

國立臺北科技大學 108 學年度碩士班招生考試

系所組別：3602

化學工程與生物科技系生化與生醫工程碩士班

第一節 普通化學 試題 (選考)

第一頁 共四頁

注意事項：

1. 本試題共 40 題，每題 2.5 分，共 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

1. What is the basis of the VSEPR model of molecular bonding?
 - A) The regions of electron density on an atom will organize themselves so as to maximize s -character.
 - B) The regions of electron density in the valence shell of an atom will arrange themselves so as to maximize overlap.
 - C) The atomic orbitals of the bonding atoms must overlap for a bond to form.
 - D) The electron domains in the valence shell of an atom will arrange themselves so as to minimize repulsions.
 - E) The hybrid orbitals will form as necessary to, as closely as possible, achieve spherical symmetry.
2. What is the molecular shape of H_2O ?
 - A) T-shaped. B) Tetrahedral. C) Linear. D) Trigonal pyramidal. E) Bent.
3. Which of the molecules has a **see-saw** shape?
 - A) BCl_3 . B) CCl_4 . C) $TeCl_4$. D) XeF_4 . E) SF_6 .
4. What are the hybridizations of iodine in IF_3 and IF_5 , respectively?
 - A) sp^3 , sp^3d . B) sp^3d , sp^3d^2 . C) sp^3d , sp^3 . D) sp^3d^2 , sp^3d . E) sp^3d^2 , sp^3d^2 .
5. What is the highest energy occupied molecular orbital in the F—F bond of the F_2 molecule?
 - A) π^*_{2s} . B) π_{2s} . C) σ^*_{1p} . D) π^*_{2p} . E) π_{2p} .
6. Which of the following Lewis structures would be an expansion to the octet rule?
 - A) SiF_4 . B) CF_4 . C) CCl_4 . D) PO_4^{3-} . E) NF_3 .
7. Why don't we draw double bonds between the Be atom and the Cl atoms in $BeCl_2$?
 - A) That would give positive formal charges to the chlorine atoms and a negative formal charge to the beryllium atom.
 - B) There aren't enough electrons.
 - C) That would result in more than eight electrons around beryllium.
 - D) That would result in more than eight electrons around each chlorine atom.
 - E) That would result in the formal charges not adding up to zero.
8. What is the electron configuration of the sulfide ion (S^{2-})?
 - A) $[Ne]3s^2$. B) $[Ne]3s^23p^1$. C) $[Ne]3s^23p^4$. D) $[Ne]3p^2$. E) $[Ne]3s^23p^6$.
9. Which statement about atmospheric pressure is **false**?
 - A) As air becomes thinner, its density decreases.
 - B) Air actually has weight.
 - C) With an increase in altitude, atmospheric pressure increases as well.
 - D) The warmer the air, the lower the atmospheric pressure.
 - E) Atmospheric pressure prevents water in lakes, rivers, and oceans from boiling away.
10. According to kinetic-molecular theory, in which of the following gases will the root-mean-square speed of the molecules be the highest at $200^\circ C$?
 - A) HCl . B) Cl_2 . C) H_2O . D) SF_6 . E) all gases have the same root-mean-square speed.
11. What is the molecular weight (g/mol) of an unknown gas that has a density of 4.90 g/L at STP?
 - A) 1.40×10^2 . B) 1.30×10^2 . C) 1.20×10^2 . D) 1.10×10^2 . E) 9×10^1 .

