

臺灣綜合大學系統 108 學年度學士班轉學生聯合招生考試試題

科目名稱	普通化學 B	類組代碼	共同考科
		科目碼	E0018

※本項考試依簡章規定各考科均「不可以」使用計算機

本科試題共計 7 頁

請將答案寫在答案卷上，並清楚標明題號。

一、選擇題(50%；每題 2%)

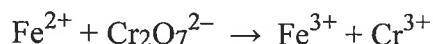
1. Which of the experiments listed below did *not* provide the information stated about the nature of the atom?

- A. The Rutherford experiment proved that the Thomson "plum pudding" model of the atom was essentially correct.
- B. The Rutherford experiment determined the charge on the nucleus.
- C. The cathode-ray tube proved that electrons have a negative charge.
- D. Millikan's oil-drop experiment showed that the charge on any particle was a simple multiple of the charge on the electron.

2. Compound X_2Y is 60% X by mass. Calculate the percent Y by mass of the compound X_2Y_2 .

- A. 30% B. 80% C. 40% D. 20% E. 60%

3. The following unbalanced reaction occurs in basic media:



The coefficient for water in the balanced equation is _____, and water appears on the _____ side of the equation.

- A. 14, left B. 14, right C. 7, right D. 7, left E. none of these

4. How is the observed pressure of a gas related to the ideal pressure?

- A. The relationship depends on the gas.
- B. They are equal.
- C. The observed pressure is greater than the ideal pressure.
- D. The observed pressure is less than the ideal pressure.
- E. none of these

5. For the reaction $2H_2(g) + O_2(g) \rightleftharpoons 2H_2O(g)$, what is the relationship between K and K_p at temperature T ?

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

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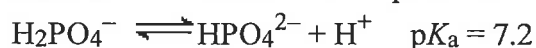
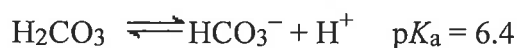
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6. The acids $\text{HC}_2\text{H}_3\text{O}_2$ and HF are both weak, but HF is a stronger acid than $\text{HC}_2\text{H}_3\text{O}_2$. HCl is a strong acid. Order the following according to base strength.

- A. $\text{Cl}^- > \text{F}^- > \text{C}_2\text{H}_3\text{O}_2^- > \text{H}_2\text{O}$ B. $\text{C}_2\text{H}_3\text{O}_2^- > \text{F}^- > \text{H}_2\text{O} > \text{Cl}^-$
 C. $\text{C}_2\text{H}_3\text{O}_2^- > \text{F}^- > \text{Cl}^- > \text{H}_2\text{O}$ D. $\text{F}^- > \text{C}_2\text{H}_3\text{O}_2^- > \text{H}_2\text{O} > \text{Cl}^-$
 E. none of these

7. Consider a solution consisting of the following two buffer systems:



At pH 6.4, which one of the following is true of the relative amounts of acid and conjugate base present?

- A. $[\text{H}_2\text{CO}_3] > [\text{HCO}_3^-]$ and $[\text{H}_2\text{PO}_4^-] > [\text{HPO}_4^{2-}]$
 B. $[\text{HCO}_3^-] > [\text{H}_2\text{CO}_3]$ and $[\text{HPO}_4^{2-}] > [\text{H}_2\text{PO}_4^-]$
 C. $[\text{H}_2\text{CO}_3] > [\text{HCO}_3^-]$ and $[\text{HPO}_4^{2-}] > [\text{H}_2\text{PO}_4^-]$
 D. $[\text{H}_2\text{CO}_3] = [\text{HCO}_3^-]$ and $[\text{HPO}_4^{2-}] > [\text{H}_2\text{PO}_4^-]$
 E. $[\text{H}_2\text{CO}_3] = [\text{HCO}_3^-]$ and $[\text{H}_2\text{PO}_4^-] > [\text{HPO}_4^{2-}]$

8. Which statement is true of a process in which 1 mol of a gas is expanded from state A to state B?

- A. The final volume of the gas will depend on the path taken
 B. The amount of work done in the process must be the same, regardless of the path.
 C. When the gas expands from state A to state B, the surroundings are doing work on the system.
 D. The amount of heat released in the process will depend on the path taken
 E. It is not possible to have more than one path for a change of state.

9. Consider the dissociation reaction of the acid HF .



Why is ΔS negative?

