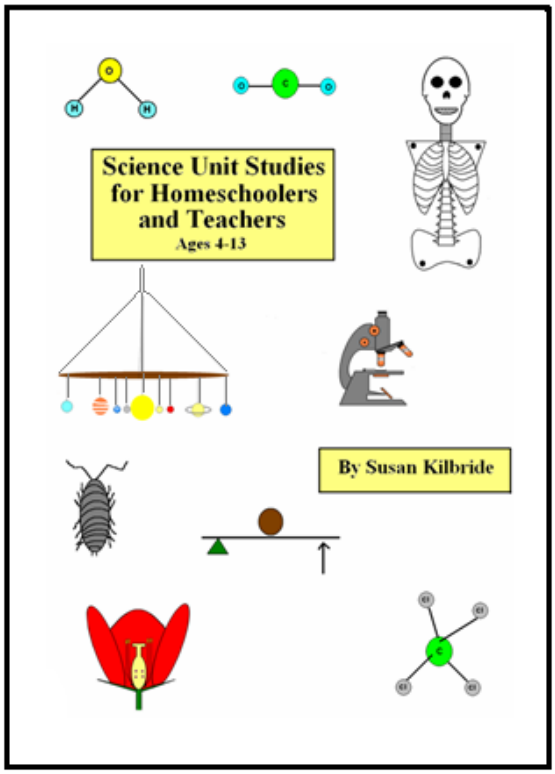
Atoms and Molecules

An excerpt from the book:

Science Unit Studies for Homeschoolers and Teachers

Ages 4-13



If you are interested in purchasing the complete book, it is available in paperback at Amazon.com. **This particular excerpt is in color, but the book itself is in black and white.**

A table of contents that shows the age ranges for each chapter in the book "Science Unit Studies for Homeschoolers and Teachers" is included in this excerpt.

Praise for
Science Unit Studies for Homeschoolers and Teachers

You make learning science fun!

-Brianna, homeschooler, age 10-

My two boys absolutely love Sue's unit studies. Their favorite activity has been building molecules out of colored marshmallows and toothpicks. That project really helped them to grasp the concept of atoms and molecules, and gave them a terrific introduction to the Periodic Table. The lesson plans in "Science Unit Studies for Homeschoolers & Teachers" provide step-by-step instruction to parents to guide them simply and easily through each day's science activities. It makes science fun for students and parents.

-Claire Brouwer, homeschooling mother of two boys, ages 9 and 11-

We used "Science Unit Studies for Homeschoolers and Teachers" at home as part of our homeschooling science lessons. The directions were easy to follow and I loved that they used materials that could be purchased from the grocery store. My children, ages 5, 7 and 9 became excited about learning science, actually jumping up and down when it was time to start Science lessons!

-Ilya Perry, homeschooling mother of three with a degree in elementary education-

Excellent age-appropriate activities and effective assessment tools with which to measure authentic learning

-Frank Hustace, Masters in Education, Stanford University and former Headmaster of Waimea Country School-

Sue's science units made learning fun and introduced key scientific concepts that will serve as building blocks for our daughter's ongoing science education.

-Mia King, national bestselling author of *Good Things* and homeschooling mother of three-

The best part is seeing how proud they feel when they really understand what they are learning, and they realize it is fun. This is not just a science curriculum with a bunch of reading and answering questions. "Science Unit Studies for Homeschoolers & Teachers" introduces children to even the more difficult concepts in a way that has their interest and holds their interest all the way through to the next lesson. I definitely recommend this book for any family wanting to nurture the innate love of learning about the world around them.

-Rachel, homeschooling mother of three-

It's obvious Ms. Kilbride's units of study were developed using both her extensive knowledge of the scientific realm, and how children learn best. Her activities are well though out, age-appropriate, and easy to follow. I thoroughly enjoyed our well-guided exploration of weather!