注意：背面尚有試題

12. Which statement is true about liquids but **not** true about solids?
 A) They flow and are highly ordered.
 B) They are highly ordered and not compressible.
 C) They flow and are compressible.
 D) They assume both the volume and the shape of their containers.
 E) They flow and are not compressible.
13. Which molecule has hydrogen bonding as the predominant intermolecular force?
 A) CH₄. B) C₆H₆. C) CH₃OH. D) CO₂. E) C₄H₁₀.
14. What intermolecular force is responsible for the fact that ice is less dense than liquid water?
 A) London dispersion forces. B) Dipole-dipole forces. C) Ion-dipole forces.
 D) Hydrogen bonding. E) Ionic bonding.
15. Which one of the following is an addition polymer with the same structure as polyethylene except that one hydrogen atom on every other carbon atom is replaced by a benzene ring?
 A) Polyvinyl alcohol. B) Polystyrene. C) Polyethylene.
 D) Polyethylene glycol. E) Teflon.
16. The solubility of nitrogen gas at 25 °C and 101.325 kPa is 6.8×10^{-4} mol/L. If the partial pressure of nitrogen gas in air is 77.01 kPa, what is the concentration (molarity) of dissolved nitrogen?
 A) 6.8×10^{-4} M. B) 5.2×10^{-4} M. C) 4.9×10^{-4} M.
 D) 3.8×10^{-4} M. E) 1.1×10^{-5} M.
17. Which of the following statements is **false**?
 A) Nonpolar liquids tend to be insoluble in polar liquids.
 B) The weaker the attraction between the solute and solvent molecules, the greater the solubility.
 C) Substances with similar intermolecular attractive forces tend to be soluble in one another.
 D) The solubility of a gas increases in direct proportion to its partial pressure above the solution.
 E) The solubility of gases in water decreases with increasing temperature.

18. The rate law of a reaction is $\text{rate} = k[D][X]$. Which of the following is the units of the rate constant?
 A) mol L⁻¹s⁻¹. B) L mol⁻¹s⁻¹. C) mol² L⁻²s⁻¹. D) mol L⁻¹s⁻². E) L² mol⁻²s⁻¹.

19. Which of the following experimental methods **cannot** be used to measure the rate of a reaction?
 A) measurement of the absorbance of a colored reactant with time,
 B) measurement of the change in the partial pressure of a gas-phase product over time,
 C) measurement of the equilibrium concentration of an acidic product via titration with a strong base,
 D) measurement of the absorbance of a colored product with time,
 E) measurement of the change in the partial pressure of a gas-phase reactant over time

20. The data in the table below were obtained for the reaction: $A + B \rightarrow C$
 Which of the following is the rate law for this reaction?

Experiment Number	[A] (M)	[B] (M)	Initial Rate (M/s)
1	0.451	0.885	1.13
2	0.451	1.77	1.13
3	1.35	0.885	10.17

- A) $k[A][B]$. B) $k[P]$. C) $k[A]^2[B]$. D) $k[A]^2[B]^2$. E) $k[A]^2$.

21. The acid-catalyzed reaction of acetone, CH₃COCH₃, with iodine can be represented by the following net reaction: $\text{CH}_3\text{COCH}_3 + \text{I}_2 \xrightarrow{\text{H}^+} \text{CH}_2\text{ICOCH}_3 + \text{H}^+ + \text{I}^-$
 It is found experimentally that the rate law for this reaction is $\text{Rate} = k[\text{CH}_3\text{COCH}_3][\text{H}^+]$. Suppose that in trial 1, the initial rate of the reaction is measured with initial concentrations of acetone, iodine, and hydrogen ion all equal to 0.10 M. Then, in trial 2 the initial rate of the reaction is measured with the initial concentrations all equal to 0.20 M. By a factor of which one will be the initial rate of trial 2 larger than the initial rate of trial 1?
 A) 2. B) 4. C) 8. D) 16. E) 64.

22. Which monomer is polymerized to make natural rubber?
 A) urethane, B) ethylene, C) styrene, D) isoprene, E) propylene.

