銘傳大學 100 學年度轉學生招生考試

生物科技學系

二年級第二節

「普通化學」試題

（第 1 頁共 4 頁）（限用答案本作答） ☑可使用計算機 ☐不可使用計算機

Ming Chuan University Entrance Exam of Gen. Chem. for Transferring Students Summer 2011.

Please feel free to use your calculator. (可以使用計算機) The table of atomic masses is on the last page.

Multiple Choices. 2 pts each.

1. The relationship between the quantities of chemical reactants and products is called **A.** Lyophilization. **B.** Stoichiometry. **C.** Spectrophotometry. **D.** Geometry.
2. Which one of the following acids is a strong acid? **A.** Oxalic acid. **B.** Citric acid. **C.** Aspirin. **D.** Perchloric acid.
3. Which one of the following molecules can behave as an amphiprotic species? **A.** H_2O. **B.** PH_3. **C.** N_2H_4. **D.** NO.
4. What is the name of this ionic species, PO_4^{3-}? **A.** Phosphate. **B.** Carbonate. **C.** Sulfate. **D.** Nitrate.
5. What is the concentration of a solution that has molar absorptivity (ε) and absorbance (A) of 6,600 $cm^{-1}M^{-1}$ and 0.75, respectively, assuming that the path length in a UV spectrometer is 1 cm? **A.** 5. **B.** 0.114. **C.** 3.73. **D.** 2.45. mM. [*Hint*: Beer's law, $A = \varepsilon bc$]
6. Which one of the following thermodynamic quantities is a state function that does not depend on the path taken to go from the initial state to the final state? **A.** Heat, q. **B.** Work, w. **C.** Enthalpy, ΔH or q_p. **D.** All of the above.
7. What is the thermodynamic quantity that can be directly measured in a bomb calorimeter? **A.** Work, w. **B.** Enthalpy, ΔH or q_p. **C.** Gibb's free energy, ΔG. **D.** Internal energy, ΔE or q_v.
8. What is the constant that is proposed to show that energy is quantized during blackbody radiation? **A.** Avogadro number, N. **B.** Planck constant, h. **C.** Boltzmann constant, k. **D.** Rydberg constant, R.
9. For the photoelectric effect, electrons are ejected when light strikes the surface of a metal, but only if the **A.** Intensity. **B.** Angle. **C.** Radiation. **D.** Frequency. of the light reaches a certain threshold.
10. The potential energy of an electron in the nth level = $E_n = -Rhc/n^2$, where R, h, c, and n are Rydberg constant, Planck constant, speed of light, and principal quantum number, respectively. The principal quantum number, n, defines **A.** The energy. **B.** The distance of the electron from the nucleus. **C.** All of the above. **D.** None of the above.
11. Which one of the following statements is correct concerning the equation, $\lambda = h/mv$, proposed by de Broglie, where $mv = p$ (momentum)? **A.** This is the particle-wave duality of electrons or anything. **B.** The electronic configuration of Fe^{3+}. **C.** The light intensity of blackbody radiation. **D.** The threshold of photon having the ability to eject electrons from a metal plate.
12. An electron at a given point in space can be described by a wave function, ψ. The square of the wavelength, ψ^2, defines the **A.** Altitude. **B.** Depth. **C.** Area. **D.** Probability. of finding the electron. Scientists refer to this quantity as the electron density.
13. What is the magnetic quantum number, m_l, related to the orbitals within a subshell? **A.** Energy. **B.** Distance to the nucleus. **C.** Shape. **D.** Orientation.
14. Elements and compounds that have unpaired electrons (↑) are attracted to a magnet. These species are referred to as **A.** Ferromagnetism. **B.** Paramagnetism. **C.** Diamagnetism. **D.** All of the above.