-Christine Hustace, Homeschooling mom and resource teacher for over fifteen years-

"What I liked best about Sue's science class is learning about atoms and molecules, and weather. I enjoyed the experiment we did on cookies--and we got to eat them! What I liked about Sue as a teacher is that she gave us fun tests. I learned a lot and want to take another class from her.

-Maya Gee, homeschooler, age 8-

I'm impressed with the weather lesson. It's very thorough and easy to follow. You do a really good job of writing this down.

-Susan L., homeschooling mother of three and science educator for 33 years-

Book Overview

If you are a homeschooler or teacher who is looking for fun ideas on how to teach science, then this book is for you! Its hands-on approach is designed to capture students' interest and promote a love of science and learning. The first ten chapters are for younger children ages 4-7, while the second ten chapters are for children ages 8-13. Each chapter is filled with fun science activities that teach a particular science concept. The activities are designed to use common household items, so you won't need to buy lots of expensive scientific equipment or chemicals. This book is sure to get your kids loving science!

Note to the Reader

This book was written by a homeschooling parent for other homeschooling parents. However, it can also easily be used by elementary school teachers since most of the units have been tested in a classroom setting. Homeschoolers vary greatly in ability, so the suggested ages are just listed as a general guideline. The units build upon each other, so it is recommended that you teach them in the same order as the table of contents, though since homeschooling parents are inclined to want to go their own way in teaching, it is not necessary that you do so! Please, however, do not go your own way when it comes to any of the safety precautions mentioned in the book, especially those regarding checking for food allergies. This book was written for homeschooling parents and teachers, not for students to do on their own. Some of the activities, such as those using a stove, should have adult supervision, and some of the activities use small items which could be a choking hazard for young children, so make sure that the younger siblings of your students don't get hold of them (or that your students themselves don't put them in their mouths!)

There is a materials list in the beginning of each chapter. The amounts listed on these materials lists are based on one student, so if you have more than one student, you will need to increase the quantities of some of the items. Check the individual activities within the chapter to determine the amounts you will need for more students. Most of the materials needed for these units are either common household items or are easily obtained from grocery, hardware, drug, discount stores, the local library, or pet stores. However, there is one chapter (Microscopes and Invisible Creatures) that requires the use of a microscope for some of the activities. A number of the activities in that chapter can be completed without a microscope, but if you can find access to one, the experience will be much more fun for your students.

"Fun" is the key word here, the goal in writing this book was to give homeschooling parents and teachers some ideas for how to teach science in a way that will capture students' interest, and open their eyes to the fun in the world of science.

Table of Contents

Chapter 13: Atoms and Molecules
Ages 8-13

Materials Needed For This Unit

Aluminum Foil
Pie pan
A glass soda bottle or something similar
*One or two packages of colored marshmallows
Hammer
A quarter
Dark construction paper
Cotton string
Food coloring
A glass jelly jar that holds more than two Cups
Sugar
Peppermint extract
Ice
Drawing paper
A glass jar that holds at least two cups of water
Saucepan
Toothpicks
Sugar
Magnifying glass
Epsom salts
Table salt
Drinking glass
Paperclip
Perfume in a spray bottle
Measuring cup
Balloon
Eyedropper
Pencils
Markers or crayons

*You can substitute colored balls of clay or gumdrops for the marshmallows.

Part 1: Definition of an Atom

Hold up a piece of aluminum foil and ask your students if they know what it is made of (aluminum). Give a piece to each of your students and have them rip the foil in half. Now tell them to rip the foil in half again and have them keep ripping it in half until it cannot be ripped any smaller. Have them imagine that they keep ripping it in half until they have ripped it into such a small piece that they have to look at it under a microscope to see it. Tell them that eventually they could rip it so small that it would be the smallest piece of aluminum in the world. At that point, if you ripped it again, it would no longer be aluminum. When they get to that smallest piece, it is called an ***atom***. Atoms are so small that they can only be seen under a special microscope called an electron microscope. They are so small that millions of them could fit in the head of a pin.