23. A 35.00-L vessel at 700 K initially contains HI(g) at a pressure of 5.80 atm; at equilibrium, it is found that the partial pressure of H₂(g) is 0.56 atm. What is the partial pressure of HI(g) at equilibrium? $2\text{HI}(g) \rightleftharpoons \text{H}_2(g) + \text{I}_2(g)$.
 A) 0.561 atm. B) 4.67 atm. C) 5.23 atm. D) 5.8 atm. E) 6.36 atm.
24. The following reaction is investigated (assume an ideal gas mixture):
 $2\text{N}_2\text{O}(g) + \text{N}_2\text{H}_4(g) \rightleftharpoons 3\text{N}_2(g) + 2\text{H}_2\text{O}(g)$
 Initially there are 0.100 mol of N₂O and 0.25 mol of N₂H₄, in a 10.0-L container. If there are 0.059 mol of N₂O at equilibrium, how many moles of N₂ are present at equilibrium?
 A) 4.1×10^{-2} . B) 1.2×10^{-1} . C) 6.2×10^{-2} . D) 2.1×10^{-2} . E) none of these.
25. A 2.50-mol sample of HI is placed in a 1.00-L vessel at 460°C, and the reaction system is allowed to come to equilibrium. The HI partially decomposes, forming 0.190 mol H₂ and 0.190 mol I₂ at equilibrium. What is the equilibrium constant K_c for the following reaction at 460 °C? $1/2 \text{H}_2(g) + 1/2 \text{I}_2(g) \rightleftharpoons \text{HI}(g)$.
 A) 1.23×10^2 . B) 8.10×10^{-3} . C) 1.72×10^{-2} . D) 11.1. E) 7.63.
26. A sample of ammonia gas was allowed to come to equilibrium at 400 K.
 $2\text{NH}_3(g) \rightleftharpoons \text{N}_2(g) + 3\text{H}_2(g)$. At equilibrium, it was found that the concentration of H₂ was 0.0484 M, the concentration of N₂ was 0.0161 M, and the concentration of NH₃ was 0.295 M. What was the initial concentration of ammonia?
 A) 0.161 M. B) 0.228 M. C) 0.36 M. D) 0.311 M. E) 0.328 M.
27. The K_a of hypochlorous acid (HClO) is 3.0×10^{-8} at 25.0 °C. What is the percent ionization of hypochlorous acid in a 0.015 M aqueous solution of HClO at 25.0 °C?
 A) 4.5×10^{-8} . B) 14. C) 2.1×10^{-5} . D) 0.14. E) 1.4×10^{-3} .
28. Which one of the following pairs **cannot** be mixed together to form a buffer solution?
 A) C₅H₅N, C₅H₅NHCl. B) HC₂H₃O₂, NaOH (C₂H₃O₂⁻ = acetate).
 C) KOH, HI. D) NH₂CH₃, HCl. E) NaClO, HNO₃.
29. Which solution has the greatest buffering capacity?
 A) 0.335 M NH₃ and 0.100 M NH₄Cl. B) 0.085 M NH₃ and 0.090 M NH₄Cl.
 C) 0.540 M NH₃ and 0.550 M NH₄Cl. D) 0.200 M NH₃ and 0.565 M NH₄Cl.
 E) They are all buffer solutions and would all have the same capacity.
30. Photoionization processes (e.g., $\text{N}_2 + h\nu \rightarrow \text{N}_2^+ + e^-$) remove UV of < 150 nm. Which photoreaction is the principal absorber of UV in the 150-200 nm range in the upper atmosphere?
 A) $\text{N}_2 + h\nu \rightarrow 2\text{N}$. B) $\text{O}_2 + h\nu \rightarrow 2\text{O}$. C) $\text{O}_3 + h\nu \rightarrow \text{O}_2 + \text{O}$.
 D) $\text{N}_2 + \text{O}_2 + h\nu \rightarrow 2\text{NO}$. E) $\text{NO} + \text{O}_2 + h\nu \rightarrow \text{NO}_3$.
31. Which one of the following processes produces a decrease of the entropy of the system?
 A) Dissolving sodium chloride in water.
 B) Sublimation of naphthalene.
 C) Dissolving oxygen in water.
 D) Boiling of alcohol.
 E) Explosion of nitroglycerine.
32. Which of the following statements is **false**?
 A) The change in entropy in a system depends on the initial and final states of the system and the path taken from one state to the other.
 B) Any irreversible process results in an overall increase in entropy.
 C) The total entropy of the universe increases in any spontaneous process.
 D) Entropy increases with the number of microstates of the system.
 E) The second law of thermodynamics states that for any spontaneous process, the entropy of the universe increases.
33. Which one of the following correctly indicates the relationship between the entropy of a system and the number of different arrangements, W, in the system?
 A) $S = kW$. B) $S = \frac{k}{W}$. C) $S = \frac{W}{k}$. D) $S = k \ln W$. E) $S = Wk$.
34. Which one of the following statements is true about the equilibrium constant for a reaction if ΔG° for the reaction is negative?
 A) $K = 0$. B) $K = 1$. C) $K > 1$. D) $K < 1$. E) More information is needed.

