

九十九學年度 國立中正大學化學暨生物化學系
大學入學甄試化學性向測驗 試題

選擇題(單選)：成績滿分 = 100 分，每題 2.5 分

考試日期：04/17/2010 星期六

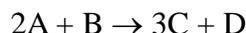
1. According to the law of definite proportions (定比定律),

(a) if the same two elements form two different compounds, they do so in the same ratio, (b) it is not possible for the same two elements to form more than one compound, (c) the ratio of the masses of the elements in a compound is always the same, (d) the total mass after a chemical change is the same as before the change, (e) none of these.

2. 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) Millikan's oil-drop experiment showed that the charge on any particle was a simple multiple of the charge on the electron, (d) The cathode-ray tube proved that electrons have a negative charge.

3. In the reaction



3.0 mol A and 2.0 mol B react to form 4.0 mol C. What is the percent yield of this reaction?

(a) 50%, (b) 67%, (c) 75%, (d) 89%, (e) 100%.

4. You have 130.0 mL of a 0.240 M solution of NaCl sitting in a beaker. After several days you test the solution and find that it has a concentration of 0.410 M. How much water must have evaporated? (Assume volumes are additive.)

(a) 76.1 mL, (b) 53.9 mL, (c) 206 mL, (d) 130 mL, (e) 129 mL.

5. Bromine exists naturally as a mixture of bromine-79 and bromine-81 isotopes. An atom of bromine-79 contains

(a) 35 protons, 44 neutrons, and 35 electrons, (b) 34 protons and 35 electrons only, (c) 44 protons, 44 electrons, and 35 neutrons, (d) 35 protons, 79 neutrons, and 35 electrons, (e) 79 protons, 79 electrons, and 35 neutrons.

6. A sample of N₂ gas is contaminated with a gas (gas A) of unknown molar mass. The partial pressure of each gas is known to be 200 torr at 25 °C. The gases are allowed to effuse through a pinhole, and it is found that gas A escapes at 2.65 times the rate of N₂. The molar mass of gas A is

(a) 3.99 g/mol, (b) 197 g/mol, (c) 74.2 g/mol, (d) 10.6 g/mol, (e) 28.0 g/mol.

7. According to the Brønsted-Lowry definition, an acid is

(a) a substance that increases the hydroxide ion concentration in a solution, (b) a substance that increases the hydrogen ion concentration in a solution, (c) a substance that can accept a proton from another species in solution, (d) a substance that can donate a proton to another species, (e) an electron pair acceptor.

8. Magnesium metal reacts with hydrochloric acid to form aqueous magnesium chloride and hydrogen gas. When 3.65 g of magnesium is added to 50.0 mL of 3.00 M hydrochloric acid, what mass of hydrogen is produced, assuming a complete reaction? (Mg: 24.31 amu)

(a) 0.123 g, (b) 0.151 g, (c) 0.246 g, (d) 0.302 g, (e) none of these.

9. To calculate the concentration in molarity of a salt solution, you need to know

(a) the mass of the salt added to the solution and the volume of water added to the solution, (b) the mass of the salt added to the solution and the total volume of the solution, (c) the mass of the salt added, the molar mass of the salt, and the total volume of the solution, (d) the molar mass of the salt and the total volume of the solution, (e) the mass of the salt added, the molar mass of the salt, the volume of water added, and the total volume of the solution.

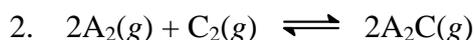
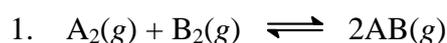
10. What mass of styrene (molar mass 104.1 g/mol) contains 4.50×10^{20} molecules of styrene?

(a) 7.48×10^{-4} g, (b) 7.48×10^{-3} g, (c) 7.78×10^{-2} g, (d) 0.00778 g, (e) 7.48×10^4 g.

11. When the equation $C_{10}H_{22} + O_2 \rightarrow CO_2 + H_2O$ is balanced with the smallest set of integers, the sum of the coefficients is

(a) 4, (b) 64, (c) 75, (d) 44, (e) 53.

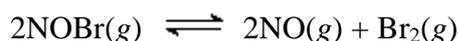
12. For the hypothetical reactions 1 and 2, $K_1 = 10^2$ and $K_2 = 10^{-4}$.



What is the value for K for reaction 3?

(a) 10^{-2} , (b) 10^4 , (c) 10^6 , (d) 10^2 , (e) 10^{-4} .

13. Consider the reaction (assume an ideal gas mixture)



A 3.0 L vessel was initially filled with pure NOBr at a pressure of 3.6 atm and 300 K. At equilibrium, the partial pressure of NOBr was 2.3 atm. Determine the value of K_p for the reaction.

