國立中正大學
110學年度碩士班招生考試
試 題

［第2節］

科目名稱	一般化學
系所組別	化學暨生物化學系

－作答注意事項－

※作答前請先核對「試題」、「試卷」與「准考證」之系所組別、科目名稱是否相符。

1. 預備鈴響時即可入場，但至考試開始鈴響前，不得翻閱試題，並不得書寫、畫記、作答。

2. 考試開始鈴響時，即可開始作答；考試結束鈴響畢，應即停止作答。

3. 入場後於考試開始40分鐘內不得離場。

4. 全部答題均須在試卷（答案卷）作答區內完成。

5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。

6. 試題須隨試卷繳還。

第一部份：單選題(共 30 題，每題 3 分，共 90 分)

1. Boron naturally occurs in two isotopic forms. The more common isotope is ^{11}B (atomic mass 11.01 amu), which is 80.00% abundant. The average atomic mass of boron is 10.81. What is the mass of the other isotope?

   A) 10.91 amu.　B) 10.01 amu.　C) 10.81 amu.　D) 11.00 amu.　E) 11.01 amu.

2. Adipic acid contains 49.32% C, 43.84% O, and 6.85% H by mass. What is the empirical formula?

   A) $C_2H_5O_4$　B) $C_3H_5O_2$　C) C_2HO_3　D) $C_3H_3O_4$　E) C_3HO_3

3. When the following equation is balanced, what is the sum of the coefficients?

   $$Al_2(SO_4)_3 + Ca(OH)_2 \rightarrow Al(OH)_3 + CaSO_4$$
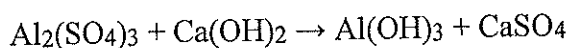
   A) 10　　B) 8　　C) 4　　D) 9　　E) 3

4. Which of the following statements is(are) true?

   Oxidation and reduction

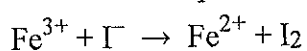   I. cannot occur independently of each other.

   II. accompany all chemical changes.

   III. describe the loss and gain of electron(s), respectively.

   IV. result in a change in the oxidation states of the species involved.

   A) I only　B) II only　C) III only　D) IV only　E) I, III, and IV

5. In the balanced equation for the following redox equation, what is the sum of the coefficients?

   $$Fe^{3+} + I^- \rightarrow Fe^{2+} + I_2$$

   A) 7　B) 4　C) 6　D) 8　E) 5

6. A sample of nitrogen gas has a volume of 180.0 mL at STP. What volume does the gas occupy if the absolute temperature and pressure are each doubled?

   A) 90.00 mL　B) 360.0 mL　C) 720.0 mL　D) 44.8 L　E) 180.0 mL

7. Which of the following statements is true concerning ideal gases?

   A) The temperature of the gas sample is directly related to the average velocity of the gas particles.

   B) At STP, 1.0 L of Ar(*g*) contains about twice the number of atoms as 1.0 L of Ne(*g*) because the molar mass of Ar is about twice that of Ne.

   C) A gas exerts pressure as a result of the collisions of the gas molecules with the walls of the container.
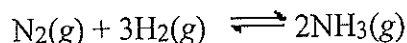
   D) The gas particles in a sample exert attraction on one another.

   E) All of these statements are false.

8. Ammonia is prepared industrially by the following reaction:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

For the reaction, $\Delta H° = -92.2$ kJ and K (at 25°C) $= 4.0 \times 10^8$. When the temperature of the reaction is increased to 500°C, which of the following statements is true?

A)   Product formation (at equilibrium) is not favored as the temperature is raised.

B) K for the reaction will be larger at 500°C than at 25°C.

C)   The reaction of N_2 with H_2 to form ammonia is endothermic.

D)   At equilibrium, more NH_3 is present at 500°C than at 25°C.

E)   None of these is true.

