Atomic Structure Worksheet

1. Define an atom. What are the main components of an atom?
2. List the three subatomic particles and provide their relative masses, charges, and locations in the atom.
3. What is the difference between an element and an atom?
4. Describe Dalton's atomic theory in your own words. Highlight its key postulates.
5. Summarize Rutherford's gold foil experiment and its significance in the discovery of the nucleus.
6. Explain Bohr's model of the atom. How does it improve upon Rutherford's model?
7. Who discovered the electron, and what experiment led to its discovery? Include a brief explanation.
8. Compare and contrast the proton and neutron in terms of their properties.
9. How did James Chadwick confirm the existence of the neutron?
10. Define atomic number and mass number. Provide an example of how they are calculated.
11. What are isotopes? Give two examples of isotopes and their applications.
12. Calculate the number of neutrons in an atom of chlorine-37 ($^{37}_{17}Cl$).
13. What is the Aufbau principle? Explain how it is used to determine electron configuration.
14. Write the electron configuration for an atom of oxygen ($Z = 8$).
15. State Hund's rule and provide an example of its application.
16. How does the periodic table relate to atomic structure? Give an example.
17. Explain the trend of atomic radius across a period and down a group in the periodic table.
18. What is ionization energy? Why does it generally increase across a period?
19. Describe one real-world application of isotopes, such as in medicine or archaeology.
20. How does the concept of atomic structure help us understand chemical bonding?

Solutions

1. An atom is the smallest unit of matter that retains the properties of an element. Its main components are protons, neutrons, and electrons.

2. Subatomic particles:

   - Proton: Mass = 1.672×10^{-27} kg, Charge = $+1$, Location = Nucleus
   - Neutron: Mass = 1.675×10^{-27} kg, Charge = 0, Location = Nucleus
   - Electron: Mass = 9.109×10^{-31} kg, Charge = -1, Location = Electron cloud

3. An element is a pure substance made up of only one type of atom, while an atom is the smallest unit of an element.

4. Dalton's atomic theory states that all matter is composed of atoms, atoms are indivisible, atoms of the same element are identical, and compounds are formed by combinations of atoms.

5. Rutherford's gold foil experiment involved alpha particles being directed at thin gold foil. Most passed through, but some deflected, leading to the discovery of the nucleus.

6. Bohr's model introduced quantized energy levels, where electrons orbit the nucleus without radiating energy, improving upon Rutherford's model.

7. J.J. Thomson discovered the electron using the cathode ray tube experiment, demonstrating the existence of negatively charged particles.

8. Protons are positively charged and have a mass similar to neutrons, which are neutral particles.

9. Chadwick used scattering experiments to identify the neutron, showing it as a neutral particle with similar mass to the proton.

10. Atomic number (Z) is the number of protons; mass number (A) is $Z+$ neutrons. Example: Carbon-12 (${}^{12}_{6}C$).

11. Isotopes are atoms of the same element with different numbers of neutrons. Examples: Carbon-14 (dating), Iodine-131 (medicine).

12. Neutrons = Mass number - Atomic number $= 37 - 17 = 20$.

13. The Aufbau principle states that electrons fill orbitals in increasing energy order.

14. Oxygen ($Z = 8$): $1s^2 2s^2 2p^4$.

15. Hund's rule: Electrons occupy orbitals singly before pairing. Example: $2p^3$ orbitals of nitrogen.

16. The periodic table reflects atomic structure; for example, elements in Group 1 have 1 valence electron.

17. Atomic radius decreases across a period (more nuclear charge) and increases down a group (more shells).

18. Ionization energy is the energy to remove an electron. It increases across a period due to higher nuclear charge.

19. Isotopes in medicine: Iodine-131 for thyroid treatment.

20. Atomic structure explains bonding, e.g., covalent bonds involve electron sharing between atoms.