

國立臺灣大學九十六學年度轉學生入學考試試題

題號：35

科目：普通化學(B)

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※ 注意：請於試卷上「選擇題作答區」依序作答。

$h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$; $R_H = 1.096776 \times 10^7 \text{ m}^{-1}$; $C = 3.00 \times 10^8 \text{ m/s}$;

Gas constant: $R = 8.314 \text{ J/mol}\cdot\text{K} = 0.082 \text{ L}\cdot\text{atm/mol}\cdot\text{K}$; $1 \text{ L}\cdot\text{atm} = 101.3 \text{ J}$

I. 選擇題 (69%, 每題答案可能 1 至多個, 全部選對始得題分, 3 分)

1. Which of the following conversions is **CORRECT**?

(a) $1 \text{ nm} = 1 \times 10^{-6} \text{ m}$ (b) $2 \text{ mg} = 2 \times 10^{-3} \text{ g}$ (c) $3 \text{ }\mu\text{L} = 3 \times 10^{-9} \text{ L}$ (d) $4 \text{ cmHg} = 4 \text{ torr}$

2. Which of the following compounds has **CORRECT** formula?

(a) ammonium sulfide, $(\text{NH}_4)_2\text{SO}_4$ (b) propanoic acid, $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$
(c) potassium hydrogen phosphate, KH_2PO_4 (d) mercurous chloride, Hg_2Cl_2

3. Indicate which of the following is a permissible sets of quantum numbers?

(a) $n = 2, l = 1, m_l = +1, m_s = +1/2$ (b) $n = 3, l = 2, m_l = 0, m_s = -1/2$
(c) $n = 0, l = 0, m_l = 0, m_s = 0$ (d) $n = 1, l = 1, m_l = +1, m_s = +1$

4. Which of the following ranking is correct?

(a) ionic radius: $\text{F}^- < \text{Na}^+$ (b) atomic radius: $\text{Li} < \text{Na} < \text{K}$
(c) first ionization energy: $\text{Li} < \text{O} < \text{Ne}$ (d) acidity: $\text{MgO} < \text{P}_2\text{O}_5 < \text{SO}_3$

5. For the following central atom (underlined), which one has the sp^2 hybrid orbitals?

(a) P F_3 (b) S O_3 (c) B Cl_3 (d) C H_2O

6. Which one of the following sets is an example of isoelectronic?

(a) $\text{F}, \text{Cl}, \text{Br}$ (b) $\text{Be}^{2+}, \text{Mg}^{2+}, \text{Ca}^{2+}$ (c) O_2, O_3 (d) $\text{C}^{4+}, \text{N}^{3-}, \text{O}^{2-}$

7. Which one of the following crystal structures has 2 atoms/unit cell

(a) simple cubic (b) face-centered cubic (c) body-centered cubic (d) none of the above

8. A stock bottle of nitric acid indicated that the solution is 67.0% HNO_3 by mass and has a density of 1.40 g/mL. Calculate the molarity of the solution. ($H = 1.00, N = 14.0, O = 16.0$)

(a) 22.2 (b) 14.9 (c) 10.6 (d) 0.0148

9. Concerning with the dimethyl ether (CH_3OCH_3), ethanol ($\text{CH}_3\text{CH}_2\text{OH}$), and water (H_2O), which of the following statements is true?

(a) At same temperature, dimethyl ether shows highest vapor pressure.
(b) Dimethyl ether has the greatest enthalpy of vaporization (ΔH_{vap}).
(c) Dimethyl ether has the highest normal boiling point.
(d) All these three species are capable of hydrogen-bonding among themselves.

10. At 63.5°C , the vapor pressure of H_2O is 175 torr, and that of ethanol, $\text{C}_2\text{H}_5\text{OH}$, is 400 torr. Assuming ideal-solution is formed by mixing equal moles of H_2O and $\text{C}_2\text{H}_5\text{OH}$ at 63.5°C .

(a) The mole fraction of ethanol in the solution is 0.500.
(b) The partial pressure of ethanol over the solution is 200 torr.
(c) The total vapor pressure of the solution is 575 torr.
(d) The mole fraction of the ethanol in the vapor above the solution is 0.500.

