

Name:

Instructor:

Date:

Atomic Structure

Relationship between electron arrangement in an atom and the periodic table.

Introduction

Atoms (the smallest particle which cannot be divided further and can exist on their own or in connection with others) are made of a nucleus which is composed of protons and neutrons.

Electrons orbit the nucleus and have a specific energy value. Electrons can also change their energy states to a lower or higher energy level. This lab will focus on understanding how electrons are arranged in an atom. It will also determine how the arrangement of electrons in an atom are related to the periodic table.

Materials

The periodic table.

Method

Different elements in the periodic table were identified as well as the number of electrons.

Arrangement of electrons from the lowest energy level to highest energy level was conducted.

Electrons in each orbital, i.e., s orbitals, p orbitals, d orbitals, and f orbitals were determined.

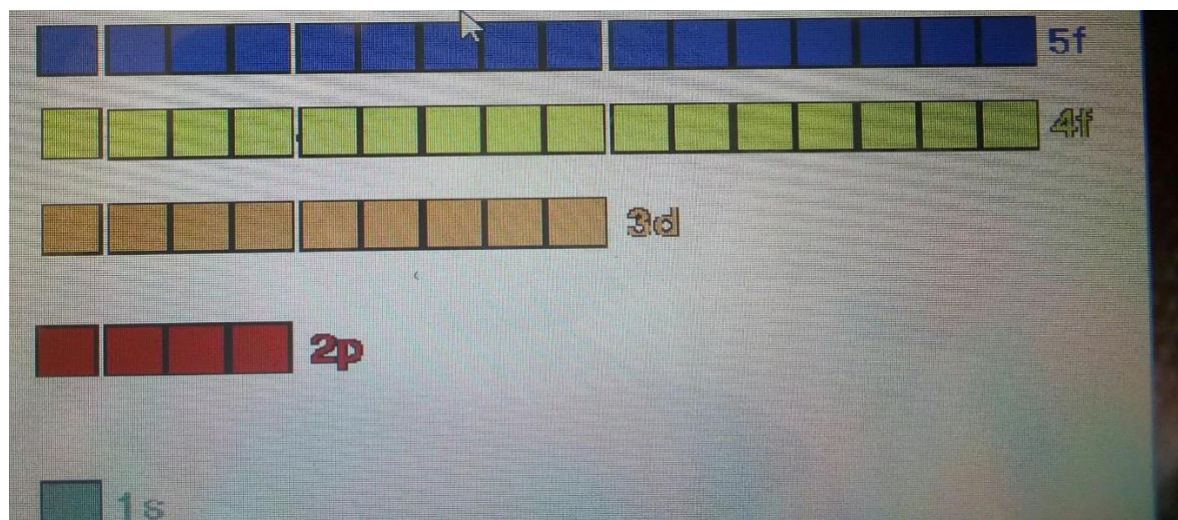
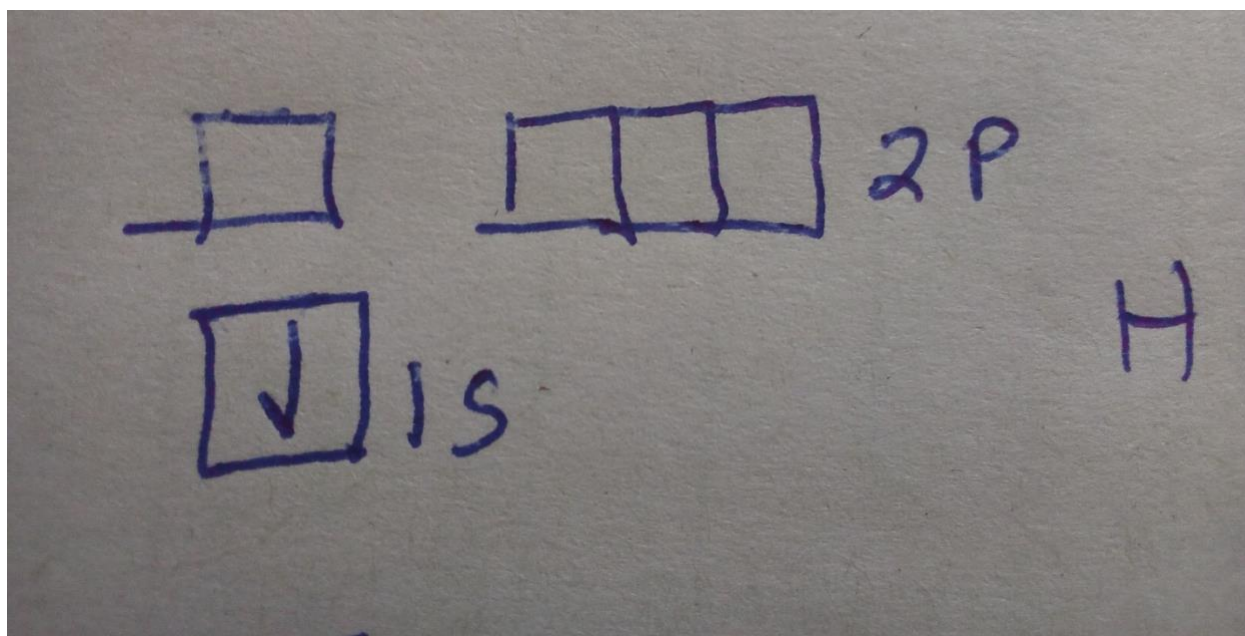


