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

Study Guide

Everything you need from our exam experts!

Questions

1. **Who discovered the nucleus of the atom?**
   - A. Thompson
   - B. Rutherford
   - C. Dalton
   - D. Bohr

2. **What is the main gas law equation?**
   - A. P = nRT
   - B. P + V = nRT
   - C. PV = nRT
   - D. PV = nRT^2

3. **What does it indicate when an element has low ionization energy?**
   - A. It easily gains electrons
   - B. It can easily lose electrons
   - C. It forms strong bonds
   - D. It is highly electronegative

4. **How many valence electrons does hydrogen possess?**
   - A. 1
   - B. 2
   - C. 3
   - D. 4

5. **What is the shape of a molecule with 6 electron domains?**
   - A. Tetrahedral
   - B. Trigonal bipyramidal
   - C. Octahedral
   - D. Linear

6. **How is weight defined?**
   - A. Mass of an object
   - B. Measure of force of gravity on an object
   - C. Volume of an object
   - D. Density of an object

7. What is the equilibrium reaction represented by the equation: A + B ↔ C + D, if more A is added?

A. The reaction will favor products

B. The reaction will favor reactants

C. The reaction will remain unchanged

D. The reaction will shift to the right

8. Which factors affect the solubility of a compound?

A. Only temperature

B. Temperature and pressure

C. Temperature, pressure, and the presence of other solutes

D. Only the nature of the solute

9. A high vapor pressure indicates what regarding a substance's boiling point?

A. Higher boiling point

B. Lower boiling point

C. Stable boiling point

D. Variable boiling point

10. In a chemical equilibrium reaction, what happens if SO3 is removed from the system?

A. The concentration of SO2 increases

B. The concentration of O2 increases

C. The concentration of SO2 decreases more than O2

D. The reaction completely shifts left

Answers

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

Explanations

1. Who discovered the nucleus of the atom?

A. Thompson

B. Rutherford

C. Dalton

D. Bohr

The nucleus of the atom was discovered by Ernest Rutherford through his famous gold foil experiment conducted in 1909. In this experiment, Rutherford directed a beam of alpha particles at a very thin gold foil and observed that while most particles passed through the foil, some were deflected at large angles. This unexpected behavior indicated that there was a small, dense region within the atom that could repel the positively charged alpha particles, leading to the conclusion that this region was the nucleus. This landmark experiment revolutionized the understanding of atomic structure by suggesting that atoms are mostly empty space with a tiny, dense nucleus at the center, which contains positively charged protons (and later discovered neutrons). The discovery of the nucleus was a pivotal moment in modern atomic theory, distinguishing Rutherford's model of the atom from earlier models that could not explain the observed results of the experiment. Other scientists like Thomson, Dalton, and Bohr contributed significantly to atomic theory, but it was Rutherford's work that specifically identified the location and existence of the nucleus.

2. What is the main gas law equation?

A. P = nRT

B. P + V = nRT

C. PV = nRT

D. PV = nRT^2

The main gas law equation is expressed as PV = nRT. This equation is known as the ideal gas law and describes the relationship between pressure (P), volume (V), the number of moles of gas (n), the ideal gas constant (R), and temperature (T) in Kelvin. In this equation, each term plays a significant role: - P represents the pressure of the gas, indicating how much force the gas particles exert on the walls of their container. - V represents the volume of the gas, which refers to the space the gas occupies. - n is the number of moles, a measure of the amount of substance present in the sample. - R is the ideal gas constant, which interrelates the units for pressure, volume, temperature, and amount of gas. - T is the temperature of the gas in Kelvin, which reflects the average kinetic energy of the gas particles. This equation is foundational in the study of gases because it links all the crucial properties together, allowing scientists and chemists to predict the behavior of gases under varying conditions. It applies specifically to ideal gases, which behave according to the assumptions of the kinetic molecular theory. The other choices do not accurately represent the ideal gas law. For example, the

3. What does it indicate when an element has low ionization energy?

A. It easily gains electrons

B. It can easily lose electrons

C. It forms strong bonds

D. It is highly electronegative

When an element has low ionization energy, it means that it requires relatively little energy to remove an electron from an atom in its gaseous state. This characteristic indicates that the element can easily lose electrons, which is typically a property of metals. Metals tend to have low ionization energies because their outermost electrons are not held tightly by the nucleus, allowing them to be removed more easily. As a result, these elements can readily participate in chemical reactions, often forming cations by losing one or more electrons. In contrast, elements with high ionization energies are more likely to hold onto their electrons, suggesting a tendency to gain electrons rather than lose them. The other choices refer to different behaviors or properties of elements that do not correlate directly with low ionization energy; for example, easily gaining electrons relates more to nonmetals and their affinities, while electronegativity concerns an atom's ability to attract electrons in chemical bonds, both of which are not indicative of low ionization energy.

4. How many valence electrons does hydrogen possess?

A. 1

B. 2

C. 3

D. 4

Hydrogen possesses one valence electron. This is because hydrogen is located in Group 1 of the periodic table, where elements typically have one valence electron in their outermost shell. As the simplest element, hydrogen consists of a single proton and a single electron. This single electron is the only one available for bonding and chemical interactions, making it a crucial component in many chemical reactions. When determining the number of valence electrons in an element, it is important to consider its position in the periodic table. Hydrogen's electron configuration is $1s^1$, indicating that it has one electron in the first principal energy level. Since only this single electron is involved in bonding, it serves as hydrogen's only valence electron, contrasting with other options that suggest it has more than one valence electron.