Tell them that scientists have found all of the different kinds of atoms in the world, and that they have written them down in something called the ***Periodic Table of the Elements***. **Elements** are the names for the different types of atoms.

Show them the Periodic Table on the following two pages and name some of the elements. Have them find aluminum on the table. See if there are any other elements that they recognize. Tell them that everything in the world is made of atoms, including themselves!

Periodic Table of the Elements

1	H																
Hydrogen																	
1.00794																	
3	Li	4	Be														
Lithium		Beryllium															
6.941		9.012182															
11	Na	12	Mg														
Sodium		Magnesium															
22.98977		24.305															
19	K	20	Ca	21	Sc	22	Ti	23	V	24	Cr	25	Mn	26	Fe	27	Co
Potassium		Calcium		Scandium		Titanium		Vanadium		Chromium		Manganese		Iron		Cobalt	
39.0983		40.078		44.95591		47.867		50.9415		51.9661		54.93805		55.845		58.9332	
37	Rb	38	Sr	39	Y	40	Zr	41	Nb	42	Mo	43	Tc	44	Ru	45	Rh
Rubidium		Strontium		Yttrium		Zirconium		Niobium		Molybdenum		Technetium		Ruthenium		Rhodium	
85.4678		87.62		88.9059		91.224		92.90638		95.94		[98]		101.07		102.9055	
55	Cs	56	Ba	57-71	La-Lu	72	Hf	73	Ta	74	W	75	Re	76	Os	77	Ir
Cesium		Barium		Lanthanide Series		Hafnium		Tantalum		Tungsten		Rhenium		Osmium		Iridium	
132.90545		137.3270				178.49		180.9479		183.84		186.207		190.23		192.22	
87	Fr	88	Ra	89-103	Ac-Lr	104	Rf	105	Db	106	Sg	107	Bh	108	Hs	109	Mt
Francium		Radium		Actinide Series		Rutherfordium		Dubnium		Seaborgium		Bohrium		Hassium		Meitnerium	
[223]		[226]				[261]		[262]		[266]		[264]		[269]		[268]	

57	La	58	Ce	59	Pr	60	Nd	61	Pm	62	Sm
Lanthanum		Cerium		Praseodymium		Neodymium		Promethium		Samarium	
138.9055		140.116		140.90765		144.24		[145]		150.36	
89	Ac	90	Th	91	Pa	92	U	93	Np	94	Pu
Actinium		Thorium		Protactinium		Uranium		Neptunium		Plutonium	
[227]		232.0381		231.0359		238.0289		[237]		[244]	

																		2	He Helium 4.0026
						5	B Boron 10.811	6	C Carbon 12.011	7	N Nitrogen 14.00674	8	O Oxygen 15.9994	9	F Fluorine 18.9984	10	Ne Neon 20.1797
						13	Al Aluminum 26.982	14	Si Silicon 28.0855	15	P Phosphorus 30.974	16	S Sulfur 32.065	17	Cl Chlorine 35.453	18	Ar Argon 39.948
28	Ni Nickel 58.6934	29	Cu Copper 63.546	30	Zn Zinc 65.39	31	Ga Gallium 69.72	32	Ge Germanium 72.61	33	As Arsenic 74.9216	34	Se Selenium 78.96	35	Br Bromine 79.904	36	Kr Krypton 83.8
46	Pd Palladium 106.42	47	Ag Silver 107.8682	48	Cd Cadmium 112.411	49	In Indium 114.82	50	Sn Tin 118.71	51	Sb Antimony 121.76	52	Te Tellurium 127.6	53	I Iodine 126.905	54	Xe Xenon 131.29
78	Pt Platinum 195.08	79	Au Gold 196.96659	80	Hg Mercury 200.59	81	Ti Thallium 204.383	82	Pb Lead 207.2	83	Bi Bismuth 208.98	84	Po Polonium [209]	85	At Astatine [210]	86	Rn Radon [222]
110	Ds Darmstadtium [281]	111	Rg Roentgenium [280]	112	Cn Copernicium [285]	113	Uut Ununtrium [284]	114	Uuq Ununquadium [289]	115	Uup Ununpentium [288]	116	Uuh Ununhexium [293]	117	Uus Ununseptium [294]	118	Uuo Ununoctium [294]