Fig 1

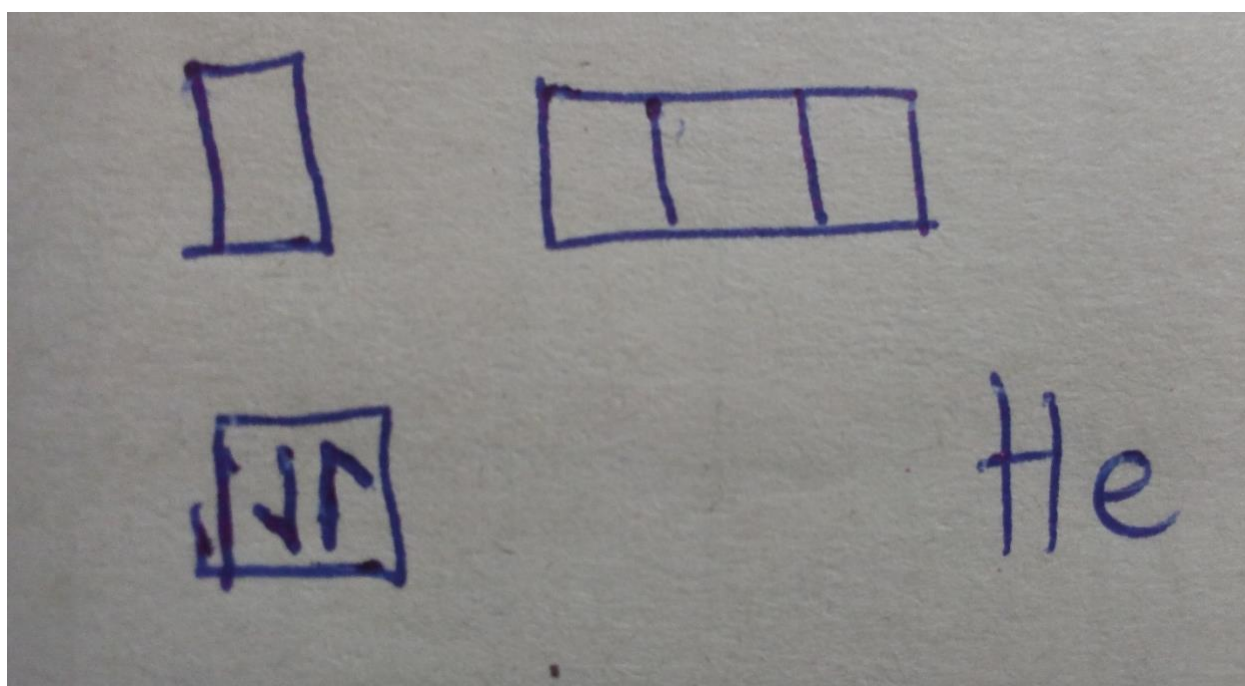
Data

Table 1

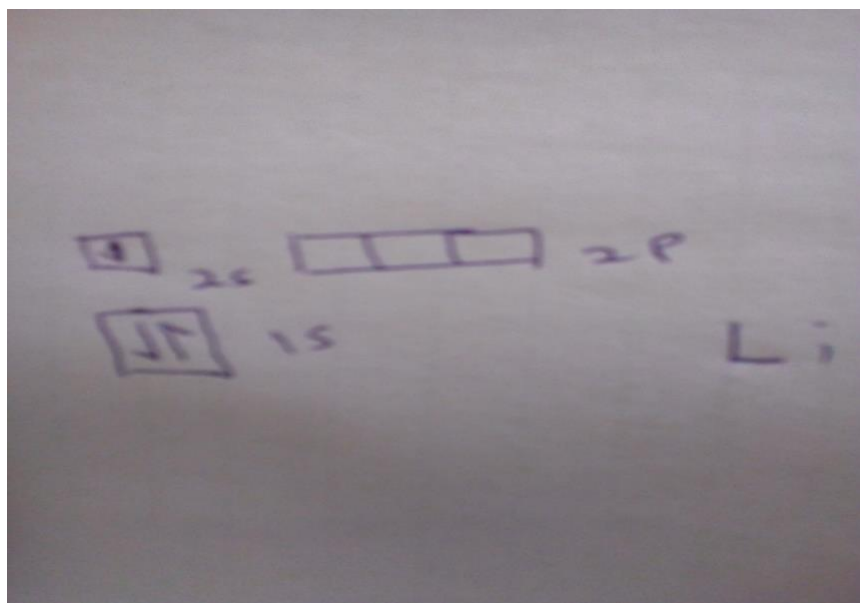
Energy level	s orbitals	p orbitals	d orbitals	f orbitals
1	1	0	0	0
2	1	3	0	0
3	1	3	5	0
4	1	3	5	7
5	1	3	5	7



