

American Chemical Society (ACS) Chemistry Practice Exam (Sample)

Study Guide



Everything you need from our exam experts!

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SAMPLE

Questions

- 1. How would you determine the number of neutrons in an atom?**
 - A. Subtract the atomic number from the mass number**
 - B. Add the atomic number to the mass number**
 - C. Multiply the atomic number by the mass number**
 - D. Divide the mass number by the atomic number**
- 2. In a titration, which term refers to the solution being analyzed?**
 - A. Titrant**
 - B. Titrand**
 - C. Analyte**
 - D. Reagent**
- 3. P1V1 will always equal what if temperature and particle numbers are constant?**
 - A. P2V2**
 - B. P1V2**
 - C. P2V1**
 - D. P1+V1**
- 4. What primarily affects the vapor pressure of a liquid?**
 - A. Initial volume**
 - B. Concentration**
 - C. Temperature**
 - D. Density**
- 5. What describes the molecular geometry of a molecule with 5 electron domains, 2 bonding pairs, and 3 nonbonding pairs?**
 - A. T-shaped**
 - B. Linear**
 - C. Bent**
 - D. Trigonal bipyramidal**

- 6. What is the chemical formula for sulfuric acid?**
- A. HCl**
 - B. H₂SO₄**
 - C. HNO₃**
 - D. H₃PO₄**
- 7. When does a chemical bond form between two atoms?**
- A. When they are at a large distance from each other**
 - B. When their electron probabilities overlap**
 - C. When their atomic masses are equal**
 - D. When they possess different energy levels**
- 8. What does effective nuclear charge describe?**
- A. The total positive charge experienced by an electron**
 - B. The average distance between electrons and the nucleus**
 - C. The number of protons in the nucleus only**
 - D. The number of valence electrons in an atom**
- 9. What is the general solubility rule for sulfates (SO₄²⁻)?**
- A. Insoluble in all cases**
 - B. Soluble except in Sr²⁺, Hg²⁺, Ba²⁺, Pb²⁺, Ca²⁺**
 - C. Totally soluble**
 - D. Soluble only in acidic environments**
- 10. What is molecular weight defined as?**
- A. The density of a substance**
 - B. The sum of the mass of each element**
 - C. The mass of one mole of a substance**
 - D. The total number of atoms in a compound**

Answers

SAMPLE

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

SAMPLE

Explanations

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1. How would you determine the number of neutrons in an atom?

A. Subtract the atomic number from the mass number

B. Add the atomic number to the mass number

C. Multiply the atomic number by the mass number

D. Divide the mass number by the atomic number

To determine the number of neutrons in an atom, you start with two key pieces of information: the atomic number and the mass number. The atomic number represents the number of protons in the nucleus of an atom, while the mass number is the total number of protons and neutrons combined. By subtracting the atomic number (which tells you how many protons there are) from the mass number (the total count of protons and neutrons), you are left with the number of neutrons. This is because the mass number is composed of both protons and neutrons. Thus, the formula can be expressed as: $\text{Number of Neutrons} = \text{Mass Number} - \text{Atomic Number}$. This method provides an accurate count of neutrons, essential for understanding isotopes and various properties of elements. The other choices, while involving the atomic and mass numbers, do not yield the correct count of neutrons in an atom as they either combine the quantities incorrectly or do not relate to the neutrons directly.

2. In a titration, which term refers to the solution being analyzed?

A. Titrant

B. Titrand

C. Analyte

D. Reagent

In a titration, the solution being analyzed is referred to as the titrand. This term specifically denotes the substance in the reaction that is being measured to determine its concentration. During the process of titration, the titrand is combined with another solution, known as the titrant, which is added in a controlled manner to react with the titrand. The analyte is also a term often used interchangeably with titrand in certain contexts, but it encompasses any substance whose chemical constituents are being identified and measured, which can include multiple samples beyond what is typically involved in a titration setup. In addition, the reagent refers to a substance added to cause a chemical reaction or to assist in the analysis, but it is not specifically the solution whose concentration is being analyzed. Thus, the correct term for the solution being analyzed in the context of a titration is titrand, making it the right choice.