- A. The reaction is expected to be exothermic, and ΔS thus should be negative.
 B. The reaction is expected to be endothermic, and thus ΔS should be negative.
 C. Each HF molecule produces two ions when it dissociates.
 D. The ions are hydrated.
 E. none of these

背面有題，請繼續作答。

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10. In which of the following cases can E° be equal to zero?
 I. In any cell at equilibrium II. In a concentration cell
 III. E° can never be equal to zero.
 A. I only B. III C. I and II D. II only E. none of these
11. For a reaction in a voltaic cell, both ΔH° and ΔS° are positive. Which of the following statements is true?
 A. E°_{cell} will increase with an increase in temperature.
 B. E°_{cell} will decrease with an increase in temperature
 C. E°_{cell} will not change when the temperature increases.
 D. $\Delta G^\circ > 0$ for all temperatures.
 E. None of the above statements is true.
12. Which of the following is *not* determined by the principal quantum number, n , of the electron in a hydrogen atom?
 A. the minimum wavelength of the light needed to remove the electron from the atom
 B. the energy of the electron
 C. the shape of the corresponding atomic orbital(s)
 D. the size of the corresponding atomic orbital(s)
 E. All of the above are determined by n .
13. Which of the following ionic compounds has the largest lattice energy; that is, which has the lattice energy most favorable to a stable lattice?
 A. LiF B. LiI C. CsF D. MgO E. CsI
14. Which of the following has a central atom that is dsp^3 hybridized?
 A. SO_2 B. SBr_6 C. CF_4 D. SCl_4 E. SF_4^-
15. The spectrochemical series is
 $\Gamma^- < \text{Br}^- < \text{Cl}^- < \text{F}^- < \text{OH}^- < \text{H}_2\text{O} < \text{NH}_3 < \text{en} < \text{NO}_2^- < \text{CN}^-$
 Which of the following complexes will absorb visible radiation of the highest energy (shortest wavelength)?
 A. $[\text{Co}(\text{OH})_6]^{3-}$ B. $[\text{Co}(\text{NH}_3)_6]^{3+}$ C. $[\text{Co}(\text{I})_6]^{3-}$
 D. $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$ E. $[\text{Co}(\text{en})_3]^{3+}$

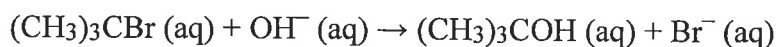
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16. The reaction of $(\text{CH}_3)_3\text{CBr}$ with hydroxide ion proceeds with the formation of $(\text{CH}_3)_3\text{COH}$.



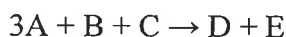
The following data were obtained at 55°C .

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

17. Consider the reaction



where the rate law is defined as

$$-\frac{\Delta[\text{A}]}{\Delta t} = k[\text{A}]^2[\text{B}][\text{C}]$$

An experiment is carried out where $[\text{B}]_0 = [\text{C}]_0 = 1.00 \text{ M}$ and $[\text{A}]_0 = 2.46 \times 10^{-4} \text{ M}$. After 2.96 min, $[\text{A}] = 3.20 \times 10^{-5} \text{ M}$. What is the value of k ?

- A. $8.30 \times 10^7 \text{ L}^3/\text{mol}^3 \cdot \text{s}$ B. $4.02 \times 10^{-7} \text{ L}^3/\text{mol}^3 \cdot \text{s}$
C. $2.14 \times 10^{-5} \text{ L}^3/\text{mol}^3 \cdot \text{s}$ D. $1.53 \times 10^2 \text{ L}^3/\text{mol}^3 \cdot \text{s}$
E. $9.18 \times 10^3 \text{ L}^3/\text{mol}^3 \cdot \text{s}$

18. A *p*-type semiconductor

- A. is made by doping host atoms with atoms having more valence electrons than the host.
B. has electrons that lie close in energy to the conduction bands.
C. is made by doping host atoms with atoms having fewer valence electrons than the host.
D. two of these
E. none of these

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19. Liquid A has vapor pressure x . Liquid B has vapor pressure y , and $x > y$. What is the mole fraction of A in the liquid mixture if the vapor above the solution is 50% A?

- A. $y/(2x + 2y)$ B. $y/(x + y)$ C. $x/(2x + 2y)$ D. $x/(x + y)$ E. none of these

20. Which of the following complexes shows geometric isomerism? A

- A. $K[Co(H_2O)_2Cl_4]$ B. $[Co(H_2O)_5Cl]Cl_2$ C. $[Co(H_2O)_5Cl]SO_4$
D. $Na_3[CoCl_6]$ E. $[Co(H_2O)_6]Cl_3$

21. Choose the species with the smallest hydration energy (absolute value).

- A. F^- B. Cl^- C. Br^- D. I^- E. All are the same

22. The nuclide ${}_{90}^{232}Th$ is radioactive. When one of these atoms decays, a series of α - and β^- -particle emissions occurs, taking the atom through many transformations to end up as an atom of ${}_{82}^{208}Pb$. How many α particles are emitted in converting



- A. 8 B. 10 C. 4 D. 6 E. 2

23. Which reaction will produce an isotope of the parent nuclide?

- A. ${}_{89}^{227}Ac \rightarrow \beta + ?$ B. ${}_{33}^{73}As + e \rightarrow ?$ C. ${}_{7}^{13}N \rightarrow \beta + ?$
D. ${}_{35}^{88}Br \rightarrow n + ?$ E. ${}_{84}^{210}Po \rightarrow He + ?$

24. Which of the following molecules is optically active?

- A. CH_3OH B. CH_2Cl_2 C. $CH_3CH_2CClFOH$
D. $CH_3CH_2OCH_3$ E. $(CH_3)_2CHOH$

25. When C_4H_8 is treated with water and H_2SO_4 , a tertiary alcohol is produced.

Which of the following structures could represent C_4H_8 in this reaction?