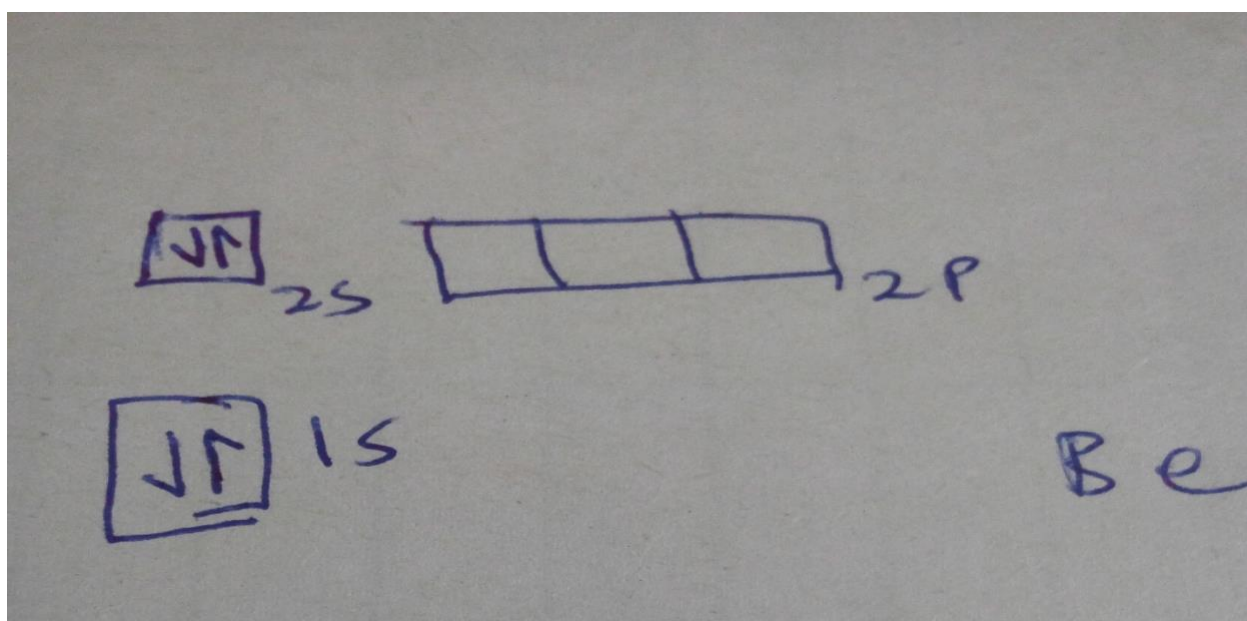
Sketch 1



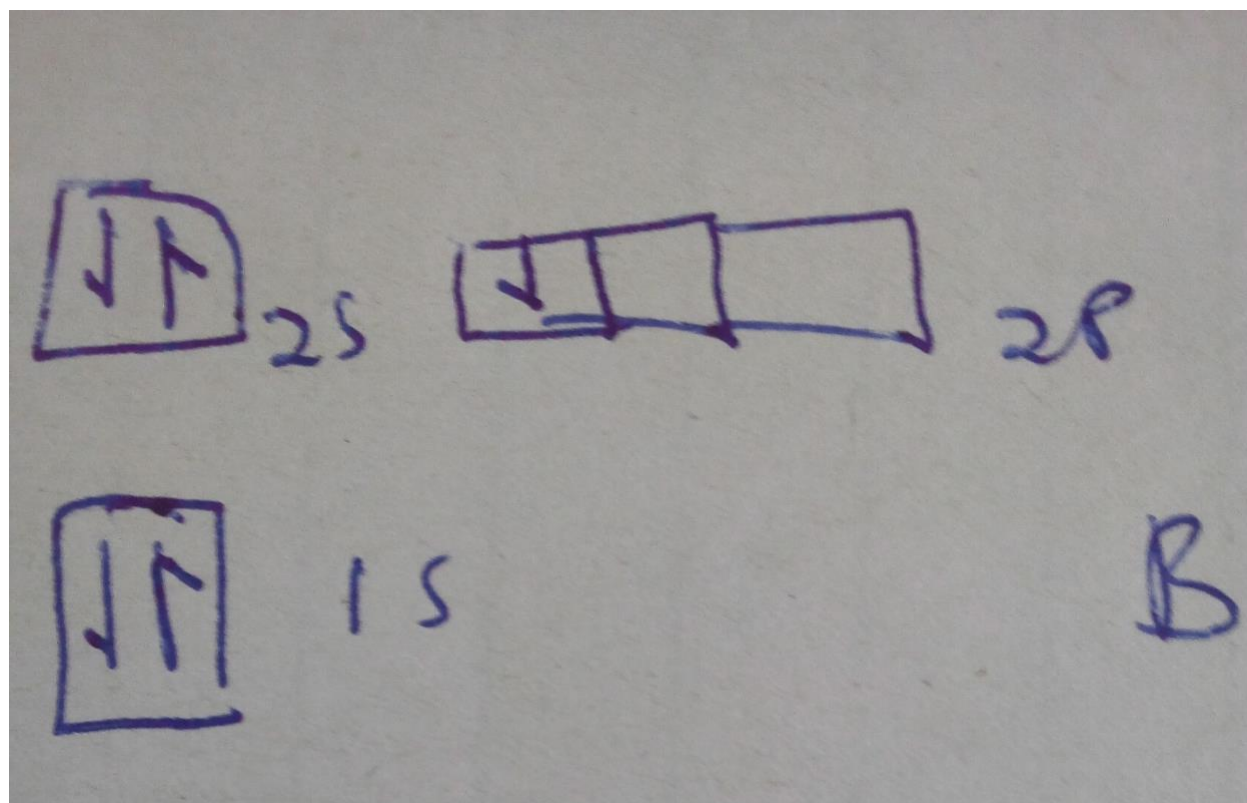
Sketch 2



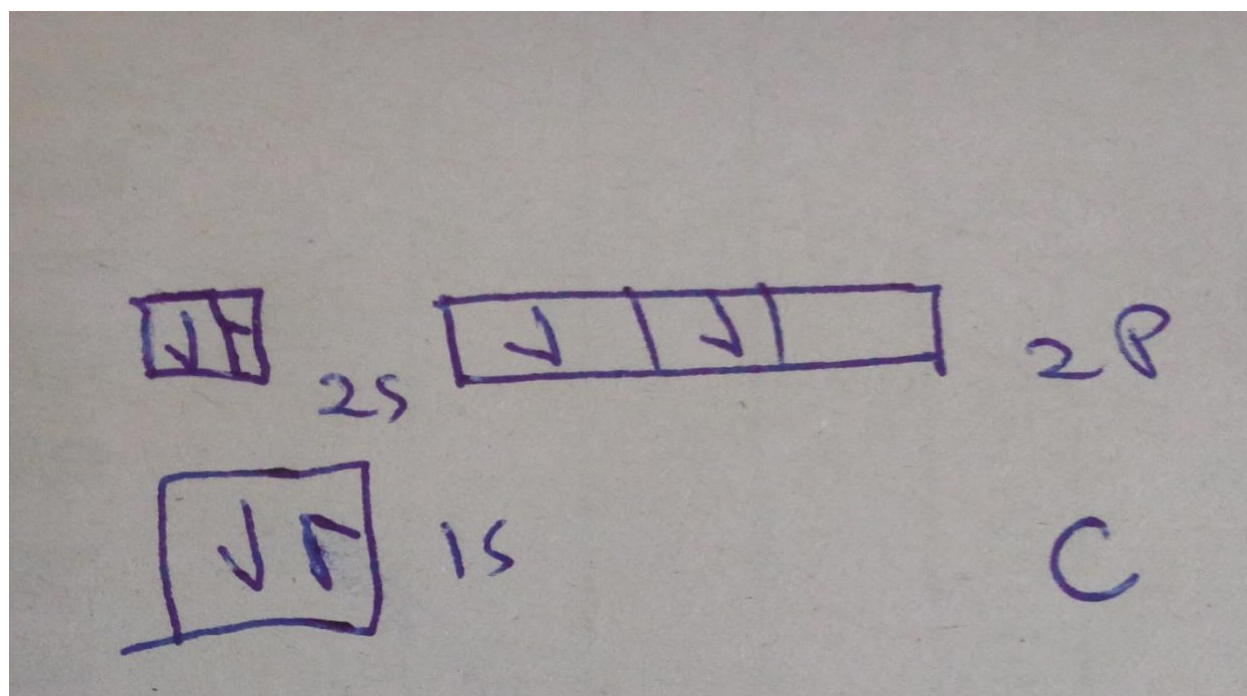
Sketch 3



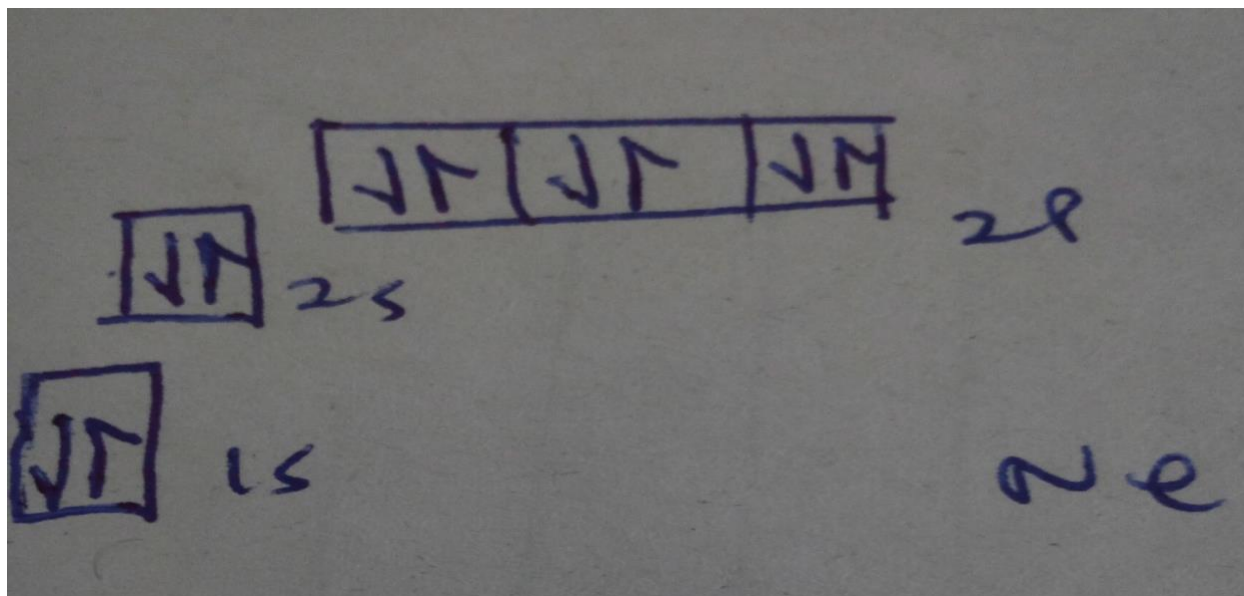
Sketch 4



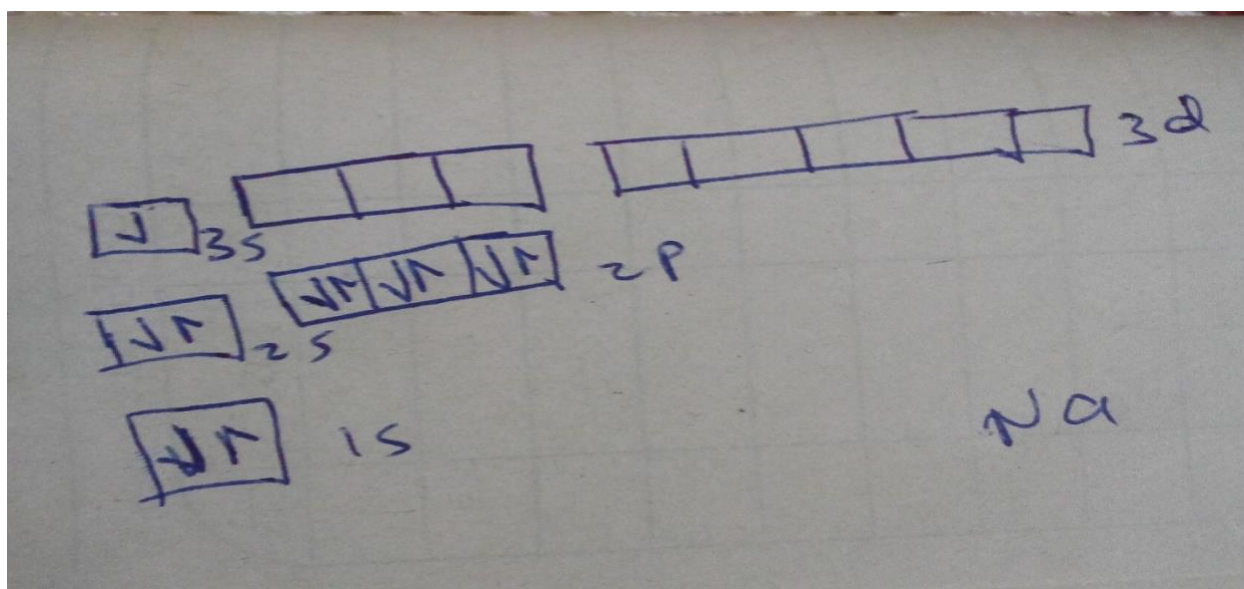
Sketch 5



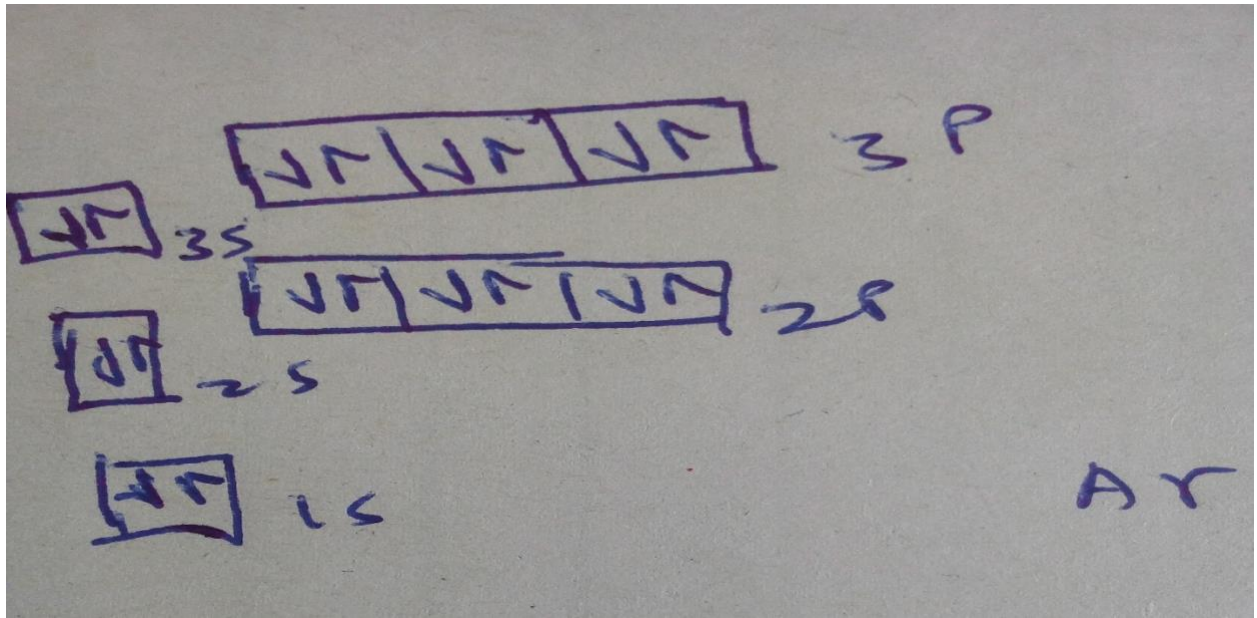