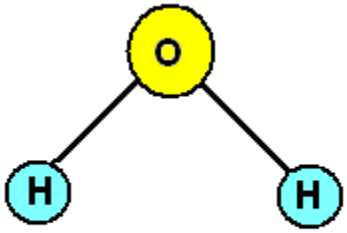
63	Eu Eruropium 151.964	64	Gd Gadolinium 157.25	65	Tb Terbium 158.93	66	Dy Dysprosium 162.5	67	Ho Holmium 164.93	68	Er Erbium 167.26	69	Tm Thulium 168.93421	70	Yb Ytterbium 173.04	71	Lu Lutetium 174.968
95	Am Americium [243]	96	Cm Curium [247]	97	Bk Berkelium [247]	98	Cf Californium [251]	99	Es Einsteinium [252]	100	Fm Fermium [257]	101	Md Mendelevium [258]	102	No Nobelium [259]	103	Lr Lawrencium [262]

Part 2: Definition of a Molecule

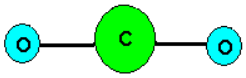
Show your students the Periodic Table again. Ask them to find water on it. When they can't find it, ask them why they think water is not on there (because it's not an atom). Water, like everything in the world, is made of atoms, but it isn't made of all one type of atom. It is made of two different types of atoms: hydrogen and oxygen. Have them find (or show them) hydrogen and oxygen on the Periodic Table. Water is made of two hydrogen atoms and one oxygen atom. When you add two or more atoms together, it is called a ***molecule***. Two hydrogen atoms and one oxygen atom together make a water molecule. All molecules are made up of two or more atoms.

Activity:

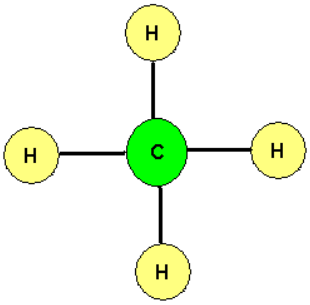
Have them make models of molecules with toothpicks and colored marshmallows (you can substitute gumdrops or balls of clay for the marshmallows if you like). Start with a water molecule. Choose a color to be oxygen and a color to be hydrogen. Attach the two hydrogen marshmallows to the oxygen marshmallow with the toothpicks so it looks like this:



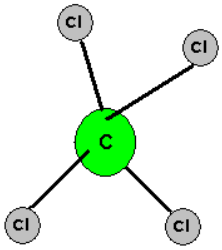
After they have finished making the water molecule, have them make these molecules:



Carbon Dioxide



Methane



Carbon Tetrachloride

*Point out to your students that "di" means two, so carbon di*oxide *means a carbon molecule with two oxygen molecules. "Tetra" means four, so carbon tetra*chloride *means a carbon molecule with four chlorine molecules.*

Part 3: Crystals

Activity:

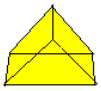
Make eight or more water molecules with marshmallows like you did in the previous activity; only this time push each molecule's hydrogen "atoms" up the toothpicks until they are touching the larger oxygen "atom." Next, take two of the water molecules and connect them to each other by pushing one molecule's oxygen atom onto one of the toothpicks sticking out of one of the other molecule's hydrogen "atoms." Continue adding the other water molecules in the same way until you have a three-dimensional structure. Each oxygen atom can have up to four hydrogen atoms connected to it.

Tell them that they have just made a model of ice crystals! Different molecules have different shapes. When molecules of the same substance attach to each other without any interference from outside forces, they will go together like puzzle pieces, depending on the shape of each individual molecule.

