Test Review № 4

Electron Dot Diagrams. Electron dot diagrams are a useful way to show the arrangement of outer electrons of an atom. They show valence electrons as dots at 12 o'clock, 3 o'clock, 6 o'clock, and 9 o'clock, and the rest of the atom, known as the kernel, as a symbol. Each of the clock positions represents one of the four outer orbitals. An orbital can hold a maximum of two electrons. The first orbital, represented by any one of the clock positions, is filled with a pair of electrons before putting electrons into the other orbitals. The remaining three orbitals each receive one electron before pairing occurs. Silicon, for example, has four valence electrons. As a result, it will have two electrons in one of the clock positions and one electron in each of two of the remaining three.

Average Atomic Mass

The atomic mass listed on the *Periodic Table* is the average mass of the isotopes. Carbon, for example, has two naturally occurring stable isotopes. The large majority of carbon atoms, 98.89%, are ^{12}C, while only 1.108% are ^{13}C. That is why the average mass is so close to 12.

The average mass is determined by the procedure illustrated in the box to the right. The mass of each isotope is multiplied by its percentage. Then these products are added to find the average.

Average Atomic Mass

$$m_{avg} = p_1m_1 + p_2m_2 + \ldots p_nm_n$$

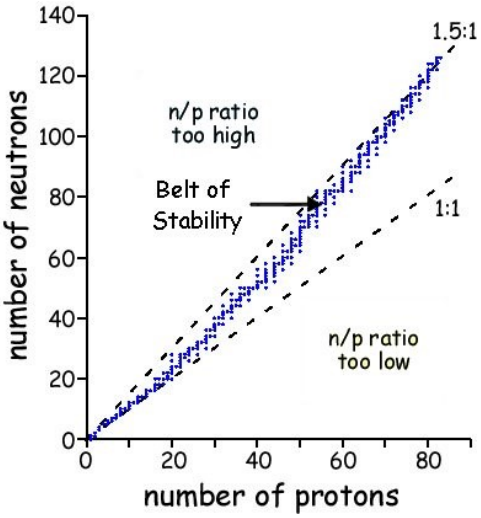
m_{avg} – average mass; p_1 – percentage of isotope 1;
m_1 – mass of isotope 1; p_2 – percentage of isotope 2;
m_2 – mass of isotope 2; p_n – percentage of isotope n;
m_n – mass of isotope n; n – the number of isotopes

Example

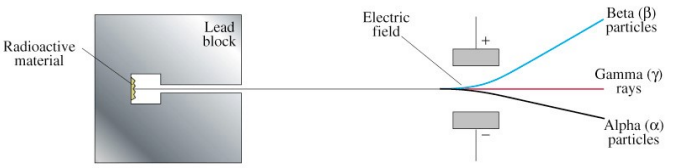
What is the average mass of chlorine if a sample consists of 77.35% Cl–35 and 22.65% Cl–37?

m_{avg}	=	(0.7735)(35)	+	(0.2265)(37)
	=	27.07	+	8.381
	=	35.45		

Nuclear Instability. Protons repel each other. The higher the atomic number is, the greater the repulsion among protons is, making the nucleus unstable. Atoms with atomic numbers above 82 have no stable isotopes. Neutrons help to stabilize the nucleus. Hydrogen is the only element that does not have neutrons. As the number of protons increases, the number of neutrons needed to keep the nucleus stable increases. The ratio of neutrons to protons in stable nuclei is between 1:1 and 1.5:1, the higher ratio being associated with larger nuclei that have larger repulsive forces. Stable atoms have a ratio of neutrons to protons that falls in the belt of stability.