Sketch 6



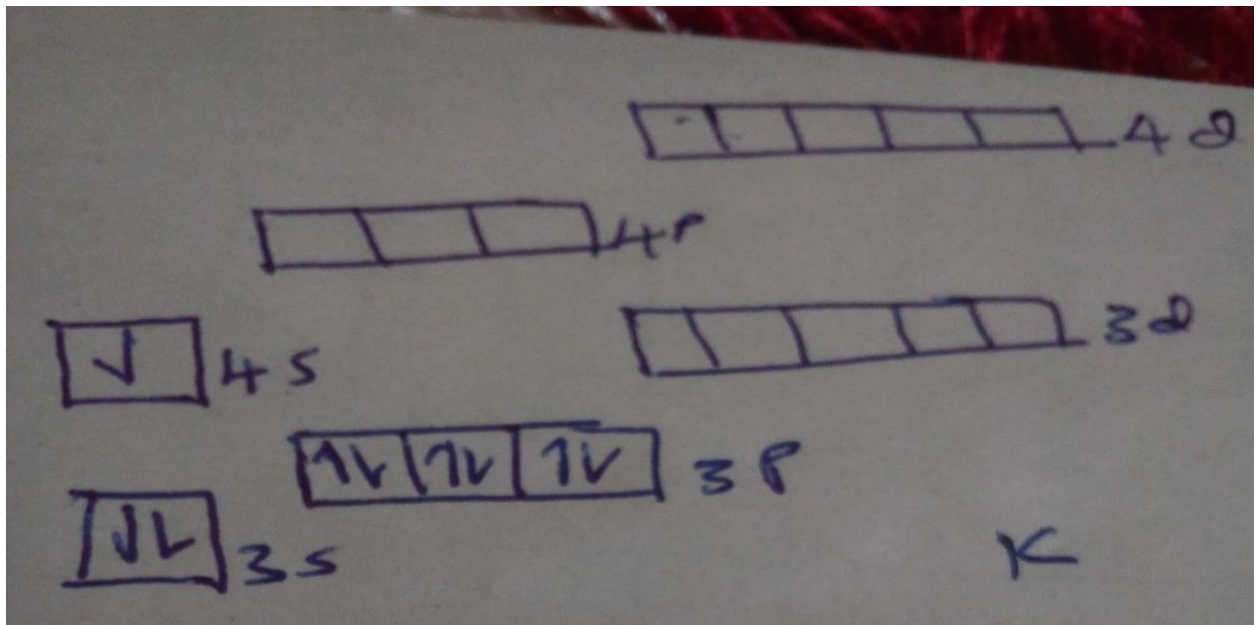
Sketch 7



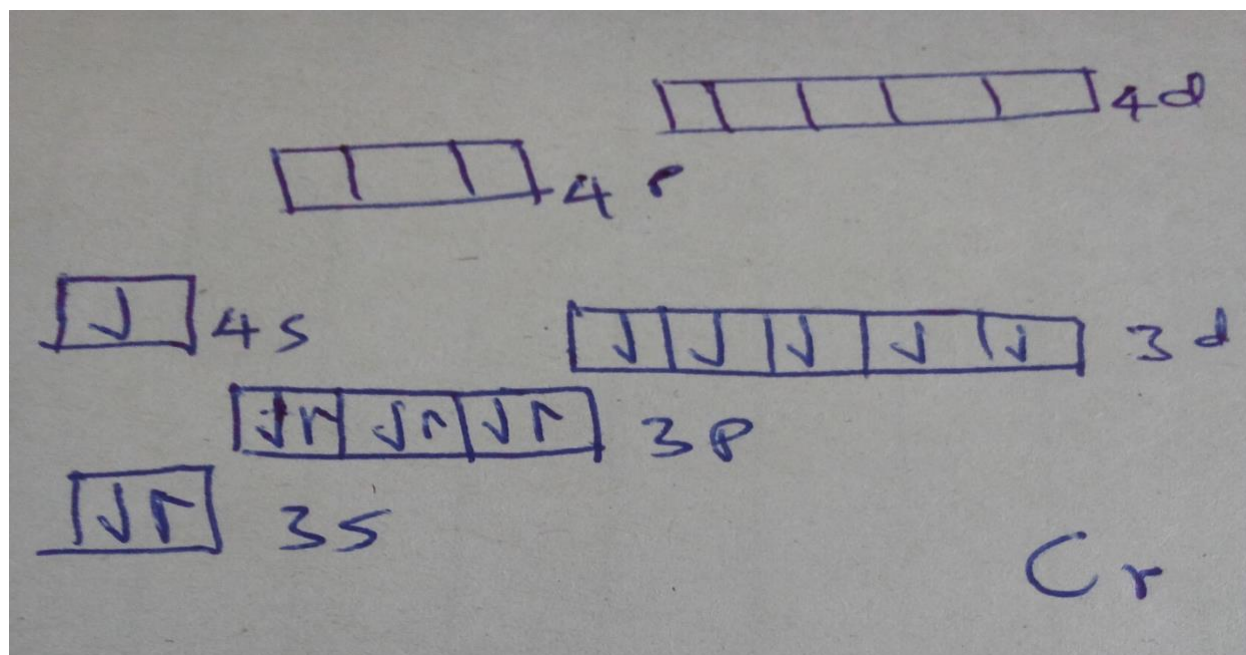
Sketch 8



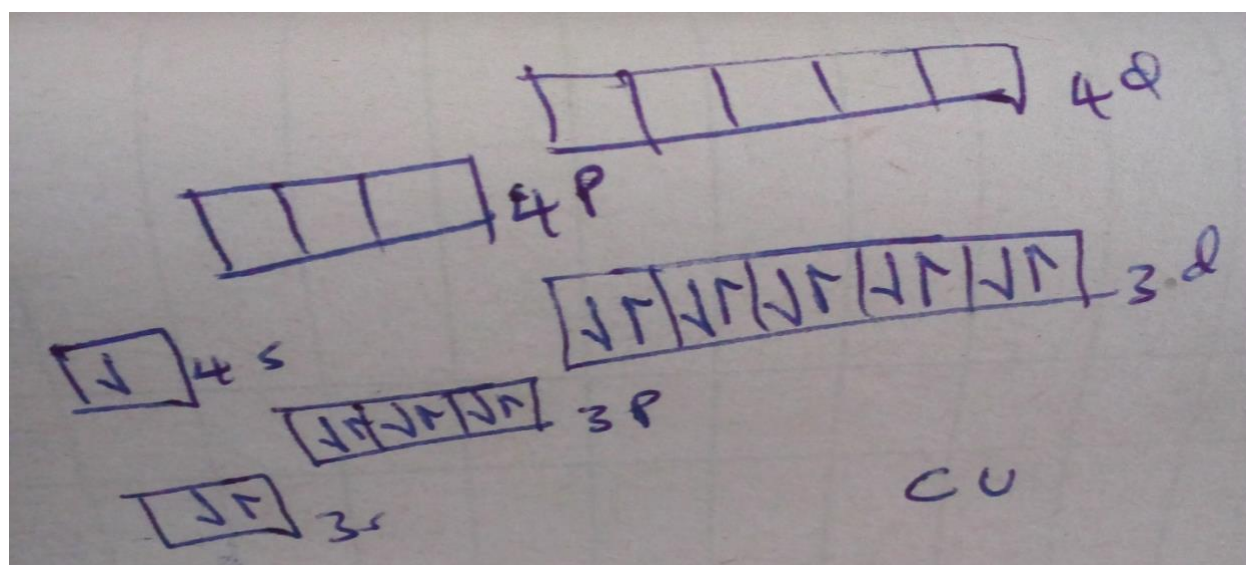
Sketch 9



Sketch 10



Sketch 11



Sketch 12

1A																	3A	4A	5A	6A	7A	8A		
1	H																	B	C	N	O	F	Ne	
2	Li	Be											B	C	N	O	F	Ne						
3	Na	Mg	3B	4B	5B	6B	7B	8B				1B	2B	3A	4A	5A	6A	7A	8A					
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr						
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe						
6	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn						
7	Fr	Ra																	Ac					
Lanthanides			Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb									
actinides			Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Mn	Ug									

Sketch 13

Results

The number of s, p, d, and f orbitals is different in each energy level. There is one s orbital in each energy level. In the first energy level, there are no p, d, and f orbitals. From the second energy level to the fifth, there are three p orbitals. In level 2, there are no d and f orbitals. From level three to five, there are 5 d orbitals. Level three lacks f orbitals. In level 4 and 5, there are 7 f orbitals.