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15. Which one of the following species is isoelectronic with CO? **A.** CN^-. **B.** OH^-. **C.** Br_2. **D.** Cl_2. [*Hint*: Molecules and ions having the same number of valence electrons and the same Lewis structures are said to be isoelectronic.]
16. Which is most likely the structure that represents the resonance structure of molecular ozone, O_3? **A.** $O^{\cdots}\!-\!O^{\cdots}\!-\!O$. **B.** O–O=O. **C.** O=O–O. **D.** All of the above.
17. What is the formal charge on N in NO_3^-? **A.** -1. **B.** 0. **C.** +1. **D.** +2.
18. The basis or valence bond theory (VBT) is the **A.** Cross-linkng. **B.** Orthogonality. **C.** Substitution. **D.** Overlap. of atomic orbitals.
19. What is the molecular geometry of the molecule with a central atom having sp^3d hybridization? **A.** Square planar. **B.** Tetrahedron. **C.** Trigonal-bipyramidal. **D.** Octahedron.
20. The MO configuration of NO, nitric oxide, is [core electrons]$(\sigma_{2s})^2(\sigma^*_{2s})^2(\pi_{2p})^4(\sigma_{2p})^2(\pi^*_{2p})^1$. What is the bond order between N and O? **A.** 2.5. **B.** 2.0. **C.** 1.5. **D.** 1.
21. For the hydration of potassium (K^+) and lithium (Li^+) ions, they can be expressed as $K^+\cdots{}^{\delta-}OH_2$ and $Li^+\cdots{}^{\delta-}OH_2$. Which type of hydration exhibits a more exothermic value? **A.** $K^+\cdots{}^{\delta-}OH_2$. **B.** $Li^+\cdots{}^{\delta-}OH_2$. **C.** $K^+\cdots{}^{\delta-}OH_2\cdots Li^+$. **D.** $Li^+\cdots{}^{\delta-}OH_2\cdots K^+$.
22. For polar compounds and non-polar compounds of approximately the same molecular weights, which is expected to exhibit a higher value for their enthalpy of vaporization? **A.** Polar compounds. **B.** Non-polar compounds. **C.** It depends on the atmosphere. **D.** Molecular recognition needs to be taken into consideration.
23. When n-C_8H_{18} and CCl_4 are mixed, which one of the following statements is correct? **A.** The energy of the system is more dispersed than in the two. **B.** Entropy, ΔS, of the system is increased. **C.** Induced-dipole/induced dipole forces occur between these two molecules. **D.** All of the above.
24. For the colligative properties of solution, which one of the following statements is INCORRECT for freezing point depression? **A.** Solution containing the solutes can solidify. **B.** Due to the presence of solutes, solvent molecules are farther apart, making it difficult for them (solvent molecules) to approach. **C.** Temperature needs to be lowered for pure solvent molecules to get cloaser. **D.** None of the above.
25. For the reaction, $NO_2(g) + CO(g) \leftrightarrow NO(g) + CO_2(g)$, how does the activated complex look like at the transition state? **A.** ONO•••NO. **B.** O=N•••O•••C≡O. **C.** O≡C•••C≡O. **D.** ON•••O•••O=C=O., where "•••" indicates a partial bond.
26. In the Arrhenius equation, k = rate constant = $Ae^{-Ea/RT}$, which term is related to the number of collisions, and to the fraction of collisions that have the correct geometry? **A.** k. **B.** A. **C.** Ea. **D.** R.
27. For a chemical reaction, aA + bB → cC + dD, which one of the following statements is INCORRECT? **A.** The reaction quotient, Q, is equal to $[C]^c[D]^d/[A]^a[B]^b$. **B.** The equilibrium constant, K, is also equal to $[C]^c[D]^d/[A]^a[B]^b$. **C.** When $Q < K$, the reaction is moving forward (→). **D.** When $Q < K$, the reaction is moving backward (←).
28. The K_a of $C_2H_5CO_2H$, CH_3CO_2H, and HCO_2H is 1.3×10^{-5}, 1.8×10^{-5}, and 1.8×10^{-4}, respectively. This is because **A.** C_2H_5OH has the highest molecular weight. **B.** CH_3CO_2H is naturally found. **C.** Alkyl group, C_2H_5-, is an electron-donating group. **D.** HCO_2H has the lowest molecular weight.

