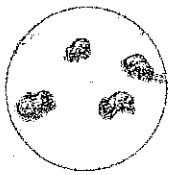
250

Matter

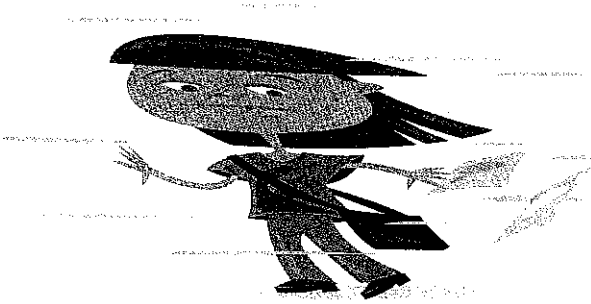
Matter is the "stuff" that all objects and substances in the universe are made of. Because all matter takes up space (has **volume**) and contains a certain amount of material (has **mass**), all matter can be detected and measured.

You can observe some types of matter easily with your senses. For example, you can see or feel things like rocks, trees, bicycles, and different kinds of animals. And you can see and smell things like smoke from a fire.

Other types of matter are a little more difficult to observe. The dust mites that live in your upholstered furniture and rugs are an example of matter that is too small to see with the naked eye. They can be observed only with special instruments, like a microscope.



Another example of matter that's hard to detect is air, the invisible gas that surrounds you. How do you know it's there? You can't see it or smell it, but you know it exists because you can feel it when the wind blows and see it bend the branches of trees.



Word Watch!

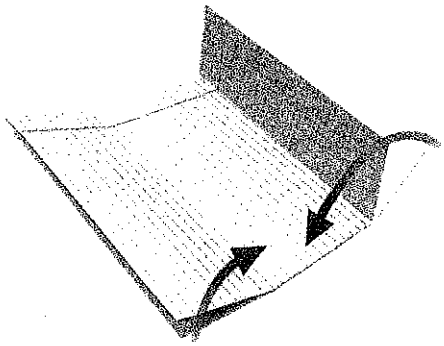
The word *matter* comes from the Latin word *materia*, meaning "material" or "stuff."

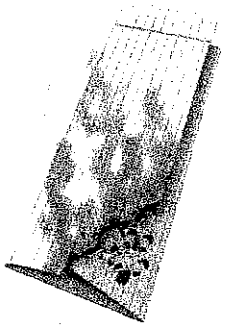
Chemical properties describe matter based on its ability to change into a new kind of matter with different properties. For example, paper is flammable: it is capable of burning in the presence of oxygen. Flammability is a chemical property of paper. A chemical property of iron is its tendency to rust. Rusting occurs when iron reacts with oxygen to produce iron oxide. Reactivity to acid and to water are two more examples of chemical properties.

SEE ALSO
265 Periodic Table
269 Chemical Reactions

Physical and Chemical Changes

If you fold a sheet of paper into thirds, you're left with a piece of paper one-third the size of the original. But the newly folded paper is still paper. Two physical properties of the paper—its size and shape—have changed, but not its chemical properties. Such a change is called a **physical change.**

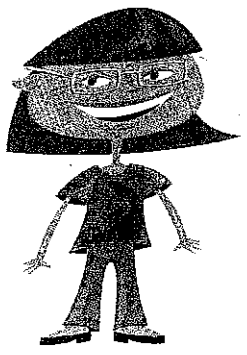




If you hold a lit match to the paper, the paper will burn. What you're left with—ash, gases, and smoke—is no longer paper. The chemical properties of the paper have changed, producing new substances. This kind of change is called a **chemical change.**

SEE ALSO
269 Chemical Reactions

Many physical changes can be reversed. For example, you can unfold the piece of paper to return it to its original size and shape. Most chemical changes, on the other hand, cannot easily be undone. For example, you can't "unburn" a charred piece of paper.



253

States of Matter

Think about the differences between, for example, a rock, milk, and air. The shape of a rock does not change unless you cut or smash it. Milk takes on the shape of its container, and if you pour it on the floor it will spread out to form a puddle. Air spreads out even more than milk does. And it keeps spreading out in all directions.

Rocks, milk, and air represent different physical forms in which a substance can exist: a rock is a **solid,** milk is a **liquid,** and air is a **gas.** Solids, liquids, and gases are three **states of matter.** The chart below lists the defining features of each state.

Word Watch!

The three states of matter are also known as the phases of matter.

SEE ALSO

254 Changing States of Matter

State of Matter	Defining Features
Solid	• keeps its shape and volume
Liquid	• takes on the shape of its container • keeps the same volume, in a container or not • can flow
Gas	• takes on the shape and volume of its container • can flow (through a room, for example)

Did You Know?

A fourth state of matter is called a plasma. Like a gas, a plasma does not have a definite shape or volume. Plasmas only exist at very high temperatures. Stars, including the sun, are made of matter in a plasma state.

SEE ALSO

255 Atoms

259 Elements, Molecules, and Compounds

But why are solids solid, liquids liquidy, and gases gassy? To answer this question, you first need to understand three things:

- All matter is made up of tiny particles called atoms and molecules.
- These particles attract each other; the greater the attraction, the closer the particles get.
- These particles are constantly in motion and bumping into each other. The temperature of a substance is related to the speed at which its particles move.

