1. The discovery of the electron as a subatomic particle was a result of

   A) collision theory
   B) kinetic molecular theory
   C) the gold-foil experiment
   D) experiments with cathode ray tubes

2. The part of an atom that has an overall positive charge is called

   A) an electron
   B) the nucleus
   C) the first shell
   D) the valence shell

3. Which statement describes the charge and location of an electron in an atom?

   A) An electron has a positive charge and is located outside the nucleus.
   B) An electron has a positive charge and is located in the nucleus.
   C) An electron has a negative charge and is located outside the nucleus.
   D) An electron has a negative charge and is located in the nucleus.

4. Four statements about the development of the atomic model are shown below.

   A: Electrons have wavelike properties.
   B: Atoms have small, negatively charged particles.
   C: The center of an atom is a small, dense nucleus.
   D: Atoms are hard, indivisible spheres.

   Which order of statements represents the historical development of the atomic model?

   A) $C \rightarrow D \rightarrow A \rightarrow B$
   B) $C \rightarrow D \rightarrow B \rightarrow A$
   C) $D \rightarrow B \rightarrow A \rightarrow C$
   D) $D \rightarrow B \rightarrow C \rightarrow A$

5. What is the overall charge of an ion that has 12 protons, 10 electrons, and 14 neutrons?

   A) 2–
   B) 2+
   C) 4–
   D) 4+

6. Which conclusion was a direct result of the gold foil experiment?

   A) An atom is mostly empty space with a dense, positively charged nucleus.
   B) An atom is composed of at least three types of subatomic particles.
   C) An electron has a positive charge and is located inside the nucleus.
   D) An electron has properties of both waves and particles.

7. In Rutherford's gold foil experiments, some alpha particles were deflected from their original paths but most passed through the foil with no deflection. Which statement about gold atoms is supported by these experimental observations?

   A) Gold atoms consist mostly of empty space.
   B) Gold atoms are similar to alpha particles.
   C) Alpha particles and gold nuclei have opposite charges.
   D) Alpha particles are more dense than gold atoms.

8. A sample of matter must be copper if

A) each atom in the sample has 29 protons
B) atoms in the sample react with oxygen
C) the sample melts at 1768 K
D) the sample can conduct electricity

9. What is the total charge of the nucleus of a nitrogen atom?

A) +5 B) +2 C) +7 D) +1

10. As the number of neutrons in the nucleus of a given atom of an element increases, the atomic number of that element

A) decreases B) increases
C) remains the same

11. The atomic mass of an element is the weighted average of the atomic masses of

A) the least abundant isotopes of the element
B) the naturally occurring isotopes of the element
C) the artificially produced isotopes of the element
D) the natural and artificial isotopes of the element

12. Which quantity can vary among atoms of the same element?

A) mass number
B) atomic number
C) number of protons
D) numbers of electrons

13. The nuclides I-131 and I-133 are classified as

A) isomers of the same element
B) isomers of Xe-131 and Cs-133
C) isotopes of the same element
D) isotopes of Xe-131 and Cs-133

14. The nucleus of an atom of cobalt-58 contains

A) 27 protons and 31 neutrons
B) 27 protons and 32 neutrons
C) 59 protons and 60 neutrons
D) 60 protons and 60 neutrons

15. Atoms of ^{16}O, ^{17}O, and ^{18}O have the same number of

A) neutrons, but a different number of protons
B) protons, but a different number of neutrons
C) protons, but a different number of electrons
D) electrons, but a different number of protons

16. Which two nuclides are isotopes of the same element?

A) $^{20}_{11}\mathrm{Na}$ and $^{20}_{10}\mathrm{Ne}$ B) $^{39}_{19}\mathrm{K}$ and $^{40}_{20}\mathrm{Ca}$
C) $^{39}_{19}\mathrm{K}$ and $^{42}_{19}\mathrm{K}$ D) $^{14}_{6}\mathrm{C}$ and $^{14}_{7}\mathrm{N}$

17. The table below gives the atomic mass and the abundance of the two naturally occurring isotopes of bromine.

Naturally Occurring Isotopes of Bromine

Isotopes	Atomic Mass (u)	Natural Abundance (%)
Br-79	78.92	50.69
Br-81	80.92	49.31

Which numerical setup can be used to calculate the atomic mass of the element bromine?

