

單一選擇題，共 40 題，每題 2.5 分，共 100 分，答錯不倒扣。請在答案卷上作答。

- Which one is related to the Rutherford's scattering experiment :
(a) e/m ratio (1.76×10^{11} C/Kg), (b) electronic charge (1.60×10^{-19} C), (c) nuclear model of the atom, (d) electronic mass (9.11×10^{-31} Kg), (e) finding the existence of an electron.
- Calculate the solubility of Ag_2CrO_4 [$K_{sp} = 9.0 \times 10^{-12}$] in a 1.0×10^{-2} M AgNO_3 solution.
(a) 1.3×10^{-4} mol/L, (b) 2.3×10^{-8} mol/L, (c) 9.0×10^{-8} mol/L, (d) 9.0×10^{-10} mol/L, (e) none is correct.
- Which of the following is a part of Dalton's atomic theory ?
(a) atoms are rearranged but not changed during a chemical reaction,
(b) atoms break down during radioactive decay,
(c) atoms contain protons, neutrons, and electrons,
(d) isotopes of the same element have different masses.
(e) none is correct.
- A compound responsible for the odor of garlic has a molecular weight of 146 g/mol. A 0.650 g sample of the compound contains 0.321 g of carbon, 0.044 g of hydrogen, and 0.285 g of sulfur. What is the molecular formula of the compound ?
(a) CH_5S , (b) $\text{C}_3\text{H}_5\text{S}$, (c) $\text{C}_3\text{H}_{14}\text{S}_3$, (d) $\text{C}_6\text{H}_{10}\text{S}_2$, (e) none is correct.
- Mendeleev arranged the elements according to
(a) atomic number and atomic weight,
(b) atomic weight and chemical reactivity,
(c) electron configuration and atomic weight,
(d) physical state and relative abundance,
(e) none is correct.
- The greater the electronegativity difference between two bonded atoms, the
(a) greater the bond order,
(b) greater the covalent character of the bond,
(c) greater the ionic character of the bond,
(d) more unstable the bond,
(e) none is correct.
- Which one is Boyle's law,
(a) $V = bT$ (at constant P & n), (b) $V = an$ (at constant T & P), (c) $V = k/P$ (at constant T & n), (d) none is true, (e) none is correct.
- The hybridization of the central atom in XeF_5^+ is :
(a) sp , (b) sp^2 , (c) sp^3 , (d) dsp^3 , (e) d^2sp^3 .
- What hybridization is predicted for the nitrogen atom in the NO_3^- ion ?
(a) sp^2 , (b) sp^3 , (c) sp^3d , (d) sp^3d^2 , (e) none is correct.
- Which conditions of P (pressure), T (temperature), and n (mole), respectively, are most ideal ?
(a) high P, high T, high n, (b) low P, low T, low n, (c) high P, low T, high n, (d) low P, high T, high n, (e) low P, high T, low n.

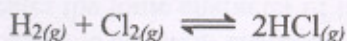
11. It is found that 250. mL of gas at STP has a mass of 1.00 g. What is the molar mass ?

- (a) 89.6 g/mol, (b) 28.0 g/mol, (c) 14.0 g/mol, (d) 22.4 g/mol, (e) none of these.

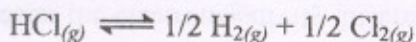
12. When 0.72 g of a liquid is vaporized at 110°C and 0.967 atm, the gas occupies a volume of 0.559 L. The empirical formula of the gas is CH₂. What is the molecular formula of the gas ?

- (a) CH₂, (b) C₂H₄, (c) C₃H₆, (d) C₄H₈, (e) none is correct.

13. If, at a given temperature, the equilibrium constant for the reaction



is K_p , then the equilibrium constant for the reaction can be represented as:

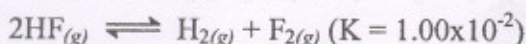


- (a) $\frac{1}{K_p^2}$, (b) K_p^2 , (c) $\frac{1}{\sqrt{K_p}}$, (d) $\sqrt{K_p}$, (e) none is correct.

14. The reaction quotient for a system is 7.2×10^2 . If the equilibrium constant for the system is 36, what will happen as equilibrium is approached ?

- (a) There will be a net gain in product, (b) there will be a net gain in reactant, (c) there will be a net gain in both product and reactant, (d) there will be no net gain in either product or reactant, (e) the equilibrium constant will decrease until it equals the reaction quotient.

15. Consider the following reaction:



Given 1.00 mole of HF_(g), 0.500 mole of H_{2(g)}, and 0.750 mole of F_{2(g)} are mixed in a 5.00-L flask, determine the reaction quotient, Q, and the net direction to achieve equilibrium.

