Texas A&M University (TAMU) CHEM107 General Chemistry for Engineering Students Exam 2 Practice (Sample)

Study Guide

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Questions

1. Under which conditions are gases considered ideal?

   A. High pressure and low temperature

   B. High temperature and low pressure

   C. Low temperature and high pressure

   D. Standard temperature and low pressure

2. What describes the process of dilution?

   A. Concentrating a solute by removing solvent

   B. Reducing the concentration of a solute by adding more solvent

   C. Increasing the temperature of a solution to dissolve more solute

   D. Mixing two solutions of equal concentration

3. What is the formula for calculating energy using wavelength?

   A. E = h * c / wavelength

   B. E = mc^2

   C. E = k * T

   D. E = PV

4. How are gas particles generally spaced?

   A. Close together

   B. Far apart

   C. Randomly organized

   D. Evenly distributed

5. Which trends are observed when moving toward the top right of the periodic table?

   A. Atomic Radii and Ionic Radii

   B. Ionization Energy, Electronegativity, Electron Affinity

   C. Mass Number and Density

   D. Melting Point and Boiling Point

6. What is resonance in chemistry?

A. A process that leads to the formation of ions

B. A phenomenon where a molecule can be represented by two or more valid Lewis structures

C. A type of chemical reaction involving electron transfer

D. A measurement of how a molecule absorbs light

7. A large negative electron affinity value indicates what tendency in an element?

A. More likely to form cations

B. More likely to form anions

C. Less likely to gain electrons

D. Equal likelihood of forming cations or anions

8. Which type of photon transition corresponds to the longest wavelength?

A. Highest energy

B. Lowest energy

C. Intermediate energy

D. Variable energy

9. How does the concept of limiting reactants affect product yield?

A. It decreases the total mass of reactants used.

B. It precludes the formation of any products.

C. It determines the maximum amount of product that can be formed.

D. It affects the temperature of the reaction.

10. According to Charles's law, what is the relationship between gas volume and temperature?

A. Volume is inversely proportional to temperature

B. Volume is directly proportional to temperature at constant pressure

C. Temperature is irrelevant to volume

D. Volume increases as temperature decreases

Answers

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

Explanations

1. Under which conditions are gases considered ideal?

A. High pressure and low temperature

B. High temperature and low pressure

C. Low temperature and high pressure

D. Standard temperature and low pressure

Gases are considered ideal when they behave according to the ideal gas law, which assumes that the gas molecules do not interact with each other and occupy no volume. This ideal behavior is most closely approximated under conditions of high temperature and low pressure. At high temperatures, the kinetic energy of the gas particles increases, which causes them to move more rapidly and reduces the effect of intermolecular forces. As temperature increases, gas molecules are less likely to condense into a liquid or experience attraction or repulsion from one another, aligning with the assumption of ideal gas behavior that their interactions are negligible. Additionally, at low pressures, gas particles are spaced far enough apart that their volumes contribute very little to the overall behavior of the gas. The particles are less likely to collide with each other, and the effects of their physical size can be ignored, further supporting ideal gas assumptions. In contrast, at low temperatures and high pressures, gases deviate from ideal behavior due to significant intermolecular attractions and the volume of the gas particles themselves becoming significant in comparison to the space they occupy. Thus, the combination of high temperature and low pressure creates the conditions under which gases behave most ideally.

2. What describes the process of dilution?

A. Concentrating a solute by removing solvent

B. Reducing the concentration of a solute by adding more solvent

C. Increasing the temperature of a solution to dissolve more solute

D. Mixing two solutions of equal concentration

The process of dilution is best described by the reduction of the concentration of a solute through the addition of more solvent. When a solvent is added to a solution, the solute particles become dispersed in a larger volume of liquid. This results in a lower concentration of solute per unit of volume since the number of solute particles remains unchanged, while the total volume of the solution increases. In practical terms, if you start with a solution of a certain concentration and you add solvent, you're effectively reducing the amount of solute in each unit of volume, which can be quantified using the dilution equation: M1V1 = M2V2. Here, M represents molarity and V represents volume, demonstrating how the initial and final concentrations relate based on their respective volumes. This concept is fundamental in chemistry because it governs how solutions are prepared for various applications, including titrations and standardization of solutions.