3. P_1V_1 will always equal what if temperature and particle numbers are constant?

A. P_2V_2

B. P_1V_2

C. P_2V_1

D. $P_1 + V_1$

In this scenario, the relationship illustrated is derived from the ideal gas law, which states that for a given amount of gas at constant temperature and number of particles, the product of pressure (P) and volume (V) remains constant. This relationship can be expressed mathematically as $P_1V_1 = P_2V_2$, known as Boyle's Law. When the temperature and the number of gas particles are held constant, any change in volume is inversely related to the change in pressure. Consequently, if the volume increases (V_2), the pressure must decrease (P_2) to maintain the equality. Likewise, if the volume decreases, the pressure increases. This direct relationship between pressure and volume under constant temperature conditions explains why P_1V_1 equals P_2V_2 , validating the choice. The other options do not reflect this direct relationship established by Boyle's Law. For instance, P_1V_2 or P_2V_1 fail to maintain the necessary balance as they do not imply the constant nature of the product of pressure and volume when one of them changes due to a corresponding change in the other. $P_1 + V_1$ does not relate to a product at all, further illustrating why the correct answer emphasizes the equality of the products in these

4. What primarily affects the vapor pressure of a liquid?

A. Initial volume

B. Concentration

C. Temperature

D. Density

Vapor pressure is fundamentally influenced by temperature because it is a measure of the tendency of a liquid to evaporate. As the temperature increases, the kinetic energy of the molecules in the liquid also increases. This higher kinetic energy allows more molecules to overcome intermolecular forces and transition into the gas phase, thereby increasing the vapor pressure. At elevated temperatures, more molecules have sufficient energy to escape into the vapor phase, resulting in a greater concentration of vapor above the liquid, which corresponds to a higher vapor pressure. Conversely, at lower temperatures, the kinetic energy of the molecules decreases, leading to a lower vapor pressure since fewer molecules can transition to the gas phase. Other factors like initial volume, concentration, and density might have indirect effects on the system, but they do not fundamentally determine the vapor pressure of a liquid. Initial volume or concentration could alter the amount of liquid present but do not change the inherent property of the liquid's vapor pressure. Density relates to mass per unit volume and also does not directly impact the vapor pressure as temperature does. Thus, temperature is the primary factor affecting vapor pressure in liquids.

5. What describes the molecular geometry of a molecule with 5 electron domains, 2 bonding pairs, and 3 nonbonding pairs?

A. T-shaped

B. Linear

C. Bent

D. Trigonal bipyramidal

The molecular geometry of a molecule with 5 electron domains, including 2 bonding pairs and 3 nonbonding pairs, is best described as T-shaped. When determining the molecular geometry, it is essential to consider both the bonding and nonbonding electron pairs. In this scenario, with 5 electron domains, the arrangement of those domains is fundamentally trigonal bipyramidal, a geometry characterized by 2 positions in a plane and 3 extending above and below that plane. However, since there are 3 nonbonding pairs, they will occupy the equatorial positions (the plane) due to their greater repulsive effect compared to bonding pairs. This forces the 2 bonding pairs into the axial positions of the trigonal bipyramidal structure. As a result, the overall shape of the molecule, taking into account the positions of the bonding pairs versus the nonbonding pairs, adopts a T shape. This arrangement effectively minimizes electron pair repulsion while allowing for the necessary angles between bonds. While the options contained may point toward different shapes, recognizing that the basic arrangement starts as trigonal bipyramidal is key to understanding how the presence of 3 nonbonding sets alters the geometry to T-shaped.

6. What is the chemical formula for sulfuric acid?

A. HCl

B. H₂SO₄

C. HNO₃

D. H₃PO₄

Sulfuric acid is a highly important and widely used chemical in various industrial processes, and its correct chemical formula is H₂SO₄. This formula indicates that one molecule of sulfuric acid is composed of two hydrogen atoms, one sulfur atom, and four oxygen atoms. Each element in the formula contributes to the properties and behavior of sulfuric acid. The presence of sulfur in the formula relates to its classification as a strong acid due to sulfur's capability to release protons (H⁺ ions) in solution, which is characteristic of acids. The oxygen atoms are involved in the formation of sulfate ions when sulfuric acid dissociates in solution, further ensuring its strong acidic properties. In contrast, the other chemical formulas provided correspond to different acids: HCl is hydrochloric acid, HNO₃ is nitric acid, and H₃PO₄ is phosphoric acid. Although all are acids, their chemical structures and properties vary significantly from that of sulfuric acid.