Discussion

There are more orbitals in higher energy levels because the energy levels become closer to one another. The energy becomes less negative thus as the energy levels go further from the nucleus. Some types of orbitals have more orbitals at each energy level so as to accommodate the number of electrons. s orbitals are different from p orbitals because s have one orientation while p have s different orientations, i.e., p_x , p_y , and p_z . Their shapes are also different, s are spherical while p are shaped like a dumbshell

The arrows in sketch 1 and 2 represent the direction of the spins of electrons. They arrows are pointed in different directions to show that electrons move in different directions. The direction of the arrow represents the direction in which the electron is rotating in. The reason why the second electron in helium goes to the same orbital is to ensure that the energy level is filled and establish stability. The third electron in Lithium goes to the next orbital as shown in sketch 3. This is because the maximum number of electrons in each orientation is two. The maximum number of electrons which can be put in an orbital is two. These electrons must have different spins which allows them to occupy that orbital. The reason why electrons are able to occupy the same place is because they have a positive and negative charge attributable to the direction of spins. Electrons in helium occupy the s orbital because it is the lowest energy level and closest to the nucleus, thus a stronger attraction. These electrons can move to the second energy level in case of an excitation.

The first row of the periodic table has two atoms. Hydrogen and helium occupy the first row in the periodic table. Electrons in these atoms occupy the first orbital (s orbital). The energy levels of the orbitals increases down the table from level 1 to higher levels.

The third electron in lithium goes in the 2s orbital because it is not filled and it is lower than the 2p orbital. The fourth electron representing beryllium goes into the 2s orbital because an orbital

must be assigned a maximum of 2 electrons. It does not go into the 2p orbital because 2s is not filled and 2p is higher. The fifth electron representing boron would go into the 2p orbital because 2s is filled. P orbitals are absent in the first energy level because the first energy level can only accommodate 2 electrons. The sixth electron in carbon will go into the second 2p orbital with a downward spin as shown in sketch 6. It goes to this empty box because electrons are assigned with the same spin for all boxes before the opposite spin is assigned. The 2s and 2p orbitals in boron have different energies because the 2s orbital is filled while the 2p orbital has only one electron and it requires 6 electrons to be filled. The electron for boron is placed in the left p orbital because they are filled in an orderly manner from the left to the right. These electrons have equal energies. The next electron for nitrogen will be assigned in the third box in the 2p Orbital. The relative energies between 2s and 2p will increase. The eighth electron for oxygen will be assigned in the left box of the 2p orbital, ninth will be placed in the second box of 2p orbital and the tenth electron will be placed into the third box of the 2p orbital. The second energy level in neon has eight electrons. The number of energy levels increases as one goes down the periodic table.

For sodium, the 11th electron will occupy the 3s orbital as shown in sketch 8. From sodium to argon, the energy levels increase as the number of electrons. From sodium to argon, the 3s and 3p orbitals are filled as the energy difference increases. This is shown in sketch 9 representing argon. The 19th electron of potassium will be located into the 4s orbital as shown in sketch 10. The 19th electron goes into the 4s orbital instead of 3d because 4s has a lower energy than 3d. The third row of the periodic table has 8 atoms, which shows the total number of electrons in the outermost energy level. The location of potassium is in the 4th row, which is the reason why the 19th electron occupies the 4s orbital. From K to V, electrons fill the 4s orbital and shift to the 3d

orbital. 3d orbital has higher energy than 4s thus the relative energy between orbitals increases. For Cr, one electron in the 4s orbital moves to the 3d orbital to fill the electrons with the lower spin as shown in sketch 11.

From chromium to nickel, the electrons fill the 4s orbital and the 3d orbital. However, the 3d orbital is not filled for both spins with 2 unpaired electrons. For copper, the 3d orbital has one unpaired electron, which causes one electron from the 4s orbital to be used to pair the unpaired electron in 3d orbital as shown in sketch 12. The unpaired electron in 4s orbital is filled by the 30th electron of zinc. From gallium to krypton, the 4p orbital is fully filled with all electrons paired.

The energies of 4s and 3d orbitals become equalized as electrons are added from K to Cr. This is to ensure that the third energy level is filled before the fourth energy level is allocated with electrons. Cr has a half filled 4s orbital rather than a filled 4s orbital because a higher energy level cannot be filled before a lower energy level is full. The electron arrangement of copper as shown in sketch 12 is because the 3d orbital is lower than the 4s orbital, thus has to be fully filled before the 4s orbital in the fourth energy level. Elements Sc and Zn on the periodic table are in the 4th row. Sc is filled up to the 4s orbital but has only one electron in the 3d orbital. On the other hand, Zn has all electrons filled up to the 4s orbital. The fourth row has 18 atoms which represents an increase in the number of orbitals occupied with electrons. The orbitals filled right before 4f orbitals are the 5s and 4d orbitals.

Conclusion

From this lab, it was identified that as the number of electrons in an atom increase, the number of orbitals increases. As one goes from period one to period 7 in the periodic table, the number of orbitals and energy increases.