

BIO QUIZ – Questions & Answers - The Chemistry of Life

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- 1) Compare protons, neutrons, and electrons.
- 2) Compare the concepts of Atomic Number, Atomic Mass, and Mass Number
- 3) Explain the concepts: Periodic Table, Groups, Periods, Families?
- 4) What happens when you move one step from left-to-right on the Periodic Table: Example: From Potassium(K) to Calcium (C) ?
- 5) What happens when you move one step from top-to-bottom on the Periodic Table: Example: From Hydrogen(H) to Lithium(Li) ?
- 6) What role do Neutrons play in maintaining the stability of the atom's nucleus?
- 7) Compare the concepts of Electronegativity and Ionization Energy.
- 8) What are the (4) Periodic Trends that explain the relationship between elements on the Periodic Table?

1) Compare protons, neutrons, and electrons.

Protons, neutrons, and electrons are the fundamental subatomic particles that make up an atom. Protons are positively charged particles found in the nucleus of an atom, and they determine the element's identity by defining the atomic number. Neutrons, which are also located in the nucleus, have no electrical charge and are slightly heavier than protons. They contribute to the atomic mass and play a key role in the stability of the nucleus by offsetting the repulsive forces between protons.

Electrons, on the other hand, are negatively charged particles that orbit the nucleus in energy levels or shells. They are much smaller and lighter than protons and neutrons. Electrons determine the chemical behavior of an atom, as they are involved in forming bonds with other atoms.

The number of electrons usually equals the number of protons in a neutral atom, balancing the overall charge. However, electrons can be lost or gained, forming ions with positive or negative charges.

2) Compare the concepts of Atomic Number, Atomic Mass, and Mass Number

The atomic number of an element is the number of protons in the nucleus of an atom, which uniquely identifies the element. It also determines the element's position on the Periodic Table and defines its chemical properties. For example, hydrogen has an atomic number of 1, meaning every hydrogen atom has one proton.

Atomic mass, often expressed in atomic mass units (amu), is the weighted average mass of an atom's isotopes, taking into account their relative abundances.

The mass number, on the other hand, is the total number of protons and neutrons in the nucleus of a specific isotope.

While the atomic number is always a whole number, the atomic mass is often a decimal due to the averaging of different isotopes. The mass number helps distinguish between different isotopes of an element, which have the same atomic number but different numbers of neutrons.

3) Explain the concepts: Periodic Table, Groups, Periods, Families?

The Periodic Table is a systematic arrangement of elements in order of increasing atomic number, which reveals the recurring or periodic trends in their properties. Elements are arranged in rows called periods and columns known as groups or families. Each period represents a new energy level for electrons, with elements in the same period having the same number of electron shells.

Groups are the vertical columns on the Periodic Table, and elements within a group share similar chemical properties due to having the same number of valence electrons. For example, all elements in Group 1, known as the alkali metals, are highly reactive and have one valence electron.

Families, a concept closely related to groups, means that the elements within a family have similar properties. Families are sometimes used interchangeably with groups but can also refer to categories of elements with similar properties, such as the noble gases or transition metals.

4) What happens when you move one step from left-to-right on the Periodic Table: Example: From Potassium(K) to Calcium (C) ?

When moving one step from left to right on the Periodic Table, such as from Potassium (K) to Calcium (Ca), the atomic number increases by one, meaning there is one more proton and one more electron in the atom. This results in an increase in the nuclear charge, pulling the electrons closer to the nucleus and generally leading to a decrease in atomic radius. As a result, the element on the right tends to be less reactive if we are comparing elements within the same period.

Additionally, the chemical properties change significantly as you move across a period. For instance, Potassium is a highly reactive alkali metal with one valence electron, while Calcium is an alkaline earth metal with two valence electrons. This difference in the number of valence electrons alters their reactivity and bonding characteristics, with Calcium forming more stable compounds than Potassium.

5) What happens when you move one step from top-to-bottom on the Periodic Table: Example: From Hydrogen(H) to Lithium(Li) ?