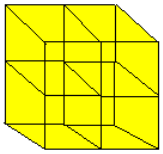
Activity:

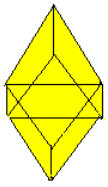
Have your students draw (or draw for them) three-dimensional figures starting with different shapes. For example:

You can start with a cube, or a roof-shape, or any shape you please:



Then build on your original shape to create a larger structure:





Just like the cube and the roof-shape can be the building blocks of a larger shape, molecules are the building blocks of the shapes of crystals.

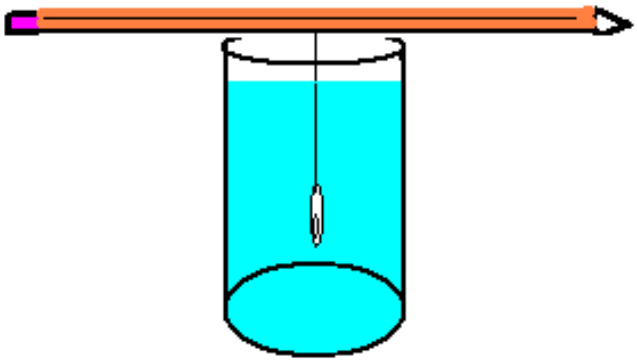
Now tell your students that it is time to see some real shapes that molecules make when they join together.

***Activity*:**

Look at some salt under a magnifying glass and notice the shape of the crystals. Salt molecules join together to make cubes. Smash the salt with a hammer and look at the crystals again. Tell your students that in real life, outside forces such as erosion, pressure, and heat act on groups of molecules so that their shapes aren't what they would be if left alone. A salt molecule is made of one atom of sodium and one atom of chloride. When salt molecules are allowed to attach to each other freely, they make salt crystals.

Activity:

Grow some crystals to see how they form different shapes. To grow crystals, you need to make a ***saturated solution****, which is basically a mixture that is as full of sugar, or whatever you put in it, as it can get. Sugar crystals are fun to grow because you can eat them! Take a rough string (not too slippery or the crystals won't be able to stick to it) and tie a paperclip to one end to weigh it down. Tie the other end to the middle of a pencil and hang the string into an open jelly jar with the paperclip on the bottom. Jelly jars can usually withstand having hot water poured into them, but be careful when pouring the mixture into the jar, just in case it breaks. Don't let the string touch the sides of the glass. Make a saturated solution of sugar by boiling one cup of water in a saucepan and gradually stirring in 3 cups of sugar, tablespoon by tablespoon. Pour the sugar mixture into the jar. You can add a few drops of food coloring if you would like your crystals to be colored. Let the jar sit for a few days. This recipe is designed to make lots of crystals quickly, so if you just want the crystals on the string, you can take them out early, or leave the string in and watch the crystals take over the jar! Table sugar molecules are made of 12 atoms of carbon, 22 atoms of hydrogen, and 11 molecules of oxygen.*



Epsom Salts make very pretty spiky-shaped crystals. To see them, cut a piece of dark colored construction paper to fit the bottom of a pie-pan. Thoroughly mix 1 Tablespoon Epsom salts with 3 Tablespoons of warm water in a glass. Pour the mixture onto the construction paper in the pie pan. Let it sit in a warm place until the water evaporates. Sometimes the crystals are even better on the bottom side of the paper, so check both sides. Epsom Salt molecules are made from one atom of magnesium, one atom of sulfur, and four atoms of oxygen. Even though they are called "salt," they are <u>not</u> *edible, so make sure your students don't taste them!*

When we "grow crystals," we are breaking the molecules apart from each other and allowing them to come back together in their natural pattern. Crystals are good examples of the different kinds of shapes molecules can make when they join together.

Part 4: Characteristics of Molecules

A. Molecules Move

Activity:

Place a glass of water on a table. Put a few drops of food coloring in it and watch what happens. The food coloring will eventually move throughout the glass.

