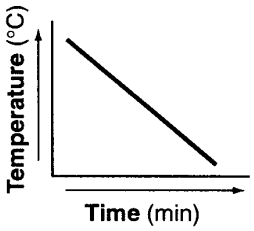
A)



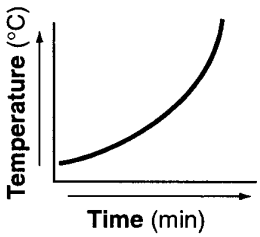
B)



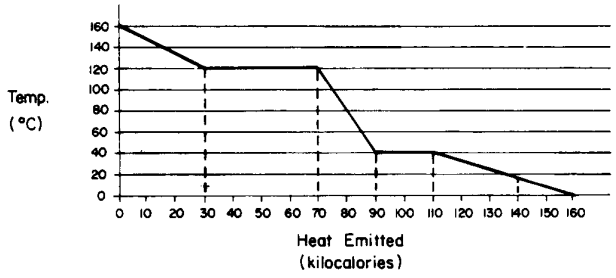
C)



D)



21. The graph below represents the uniform cooling of a substance, starting as a gas at 160°C. At which temperature does a phase change occur for this substance?



A) 0°C B) 40°C C) 80°C D) 140°C

22. Which phase change is endothermic?

A) $H_2O(\ell) \rightarrow H_2O(g)$ B) $I_2(g) \rightarrow I_2(s)$
C) $Hg(\ell) \rightarrow Hg(s)$ D) $H_2S(g) \rightarrow H_2S(\ell)$

23. Which equation represents sublimation?

A) $Hg(\ell) \rightarrow Hg(s)$
B) $H_2O(s) \rightarrow H_2O(g)$
C) $NH_3(g) \rightarrow NH_3(\ell)$
D) $CH_4(\ell) \rightarrow CH_4(g)$

24. Which sample of matter sublimes at room temperature and standard pressure?

A) $Br_2(\ell)$ B) $Cl_2(g)$
C) $CO_2(s)$ D) $SO_2(aq)$

25. Which statement explains why Br_2 is a liquid at STP and I_2 is a solid at STP?

A) Molecules of Br_2 are polar, and molecules of I_2 are nonpolar.
B) Molecules of I_2 are polar, and molecules of Br_2 are nonpolar.
C) Molecules of Br_2 have stronger intermolecular forces than molecules of I_2 .
D) Molecules of I_2 have stronger intermolecular forces than molecules of Br_2 .

26.

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27. Two grams of potassium chloride are completely dissolved in a sample of water in a beaker. This solution is classified as

A) an element
B) a compound
C) a homogeneous mixture
D) a heterogeneous mixture

28. Which formula represents a mixture?

A) $C_6H_{12}O_6(\ell)$ B) $C_6H_{12}O_6(s)$
C) LiCl(aq) D) LiCl(s)

29. An example of a heterogeneous mixture is

A) H_2O + Oil B) $C_{12}H_{22}O_{11}$
C) CO D) CO_2

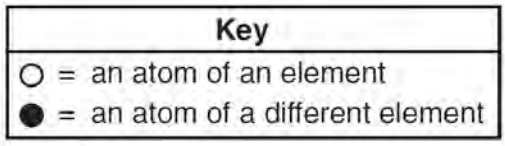
30. The table below shows the data collected by a student as heat was applied at a constant rate to a solid below its freezing point.

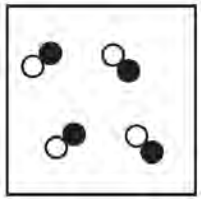
Time (min)	**Temperature** (°C)	**Time** (min)	**Temperature** (°C)
0	20	18	44
2	24	20	47
4	28	22	51
6	32	24	54
8	32	26	54
10	32	28	54
12	35	30	54
14	38	32	58
16	41	34	62

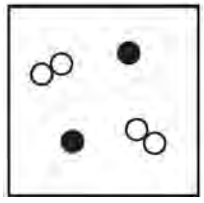
What is the boiling point of this substance?

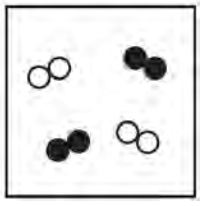
A) 32°C B) 54°C C) 62°C D) 100°C

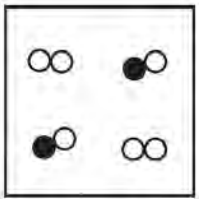
31. Which particle diagram represents a mixture of an element and a compound?



