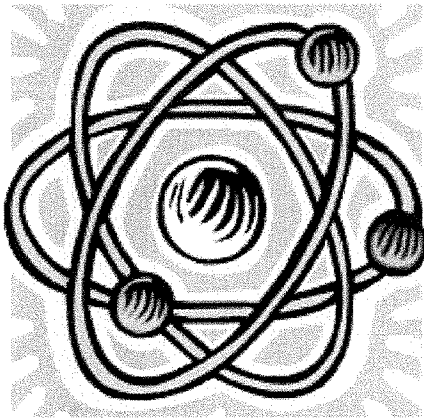




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States of Matter: Facts



Matter is all around us. Matter is the air you are breathing. Matter is the computer you are reading from now. Matter is the stuff you touch and see. And it is more. Matter is defined as anything that has mass and takes up space. Matter is found in 3 major states; solid, liquid and gas.

So what is matter made of? All matter is made of atoms. Atoms are the smallest particle of matter. They are so small that you cannot see them with your eyes or even with a standard microscope. A standard sheet of paper is

about a million atoms thick. Science has come up with a technology to identify atoms called a scanning tunneling microscope (STM) which uses electricity to map atoms. There is more about atoms later, but first let's learn about the three states of matter.

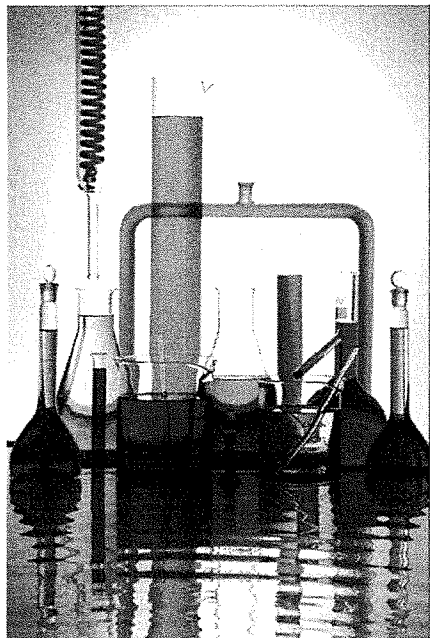
Solids

Matter that is composed of atoms packed tightly together are known as solids. You cannot walk through a solid wall. The matter is packed so tight that it prevents you from moving through it. Solids hold their shape at room temperature. The pencil that you left in the desk at school will still be the same shape when you return tomorrow.

Even in solids there is a small space between the atoms. Depending on how tight the atoms are packed determines the density of matter. This means that a one inch block of wood is not as dense as a one inch block of gold. There is more space between the atoms of the wood than the atoms of the gold.



Liquids

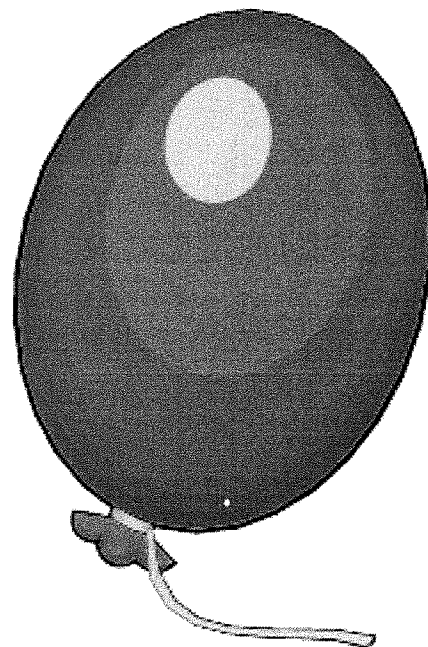


Liquids do not hold their shape at room temperature. There is space between the atoms of a liquid and they move slightly all of the time. This allows you to stick your finger into water and pull it back out, letting the water fill back in where your finger once was. But when walking through the water in the swimming pool, you have to push the water out of the way - this means that you feel the heaviness of the water. Liquids flow or pour and can take on the shape of a container. If the liquid is poured into a wider or narrower container, the liquid will take on that new shape. Liquids are affected by gravity. If you pour only half a cup of milk, the top half of the container would have no milk. Liquids cannot be handed to another person well without the container. Imagine going into a restaurant

and asking for lemonade. What if the waiter just put the lemonade into your hands - no glass or cup? Could you lay the lemonade on the table to drink in a few minutes? Even water in a river or a lake has a container - the banks, the bottom, the shore - they form the container.