Radioactivity. Unstable nuclei break apart or decay. Decaying nuclei release high speed particles and energy called radioactive emissions. Radioactive emissions separate in an electric field into three main types: [1] alpha particles – helium nucleus; [2] beta particles – electron; and [3] gamma rays – energy. Other important emissions include positrons



COMMON RADIOACTIVE EMISSIONS				
Particle	**Mass**	**Charge**	**Symbol**	**Penetrating Power**
Alpha	4 amu	2+	${}^{4}_{2}He$ or α	low
Beta	0 amu	1–	${}^{0}_{-1}e$ or β^-	moderate
Positron	0 amu	1+	${}^{0}_{+1}e$ or β^+	moderate
Gamma	0 amu	0	γ	high

Natural Radioactive Decomposition. An unstable nucleus emits particles. Alpha decay is the loss of an alpha particle or helium nucleus. The general format for alpha decay is ${}^{A}_{Z}X \rightarrow {}^{4}_{2}He + {}^{A-4}_{Z-2}Y$. The loss of an alpha particle reduces the mass by 4 amu and reduces the atomic number by 2. Beta decay is the loss of a beta particle. A beta particle is an electron formed from the decay of a neutron into a proton and an electron (${}^{1}_{0}n \rightarrow {}^{1}_{1}p + {}^{0}_{-1}e$). The general format for beta decay is ${}^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}e$. The loss of a beta particle does not effect the mass, but it increases the atomic number by 1. Positron emission - conversion of a proton to a neutron (${}^{1}_{1}p \rightarrow {}^{1}_{0}n + {}^{0}_{+1}e$). A positron is a particle similar to an electron in mass and size, but with a positive charge. The general format for positron emission is ${}^{A}_{Z}X \rightarrow {}^{A}_{Z-1}Y + {}^{0}_{+1}e$. Loss of a positron does not effect the mass, but the atomic number decreases by 1.

Rules for writing nuclear equations

1. the masses on each side of the equation must be equal
2. the charges on each side of the equation must be equal

General Format

$${}^{A}_{Z}X \rightarrow {}^{a}_{z}x + {}^{A-a}_{Z-z}Y$$

Development of the Periodic Table. Dmitri Mendeleev (1869) prepared a card for each of the known elements listing the symbol, the atomic mass, and the chemical properties. He arranged the cards in order of increasing atomic mass and noticed a pattern: *MENDELEEV'S PERIODIC LAW* – When the elements are arranged in increasing order of atomic mass, the chemical properties repeat themselves periodically. Moseley noticed that when all the elements were arranged in order of mass a few were not in the right family with respect to properties. He used a procedure called X-ray diffraction to determine the atomic number of the elements. When the elements were arranged in increasing order of atomic number, the discrepancies in Mendeleev's table disappeared. *THE PERIODIC LAW* – When the elements are arranged in increasing order of atomic number, the chemical properties repeat themselves periodically. The modern Periodic Table is arranged in order of increasing atomic number.

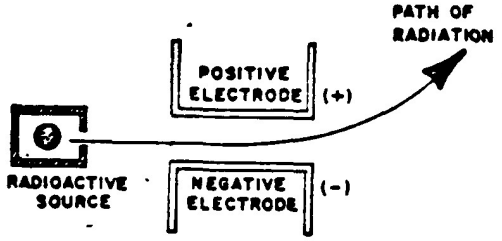
Answer the questions below by circling the number of the correct response

1. Which of the following is the correct electron dot diagram for helium?

   (1) **He** (2) **He** (3) **He** (4) **He**

2. Frischium comes in three isotopes with the following abundances: 90.000 percent Fs–500; 8.0000 percent Fs–501; and 2.0000 percent Fs–503. The average mass is (1) 598.2 amu (2) 501.33 amu (3) 499.85 amu (4) 500.14 amu

3. A radioactive source emits radiation which is deflected as shown in the diagram below.



   This radiation could be (1) $^{0}_{-1}e$ (2) $^{4}_{2}\mathrm{He}$ (3) $^{1}_{1}\mathrm{H}$ (4) $^{1}_{0}\mathrm{n}$

4. Which product of nuclear decay has mass but no charge?
   (1) alpha particles (2) neutrons (3) gamma rays (4) beta positrons

5. According to the equation $X \rightarrow {}^{208}_{82}Pb + {}^{4}_{2}He$, the nucleus correctly represented by X is
   (1) $^{204}_{80}Hg$ (2) $^{212}_{84}Po$ (3) $^{204}_{80}Bi$ (4) $^{212}_{84}Pb$

