Score _____ / 100 pts.

Name _____
Class _____ Date _____

Matter on Earth and in the universe is made of atoms that have structure, mass, and a common origin. The periodic table is used to organize elements by structure. A relationship exists between the chemical behavior and the structure of atoms. The periodic table reflects this relationship.

The nucleus of an atom is a tiny fraction of the volume of the atom. Each proton or neutron in the nucleus is nearly 2,000 times the mass of an electron. Electrons move around the nucleus.

STANDARD I: Students will understand that all matter in the universe has a common origin and is made of atoms, which have structure and can be systematically arranged on the periodic table.

Objective 1 Recognize the origin and distribution of elements in the universe.

1. How do the atoms and elements on earth compare those on the far side of the universe? We say that all matter in our universe has a "common origin". What does that mean?
   Elements and matter are consistently the same throughout the universe. Matter is theorized to have originated in an initial explosion where the simplest element, hydrogen, was formed. As hydrogen spread out through empty space gravity "clumped" the hydrogen gas into large massive clouds. When the clouds were massive enough, and pressure in the center of the clump was sufficient, hydrogen atoms began to fuse together in a nuclear fusion reaction to create helium. A star is born. When all the hydrogen has fused into helium, the fusion reactions stop, cooling and collapse occurs, and when pressure is sufficient helium then begins to fuse into other elements. Lithium elements to Iron elements are formed in this second stage. As helium is used up and elements are created and thrown into space, the star cools and collapses again. This final stage creates so much pressure as it cools that the star rebounds and explodes, creating the remaining elements found in the universe and sending them out into space traveling an near the speed of light. Elements are formed from the stars, a "common origin."

2. What is the current theory for the origin of our universe? What evidence do we have to support this theory?
   See question 1. Evidence supporting the big bang includes the disproportionate amount of hydrogen found in the universe. The universe is expanding, as shown by the shift in light frequencies due to the Doppler Effect, or the red shift. Vast amounts of gamma radiation are found in space, which may have originated from an initial explosion.

3. What is the most abundant element in the universe? Where do all the other elements come from? What is the element of life?
   Hydrogen is the most abundant element in the universe. See question 1 for an explanation of where other elements come from. Carbon is the element of life.

4. Light elements are those with small nuclei. Where are these elements located on the periodic table? _____ Heavy elements are those with big nuclei. Where are these elements located on the periodic table? _____. The universe is composed mostly of _____ (light /heavy) elements. Why?
   The periodic table is ordered by atomic number or the number of protons. Increasing the number of protons and neutrons found in an atom increases its mass. Light elements are found at the beginning of the periodic table with hydrogen-1. Heavy elements are found toward the end of the periodic table.

5. When planets form, lots of heavy elements pull together because of their gravity. This means that earth has _____ (more/less) of a concentration of heavy elements than is normal. (And it is a good thing too, or else life would be impossible.)

Objective 2 Relate the structure, behavior, and scale of an atom to the particles that compose it.

6. How did the following scientists contribute to our current understanding of the atom. Is our current model "perfect "?

   Democritus: Greek philosopher – Introduced idea of "atomos" or particles that cannot be cut.

   Dalton: Father of atomic theory. Proposed five postulates to explain conservation of mass experiments.

   Thompson: Used cathode ray experiment to prove that atoms were made of smaller particles. He discovered the electron.

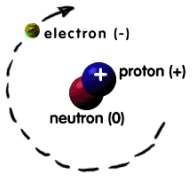
   Millikan: Used oil drop experiment to measure the charge on an electron.

   Rutherford: Used the gold foil experiment to discover the nucleus of the atom.

   Bohr: Used the atomic emission spectra from hydrogen gas to explain electron energy levels.

   Schrödinger (Wave Function): Described the energy levels using a wave function. He determined the three dimensional shape and probable location of electron orbitals.

7. Describe the location, size, and charge of each of the major particles in an atom. Then draw a simple picture of an atom.

	Location	Relative Size	Charge	Picture
Proton	nucleus	big (1 amu)	+	
Neutron	nucleus	big (1 amu)	0	
Electron	electron cloud	small (.0005 amu)	-	

8. Protons and neutrons are _2000_ times bigger than electrons. Do electrons travel in perfect circles? What do we call the region where an electron can PROBABLY be found? Electrons travel as waves around the nucleus. Higher energy levels of electrons increase the distance where electrons are probably located. The probability location of electron waves are described by solving the wave function equation, and probabilities are represented by three dimensional regions of space called orbitals

9. Atoms are made up mostly of _empty space_. Most of the mass is concentrated in a tiny ball called the _nucleus_. How did Rutherford's gold foil experiment help prove this? Rutherford's experiment passed alpha particles, which are positive, through an extremely thin foil of gold. Most alpha particles passed through the gold, but some were deflected by very small very dense positively charged particles. This intermittent deflection demonstrated that most of the gold foil was empty space, and a very small part of it actually had matter. This very small part was the nucleus.