Gases

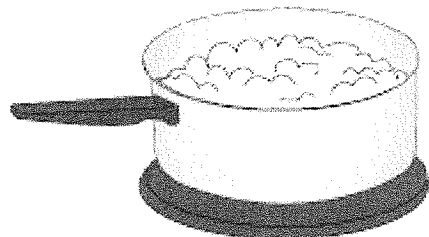
Gases not only do not hold their shape at room temperature, they don't even stay put. Gases are always moving. There is so much space between the atoms in gas that you can move around in them easily. When you walk from one side of the room to the other, you have walked through a bunch of gases that make up our air. You barely even know they are there. Gases will take on the shape of their container and can be compressed into a smaller space. Like when we compress air into a balloon - it fills out the balloon shape. Gases will fill up the space too. You don't see only half of the balloon filled with air - the air is not as influenced by gravity as a liquid or a solid would be.



For a better understanding, take a look at these animations of the behavior of solids, liquids and gases.

Change of State

Matter can move from one state to another, but can still be the same substance. A change of state, also called a phase change, is a physical change from one state of matter to another, for example, from solid to liquid or from liquid to gas.



How does matter move from one phase to another? If the motion of the atoms is altered by pressure or temperature, the state can change too. By lowering the temperature of water, it can freeze into a solid. By heating water, it can become steam which is a gas. Whether solid, liquid or gas - water is still water.

Pressure can change matter from one state to another. Deep in the earth solids turn to liquids because the heavy weight of layers and layers of the earth push down on the solids causing them to turn to liquid magma. This is just one example of how pressure can change matter too.

Other matter changes too, but often only exists in two states or requires the help of humans and technology to move through all three phases. Water is the only matter on earth that can be found naturally in all three - solid, liquid and a gas.

More About Atoms

An atom is made up of a nucleus of neutrons and protons - even smaller particles than an atom. They are called subatomic particles. Electrons circle around this nucleus. Atoms tend to have the same number of electrons as the number of protons in the nucleus. This number is very significant. Each kind of atom has a different number of protons. For example: oxygen has 8 protons. That means it also has 8 electrons. The 8 is known as its atomic number. But gold has 79 protons and 79 electrons. If you wanted to know how many protons and electrons are found in any given atom, the Periodic Table of the Elements is the place to find out.

Periodic Table of the Elements

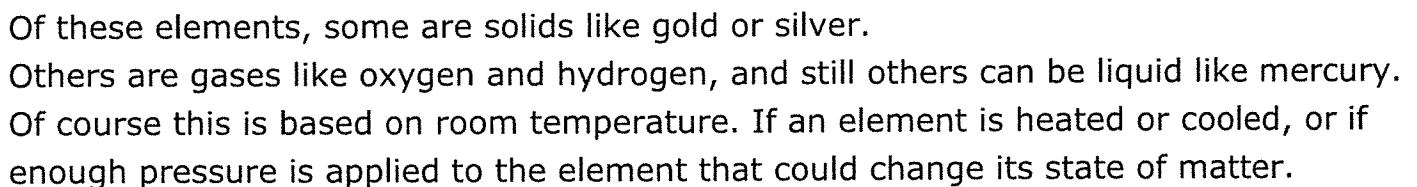
Legend:

