Multiple Choice

1. Which statement best describes electrons?
   a. They are positive subatomic particles and are found in the nucleus.
   b. They are positive subatomic particles and are found surrounding the nucleus.
   c. They are negative subatomic particles and are found in the nucleus.
   d. They are negative subatomic particles and are found surrounding the nucleus.

2. Which statement matches a subatomic particle with its charge?
   a. A neutron has a negative charge.
   b. A proton has a negative charge.
   c. A neutron has no charge.
   d. A proton has no charge.

3. An orbital is a region of space where there is a high probability of finding
   a. a proton
   b. a neutron
   c. a positron
   d. an electron

4. An atom of carbon-12 and an atom of carbon-14 differ in
   a. atomic number
   b. mass number
   c. nuclear charge
   d. number of electrons

5. An atom of any element must contain
   a. an equal number of protons and neutrons
   b. an equal number of protons and electrons
   c. more electrons than neutrons
   d. more electrons than protons

6. Which statement compares the masses of two subatomic particles?
   a. The mass of an electron is greater than the mass of a proton.
   b. The mass of an electron is greater than the mass of a neutron.
   c. The mass of a proton is greater than the mass of an electron.
   d. The mass of a proton is greater than the mass of a neutron.

7. The valence electrons of a germanium atom in the ground state are located in the
   a. first shell
   b. third shell
   c. second shell
   d. fourth shell

8. According to the wave-mechanical model of the atom, electrons in an atom
   a. travel in defined circles
   b. are most likely found in an excited state
   c. have a positive charge
   d. are located in orbitals outside the nucleus
9. During a flame test, ions of a specific metal are heated in the flame of a gas burner. A characteristic color of light is emitted by these ions in the flame when the electrons 
a. gain energy as they return to lower energy levels  
b. gain energy as they move to higher energy levels  
c. emit energy as they return to lower energy levels  
d. emit energy as they move to higher energy levels

10. A bright line spectrum is to an element like a(n) ____________ is to a person.  
a. brain  
b. fingerprint  
c. eye  
d. ear

11. The lines in the bright line spectrum of an atom are due to 
a. nuclear transitions in atoms  
b. movement of electrons from higher energy states to lower energy states  
c. movement of electrons from lower energy states to higher energy states  
d. the presence of isotopes

12. In the “ground state” the electron in a hydrogen atom is 
a. in the highest possible energy  
b. in the lowest possible energy  
c. not moving  
d. in the nucleus

13. Which pair must represent atoms of the same element?  
a. \(^{14}_{6}X\) and \(^{14}_{7}X\)  
b. \(^{12}_{6}X\) and \(^{13}_{6}X\)  
c. \(^{2}_{1}X\) and \(^{4}_{2}X\)  
d. \(^{13}_{6}X\) and \(^{14}_{7}X\)

14. In all samples of the element potassium, each atom has 
a. 19 protons  
b. 20 neutrons  
c. 39 protons and neutrons  
d. 39 nucleons

15. An ion that consists of 7 protons, 6 neutrons, and 10 electrons has a net charge of 
a. 4-  
b. 3+  
c. 3-  
d. 4+

16. The major portion of an atom’s mass consists of 
a. electrons and protons  
b. electrons and neutrons  
c. neutrons and positrons  
d. neutrons and protons
17. An atom in the ground state has a stable valence electron configuration. This atom could be an atom of
   a) Al
   b) Cl
   c) Na
   d) Ne

18. Which is the electron configuration of a fluorine atom in the excited state?
   a. 2-6  b. 2-7  c. 2-6-1  d. 2-7-1

19. Which electron configuration represents an excited state for a potassium atom?
   a. 2-8-7-1  b. 2-8-8-1  c. 2-8-7-2  d. 2-8-8-2

20. Which diagram represents the nucleus of an atom of $^{27}_{13}\text{Al}^+$?

21. In a calcium atom in the ground state, the electrons that possess the least amount of energy are located in the
   a. first electron shell
   b. second electron shell
   c. third electron shell
   d. fourth electron shell

22. Which sequence represents a correct order of historical developments leading to the modern model of the atom?
   a. the atom is a hard sphere $\rightarrow$ most of the atom is empty space $\rightarrow$ electrons exist in orbitals outside the nucleus
   b. the atom is a hard sphere $\rightarrow$ electrons exist in orbitals outside the nucleus $\rightarrow$ most of the atom is empty space
   c. most of the atom is empty space $\rightarrow$ electrons exist in orbitals outside the nucleus $\rightarrow$ the atom is a hard sphere
   d. most of the atom is empty space $\rightarrow$ the atom is a hard sphere $\rightarrow$ electrons exist in orbitals outside the nucleus