10. What gives an atom its identity? What do we call this number? Where do we find this number on the periodic table? If an atom with no charge has 12 protons, how many electrons will it have? Atomic identity is determined by the number of protons. The number of protons is the atomic number. The atomic number is found above the symbol. 12 protons would provide 12+ charge, you would need 12 electrons providing 12- charge to make the atom neutral.

11. What do we call an atom that is no longer neutrally charged? _____ If an atom gains an electron, it becomes a _____ (+/-) ion. If an atom loses an electron, it becomes a _____ (+/-) ion. How can you predict how many electrons an atom will gain or lose? Atoms that gain charge are called ions. Gaining electrons gives negative charge. Losing electrons leaves an atom with positive charge. The number of electrons in the outer energy level, valence electrons, will stabilize when the energy level is full. Charge depends on how many electrons must be gained or lost to fill outer energy levels. The number of electrons in this outer energy level is normally 8.

12. What is "mass number"? _____ How do you calculate it? _____ If an atom has 5 protons and 6 neutrons, then the atomic number is _6_ and the atomic mass is _11_. What is this element? _carbon_ Mass number is the total number of protons and neutrons. It is calculate by adding the number of protons to the number of neutrons. The element with 6 protons is carbon.

13. What do we call atoms that have the same number of protons (identity) but different numbers of neutrons (mass)? Atoms with the same number of protons but different overall masses are called isotopes.

14. Write the correct symbol for the atom that has 6 protons and 8 neutrons. ${}^{14}_{6}C$

15. How many neutrons does Chlorine 37 have? How many neutrons does Chlorine 38 have? How many protons do they have? Chlorine 37 has 20 neutrons and 17 protons. Chlorine 38 has 21 neutrons and 17 protons.

16. How many objects are in a dozen? _12_ How many objects are in a mole? _6.02×10^{23}_

17. What does amu stand for? _atomic mass unit_ One water molecules has a mass of 18 amu. This is too small to measure in the lab. How much would one mole of water molecules weigh? One mole of water has a mass of 18 grams. The scale of the mole was designed to have the same numerical measurement in grams as an atom in atomic mass units.

18. What is the molar mass of the following? $Ca(OH)_2$ CuO CH_4 $C_6H_{12}O_6$
    74.10g/n, 79.55g/n, 16.05g/n, and 180.18g/n respectively.

Objective 3 Correlate atomic structure and the physical and chemical properties of an element to the position of the element on the periodic table.

19. Where are metals located on the periodic table? Nonmetals? Metalloids/Semi-metals? Transition metals? Define the following, and say which category they belong with.
    Lustrous – Shiny (metals)
    Malleable – Shape forms (metals)
    Conductor – Heat and electricity flow (metals)
    Brittle – shatters with impact (nonmetals)
    Dull – Not Shiny (non-metals)
    High Electronegativity – (nonmetals)
    Semiconductor - metalloids partial conductors
    Oxides are basic in solution – (Metals)

Metals are located below the staircase B to At. Nonmetals are located above the staircase. Metalloids are located on the staircase. Metals are elements that tend to give up electrons to stabilize. Metals have characteristics such as: lustrous, conductors, and high malleability. Metals form positive ions. Non-metals are elements that tend to attract or share electrons to stabilize. Non-metals form negative ions and have characteristics such as: dull, brittle, and high electronegativity. Metalloids exhibit characteristics of both non-metals and metals.

20. Vertical columns on the periodic table are called _groups_ or _families_. Horizontal rows on the periodic table are called _periods_. How can you tell which elements will have similar properties? Why do they have similar properties? Elements with similar properties have the same number of valence electrons. These similar elements are found in the same group.

21. Match the following descriptions with their groups on the periodic table.
    a. Element Bob tends to steal electrons or hog them when bonding. It probably belongs to the _halogen_ family.
    b. Element Betty explodes when I put it in water. _alkali metal_ family.
    c. Element Bobby forms lots of bonds all the time. _group 14_ family.
    d. Element Snobby refuses to bond with anything. _noble gas_ family.