- Alkali Metals:** Group 1 (Li, Na, K, Rb, Cs, Fr)
- Alkaline Earth Metals:** Group 2 (Be, Mg, Ca, Sr, Ba, Ra)
- Transition Metals:** Groups 3-10 (Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Kr, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, I, Xe, Hf, Ta, W, Re, Os, Ir, Pt, Au, Hg, Tl, Pb, Bi, Po, At, Rn, Rf, Db, Sg, Bh, Hs, Mt, Ubn, Uub, Uut, Uuq, Uup, Uuh, Uus, Uuo)
- Lanthanides and Actinides:** f-block (La, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Ac, Th, Pa, U, Np, Pu, Am, Cm, Bk, Cf, Es, Fm, Md, No, Lr)
- Other Groups:** Halogens (F, Cl, Br, I, At), Noble Gases (Ne, Ar, Kr, Xe, Rn), Metalloids (B, Si, P, S, Se, Te, As, Sb, Bi, Po, At, Rn), and others (C, N, O, F, Ne, Na, Mg, Al, Si, P, S, Cl, Ar, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Ge, As, Se, Br, Kr, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, I, Xe, Hf, Ta, W, Re, Os, Ir, Pt, Au, Hg, Tl, Pb, Bi, Po, At, Rn, Rf, Db, Sg, Bh, Hs, Mt, Ubn, Uub, Uut, Uuq, Uup, Uuh, Uus, Uuo)

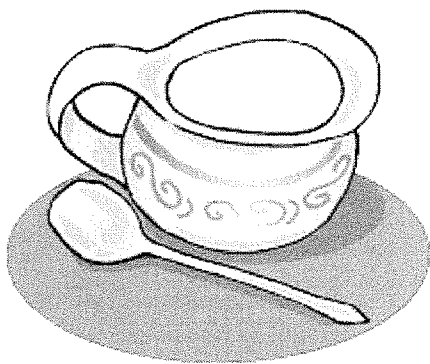
Table Structure:

- Groups (Columns):** 1 to 18.
- Periods (Rows):** 1 to 7.
- Block Structure:** s-block (Groups 1-2), p-block (Groups 13-18), d-block (Groups 3-10), and f-block (Lanthanides and Actinides).

The table only tells us about the atoms of the 100 or so elements found on the earth. An element cannot be broken down into smaller components. Gold is not made of anything - except the element gold. The smallest possible piece of gold is just gold. If it were any smaller it would be the subatomic particles - protons, neutrons and electrons.



4/8

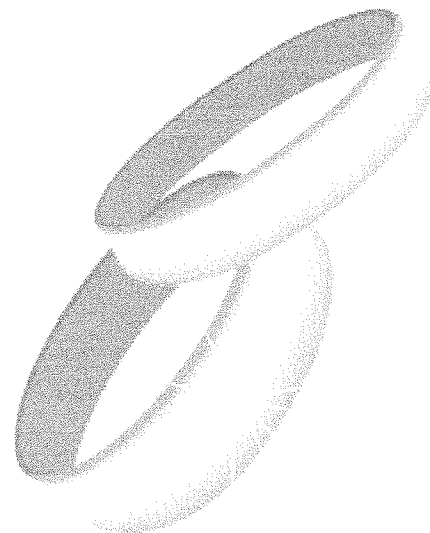


I bet you can't find salt on the Periodic Table of the Elements. That's because salt is actually made of two elements; sodium and chloride. You can find both of those on the table. The sodium and chloride atoms of salt are linked together much like magnets can link together. We call this a compound. Water is a compound made of oxygen and hydrogen. Sugar - the white stuff you put into cookies - is made of carbon, hydrogen and oxygen. Lots of

the substances around us are compounds. From vinegar to household bleach to nail polish remover to baking soda to aspirin - we use compounds all around our homes.

Properties

All matter has qualities about it that describe it scientifically. We call these properties. They can explain the physical or the chemical qualities of a matter. Some of the ways that we describe matter are by its color, its shininess, and its state at room temperature or its odor. Mass, temperature at which it changes states, electric conductivity and flexibility are also properties of matter. These are different for each type of matter and can help scientists identify a matter.



Plasma

We often talk about the three states of matter; solid, liquid and gas. Most of the matter that we use is in one of those three forms. But there is another that we see and use and that we would have a hard time living without - plasma. It is often called the fourth state of matter. Plasma is electrically charged, does not hold its shape, has a huge amount of energy and is very difficult state to manipulate without a laboratory. Plasma can be found here on the earth in flames, lightning, and the polar auroras. The sun, the stars, and some other space events and objects are also made of plasma matter.



More States of Matter?

