國立成功大學

114學年度碩士班招生考試試題

編　號：48

系　所：地球科學系

科　目：普通化學

日　期：0211

節　次：第 2 節

注　意：1.不可使用計算機
　　　　2.請於答案卷(卡)作答，於試題上作答，不予計分。

一、選擇題: (66 %; 每題 3 分)

1. An element's most stable ion forms an ionic compound with chlorine having the formula XCl_2. If the mass number of the ion is 24 and it has 10 electrons, what is the element and how many neutrons does it have?

   (A) Ne, 14 neutrons ; (B) Ne, 16 neutrons ; (C) O, 16 neutrons ; (D) Mg, 12 neutrons ; (E) Na, 11 neutrons.

2. How many atoms of hydrogen are present in 4.0 g of ammonia? (N:14 ; H: 1)

   (A) 4.2×10^{23} ; (B) 7.8×10^{24} ; (C) 1.2×10^{24} ; (D) 1.8×10^{24} ; (E) 0.70

3. When the equation $NH_3 + O_2 \rightarrow NO + H_2O$ is balanced with the smallest set of integers, the sum of the coefficients is

   (A) 4 ; (B) 12 ; (C) 14 ; (D) 19 ; (E) 24

4. Consider five solutions that all have the same mass of solute in 100.0 mL of solution. Which has the highest concentration as measured in molarity?
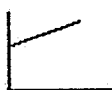
   (A) KCl ; (B) NaF ; (C) NaCl ; (D) Na_2SO_4 ; (E) $CaCl_2$

5. An aqueous solution of barium nitrate reacts with an aqueous solution of sodium sulfate. Identify the precipitate solid and indicate its coefficient in the balanced equation.

   (A) $NaNO_3$, 1 ; (B) $NaNO_3$, 2 ; (C) $BaSO_4$, 1 ; (D) $BaSO_4$, 2 ; (E) no precipitate formed

6. The pressure of an ideal gas versus the volume at constant temperature and number of moles.
   Which graph represents the plot?

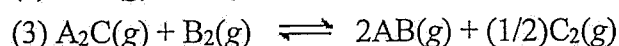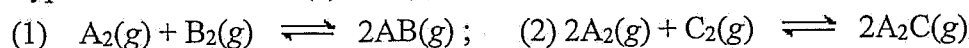   (A)　　　(B)　　　(C)　　　(D)　　　(E) none of these

7. Calculate the following ratio of effusion rate at T_1 / effusion rate at T_2 for a gas at Kelvin temperatures T_1 and T_2 where $T_2 = 2T_1$.

   (A) 0.5 ; (B) 2.0 ; (C) $1/\sqrt{2}$; (D) $\sqrt{2}$; (E) 1.0

8. A 250.0-L cylinder contains 65.0% He(g) and 35.0% Kr(g) by mass at 25.0°C and 1.35 atm total pressure. What is the partial pressure of He in this container? (He: 4 ; Kr: 84)

   (A) 1.35 atm ; (B) 1.32 atm ; (C) 0.878 atm ; (D) 0.675 atm ; (E) 0.473 atm

9. For the hypothetical reactions (1) and (2) , $K_1 = 10^2$ and $K_2 = 10^{-4}$.

   (1) $A_2(g) + B_2(g) \rightleftharpoons 2AB(g)$;　　(2) $2A_2(g) + C_2(g) \rightleftharpoons 2A_2C(g)$

   (3) $A_2C(g) + B_2(g) \rightleftharpoons 2AB(g) + (1/2)C_2(g)$

   (A) 10^4 ; (B) 10^{-4}; (C) 10^2; (D) 10^{-2}; (E) 10^6 .

10. Given that the K_a for HOCl is 3.5×10^{-8} at 25°C, calculate the K value for the reaction of HOCl with OH$^-$.
   (A) 2.9×10^{-7} ; (B) 2.9×10^7 ; (C) 3.5×10^{-22} ; (D) 3.5×10^{-8} ; (E) 3.5×10^6

11. Calculate [H$^+$] in a solution that is 0.24 M in NaF and 0.48 M in HF. ($K_a = 7.0 \times 10^{-4}$)
   (A) 0.46 M ; (B) 3.8×10^{-4} M ; (C) 1.4×10^{-3} M ; (D) 1.8×10^{-2} M ; (E) 1.1×10^{-4} M

12. A solution containing 10.0 mmol of CO_3^{2-} and 5.0 mmol of HCO_3^- is titrated with 1.0 M HCl.
   What volume of HCl must be added to reach the first equivalence point?
   (A) 5.0 mL ; (B) 10.0 mL ; (C) 15.0 mL ; (D) 20.0 mL ; (E) 25.0 mL

13. Given the equation $S(s) + O_2(g) \rightarrow SO_2(g)$, $\Delta H = -296$ kJ, which of the following statements is(are) true?
   I. The reaction is exothermic. ;   II. When 0.500 mol of sulfur is reacted, 148 kJ of energy is released.
   III. When 32.0 g of sulfur is burned, 2.96×10^5 J of energy is released. (S: 32)
   (A) All are true ; (B) I and II are true ; (C) I and III are true ; (D) II and III are true; (E) Only I is true