35. According to the first law of thermodynamics, the energy of the universe is constant. Does this mean that ΔE is always equal to zero?
- A) No, ΔE does not always equal zero, but this is due only to factors such as friction and heat.
 B) No, ΔE never equals zero because energy is always flowing between the system and the surroundings.
 C) No, ΔE does not always equal zero because it refers to the system's internal energy, which is affected by heat and work.
 D) Yes, $\Delta E = 0$ at all times, which is why $q = -w$.
 E) No, ΔE never equals zero because work is always being done on the system or by the system.

36. A gas absorbs 0.0 J of heat and then performs 99.5 J of work. What is the change in internal energy of the gas?
- A) -99.5 J. B) 59.5 J. C) 139.5 J. D) 99.1 J. E) none of these.

37. Consider the following cell reaction: $2\text{Cr}(s) + 6\text{H}^+(aq) \rightarrow 2\text{Cr}^{3+}(aq) + 3\text{H}_2(g)$; $E^\circ_{\text{cell}} = 0.74\text{V}$. Under standard-state conditions, what is E° for the following half-reaction?
- $\text{Cr}^{3+}(aq) + 3e^- \rightarrow \text{Cr}(s)$.
- A) -0.74 V. B) 0.25 V. C) -0.37 V. D) 0.37 V. E) 0.74 V.

38. A strip of iron is placed in a 1 M solution of iron(II) sulfate, and a strip of copper is placed in a 1 M solution of copper(II) chloride. The two solutions are connected with a salt bridge, and the two metals are connected by a wire. Which of the following takes place?
- | Reduction Half-Reaction | E° (V) |
|---|---------------|
| $\text{Fe}^{2+}(aq) + 2e^- \rightleftharpoons \text{Fe}(s)$ | -0.41 |
| $\text{Cu}^{2+}(aq) + 2e^- \rightleftharpoons \text{Cu}(s)$ | 0.34 |
- A) Sulfur deposits at the iron electrode.
 B) The Fe(II) concentration of the iron half-cell decreases.
 C) Copper atoms deposit at the cathode.
 D) Chlorine is produced at the copper electrode.
 E) Chlorine is produced at the iron electrode.

39. In a volumetric analysis experiment, an acidic aqueous solution of methanol (CH_3OH) is titrated with a solution of potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) according to the following balanced chemical equation: $2\text{K}_2\text{Cr}_2\text{O}_7(aq) + 8\text{H}_2\text{SO}_4(aq) + 3\text{CH}_3\text{OH}(aq) \rightarrow 2\text{Cr}_2(\text{SO}_4)_3(aq) + 11\text{H}_2\text{O}(l) + 3\text{HCOOH}(aq) + 2\text{K}_2\text{SO}_4(aq)$. What volume of 0.00143 M $\text{K}_2\text{Cr}_2\text{O}_7$ is required to titrate 1.90 g of CH_3OH dissolved in 50.0 mL of solution?
- A) 62.1 mL, B) 1990 mL, C) 27.6mL, D) 50 mL, E) 885 mL.

40. Which of the following statements is true concerning the electron configuration $[\text{Ne}]3p^2$?
- A) This configuration cannot be the ground-state electron configuration for a Mg atom because it violates the Pauli exclusion principle.
 B) This configuration cannot be the ground-state electron configuration for a Mg atom because it violates Hund's rule.
 C) This configuration is the ground-state electron configuration for a Mg atom.
 D) This configuration cannot be the ground-state electron configuration for a Mg atom because it violates the Heisenberg uncertainty principle.
 E) This configuration cannot be the ground-state electron configuration for a Mg atom because it violates the Aufbau principle.