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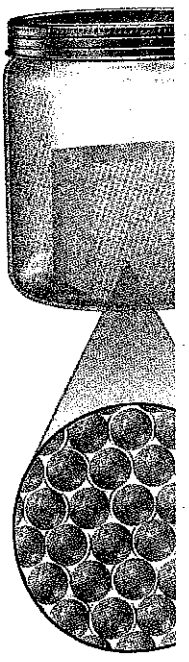
Solid



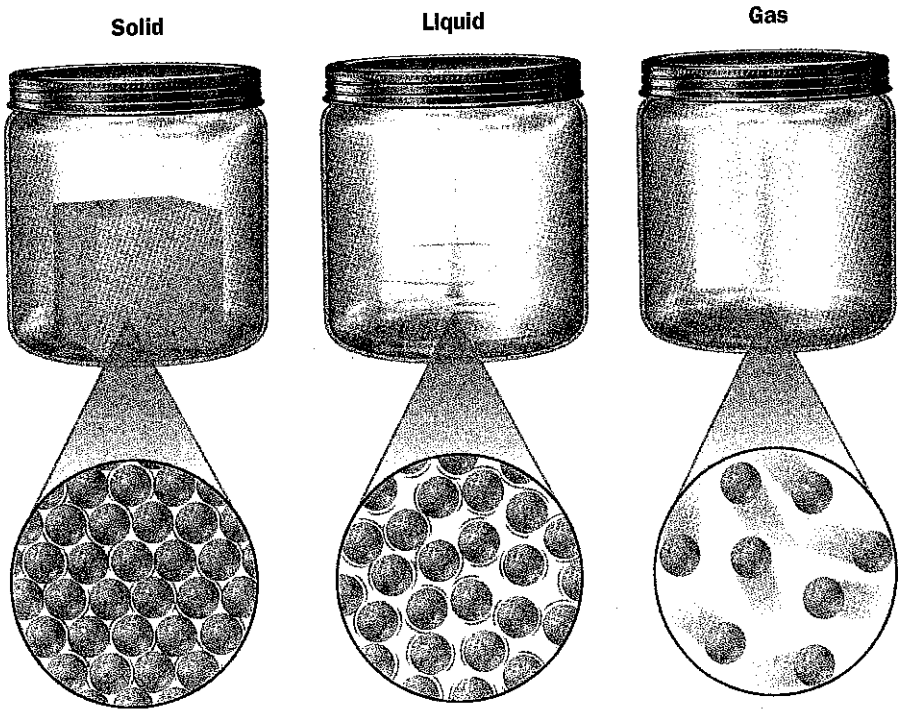
The state of a substance depends on how fast its particles move and how strong the attraction is between the particles.

Solid The particles of a substance in its solid state vibrate in place, but the vibration isn't great enough to overcome the attraction between the particles and cause them to separate. As a result, the forces between the particles cause them to lock together.

Liquid The particles of a substance move even faster when the substance is in a liquid state. As a result, the particles in a liquid can overcome some of the attraction between them. So, unlike the particles in a solid, which are locked together, the particles in a liquid can flow around and over each other. If you spill a glass of water on the floor, for example, the water molecules stick together enough to make a puddle, but not enough to keep the shape the water had when it was in the glass.

Gas The particles of a substance move fastest when the substance is in a gaseous state—so fast that they are able to overcome the attraction between them and separate from each other entirely. That's why a gas will spread out in all directions, filling up a balloon, a room, or the atmosphere.

SEE ALSO
213 Earth's Atmosphere



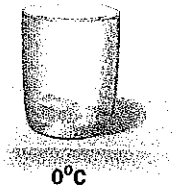
254

Changing States of Matter

Water is a substance that can be found in three states: solid ice, liquid water, and water vapor (a gas). You know from experience that water can change from one state to another. The same is true of many other substances as well.

Melting: From Solid to Liquid

If you put an ice cube in a cup and set it on the counter, the ice will melt. **Melting** is the change from a solid state to a liquid state. The temperature at which a solid melts is called its **melting point.** The melting point of ice is 0°C.



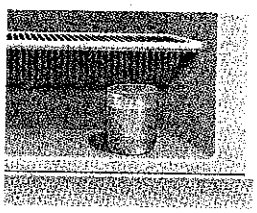
0°C

SEE ALSO
253 States of Matter

What causes a solid to melt? If you heat a solid, the particles in that solid will begin to move faster. If you keep heating the solid, eventually the motion of the particles will become great enough to overcome the attraction that locks the particles together. When that happens, the solid becomes a liquid.

Freezing: From Liquid to Solid

If you place a cup of water in the freezer, the water will turn to solid ice. **Freezing** is the change from a liquid state to a solid state. The temperature at which a liquid freezes is called its **freezing point.** Because freezing is the reverse of melting, a substance will freeze at the same temperature at which it melts.

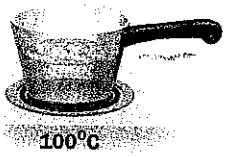


0°C

What causes a liquid to freeze? If you cool a liquid, the liquid's particles will begin to slow down. If you keep cooling the liquid, eventually the motion of the particles will slow to the point where they cannot overcome the attraction between them. At some point, the particles will lock together. When that happens, the liquid becomes a solid.

Vaporization: From Liquid to Gas

If you place a pan of water on a hot stove, eventually the water will begin to boil. Water vapor (or steam) is produced during **vaporization,** the change from a liquid state to a gaseous state. Boiling causes the liquid water to vaporize. The **boiling point** of water is 100°C.



100°C

The same process that causes a solid to melt causes a liquid to vaporize. As a substance is heated, its particles begin to move faster and faster. During vaporization, the fastest particles are able to overcome the attraction of the particles around them and break free completely. These escaped particles become a gas—water vapor.

