

111 學年度國立中正大學化學暨生物化學系
學士班甄選入學化學能力測驗 試題

選擇題(單選)，共 40 題，每題 2.5 分，共 100 分，答錯不倒扣

1. When 3.0 L of hydrogen gas (H_2) reacts with 1.0 L of nitrogen gas (N_2), 2.0 L of gaseous product is formed. All volumes of gases are measured at the same temperature and pressure. What is the formula of the product?
(A) N_3H , (B) N_2H_3 , (C) NH_4 , (D) N_2H_4 , (E) NH_3 .
2. What is the hybridization of C in the ion CN^- ?
(A) sp , (B) sp^2 , (C) sp^3 , (D) dsp^3 , (E) d^2sp^3 .
3. A single atom of an element weighs 5.81×10^{-23} g. Identify the isotope.
(A) ^{80}Br , (B) ^{35}Cl , (C) ^{103}Rh , (D) ^{45}Sc , (E) none of these.
4. Compound X_2Y is 60% X by mass. Calculate the percent Y by mass of the compound X_2Y_2 .
(A) 20%, (B) 30%, (C) 40%, (D) 60%, (E) 80%.
5. Consider the reaction between 50.0 mL of 0.200 M sodium hydroxide and 75.0 mL of 0.100 M HCl. Which of the following statements is correct?
(A) after the reaction, the concentration of Na^+ is greater than the concentration of OH^- , (B) the NaOH is the limiting reactant, (C) after the reaction, the concentration of Na^+ is equal to the concentration of Cl^- , (D) after the reaction, the concentration of Na^+ is still 0.200 M because Na^+ is a spectator ion, (E) none of these are correct.
6. Which pair of ions would *not* be expected to form a precipitate when dilute solutions of each are mixed?
(A) Cu^{2+} , S^{2-} , (B) Ag^+ , Cl^- , (C) Ca^{2+} , PO_4^{3-} , (D) Mn^{2+} , OH^- , (E) Mg^{2+} , SO_4^{2-} .
7. Consider a sample of neon gas in a container fitted with a movable piston (assume the piston is massless and frictionless). The temperature of the gas is increased from 20.0 °C to 40.0 °C. The density of neon
(A) increases less than 10%, (B) decreases less than 10%, (C) increases more than 10%, (D) decreases more than 10%, (E) does not change.
8. Which of the following has the largest radius?
(A) O^{2-} , (B) F^- , (C) Ne, (D) Na^+ , (E) Mg^{2+} .

9. Under which of the following conditions does a gas behave most ideally?

- (A) STP, (B) $P = 1.0 \text{ atm}$, $T = 100.0 \text{ }^\circ\text{C}$, (C) $P = 0.50 \text{ atm}$, $T = 100.0 \text{ }^\circ\text{C}$, (D) $P = 0.50 \text{ atm}$, $T = 0.0 \text{ }^\circ\text{C}$, (E) $P = 2.0 \text{ atm}$, $T = -100.0 \text{ }^\circ\text{C}$.

10. The equilibrium constant for $A + 2B \rightleftharpoons 3C$ is 1.0×10^{-6} .

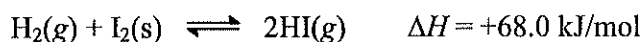
Determine the equilibrium constant for $4A + 8B \rightleftharpoons 12C$.

- (A) 4×10^{-6} , (B) 1.0×10^{24} , (C) 1.0×10^{-6} , (D) 4×10^{-24} , (E) 1.0×10^{-24} .

11. For the reaction $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{H}_2\text{O}(\text{g})$, what is the relationship between K and K_p at temperature T ?

- (A) $K = K_p$, (B) $K = K_p(RT)$, (C) $K_p = K(RT)^2$, (D) $K_p = K(RT)$, (E) $K = K_p(RT)$.

12. Consider the following equilibrium:



Which of the following statements about the equilibrium is *false*?

- (A) if the system is heated, the right side is favored, (B) this is a heterogeneous equilibrium, (C) if the pressure on the system is increased by changing the volume, the left side is favored, (D) adding more $\text{H}_2(\text{g})$ increases the equilibrium constant, (E) removing HI as it forms forces the equilibrium to the right.

13. Which of the following indicates the most acidic solution?

- (A) $[\text{OH}^-] = 0.5 \text{ M}$, (B) $[\text{H}^+] = 0.3 \text{ M}$, (C) $\text{pOH} = 5.9$, (D) $\text{pH} = 1.2$, (E) $[\text{H}^+] = 1.0 \times 10^{-4} \text{ M}$.

