

臺灣綜合大學系統 112 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 A	類組代碼	共同考科
		科目碼	E0017

※本項考試依簡章規定所有考科均「不可」使用計算機。

本科試題共計 3 頁

一、單選題 (80%，每題 2.5 分，不倒扣) 請於答案卡上作答，否則不予計分。

- When 3.0 L of oxygen gas (O_2) reacts with 1.5 L of nitrogen gas (N_2), 3.0 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) NO_4 ; (B) NO_2 ; (C) N_2O_3 ; (D) N_2O ; (E) NO .
- What is the correct formula for manganese (IV) oxide?
(A) MnO_4 ; (B) MnO_3 ; (C) Mg_2O_3 ; (D) MnO_2 ; (E) MgO .
- The empirical formula of styrene is CH ; its molar mass is 78.1. What is the molecular formula of styrene?
(A) C_6H_6 ; (B) C_8H_8 ; (C) $C_{10}H_{12}$; (D) $C_{12}H_6$; (E) $C_{14}H_{14}$.
- When the equation $NH_3 + O_2 \rightarrow NO + H_2O$ is balanced with the smallest set of integers, the sum of the coefficients is:
(A) 4; (B) 12; (C) 14; (D) 19; (E) 24.
- In the following reaction, which species is the reducing agent?
 $3Cu + 6H^+ + 2HNO_3 \rightarrow 3Cu^{2+} + 2NO + 4H_2O$
(A) H^+ ; (B) N in NO ; (C) Cu ; (D) Cu^{2+} ; (E) N in HNO_3 .
- How much water must be added to 20.0 mL of a 9.60 M sulfuric acid solution to make a 0.480 M solution? (Assume volumes are additive.)
(A) 400 mL; (B) 200 mL; (C) 180 mL; (D) 380 mL; (E) none of these.
- Consider three 1-L flasks at the same temperature and pressure. Flask A contains CO gas, flask B contains N_2 gas, and flask C contains O_2 gas. Which contains the lowest density?
(A) flask A; (B) flask B; (C) flask C; (D) Two of the flasks contain gases at the same density.
(E) All are the same.
- Calculate the following ratio of effusion rate at T_1 / Effusion rate at T_2 for a gas at Kelvin temperatures T_1 and T_2 where $T_2 = 2T_1$.
(A) 0.5; (B) 2.0; (C) 1.0; (D) $1/\sqrt{2}$; (E) $\sqrt{2}$
- Calculate the temperature at which the average kinetic energy of O_2 gas is twice that of He gas at $10.0^\circ C$.
(A) $293^\circ C$; (B) $20^\circ C$; (C) $2.5^\circ C$; (D) $40^\circ C$; (E) $859^\circ C$
- The reduction potentials for Au^{3+} and Ni^{2+} are as follows: (Hint: $96500 \times 1.73 = 167,000$)
 $Au^{3+} + 3e^- \rightarrow Au \quad E^\circ = +1.50 V$; $Ni^{2+} + 2e^- \rightarrow Ni \quad E^\circ = -0.23 V$
Calculate ΔG° (at $25^\circ C$) for the reaction: $2Au^{3+} + 3Ni \rightarrow 3Ni^{2+} + 2Au$
(A) $-5.0 \times 10^2 kJ$; (B) $5.0 \times 10^2 kJ$; (C) $-2140 kJ$; (D) $1.0 \times 10^3 kJ$; (E) $-1.0 \times 10^3 kJ$.
- To decrease the value of K for the following exothermic reaction, we should
 $2A(g) + B(g) \rightleftharpoons 2C(g)$
(A) decrease the temperature.; (B) increase the temperature.; (C) decrease the pressure.;
(D) increase the C pressure.; (E) Two of these are necessary.
- Calculate the pH of the $1.0 \times 10^{-12} M$ $NaOH$ aqueous solutions at $25^\circ C$.
(A) $pH \approx 2.0$; (B) $pH \approx 12$; (C) $pH \approx 4.0$; (D) $pH \approx 6.0$; (E) $pH \approx 7.0$.
- At $25^\circ C$, given that the K_a for HA is 3.5×10^{-8} , calculate the K value for the reaction of HA with OH^- .
(A) 3.5×10^6 ; (B) 3.5×10^{-8} ; (C) 3.5×10^{-22} ; (D) 2.9×10^{-7} ; (E) none of these
- Which of the following species is present in the greatest concentration in a $0.100 M H_2SO_4$ solution in H_2O ?
(A) H_3O^+ ; (B) HSO_4^- ; (C) H_2SO_4 ; (D) SO_4^{2-} ; (E) All species have the same concentration.