3. What is the formula for calculating energy using wavelength?

A. E = h * c / wavelength

B. E = mc^2

C. E = k * T

D. E = PV

The formula for calculating energy using wavelength is derived from the relationship between energy, wavelength, and the constants that describe electromagnetic radiation. In option A, the formula \(E = \frac{h \cdot c}{\text{wavelength}} \) successfully captures this relationship, where \(E \) represents energy, \(h \) is Planck's constant (\(6.626 \times 10^{-34} \, \text{J s} \)), and \(c \) is the speed of light in a vacuum (\(3.00 \times 10^8 \, \text{m/s} \)). This equation arises from the understanding that energy can also be expressed in a wave context. More specifically, the energy of a photon is inversely proportional to its wavelength—shorter wavelengths correspond to higher energy photons, and vice versa. This is fundamental in fields such as quantum mechanics and photonics. Other options represent different physical relationships. For instance, \(E = mc^2 \) is Einstein's mass-energy equivalence formula, applicable in nuclear physics rather than for photon energy. The formula \(E = kT \) relates energy to temperature in statistical mechanics, specifically for particles in a

4. How are gas particles generally spaced?

A. Close together

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Gas particles are generally spaced far apart compared to liquids and solids. This is primarily due to the significant amount of energy they possess, which allows them to overcome intermolecular forces that would otherwise hold the particles closer together. In a gaseous state, particles are in constant motion and they have high kinetic energy. This spacing leads to the properties of gases, such as their ability to expand to fill the shape and volume of their container. The large distances between gas particles also explain why gases are compressible—when external pressure is applied, the particles can be pushed closer together. While gases do exhibit randomness in their motion and can occupy any volume available to them, the primary aspect distinguishing gas behavior is their far spacing relative to each other, influenced by their kinetic energy and the nature of their intermolecular interactions.

5. Which trends are observed when moving toward the top right of the periodic table?

   A. Atomic Radii and Ionic Radii

   B. Ionization Energy, Electronegativity, Electron Affinity

   C. Mass Number and Density

   D. Melting Point and Boiling Point

When moving toward the top right of the periodic table, the trends observed include an increase in ionization energy, electronegativity, and electron affinity. Ionization energy refers to the energy required to remove an electron from an atom or ion in its gaseous state. As you move to the right across a period, elements have a greater positive charge in the nucleus due to an increase in protons, which more strongly attracts the electrons. Thus, it requires more energy to remove an electron, leading to higher ionization energies. Electronegativity is the tendency of an atom to attract electrons in a chemical bond. Similar to ionization energy, electronegativity increases as one moves to the right in the periodic table because of the increasing nuclear charge, resulting in a stronger attraction to bonding electrons. Electron affinity, which is the energy change that occurs when an electron is added to a neutral atom, also shows a trend of increasing values as you move right and up the periodic table. This increase is due to the atoms' desire to achieve a full valence shell and the effective nuclear charge that makes gaining an electron more energetically favorable. The other choices focus on trends that do not consistently increase as one moves towards the top right of the

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   B. A phenomenon where a molecule can be represented by two or more valid Lewis structures

   C. A type of chemical reaction involving electron transfer

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Resonance in chemistry refers to a phenomenon where a molecule can be represented by two or more valid Lewis structures, known as resonance structures or contributing structures. These different structures depict the same arrangement of atoms but vary in the distribution of electrons, particularly the placement of double bonds and lone pairs. The actual structure of the molecule is a resonance hybrid, which is a weighted average of all the contributing Lewis structures. Resonance is significant because it helps to explain the stability and properties of molecules. For instance, compounds with resonance tend to have delocalized electrons, which can lead to lower energy states and increased stability compared to any single resonance structure. This concept is critical in understanding the behavior and reactivity of organic molecules, as well as the concept of hybridization and aromaticity. For example, in benzene, the molecule can be represented by two resonance structures that depict alternating double bonds. However, the actual molecule does not switch between these structures but exists as a hybrid, where the electrons are delocalized around the entire ring, contributing to its unique stability and reactivity. This understanding of resonance is essential for predicting chemical behavior and properties in more complex molecular systems.