A pan of water left on the counter top will evaporate over several days. **Evaporation** is vaporization that occurs at the surface of a liquid. Evaporation can take place at temperatures below the liquid's boiling point.

Condensation: From Gas to Liquid

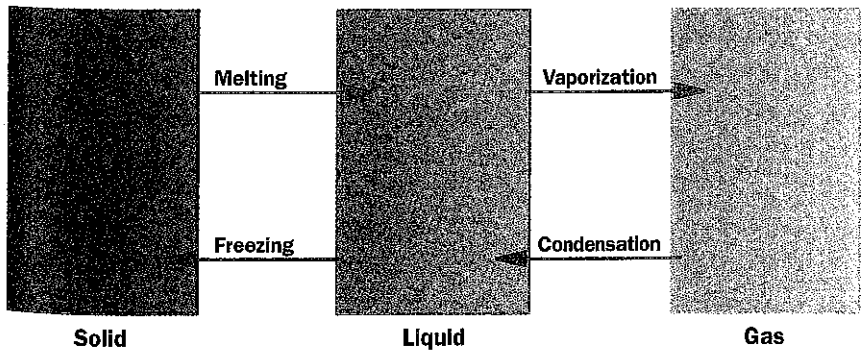
100°C

If you pour cold juice into a glass on a humid summer day, you will begin to notice beads of water forming on the outside of the glass. What you observe is water vapor from the air around the glass that has condensed on the glass. **Condensation** is the change from a gaseous state to a liquid state. The temperature at which a gas condenses is called its **condensation point.** At sea level, the condensation point of water vapor is 100°C—the same as the boiling point of water. That is because condensation is the reverse of vaporization.

SEE ALSO
226 Humidity and Dew Point

The same process that causes a liquid to freeze causes a vapor to condense. As a vapor cools, its particles begin to slow down. Condensation takes place when the particles slow down so much that they cannot overcome the attraction of the particles around them. When this happens, they clump together to form a liquid.

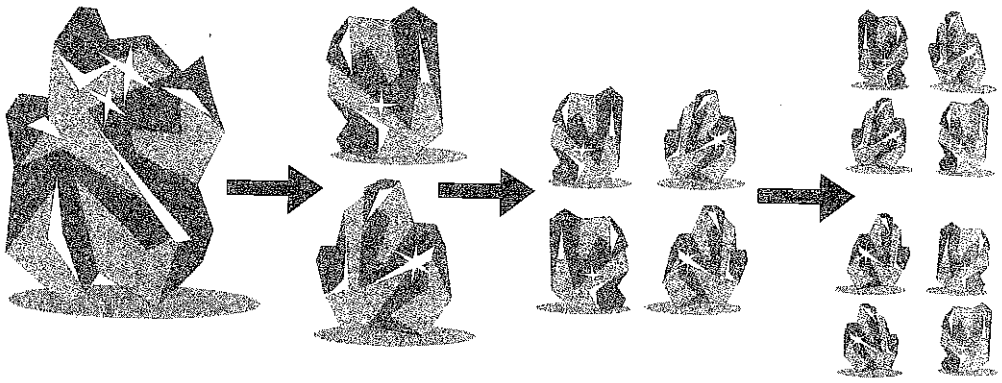
SEE ALSO
253 States of Matter



255

Atoms

Imagine finding a gold nugget while panning for gold in Colorado. You decide to share your prize with family and friends by having it cut into smaller pieces. Using a special tool, you cut the nugget in half, then in half again, over and over. Eventually you end up with a piece of gold that is too small to cut with your tool!



But you've got a lot of family and friends, so suppose you were able to keep cutting the gold into smaller and smaller pieces. Would you be able to keep cutting forever? The answer is no! At some point you would end up with a piece that could not be divided. That smallest piece would be an atom.

SEE ALSO

259 Elements, Molecules, and Compounds

265 Periodic Table

An **atom** is the smallest particle into which an element (such as gold) can be divided and still maintain the properties of that element. Because all matter is made up of elements, and all elements are made up of atoms, atoms are considered the building blocks of matter.

Word Watch!

The word *atom* comes from the Greek word *atomos*, which means "indivisible."

SCILINKS NSTA Keyword: Atomic Models
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Code: GSSM255

Mixtures, Solutions, and Suspensions

271

SEE ALSO

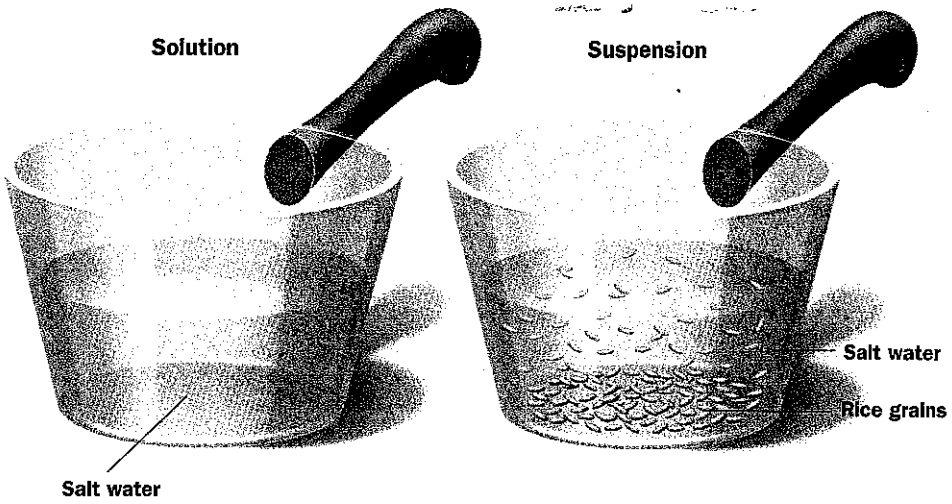
262 Compounds

A compound is a substance made of two or more elements that are combined chemically. The ratio of the elements that form a particular compound is always the same. The properties of a compound are different from the properties of the elements from which it is made. A compound can be separated only by chemical means. Table salt (NaCl, or sodium chloride) is an example of a compound.

