Name(s) _____

Worksheet: *Subatomic Structure, Isotopes & Mass*

1. Fill in the blanks in the following chart. Be sure to include ionic charges when appropriate. The first row is completed as an example.

Nuclear Symbol	Number of Protons	Number of Neutrons	Number of Electrons	Atomic Number (Z)	Mass Number (A)
$^{12}_{6}C$	6	6	6	6	12
$^{14}_{7}N$			7		
	7	8	7		
			18	20	40
$^{17}O^{2-}$				8	
^{56}Fe			26		
$^{19}F^{-}$				9	

2. Refer to the chart you completed in Question 1 and identify:
   (a) All of the isotopes in the chart

   (b) The atoms and ions that are isoelectronic (those with the same number of electrons).

3. Why is the identity of an element determined by the number of protons in its nucleus? Why can't an element's identity be determined by the number of neutrons or the number of electrons?

4. Arrange the following in order of increasing mass: (a) the mass of a proton, (b) the mass of a grain of sand, (c) 15.999 amu, (d) the mass of a single carbon atom, and (e) the mass of an electron.

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5. What percentage of the total weight of a carbon-12 atom (6 protons, 6 neutrons, 6 electrons) is found in the nucleus?

6. Which element is the standard for assigning the atomic mass of all elements?

7. If the entire population of the earth, which is over seven billion, were put to work counting the number of atoms in twelve grams of carbon-12, how long would it take to complete the task? Assume that each person works 8 hours per day, 250 days per year, and that each person can count three atoms per second.

8. If the weight of a proton was the same as the weight of a 16 lb bowling ball, and if the weights of the subatomic particles remained relatively the same, what would the weight in lbs of a neutron and electron be respectively?

n =

e^- =

9. Naturally-occurring boron, atomic number 5, is a mixture of two isotopes, boron-10 and boron-11. Work in pairs to sketch representations of each of these atoms, specifically illustrating the difference between the isotopes. When each pair is finished, compare sketches and discuss and resolve any differences.

10. Boron is present in small amounts in the earth. It is a necessary nutrient for plants, although it is toxic to humans in large amounts. The boron-10 isotope has a mass of 10.0129 amu and boron-11 has a mass of 11.00931 amu. The atomic mass of boron is 10.811 amu.

    (a) Without using a calculator, choose the best estimate among the following for the percentage abundance of the two boron isotopes:

    (i) 40% ^{10}B and 60% ^{11}B
    (ii) 80% ^{10}B and 20% ^{11}B
    (iii) 20% ^{10}B and 80% ^{11}B
    (iv) 60% ^{10}B and 40% ^{11}B

    (b) Calculate the actual percentage abundance of the boron isotopes. How does your calculated value compare with your estimate from part (a)?

11. Nitrogen is 99.63% ^{14}N at 14.00307 amu and 0.37% ^{15}N at 15.00011 amu. Determine the atomic mass of nitrogen. How does your calculated value compare with the value given on the periodic table?

12. The C_{60} molecule has probably been a product of campfire burning since the earliest history of human civilization, yet it was not formally proposed to exist until 1985, and its existence was finally verified in 1990. The 1996 Nobel Prize in Chemistry was awarded to R.F. Curl, Jr., H.W. Kroto, and R.E. Smalley for their discovery of this general class of molecule, known as fullerenes. As indicated by the formula, the molecule consists of sixty carbon atoms. Because of its shape, it was named buckminsterfullerene in honor of Buckminster Fuller, a twentieth century visionary engineer, architect, scientist, and philosopher.

    (a) Is every molecule of C_{60} identical? Is every atom of C_{60} identical? Briefly explain your answers.

    (b) Briefly explain how the presence of fullerene in charcoal artifacts that were thought to be from neanderthal firepits would be, or could be used by anthropologists to prove they were indeed from that period of time.