

選擇題，共 40 題，每題 2.5 分，共 100 分，答錯不倒扣。

- Which of the following pairs can be used to illustrate the law of multiple proportions (倍比定律)?
(a) SO and SO₂, (b) CO and CaCO₃, (c) H₂O and C₁₂H₂₂O₁₁, (d) H₂SO₄ and H₂S, (e) KCl and KClO₂.
- ${}^{40}_{20}\text{Ca}^{2+}$ has
(a) 20 protons (質子), 18 neutrons(中子), and 18 electrons(電子),
(b) 20 protons, 20 neutrons, and 20 electrons,
(c) 20 protons, 22 neutrons, and 18 electrons,
(d) 20 protons, 20 neutrons, and 18 electrons,
(e) 20 protons, 20 neutrons, and 22 electrons.
- Naturally occurring element X exists in three isotopic forms (同位素的形式): X-28 (27.977 amu, 92.21% abundance), X-29 (28.976 amu, 4.70% abundance), and X-30 (29.974 amu, 3.09% abundance). Calculate the atomic weight of X.
(a) 14.0, (b) 28.1, (c) 29, (d) 72.7, (e) 36.2 amu.
- Phosphorus (磷) has the molecular formula P₄ and sulfur (硫) has the molecular formula S₈. How many grams of phosphorus contain the same number of molecules as 6.41 g of sulfur? (P=31, S=32)
(a) 6.41, (b) 6.19, (c) 3.21, (d) 3.10 g, (e) none of these.
- Which of the following aqueous solutions (水溶液) contains the greatest number of ions (離子)?
(a) 400.0 mL of 0.10 M NaCl,
(b) 300.0 mL of 0.10 M CaCl₂,
(c) 200.0 mL of 0.10 M FeCl₃,
(d) 200.0 mL of 0.10 M KBr,
(e) 800.0 mL of 0.10 M sucrose (蔗糖).
- A 51.24-g sample of Ba(OH)₂ is dissolved in enough water to make 1.20 liters of solution. How many mL of this solution must be diluted (稀釋) with water in order to make 1.00 liter of 0.100 M Ba(OH)₂? (Ba=137.3)
(a) 400, (b) 333, (c) 278, (d) 1.20 x 10³ mL, (e) none of these.
- Which pair of ions would *not* be expected to form a precipitate (沉澱) when dilute solutions of each are mixed?
(a) Al³⁺, S²⁻, (b) Pb²⁺, Cl⁻, (c) Ba²⁺, PO₄³⁻, (d) Pb²⁺, OH⁻, (e) Mg²⁺, SO₄²⁻.
- 1.00 mL of a 3.50 x 10⁻⁴ M solution of oleic acid (油酸) is diluted with 9.00 mL of petroleum ether (石油醚), forming solution A. 2.00 mL of solution A is diluted with 8.00 mL of petroleum ether, forming solution B. How many grams of oleic acid are 5.00 mL of solution B? (molar mass (分子量) for oleic acid = 282 g/mol)
(a) 4.94 x 10⁻⁴, (b) 7.00 x 10⁻⁶, (c) 4.94 x 10⁻⁵, (d) 1.97 x 10⁻⁶, (e) 9.87 x 10⁻⁶ g.

9. Gaseous chlorine (氯氣) is held in two separate containers at identical temperature and pressure. The volume of container 1 is 1.30 L and it contains 6.70 mol of the gas. The volume of container 2 is 2.20 L. How many moles of the gas are in container 2.

(a) 11.3, (b) 19.2, (c) 0.427, (d) 3.96 mol, (e) none of these.

10. A gas sample is heated from -20.0°C to 57.0°C and the volume is increased from 2.00 L to 4.50 L. If the initial pressure is 0.125 atm, what is the final pressure?

(a) 0.189, (b) 0.555, (c) 0.0605, (d) 0.247 atm, (e) none of these.

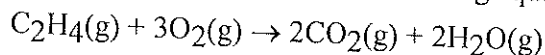
11. You are holding two balloons (氣球), an orange balloon and a blue balloon. The orange balloon is filled with neon (Ne) gas and the blue balloon is filled with argon (Ar) gas. The orange balloon has twice the volume of the blue balloon. Which of the following best represents the mass ratio of Ne:Ar in the balloons?

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

12. A 4.40-g piece of solid CO_2 (dry ice, 乾冰) is allowed to sublime (昇華) in a balloon. The final volume of the balloon is 1.00 L at 300 K. What is the pressure of the gas?

(a) 2.46, (b) 246, (c) 0.122, (d) 122 atm, (e) none of these.

13. Gaseous C_2H_4 reacts with O_2 according to the following equation:



What volume of oxygen at STP (標準狀態) is needed to react with 1.50 mol of C_2H_4 ?

(a) 4.50, (b) 33.6, (c) 101, (d) 67.2 L, (e) not enough information is given to solve the problem.

