

國立中央大學104學年度碩士班考試入學試題

所別：水文與海洋科學研究所碩士班 不分組(一般生) 科目：普通化學 共 2 頁 第 1 頁  
水文與海洋科學研究所碩士班 不分組(在職生)

本科考試禁用計算器

\*請在答案卷(卡)內作答

Please use the following information to answer the questions or solve the problems.

Gas constant:  $R = 0.082 \text{ atm L mol}^{-1} \text{ K}^{-1}$

Atomic weight: H = 1, C = 12, O = 16, Na = 23

Atomic number: C = 6, Mg=12, Si = 14, P = 15, Ar = 18, K = 19, Fe = 26, Ni=28,

Cu = 29, Br = 35, Sr=38, W=74, Os=76, Ir=77, Po = 84

Solubility product: AgCl,  $K_{sp} = 1.8 \times 10^{-10}$

Dissociation constant: acetic acid  $K = 1.7 \times 10^{-5}$ , water  $K = 1.0 \times 10^{-14}$

1 mM =  $10^{-3} \text{ M}$

參考用

A. Multiple choices (2.5 points each)

1. Which of the following as a solid has a crystal structure containing discrete (or separate) molecules? a. Table salt, b. glucose, c. gold, d. graphite, e. glass.
2. Which of the following nuclear decay results in an increase in the nuclear charge? a. alpha decay, b. beta decay, c. electron capture decay, d. positron decay, e. gamma decay, f. none of the above.
3. Which of the following compounds is non-polar? a.  $\text{CH}_4$ , b.  $\text{H}_2\text{O}$ , c. HF, d.  $\text{CH}_3\text{OH}$ , e.  $\text{NH}_3$ .
4. Which of the following species would not function as an oxidizing agent? a.  $\text{MnO}_4^-$ , b.  $\text{Mn}^{2+}$ , c.  $\text{H}^+$ , d. S, e.  $\text{Br}^-$
5. Which of the following diatomic molecules has the greatest bond strength? A.  $\text{Cl}_2$ , b. HCl, c. CO, d.  $\text{H}_2$ , e. HF.
6. The oxidation number of phosphorus in  $\text{MgHPO}_4$  is a. -5, b. +1, c. +3, d. +4, e. +5.
7. In the water molecule the valence electrons are arranged about the central oxygen atom in term of a a. pyramid, b. tetrahedron, c. trigonal plane, d. bent structure, e. square plane.
8. What is the molarity of a  $\text{Na}_2\text{SO}_3$  solution, which contains 12.6 mg of sodium sulfite in 2.0 L of solution? a. 0.10 M, b. 0.050 M, c. 0.10 mM, d. 0.050 mM, e. 0.020 mM, f. None of the above.
9. All of the following are true except: a) An ion has a positive or negative charge. b) Metals tend to form positive ions. c) Ions are formed by adding electrons to a neutral atom. d) Ions are formed by changing the number of neutrons in an atom's nucleus. e) Ions are formed by removing electrons from a neutral atom.
10. What is the electron configuration for the most stable ion of the element magnesium?  
a)  $1s^2 2s^2 2p^6 3s^2 3p^2$  b)  $1s^2 2s^2 2p^6 3s^1$  c)  $1s^2 2s^2 2p^6 3s^2 3p^6$  d)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^2$  e)  $1s^2 2s^2 2p^6$
11. Which one of the following is a nonmetal? a) Os b) Ir c) W d) Sr e) Br

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12. Which of the following is most likely to be an ionic compound? a)  $\text{NF}_3$  b)  $\text{Na}_2\text{O}$  c)  $\text{CO}_2$  d)  $\text{N}_2$  e)  $\text{CH}_4$
13. The ground state electron configuration of Nickel is given by a)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$  b)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$  c)  $[\text{Kr}] 5s^2 4d^6$  d)  $1s^2 2s^2 3s^2 3p^6 3d^8$  e)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1 4p^3$
14. Which of the following has 2 unpaired electrons in its electron configuration? a) As b) P c)  $\text{S}^{2-}$  d)  $\text{Ge}^{+2}$  e) Si
15. Which one of the following metals is the most reactive? a) Li b) Na c) K d) Cs e) Rb
16. The ability of an atom in a molecule to attract electron density to itself is termed a) paramagnetism b) diamagnetism c) electronegativity d) electron affinity e) ionization potential
17. The molecule ( $\text{H}_2\text{C}=\text{C}=\text{CH}_2$ ) has \_\_\_\_\_  $\sigma$  and \_\_\_\_\_  $\pi$  bonds, respectively. a) 4 and 2 b) 2 and 4 c) 2 and 2 d) 2 and 6 e) 6 and 2
18. Which one of the following elements has the largest first ionization energy? a) Na b) Rb c) Al d) Te e) Cl
19. The volume of a microsyringe is  $10.0 \mu\text{l}$ . This is the same as a.  $10.0 \mu\text{g}$ , b.  $0.0100 \text{ mL}$ , c.  $0.0100 \text{ m}^3$ , d.  $0.0100 \text{ g}$ , e.  $10.0 \text{ mg}$ .
20. What is the ideal bond angle for the C-O-C bond in the molecule ( $\text{H}_3\text{C}-\text{O}-\text{CH}_3$ )? a)  $180^\circ$  b)  $120^\circ$  c)  $109^\circ$  d)  $90^\circ$  e)  $135^\circ$

參考用

B. Short questions (5 points each)

1. Balance the following reactions:  
 $3 \text{CH}_3\text{CH}_2\text{COOH} + \_ \text{O}_3 = \_ \text{CO}_2 + \_ \text{H}_2\text{O}$   
 $\text{NO}_3^- + \_ \text{I}^- = \_ \text{IO}_3^- + \_ \text{NO}_2$
2. What is the density (g/L) of the ethane,  $\text{C}_2\text{H}_6$ , at  $25^\circ\text{C}$  and 1.1 atm pressure?
3. What are the electron-dot structures of  $\text{BrO}_3^-$  ion and  $\text{HNO}_3$ ?
4. Draw the structure of methane molecule. Is it a polar or non-polar molecule? Explain.
5. What is hydrogen bonding between water molecules? Use a diagram to explain.
6. The gaseous reaction  $2\text{H}_2 + 2\text{NO} = 2\text{H}_2\text{O} + \text{N}_2$  is first order in  $\text{H}_2$  and second order in  $\text{NO}$ . Please write equations of (a) the equilibrium constant, and (b) the rate law.
7. The molar solubility of  $\text{PbBr}_2$  is 0.010 M. Calculate its solubility product.
8. The second dissociation constant of sulfuric acid is  $10^{-2}$ . Calculate the concentration of sulfate in a 0.20 M sulfuric acid solution.
9. Assign oxidation state (or oxidation numbers) to nitrogen in each of the following compounds: (a)  $\text{N}_2\text{H}_4$  (b)  $\text{Na}_3\text{N}$  (c)  $\text{N}_2\text{O}_3$  (d)  $\text{NO}_3^-$
10. A soda water is bottled under a  $\text{CO}_2$  pressure of 4.0 atm. The solubility of  $\text{CO}_2$  at 4.0 atm is 0.68 g/100 cc  $\text{H}_2\text{O}$ . What is its concentration of  $\text{CO}_2$  after the bottle is opened if the partial pressure of  $\text{CO}_2$  is  $4.0 \times 10^{-4}$  atm?

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