14. In which of the following cases must cell potential E be equal to zero?
   I. In any cell at equilibrium ; II. In a concentration cell ; III. $E°$ can never be equal to zero.
   (A) I only ; (B) II only ; (C) III only ; (D) I and II ; (E) II and III

15. 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) 1/9 ; (E) 1/16

16. The reaction $2A + B \rightarrow C$ has the following proposed mechanism.
   Step 1: $A + B \rightleftharpoons D$ (fast equilibrium)
   Step 2: $D + B \rightarrow E$
   Step 3: $E + A \rightarrow C + B$
   If step 2 is the rate-determining step, what should be the rate of formation of C?
   (A) $k[A]$; (B) $k[A]^2[B]$; (C) $k[A]^2[B]^2$; (D) $k[A][B]$; (E) $k[A][B]^2$

17. Which of the compounds below is an example of a network solid?
   (A) $S_8(s)$; (B) $MgO(s)$; (C) $SiO_2(s)$; (D) $NaCl(s)$; (E) $C_{25}H_{52}(s)$

18. When a nonvolatile solute is added to a volatile solvent, the solution vapor pressure _____, the boiling point _____, the freezing point _____, and the osmotic pressure across a semipermeable membrane _____.
   (A) decreases, increases, decreases, decreases ; (B) increases, increases, decreases, increases ;
   (C) increases, decreases, increases, decreases ; (D) decreases, decreases, increases, decreases ;
   (E) decreases, increases, decreases, increases

19. Which of the following crystal field diagrams is correct for $Co(CN)_6^{4-}$, where CN^- is a strong-field ligand? (Co: $[Ar]4s^23d^7$)

(A) ⇅　⇅　⇅
　　⇅　⇅　⇅

(B) ↿　—　—
　　⇅　⇅　⇅

(C) ↿　↿
　　⇅　⇅　⇅

(D) ↿　↿　↿
　　⇅　⇅
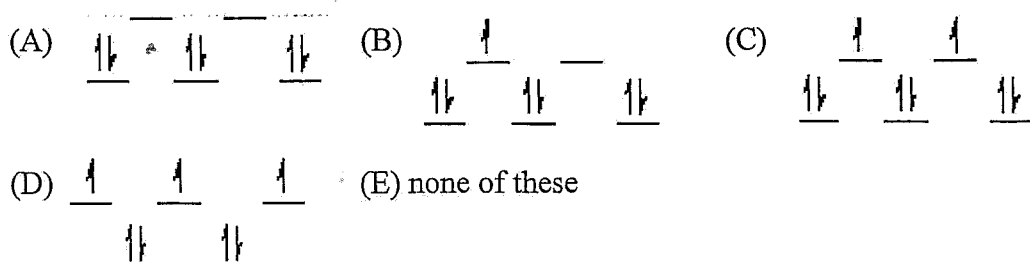
(E) none of these

20. Choose the correct molecular structure for NO_3^-.

(A) trigonal bipyramidal ; (B) tetrahedral ; (C) octahedral ; (D) trigonal planar ; (E) none of these

21. Which of the following have a -C-O-C- functional group?

(A) esters ; (B) ethers ; (C) amines ; (D) aldehydes ; (E) alcohols

22. Which one of the following statements about the structure of proteins is *incorrect*?

(A) Disulfide bonds provide strong intrachain interactions.

(B) Hydrogen bonding stabilizes the α-helix proteins.

(C) Nonpolar groups tend to face the outside of a protein in an aqueous solution.

(D) Ionized amino acid side chains can form salt bridges within a protein.

(E) Heat can disrupt tertiary structure.

二、問答與計算題 (34 % ; 計算與問答題需寫過程否則不予計分)

1. The half-life ($t_{1/2}$) of the C-14 decay is 2000 years.

    (a). Calculate the reaction constant (k) of C-14 decay. (4 %)

    (b). How much of a 2.00-mg sample of C-14 remains after 8000 years? (4 %)

2. Use the molecular orbital model to draw MO energy-level diagrams for predicting the magnetism and bond order of B_2 and F_2 molecule. (能階排列順序要畫對才給分 10 %)

3. (a). Use an equation to describe the Second law of Thermodynamics. (2%)

    (b). Calculate the entropy of a perfect crystal at T = 0 K. (2 %)

    (c). A NCKU student measured different equilibrium constant K values at different temperatures. Please teach the student to use these data to calculate the $\Delta H°$ and $\Delta S°$ values. ($\Delta H°$ and $\Delta S°$ are temperature-independent) (6 %)

4. (a) Write down an equation to describe the photoelectric effect. (2 %)

    (b) When a metal surface with an electron-binding energy of E_0 is radiated with a photon with a frequency v ($hv > E_0$), please calculate the wavelength of the emitted electron. (Hint: the mass of electron is m_e) (4 %)