14. At 500.0 K, one mole of gaseous ONCl is placed in a one-liter container. At equilibrium (平衡) it is 9.0% dissociated (解離) according to the equation shown here: $2\text{ONCl} \rightleftharpoons 2\text{NO} + \text{Cl}_2$

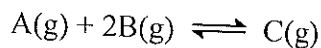
Determine the equilibrium constant (平衡常數).

(a) 2.2×10^2 , (b) 1.1×10^2 , (c) 9.1×10^{-1} , (d) 4.4×10^{-4} , (e) 2.2×10^{-4} .

15. Consider the reaction $\text{H}_2 + \text{I}_2 \rightleftharpoons 2\text{HI}$ whose $K = 54.8$ at 425°C . If an equimolar mixture of reactants gives the concentration of the product to be 0.50 M at equilibrium, determine the concentration (濃度) of the hydrogen (氫氣).

(a) 4.6×10^{-3} , (b) 6.8×10^{-2} , (c) 1.2×10^{-3} , (d) 9.6×10^{-2} , (e) 1.6×10^{-4} M.

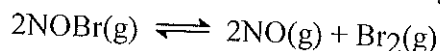
16. For the reaction given below, 2.00 moles of A and 3.00 moles of B are placed in a 6.00-L container.



At equilibrium, the concentration of A is 0.300 mol/L. What is the concentration of B at equilibrium?

(a) 0.300, (b) 0.433, (c) 0.500, (d) 0.600 mol/L, (e) none of these.

17-18. Consider the following reaction (assume an ideal gas mixture):



A 1.0-liter vessel was initially filled with pure NOBr , at a pressure (壓力) of 4.0 atm, at 300 K.

17. After equilibrium was established, the partial pressure of NOBr was 2.5 atm. What is K_p for the reaction ?

(a) 0.75, (b) 0.45, (c) 0.27, (d) 0.18, (e) none of these.

18. After equilibrium was reached, the volume (體積) was increased to 2.0 liters, while the temperature (溫度) was kept at 300 K. This will result in:

(a) an increase in K_p , (b) a decrease in K_p , (c) a shift in the equilibrium position to the right, (d) a shift in the equilibrium position to the left, (e) none of these.

19. Which of the following is not true for a solution at 25°C that has a hydroxide concentration of $2.5 \times 10^{-6} \text{ M}$?

(a) $K_w = 1 \times 10^{-14}$, (b) the solution is acidic, (c) the solution is basic, (d) the $[\text{H}^+]$ is $4 \times 10^{-9} \text{ M}$, (e) the K_w is independent of what the solution contains.

20. Calculate the pH of a 0.30 M solution of NH_4Cl . (K_b for $\text{NH}_3 = 1.8 \times 10^{-5}$)

(a) 3.33, (b) 4.89, (c) 9.11, (d) 7.00, (e) 11.67.

21. The K_f for the complex ion $\text{Ag}(\text{NH}_3)_2^+$ is 1.7×10^7 . The K_{sp} for AgCl is 1.6×10^{-10} . Calculate the molar solubility (溶解度) of AgCl in 1.0 M NH_3 .

(a) 5.2×10^{-2} , (b) 4.7×10^{-2} , (c) 2.9×10^{-3} , (d) 1.3×10^{-5} , (e) 1.7×10^{-10} .

22. Which of the following compounds (化合物) has the lowest solubility in mol/L in water at 25°C?

(a) Ag_3PO_4 $K_{sp} = 1.8 \times 10^{-18}$,
(b) $\text{Sn}(\text{OH})_2$ $K_{sp} = 5 \times 10^{-26}$,
(c) $\text{Al}(\text{OH})_3$ $K_{sp} = 2 \times 10^{-33}$,
(d) CaSO_4 $K_{sp} = 6.1 \times 10^{-5}$,
(e) CdS $K_{sp} = 3.6 \times 10^{-29}$.

23. The enthalpy of fusion (溶解熱) of ice is 6.020 kJ/mol. The heat capacity (熱容量) of liquid water is 75.4 J/mol°C. What is the smallest number of ice cubes at 0°C, each containing one mole of water, necessary to cool 500. g of liquid water initially at 20°C to 0°C ?

(a) 1, (b) 7, (c) 14, (d) 15, (e) 126.

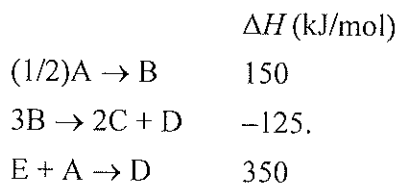
24. $\text{C}_2\text{H}_5\text{OH}(\text{l}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l})$, $\Delta H = -1.37 \times 10^3 \text{ kJ}$

For the combustion (燃燒) of ethyl alcohol (乙醇) as described in the above equation, which of the following is true ?

- I. The reaction is exothermic (放熱的).
- II. The enthalpy (焓) change would be different if gaseous water were produced.
- III. The reaction is not an oxidation-reduction (氧化-還原) one.
- IV. The products of the reaction occupy a larger volume than the reactants.