(a) 0.73, (b) 0.42, (c) 0.21, (d) 1.2, (e) 0.07.

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





(a) Cl_2 , (b) H_2 , (c) Mg , (d) Mg^{2+} , (e) Cl^{-} .

15. Nitrogen gas reacts with hydrogen gas to form ammonia. At 200°C in a closed container, 1.1 atm of nitrogen gas is mixed with 2.1 atm of hydrogen gas. At equilibrium, the total pressure is 2.2 atm. Calculate the partial pressure of hydrogen gas at equilibrium.

(a) 2.1 atm, (b) 0.60 atm, (c) 0.70 atm, (d) 0.50 atm, (e) 0.0 atm.

16. The heat combustion of acetylene, $\text{C}_2\text{H}_2(\text{g})$, at 25°C , is -1299 kJ/mol . At this temperature, ΔH°_f values for $\text{CO}_2(\text{g})$ and $\text{H}_2\text{O}(\text{l})$ are -393 and -286 kJ/mol , respectively. Calculate ΔH°_f for acetylene.

(a) 2376 kJ/mol, (b) 625 kJ/mol, (c) 227 kJ/mol, (d) -625 kJ/mol , (e) -227 kJ/mol .

17. The pH of a 0.21 M solution of a weak monoprotic acid, HA, is 2.66. Calculate K_a for this acid.

(a) 2.1×10^{-4} , (b) 2.2×10^{-3} , (c) 4.8×10^{-6} , (d) 2.3×10^{-5} , (e) 4.6×10^{-10} .

18. You have a solution of 0.10 M Cl^{-} and $0.10 \text{ M CrO}_4^{2-}$. You add 0.10 M silver nitrate dropwise into the solution. K_{sp} for Ag_2CrO_4 is 9.0×10^{-12} and for AgCl is 1.6×10^{-10} . Which of the following will precipitate first?

(a) silver chloride, (b) silver chromate, (c) silver nitrate, (d) cannot be determined from the information given, (e) none of these.

19. How many electrons can be described by the quantum numbers $n = 4$, $l = 3$, $m_l = 0$?

(a) 0, (b) 2, (c) 6, (d) 10, (e) 14.

20. For the reaction below, $K_p = 1.16$ at 800°C .



If a 25.0 g sample of CaCO_3 (molar mass 100.1 g/mol) is put into a 10.2 L container and heated to 800°C , what percent of the CaCO_3 will react to reach equilibrium?

(a) 23.7%, (b) 53.8%, (c) 13.4%, (d) 100%, (e) 47.4%.

21. Which of the following is *not* determined by the principal quantum number, n , of the electron in a hydrogen atom?

(a) The energy of the electron, (b) The minimum wavelength of the light needed to remove the electron from the atom, (c) The size of the corresponding atomic orbital(s), (d) The shape of the corresponding atomic orbital(s), (e) All of the above are determined by n .

22. An atom of fluorine contains 9 electrons. How many of these electrons are in s orbitals?

(a) 2, (b) 4, (c) 6, (d) 8, (e) 10.

23. Estimate the bond energy of the N₂ molecule.

$$\Delta H_f^\circ \text{ for NH}_3 = -46.0 \text{ kJ/mol}$$

$$\text{N-H bond energy} = 391 \text{ kJ/mol}$$

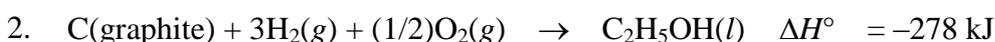
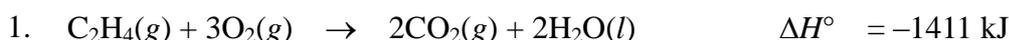
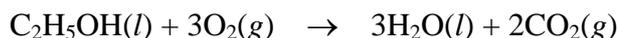
$$\text{H-H bond energy} = 432 \text{ kJ/mol}$$

(a) 1140 kJ/mol, (b) 479 kJ/mol, (c) 958 kJ/mol, (d) 1004 kJ/mol, (e) 1096 kJ/mol.

24. In the Lewis structure for I₃⁻, there are _____ electrons around the central iodine atom.

(a) 4, (b) 6, (c) 8, (d) 10, (e) 12.

25. Using Hess's law and equations 1–3 below, find ΔH° at 25 °C for the oxidation of C₂H₅OH(l).



(a) 44 kJ, (b) 632 kJ, (c) -1367 kJ, (d) -1742 kJ, (e) none of these.