23. What information is necessary to determine the atomic mass of the element chlorine?
   a. the atomic mass of each artificially produced isotope of chlorine, only
   b. the relative abundance of each naturally occurring isotope of chlorine, only
   c. the atomic mass and the relative abundance of each naturally occurring isotope of chlorine
   d. the atomic mass and the relative abundance of each naturally occurring and artificially produced isotope of chlorine
24. Each diagram to the right represents the nucleus of a different atom. Which diagrams represent nuclei of the same element?
   a. $D$ and $E$, only
   b. $D$, $E$, and $Q$
   c. $Q$ and $R$, only
   d. $Q$, $R$, and $E$

   ![Diagram of atomic nuclei]

   **Short Answer.**

25. Write both the name and the charge of the particle that is gained by a Fluorine atom when it becomes a Fluoride ion.

   Base your answers to question 26 on the diagram below, which shows bright-line spectra of selected elements D, E and G.

   ![Bright-Line Spectra Diagram]

26. Identify the two elements in the **Mixture** spectrum ___________

27. The Balmer series refers to the visible bright lines in the spectrum produced by hydrogen atoms. The color and wavelength of each line in this series are given in the table below. Explain, in terms of both subatomic particles and energy states, how the Balmer series is produced.

   **Balmer Series for Hydrogen**
<table>
<thead>
<tr>
<th>Color</th>
<th>Wavelength (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>red</td>
<td>656.3</td>
</tr>
<tr>
<td>blue green</td>
<td>486.1</td>
</tr>
<tr>
<td>blue</td>
<td>434.1</td>
</tr>
<tr>
<td>violet</td>
<td>410.2</td>
</tr>
</tbody>
</table>
28. Calculate the atomic mass of sulfur using the information below. **Show all work for credit!**

<table>
<thead>
<tr>
<th>Naturally Occurring Isotopes of Sulfur</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Isotope</strong></td>
</tr>
<tr>
<td>$^{32}\text{S}$</td>
</tr>
<tr>
<td>$^{33}\text{S}$</td>
</tr>
<tr>
<td>$^{34}\text{S}$</td>
</tr>
<tr>
<td>$^{36}\text{S}$</td>
</tr>
</tbody>
</table>

29-31: Base your answers to these questions on the information and diagram below.

One model of the atom states that atoms are tiny particles composed of a uniform mixture of positive and negative charges. Scientists conducted an experiment where alpha particles were aimed at a thin layer of gold atoms.

Most of the alpha particles passed directly through the gold atoms. A few alpha particles were deflected from their straight-line paths. An illustration of the experiment is shown below.

29. Most of the alpha particles passed directly through the gold atoms undisturbed. What does this evidence suggest about the structure of gold atoms?

30. A few of the alpha particles were deflected. What does this evidence suggest about the structure of the gold atoms?

31. How should the earlier model of the atom be revised based on the results of this experiment?
BONUS Questions

1. Silver consists of two isotopes $^{107}\text{Ag}$ and $^{109}\text{Ag}$. Its average atomic mass is 107.87. Calculate the percentage of each isotope in naturally occurring silver. (Assume that the masses are 107.00 and 109.00 respectively.)

2. Write the noble gas configuration that N will achieve when it becomes an ion.

3. Draw the orbital diagram for Mg. 


1. ___ 2s ___ 2p ___ ___ ___ 3s ___ 3p ___ ___ ___

4. 1s ___ 2s ___ 2p ___ ___ ___ 3s ___ 3p ___ ___ ___
25. Write both the name and the charge of the particle that is gained by a Fluorine atom when it becomes a Fluoride ion.

Base your answers to question 26 on the diagram below, which shows bright-line spectra of selected elements D, E and G.

26. Identify the two elements in the Mixture spectrum ________________

27. The Balmer series refers to the visible bright lines in the spectrum produced by hydrogen atoms. The color and wavelength of each line in this series are given in the table below. Explain, in terms of both subatomic particles and energy states, how the Balmer series is produced.