A **mixture** is a combination of two or more substances that have *not* combined chemically. A mixture can contain elements, compounds, or both, and in any amounts. Because the substances in a mixture are not combined chemically, they keep their unique properties and can be separated by physical means. Fruit salad is an example of a mixture.

Let's say you want to cook a pot of rice. First you add a pinch of salt to the water and stir. You notice the salt crystals seem to disappear. Where did they go? They dissolved and spread out evenly in the pot of water. This kind of mixture is called a solution. A **solution** is a mixture that looks like a single substance and has the same properties throughout.

Once the salted water begins to boil, you add the rice and stir. The rice grains swirl around in the pot of water. When you stop stirring, they settle to the bottom. This kind of mixture, in which the components are dispersed but large enough to see and to settle out, is called a **suspension.**



Parts of a Solution

Within a solution, one substance is dissolved in another substance. The substance that dissolves is called a **solute.** The substance into which a solute dissolves is called a **solvent.** In the example of salt water, the salt is the solute and the water is the solvent.

Solutions are not always in liquid form, however. Some gases and solids are also considered solutions. For example, the air you breathe contains oxygen dissolved in nitrogen. Bronze is a solution of the metals copper and tin.

Many substances dissolve in water. For this reason, water is considered a "universal" solvent.

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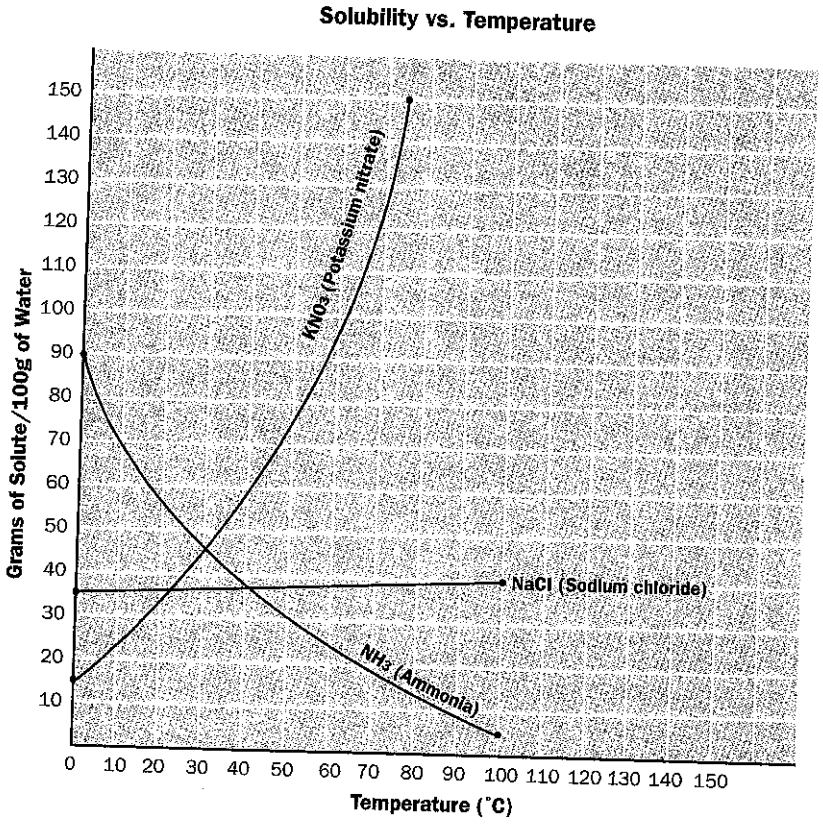
Solubility and Temperature

SEE ALSO
271 Mixtures, Solutions, and Suspensions
272 Parts of a Solution

Hot tea will dissolve more sugar than cold tea. But cold soda will dissolve more carbon dioxide gas than warm soda. Temperature has an effect on solubility. **Solubility** is the ability of a substance to dissolve in another substance.



Temperature is not the only factor that affects solubility. Solubility of gases is also greatly affected by changes in pressure. Have you noticed what happens when you open a can of soda? Carbon dioxide dissolved in the liquid escapes rapidly from the bottle, sometimes more rapidly than you would like! Carbon dioxide gas is more soluble at higher pressures. When you open the can, you decrease the pressure on the gas, and it comes out of solution.

275 Forces in Nature

280 Balanced a Unbalance Forces

283

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CHAPTER 2

CHEMISTRY OF MATTER

- *THE PHYSICAL SETTING: KEY IDEA 3*
  Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.
- *THE PHYSICAL SETTING: KEY IDEA 4*
  Energy exists in many forms and when these forms change, energy is conserved.

Elements

Matter is made of elements. For example, air contains nitrogen and oxygen. **Elements** cannot be chemically broken down into simpler substances. There are more than one hundred known elements. Most elements are solids at room temperature. Elements combine in many ways to produce compounds that make up all living and nonliving substances. Few elements are found in their pure form.