14. Which of the following reactions is associated with the definition of K_b ?

- (A) $\text{Zn}(\text{OH})_2^{2+} \rightleftharpoons [\text{Zn}(\text{OH})_2\text{OH}]^+ + \text{H}^+$, (B) $\text{CN}^- + \text{H}^+ \rightleftharpoons \text{HCN}$,
(C) $\text{F}^- + \text{H}_2\text{O} \rightleftharpoons \text{HF} + \text{OH}^-$, (D) $\text{Cr}^{3+} + 6\text{H}_2\text{O} \rightleftharpoons \text{Cr}(\text{OH})_6^{3+}$,
(E) none of these.

15. Which of the following will yield a carboxylic acid upon oxidation?

- (A) a secondary alcohol, (B) an aldehyde, (C) a cycloalkane, (D) a ketone, (E) a tertiary alcohol.

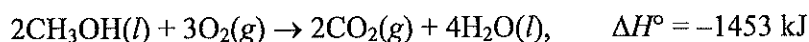
16. Which is the correct mathematical expression for the molar solubility (x) in moles per liter of $\text{Fe}_3(\text{PO}_4)_2$?

- (A) $6x^2$, (B) $12x^3$, (C) $6x^5$, (D) $108x^5$, (E) $5x^6$.

17. The enthalpy of formation of an element in its standard state is

- (A) the enthalpy of its reaction with hydrogen, (B) the enthalpy of its reaction with oxygen, (C) determined by its melting point, (D) zero, (E) none of these.

18. Using the information below, calculate ΔH°_f for $\text{CH}_3\text{OH}(l)$.



$$\Delta H^\circ_f \text{ for } \text{CO}_2(g) = -393.5 \text{ kJ/mol}$$

$$\Delta H^\circ_f \text{ for } \text{H}_2\text{O}(l) = -286 \text{ kJ/mol}$$

(A) -239 kJ/mol , (B) 774 kJ/mol , (C) $-3.38 \times 10^3 \text{ kJ/mol}$, (D) -774 kJ/mol , (E) 239 kJ/mol .

19. When a stable diatomic molecule spontaneously forms from its atoms, what are the signs of ΔH° , ΔS° , and ΔG° , respectively?

(A) +, +, +, (B) +, -, -, (C) -, +, +, (D) -, -, +, (E) -, -, -.

20. How many electrons are transferred in the following reaction?



(A) 2, (B) 3, (C) 4, (D) 6, (E) 8.

21. If a reducing agent X reacts with an oxidizing agent A^{2+} to give X^{2+} and A, and the equilibrium constant for the reaction is 1.0, then what is the E° value for the oxidation–reduction reaction at 25°C ?

(A) 0.0 V, (B) -1.0 V , (C) 1.0 V, (D) 0.030 V, (E) 0.55 V.

22. If a constant current of 5.5 amperes is passed through a cell containing Cr^{3+} for 2.5 hour, how many grams of Cr will plate out onto the cathode? (The atomic mass of Cr is 52 g/mol.)

(A) 27 g, (B) 0.15 g, (C) 8.9 g, (D) 80 g, (E) 1.3 g.

23. From the following list of observations, choose the one that most clearly supports the conclusion that atoms contain electrons.

(A) the emission spectrum of hydrogen, (B) the photoelectric effect, (C) the scattering of alpha particles by metal foil, (D) diffraction, (E) cathode “rays”.

24. What are the building blocks of proteins?

(A) nucleotides, (B) glucose and sucrose, (C) amino acids, (D) lipids, (E) all of these.

25. How many electrons can be described by the quantum numbers $n = 4$, $l = 3$, $m_l = 0$?

(A) 0, (B) 2, (C) 6, (D) 10, (E) 14.

26. An element's most stable ion forms an ionic compound with chlorine having the formula XCl_2 . If the mass number of the ion is 40 and it has 18 electrons, what is the element and how many neutrons does it have?

(A) Ar, 22 neutrons, (B) Ar, 24 neutrons, (C) S, 24 neutrons, (D) K, 19 neutrons, (E) Ca, 20 neutrons.

27. Which of the following shows these molecules in order from most polar to least polar?
 (A) $\text{CH}_4 > \text{CF}_2\text{Cl}_2 > \text{CF}_2\text{H}_2 > \text{CCl}_4 > \text{CCl}_2\text{H}_2$, (B) $\text{CH}_4 > \text{CF}_2\text{H}_2 > \text{CF}_2\text{Cl}_2 > \text{CCl}_4 > \text{CCl}_2\text{H}_2$,
 (C) $\text{CF}_2\text{Cl}_2 > \text{CF}_2\text{H}_2 > \text{CCl}_2\text{H}_2 > \text{CH}_4 = \text{CCl}_4$, (D) $\text{CF}_2\text{H}_2 > \text{CCl}_2\text{H}_2 > \text{CF}_2\text{Cl}_2 > \text{CH}_4 = \text{CCl}_4$,
 (E) $\text{CF}_2\text{Cl}_2 > \text{CF}_2\text{H}_2 > \text{CCl}_4 > \text{CCl}_2\text{H}_2 > \text{CH}_4$.

