**Atomic Structure Exploration Activity Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Score: \_\_\_\_\_\_ / 15 Submit Team envelope with subshell pieces and names of team on outside.**

Quantum mechanics is the current model for the electronic structure of the atom. This complex mathematical model has been confirmed by all experiments performed for the past century. Even though it is complex it is worth our time to explore and describe.

**Review of Atomic History: What do we already know about quantum mechanics?**

1. Just like the nuclear model, \_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are located within the nucleus while \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are located outside the nucleus.

2. Just like the Bohr model, electrons are located in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ energy levels. In the Bohr model, these levels are called orbits. In Quantum Mechanics, they are called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

3. An orbital is a region of space surrounding the nucleus where there is a 95% \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of finding an electron. An orbital can hold a maximum of \_\_\_\_\_ electrons.

4. The quantum mechanical model is necessary to accurately describe the \_\_\_\_\_\_\_\_\_\_\_\_\_ nature of matter.

**Procedure**

1. Cut around each of the images on the subshell sheets. Each piece you create of this atomic structure set represents a collection of orbitals called a subshell. Use the colored form as reference to color pieces.

2. Describe how each of the following subshell descriptions are represented with the symbols in your set indicating both the shape of each piece and the colors you used:

a) s subshell = 1 orbital \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b) p subshell = 3 orbitals\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

c) d subshell = 5 orbitals \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

d) f subshell = 7 orbitals\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. In what way do subshells of the same shape differ from each other? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The size of the subshell reflects the approximate energy level of the subshell and is represented by the first of four quantum numbers: **the principle quantum number n.**  n is an integer that varies from 1-7.

3. How many s subshells are there? \_\_\_\_\_\_ p subshells? \_\_\_\_\_ d subshells? \_\_\_\_\_\_ f subshells? \_\_\_\_\_\_

4. a) The energy levels available for s subshells starts counting at 1. E.g. 1s, 2s, etc… The number in front of the s indicates **n**. List the allowed s subshell designations here: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Label your “s” subshells/orbitals on the back of each piece with 1s being the smallest one.

b) The energy levels available for p subshells starts counting at n = 2. E.g. 2p, 3p, etc… List the allowed p subshell designations here: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Label your p subshells on the back of each piece with 2p being the smallest one.

c) The energy levels available for d subshells starts counting at n = 3. E.g. 3d, 4d, etc… List the allowed d subshell designations here: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Label your d subshells on the back of each piece with 3d being the smallest one.

d) The energy levels available for f subshells starts counting at n = 4. E.g. 4f, 5f, etc… List the allowed f subshell designations here: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Label your f subshells on the back of each piece with 4f being the smallest one.

5. Record the following data onto your subshell pieces. (Note: all orbitals within a subshell have the same energy.)

**For s For p For d For f**

**For n=1 shell** 1s = -13.6

**For n=2 shell**  2s = -3.6 2p = -3. 4

**For n=3 shell** 3s = -1.8 3p = -1.5 3d = -1.3

**For n=4 shell** 4s = - 1.4 4p = -1.2 4d = -1.0 4f = -0.7

**For n=5 shell** 5s = -1.1 5p = -0.9 5d = -0.6 5f = -0.3

**For n=6 shell** 6s = -0.8 6p = -0.5 6d = -0.2

**For n=7 shell** 7s = -0.4 7p = -0.1

6. As the size of a subshell increases, does its energy increase or decrease? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

7. As the number of orbitals in a subshell increases (s, p, d, f), does its energy increase or decrease? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

8. Rank your subshell pieces from lowest energy (most negative) to highest energy (least negative). Record the resulting order of subshells here: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

9.Three quantum numbers are needed to identify any specific orbital’s orientation, size and shape. One tells the\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the orbital (n = 1, 2, 3,…), one tells the \_\_\_\_\_\_\_\_\_\_\_ of the orbital (s, p, d, f), and the third tells the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of that shape (x, y, z, z2, x2 –y2, xy, yz, xz,).

10. Four quantum numbers are need to identify any specific electron because every orbital can hold up to \_\_\_\_\_ electrons. An orbital can be empty with \_\_\_\_\_ electrons inside. An orbital can be half filled with \_\_\_\_ electron inside or completely filled with \_\_\_\_\_ electrons inside. The electrons are called spin \_\_\_\_ and spin \_\_\_\_\_\_\_\_\_\_ and are often represented with small half arrows: or or .