

Advanced Chemistry Assessment

Chemistry · Answer Key · 25 Questions

1. What is the hybridization state of the central carbon atom in a molecule of carbon dioxide (CO₂)?

- A) sp³
- B) sp²
- C) sp**
- D) dsp²

2. Which of the following describes the entropy change (ΔS) for the process of water freezing into ice at -10°C?

- A) $\Delta S > 0$
- B) $\Delta S < 0$**
- C) $\Delta S = 0$
- D) ΔS is undefined

3. According to the Arrhenius equation, what happens to the rate constant (k) as the activation energy (E_a) increases at a constant temperature?

- A) It increases exponentially
- B) It remains constant
- C) It decreases exponentially**
- D) It increases linearly

4. In an electrochemical cell, which electrode is defined as the site of oxidation?

- A) The cathode
- B) The anode**
- C) The salt bridge
- D) The external circuit

5. Which molecular geometry is associated with an AX₄E₂ electron domain geometry according to VSEPR theory?

- A) Tetrahedral
- B) Square planar**
- C) See-saw
- D) T-shaped

6. What is the formal charge of the oxygen atom in the hydronium ion (H₃O⁺)?

- A) -1
- B) 0
- C) +1**
- D) +2

7. Which radiation type has the highest penetrating power through matter?

- A) Alpha particles
- B) Beta particles
- C) Gamma rays**
- D) Positrons

8. In a first-order reaction, what does a plot of $\ln[\text{reactant}]$ versus time produce?

- A) A curve with a positive slope
- B) A straight line with a negative slope**
- C) A straight line with a positive slope
- D) A hyperbola

9. Which element has the highest electronegativity according to the Pauling scale?

- A) Oxygen
- B) Fluorine**
- C) Chlorine
- D) Nitrogen

10. What is the conjugate base of the dihydrogen phosphate ion (H_2PO_4^-)?

- A) H_3PO_4
- B) HPO_4^{2-}**
- C) PO_4^{3-}
- D) H_2PO_4^-

11. Which law states that the total pressure of a mixture of gases is equal to the sum of the partial pressures of the individual gases?

- A) Boyle's Law
- B) Charles's Law
- C) Dalton's Law**
- D) Henry's Law

12. What is the oxidation state of manganese in the permanganate ion (MnO_4^-)?

- A) +2
- B) +4
- C) +6
- D) +7**

13. Which crystal system is characterized by three unequal axes at right angles ($a \neq b \neq c, \alpha = \beta = \gamma = 90^\circ$)?

- A) Cubic
- B) Tetragonal
- C) Orthorhombic**
- D) Triclinic

14. Which spectroscopic technique is primarily used to determine the functional groups present in an organic molecule?

- A) Mass spectrometry
- B) Infrared (IR) spectroscopy**
- C) NMR spectroscopy
- D) UV-Vis spectroscopy

15. How many d-orbitals are contained within a single d-subshell?

- A) 1
- B) 3
- C) 5**
- D) 7

16. What is the bond order of the nitrogen molecule (N_2) based on molecular orbital theory?

- A) 1
- B) 2
- C) 3**
- D) 4

17. Which thermodynamic property is a state function?

- A) Work
- B) Heat
- C) Enthalpy**
- D) Power

18. What happens to the solubility of a gas in a liquid as the temperature increases?

- A) It increases
- B) It decreases**
- C) It remains constant
- D) It fluctuates unpredictably

19. Which type of intermolecular force is primarily responsible for the high boiling point of water?

- A) London dispersion forces
- B) Dipole-dipole interactions
- C) Hydrogen bonding**
- D) Ionic bonding

20. What is the molar volume of an ideal gas at Standard Temperature and Pressure (STP, 0°C and 1 atm)?

- A) 22.4 L**
- B) 24.8 L
- C) 10.0 L
- D) 27.3 L

21. Which quantum number describes the orientation of an orbital in space?

- A) Principal
- B) Angular momentum
- C) Magnetic**
- D) Spin

22. In a buffer solution, which components are present to resist changes in pH?

- A) A strong acid and its salt
- B) A weak base and its salt
- C) A weak acid and its conjugate base**
- D) A strong acid and a strong base

23. Which law states that the rate of effusion of a gas is inversely proportional to the square root of its molar mass?

- A) Graham's Law**
- B) Gay-Lussac's Law
- C) Raoult's Law
- D) Nernst's Law

24. What is the maximum number of electrons that can occupy the 4f subshell?

- A) 6
- B) 10
- C) 14**
- D) 18

25. Which organic compound is the simplest alkene?

A) Methane

B) Ethene

C) Ethyne

D) Propene