

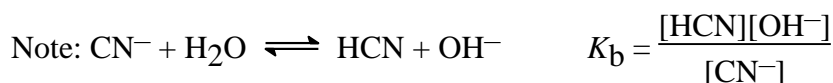
選擇題，共 40 題，每題 2.5 分，共 100 分，答錯不倒扣。

- How many significant figures (有效數字) are there in the number 3.1400?
(A) 2, (B) 3, (C) 4, (D) 5, (E) none of these.
- A titration (滴定) was performed to find the concentration of hydrochloric acid (鹽酸) with the following results:

Trial	Molarity
1	1.25 ± 0.01
2	1.24 ± 0.01
3	1.26 ± 0.01

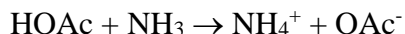
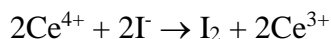
The actual concentration of HCl was determined to be 1.000 M; the results of the titration are:

- (A) both accurate and precise, (B) accurate but imprecise, (C) precise but inaccurate, (D) both inaccurate and imprecise, (E) none of these.
- Which of the following pairs of compounds can be used to illustrate the law of multiple proportions(倍比定律)?
(A) NH_4 and NH_4Cl , (B) ZnO_2 and ZnCl_2 , (C) H_2O and HCl , (D) NO and NO_2 , (E) none of these.
- The scientist whose alpha-particle scattering (散射的) experiment led him to conclude that the nucleus of an atom contains a dense center of positive charge is
(A) J. J. Thomson, (B) Lord Kelvin, (C) Ernest Rutherford, (D) John Dalton, (E) none of these.
- The numbers of protons, neutrons, and electrons in ${}^{39}_{19}\text{K}^+$ are:
(A) 19 p, 20 n, 18 e, (B) 20 p, 19 n, 20 e, (C) 19 p, 20 n, 20 e, (D) 19 p, 20 n, 19 e, (E) none of these.
- Naturally occurring copper exists in two isotopic (同位素的) forms: ${}^{63}\text{Cu}$ and ${}^{65}\text{Cu}$. The atomic mass of copper is 63.55 amu. What is the approximate natural abundance (豐富) of ${}^{63}\text{Cu}$?
(A) 63%, (B) 90%, (C) 70%, (D) 50%, (E) none of these.
- A sample of ammonia (氨) has a mass of 56.6 g. How many molecules are in this sample? (H=1, N=14)
(A) 3.32, (B) 17.03×10^{24} , (C) 6.78×10^{23} , (D) 2.00×10^{24} molecules, (E) none of these.
- The limiting reactant (限量反應物) in a reaction
(A) has the lowest coefficient (係數) in a balanced equation (平衡方程式).
(B) is the reactant for which you have the fewest number of moles.
(C) has the lowest ratio of moles available/coefficient in the balanced equation.
(D) has the lowest ratio of coefficient in the balanced equation/moles available.
(E) none of these.
- If K_a for HCN is 6.2×10^{-10} , what is K_b for CN^- ?



- (A) 6.2×10^{-24} , (B) 6.2×10^4 , (C) 1.6×10^{-5} , (D) 1.6×10^{23} , (E) none of these.

10. The following reactions:



are examples of

- (A) acid-base reactions.
(B) precipitation (沉澱), acid-base, and redox (氧化還原) reactions, respectively.
(C) redox, acid-base, and precipitation reactions, respectively.
(D) precipitation, redox, and acid-base reactions, respectively.
(E) none of these.
11. Aqueous solutions of sodium sulfide and copper(II) chloride are mixed together. Which statement is correct?
(A) Both NaCl and CuS precipitate from solution.
(B) No precipitate forms.
(C) CuS will precipitate from solution.
(D) NaCl will precipitate from solution.
(E) none of these.
12. In which of the following does nitrogen have an oxidation state of +4?
(A) HNO₃, (B) NO₂, (C) N₂O, (D) NH₄Cl, (E) none of these.
13. When the following reaction is balanced in acidic solution, what is the coefficient of I₂?
$$\text{IO}_3^- + \text{I}^- \rightarrow \text{I}_2$$

(A) 1, (B) 2, (C) 3, (D) 4, (E) none of these.
14. A balloon has a volume of 1.20 liters at 24.0°C. The balloon (氣球) is heated to 48.0°C. Calculate the new volume of the balloon.
(A) 1.20 L, (B) 1.30 L, (C) 1.40 L, (D) 2.40 L, (E) none of these.
15. The valve (閥) between a 5-L tank (箱子) containing a gas at 9 atm and a 10-L tank containing a gas at 6 atm is opened. Calculate the final pressure in the tanks.
(A) 3 atm, (B) 4 atm, (C) 7 atm, (D) 15 atm, (E) none of these.
16. Into a 3.00-liter container at 25°C are placed 1.23 moles of O₂ gas and 3.20 moles of solid C (graphite). If the carbon and oxygen react completely to form CO_(g), what will be the final pressure in the container at 25°C?
(A) 20.1 atm, (B) 26.1 atm, (C) 10.2 atm, (D) 1.68 atm, (E) none of these.