28. How many of the following gases at STP are less dense than air at STP?

NH_3 , He, Kr, and F_2

- (A) 0, (B) 1 (C) 2, (D) 3, (E) 4.

29. For the reaction $\text{A} + \text{B} \rightarrow \text{products}$, the following data were obtained.

Initial Rate (mol/L · s)	0.030	0.059	0.060	0.090	0.090
$[\text{A}]_0$ (mol/L)	0.10	0.20	0.20	0.30	0.30
$[\text{B}]_0$ (mol/L)	0.20	0.20	0.30	0.30	0.50

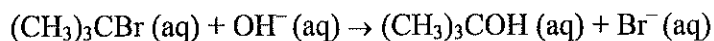
What is the experimental rate law?

- (A) Rate = $k[\text{A}]$, (B) Rate = $k[\text{B}]$, (C) Rate = $k[\text{A}][\text{B}]$, (D) Rate = $k[\text{A}]^2[\text{B}]$, (E) Rate = $k[\text{A}][\text{B}]^2$.

30. What is the electron configuration of Co^{3+} ?

- (A) $[\text{Ar}] 3d^4$, (B) $[\text{Ar}] 3d^6$, (C) $[\text{Ar}] 4s^2 3d^4$, (D) $[\text{Ar}] 4s^2 4d^4$, (E) none of these.

31. The reaction of $(\text{CH}_3)_3\text{CBr}$ with hydroxide ion proceeds with the formation of $(\text{CH}_3)_3\text{COH}$.



The following data were obtained at 55°C .

Exp.	$[(\text{CH}_3)_3\text{CBr}]_0$ (mol/L)	$[\text{OH}^-]_0$ (mol/L)	Initial Rate (mol/L · s)
1	0.10	0.10	1.0×10^{-3}
2	0.20	0.10	2.0×10^{-3}
3	0.10	0.20	1.0×10^{-3}
4	0.30	0.20	?

What will the initial rate (in mol/L · s) be in Experiment 4?

- (A) 3.0×10^{-3} , (B) 6.0×10^{-3} , (C) 9.0×10^{-3} , (D) 18×10^{-3} , (E) none of these.

32. How many electrons are involved in pi bonding in benzene, C_6H_6 ?

- (A) 12, (B) 30, (C) 6, (D) 3, (E) 18.

33. The normal boiling point of liquid X is less than that of Y, which is less than that of Z. Which of the following is the correct order of increasing vapor pressure of the three liquids at STP?

- (A) X, Y, Z, (B) Z, Y, X, (C) Y, X, Z, (D) X, Z, Y, (E) Y, Z, X.

34. A 50.0 g sample of ethyl alcohol (C_2H_5OH) is dissolved in 75.0 g of water. What is the mole fraction of ethyl alcohol?
(A) 0.207, (B) 0.414, (C) 0.342, (D) 0.667, (E) none of these.
35. A solution of two liquids, A and B, shows negative deviation from Raoult's law (拉午耳定律). This means that
(A) molecules of A interact strongly with other A-type molecules, (B) the two liquids have a positive heat of solution, (C) molecules of A interact weakly, if at all, with B molecules, (D) the molecules of A hinder the strong interaction between B molecules, (E) molecules of A interact more strongly with B than with A or and more strongly than B with B.
36. Which of the following ions interfere(s) with the action of detergents in hard water?
(A) Na^+ , (B) Ca^{2+} , (C) Mg^{2+} , (D) Ca^{2+} and Mg^{2+} , (E) Na^+ , Ca^{2+} , and Mg^{2+} .
37. Choose the element with the smallest electronegativity.
(A) N, (B) P, (C) Sn, (D) As, (E) I.
38. Choose the species with the largest bond strength.
(A) F_2 , (B) Cl_2 , (C) Br_2 , (D) I_2 , (E) all are the same.
39. For the process $Co(NH_3)_5Cl^{2+} + Cl^- \rightarrow Co(NH_3)_4Cl_2^+ + NH_3$, what would be the ratio of *cis* to *trans* isomers in the product?
(A) 1:1, (B) 1:2, (C) 1:4, (D) 4:1, (E) 2:1.
40. Which of the following transition metals is a component of vitamin B_{12} ?
(A) manganese, (B) chromium, (C) cobalt, (D) copper, (E) zinc.