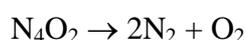
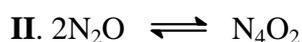
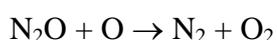
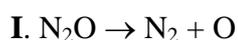
26. The reaction $\text{A} \rightarrow \text{B} + \text{C}$ is known to be zero order in A with a rate constant of $3.8 \times 10^{-2} \text{ mol/L} \cdot \text{s}$ at 25 °C. An experiment was run at 25 °C where $[\text{A}]_0 = 1.8 \times 10^{-3} \text{ M}$. What is the rate after 6.7 minutes?

(a) $3.8 \times 10^{-2} \text{ mol/L} \cdot \text{s}$, (b) $1.5 \times 10^{-11} \text{ mol/L} \cdot \text{s}$, (c) $6.7 \times 10^{-4} \text{ mol/L} \cdot \text{s}$, (d) $1.8 \times 10^{-3} \text{ mol/L} \cdot \text{s}$, (e) $6.8 \times 10^{-5} \text{ mol/L} \cdot \text{s}$.

27. What is the wavelength of light that is emitted when an excited electron in the hydrogen atom falls from the $n = 5$ level to the $n = 2$ level?

(a) $5.12 \times 10^{-7} \text{ m}$, (b) $4.34 \times 10^{-7} \text{ m}$, (c) $6.50 \times 10^{-7} \text{ m}$, (d) $5.82 \times 10^{-7} \text{ m}$, (e) None of these.

28. The experimental rate law for the decomposition of nitrous oxide (N₂O) to N₂ and O₂ is $\text{Rate} = k[\text{N}_2\text{O}]^2$. Two mechanisms are proposed:



Which of the following could be a correct mechanism?

(a) Mechanism I with the first step as the rate-determining step, (b) Mechanism I with the second step as the rate-determining step, (c) Mechanism II with the second step as the rate-determining step, (d) Two of these could be correct, (e) none of these could be correct.

29. Which of the following statements is true?

(a) When two opposing processes are proceeding at identical rates, the system is at equilibrium, (b) Catalysts are an effective means of changing the position of an equilibrium, (c) The concentration of the products equals that of the reactants and is constant at equilibrium, (d) An endothermic reaction shifts toward reactants when heat is added to the reaction, (e) none of the above statements is true.

- 30.** When a 1.50 g sample of glutamic acid is dissolved in 100.0 g of H₂O, the resulting solution freezes at -0.190 °C. K_f for H₂O is 1.86 °C/m. The molar mass of glutamic acid is
(a) 14.7 g/mol, (b) 1.50 g/mol, (c) 189 g/mol, (d) 28.0 g/mol, (e) 147 g/mol.
- 31.** What ions are very important for the proper functioning of biologic systems, such as nerves and muscles?
(a) alkaline earth metal ions, (b) alkali metal ions, (c) oxygen ions, (d) sulfur ions, (e) nitrogen ions.
- 32.** Choose the species with the largest bond strength.
(a) F₂, (b) Cl₂, (c) Br₂, (d) I₂, (e) All are the same.
- 33.** Which metal ion has a d⁶ electron configuration?
(a) Mn²⁺, (b) Ni²⁺, (c) Fe³⁺, (d) Co³⁺, (e) Ti²⁺.
- 34.** Which of the following is polar?
(a) SiF₄, (b) XeF₂, (c) BCl₃, (d) NBr₃, (e) SBr₆.
- 35.** Which of the following processes decreases the atomic number by 2?
(a) alpha-particle production, (b) beta production, (c) gamma-ray production, (d) positron-particle production, (e) proton production.
- 36.** Which of the following, upon reacting with oxygen, would form the greatest amount of carbon dioxide?
(a) *n*-pentane (正戊烷), (b) isopentane (異戊烷), (c) neopentane (新戊烷), (d) Two of these would form equal amounts, (e) All of these would form equal amounts.
- 37.** In which of the following lists do all members have a C=O bond?
(a) ester, aldehyde, secondary alcohol, ketone, (b) any alcohol, ether, ester, (c) ester, aldehyde, ketone, (d) secondary alcohol, ketone, aldehyde, (e) carboxylic acid, ether, tertiary alcohol.
- 38.** The overall shape of a protein is maintained by
(a) hydrogen bonding, (b) ionic bonds, (c) dipole-dipole bonding, (d) covalent bonds, (e) all of these.
- 39.** The Cl–Kr–Cl bond angle in KrCl₄ is closest to
(a) 90°, (b) 109°, (c) 120°, (d) 150° (e) 180°.
- 40.** Vitamin C contains the elements C, H, and O. It is known to contain 40.9% C and 4.58% H by mass. The molar mass of vitamin C has been found to be about 180. The molecular formula for vitamin C is
(a) C₂H₃O₂, (b) C₃H₄O₃, (c) C₄H₆O₄, (d) C₆H₈O₆, (e) none of these.