Review Questions

1. Matter can be made of combinations of different _____.
2. There are more than _____ known elements.
3. Most elements are _____ at room temperature.
4. Elements can not be physically or _____ broken down into simpler substances.

Atoms

Atoms are the smallest part of an element. Atoms are too small to be seen with a light microscope. Scientists have learned about atoms from experiments. Scientists use models as visual representations of what they are studying.

Atoms are always in motion. The higher the temperature, the more the atoms vibrate or move. The core or center of the atom is called the nucleus. The nucleus contains protons and neutrons. Protons have a positive charge. Neutrons have no charge. Surrounding the nucleus are electrons. Electrons are very small, and have a negative charge.

Atoms of one element are different from the atoms of another element. Atoms of different elements have a different number of protons. The number of protons is the atomic number. There must be an equal number of protons and electrons to keep the charge of the whole atom at zero. In an atom, the positive charges equal the negative charges. Atomic mass is expressed in atomic mass units.

Review Questions

8. The first letter of the symbol of an element is a _____ letter.
9. Elements are arranged in order of _____ atomic number.
10. Elements in the same group have similar _____.
11. _____ are malleable, have luster, and are good conductors.
12. Non-metals are _____ conductors of heat.
13. The elements that do not react with other elements are the _____.

Matter

Matter is made of atoms. Matter has mass and takes up space (volume). Matter is not energy. Energy has no mass and does not take up space. Energy is used to change matter. For example, heat energy can change solid water (ice) to liquid water. Matter is identified by its properties or characteristics. **Physical properties** such as size, color, shape, and melting point can be observed. **Chemical properties** describe how the matter reacts with other matter. For example, iron will form rust when exposed to air.

Review Questions

14. Matter is anything that has _____ and _____.
15. Is it matter (**M**) or energy (**E**)?
    - **a.** sunlight _____
    - **b.** air _____
    - **c.** electricity _____
    - **d.** sand _____
16. Is it a chemical property (**C**) or a physical property (**P**) ?
    - **a.** 23.9 grams _____
    - **b.** irregular shape _____
    - **c.** combines with oxygen _____
    - **d.** boils at 100°C _____

Phases (states) of Matter

There are three **phases of matter**: solid, liquid, and gas. In each phase the position and motion of the particles are different.

Phase	Position of particles	Motion of particles	Examples
Solid (s)	close together in fixed positions, definite volume and shape	can only vibrate	wood, rock, ice
Liquid (l)	loosely packed, can change position by sliding past each other, definite volume, no definite shape	more motion than a solid	milk, water
Gas (g)	very far apart, spread out, fills container no definite volume or shape	move freely, in constant motion	air, oxygen, helium

Matter can change phase (state) depending on the motion of its particles. The phase of matter depends on the attractive force between the particles. If heat energy is added to a solid, the particles will move apart and it will change to a liquid. This is called **melting**. If heat is removed from a liquid, it will become a solid as the particles move closer together. This is called **freezing**.

When heat is added to a liquid, it will change to a gas as the particles faster and further apart. This occurs during **boiling** or **evaporation.** If heat is removed from a gas, it will become a liquid as the particles move closer together and slower. This is called **condensation**.

Review Questions

17. A _____ has no definite shape or volume.

18. A _____ has a definite volume but no definite shape.

19. The size of the container will determine the volume of _____.

20. Particles in a _____ have the least motion or kinetic energy.

21. The change from solid to liquid is called _____.

22. If heat energy is added to a liquid it can become a _____.

23. Condensation is the change from _____ to _____.

Density

Density is a physical property of matter. Every substance has a measurable density. Aluminum has a density of 2.7g/cm^3. Gold has a density of 19.3 g/cm^3. Density can be used to identify matter. **Density** is the concentration of mass in an object. It is the amount of matter in a given amount of space. If two objects have the same volume, but one has more mass, then the one with more mass is more dense.

Density is calculated by dividing the mass of an object by its volume. Mass is measured in grams with a triple beam balance. Volume is measured in milliliters (mL) with a graduated cylinder or in cubic centimeters (cm^3) with a ruler.

$$D = \frac{M}{V}$$

The density of a substance can change. As the temperature of matter increases, its density decreases (hot air rises). As pressure increases, density increases (matter is compressed). Gases are the least dense state of matter, solids (except for ice) are the densest.

Buoyancy is the tendency of an object to float or sink. An object will float if it is less dense than the substance it is placed in. For example, cork floats in water but lead sinks. Cork is less dense than water. Lead is more dense than the water or cork.

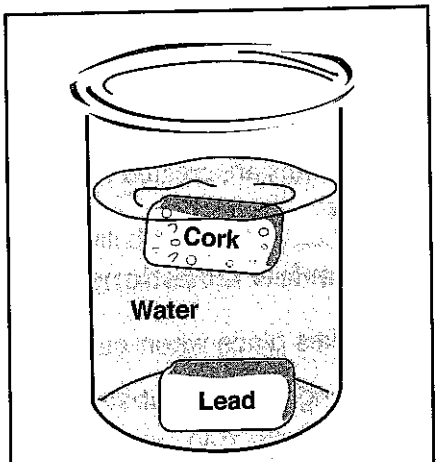


FIGURE 2. COMPARING DENSITY

Review Questions

24. Density is the amount of _____ in a unit of volume.

25. A substance with a mass of 12.0 grams and a volume of 4.0 cm^3 will have a density of _____.

26. Density is a _____ property of matter.

27. As temperature increases, density will _____.

28. As pressure increases, density will _____.

29. A _____ is the least dense phase of matter.

Review Questions

26. Heat is a form of electromagnetic energy known as _____ radiation.

27. Most substances will _____ when heated.

28. When a material is cooled, the substance will usually _____.

29. When heat is removed, the temperature _____.

30. For each statement select the process that is occurring.

	Description	Reflection	Absorption
a.	A shiny, smooth surface		
b.	We see the Moon at night		
c.	A dark shirt becomes very warm		
d.	We see our face in a mirror		

