普通化學 試題　（限用答案本作答）

General Chemistry Exam for Students Transferring to the Department of Biotechnology at MCU

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

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

2. 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?

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

4. 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?]

5. 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?

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

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

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

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 ΔH_{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 (π 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.]

13. 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.

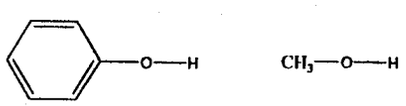
14. The equilibrium constant *Kp* for the reaction, $2SO_3(g) \leftrightarrow 2SO_2(g) + O_2(g)$, is 5.0×10^{-4} at 302°C. What is *Kc* for this reaction? [*Hint*: $Kp = Kc(RT)^{\Delta n}$, where Δn = moles of gaseous products – moles of gaseous reactants, *R* stands for gas constant (0.0821 L•atm/K•mol).]

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 ΔH and ΔS 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.

17. The equilibrium constant *Kp* for the reaction, $CO(g) + Cl_2(g) \leftrightarrow COCl_2(g)$, is 5.62×10^{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. Consider these two compounds:

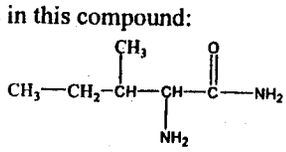


Phenol　　Methanol

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 ionization. Only one of the conjugate bases can be stabilized by resonance.)

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

20. Indicate the asymmetric carbon atoms in this compound:



本試題兩面印刷　　試題完