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。

1. 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.
2. What is the correct formula for manganese (IV) oxide?
   (A) MnO_4 ; (B) MnO_3 ; (C) Mg_2O_3 ; (D) MnO_2 ; (E) MgO.
3. 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) $C_{10}H_{22}$; (D) $C_{12}H_6$; (E) $C_{14}H_{14}$.
4. 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.
5. 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.
6. 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 .
7. 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.
8. 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) $\sqrt{2}$
9. Calculate the temperature at which the average kinetic energy of O_2 gas is twice that of He gas at 10.0°C.
   (A) 293°C ; (B) 20°C ; (C) 2.5°C ; (D) 40°C ; (E) 859°C
10. The reduction potentials for Au^{3+} and Ni^{2+} are as follows: (Hint: 96500 x 1.73 = 167,000)
    $Au^{3+} + 3e^- \rightarrow Au$ $\quad E° = +1.50$ V ; $\quad Ni^{2+} + 2e^- \rightarrow Ni$ $\quad E° = -0.23$ V
    Calculate $\Delta G°$ (at 25°C) for the reaction: $2Au^{3+} + 3Ni \rightarrow 3Ni^{2+} + 2Au$
    (A) -5.0×10^2 kJ ; (B) 5.0×10^2 kJ ; (C) –2140 kJ ; (D) 1.0×10^3 kJ; (E) -1.0×10^3 kJ.
11. 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.
12. Calculate the pH of the 1.0×10^{-12} *M* NaOH aqueous solutions at 25°C.
    (A) pH ≈ 2.0 ; (B) pH ≈ 12 ; (C) pH ≈ 4.0 ; (D) pH ≈ 6.0 ; (E) pH ≈7.0.
13. At 25°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
14. 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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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.

16. How many different possible triethylbenzenes exist?
(A) 6 ; (B) 5 ; (C) 4 ; (D) 3 ; (E) 2.

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 $\Delta S < 0$.

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.

19. A radioactive isotope of vanadium, $^{53}_{23}V$, 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.

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.

21. Which of the following complexes shows geometric isomerism?
(A) $[Co(H_2O)_5Cl]SO_4$; (B) $[Co(H_2O)_6]Cl_3$; (C) $[Co(H_2O)_5Cl]Cl_2$; (D) $K[Co(H_2O)_2Cl_4]$; (E) $Na_3[CoCl_6]$.

22. How many unpaired electrons are there in the complex ion $[Co(NO_3)_6]^{4-}$? For this ion, the nitrate ligands produce a very strong crystal field. (Co: $[Ar]4s^23d^7$)
(A) 1 ; (B) 2 ; (C) 3 ; (D) 4; (E) 5.

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.

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.

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.

26. How many acceptable and equivalent resonance structures can be drawn for NO_3^-?
(A) 0 ; (B) 1 ; (C) 2 ; (D) 3 ; (E) 4.

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.

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.

29. Calculate Δ*E* 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.

 背面有題，請繼續作答。

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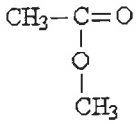
30. Which of the following statements is true for a monatomic ideal gas?
(A) $E = C_p RT$; (B) $C_p = 2.5\ R$; (C) $C_v = C_p + R$; (D) C_v is temperature dependent ; (E) $C_v = C_p$.

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, $\mathbf{q_p = \Delta H}$. (3 %)
(b) Justify: at constant temperature and pressure, $\mathbf{\triangle G =}$ **maximum of** $\mathbf{W_{useful}}$ (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 $\mathbf{B_2}$ molecule. (6 %)