6. In the reaction $^{24}_{11}Na \rightarrow {}^{24}_{12}Mg + X$, the particle represented by tile letter X is (1) a proton (2) a neutron (3) an electron (4) a positron

7. When an atom emits a beta particle, the total number of nucleons
   (1) decreases (2) increases (3) remains the same

8. When a beta particle ($^{0}_{-1}e$) is emitted by the nucleus of an atom the mass number of the atom (1) decreases (2) increases (3) remains the same

9. According to Reference Table N, a product of the radioactive decay of $^{226}_{88}\mathrm{Ra}$ is (1) $^{4}_{2}\mathrm{He}$ (2) $^{226}_{89}\mathrm{U}$ (3) $^{0}_{-1}e$ (4) $^{230}_{90}\mathrm{U}$

10. Which of the following statements is true with respect to the reaction below:

$$^{249}_{98}Cf + {}^{15}_{7}N \rightarrow {}^{260}_{105}Db + 4\,{}^{1}_{0}n$$

   (1) The formation of Db is a result of a chemical reaction between Cf and nitrogen in air
   (2) The formation of Db is a result of radioactive decay of Cf
   (3) The formation of Db is a result of a natural transmutation
   (4) The formation of Db is a result of an artificial transmutation

11. With what is aluminum bombarded in the reaction below to produce ^{30}P?

$$^{27}_{13}Al + ? \rightarrow {}^{30}_{15}P + {}^{1}_{0}n$$

   (1) alpha particle (2) beta particle (3) positron (4) ^{15}N

12. The change that is undergone by an atom of an element made radioactive by bombardment with high-energy protons is called
   (1) natural transmutation (2) artificial transmutation (3) natural decay (4) radioactive decay

13. Which of the following is the correct electron dot diagram for nitrogen?

   (1) **N** (2) **N** (3) **N** (4) **N**

14. In the Periodic Table, the elements are arranged in order of increasing (1) atomic size, (2) atomic number, (3) atomic mass, (4) ionization energy

15. The chemical properties of the elements are periodic functions of their atomic (1) spin, (2) isotopes, (3) mass, (4) number.

For questions 16-20, refer to *Table N* to determine the type of decay, and complete the equation to show the products of decay.

16. ^{238}U

17. ^{90}Sr

18. ^{239}Pu

19. ^{19}Ne

20. ^{3}H

For questions 21-30, which of the following describes (1) alpha particles only, (2) beta particles only, (3) positrons only, (4) alpha particles and beta particles only, (5) alpha particles and positrons only, (6) beta particles and positrons only, (7) alpha particles , beta particles , and positrons.

21. Positively charged

22. Natural radiation

23. Charged particle

24. Particle with a mass of 4 amu

25. Negatively charged

26. Particle with a mass of 0 amu

27. Causes the atomic number to decrease by one when released

28. Causes the atomic number to decrease by two when released

29. Causes the atomic number to increase by one when released

30. Released from the nucleus

Answers

1. 2
2. 4
3. 1
4. 2
5. 2
6. 3
7. 3
8. 3
9. 1
10. 4
11. 1
12. 2
13. 3
14. 2
15. 4
16. ${}^{238}_{92}U \rightarrow {}^{4}_{2}He + {}^{234}_{90}Th$
17. ${}^{90}_{38}Sr \rightarrow {}^{0}_{-1}e + {}^{90}_{39}Y$
18. ${}^{239}_{94}Pu \rightarrow {}^{4}_{2}He + {}^{235}_{92}U$
19. ${}^{19}_{10}Ne \rightarrow {}^{0}_{+1}e + {}^{19}_{9}F$
20. ${}^{3}_{1}H \rightarrow {}^{0}_{-1}e + {}^{3}_{2}He$
21. 5
22. 7
23. 7
24. 1
25. 2
26. 6
27. 3
28. 1
29. 2
30. 7