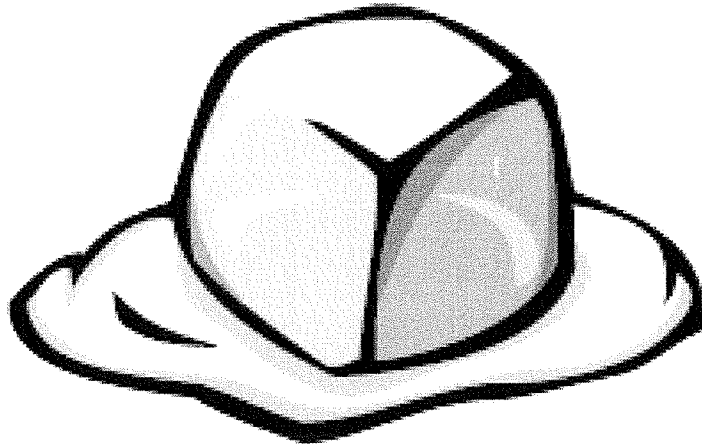
Did you know that there are more phases of matter? We aren't as familiar with them nor do we see them every day. Some exist only in theory, others can be reproduced in laboratories, some are so new that scientists are still figuring out the details and others might exist, but have not yet been found in nature. They include: quark-gluon plasmas, Bose-Einstein condensates, fermionic condensates, strange matter, liquid crystals, quantum spin liquid (QSL), superfluids, supersolids and the paramagnetic and ferromagnetic phases of magnetic materials. New theories and discoveries are happening all of the time, so you'll have to keep studying your physical science to learn more about these states of matter.



What is meant by room temperature?

State of matter of an element or atom is based on its behavior at room temperature. But what exactly is room temperature? Room temperature refers to air temperature not being specifically heated or cooled. Usually between 20 to 25°C (68 to 77°F). While

the actual temperature could be hotter or cooler than these figures, it simply means that the matter has not been placed in an oven or a freezer, but was left out in the room to attain the temperature of the rest of the room. If an ice cube was left out in the room for a period of time, it would melt and become liquid water. Water is a liquid at room temperature. A diamond, on the other hand, is a solid at room temperature and will not change state no matter how long it sits there.

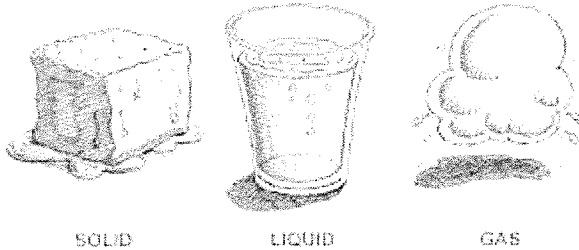


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All About States of Matter

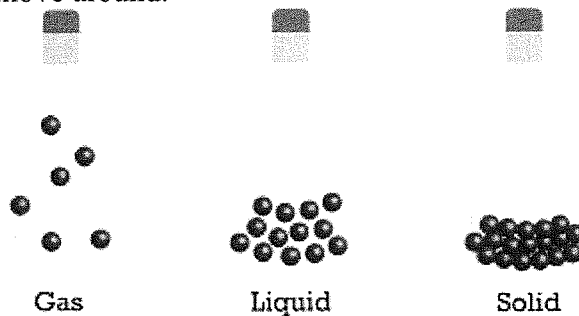
You've likely heard about the three states of matter – gases, solids and liquids. But did you know there are actually six forms of matter? In laboratories, scientists can create plasmas, Bose-Einstein condensates and fermionic condensates, according to NASA. But, for our discussion, we'll focus on the first three because those are the states of matter you're likely to interact with.



All About States of Matter: Three main states of matter are solid, liquid and gas.

Fun Facts about States of Matter for Kids

- Liquids, like water, oil and soda, shift to fit inside the container they're in. If you look at them under a microscope, you'll see that they have particles that are close together, but have no rhyme or reason. The molecules move around.
- Gases, including air, steam and helium, are free-flowing. You can easily put your hand through them. Gases shift to fit their container and can even fill it. Their molecules are spaced far apart and wiggle and jiggle.
- Solids, like your desk, your backpack and your pants, are firm and stable. Their molecules are grouped together in organized patterns. The molecules might vibrate slightly, but they don't move around.



Molecules of Solid Don't move around. Liquid Molecules are close together without rhyme and they move around. Gas molecules are spaced far apart and wiggle and jiggle.

