

1. Which of the following has a positive charge?

- (a) proton
- (b) neutron
- (c) anion
- (d) electron
- (e) atom

2.

Rutherford carried out experiments in which a beam of alpha particles was directed at a thin piece of metal foil. From these experiments he concluded that:

- (a) electrons are massive particles.
- (b) the positively charged parts of atoms are moving about with a velocity approaching the speed of light.
- (c) the positively charged parts of atoms are extremely small and extremely heavy particles.
- (d) the diameter of an electron is approximately equal to that of the nucleus.
- (e) electrons travel in circular orbits around the nucleus.

3.

Consider the species ^{72}Zn , ^{75}As and ^{74}Ge . These species have:

- (a) the same number of electrons.
- (b) the same number of protons.
- (c) the same number of neutrons.
- (d) the same number of protons and neutrons.
- (e) the same mass number.

4.

The neutral atoms of all of the isotopes of the same element have

- (a) different numbers of protons.
- (b) equal numbers of neutrons.
- (c) the same number of electrons.
- (d) the same mass numbers.
- (e) the same masses.

5.

What is the atomic weight of a hypothetical element consisting of two isotopes, one with mass = 64.23 amu (26.0%), and one with mass = 65.32 amu?

- (a) 65.3 amu
- (b) 64.4 amu
- (c) 64.9 amu
- (d) 65.0 amu
- (e) 64.8 amu

6.

Naturally occurring rubidium consists of just two isotopes. One of the isotopes consists of atoms having a mass of 84.912 amu; the other of 86.901 amu. What is the percent natural abundance of the heavier isotope?

- (a) 15%
- (b) 28%
- (c) 37%
- (d) 72%
- (e) 85%

7.

What is the frequency of light having a wavelength of 4.50×10^{-6} cm?

- (a) $2.84 \times 10^{-12} \text{ s}^{-1}$
- (b) $2.10 \times 10^4 \text{ s}^{-1}$
- (c) $4.29 \times 10^{14} \text{ s}^{-1}$
- (d) $1.06 \times 10^{22} \text{ s}^{-1}$
- (e) $6.67 \times 10^{15} \text{ s}^{-1}$

8.

The emission spectrum of gold shows a line of wavelength 2.676×10^{-7} m. How much energy is emitted as the excited electron falls to the lower energy level?

- (a) $7.43 \times 10^{-19} \text{ J}$
- (b) $5.30 \times 10^{-20} \text{ J}$
- (c) $6.05 \times 10^{-19} \text{ J}$
- (d) $3.60 \times 10^{-20} \text{ J}$
- (e) $5.16 \times 10^{-20} \text{ J}$

9.

Which of the responses contains all the statements that are consistent with the Bohr theory of the atom (and no others)?

- (1) An electron can remain in a particular orbit as long as it continually absorbs radiation of a definite frequency.
- (2) The lowest energy orbits are those closest to the nucleus.
- (3) An electron can jump from the K shell ($n = 1$ major energy level) to the M shell ($n = 3$ major energy level) by emitting radiation of a definite frequency.

- (a) 1,2,3
- (b) 2 only
- (c) 3 only
- (d) 1,2
- (e) 2,3

10.

The Heisenberg Principle states that _____.

- (a) no two electrons in the same atom can have the same set of four quantum numbers.

- (b) two atoms of the same element must have the same number of protons.
- (c) it is impossible to determine accurately both the position and momentum of an electron simultaneously.
- (d) electrons of atoms in their ground states enter energetically equivalent sets of orbitals singly before they pair up in any orbital of the set.
- (e) charged atoms (ions) must generate a magnetic field when they are in motion.

11.

Which statement about the four quantum numbers which describe electrons in atoms is **incorrect**?

- (a) n = principal quantum number, $n = 1, 2, 3, \dots$
- (b) l = subsidiary (or azimuthal) quantum number, $l = 1, 2, 3, \dots, (n-1)$
- (c) m_l = magnetic quantum number, $m_l = (-l), \dots, 0, \dots, (+l)$
- (d) m_s = spin quantum number, $m_s = +1/2$ or $-1/2$.
- (e) The magnetic quantum number is related to the orientation of atomic orbitals in space.

12.

Which atomic orbital is spherical in shape? (Note: you should know and be able to recognize the shapes of the s orbital, p_x , p_y , and p_z orbitals, and d_{xy} , d_{yz} , d_{xz} , $d_{x^2-y^2}$ and d_{z^2} orbitals.)

- (a) 2s
- (b) 3p
- (c) 3d
- (d) 4f
- (e) they are all spherical

13.

The maximum number of electrons that can be accommodated in a sublevel for which $l = 3$ is:

- (a) 2
- (b) 10
- (c) 6
- (d) 14
- (e) 8

14.

The ground state electron configuration for arsenic is:

- (a) $[\text{Ar}] 4s^2 4p^{13}$
- (b) $[\text{Kr}] 4s^2 4p^1$
- (c) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{12} 4s^2 4p^1$
- (d) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8 4p^5$
- (e) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^3$

15.

Which of the following electron configurations is correct for nickel?

- (a) [Ar] $4s^1 3d^8$
- (b) [Kr] $4s^1 4d^8$
- (c) [Kr] $4s^1 3d^8$
- (d) [Kr] $4s^2 3d^8$
- (e) [Ar] $4s^2 3d^8$

16.

The outer electronic configuration ns^2np^4 corresponds to which one of the following elements in its ground state?

- (a) As
- (b) Ca
- (c) Cr
- (d) Br
- (e) S

17.

In the ground state of a cobalt atom there are _____ unpaired electrons and the atom is _____.

- (a) 3, paramagnetic
- (b) 5, paramagnetic
- (c) 2, diamagnetic
- (d) 0, diamagnetic
- (e) 2, paramagnetic

18.

Which one of the following sets of quantum numbers **could** be those of the distinguishing (last) electron of Mo?

- (a) $n = 4, l = 0, m_l = 0, m_s = +1/2$
- (b) $n = 5, l = 1, m_l = 9, m_s = -1/2$
- (c) $n = 4, l = 2, m_l = -1, m_s = +1/2$
- (d) $n = 5, l = 2, m_l = +2, m_s = -1/2$
- (e) $n = 3, l = 2, m_l = 0, m_s = +1/2$

19.

How many p electrons are there in an atom of rubidium?

- (a) 12
- (b) 18
- (c) 24
- (d) 9
- (e) 6

20.

A neutral atom of an element has 2 electrons in the first energy level, 8 in the second energy level and 8 in the third energy level. This information does **not** necessarily tell us:

- (a) the atomic number of the element.
- (b) anything about the element's chemical properties.
- (c) the total number of electrons in s orbitals.
- (d) the total number of electrons in p orbitals.
- (e) the number of neutrons in the nucleus of an atom of the element.

21. The three basic components of an atom are:

- a. Protons, neutrons, and ions
- b. Protons, neutrons, and electrons
- c. Protons, neutrinos, and ions
- d. Protium, deuterium, and tritium

22. An element is determined by the number of

- a. Atom
- b. Electron
- c. Neutrons
- d. Protons

23. The nucleus of an atom consists of:

- a. Electron
- b. Neutrons
- c. Protons and Neutrons
- d. **Protons, neutrons and electrons**

24. A single proton has what electrical charge?

- a. No charge
- b. Positive charge
- c. Negative charge
- d. **Either positive or negative**

25. Which particles have approximately the same size and mass as each other?

- a. Neutrons and electrons
- b. Electrons and protons
- c. Protons and neutrons
- d. none