- (a) Q = 0.150; the equilibrium shifts to the right.
 (b) Q = 0.375; the equilibrium shifts to the left.
 (c) Q = 0.150; the equilibrium shifts to the left.
 (d) Q = 0.375; the equilibrium shifts to the right.
 (e) Q = 0.150; the system is at equilibrium.

16. At 0°C, the ion-product constant of water, K_w , is 1.2×10^{-15} . The pH of pure water at 0°C is :

- (a) 7.00, (b) 6.88, (c) 7.56, (d) 7.46, (e) none is correct.

17. The equilibrium constant for the reaction is :



- (a) $\frac{1}{K_b(\text{NH}_3)}$, (b) $\frac{1}{K_a(\text{NH}_4^+)}$, (c) $\frac{K_w}{K_a(\text{NH}_4^+)}$, (d) $\frac{K_w}{K_b(\text{NH}_3)}$, (e) $\frac{K_b(\text{NH}_3)}{K_w}$.

18. Which of the following is true for a buffered solution ?

- (a) The solution resists change in its [H⁺].
 (b) The solution will not change its pH very much even if a concentrated acid is added.
 (c) The solution will not change its pH very much even if a strong base is added.
 (d) Any H⁺ ions will react with a conjugate base of a weak acid already in solution.
 (e) All of these.

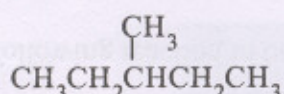
19. For a solution equimolar in HCN and NaCN, which statement is false ?

- (a) This is an example of the common ion effect.
- (b) The $[H^+]$ is larger than it would be if only the HCN was in solution.
- (c) The $[H^+]$ is equal to the K_a .
- (d) Addition of more NaCN will shift the acid dissociation equilibrium of HCN to the left.
- (e) Addition of NaOH will increase $[CN^-]$ and decrease $[HCN]$.

20. Which of the following solutions will be the best buffer at a pH of 9.26 ? (K_a for $HC_2H_3O_2$ is 1.8×10^{-5} , K_b for NH_3 is 1.8×10^{-5}).

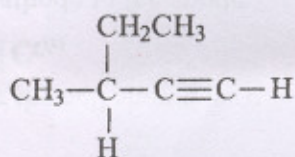
- (a) 0.10 M $HC_2H_3O_2$ and 0.10 M $NaC_2H_3O_2$, (b) 5.0 M $HC_2H_3O_2$ and 5.0 M $NaC_2H_3O_2$, (c) 0.10 M NH_3 and 0.10 M NH_4Cl , (d) 5.0 M NH_3 and 5.0 M NH_4Cl , (e) 5.0 M $HC_2H_3O_2$ and 5.0 M NH_3 .

21. Name the following:



- (a) *n*-hexane, (b) isohexane, (c) 1,2,3-trimethylpropane, (d) methyl-diethylmethane, (e) 3-methylpentane.

22. Name the following:

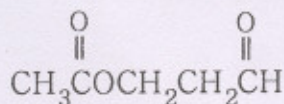


- (a) 1-hexyne, (b) 2-ethynyl butane, (c) 2-ethyl-3-butyne, (d) 3-methyl-1-pentyne, (e) 3-methyl-4-pentyne.

23. Which of the following is not a structural isomer of 1-pentene ?

- (a) 2-pentene, (b) 2-methyl-2-butene, (c) cyclopentane, (d) 3-methyl-1-butene, (e) 1-methyl-cyclobutene.

24. Identify all the functional groups present in the following organic compound. 1) ketone, 2) aldehyde, 3) acid, 4) alcohol, 5) ether, 6) ester, 7) amine



- (a) 2,6, (b) 2,5, (c) 1,2, (d) 1,2,5, (e) 3,4.

25. Which of the following is known as wood alcohol?

- (a) methanol, (b) ethanol, (c) propanol, (d) isopropanol, (e) none of these.

26. The complex ions of Zn^{2+} are all colorless. The most likely explanation for this is :

- (a) Zn^{2+} is paramagnetic.
- (b) Zn^{2+} exhibits d orbital splittings in its complexes such that they absorb wavelengths in the visible region.
- (c) Since Zn^{2+} is a d^{10} ion, it does not absorb visible light even though the d orbital splittings are correct for absorbing visible wavelengths.
- (d) Zn^{2+} is not a transition metal ion.
- (e) None of these is correct.

27. Which of the following ligands might give linkage isomers ?

- (a) NO_2^- , (b) SCN^- , (c) $H_2NHC_2H_2NH_2$, (d) a and b, (e) a, b, and c.

28. Which of the following is paramagnetic ?

(a) $\text{Zn}(\text{H}_2\text{O})_6^{2+}$, (b) $\text{Co}(\text{NH}_3)_6^{3+}$ (strong field), (c) $\text{Cu}(\text{CN})_3^{2-}$, (d) $\text{Mn}(\text{CN})_6^{2-}$ (strong field), (e) none of these.