17. Order the following in increasing rate of effusion (逸散):

F₂, Cl₂, NO, NO₂, CH₄

- (A) Cl₂ < NO₂ < F₂ < NO < CH₄
- (B) Cl₂ < F₂ < N₂O < CH₄ < NO
- (C) CH₄ < NO₂ < NO < F₂ < Cl₂
- (D) CH₄ < NO < F₂ < NO₂ < Cl₂
- (E) none of these.

18. The value of the equilibrium constant (平衡常數), K , is dependent on

- I. The temperature of the system.
- II. The nature of the reactants and products.
- III. The concentration of the reactants.
- IV. The concentration of the products.

(A) I, II, (B) II, III, IV (C) III, IV, (D) I, III, IV, (E) none of these.

19. Consider the gaseous reaction $\text{CO}_{(g)} + \text{Cl}_{2(g)} \rightleftharpoons \text{COCl}_{2(g)}$. What is the expression for K_p in terms of K ?

(A) $K(RT)$, (B) $K/(RT)$, (C) $K(RT)^2$, (D) $K/(RT)^2$, (E) none of these.

20. Given the reaction $\text{A}(g) + \text{B}(g) \rightleftharpoons \text{C}(g) + \text{D}(g)$. You have the gases A, B, C, and D at equilibrium. Upon adding gas A, the value of K :

- (A) increases because by adding A, more products are made, increasing the product to reactant ratio.
- (B) decreases because A is a reactant of the product to reactant ratio decreases.
- (C) does not change because A does not figure into the product to reactant ratio.
- (D) does not change as long as the temperature is constant.
- (E) none of these

21. Given the following acids and K_a values:

HClO₄	HOAc	HCN	HF
1×10^7	1.76×10^{-5}	4.93×10^{-10}	3.53×10^{-4}

which shows the conjugate (共軛) bases listed by increasing strength?

- (A) CN⁻, F⁻, OAc⁻, ClO₄⁻
- (B) ClO₄⁻, F⁻, OAc⁻, CN⁻
- (C) CN⁻, ClO₄⁻, F⁻, OAc⁻
- (D) ClO₄⁻, OAc⁻, CN⁻, F⁻
- (E) none of these

22. As water is heated, its pH decreases. This means that

- (A) the water is no longer neutral.
- (B) the K_w value is decreasing.
- (C) the water has a lower [OH⁻] than cooler water.
- (D) the dissociation of water is an endothermic process.
- (E) none of these

23. Which of the following compounds has the lowest solubility (溶解度) in mol/L in water?

- (A) $\text{Al}(\text{OH})_3$ $K_{\text{sp}} = 2 \times 10^{-32}$
(B) CdS $K_{\text{sp}} = 1.0 \times 10^{-28}$
(C) PbSO_4 $K_{\text{sp}} = 1.3 \times 10^{-8}$
(D) $\text{Sn}(\text{OH})_2$ $K_{\text{sp}} = 3 \times 10^{-27}$
(E) none of these

24. Determine ΔG° for the following reaction: $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$

Substance	ΔG_f° (kJ/mol)
$\text{CH}_4(\text{g})$	-50.7
$\text{O}_2(\text{g})$	0
$\text{CO}_2(\text{g})$	-394.4
$\text{H}_2\text{O}(\text{l})$	-237.4

(A) 207.7, (B) 106.3, (C) 943.1, (D) 130.4, (E) 817.9 kJ.

25. Consider the following data:

	ΔH (kJ)
$\text{Ca}(\text{s}) + 2\text{C}(\text{graphite}) \rightarrow \text{CaC}_2(\text{s})$	-62.8
$\text{Ca}(\text{s}) + 1/2\text{O}_2(\text{g}) \rightarrow \text{CaO}(\text{s})$	-635.5
$\text{CaO}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{Ca}(\text{OH})_2(\text{aq})$	-653.1
$\text{C}_2\text{H}_2(\text{g}) + (5/2)\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2 + \text{H}_2\text{O}(\text{l})$	-1300
$\text{C}(\text{graphite}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$	-393.51

Use Hess's law to find the change in enthalpy (焓) at 25°C for the following equation:



(A) -255, (B) -677, (C) -452, (D) -819, (E) -713 kJ.