States of Matter Vocabulary

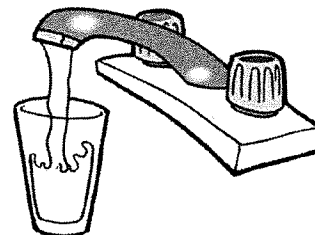
1. **Laboratory**: a place where a scientist experiments and learns
2. **Interact**: participate, work with
3. **Container**: jar, bottle, box or similar product
4. **Molecule**: composed of one or more atom, the smallest particle of a substance
5. **Vibrate**: buzz or move

Name: _____

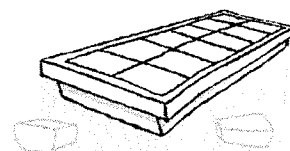
Three States of Matter

by Leslie Cargile

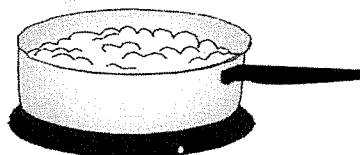
Let's take a walk into an imaginary kitchen. There are ice cubes in the freezer, water running from the faucet and steam rising from a pot of boiling water. We will turn off our pretend faucet so we don't waste water. What do these three things all have in common?



Simply put our imaginary kitchen shows us the three different states of matter. Matter makes up everything that is in our universe. Atoms join together making molecules. Molecules stack together in different ways to make the three different states of matter; solids, liquids and gases.



Solids are easy to think about. The chair you're sitting in is a solid. The floor you walk on is solid. Pretty much everything that has a defined shape is a solid. The molecules of solids are like a box full of oranges stacked tightly together, so tight that they can't move.



Liquids include the water you drink, or the oceans that roll around the earth. A liquid will take the shape of whatever you put it in. Think of a beanbag chair that is missing some of its' stuffing. It will roll around, but it stays together. The molecules of a liquid are close and stick together, but not so close that they can't slide around each other. If you pour water from one container into another without spilling, you will have the same amount of water.

Gases are different than the other two states of matter. They are very loosely attached, some escaping their bonds and disappearing. If we were back in our imaginary kitchen and we tried to catch all of the steam molecules, we would find it nearly impossible.

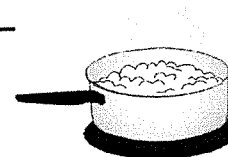
Heat can affect the state of matter. Let's take an imaginary ice-cube and set it on our stove in a pot. Turn the imaginary heat on. Soon the heat has melted our ice cube into a puddle of water. Leave the heat on a little while longer and our puddle of water will evaporate into the air. Even though you can't see the water, it's not gone. It turned into water vapor, which is a gas in the air around you.

Try it out with the help of an adult and see what happens. Can you catch all of your steam and turn it back into an ice-cube? Probably not, but add some food coloring to a pitcher of water and then fill an ice tray. What you will have is an exciting afternoon exploring the worlds of solids, liquids, and gases.

Name: _____

Why Does Matter Matter?

by Kelly Hashway



solids	volume	container	matter	ice	juice
gases	mass	atoms	chair	oxygen	melting
liquids	shape	space	milk	helium	

Choose a word from the box to complete each sentence.

1. The three basic properties of matter are _____,
_____, and _____.
2. All matter is made up of tiny particles called _____.
3. Volume is the amount of _____ that matter takes up.
4. Mass is the amount of _____ an object has.
5. Liquids take the shape of their _____.
6. _____ do not have a definite shape or volume.
7. _____ do not have a definite shape, but they do have a definite volume.
8. _____ have a definite shape and volume.
9. A _____ and _____ are examples of solids.
10. _____ and _____ are examples of liquids.
11. _____ and _____ are examples of gas.
12. Solid ice is _____ when it is changing into a liquid.

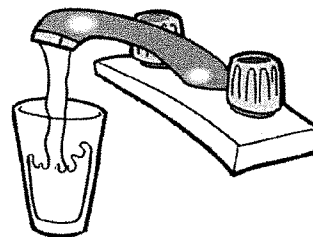
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Three States of Matter

by Leslie Cargile

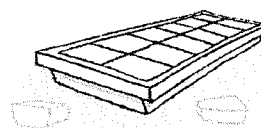
1. Atoms that are joined together are called...