7. When does a chemical bond form between two atoms?

- A. When they are at a large distance from each other
- B. When their electron probabilities overlap**
- C. When their atomic masses are equal
- D. When they possess different energy levels

A chemical bond forms between two atoms primarily when their electron probabilities overlap. This overlap allows for the sharing or transfer of electrons, which is the fundamental mechanism behind the formation of covalent and ionic bonds. In a covalent bond, for example, two atoms may share one or more pairs of electrons, leading to stability as both atoms achieve a more energetically favorable electron configuration. The overlap of electron probabilities plays a crucial role in the lower potential energy of the bonded atoms compared to their energy when they are separate. This interaction essentially creates a strong attractive force that holds the two atoms together, thereby forming a stable chemical bond. In contrast, the other options do not accurately describe the conditions necessary for bond formation. When atoms are at a large distance from each other, they tend to exist as separate entities with no significant interaction. The equality of atomic masses does not impact the bond formation directly, as bonding is more related to electronic configuration rather than mass. Lastly, the possession of different energy levels alone does not lead to the bonding of atoms; rather, it is the interaction of their electron clouds that plays a critical role.

8. What does effective nuclear charge describe?

- A. The total positive charge experienced by an electron**
- B. The average distance between electrons and the nucleus
- C. The number of protons in the nucleus only
- D. The number of valence electrons in an atom

Effective nuclear charge refers to the net positive charge that an electron experiences from the nucleus of an atom, taking into account the shielding effect caused by other electrons. This concept is crucial in understanding various atomic properties, such as atomic size, ionization energy, and electron affinity. In an atom, the positively charged protons in the nucleus attract negatively charged electrons. However, inner electrons partially shield outer electrons from this nuclear charge. This results in outer electrons experiencing a reduced charge, referred to as the effective nuclear charge. The effective nuclear charge can be approximated by the formula $Z_{\text{eff}} = Z - S$, where Z is the total number of protons (the atomic number), and S is the shielding constant, representing the extent to which other electrons shield the outer electron from the full nuclear charge. Understanding effective nuclear charge helps explain why elements display periodic trends in properties, as it affects how tightly electrons are held by the nucleus and their overall interactions within the atom.

9. What is the general solubility rule for sulfates (SO_4^{2-})?

A. Insoluble in all cases

B. Soluble except in Sr^{2+} , Hg^{2+} , Ba^{2+} , Pb^{2+} , Ca^{2+}

C. Totally soluble

D. Soluble only in acidic environments

The general solubility rule for sulfates (SO_4^{2-}) states that most sulfates are soluble in water, with certain exceptions. The correct choice highlights that sulfates are soluble except in the presence of specific cations such as strontium (Sr^{2+}), mercury (Hg^{2+}), barium (Ba^{2+}), lead (Pb^{2+}), and calcium (Ca^{2+}). These exceptions arise because these particular cations form sulfates that are significantly less soluble in water due to their relatively higher lattice energies compared to the solvation energy gained when they dissolve. For instance, the sulfate salts of barium and lead are known to precipitate out of solution due to this decreased solubility. This makes option B an accurate reflection of the solubility behavior of sulfates in relation to specific ions. In contrast, sulfates are generally considered soluble when combined with alkali metals (like sodium and potassium) and with ammonium (NH_4^+), establishing the broader pattern of solubility that option B encompasses.

10. What is molecular weight defined as?

A. The density of a substance

B. The sum of the mass of each element

C. The mass of one mole of a substance

D. The total number of atoms in a compound

Molecular weight is defined as the sum of the mass of each element in a molecule, taking into account the number of atoms of each element present. This means that to determine the molecular weight, you would calculate the individual atomic masses of all the elements in the molecular formula and then sum them together. For example, in a water molecule (H_2O), you would sum the mass of two hydrogen atoms and one oxygen atom to find the molecular weight. Identifying the molecular weight is essential in chemistry as it helps in determining the amount of substance in moles when dealing with chemical reactions and solutions. Understanding this concept also forms the basis for stoichiometry, facilitating accurate measurements and calculations in various chemical processes.