Changes in the Phases of Matter

Matter can change state or phase when heat is absorbed or released. This is a physical change, there is no chemical change in the substance. When heat is added, molecules gain energy from the environment. As heat is added to water, the molecules move faster and further apart. They finally move fast enough to escape from their container as vapor. Energy is absorbed when a solid changes to a liquid (melting), or when a liquid changes to a gas (**evaporation**). When heat is removed, the particles of matter lose energy. Heat is removed when gases change to a liquid (**condensation**), or a liquid changes to a solid (**freezing**).

A substance's **freezing point** is the temperature at which its liquid form changes to a solid. Liquid water changes to ice at 32°F or 0°C. Every liquid has its own freezing point. Alcohol freezes at –117°C, and ocean water at –1°C. The melting point is the same as the freezing point. Melting will occur when heat is added, freezing will occur when heat is removed.

A substance's **boiling point** is the temperature when it evaporates, or changes from a liquid to a gas. Alcohol boils at 78°C; water boils at 100°C. Water vapor will condense at 100°C when heat is removed.

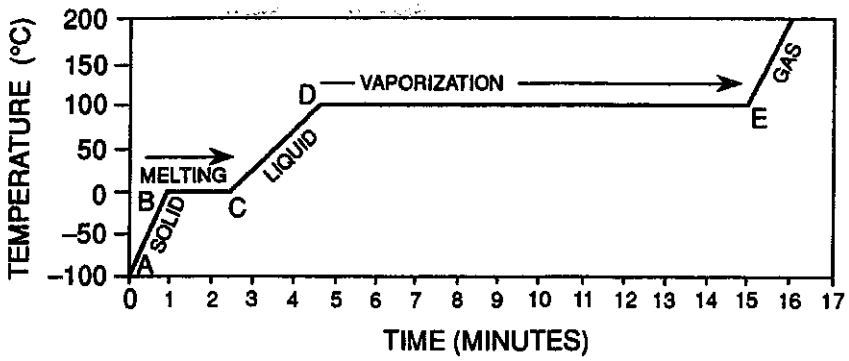


FIGURE 10. PHASE CHANGE

Review Questions

31. The phase change from solid to liquid is _____.

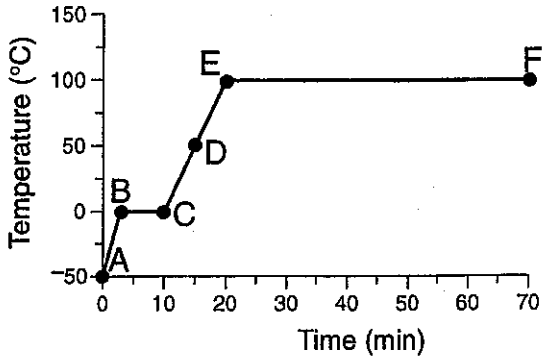
32. During melting, heat is _____.

33. Energy is _____ when a gas changes to a liquid.

34. Energy is released when a liquid changes to a _____.

35. Molecules of a _____ have the most heat energy.

36. The graph shows the heating of a solid material until it becomes a gas.



a. Temperature when the solid melts is _____

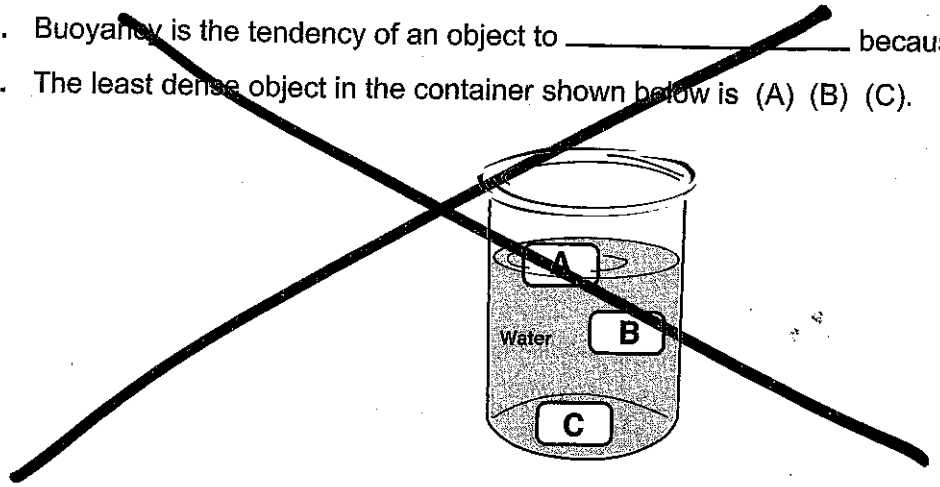
b. Letter at which all the material is a liquid _____

c. Letter where the material has the least energy _____

d. Letter where the material begins to boil _____

30. Buoyancy is the tendency of an object to _____ because of its density.

31. The least dense object in the container shown below is (A) (B) (C).



Physical and Chemical Changes

A **physical change** occurs when matter changes form but its chemical composition and properties stay the same. Sawing wood into pieces or boiling water only changes the physical appearance of the matter.