5. What is the shape of a molecule with 6 electron domains?

A. Tetrahedral

B. Trigonal bipyramidal

C. Octahedral

D. Linear

In molecular geometry, the shape of a molecule is determined by the arrangement of its electron domains around a central atom. When there are six electron domains, whether they are bonding pairs or lone pairs, the molecular shape adopts an octahedral configuration. In an octahedral shape, the six electron domains are arranged in such a way that they maximize their distance from one another to minimize repulsion, which is a fundamental principle based on VSEPR (Valence Shell Electron Pair Repulsion) theory. In this arrangement, the electron domains occupy the vertices of an octahedron. This results in bond angles of 90 degrees between adjacent pairs of bonds. Tetrahedral and trigonal bipyramidal configurations apply to four and five electron domains, respectively, while a linear shape pertains to a scenario with only two electron domains. Therefore, with six electron domains, the appropriate shape is indeed octahedral.

6. How is weight defined?

A. Mass of an object

B. Measure of force of gravity on an object

C. Volume of an object

D. Density of an object

Weight is fundamentally defined as the measure of the gravitational force exerted on an object. It is influenced by both the mass of the object and the gravitational acceleration acting on it, which varies depending on the location (for example, weight will differ on the Moon compared to Earth due to the difference in gravitational pull). While mass reflects the amount of matter in an object and is constant regardless of location, weight varies based on the gravitational field strength. As such, the correct interpretation focuses on the interaction between an object's mass and the gravitational force acting upon it, which defines its weight. This distinction highlights the relational aspect of weight compared to other physical properties like volume or density, which do not account for gravitational influence.

7. What is the equilibrium reaction represented by the equation: A + B ↔ C + D, if more A is added?

A. The reaction will favor products

B. The reaction will favor reactants

C. The reaction will remain unchanged

D. The reaction will shift to the right

When more A is added to the equilibrium reaction A + B ↔ C + D, the system experiences a disturbance. According to Le Chatelier's principle, when a change is made to a system at equilibrium, the system will adjust to counteract that change and restore a new equilibrium state. By adding more of the reactant A, the reaction will shift in the direction that consumes A in order to reduce its concentration. This shift will favor the formation of products, which in this case are C and D. Therefore, the reaction moves to the right, resulting in an increase in the concentrations of C and D while decreasing the concentration of A and B until a new equilibrium is established. This explanation highlights the underlying principle of Le Chatelier's, showing how addition of a reactant influences the equilibrium position.

8. Which factors affect the solubility of a compound?

A. Only temperature

B. Temperature and pressure

C. Temperature, pressure, and the presence of other solutes

D. Only the nature of the solute

The solubility of a compound is influenced by multiple factors, making the combination of temperature, pressure, and the presence of other solutes significant in determining how well a substance will dissolve in a solvent. Temperature plays a crucial role; for many solid solutes, solubility increases with temperature, while for gases, solubility typically decreases as temperature rises. This is due to increased kinetic energy, which can lead molecules to escape from the liquid into the gas phase. Pressure primarily affects the solubility of gases. According to Henry's Law, the solubility of a gas in a liquid is directly proportional to the pressure of that gas above the liquid. Higher pressure increases the number of gas molecules that can be dissolved in the solvent. The presence of other solutes can also have a significant impact on solubility. This phenomenon, known as the common ion effect, occurs when a solute is introduced to a solution that already contains a component that is also part of the solute's equilibrium, thereby shifting the equilibrium and reducing solubility. Additionally, interactions between different solutes, as well as changes in solvent properties, can further influence how readily a compound will dissolve. Taking these factors into account helps to understand the

9. A high vapor pressure indicates what regarding a substance's boiling point?

A. Higher boiling point

B. Lower boiling point

C. Stable boiling point

D. Variable boiling point

A high vapor pressure indicates that a substance readily vaporizes, which correlates to a lower boiling point. This is because substances with high vapor pressures have a greater tendency to escape from the liquid phase into the gas phase at lower temperatures. As the temperature rises, the kinetic energy of the molecules increases, and once the vapor pressure equals the atmospheric pressure, the substance will boil. Therefore, if a substance has a high vapor pressure at a given temperature, it means that it can reach this crucial point of equal pressure at a lower temperature compared to substances with lower vapor pressures, which require more heat to reach their boiling point. Consequently, a substance with high vapor pressure will boil at lower temperatures, leading to the conclusion that a high vapor pressure corresponds to a lower boiling point.

10. In a chemical equilibrium reaction, what happens if SO3 is removed from the system?

A. The concentration of SO2 increases

B. The concentration of O2 increases

C. The concentration of SO2 decreases more than O2

D. The reaction completely shifts left

In a chemical equilibrium, the system strives to maintain a balance between the reactants and products. When a component, such as SO3, is removed from the system, the equilibrium position will shift in a direction that counteracts the change according to Le Chatelier's principle. By removing SO3, the system responds by shifting the equilibrium to the left, which is the direction that produces more SO3 from the available SO2 and O2. This shift will lead to an increase in the concentration of both SO2 and O2, as both are reactants in the reverse reaction. The concentration of SO2 will indeed increase as more of it reacts with O2 to form SO3. However, the phrasing of the correct answer highlights that the concentration of SO2 specifically increases more than that of O2. This can occur because, depending on the stoichiometry of the reaction, the molar ratios of the substances being consumed or produced may vary, leading to a disproportionate increase in one compared to the other. Thus, the response reflects the adjustment of the system towards re-establishing equilibrium after the removal of SO3. In a scenario where SO2 and O2 are utilized in a way that drives the forward reaction, the