銘傳大學 96 學年度研究所碩士班招生考試
管理研究所碩士班(甲組)
第一節

普通化學試題

(第一頁共二頁)
(限用答案本作答)

General Chemistry Exam

Please feel free to use your calculator if necessary (可以使用計算機). 5 pts each.

1. Explain why a solution of HCl in benzene does not conduct electricity, whereas HCl in water does.

2. In which one of these pairs do the two species resemble each other most closely in chemical properties? (a) ${}^{1}_{1}H$ and ${}^{1}_{1}H^{+}$, (b) ${}^{14}_{7}N$ and ${}^{14}_{7}N^{3-}$, (c) ${}^{12}_{6}C$ and ${}^{13}_{6}C$.

3. Why do the 3*s*, 3*p*, and 3*d* orbitals have the same energy in a hydrogen atom but different energies in a many-electron atom?

4. Consider the reaction, $MnO_2 + 4HCl \rightarrow MnCl_2 + Cl_2 + 2H_2O$. If 0.86 mole of $MnO_2$ and 48.2 g of HCl (M.W. = 36.5 g/mol) react, which reagent will be used up first? How many grams of $Cl_2$ will be produced?

5. The work done to compress a gas is 74 kJ. As a result, 26 kJ of heat is given off to the surroundings. Calculate the change in energy of the gas. [*Hint*: $\Delta E = w + q$. What are the signs (positive or negative?) of work and heat here?]

6. Write three reasonable resonance structures of the azide ion $N_3^-$ in which the atoms are arranged as NNN. Show formal charges.

7. Please briefly describe molecular orbital theory (MOT)? How does it differ from valence bond theory (VBT)?

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8. Predict the geometries of these ions: (a) $ICl_2^-$ (b) $SnCl_5^-$.

9. Which of these species has a longer bond, $B_2$ or $B_2^+$(2 pts)? Explain in terms of MOT (3 pts). [*Hint*: The ground-state electron configuration of $B_2$ is $(\sigma_{1s})^2 (\sigma^*_{1s})^2 (\sigma_{2s})^2 (\sigma^*_{2s})^2 (\pi_{2py})^1 (\pi_{2pz})^1$.]

10. Please explain the term, critical temperature ($T_c$).

11. Diethyl ether is a volatile, highly flammable organic liquid that is used mainly as a solvent. The vapor pressure of diethyl ether is 401 mmHg at 18°C. Calculate its vapor pressure at 32°C. {*Hint*: $\ln(P_1/P_2) = (-\Delta H_{vap}/R)[(1/T_1) - (1/T_2)]$, where $\Delta H_{vap}$ and $R$ stand for the heat of vaporization for diethyl ether (26.0 kJ/mol) and gas constant (8.314 J/K•mol), respectively.}

12. A solution is prepared by dissolving 35.0 g of hemoglobin (Hb) in enough water to make up to 1 L in volume. If the osmotic pressure of the solution is found to be 10.0 mmHg at 25°C, calculate the molar mass of hemoglobin. [*Hint*: The osmotic pressure ($\pi$ in atm) of a solution: $\pi = MRT$, where $M$, $R$ and $T$ stand for molarity, gas constant (0.0821 L•atm/K•mol) and absolute temperature (K), respectively.]

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13. The equilibrium constant *Kp* for the reaction, $2SO_3(g) \leftrightarrow 2SO_2(g) + O_2(g)$, is $5.0 \times 10^{-4}$ at 302°C. What is *Kc* for this reaction? [*Hint*: $Kp = Kc(RT)^{\Delta n}$, where $\Delta n$ = moles of gaseous products – moles of gaseous reactants, *R* stands for gas constant (0.0821 L•atm/K•mol).]

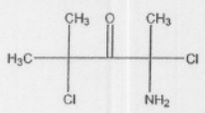
14. For the reaction, $X_2 + Y + Z \rightarrow XY + XZ$, it is found that doubling the concentration of $X_2$ doubles the reaction rate, tripling the concentration of Y triples the rate, and doubling the concentration of Z has no effect. (a) What is the rate law for this reaction? (b) Why is it that the change in the concentration of Z has no effect on the rate? (c) Suggest a mechanism for the reaction that is consistent with the rate law.

15. Classify each of these species as a weak or strong base: (a) LiOH, (b) $CN^-$, (c) $H_2O$, (d) $ClO_4^-$, (e) $NH_2^-$.

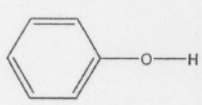
16. Find the temperatures at which reactions with these $\Delta H$ and $\Delta S$ values would become spontaneous: (a) $\Delta H = -126$ kJ, $\Delta S = 84$ J/K; (b) $\Delta H = -11.7$ kJ, $\Delta S = -105$ J/K. [$\Delta G = \Delta H - T\Delta S$]

17. The equilibrium constant *Kp* for the reaction, $CO(g) + Cl_2(g) \leftrightarrow COCl_2(g)$, is $5.62 \times 10^{35}$ at 25°C. Calculate $\Delta G°_f$ for $COCl_2$ of one mole at 25°C, given that $\Delta G°_f$ for CO is −137.3 kJ/mol. [*Hint*: $\Delta G° = -RT\ln Keq$, where R = 8.314 J/K•mol, and $\Delta G°_{rxn} = \Sigma n\Delta G°_f$ (products) − $\Sigma m\Delta G°_f$ (reactants)]

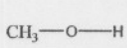
18. Indicate the asymmetric carbon atoms in this compound:




19. Consider these two compounds:




Phenol




Methaol

Experimentally, phenol is found to be a stronger acid than methanol. Explain this difference in terms of the structures of the conjugate bases. (*Hint*: A more stable conjugate base favors more ionization.)

20. What type(s) of intermolecular forces exist between these ion pairs? (a) $Cl_2$and $CBr_4$ (b) $I_2$ and $NO_3^-$?

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