A) 

B) 

C) 

D) 

32. Bronze contains 90 to 95 percent copper and 5 to 10 percent tin. Because these percentages can vary, bronze is classified as

A) a compound B) an element
C) a mixture D) a substance

33. At room temperature, a mixture of sand and water can be separated by

A) ionization B) combustion
C) filtration D) sublimation

34. An aqueous solution of sodium chloride is best classified as a

A) homogeneous compound
B) homogeneous mixture
C) heterogeneous compound
D) heterogeneous mixture

35. One similarity between all mixtures and compounds is that both

A) are heterogeneous
B) are homogeneous
C) combine in a definite ratio
D) consist of two or more substances

36. Two substances in a mixture differ in density and particle size. These properties can be used to

A) separate the substances
B) chemically combine the substances
C) determine the freezing point of the mixture
D) predict the electrical conductivity of the mixture

37. Petroleum can be separated by distillation because the hydrocarbons in petroleum are

A) elements with identical boiling points
B) elements with different boiling points
C) compounds with identical boiling points
D) compounds with different boiling point

38. Base your answer to the following question on the information below.

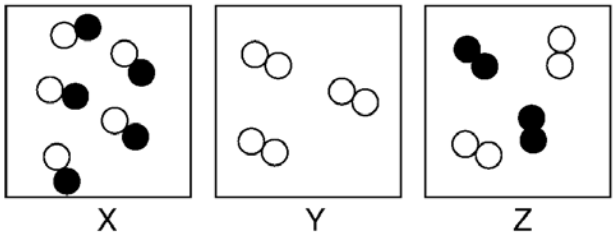
Cold packs are used to treat minor injuries. Some cold packs contain $NH_4NO_3(s)$ and a small packet of water at room temperature before activation. To activate this type of cold pack, the small packet must be broken to mix the water and $NH_4NO_3(s)$. The temperature of this mixture decreases to approximately 2°C and remains at this temperature for 10 to 15 minutes.

Identify the type of mixture formed when the $NH_4NO_3(s)$ is completely dissolved in the water.

39. Describe diagrams *X, Y,* and *Z* using the following terms:

Pure substance
Compound
Element
Mixture of elements
Mixture of compounds

You may use more than one term for each diagram.



Key
Atom of element A = ○
Atom of element B = ●

X _____

Y _____

Z _____

40. Which sample of matter can be separated into different substances by physical means?

A) LiCl(aq) B) LiCl(s)
C) $NH_3(g)$ D) $NH_3(\ell)$

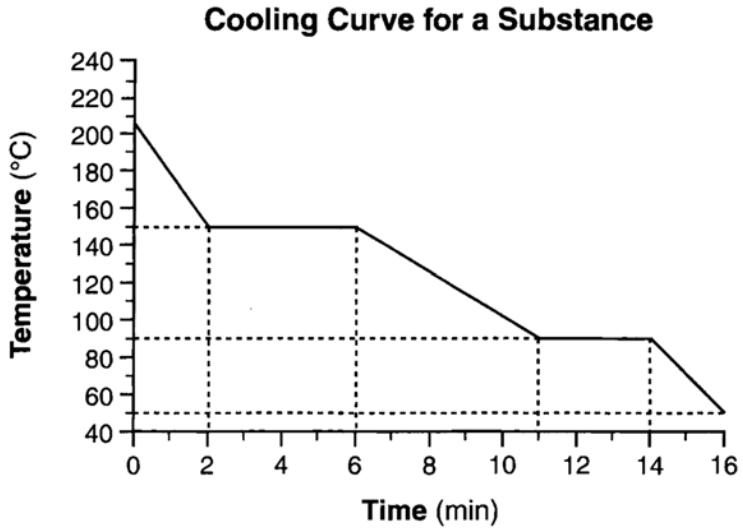
41. A beaker contains both alcohol and water. These liquids can be separated by distillation because the liquids have different

A) boiling points B) densities
C) particle sizes D) solubilities

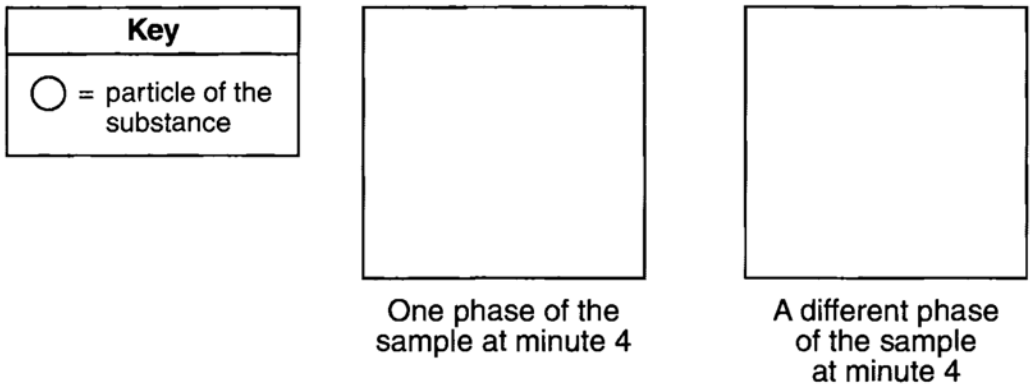
42. **OMIT**

Base your answers to questions **43** and **44** on the information below.

Starting as a gas at 206°C, a sample of a substance is allowed to cool for 16 minutes. This process is represented by the cooling curve below.



43. Using the key below, draw *two* particle diagrams to represent the *two* phases of the sample at minute 4. Your response must include *at least six* particles for *each* diagram.



44. At what time do the particles of this sample have the *lowest* average kinetic energy?

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