26. In which case must a reaction be spontaneous (自發的) at all temperatures?

- (A) ΔH is positive, ΔS is positive.
(B) $\Delta H = 0$, ΔS is negative.
(C) $\Delta S = 0$, ΔH is positive.
(D) ΔH is negative, ΔS is positive.
(E) none of these

27. For the process $\text{CHCl}_3(\text{s}) \rightarrow \text{CHCl}_3(\text{l})$, $\Delta H^\circ = 9.2 \text{ kJ/mol}$ and $\Delta S^\circ = 43.9 \text{ J/(mol}\cdot\text{K)}$. What is the melting point of chloroform (氯仿)?

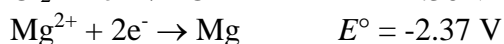
(A) -63°C , (B) 210°C , (C) 5°C , (D) 63°C , (E) none of these.

28. Consider the following processes:
- I. Condensation of a liquid.
 - II. Increasing the volume of 1.0 mol of an ideal gas at constant temperature.
 - III. Dissolving an ionic solid in water.
 - IV. Heating 1.0 mol of an ideal gas at constant volume.

For how many of these is ΔS positive?

(A) 1, (B) 2, (C) 3, (D) 4, (E) none of these.

29. Which of the following is the best reducing agent?



(A) Cl_2 , (B) Cl^- , (C) Mg , (D) Mg^{2+} , (E) none of these.

30. The galvanic cell described by $\text{Zn}_{(s)} \mid \text{Zn}^{2+}_{(aq)} \parallel \text{Cu}^{2+}_{(aq)} \mid \text{Cu}_{(s)}$ has a standard cell potential (電池電位) of 1.101 volts. Given that $\text{Zn}_{(s)} \rightarrow \text{Zn}^{2+}_{(aq)} + 2\text{e}^-$ has an oxidation potential of 0.762 volts, determine the reduction potential for Cu^{2+} .

(A) -1.863 V , (B) 1.863 V , (C) -0.339 V , (D) 0.339 V , (E) none of these.

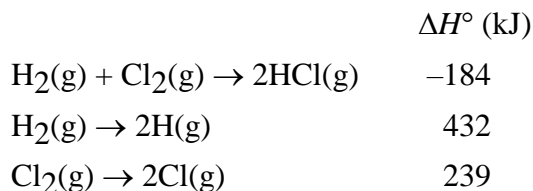
31. The energy of the light emitted when a hydrogen electron goes from $n = 2$ to $n = 1$ is what fraction of its ground-state ionization energy (游離能)?

(A) $3/4$, (B) $1/2$, (C) $1/4$, (D) $1/8$, (E) none of these.

32. Select the molecule among the following that has a dipole moment (偶極矩).

(A) CO_2 , (B) BF_3 , (C) XeF_4 , (D) SF_4 , (E) none of these.

33. Using the following data reactions



calculate the energy of an H-Cl bond.

(A) 770 kJ, (B) 428 kJ, (C) 518 kJ, (D) 326 kJ, (E) none of these.

34. The hybridization (混成) of Cl in ClF_2^+ is:

(A) sp , (B) sp^2 , (C) sp^3 , (D) dsp^3 , (E) none of these.

35. Which of the following molecules has a bond order of 1.5?

(A) O_2^+ , (B) N_2 , (C) O_2^- , (D) C_2 , (E) none of these.

36. The reaction : $2A + B \rightarrow C$ has the following proposed mechanism:

Step 1: $A + B \rightleftharpoons D$ (fast equilibrium)

Step 2: $D + B \rightarrow E$

Step 3: $E + A \rightarrow C + B$

If step 2 is the rate-determining step (速率決定步驟), then the rate of formation of C should equal:

(A) $k[A]$, (B) $k[A][B]^2$, (C) $k[A]^2[B]$, (D) $k[A]^2[B]^2$, (E) $k[A][B]$.

37. The following data were obtained at 25°C:

[A] ₀	[B] ₀	[C] ₀	Rate
0.1	0.2	0.3	0.063
0.3	0.4	0.2	0.084
0.6	0.4	0.2	0.168
0.3	0.4	0.1	0.021
0.6	0.2	0.2	0.168

What is the correct rate law (速率定律式)?

(A) $\text{Rate} = k[A][B][C]$,

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

(C) $\text{Rate} = k[A][C]^2$,

(D) $\text{Rate} = k[A]^3[B]^2[C]$,

(E) none of these.

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

(A) $[Ar]4s^23d^6$, (B) $[Ar]4s^13d^7$, (C) $[Ar]4s^23d^8$, (D) $[Ar]3d^8$, (E) none of these.

39. According to crystal field theory (晶體場理論), how many unpaired electrons are present in the complex ion $[Fe(H_2O)_6]^{3+}$? The water molecules are weak field ligands.

(A) 3, (B) 4, (C) 5, (D) 6, (E) none of these.

40. How many isomers (異構物) are there of "dichloroethene"?

(A) 2, (B) 3, (C) 4, (D) 5, (E) none of these.