- A. $CH_3CH_2CH = CH_2$ B. $CH_3CH = CHCH_3$ C. $CH_3CH_2CH_2CH_3$
D. $(CH_3)_2C = CH_2$ E. none of these

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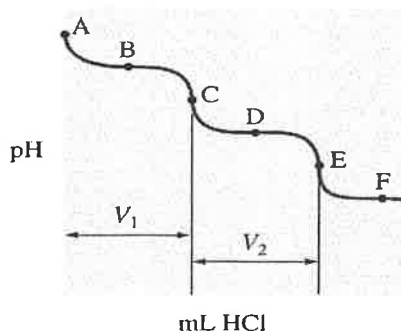
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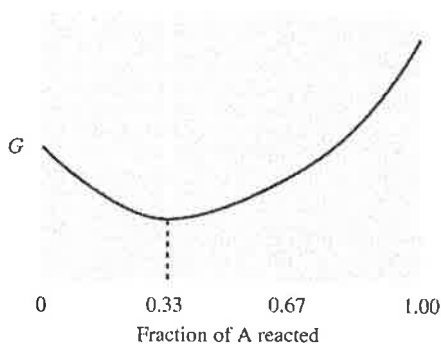
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二、非選擇題(50%)

- Please show how to prepare a buffered solution with pH of 4.37 by using benzoic acid ($\text{HC}_7\text{H}_5\text{O}_2$; $K_a = 6.4 \times 10^{-5}$) (6%)
- Consider the titration curve shown as following for the titration of Na_2CO_3 with HCl . Please answer the following questions. Be accounting for your answer. (8%)



- If a mixture of NaHCO_3 and Na_2CO_3 was titrated, what would be the relative sizes of V_1 and V_2 ?
 - If a mixture of NaOH and Na_2CO_3 was titrated, what would be the relative sizes of V_1 and V_2 ?
- Consider the following diagram of free energy (G) versus fraction of A reacted in terms of moles for the reaction $2\text{A}(\text{g}) \rightarrow \text{B}(\text{g})$.



Before any A has reacted, $P_A = 3.0 \text{ atm}$ and $P_B = 0$. Determine the sign of ΔG° and the value of K for this reaction. (6%)

- Write the Lewis structures that obey the octet rule for the following species. Assign the formal charge to each central atom, for each molecule or ion. (6%)
 - POCl_3
 - XeO_4
 - NO_4^{3-}

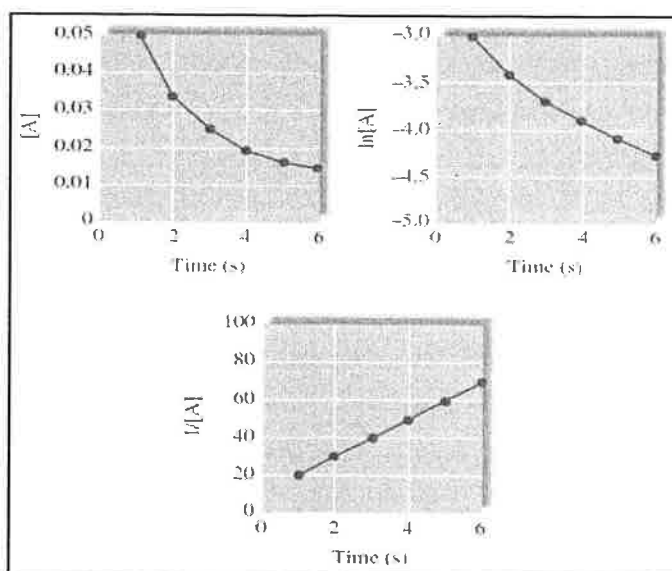
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5. Based on the concentration cell, please answer the following questions. (9%)
- What is the driving force for a concentration cell to produce a voltage?
 - Is the higher or the lower ion concentration solution present at the anode? Why?
 - When the anode ion concentration is decreased and/or the cathode ion concentration is increased, both give rise to larger cell potential. Why?
6. Which of the following statements is (are) true? Correct the false statements. (5%)
- A concentrated solution in water will always contain a strong or weak electrolyte.
 - A strong electrolyte will break up into ions when dissolved in water.
 - An acid is a strong electrolyte
 - A real gas behaves most ideally when the container volume is relatively large and the gas molecules are moving relatively quickly.
 - A catalyst does not change the value of the rate constant.
7. Experiment data for the reaction of $A \rightarrow 2B + C$ have been plotted in the following three different ways. Please answer the following three questions: (10%)



- What is the order of the reaction with respect to A, and what is the initial concentration of A?
- What is the concentration of A after 9 seconds?
- What are the first three half-lives for this experiment?