1. Fluorine is an element with atomic number 9. It is located in group 17 on the periodic table and has 7 electrons in its outermost energy level. Calcium is an element with atomic number 20. It is located in group 2 on the periodic table and normally has 2 electrons in its outermost energy level. Fluorine has a tendency to gain electrons during chemical reactions, and calcium has a tendency to lose electrons during chemical reactions.

What is primarily responsible for the elements' different chemical responses?

☐ A. the number of electrons in their outermost energy levels
☐ B. their states of matter
☐ C. the speed at which the electrons travel around the nucleus
☐ D. the position of their protons and neutrons

2. Electron transitions in the hydrogen atom can emit five different sets of spectral lines that correspond to different energy ranges of the electromagnetic spectrum. The Lyman series emits radiation in the ultraviolet range. The Balmer series emits light in the visible range. The Paschen, Brackett, and Pfund series emit lower-energy infrared radiation.
Based on the diagram shown, how are these series related to the energy levels of the hydrogen atom?

- A. The transitions of all the series end at the same energy level.
- B. The transitions of the different series begin at different energy levels.
- C. The transitions of the different series end at different energy levels.
- D. The transitions of the series are not related to the energy levels.

3. Use the diagram below to answer the following question.

![Line Spectrum of the H atom](image)

Which change in energy level will result in the largest release of energy?

- A. n = 4 to n = 3
- B. n = 3 to n = 2
- C. n = 4 to n = 1
- D. n = 2 to n = 1

5. All elements have a unique atomic emission spectrum. In which of the following scenarios would this fact be most useful?

- A. when trying to determine how old an artifact is
B. when trying to determine a star's chemical composition
C. when trying to investigate a murder using DNA evidence
D. when trying to measure the speed of sound

6. Electrons always fill orbitals in the same order. Each s orbital holds 2 electrons, each set of p orbitals holds 6 electrons, each set of d orbitals holds 10 electrons, and each set of f orbitals holds 14 electrons. The order in which orbitals are filled, from first to last, is:

\[ 1s \ 2s \ 2p \ 3s \ 3p \ 4s \ 3d \ 4p \ 5s \ 4d \ 5p \ 6s \ 4f \ 5d \ 6p \ 7s \ 5f \ 6d \ 7p \]

To what element does the following electron configuration correspond?

1\(s^22s^22p^63s^23p^6\)

A. argon: 18 electrons
B. bromine: 35 electrons
C. sodium: 11 electrons
D. carbon: 6 electrons

7. According to Bohr's model of the hydrogen atom, what determines the energy of an electron?

A. the speed of its orbit
B. the direction of its orbit
C. the stability of its orbit
D. the radius of its orbit

8. A hydrogen atom emits a photon of energy. Which of the following would explain this?

A. An electron has moved from the ground state to an excited state.
B. An electron has moved from a high energy state to a low energy state.
C. An electron has been removed from the atom.
D. An electron has been absorbed by the atom.
9. What happens when a hydrogen atom changes from the excited state to the ground state?

- A. The excess energy is absorbed as heat.
- B. The excess energy is released as heat.
- C. The excess energy is released as light.
- D. The excess energy is absorbed as light.

10. A hydrogen atom returns from an excited state to the ground state in one step. Which of the following statements correctly describes the light emitted?

- A. It could have any possible energy.
- B. It will be infinite.
- C. It will be negligible.
- D. It will have a definite energy.

**Answers**

1. A
2. C
3. C
5. B
6. A
7. D
8. B
9. C
10. D

**Explanations**

1. The way in which an atom reacts chemically is mostly determined by the number of electrons in their outermost energy levels and the relative distances between the atoms' nuclei and the outermost electrons.

Atoms that have less than 4 electrons in their outermost energy levels tend to lose electrons while atoms that have more than 4 electrons in their outermost energy levels tend to gain electrons.

Also, electrons that are located farther away from the nucleus of an atom are more likely to be transferred during chemical reactions because they are not as strongly attracted to the nucleus as electrons that are more closely located.
2. An electron in hydrogen emits energy as it moves from an excited state to a lower energy level. This energy can be recorded by a spectrometer and translated into five different series of lines based on their ranges within the electromagnetic spectrum.

The different series within the hydrogen spectrum can also be defined by the fact that the electron **transitions of different series end at different energy levels**. As shown in the diagram, the Lyman series ends at \( n=1 \), the Balmer series ends at \( n=2 \), the Paschen series ends at \( n=3 \), the Beckett series ends at \( n=4 \), and the Pfund series ends at \( n=5 \).

3. The energy released when an electron moves from a high energy level to a low energy level is equal to the difference between the energy of the two states. The energy difference is greatest between \( n = 4 \) and \( n = 1 \) (1312 kJ – 82 kJ = 1230 kJ). The energy released between \( n = 2 \) and \( n = 1 \) is only 984 kJ, between \( n = 4 \) and \( n = 3 \) is 64 kJ, and between \( n = 3 \) and \( n = 2 \) is 182 kJ.

4. The electron in orbit 4 can return directly to orbit 1. It can also move from orbit 4 to 3 and then to 1, from 4 to 2 and then to 1, or from 4 to 3 to 2 to 1. This shows that there are four possible return paths for the electron.

5. Stars are hot, glowing bodies of gases. If the light produced by a star is gathered through a telescope and transferred to an emission spectrograph, the atomic emission spectrum can be analyzed. Then, the chemical/elemental composition of the star can be determined.

6. The electron configuration of an element shows how electrons are arranged around the nuclei of its atoms in their ground state. Electrons always fill the lowest energy levels first.

So, the element **argon** corresponds to the electron configuration \( 1s^22s^22p^63s^23p^6 \).

7. Bohr’s model of the hydrogen atom states that electrons move around the nucleus in one of several possible orbits like the planets moving around the Sun. Each orbit has a specific **radius** that corresponds to a specific energy level.

8. A hydrogen atom emits a photon of energy when **an electron moves from a high energy state to a lower energy state**. The energy of the photon released is equal to the difference between the energy of the two states.

9. When an atom changes from the excited state to the ground state, the electron has moved from a high energy state to a low energy state. When this occurs, **the excess energy is released as light energy**. This explains why atoms emit light when they change from an excited state back to the ground state.

Also, since the amount of light emitted or absorbed by separate atoms or molecules has distinct energy values, it can be used to identify what the substance is.

10. When an electron moves from an excited state to the ground state, it moves into definite orbits that each have a definite energy. The energy released is the difference in energy between
the two orbits. This will always be a **definite amount of energy**. Each definite amount of energy released is called a *quantum*.