During a **chemical change**, atoms and/or molecules interact to form new substances with different physical and chemical properties. When iron is exposed to air, rust is formed which has different physical and chemical properties than the original iron. Many chemical changes are started with the addition of energy.

Chemical changes can be represented by a chemical equation. The total mass of the reactants will be equal to the mass of the products. No atoms are created or destroyed, they only change form. This is called the *Law of Conservation of Mass.*

Review Questions

32. A _____ change takes place when matter only changes its appearance.

33. During a _____ change, a new substance is formed.

34. Is it a physical (**P**) or a chemical (**C**) change?

a. burning wood _____

b. sawing wood _____

c. melting ice _____

d. making yogurt _____

Chemistry of Matter

Two or more elements can chemically combine to form a **compound**. The properties of a compound are different from the elements that make up the compound. A compound is the result of a chemical change or reaction. Most matter on Earth is made of compounds. The smallest part of a compound is a **molecule**. Compounds can be broken down into the component elements by a chemical process .

An example of a compound is calcium carbonate, $CaCO_3$, which is found in chalk. This formula, $CaCO_3$, indicates that each molecule of calcium carbonate is made of one calcium atom, one carbon atom, and three oxygen atoms. The number that follows the element symbol is the number of atoms of that element in the compound. If no number is shown, the number of atoms is one.

Mixtures are two or more substances physically combined, but not chemically changed. The substances in a mixture keep their own properties. Mixtures can be separated by simple physical means. A filter can be used to separate sand and water. A magnet can separate iron from sand.

Solutions, such as air and salt water, are mixtures in which one substance is evenly mixed with another. When a substance dissolves, it goes into solution. There are two parts of a solution. The part that dissolves is the **solute**. The part into which the solute dissolves is the **solvent**. In salt water, salt is the solute and water is the solvent. A substance that dissolves in another is soluble. **Solubility**, or the ability to dissolve, can be affected by temperature, pressure, and amount of solute. To speed up the rate of dissolving, a solution can be stirred, heated, or the solute can be broken into smaller pieces.

Review Questions

35. A _____ is a substance made up of two or more elements chemically combined.

36. The smallest part of a compound is a _____.

37. In the chemical compound : **$BaCO_3$**

a. How many different elements are there? _____

b. How many atoms of carbon (**C**) are there? _____

38. A _____ can be physically separated.

39. The part of the solution which dissolves is the _____.

40. Water is a good _____.

41. If the solvent is cold, the solute will dissolve _____.

pH

A solution can be classified as acidic, basic, or neutral. The strength of acids and bases is measured on a pH scale. This scale is a series of numbers from one to fourteen. A neutral solution has a pH of 7. Acids have a pH below 7. Bases (alkaline) have a pH above 7. An indicator, such as litmus paper, is used to test the pH. Red litmus paper will turn blue in bases, and blue litmus turns red in acids.

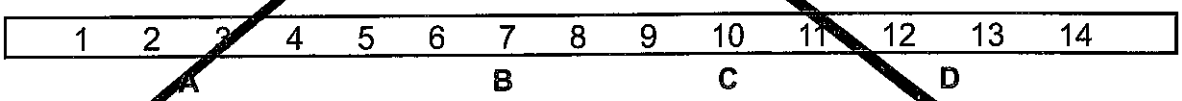
Review Questions

42. pH can be tested using _____ paper.

43. A pH of 4 means that the solution is _____.

44. Is the lettered position acidic, basic, or neutral ?

A. _____ **B.** _____ **C.** _____ **D.** _____



CHAPTER REVIEW

1. Which term is not a form of matter?
(1) atom (2) compound (3) element (4) energy

2. Atoms are made of particles. These include:
(1) protons only
(2) protons and neutrons only
(3) protons and electrons only
(4) protons, neutrons, and electrons

3. Lithium has three protons, four neutrons, and three electrons. Which describes its nucleus?
(1) three protons and four neutrons
(2) three protons, four neutrons, and three electrons
(3) three protons and three electrons
(4) four neutrons and three electrons

4. Which pair correctly matches the atomic particle to its electric charge?
(1) proton, neutral
(2) electron, negative
(3) neutron, negative
(4) electron, positive

5. Which of the following describes an atom which is neutral?
(1) 11 protons, 12 neutrons, and 12 electrons
(2) 11 protons, 11 neutrons, and 12 electrons
(3) 11 protons, 12 neutrons, and 11 electrons
(4) 11 protons, 12 neutrons, and 6 electrons

6. Elements are arranged on the *Periodic Table* according to
(1) density
(2) phase of matter
(3) number of protons
(4) abundance on Earth

7. Which set of terms describes a non-metal?
(1) shiny, malleable, good conductor
(2) dull, malleable, poor conductor
(3) dull, brittle, poor conductor
(4) shiny, brittle, poor conductor

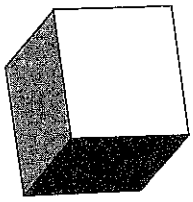
8. Which group of elements will not react with other elements?
(1) metals (2) metalloids (3) non-metals (4) noble gases

9. Which term describes a chemical characteristic of matter?
(1) temperature (2) density (3) reactivity (4) mass

10. Which activity best demonstrates that air takes up space?
(1) blowing out a candle
(2) flying a kite
(3) seeing your breath on a cold day
(4) inflating a balloon