Tell your students that even though molecules are so small that we can't see them, we can see groups of molecules. The food coloring is a group of molecules and we can watch it move through the water until the food coloring and the water are evenly mixed throughout the glass. This mixing due to molecular movement is called ***diffusion****.*

Activity:

Have your students stand about ten feet away from you. Take a perfume spray bottle and squirt one spray of perfume into the air. See how long it takes the smell to reach your students. Point out to your students that molecules not only move (diffuse) through water, they can move through air also.

B. Molecules move faster or slower depending on temperature

Activity:

You will need to prepare the bowls of water for this activity ahead of time. Fill a bowl with cold water and put it in the freezer for about 20 minutes. While the water is cooling, boil some water and pour it into another bowl. Place both bowls next to each other on a table and drop the same number of drops of food coloring in each bowl. Observe how long it takes for the color to diffuse throughout each bowl (you can even time them with a clock or stopwatch). The food coloring in the cold water bowl should take longer to diffuse than the food coloring in the hot water bowl. That is because molecules move faster in hot water than in cold water.

A fun way to illustrate molecular motion for your students is to tell them that when molecules are cold they are sluggish and don't want to move much. You can pretend you are the slow, sluggish, cold molecule while you say this (and have them move along with you if they want to). Next tell them that hot molecules move around very quickly. As you say this, start speeding up your movements and speech. As molecules start moving around more quickly, they spread apart, and pretty soon they just shoot off into the air by themselves and become a gas.

Activity:

Have your students play a game where they pretend that they are atoms at different temperatures. You call out "hot", "cold," or "warm," and they need to move accordingly. If they are "hot," they should be moving faster and farther away from each other. If they are "cold," they should be moving slower and closer together. If they are "warm," they should be moving somewhere in between.

Activity:

Boil a pot of water on the stove (a tea kettle is especially good for this). Have your students watch as the water starts turning into water vapor and "escapes" from the pot into the air.

Activity:

Leave an empty glass soda bottle (or a similar-type bottle) in the freezer for about ten minutes. Take it out and spread a film of water over the top of the bottle opening with your finger. Immediately place a quarter over the bottle opening. After a few minutes, as the air inside the bottle starts warming up, the coin will start clicking up and down. This is because as molecules of air inside the bottle start warming up, they will start moving faster, and start moving farther apart or expanding. As they move farther apart, they will start pushing on the coin at the top of the bottle and force it upward.

C. Molecules have Space Between Them

Activity:

Pour 1 cup of water in a glass jar and mark with a marker or piece of tape where the water line is. Add another cup of water to the jar and mark where the water line is with 2 cups of water in it. Now pour out all of the water. Measure 1 cup of hot tap water and pour it into the jar.

Ask your students what they think will happen if you add 1 cup of sugar to the cup of water in the jar. Do they think it will move the level of the water up to the 2 cup mark? Add 1 cup of sugar to the water and stir it with a spoon until it dissolves in the water. The level of the sugar and water will be less than the 2 cup mark. This is one case where 1 + 1 does not equal 2! One of the reasons for this is that even though molecules are so small that we can't see them, they still have spaces between them. When the sugar dissolved in the water, the sugar molecules fit into the empty spaces between the water molecules, so they don't take up as much room in the water as they did in air.

D. Molecules are Small

Activity:

Fill up an eyedropper with peppermint extract. Squeeze the extract into an unfilled balloon, making sure not to let any drip onto the outside of the balloon. Blow up the balloon and tie it shut. Wait a few minutes and smell the outside of the balloon. It should smell like peppermint.