- a. liquids
- b. molecules
- c. shapes
- d. solids



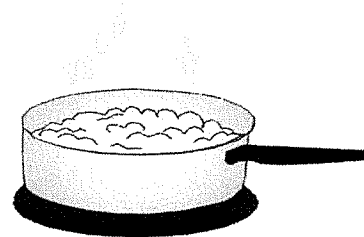
2. What shape is a liquid?

- a. sphere
- b. circle
- c. solid shape
- d. the shape of its container



3. What happens to water when it evaporates?

- a. It turns into a solid.
- b. It turns into a gas.
- c. It turns into an atom.
- d. It disappears.



4. What causes water to evaporate?

- a. warm temperatures
- b. cold temperatures
- c. electricity
- d. food coloring

5. How are molecules in a solid different from molecules in a liquid?

- a. Molecules in a liquid are more tightly packed than molecules in a solid.
- b. Molecules in a liquid cannot move, but molecules in a solid can.
- c. Molecules in a solid are more tightly packed than molecules in a liquid.
- d. Molecules are loosely packed and easily turn into steam.

6. List two examples of solids, liquids, and gases.

solids - _____

liquids - _____

gas - _____

6
C
CARBON
12













































Chemical Symbol

CARBON  Chemical Name






$$\text{Atomic Weight} = \text{Number of Protons} + \text{Number of Neutrons}$$





























































2	He	Helium	4
3			
4			
5	B	Boron	11
6	C	Carbon	12
7	N	Nitrogen	14
8	O	Oxygen	16
9	F	Fluorine	19
10	Ne	Neon	20
11			
12			
13	Al	Aluminum	27
14	Si	Silicon	28
15	P	Phosphorus	31
16	S	Sulfur	32
17	Cl	Chlorine	35
18	Ar	Argon	40