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<p>15. A 10-mL sample of tartaric acid ($K_{a1} = 1.5 \times 10^{-2}$, $K_{a2} = 2.0 \times 10^{-6}$) is titrated to a phenolphthalein(酚酞) endpoint with 20. mL of 1.0 M NaOH. What is the molarity of the acid? (A) 0.5 ; (B) 1.0 ; (C) 2.0 ; (D) 4.0 ; (E) impossible to determine.</p> <p>16. How many different possible triethylbenzenes exist? (A) 6 ; (B) 5 ; (C) 4 ; (D) 3 ; (E) 2.</p> <p>17. When heat is added to proteins, the hydrogen bonding in the secondary structure breaks apart. What are the algebraic signs of ΔH and ΔS for the denaturation process? (A) $\Delta H < 0$ and $\Delta S < 0$; (B) $\Delta H = 0$ and $\Delta S > 0$; (C) $\Delta H > 0$ and $\Delta S > 0$; (D) $\Delta H < 0$ and $\Delta S > 0$; (E) $\Delta H > 0$ and $\Delta S < 0$.</p> <p>18. A solution containing 10. mmol of CO_3^{2-} and 5.0 mmol of HCO_3^- is titrated with 1.0 M HCl. What volume of HCl must be added to reach the first equivalence point? (A) 5.0 mL ; (B) 10.0 mL ; (C) 15.0 mL ; (D) 20.0 mL ; (E) 25.0 mL.</p> <p>19. A radioactive isotope of vanadium, ${}^{53}_{23}\text{V}$, decays by producing β particles and gamma rays. The nuclide formed has the atomic number. (A) 52 ; (B) 54 ; (C) 23 ; (D) 22 ; (E) 24.</p> <p>20. The number of a certain radioactive nuclide present in a sample decays from 2.41×10^2 to 6.02×10^1 in 30 minutes. What is the half-life of this radioactive species? (A) 2.0×10^1 minutes ; (B) 2.4×10^2 minutes ; (C) 1.5×10^1 minutes ; (D) 6.0×10^2 minutes ; (E) 1.0×10^1 minutes.</p> <p>21. Which of the following complexes shows geometric isomerism? (A) $[\text{Co}(\text{H}_2\text{O})_5\text{Cl}]\text{SO}_4$; (B) $[\text{Co}(\text{H}_2\text{O})_6]\text{Cl}_3$; (C) $[\text{Co}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}_2$; (D) $\text{K}[\text{Co}(\text{H}_2\text{O})_2\text{Cl}_4]$; (E) $\text{Na}_3[\text{CoCl}_6]$.</p> <p>22. How many unpaired electrons are there in the complex ion $[\text{Co}(\text{NO}_3)_6]^{4-}$? For this ion, the nitrate ligands produce a very strong crystal field. (Co: $[\text{Ar}]4s^23d^7$) (A) 1 ; (B) 2 ; (C) 3 ; (D) 4 ; (E) 5.</p> <p>23. What ions are very important for the proper functioning of biologic systems, such as nerves and muscles? (A) alkali metal ions ; (B) nitrogen ions ; (C) oxygen ions ; (D) sulfur ions ; (E) alkaline earth metal ions.</p> <p>24. What is the expected osmotic pressure, in torr, of a 0.0100 M solution of NaCl in water at 25°C? (1.0 atm = 760 torr) (A) 0.245 torr ; (B) 0.495 torr ; (C) 374 torr ; (D) 187 torr ; (E) 561 torr.</p> <p>25. How many of the following molecules and ions contain double or triple bonds? N_2 ; H_2CO ; C_2H_4 ; C_2H_6 ; SCN^- (A) 1 ; (B) 2 ; (C) 3 ; (D) 4 ; (E) 5.</p> <p>26. How many acceptable and equivalent resonance structures can be drawn for NO_3^-? (A) 0 ; (B) 1 ; (C) 2 ; (D) 3 ; (E) 4.</p> <p>27. Which of the following molecules has a dipole moment? (A) SiCl_4 ; (B) BCl_3 ; (C) PCl_3 ; (D) Cl_2 ; (E) none of these.</p> <p>28. A certain substance, X, has a triple-point temperature of 20°C at a pressure of 2.0 atm. Which one of the following statements cannot possibly be true? (A) X can exist as a liquid above 20°C. ; (B) X can exist as a solid above 20°C. (C) Liquid X can exist as a stable phase at 25°C, 1 atm. ; (D) Both liquid and solid X have the same vapor pressure at 20°C ; (E) All of these statements could be true.</p> <p>29. Calculate ΔE for a system that releases 32 J of heat while 56 J of work is done on it. (A) 24 J ; (B) 88 J ; (C) -88 J ; (D) -24 J ; (E) 56 J.</p>			

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本科試題共計 3 頁

30. Which of the following statements is true for a monatomic ideal gas?

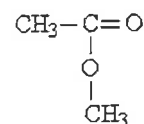
(A) $E = C_p RT$; (B) $C_p = 2.5 R$; (C) $C_v = C_p + R$; (D) C_v is temperature dependent; (E) $C_v = C_p$.

31. Specify the hybridization of the nitrogen atom in each of the following, in order.

NO_3^- N_2 NO_2^-
 (A) sp^3, sp^2, sp^2 ; (B) sp^2, sp, sp^2 ; (C) sp^2, sp^2, sp^2 (D) sp^2, sp, sp ; (E) sp^2, sp, sp^3

32. Identify the type of organic compound shown on right-hand side:

(A) alcohol; (B) ketone; (C) ether; (D) aldehyde; (E) ester.



二、非選擇題 (20% 計算與證明題需寫過程否則不予計分)

請於答案卷上作答，否則不予計分。

1. (a) Justify: at constant pressure, $q_p = \Delta H$. (3 %)

(b) Justify: at constant temperature and pressure, $\Delta G = \text{maximum of } W_{\text{useful}}$ (4 %)

2. (a) Please derive the integrated rate law of the **first-order** reaction. (4 %)

(b) Briefly describe how to get the **activation energy** of a chemical reaction. (3 %)

3. Use the molecular orbital model to **draw MO energy-level diagrams** for predicting the **magnetism** and **bond order** of B_2 molecule. (6 %)