29. How many of the following compounds exhibit geometric isomers ?

I. $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$ (square planar)

II. $[\text{Co}(\text{H}_2\text{O})_2]\text{Cl}_3$

III. $\text{Ni}(\text{NH}_3)_4(\text{NO}_2)_2$

IV. $\text{K}_2[\text{CoCl}_4]$

(a) 0, (b) 1, (c) 2, (d) 3, (e) 4.

30. Which of the following statements is true about the octahedral complexes of Ni^{2+} ?

(a) Both strong- and weak-field complexes are diamagnetic.

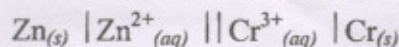
(b) The strong-field complex is diamagnetic and the weak-field complex is paramagnetic.

(c) The strong-field complex is paramagnetic and the weak-field complex is diamagnetic.

(d) Both strong- and weak-field complexes are paramagnetic.

(e) none is true.

31. Which of the following is true for the cell shown here ?



(a) The electrons flow from the cathode to the anode.

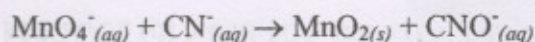
(b) The electrons flow from the zinc to the chromium.

(c) The electrons flow from the chromium to the zinc.

(d) The chromium is oxidized.

(e) The zinc is reduced.

32. When the equation for the following reaction in basic solution is balanced, what is the sum of the coefficients ?



(a) 13, (b) 8, (c) 10, (d) 20, (e) 11.

33. Tables of standard reduction potentials are usually given at 25°C . E° depends on temperature. Which of the following equations describes the temperature dependence of E° ?

(a) $E^\circ = \frac{nF}{RT} - \ln k$, (b) $E^\circ = \Delta H^\circ - T\Delta S^\circ$, (c) $E^\circ = -\frac{\Delta H^\circ}{nF} + \frac{T\Delta S^\circ}{nF}$, (d) $\ln E^\circ = -\frac{\Delta H^\circ}{RT} + \frac{\Delta S^\circ}{R}$,

(e) none of these

34. For which process is ΔS negative ?

(a) evaporation of 1 mol of $\text{CCl}_4(l)$, (b) mixing 5 mL ethanol with 25 mL water, (c) compressing 1 mol Ne at constant temperature from 1.5 atm to 0.5 atm, (d) raising the temperature of 100 g Cu from 275 K to 295 K, (e) grinding a large crystal of KCl to powder.

35. Which of the following result(s) is an increase in the entropy of the system ?

I. (See diagram shown.)

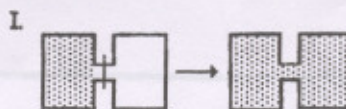
II. $\text{Br}_2(g) \rightarrow \text{Br}_2(l)$

III. $\text{NaBr}_{(s)} \rightarrow \text{Na}^+_{(aq)} + \text{Br}^-_{(aq)}$

IV. $\text{O}_2(298 \text{ K}) \rightarrow \text{O}_2(373 \text{ K})$

V. $\text{NH}_3(1 \text{ atm}, 298 \text{ K}) \rightarrow \text{NH}_3(3 \text{ atm}, 298 \text{ K})$

(a) I, (b) II, V, (c) I, III, IV, (d) I, II, III, IV, (e) I, II, III, V.



36. The second law of thermodynamics states that
- (a) the entropy of a perfect crystal is zero at 0 K, (b) the entropy of the universe is constant, (c) the energy of the universe is increasing, (d) the entropy of the universe is increasing, (e) the energy of the universe is constant.
37. Which of the following statements is (are) always true ?
- I. In order for a process to be spontaneous, the entropy of the universe must increase.
II. A system cannot have both energy disorder and positional disorder.
III. $\Delta S_{\text{univ}} = \frac{\Delta G}{T}$
IV. S° is zero for elements in their standard states.
- (a) I, (b) I, IV, (c) I, III, IV, (d) II, IV, (e) II.
38. A solution contains 0.250 M HA ($K_a = 1.0 \times 10^{-6}$) and 0.45 M NaA. What is the pH after 0.10 mole of HCl is added to 1.00 L of this solution ?
- (a) 3.17, (b) 3.23, (c) 6.00, (d) 10.77, (e) 10.83.
39. The following questions refer to the following system: A 1.0-liter solution contains 0.25 M HF and 0.60 M NaF (K_a for HF is 7.2×10^{-4}). What is the pH of this solution ?
- (a) 1.4, (b) 3.5, (c) 4.6, (d) 2.8, (e) 0.94.
40. Consider the titration of 300.0 mL of 0.500 M NH_3 ($K_b = 1.8 \times 10^{-5}$) with 0.500 M HNO_3 . After 150.0 mL of 0.500 M HNO_3 have been added, the pH of the solution is:
- (a) 4.74, (b) 11.48, (c) 2.52, (d) 9.26, (e) none of these.