NON-METALS

1  H HYDROGEN	2  He HELIUM	<div>6 C CARBON 12</div> <div>Atomic Number = Number of Protons = Number of Electrons Chemical Symbol Chemical Name Atomic Weight = Number of Protons + Number of Neutrons *</div>																																																																																																																																																																																																																																																								
3  Li LITHIUM	4  Be BERYLLIUM	5  B BORON	6  C CARBON	7  N NITROGEN	8  O OXYGEN	9  F FLUORINE	10 Ne NEON	11  Na SODIUM	12  Mg MAGNESIUM	13  Al ALUMINUM	14  Si SILICON	15  P PHOSPHORUS	16  S SULFUR	17  Cl CHLORINE	18 Ar ARGON	METALS																																																																																																																																																																																																																																										
19  K POTASSIUM	20  Ca CALCIUM	21  Sc SCANDIUM	22  Ti TITANIUM	23  V VANADIUM	24  Cr CHROMIUM	25  Mn MANGANESE	26 Fe IRON	27 Co COBALT	28 Ni NICKEL	29 Cu COPPER	30 Zn ZINC	31 Ga GALLIUM	32 Ge GERMANIUM	33 As ARSENIC	34 Se SELENIUM	35 Br BROMINE	36 Kr KRYPTON	37  Rb RUBIDIUM	38  Sr STRONTIUM	39  Y YTRITIUM	40  Zr ZIRCONIUM	41  Nb NI OBIUM	42  Mo M OLYB D E N I U M	43  Tc T E C H N E T I U M	44 Ru R U T H E N I U M	45 Rh R H O D I U M	46 Pd P A L L A D I U M	47 Ag S I L V E R	48 Cd C A D M I U M	49 In I N D I U M	50 Sn T I N	51 Sb A N T I M O N Y	52 Te T E L L U R I U M	53 I I O D I N E	54 Xe X E N O N	55  Cs C E S I U M	56  Ba B A R I U M	57  La L A N T H A N I U M	58  Ce C E R I U M	59  Pr P R A S E O D Y M I U M	60  Nd N E O D Y M I U M	61  Pm P R O M E T H I U M	62 Eu E U R O P I U M	63 Gd G A D O L I N I U M	64 Tb T E R B I U M	65 Dy D Y S P R O S I U M	66 Ho H O L M I U M	67 Er E R B I U M	68 Tm T H U L I U M	69 Yb Y T T E R B I U M	70 Lu L U T E T I U M	71 Hf H A F N I U M	72 Ta T A N T A L U M	73 W T U N G S T E N	74 Re R H E N I U M	75 Os O S M I U M	76 Ir I R I D I U M	77 Pt P L A T I N U M	78 Au G O L D	79 Hg M E R C U R Y	80 Tl T H A L L I U M	81 Pb L E A D	82 Bi B I S M U T H	83 Po P O L O N I U M	84 At A S T A T I N E	85 Rn R A D O N	86  Fr F R A N C I U M	87  Ra R A D I U M	88  Ac A C T I N I U M	89  Th T H O R I U M	90  Pa P R O T A C T I N I U M	91  U U R A N I U M	92  Np N E P T U N I U M	93 Pu P L U T O N I U M	94 Am A M E R I C I U M	95 Cm C U R I U M	96 Bk B E R K E L I U M	97 Cf C A L I F O R N I U M	98 Es E I N S T E I N I U M	99 Fm F E R M I U M	100 Md M E N D E L E V I U M	101 Nb N O B E L I U M	102 Lr L A W R E N C I U M	103 Rf R U T H E R F O R D I U M	104 Db D U B N I U M	105 Sg S E A B O R G I U M	106 Bh B O H R I U M	107 Hs H A S S I U M	108 Mt M E I T N E R I U M	109 Ds D A R M S T A D T I U M	110 Rg R O E N T G E N I U M	111 Cn C O P E R N I C I U M	112 Nh N I H O N I U M	113 Fl F L E R O V I U M	114 Mc M O S C O V I U M	115 Lv L I V E R M O R I U M	116 Ts T E N N E S S I N E	117 Og O G A N E S S O N I U M	118 	119 	120 	121 	122 	123 	124 	125 	126 	127 	128 	129 	130 	131 	132 	133 	134 	135 	136 	137 	138 	139 	140 	141 	142 	143 	144 	145 	146 	147 	148 	149 	150 	151 	152 	153 	154 	155 	156 	157 	158 	159 	160 	161 	162 	163 	164 	165 	166 	167 	168 	169 	170 	171 	172 	173 	174 	175 	176 	177 	178 	179 	180 	181 	182 	183 	184 	185 	186 	187 	188 	189 	190 	191 	192 	193 	194 	195 	196 	197 	198 	199 	200 	201 	202 	203 	204 	205 	206 	207 	208 	209 	210 	211 	212 	213 	214 	215 	216 	217 	218 	219 	220 	221 	222 	223 	224 	225 	226 	227 	228 	229 	230 	231 	232 	233 	234 	235 	236 	237 	238 	239 	240 	241 	242 	243 	244 	245 	246 	247 	248 	249 	250 	251 	252 	253 	254 	255 	256 	257 	258 	259 	260 	261 	262 	263 	264 	265 	266 	267 	268 	269

KEY

-  = Solid at room temperature
-  = Liquid at room temperature
-  = Gas at room temperature
-  = Radioactive
-  = Artificially Made

57	 La	58	 Ce	59	 Pr	60	 Nd	61	 Pm	62	 Sm	63	 Eu	64	 Gd	65	 Tb	66	 Dy	67	 Ho	68	 Er	69	 Tm	70	 Yb	71	 Lu
139	 La	140	 Ce	141	 Pr	144	 Nd	145	 Pm	150	 Sm	152	 Eu	157	 Gd	159	 Tb	163	 Dy	165	 Ho	167	 Er	169	 Tm	173	 Yb	175	 Lu
89	 Ac	90	 Th	91	 Pa	92	 U	93	 Np	94	 Pu	95	 Am	96	 Cm	97	 Bk	98	 Cf	99	 Es	100	 Fm	101	 Md	102	 No	103	 Lr
227	 Ac	232	 Th	231	 Pa	238	 U	237	 Np	244	 Pu	243	 Am	247	 Cm	247	 Bk	251	 Cf	252	 Es	257	 Fm	258	 Md	259	 No	262	 Lr

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