

所別：水文科學研究所碩士班 一般生 科目：普通化學

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:  $C = 6, Si = 14, P = 15, Ar = 18, K = 19, Cu = 29, Br = 35, Po = 84$

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

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

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

A. Multiple choices (2 points each)

1. The volume of water is 5.48 ml. This is the same as (a) 5.48 g, (b)  $0.00548 \text{ m}^3$ , (c) 0.00548 L, (d) 0.00548 kg, (e) 5.48 mg.
2. The formula for potassium carbonate is (a)  $P_2CO_3$ , (b)  $PO_2CO_3$ , (c)  $P_2C$ , (d)  $K_2CO_3$ , (e)  $K_2C$
3. If  $\Delta H = +32 \text{ kJ}$  for a chemical reaction, the reaction (a) occurs rapidly, (b) releases heat, (c) absorbs heat, (d) cannot occur, (e) requires catalyst.
4. Which radiation has the shortest wavelength? (a) UV, (b) X-ray, (c) Gamma ray, (d) Red light, (e) Radiowave.
5. The number of orbitals in an f subshell is (a) 1, (b) 2, (c) 3, (d) 5, (e) 7.
6. Which of the following elements has the highest first ionization energy? (a) F, (b) B, (c) C, (d) I, (e) Xe.
7. Which compound contains both ionic and covalent bonds? (a)  $PF_3$ , (b) KF, (c) NaH, (d)  $MgSO_4$ , (e)  $C_3H_8$ .
8. Which of the following diatomic molecules has the greatest bond strength? (a)  $Cl_2$ , (b) HCl, (c) CO, (d)  $H_2$ , (e) HF.
9. In the hydronium ion,  $H_3O^+$ , 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.
10. Which of the following molecules has pi-bonds? (a)  $CH_4$ , (b)  $H_2O$ , (c)  $C_2H_5OH$ , (d)  $C_2H_4$ , (e)  $NH_3$
11. Which of the following compound is expected to exhibit hydrogen bonding? (a)  $CH_2O$ , (b)  $CH_3F$ , (c) HF, (d)  $CH_2ClF$ , (e) None of the above.
12. What is the molarity of a  $Na_2CO_3$  solution, which contains 10.6 mg of sodium carbonate 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.
13. Which of the following phase changes is or are endothermic (absorbing heat)? (a) Condensation of vapor, (b) Crystallization of molten salt, (c) Evaporation of water, (d) Both a and b, (e) Both b and (c)

注意：背面有試題

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- Which of the following as a solid has a crystal structure containing discrete (or separate) molecules? (a) Table salt, (b) Water, (c) gold, (d) graphite, (e) glass.
- What is the conjugate base of  $\text{HSO}_4^-$ ? (a)  $\text{H}_2\text{SO}_4$ , (b)  $\text{H}_2\text{SO}_3$ , (c)  $\text{HSO}_3^-$ , (d)  $\text{SO}_4^{2-}$ , (e)  $\text{SO}_3^{2-}$ .
- The oxidation number of phosphorus in  $\text{MgHPO}_4$  is (a) -5, (b) +1, (c) +3, (d) +4, (e) +5.
- 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)  $\text{Br}^-$
- 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  $\text{NO}$ . Which is the rate law? (a)  $kP_{\text{H}_2} P_{\text{NO}}$ , (b)  $kP_{\text{H}_2}^2 P_{\text{NO}}^2$ , (c)  $kP_{\text{H}_2}^2 P_{\text{NO}}$ , (d)  $kP_{\text{H}_2} P_{\text{NO}}^2$ , (e)  $kP_{\text{H}_2\text{O}} P_{\text{N}_2}^2$
- Which of the following is a greenhouse gas? (a)  $\text{O}_2$ , (b)  $\text{N}_2$ , (c)  $\text{CO}_2$ , (d) Ar, (e) Xe
- Carbon monoxide is toxic because it (a) reacts with oxygen, (b) catalyzes smog formation, (c) undergoes photochemical reaction, (d) forms a stable complex with hemoglobin, (e) catalyzes the decomposition of ozone.

B. Short questions (6 points each)

- Balance the following reactions:  
 $3 \text{CH}_3\text{CH}_2\text{COOH} + \_ \text{O}_3 = \_ \text{CO}_2 + \_ \text{H}_2\text{O}$   
 $\text{I}^- + \_ \text{NO}_3^- + \_ \text{H}^+ = \_ \text{IO}_3^- + \_ \text{NO}_2 + \_ \text{H}_2\text{O}$
- What is the density (g/L) of the ethane,  $\text{C}_2\text{H}_6$ , at  $27^\circ\text{C}$  and 4.1 atm pressure?
- What are the electronic configurations of Si, Ar and Cu?
- What are the electron-dot structures of  $\text{BrO}_3^-$  ion and  $\text{HNO}_3$ ?
- Draw the structure of methane molecule. Is it a polar or non-polar molecule? Explain.
- What is hydrogen bonding between water molecules? Use a diagram to explain.
- Classify the following compounds into strong acids, weak acids, strong bases, weak bases, and none of the above: HBr,  $\text{B}(\text{OH})_3$ ,  $\text{NH}_3$ ,  $\text{NH}_4^+$ , CaO,  $\text{CH}_3\text{CH}_2\text{OH}$
- For the reaction  $\text{CoS}(\text{s}) + \text{H}_2(\text{g}) = \text{Co}(\text{s}) + \text{H}_2\text{O}(\text{g})$  at  $550^\circ\text{C}$ ,  $K = 67$ . Write the expression of the equilibrium constant.
- Calculate the concentrations of hydronium and hydroxide ion in the solution 0.1 M in acetic acid and 0.17 M sodium acetate.
- What is the solubility of AgCl in a solution 0.18 mM in NaCl.