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29. Which one of the following statements is INCORRECT? **A.** Cl^-, Na^+, Mg^{2+}, NO_3^-, ..., has no measurable effect on solution pH. **B.** The conjugate acidic cation of basic cation $[Al(H_2O)_5(OH)]^{2+}$ is $[Al(H_2O)_6]^{3+}$. **C.** CO_3^{2-}, is amphiprotic. **D.** All metal cations, M^{n+}, are hydrated in water, *i.e.*, $[M(H_2O)_6]^{n+}$.
30. The acidic strength of H-X, where X = F, Cl, Br, and I, is determined by two factors, H-X bond breaking enthalpy and electron affinity of X. HI is far more acidic than HF. Therefore, **A.** H-X bond strength is smaller for HI. **B.** The radius of I^- is larger than F^-. **C.** HF has a smaller molecular weight. **D.** F is more electromagnetic, compared to I. , explaining the high acidity of HI.
31. Which one of the following statements is INCORRECT concerning the dissociation of $CH_3CO_2H \rightarrow CH_3CO_2^- + H^+$? **A.** This is because the H on $-CO_2H$ is more positive. **B.** $CH_3CO_2^-$ has resonance structures. **C.** $H^+ + {}^-{:}CH_2CO_2H$ does not occur because C atom of CH_3 group is not sufficiently electronegative to accommodate the negative charge. **D.** H atoms of CH_3 group have a much larger positive partial charge than the O-H hydrogen atom.
32. The molecules or ions that bind to metal ions, such as H_2O in $[Fe(H_2O)_6]^{2+}$, are called **A.** Ligands. **B.** Atoms. **C.** Alloys. **D.** Multimers.
33. In the reaction, $PbS(s) \leftrightarrow Pb^{2+}(aq) + S^{2-}(aq)$, when PbS is dissolved in water, the lead ion concentration is greater than expected. This is because **A.** PbS has a high K_{sp} value. **B.** S^{2-} undergoes extensive hydrolysis. **C.** $[Pb^{2+}]$ cannot be affected by temperature. **D.** PbS needs to be heated.
34. Which one of the following criterion is important for a buffer solution to work efficiently? **A.** The right pH range, where it buffers. **B.** The concentrations of a buffer solution. **C.** The ratio between [conjugate base]/[acid]. **D.** All of the above.
35. For gases, Ar and CO_2, which has a larger entropy, ΔS, value? **A.** Ar. **B.** CO_2. **C.** Ar•••CO_2. **D.** CO.
36. For the reaction, $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$, $\Delta_r H° = -483.6$ kJ/mol, $\Delta_r S° = -88.8$ J/mol, $\Delta_r G° = -457.2$ kJ/mol ($\Delta G = \Delta H - T\Delta S$). Which one of the following statements is correct? **A.** The reaction is endothermic. **B.** Entropy is increased. **C.** The reaction is non-spontaneous. **D.** Some heat released is used to reverse energy dispersal.
37. Ludwig Boltzman proposed that the entropy of a system results from the number of microstates available. That is, $S = klnW$. Which one of the following phenomenon is consistent with this equation? **A.** The expansion of gases. **B.** Ethanol can be dissolved in water. **C.** Br_2 is dissolved in CCl_4. **D.** All of the above.
38. Ligands can be listed in order of their ability to split the *d* orbitals. This list is called **A.** Periodic table. **B.** Chemical analysis. **C.** Spectrochemical series. **D.** Term symbols.
39. Which one of the following compounds is likely to be stable? [*Hint*: Effective atomic number (EAN) or 18-electron rule] **A.** $CuCl_2$. **B.** $ZnCl_2$. **C.** $TiCl_2$. **D.** $Fe(CO)_5$.
40. For various triple bonds in compounds, such as carbon monoxide, C≡O and in $Ni(C{\equiv}O)_4$, which triple bond is longer? **A.** C≡O. **B.** $Ni(C{\equiv}O)_4$. **C.** It depends on the oxidation state of Ni. **D.** All of the above.