9. For nitrous acid, HNO_2, $K_a = 4.0 \times 10^{-4}$. Calculate the pH of 0.33 M HNO_2.

A)   2.92   B) 1.94   C)   3.40   D) 0.48   E) 4.36

10. Silver chromate, Ag_2CrO_4, has a K_{sp} of 9.0×10^{-12}. Calculate the solubility, in moles per liter, of silver chromate.

A) $7.8 \times 10^{-5} M$ B) $9.5 \times 10^{-7} M$ C) $9.8 \times 10^{-5} M$ D) $1.9 \times 10^{-12} M$ E) $1.3 \times 10^{-4} M$

11. The K_{sp} value for $PbSO_4(s)$ is 1.3×10^{-8}. Calculate the solubility, in moles per liter, of $PbSO_4(s)$ in a 0.0010 M solution of Na_2SO_4.

A) $4.5 \times 10^{-6} M$ B) $1.3 \times 10^{-11} M$ C) $1.3 \times 10^{-5} M$ D) $1.3 \times 10^{-8} M$ E) $1.4 \times 10^{-4} M$

12. For the reaction

$$AgI(s) + (1/2)Br_2(g) \rightarrow AgBr(s) + (1/2)I_2(s), \ \Delta H° = -54.0 \text{ kJ}$$
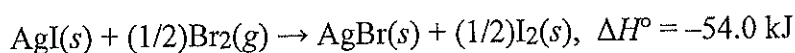
$\Delta H°_f$ for $AgBr(s) = -100.4$ kJ/mol

$\Delta H°_f$ for $Br_2(g) = +30.9$ kJ/mol

The value of $\Delta H°_f$ for $AgI(s)$ is

A) +61.8 kJ/mol   B) –77.3 kJ/mol   C) –61.8 kJ/mol   D) –123.5 kJ/mol   E) +77.3 kJ/mol

13. In an isothermal process, the pressure on 1 mol of an ideal monatomic gas suddenly changes from 4.00 atm to 100.0 atm at 25°C.

Calculate ΔE.

A)   0 kJ   B)   119 kJ   C) 59.5 kJ   D)   –59.5 kJ   E) none of these

14. Consider a weak acid, HX. The value of $\Delta G°$ for the acid's dissociation reaction at 25°C is 42.6 kJ. Determine the value of K_a for the acid.

A) 3.41×10^{-8} B) 1.63 C) 2.86×10^{-6} D) 4.26×10^5 E) none of these

15. If a constant current of 5.2 amperes is passed through a cell containing Cr^{3+} for 2.1 hour, how many grams of Cr will plate out onto the cathode? (The atomic mass of Cr is 51.996 g/mol.)

    A)　0.12 g　　B)　1.1 g　　C) 64 g　　D) 21 g　　E) 7.1 g

16. The wavelength of light associated with the $n = 2$ to $n = 1$ electron transition in the hydrogen spectrum is 1.216×10^{-7} m. By what coefficient should this wavelength be multiplied to obtain the wavelength associated with the same electron transition in the Li^{2+} ion?

    A)　1　　B) 1/3　　C)　1/4　　D) 1/7　　E) 1/9

17. Which of the following is nonpolar?

    A)　Cl_2O　　B)　CS_2　　C) SF_4　　D)　　IF_3　　E) NCl_3

18. For which of the following diatomic molecules would the bond order become greater if an electron were removed, that is, if the molecule were converted to the positive ion in its ground state?

    A)　F_2　　B)　Na_2　　C)　　P_2　　D) B_2　　E)　C_2

19. An ethyl group ($CH_3CH_2^-$) that is attached to a substituent that does not contain a hydrogen atom appears as what in a NMR spectrum?