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

25. Consider the following processes:



Calculate ΔH for : $B + D \rightarrow E + 2C$

(a) 325, (b) 525, (c) -325, (d) -175 kJ/mol, (e) none of these.

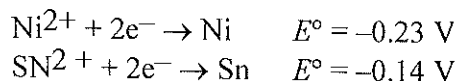
26. If the change in entropy (熵) of the surroundings (外界) for a process at 451 K and constant pressure is -326 J/K, what is the heat flow absorbed by for the system (系統) ?

(a) 326, (b) 242, (c) 147, (d) 12.1, (e) 1.2 kJ.

27. For the process $CHCl_3(s) \rightarrow CHCl_3(l)$, $\Delta H^\circ = 9.2$ kJ/mol and $\Delta S^\circ = 43.9$ J/mol/K. What is the melting point (熔點) of chloroform (氯仿) ?

(a) 63, (b) 5, (c) 0, (d) -5, (e) -63°C.

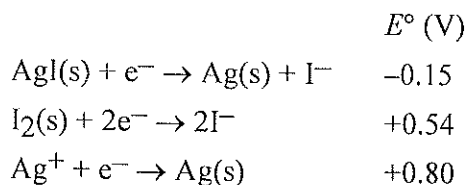
28. The reduction potentials (還原電位) for Ni^{2+} and Sn^{2+} are as follows:



Calculate the equilibrium constant at 25°C for the reaction : $Sn^{2+} + Ni \rightleftharpoons Sn + Ni^{2+}$

(a) 1.9×10^{-4} , (b) 1.9, (c) 3.0, (d) 1.5×10^{13} , (e) 1.1×10^3 .

29. Calculate the solubility product (溶解度積) of silver iodide (碘化銀) at 25°C given the following data:



(a) 2.9×10^{-3} , (b) 1.9×10^{-4} , (c) 2.1×10^{-12} , (d) 9.0×10^{-17} , (e) 2.4×10^{-24} .

30. When a hydrogen electron makes a transition from $n = 3$ to $n = 1$, which of the following statements is *true* ?

- I. Energy is emitted (放射).
- II. Energy is absorbed (吸收).
- III. The electron loses energy.
- IV. The electron gains energy.
- V. The electron cannot make this transition (躍遷).

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

31. The energy of the light emitted when a hydrogen electron goes from $n = 2$ to $n = 1$ is what fraction of its ground-state ionization energy (基底狀態的游離能)?

(a) 3/4, (b) 1/2, (c) 1/4, (d) 1/8, (e) 1/9.

32. Choose the compound with the most ionic bond (離子鍵).

(a) LiCl, (b) KF, (c) NaCl, (d) LiF, (e) KCl.

33. Which of the following molecules (分子) has a dipole moment (偶極距) ?

(a) CH₄, (b) CCl₄, (c) CO₂, (d) SO₃, (e) none of these.

34. The hybridization (混成) of the central atom in O₃ is:

(a) sp, (b) sp², (c) sp³, (d) dsp³, (e) d²sp³.

35. Which of the following molecules has a bond order (鍵級數) of 1.5 ?

(a) O₂⁺, (b) N₂, (c) O₂⁻, (d) C₂, (e) none of these.

36. A general reaction written as 1A + 2B → C + 2D is studied and yields the following data:

[A] ₀	[B] ₀	Initial Δ[C]/Δt
0.150 M	0.150 M	8.00 x 10 ⁻³ mol/L.s
0.150 M	0.300 M	1.60 x 10 ⁻² mol/L.s
0.300 M	0.150 M	3.20 x 10 ⁻² mol/L.s

What is the order of the reaction with respect to B ?

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

37. A first-order reaction is 45% complete at the end of 35 minutes. What is the length of the half-life (半生期) of this reaction ?

(a) 27, (b) 30, (c) 39, (d) 41 min, (e) none of these.

38. A metal crystallizes (結晶) in a body-centered unit cell (體心晶胞) with an edge length of 2.00 x 10² pm (pm=10⁻¹² m). Assume the atoms in the cell touch along the cube diagonal (對角線). The percentage of empty volume in the unit cell will be:

(a) 0, (b) 26.0, (c) 32.0, (d) 68.0%, (e) none of these.

39. A certain metal fluoride (氟) crystallizes in such a way that the fluoride ions occupy simple cubic lattice sites, while the metal atoms occupy the body centers of half the cubes. The formula for the metal fluoride is:

(a) MF, (b) MF₂, (c) M₂F, (d) MF₄, (e) none of these.

40. What is the electron configuration (電子組態) of the Ni(II) ion ?

(a) [Ar] 4s²3d⁶, (b) [Ar] 4s¹3d⁷, (c) [Ar] 4s²3d⁸, (d) [Ar] 3d⁸, (e) none of these.