<table>
<thead>
<tr>
<th>Color</th>
<th>Wavelength (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>red</td>
<td>656.3</td>
</tr>
<tr>
<td>blue green</td>
<td>486.1</td>
</tr>
<tr>
<td>blue</td>
<td>434.1</td>
</tr>
<tr>
<td>violet</td>
<td>410.2</td>
</tr>
</tbody>
</table>

28. Calculate the atomic mass of sulfur using the information below. Show all work for credit!

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Atomic Mass (atomic mass units, u)</th>
<th>Natural Abundance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{32}\text{S}$</td>
<td>31.97</td>
<td>94.93</td>
</tr>
<tr>
<td>$^{33}\text{S}$</td>
<td>32.97</td>
<td>0.76</td>
</tr>
<tr>
<td>$^{34}\text{S}$</td>
<td>33.97</td>
<td>4.29</td>
</tr>
<tr>
<td>$^{36}\text{S}$</td>
<td>35.97</td>
<td>0.02</td>
</tr>
</tbody>
</table>
29. Most of the alpha particles passed directly through the gold atoms undisturbed. What does this evidence suggest about the structure of gold atoms?

____________________________________________________________________________________

30. A few of the alpha particles were deflected. What does this evidence suggest about the structure of the gold atoms?

____________________________________________________________________________________

31. How should the earlier model of the atom be revised based on the results of this experiment?

______________________________________________________________________________________

_____________________________________________________________________________________
Atom Exam Answer KEY

1. d
2. c
3. d
4. b
5. b
6. c
7. d
8. d
9. c
10. b
11. b
12. b
13. b
14. a
15. e
16. d
17. d
18. c
19. c
20. 2
21. a
22. a
23. c
24. b

25. Write both the name and the charge of the particle that is gained by a Fluorine atom when it becomes a Fluoride ion.
   
   **Electron, -1 charge**

26. Write both the name and the charge of the particle that is gained by a Fluorine atom when it becomes a Fluoride ion.

Base your answers to question 26 on the diagram below, which shows bright-line spectra of selected elements D, E and G.

![Bright-Line Spectra Diagram]

26. Identify the two elements in the Mixture spectrum. **D and E**

27. The Balmer series refers to the visible bright lines in the spectrum produced by hydrogen atoms. The color and wavelength of each line in this series are given in the table below. Explain, in terms of both subatomic particles and energy states, how the Balmer series is produced.

<table>
<thead>
<tr>
<th>Color</th>
<th>Wavelength (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>red</td>
<td>656.3</td>
</tr>
<tr>
<td>blue green</td>
<td>486.1</td>
</tr>
<tr>
<td>blue</td>
<td>434.1</td>
</tr>
<tr>
<td>violet</td>
<td>410.2</td>
</tr>
</tbody>
</table>

Electrons fall down from different energy levels (or excited states) and give off different wavelengths of light.

28. Calculate the atomic mass of sulfur using the information below. **Show all work for credit!**

<table>
<thead>
<tr>
<th>Naturally Occurring Isotopes of Sulfur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isotope</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>(^{32}\text{S})</td>
</tr>
<tr>
<td>(^{33}\text{S})</td>
</tr>
<tr>
<td>(^{34}\text{S})</td>
</tr>
<tr>
<td>(^{36}\text{S})</td>
</tr>
</tbody>
</table>
BONUS Questions

1. Silver consists of two isotopes $^{107}\text{Ag}$ and $^{109}\text{Ag}$. Its average atomic mass is 107.87. Calculate the percentage of each isotope in naturally occurring silver. (Assume that the masses are 107.00 and 109.00 respectively.)

\[ \text{Ag-107} = 56.5\% \]
\[ \text{Ag-109} = 43.5\% \]

2. Write the noble gas configuration that N will achieve when it becomes an ion. 2-8

3. Draw the orbital diagram for Mg.

\[ \text{1s} \quad \text{2s} \quad \text{2p} \quad \text{3s} \quad \text{3p} \]


\[ \text{1s} \quad \text{2s} \quad \text{2p} \quad \text{3s} \quad \text{3p} \]

32. Most of the alpha particles passed directly through the gold atoms undisturbed. What does this evidence suggest about the structure of gold atoms?

\textbf{The atom is made up of mostly empty space.}

33. A few of the alpha particles were deflected. What does this evidence suggest about the structure of the gold atoms?

\textbf{The atom has a tiny, dense, positive core.}

34. How should the earlier model of the atom be revised based on the results of this experiment?

\textbf{The mass of the atom should be concentrated in a tiny nucleus at the center of the atom}