Chemistry: Form Ls2.2A Name _____

ATOMS Date _____ Period _____

Modern Theories of Matter

Aim

- list and describe the major subatomic particles and explain how they were discovered
- explain how Rutherford discovered the nucleus of the atom and describe his model of the atom
- describe Bohr's discovery of energy levels and his model of the atom

Notes

Changes to the Dalton Model of the Atom

- Discovery of electrons
  - William Crookes showed that as current passed through a cathode (negative electrode) in a glass vacuum tube, the tube glowed casting a shadow of the anode at the opposite end. (the glowing is called fluorescence)
    - the shadow showed that the light came from the cathode end of the tube
    - Crookes called the source of the light cathode rays
  - J.J. Thomson showed that cathode rays were the paths of negatively charged particles he called electrons
  - The Thomson Model
    - Protons had much more mass than electrons
    - Therefore the atom is a positively charged sphere with electrons embedded in it like seeds in a watermelon (so the atom is divisible)
- Discovery of the nucleus
  - Rutherford's alpha-scattering experiment
    - Rutherford aimed a beam of high speed alpha particles (positive charge, mass of 4 daltons) at sheets of gold foil
    - most of the particles went straight through to the scintillation screen as if there were no barrier
    - 1 in 20,000 bounced straight back or were deflected greatly
    - Rutherford concluded that the atom was mostly space with a dense positively charged nucleus
  - Rutherford's model - the nuclear atom or solar system model
    - the atom has a dense, positive core or nucleus
    - electrons orbit the nucleus at relatively great distances
- The Bohr atom (1913)
  - Bohr noticed that heated atoms give off their excess energy in the form of light
  - The light given off by the atoms corresponds to only certain frequencies or energies
  - Bohr devised a model that explained the energies of light given off based on the location of the electrons
    - Electrons continue to orbit the nucleus instead of being pulled into it because they have energy
    - The more energy the electrons have, the further away they are from the nucleus
    - When the electron absorbs energy it jumps to higher energy levels
    - The electron eventually gives off the excess energy as light and falls back down to lower energy levels
    - The energy given off corresponds to only certain frequencies of light (line spectrum) because as electrons fall from the excited state to the ground state they fall from energy level to energy level, not in between. As a result, an electron always gives of a certain quantum of energy.
  - The Bohr Model - electrons travel in fixed circular pathways around the nucleus, held in place by the proton
- Neutrons - discovered by Sir James Chadwick in 1932
  - atoms of an element could have different masses (isotopes)
  - Symbols for isotopes: ${}^{A}_{Z}X$
    - X = element
    - A = atomic mass number (mass of isotope)
    - Z = atomic number (number of protons)
    - Number of neutrons: N = A – Z
  - Examples - isotopes of hydrogen:
    - Protium: ${}^{1}_{1}H$; Deuterium: ${}^{2}_{1}H$; Tritium: ${}^{3}_{1}H$
- Summary of subatomic particles

Type of Particle	Location	Mass	Relative Mass	Charge
Proton	Center	1.67×10^{-27}kg	1	+1
Electron	Outside	9.11×10^{-31}kg	0 (1/1836)	-1
Neutron	Center	1.67×10^{-27}kg	1	0

The Orbital Model

- Purpose of the orbital model
  - the Bohr model only explained the bright line spectrum for hydrogen
  - the orbital model explains the bright line spectra of other elements by describing the location of electrons in terms of probability rather than by assigning fixed paths
    - the electron moves freely around the nucleus
    - the regions of most probable electron location are called orbitals
    - orbitals differ in size, shape, and spatial orientation
- Structure - orbitals are regions within the energy levels

Answer the multiple choice questions below by circling the number of the correct response

1. Modern atomic theory is based on the work of (1) Kepler, (2) Aristotle, (3) Dalton, (4) Leeuwenhoek.

2. Which particles have the smallest mass? (1) electrons (2) protons (3) neutrons (4) atoms

3. The nucleus of the atom was discovered by (1) Thomson, (2) Bohr, (3) Rutherford, (4) Dalton

4. Evidence that electrons exist in distinct energy levels outside the nucleus is provided by (1) cathode rays, (2) spectral lines, (3) atomic masses, (4) radioactivity.

5. When excited electrons return to the ground state, they lose excess energy in the form of (1) light, (2) gamma rays, (3) nuclear radiation, (4) sound.

6. Which of the following particles is negatively charged? (1) electron (2) proton (3) neutron (4) cation

7. How many neutrons does $^{35}_{17}\mathrm{Cl}$ have? (1) 35 (2) 17 (3) 52 (4) 18

8. The modern model of the atom shows that electrons are (1) orbiting the nucleus in fixed paths, (2) found in regions called orbitals, (3) combined with neutrons in the nucleus, (4) located in a solid sphere covering the nucleus

9. Isotopes are atoms which have different (1) atomic masses, (2) atomic radii, (3) atomic numbers, (4) electron configurations

10. An atom that contains 35 protons, 45 neutrons, and 35 electrons has an atomic number of (1) 35, (2) 80, (3) 45, (4) 115

11. Two isotopes of the same element will have the same number of (1) neutrons and electrons, (2) neutrons and nucleons, (3) protons and nucleons, (4) protons and electrons

12. An atomic mass unit is defined as exactly (1) $^1/_{12}$ the mass of a ^{12}C atom, (2) $^1/_{14}$ the mass of a ^{14}N atom, (3) $^1/_{16}$ the mass of a ^{16}O atom, (4) $^1/_{19}$ the mass of a ^{19}F atom

13. Which correctly represents all atom of neon containing 11 neutrons? (1) $^{11}_{10}\mathrm{Ne}$ (2) $^{21}_{10}\mathrm{Ne}$ (3) $^{20}_{11}\mathrm{Ne}$ (4) $^{21}_{11}\mathrm{Ne}$

14. How many electrons are in a neutral atom of $^{7}_{3}\mathrm{Li}$? (1) 7 (2) 10 (3) 3 (4) 4

15. The nucleus of a fluorine atom has a charge of (1) 1^+, (2) 19^+, (3) 9^+, (4) 0

16. The characteristic bright-line spectrum of an element is produced when electrons (1) fall back to lower energy levels, (2) are gained by a neutral atom, (3) are emitted by the nucleus as beta particles, (4) move to higher energy levels

17. What is the total number of neutrons in an atom of $^{39}_{19}\mathrm{K}$? (1) 19 (2) 20 (3) 39 (4) 58

18. Name the subatomic particles contained in the nucleus of the atom.

19. State the charge associated with each type of subatomic particle contained in the nucleus of the atom.

20. What is the net charge of the nucleus?