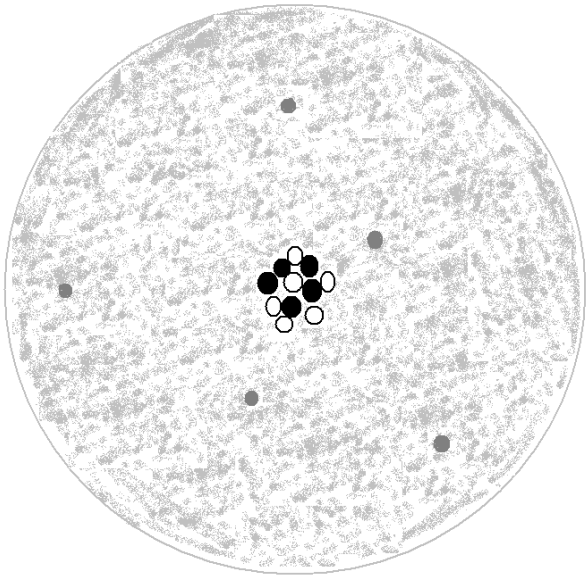
You can smell the peppermint on the outside of the balloon because the peppermint molecules were so small that they could move through the balloon to reach the outside air.

Part 5: Parts of an Atom

Remind your students that molecules are made of atoms and that atoms are the smallest possible pieces of elements. For example, if you broke an atom of iron in half, it would not be iron any more. But what are atoms themselves made of? An atom has three main parts, ***protons***, ***neutrons***, and ***electrons***. The protons and neutrons are in the center of the atom and together they are called the nucleus. The electrons move around the outside of the nucleus.

Activity:

Have your student draw a picture of an atom. It should turn out something like this:



The protons and neutrons are the black and white circles in the center of the atom, forming the nucleus. The electrons are the gray circles outside of the nucleus. Normally there is the same number of electrons as protons, so in the drawing above, the protons are the black circles, the neutrons are the white circles, and the electrons are the gray circles. The cloudy area shows the space that the electrons are moving in.

Activity:

Pretend you are the nucleus and your students are the electrons moving around you. Using the Periodic Table, figure out what type of atom you are by the number of electrons you have.

Activity:

Draw some specific atoms using the following information:

1) *A hydrogen atoms has one proton, one electron, and no neutrons*
2) *A carbon atom has 6 protons, 6 electrons, and 6 neutrons*
3) *An iron atom has 26 protons, 26 electrons, and 30 neutrons*
4) *A nitrogen atom has 7 protons, 7 electrons, and 7 neutrons*

Test for Atoms and Molecules

1) What is diffusion?
    a. Another word for “different”
    b. A type of molecule
    c. The mixing of molecules due to molecular movement.
    d. The movement of electrons in an atom.

2) What is an atom?
    a. The smallest piece of an element that can still be called that element
    b. A bomb
    c. Something that contains tritons and neutrons
    d. Something made of molecules

3) What is a molecule?
    a. A part of an atom
    b. A combination of two or more atoms
    c. A mole’s cuticle
    d. Part of an electron

4) What is a proton?
    a. The part of the atom that spins around outside the nucleus
    b. A part of an electron
    c. A light ray that comes off of electrons
    d. A particle in an atom that is part of the nucleus

5) What is an electron?
    a. The part of the atom that spins around outside the nucleus
    b. It is what crystals are made of
    c. A particle in an atom that is part of the nucleus
    d. The part of the atom that rests

6) What is a neutron?
    a. The part of the atom that spins around outside the nucleus
    b. A part of an electron
    c. A particle in an atom that is part of the nucleus
    d. A neutral molecule

7) What makes up the nucleus of an atom?
    a. Electrons and protons
    b. Protons and neutrons
    c. Electrons and neutrons
    d. Electrons, protons, and neutrons

8) Name three characteristics of molecules.
    a. They are motionless, they have space between them, they are small.
    b. They are solid objects, they are motionless, they are small.
    c. They have space between them, they move more quickly in cold temperatures than warm temperatures, they are small.
    d. They move, they have space between them, they are small.

9) What is the name of the table that scientists have listed all of the different types of atoms in?
    a. The Table of Molecules
    b. The Periodic Table of the Elements
    c. The Table of the Chemicals
    d. The Periodic Table of Molecules

10) Molecules mover faster or slower depending on what?
    a. Whether it is dark or light
    b. Whether it is sour or sweet
    c. Whether it is hot or cold
    d. Whether it is wet or dry

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