

## Valence Electrons

- 1 Which electron shell in an atom of calcium in the ground state has an electron with the greatest amount of energy?
  - (1) 1
  - (2) 2
  - (3) 3
  - (4) 4
  
- 2 Compared to the energy of an electron in the second shell of an atom of sulfur, the energy of an electron in the
  - (1) first shell is lower
  - (2) first shell is the same
  - (3) third shell is lower
  - (4) third shell is the same
  
- 3 The valence electron of which atom in the ground state has the greatest amount of energy?
  - (1) cesium
  - (2) lithium
  - (3) rubidium
  - (4) sodium
  
- 4 Compared to the energy and charge of the electrons in the first shell of a Be atom, the electrons in the second shell of this atom have
  - (1) less energy and the same charge
  - (2) less energy and a different charge
  - (3) more energy and the same charge
  - (4) more energy and a different charge
  
- 5 What is the number of valence electrons in a nitrogen atom in the ground state?
  - (1) 5
  - (2) 2
  - (3) 7
  - (4) 14
  
- 6 Strontium and barium have similar chemical properties because atoms of these elements have the same number of
  - (1) protons
  - (2) neutrons
  - (3) electron shells
  - (4) valence electrons
  
- 7 In the ground state, an atom of which element has seven valence electrons?
  - (1) sodium
  - (2) phosphorus
  - (3) nitrogen
  - (4) fluorine
  
- 8 Magnesium and calcium have similar chemical properties because their atoms in the ground state have
  - (1) equal numbers of protons and electrons
  - (2) equal numbers of protons and neutrons
  - (3) two electrons in the first shell
  - (4) two electrons in the outermost shell
  
- 9 In the ground state, valence electrons of a krypton atom are found in
  - (1) the first shell
  - (2) the outermost shell
  - (3) both the nucleus and the first shell
  - (4) both the first shell and the outermost shell
  
- 10 Which electrons in a calcium atom in the ground state have the greatest effect on the chemical properties of calcium?
  - (1) the two electrons in the first shell
  - (2) the two electrons in the fourth shell
  - (3) the eight electrons in the second shell
  - (4) the eight electrons in the third shell

Base your answers to questions 11 on the information below and on your knowledge of chemistry.

The four naturally occurring isotopes of sulfur are S-32, S-33, S-34, and S-36. The table below shows the atomic mass and percent natural abundance for these isotopes.

Naturally Occurring Isotopes of Sulfur

Isotope	Atomic Mass (u)	Natural Abundance (%)
S-32	31.972	94.99
S-33	32.971	0.75
S-34	33.968	4.25
S-36	35.967	0.01

- 11 Compare the energy of an electron in the third shell of a sulfur atom to the energy of an electron in the first shell of the same atom.

Base your answers to questions 12 on the information below and on your knowledge of chemistry.

The table below shows data for three isotopes of the same element.

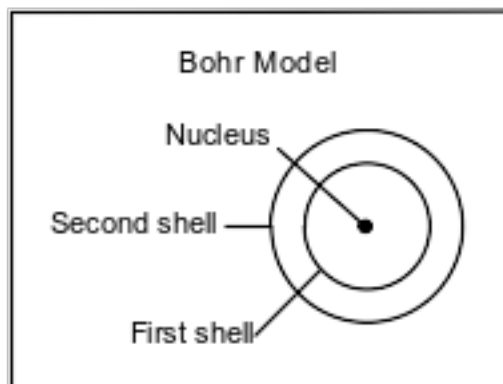
Data for Three Isotopes of an Element

Isotopes	Number of Protons	Number of Neutrons	Atomic Mass (u)	Natural Abundance (%)
Atom D	12	12	23.99	78.99
Atom E	12	13	24.99	10.00
Atom G	12	14	25.98	11.01

- 12 Compare the energy of an electron in the first electron shell to the energy of an electron in the second electron shell in an atom of isotope E.
- 13 Compare the energy of an electron in the first shell of a cadmium atom to the energy of an electron in the third shell of the same atom.

Base your answers to questions 14 on the information below and on your knowledge of chemistry.

The Bohr model of the atom was developed in the early part of the twentieth century. A diagram of the Bohr model for one atom, in the ground state, of a specific element is shown below. The nucleus of this atom contains 4 protons and 5 neutrons.



- 14 Using the Bohr model, describe the changes in electron energy and electron location when an atom changes from the ground state to an excited state.

Base your answers to questions 15 on the information below and on your knowledge of chemistry.

Sir William Ramsey is one scientist credited with identifying the noble gas argon. Sir Ramsey separated nitrogen gas from the air and reacted it with an excess of magnesium, producing solid magnesium nitride. However, a small sample of an unreactive gas remained with a density different from the density of the nitrogen gas. Sir Ramsey identified the unreactive gas as argon and later went on to discover neon, krypton, and xenon.

- 15 State, in terms of valence electrons, why the noble gases that Sir Ramsey discovered have similar chemical properties.

## Answer Keys

1 4

2 1

3 1

4 3

5 1

6 4

7 4

8 4

9 2

10 2

11 Allow 1 credit. Acceptable responses include, but are not limited to:

- The energy of an electron in the third shell is higher than the energy of an electron in the first shell.
- The third shell electron has higher energy.
- The electron in the first shell has less.
- Note: The student response must address energy of electrons, not just shells.

12 Allow 1 credit. Acceptable responses include, but are not limited to:

- An electron in the first shell of an atom of isotope E has less energy than an electron in the second shell.
- In an atom of E, an electron in the 2nd energy level has more energy than an electron in the 1st energy level.
- Electrons in shell 2 have higher energies than shell 1 electrons.
- lower in shell 1

13 Allow 1 credit. Acceptable responses include, but are not limited to:

- An electron in the first shell has less energy than an electron in the third shell.
- The third shell electron has higher energy.
- 3<sup>rd</sup> shell > 1<sup>st</sup> shell

14 Allow 1 credit. Acceptable responses include, but are not limited to:

- Change in electron energy:
- Electron energy increases.. An electron absorbs energy. more energy
- Change in electron location:
- An electron moves to a higher electron shell. from the first to the second shell second to higher energy level farther from the nucleus

15 Allow 1 credit. Acceptable responses include, but are not limited to:

- Their atoms have the same number of valence electrons.
- These elements have similar chemical properties because their atoms have valence electron shells with a complete octet.
- Their outermost shells have 8 e<sup>-</sup>.
- They have a full outermost shell of electrons.