When moving one step from top to bottom on the Periodic Table, such as from Hydrogen (H) to Lithium (Li), the atomic number increases, adding one more proton, neutron, and electron to the atom. As a result, a new electron shell is added, increasing the atomic radius. This increase in size generally causes the atom to become less effective at attracting electrons, which can reduce electronegativity and ionization energy.

The chemical properties of elements also change as you move down a group. For example, Hydrogen and Lithium are both in Group 1, but Lithium is more metallic and has a lower ionization energy, making it more reactive than Hydrogen. This trend continues down the group, with elements becoming more reactive as their atomic size increases and their valence electrons are further from the nucleus.

6) What role do Neutrons play in maintaining the stability of the atom's nucleus?

Neutrons play a crucial role in maintaining the stability of an atom's nucleus. Since protons carry a positive charge, they naturally repel each other due to electrostatic forces. Neutrons, being neutral, help to mitigate this repulsion by providing an attractive force known as the strong nuclear force, which holds the nucleus together. Without neutrons, the repulsive forces between protons would likely cause the nucleus to break apart.

The ratio of neutrons to protons is key to the stability of the nucleus. For lighter elements, a roughly equal number of neutrons and protons results in a stable nucleus. However, as elements get heavier, more neutrons are needed to offset the increased repulsion among the greater number of protons. If an atom has too few or too many neutrons compared to protons, it can become unstable, leading to radioactive decay as the atom seeks a more stable state.

7) Compare the concepts of Electronegativity and Ionization Energy.

Electronegativity refers to an atom's ability to attract and hold onto electrons within a chemical bond. It is a measure of how strongly an atom can pull electrons towards itself in a covalent bond. Elements with high electronegativity, such as fluorine, are very effective at attracting electrons, which makes them more likely to form negative ions or to polarize bonds with other atoms.

Ionization energy, on the other hand, is the energy required to remove an electron from an atom or ion in its gaseous state. It reflects how strongly an atom's nucleus holds onto its valence electrons. The first ionization energy refers to the energy needed to remove the first electron, and it generally increases across a period as the nuclear charge increases.

While both electronegativity and ionization energy are related to how atoms interact with electrons, electronegativity focuses on attraction within bonds, while ionization energy deals with the energy required to remove an electron.

8) What are the (4) Periodic Trends that explain the relationship between elements on the Periodic Table?

The four key periodic trends that explain the relationships between elements on the Periodic Table are atomic radius, ionization energy, electronegativity, and electron affinity.

Atomic Radius: This is the distance from the nucleus to the outermost electron shell. Atomic radius decreases across a period due to the increasing nuclear charge, which pulls electrons closer to the nucleus. It increases down a group as additional electron shells are added, making the atom larger.

Ionization Energy: This trend refers to the energy required to remove an electron from an atom. Ionization energy generally increases across a period as the atoms are smaller and hold onto their electrons more tightly, and it decreases down a group as the outer electrons are farther from the nucleus and more easily removed.

Electronegativity: Electronegativity is a measure of an atom's ability to attract and hold onto electrons when it forms a chemical bond with another atom. It essentially reflects how strongly an atom can pull electrons towards itself in a covalent bond.

In the Periodic Table, electronegativity values increase as you move from left to right across a period because the atoms have a higher nuclear charge, meaning their positively charged nuclei exert a stronger pull on the bonding electrons. Electronegativity decreases as you move down a group because the atoms have more electron shells, which makes the outer electrons farther from the nucleus and less strongly attracted to it.

Elements with high electronegativity, such as fluorine, oxygen, and nitrogen, tend to attract electrons more strongly and are more likely to form polar bonds, where electrons are shared unequally. On the other hand, elements with low electronegativity, like the alkali metals (e.g., sodium and potassium), are more likely to lose electrons and form positive ions in chemical reactions.

Electron Affinity: This is the energy change when an electron is added to a neutral atom, reflecting how much an atom wants to gain an electron. Electron affinity generally becomes more negative across a period, meaning atoms are more eager to gain electrons, while it decreases down a group as the added electron would be farther from the nucleus and less tightly bound.

These trends help explain the chemical behavior and reactivity of elements, influencing how they interact with one another in chemical reactions.