A) (78.92 u)(50.69) + (80.92 u)(49.31)
B) (78.92 u)(49.31) + (80.92 u)(50.69)
C) (78.92 u)(0.5069) + (80.92 u)(0.4931)
D) (78.92 u)(0.4931) + (80.92 u)(0.5069)

18. The electron configuration of an atom in the ground state is 2-4. The total number of occupied principal energy levels in this atom is

A) 1 B) 2 C) 3 D) 4

19. Which electron configuration represents an atom of an element having a completed third principal energy level?

A) 2-8-2 B) 2-8-6-2
C) 2-8-10-2 D) 2-8-18-2

20. An atom of which element in the ground state contains electrons in the fourth principal energy level?

A) Kr B) Ar C) Ne D) He

21. What is the maximum number of electrons that may be present in the second principal energy level of an atom?

A) 8 B) 2 C) 18 D) 32

22. Which principal energy level of an atom contains an electron with the lowest energy?

A) $n = 1$ B) $n = 2$ C) $n = 3$ D) $n = 4$

23. Which electron configuration represents an excited state for an atom of calcium?

A) 2-8-7-1 B) 2-8-7-2
C) 2-8-7-3 D) 2-8-8-2

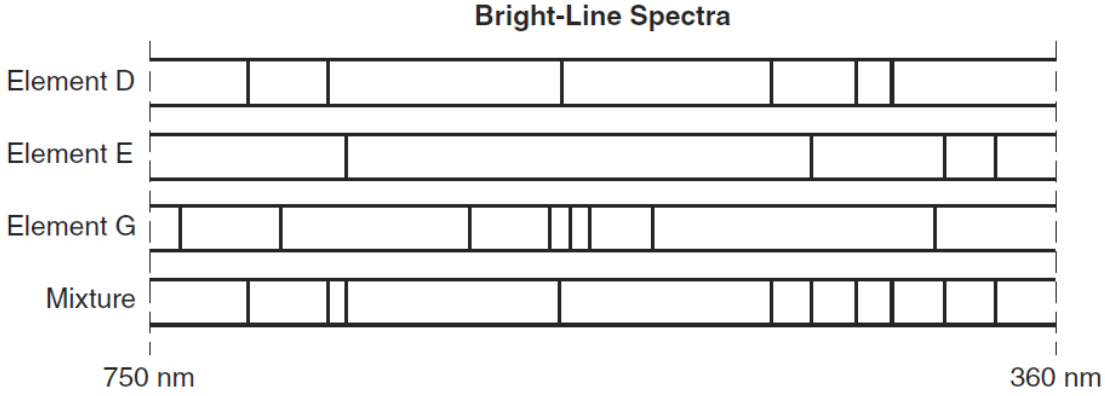
24. Which change occurs when an atom in an excited state returns to the ground state?

A) Energy is emitted.
B) Energy is absorbed.
C) The number of electrons decreases.
D) The number of electrons increases.

25. Which statement describes how an atom in the ground state becomes excited?

A) The atom absorbs energy, and one or more electrons move to a higher electron shell.
B) The atom absorbs energy, and one or more electrons move to a lower electron shell.
C) The atom releases energy, and one or more electrons move to a higher electron shell.
D) The atom releases energy, and one or more electrons move to a lower electron shell.

26. Given the bright-line spectra of three elements and the spectrum of a mixture formed from at least two of these elements:



Which elements are present in this mixture?

A) *E* and *D*, only B) *E* and *G*, only C) *D* and *G*, only D) *D*, *E*, and *G*

27. When compared with the energy of an electron in the first shell of a carbon atom, the energy of an electron in the second shell of a carbon atom is

A) less B) greater
C) the same

28. What is the electron configuration for Be^{2+} ions?

A) 1 B) 2 C) 2-1 D) 2-2

29. When the electrons of an excited atom return to a lower energy state, the energy emitted can result in the production of

A) alpha particles B) isotopes
C) protons D) spectra

30. Which particle has the *least mass?*

A) alpha particle B) beta particle
C) neutron D) proton