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11. Which of the following 0.10 M solution is acidic?
 (a) $\text{CH}_3\text{CH}_2\text{COOK}$ (b) Na_2S (c) $\text{Fe}(\text{NO}_3)_3$ (d) CH_3NH_2
12. Place the following solutions in order of increasing freezing-point depression (ΔT).
 (a) $0.1\text{ m urea} < 0.1\text{ m HF} < 0.1\text{ m HCl} < 0.1\text{ m BaCl}_2$
 (b) $0.1\text{ m BaCl}_2 < 0.1\text{ m HCl} < 0.1\text{ m HF} < 0.1\text{ m urea}$
 (c) $0.1\text{ m BaCl}_2 = 0.1\text{ m HCl} = 0.1\text{ m HF} = 0.1\text{ m urea}$
 (d) $0.1\text{ m urea} < 0.1\text{ m HCl} = 0.1\text{ m HF} < 0.1\text{ m BaCl}_2$
13. Which of the following acid and its salt would be the best choice for preparing a pH = 3.5 buffer?
 (a) HClO_2 , $K_a = 1.2 \times 10^{-2}$ (b) HF , $K_a = 7.2 \times 10^{-4}$
 (c) HOCl , $K_a = 3.5 \times 10^{-8}$ (d) HCN , $K_a = 6.2 \times 10^{-10}$
14. A typical sample of vinegar has a pH of 3.00. Assuming that vinegar is an aqueous solution of acetic acid ($K_a = 1.8 \times 10^{-5}$), calculate the concentration of acetic acid in vinegar.
 (a) 0.18 M (b) 1.0×10^{-3} M (c) 0.056 M (d) 1.8×10^{-11} M (e) none of the above
15. Consider the titration of 25 mL of 0.10 M acetic acid (CH_3COOH , $K_a = 1.8 \times 10^{-5}$) with 0.10 M sodium hydroxide solution:
 (a) Before titration, the initial pH of 0.10 M HOAc solution is equal to 1.0
 (b) After adding 12.5 mL of 0.10 M NaOH to the solution, the pH of the solution is equal to 4.74
 (c) At equivalence point, the pH of the solution is equal to 7.00
 (d) Methyl red could be used as the indicator in this titration.
16. The following reaction was carried out at 25°C with the initial concentration of NO_2 being 0.70 mol/L and no $\text{NO}_{(g)}$ or $\text{O}_{2(g)}$ initially present. At equilibrium the NO_2 concentration was found to be 0.28 mol/L. Calculate K_c for the reaction: $2\text{NO}_{2(g)} \rightleftharpoons 2\text{NO}_{(g)} + \text{O}_{2(g)}$
 (a) 0.32 (b) 0.94 (c) 0.47 (d) 0.14
17. For a first order reaction: $\text{A} \rightarrow \text{P}$, the following data were obtained

time (sec)	[A] (M)
0.0	2.00
5.0	1.00
10.0	0.50
15.0	0.25
20.0	0.125

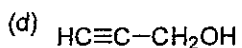
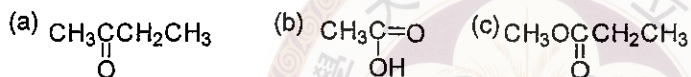
- (a) The average rate of the reaction between 0 s and 10 s is 0.15 M/s
 (b) The half life for this reaction is 5.0 sec
 (c) A plot of $1/[\text{A}]$ versus time is linear.
 (d) The rate constant for this reaction is 0.14 s^{-1}
18. For the reaction $2\text{NO}_2 + \text{F}_2 \rightarrow 2\text{NO}_2\text{F}$, the experimentally determined rate law is: $\text{Rate} = k[\text{NO}_2][\text{F}_2]$
 A suggested mechanism for this reaction is:
 step 1 $\text{NO}_2 + \text{F}_2 \xrightarrow{k_1} \text{NO}_2\text{F} + \text{F}$ slow
 step 2 $\text{F} + \text{NO}_2 \xrightarrow{k_2} \text{NO}_2\text{F}$ fast
- (a) Step 1 is the rate determining step
 (b) The rate law deduced from the mechanism is: $\text{Rate} = k[\text{NO}_2][\text{F}_2]$
 (c) This is an acceptable mechanism.
 (d) F is the catalyst in the reaction

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19. For the galvanic cell that bases on the following half-reactions under standard conditions, calculate the standard cell potential at 298 K.



- (a) -0.71 V (b) 0.71 V (c) 3.79 (d) 4.03
20. A gas is confined to a cylinder under constant atmospheric pressure. When the gas undergoes a particular chemical reaction, it releases 81 kJ of heat to its surroundings and does 17 kJ of P-V work on its surroundings.
- (a) $q = 81 \text{ kJ}$ (b) $w = 17 \text{ kJ}$ (c) $\Delta E = 98 \text{ kJ}$ (d) $\Delta H = -81 \text{ kJ}$
21. Which of the following is chelating agent?
 (a) NO_3^- (b) EDTA^{4-} (c) SCN^- (d) CN^-
22. Which of the following types of electromagnetic radiation has lowest energy?
 (a) UV (b) visible (c) IR (d) X-ray
23. Which of the following compound is an ester?



※ 注意：請於試卷上「非選擇題作答區」依序作答，並應註明作答之題號。

II. 計算問答題 (31%)

1. (a) Draw the molecular orbitals energy-level diagrams of the O_2 . (b) Determine the bond orders, (c) indicate the magnetic property (diamagnetic or paramagnetic). (11%)
2. For the complex $[\text{Mn}(\text{NH}_3)_6]^{2+}$, the NH_3 is a weak field ligand.
 (a) Sketch the energy-level diagram for the d orbitals, and indicate the placement of electrons for this complex ion.
 (b) Is the ion a high-spin or a low-spin complex? (10%)
3. Consider the Harber process, $1/2 \text{N}_2(\text{g}) + 3/2 \text{H}_2(\text{g}) \rightarrow \text{NH}_3(\text{g})$ at 25°C
 (a) Calculate the ΔH° , ΔS° , and ΔG° for the reaction.
 (b) Is this an endothermic or exothermic reaction?
 (c) Would you expect the entropy of the system to increase or decrease?
 (d) Is this a spontaneous or nonspontaneous reaction?
 (e) How is the rate of the reaction, fast or slow? (10%)

	$\text{N}_2(\text{g})$	$\text{H}_2(\text{g})$	$\text{NH}_3(\text{g})$
ΔH_f° (kJ/mol)			-46.19
S° (J/mol.K)	191.50	130.58	192.5
ΔG_f° (kJ/mol)			-16.66

試題必須隨卷繳回