11. What is the density of the object shown?

(1) 1.3 g/cm^3
(2) 5.5 g/cm^3
(3) 3.2 g/cm^3
(4) 0.3 g/cm^3



mass= 22.4 g
volume= 7.0 cm^3

12. Gold has a density of 19.3 g/cm^3. How does the density of a bar of gold compare to a gold ring?

(1) the bar of gold is more dense
(2) the gold ring is more dense
(3) they both have the same density

13. As air gets hotter and expands, the density of the air will

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

14. The particles that make up a solid

(1) can move easily
(2) are closely packed together
(3) can flow against each other
(4) are spread far apart

15. A phase change occurs because

(1) heat energy is absorbed or released
(2) elements in the compound are re-arranged
(3) two different compounds react
(4) elements are physically combined

16. The cooling of air will cause water vapor in the air to change to liquid rain drops. This change is called

(1) vaporization
(2) condensation
(3) evaporation
(4) sublimation

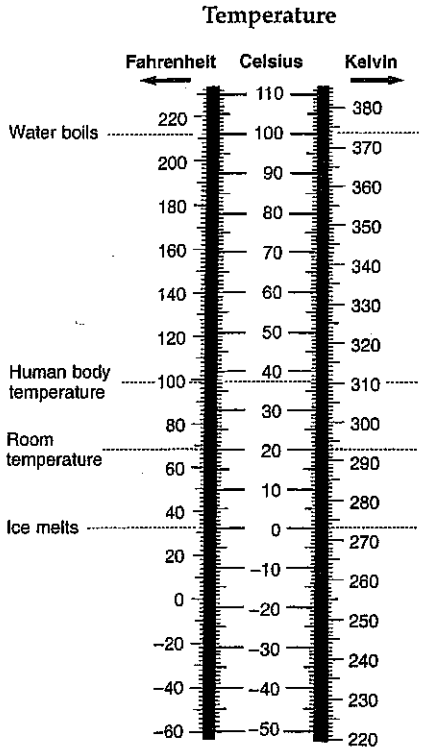
17. Particles of a gas will do all of the following *except*

(1) become arranged in a regular geometric pattern
(2) spread out to fill the entire container
(3) take on the shape of the container they are in
(4) constantly change position

18. The following equation, **H_2O (l) + heat $\longrightarrow$ H_2O (g),** describes a

(1) physical change
(2) chemical change
(3) mixture
(4) soultion

Base your answers to **questions 28-29** on the diagram of temperature scales below.



28. A temperature of 65°C is approximately equal to:

(1) 17°F

(2) 21°F

(3) 145°F

(4) 150°F

29. Average room temperature should be about:

(1) 68°C

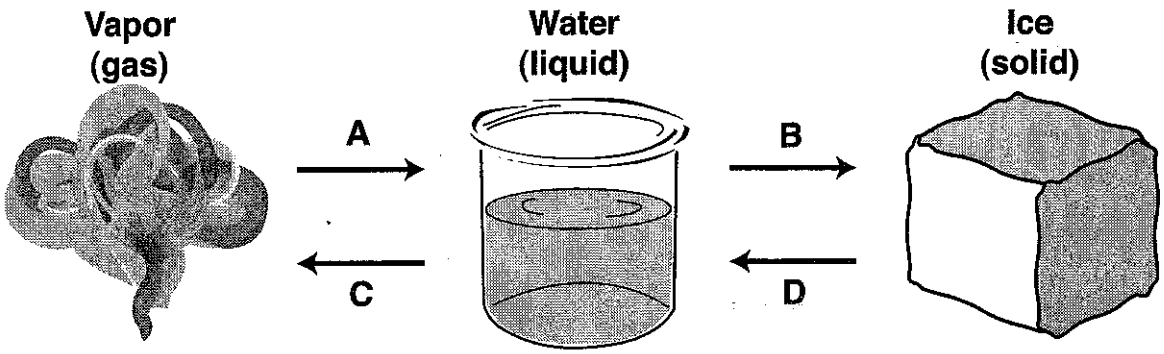
(2) 68°F

(3) 98°C

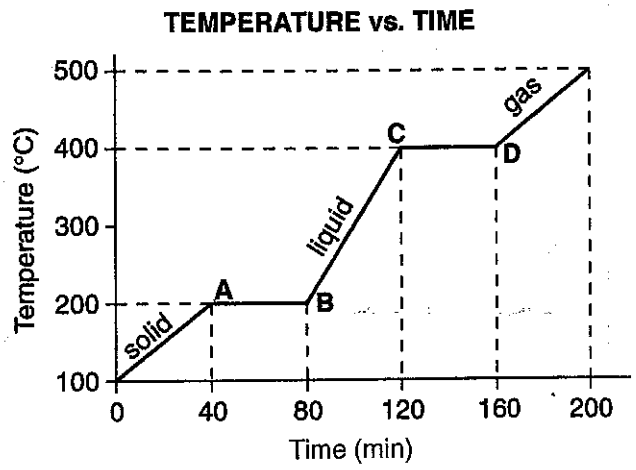
(4) 270°K

30. The diagram below represents the four processes that can occur when water changes phase. Which letter represents condensation?

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



Base your answers to **questions 31-33 on** The graph below which shows the heating of a solid material for 200 minutes until it became a hot gas.



31. The temperature at which the material began to melt was

(1) 100°C (2) 200°C (3) 400°C (4) 500°C

32. Why did the temperature remain at 200° C for 40 minutes?

(1) no heat was being added during this time

(2) the particles began to release heat energy

(3) energy was used to change the particles' positions

(4) energy was used to increase the kinetic energy

33. If heat energy was removed, then condensation would occur from letter

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