7. A large negative electron affinity value indicates what tendency in an element?

A. More likely to form cations

B. More likely to form anions

C. Less likely to gain electrons

D. Equal likelihood of forming cations or anions

A large negative electron affinity value indicates that an element has a strong tendency to gain electrons. This value reflects the energy change that occurs when an electron is added to a neutral atom in the gas phase. When the electron affinity is large and negative, it means that the process of adding an electron releases a significant amount of energy, which is thermodynamically favorable. Elements with a strong electron affinity are typically nonmetals, especially those in the upper right portion of the periodic table, like the halogens. These elements tend to gain electrons during chemical reactions, resulting in the formation of negatively charged ions (anions). The greater the negative value of the electron affinity, the more likely the element will attract and hold onto an additional electron. Other options consider behaviors that are not aligned with the properties associated with large negative electron affinities. For instance, an element that forms cations typically has a lower tendency to gain electrons, as it tends to lose them instead.

8. Which type of photon transition corresponds to the longest wavelength?

A. Highest energy

B. Lowest energy

C. Intermediate energy

D. Variable energy

The transition that corresponds to the longest wavelength is associated with the lowest energy photon. Wavelength and energy are inversely related through the equation $E = \frac{hc}{\lambda}$, where E is the energy of the photon, h is Planck's constant, c is the speed of light, and λ is the wavelength. When energy decreases, the wavelength increases; thus, the lowest energy transition will yield the longest wavelength. This principle follows the fundamental relationship that as one property (wavelength) increases, the other property (energy) must decrease to maintain a constant value, as represented in the equation. In the context of photon transitions, if a system undergoes a transition that involves the lowest energy level, the emitted or absorbed photon will have a longer wavelength compared to transitions involving higher energy levels. Therefore, the answer identifying the lowest energy transition as that which corresponds to the longest wavelength is fundamentally based on the principles of photon energy and wavelength relationship.

9. How does the concept of limiting reactants affect product yield?

A. It decreases the total mass of reactants used.

B. It precludes the formation of any products.

C. It determines the maximum amount of product that can be formed.

D. It affects the temperature of the reaction.

The concept of limiting reactants is crucial in stoichiometry, as it identifies the reactant that will be consumed first in a chemical reaction, thereby limiting the amount of product that can be formed. When a reaction takes place, all reactants do not always react in equal proportions according to their stoichiometric coefficients. The limiting reactant is the substance that runs out first, causing the reaction to stop, which ultimately determines the maximum yield of products that can be obtained based on the amount of that limiting reactant. To illustrate, consider a reaction where A and B produce C. If you start with more of A than B, and B is fully consumed first, the amount of product C that can be produced is limited by the quantity of B. Therefore, even if A is present in excess, the total amount of product is constrained by the amount of B used. Understanding limiting reactants helps predict the efficiency of reactions in industrial and laboratory settings, as managing these reactants can optimize yield and reduce waste. The correct answer fundamentally highlights how limiting reactants are central to determining the theoretical yield in a chemical reaction, guiding chemists in calculating expected product amounts from given reactant quantities.

10. According to Charles's law, what is the relationship between gas volume and temperature?

A. Volume is inversely proportional to temperature

B. Volume is directly proportional to temperature at constant pressure

C. Temperature is irrelevant to volume

D. Volume increases as temperature decreases

Charles's law states that the volume of a gas is directly proportional to its absolute temperature when the pressure is held constant. This means that as the temperature of a gas increases, its volume also increases, provided the pressure does not change. Mathematically, this relationship can be expressed as $V/T = k$, where V represents volume, T represents absolute temperature (in Kelvin), and k is a constant. When you heat a gas, the kinetic energy of the gas molecules increases, causing them to move more rapidly and collide with the walls of the container more forcefully. This increased kinetic activity results in an expansion of the gas, leading to a greater volume. Conversely, if the temperature decreases, the kinetic energy and hence the volume diminishes. This understanding highlights why the other options do not accurately represent Charles's law. They either suggest incorrect relationships or misinterpret the role of temperature in relation to gas volume. Thus, option B correctly encapsulates the essence of Charles's law, emphasizing the direct proportionality between volume and temperature under constant pressure conditions.