Questions and answers

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1. What is the concentration of CO_2 in water at 25°C when the partial pressure is 0.33 bar? [*Hint*: Henry's law: $S_g = k_H P_g$, and k_H = 0.034 mol/kg·bar for CO_2] (Although CO_2 reacts with water to give traces of H^+ and HCO_3^-, the reaction occurs to such a small extent that Henry's law is obeyed at low CO_2 partial pressures.)
2. Why cannot NF_5 exist, whereas PF_5 can?
3. Sketch the Lewis structures for $[ClF_2]^+$. What are the electron-pair and molecular geometry of this ionic species?
4. Could the cation, H_2^+, exist? What is the ion's bond order?
5. Calculate the enthalpy of vaporization of diethyl ether $(C_2H_5)_2O$. This compound has vapor pressures of 57.0 mm Hg and 534 mm Hg at -22.8 °Cand 25.0 °C, respectively. [*Hint*: $\ln(P_2/P_1) = (-\Delta_{vap}H°/R) \times (1/T_2 - 1/T_1)$, where R = 8.314 J/K·mol]
6. Assume you dissolve 10.0 g of sucrose ($C_{12}H_{22}O_{11}$) in 225 ml (225 g) of water and warm the water to 60°C. What is the vapor pressure of the water over this solution? [*Hint*: $P_{solvent} = X_{solvent}P°_{solvent}$; $P°(H_2O)$ = 149.4 mm Hg at 60°C]
7. The colorless N_2O_4 decomposes to the brown gas NO_2 in a first-order reaction, $N_2O_4(g) \rightarrow 2\ NO_2(g)$. The rate constant $k = 4.5 \times 10^3$ sec^{-1} at 274 K and $k = 1.00 \times 10^4$ sec^{-1} at 283 K. What is the activation energy, E_a? [*Hint*: $\ln(k_2/k_1) = (-E_a/R) \times (1/T_2 - 1/T_1)$; R = 8.314 J/mol·K]
8. Equilibrium exists between butane and isobutene when [butane] = 0.20 M and [isobutane] = 0.50M. An additional 2.00 mol/L of isobutene is added to the mixture. What are the concentrations of butane and isobutene after equilibrium has again been attained? [Butane ↔ Isobutane, K_{eq} = 2.5]?
9. What is the pH of the solution that results from adding 30.0 ml of 0.100 M NaOH to 45.0 ml of 0.100M acetic acid, CH_3CO_2H? [*Hint*: K_a of acetic acid = 1.8×10^{-5}, Henderson–Hasselbalch equation: pH = pKa + log([Salt]/[Acid])]
10. Use the Henderson-Hasselbalch equation to calculate the pH of 1.00 L of a buffer solution containing 15.0 g of $NaHCO_3$ and 18.0 g of Na_2CO_3. (Consider this buffer as a solution of the weak acid HCO_3^- with CO_3^{2-} as its conjugate base.) [*Hint*: For $CO_3^{2-} + H_2O \leftrightarrow HCO_3^- + OH^-$, $K_b = 2.1 \times 10^{-4}$, and $K_a \times K_b = K_w = 1\times10^{-14}$]

Periodic Table of the Elements

1 H 1.008																	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.20	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.0	45 Rh 102.9	46 Pd 106.4	47 Ag 107.8	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.7	52 Te 127.6	53 I 126.9	54 Xe 131.2
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.1	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr 223.0	88 Ra 226.0	89 Ac 227.0	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (281)	111 Rg (272)	112 Uub (285)	113 Uut (284)	114 Uuq (289)	115 Uup (288)	116 Uuh (292)		

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