    A)　　a triplet and a quartet with relative intensities of 3 and 2, respectively

    B)　　a triplet and a quartet with relative intensities of 2 and 3, respectively

    C)　　a doublet and a triplet with relative intensities of 2 and 3, respectively

    D)　　a doublet and a triplet with relative intensities of 3 and 2, respectively

    E)　　none of these

20. For the reaction A + B → products, the following data were obtained.

Initial Rate (mol/L · s)	0.030	0.059	0.060	0.090	0.090
$[A]_0$ (mol/L)	0.10	0.20	0.20	0.30	0.30
$[B]_0$ (mol/L)	0.20	0.20	0.30	0.30	0.50

    What is the experimental rate law?

    A) Rate = $k[A]^2[B]$　　B) Rate = $k[B]$　　C)　Rate = $k[A][B]$　　D) Rate = $k[A]$　　E) Rate = $k[A][B]^2$

21. The reaction $2H_2O_2 \rightarrow 2H_2O + O_2$ has the following mechanism:

    $H_2O_2 + I^- \rightarrow H_2O + IO^-$

    $H_2O + IO^- \rightarrow H_2O + O_2 + I^-$

    What is the catalyst in the reaction?

    A)　IO^-　　B)　H_2O　　C) I^-　　D)　　H_2O_2

22. A *p*-type semiconductor
   A) is made by doping host atoms with atoms having more valence electrons than the host.
   B) has electrons that lie close in energy to the conduction bands.
   C) is made by doping host atoms with atoms having fewer valence electrons than the host.
   D) two of these
   E) none of these

23. The lattice energy of NaI is –686 kJ/mol, and its heat of solution is –7.6 kJ/mol. Calculate the hydration of energy of NaI(*s*) in kJ/mol.
   A)　–678　　B)　–694　C)　　+694　　D)　+678　　E)　+15.2

24. Superoxides have the general formula
   A)　M_2O　　B)　MO　C) M_2O_2　　D) MO_2　E)　　M_2O_3

25. Which of the following complexes shows geometric isomerism?
   A)　$K[Co(H_2O)_2Cl_4]$　　　B) $[Co(H_2O)_5Cl]Cl_2$　　C) $[Co(H_2O)_5Cl]SO_4$　　D) $Na_3[CoCl_6]$
   E)　$[Co(H_2O)_6]Cl_3$

26. How many unpaired electrons are found in $[CoCl_6]^{3-}$ (weak field)?
   A)　2　B) 0　　C)　　1　　D)　　5　E) 4

27. Isomers have
   A)　different molecular formulas and different structures.
   B)　the same molecular formula and the same structure.
   C)　the same molecular formula but different structures.
   D)　different molecular formulas but the same structure.
   E)　none of these

28. Which of the following is the best description of a protein?
   A)　a chain of amino acids formed by condensation polymerization
   B)　an alternating chain of amino acids and nucleic acids
   C)　two antiparallel chains of nucleic acids connected by hydrogen bonding
   D)　a chain of amino acids connected by ester bonds
   E)　a chain of nucleotides connected by phosphodiester bonds

29. A radioactive element has a half-life of 17 min. How many minutes will it take for the number of atoms present to decay to 1/8th of the initial value?
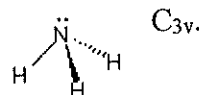   A)　450 min　B) 51 min　　C) 2.1 min　　D) 136 min　　E) 250 min

30. When 1.00 mol of a pure liquid is vaporized at a constant pressure of 1.06 atm and at its boiling point of 332.6 K, 32.16 kJ of energy (heat) is absorbed and the volume change is 27.44 L. What is ΔH for this process? (1 L-atm = 101.3 J)

　　A)　−35.11 kJ　　　B) 35.11 kJ　　　C) 29.21 kJ　　　D) −29.21 kJ　　　E) 32.16 kJ

第二部份：簡答題(5 小題，每題 2 分，共 10 分)

Draw the Lewis structures for the following molecules, considering bonding, lone pairs and resonance. And assign the point group for each molecule. For example: NH₃, C3v.

(A)NO_2^-　　　　　(B) O_3　　　　　(C) XeF_4　　　　　(D) XeF_2　　　　　(E) SF_4