國立成功大學

112學年度碩士班招生考試試題

編　號：51

系　所：地球科學系

科　目：普通化學

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節　次：第 2 節

備　註：不可使用計算機

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

一、選擇題：(60 %；每題 2 分)

1. How many protons, neutrons, and electrons does the ion $^{127}I^-$ have?

(A) 53 protons, 74 neutrons, 54 electrons ; (B) 53 protons, 74 neutrons, 53 electrons

(C) 53 protons, 74 neutrons, 52 electrons ; (D) 53 protons, 127 neutrons, 54 electrons

(E) 53 protons, 53 neutrons, 54 electrons

2. What is the correct formula for chromium(VI) oxide?

(A) CrO_6 ; (B) Cr_3O_4 ; (C) CrO_3 ; (D) Cr_2O_3 ; (E) CrO_2

3. Which compound has the smallest molar mass?

(A) C_2H_4O ; (B) CO_2 ; (C) CH_3Cl ; (D) C_2H_6 ; (E) none of these

4. The empirical formula of styrene is CH; its molar mass is about 104. What is the molecular formula of styrene?

(A) C_4H_4 ; (B) C_8H_8 ; (C) $C_{10}H_{10}$; (D) C_6H_6 ; (E) none of these

5. What volume of 12.0 M HCl is required to prepare 16.0 L of 0.250 M hydrochloric acid?

(A) 133 mL ; (B) 333 mL ; (C) 648 mL ; (D) 762 mL ; (E) none of these

6. Which pair of ions would *not* be expected to form a precipitate when dilute solutions of each are mixed?

(A) Ba^{2+}, SO_4^{2-} ; (B) Ag^+, Br^- ; (C) Ca^{2+}, PO_4^{3-} ; (D) Fe^{3+}, OH^- ; (E) Co^{2+}, SO_4^{2-}

7. A cylinder is fitted with a movable piston. The pressure inside the cylinder is P_i and the volume is V_i. What is the new pressure in the system when the piston decreases the volume of the cylinder by half?

(A) $(1/4)P_i$; (B) $(1/2)P_i$; (C) $4P_i$; (D) $2P_i$; (E) $1/2\ P_iV_i$

8. How many of the following gases at STP are less dense than air at STP?

NH$_3$, He, Kr, and F$_2$

(A) 0 ; (B) 1; (C) 2; (D) 3; (E) 4

9. If, at a given temperature, the equilibrium constant for the reaction　$H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g)$ is 4, then the equilibrium constant for the reaction　$HCl(g) \rightleftharpoons (1/2)H_2(g) + (1/2)Cl_2(g)$ can be represented as

(A) 4 ; (B) 2 ; (C) 16 ; (D) 0.5 ; (E) 0.25

10. The acids $HC_2H_3O_2$ and HF are both weak, but HF is a stronger acid than $HC_2H_3O_2$. HCl is a strong acid. Order the following according to base strength.

(A) $C_2H_3O_2^- > F^- > Cl^- > H_2O$; (B) $C_2H_3O_2^- > F^- > H_2O > Cl^-$;

(C) $Cl^- > F^- > C_2H_3O_2^- > H_2O$; (D) $F^- > C_2H_3O_2^- > H_2O > Cl^-$;

(E) none of these.

11. For nitrous acid, HNO_2, $K_a = 4.0 \times 10^{-4}$. Estimate the pH of 0.27 M HNO_2.

(A) 1.98 ; (B) 0.57 ; (C) 2.83 ; (D) 3.40 ; (E) 4.53

12. If an acid, HA, is 10.0% dissociated in a 1.0 M solution, what is K_a for this acid?

(A) 9.1×10^{-2} ; (B) 1.1×10^{-2} ; (C) 8.1×10^{-1} ; (D) 9.0×10^{-2} ; (E) 6.3×10^{-2}

13. Methyl orange is an indicator with a K_a of 1×10^{-4}. Its acid form, HIn, is red, while its base form, In^-, is yellow. At pH 6.0, the indicator will be:

(A) red. ; (B) orange. ; (C) yellow. ; (D) blue. ; (E) not enough information.

14. 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) 1.3×10^{-4} M ; (B) 7.8×10^{-5} M ; (C) 9.5×10^{-7} M ; (D) 1.9×10^{-12} M ;

(E) 9.8×10^{-6} M

15. Calculate the work for the expansion of an ideal gas from 3.1 to 6.4 L against a pressure of 1.6 atm at constant temperature.

(A) 5.3 L•atm ; (B) −5.3 L•atm ; (C) 5.9 L•atm. ; (D) −3.3 L•atm ;

(E) not enough information.

16. Calculate $\Delta H°$ for the reaction $C_4H_4(g) + 2H_2(g) \rightarrow C_4H_8(g)$, using the following data:

$\Delta H°_{combustion}$ for $C_4H_4(g) = -2341$ kJ/mol

$\Delta H°_{combustion}$ for $H_2(g) = -286$ kJ/mol

$\Delta H°_{combustion}$ for $C_4H_8(g) = -2755$ kJ/mol

(A) −128 kJ ; (B) −158 kJ ; (C) 158 kJ ; (D) 128 kJ; (E) not enough information.

17. The standard reduction potentials are as follows:

$Cr^{3+} + 3e^- \rightarrow Cr(s)$　　　$E° = -0.73$ V

$Br_2(aq) + 2e^- \rightarrow$　$2Br^-$　$E° = +1.09$ V

What is $E°$ for this cell?

(A) 1.82 V ; (B) 0.36 V ; (C) 4.75 V ; (D) 1.79 V; (E) −1.79 V.

18. Why is aluminum protected from corrosion? (E^o for Al^{3+} is −1.66 V.)

(A) Oxygen and aluminum have no affinity for one another. (B) The oxidation of aluminum is not a favored process
(C) Aluminum forms a protective oxide coating. (D) Aluminum is not protected from corrosion.
(E) At least two of these are correct.

19. Consider the the energy-level diagram for hydrogen, For which of the following transitions does the light emitted
    have the longest wavelength?
(A) $n = 2$ to $n = 1$; (B) $n = 3$ to $n = 2$; (C) $n = 4$ to $n = 1$; (D) $n = 4$ to $n = 2$;
(E) $n = 4$ to $n = 3$.

20. The energy equation for a particle in a cubic box of dimensions $L_x = L_y = L_z$　is　$E_{nx, ny, nz} = h^2/8mL^2 (n_x^2 + n_y^2 + n_z^2)$
    how many degenerate energy levels have energy equal to $14 h^2/8 mL^2$?
(A) 2 ; (B) 3 ; (C) 4 ; (D) 6 ; (E) 8.

21. Which of the following elements forms the most ionic bond with chlorine?
(A) Cs ; (B) Ca ; (C) Mg ; (D) P ; (E) Na.

22. Which of the following has a zero dipole moment?
(A) NH_3 ; (B) NO_2 ; (C) SO_2 ; (D) H_2O_2 ; (E) PF_5.

23. Which substance can be described as cations bonded together by mobile electrons?
(A) $AgCl(s)$; (B) $Ag(s)$; (C) $NaCl(s)$; (D) $S_8(s)$; (E) $SiO_2(s)$.

24. The triple point of iodine is at 90 torr and 115°C. This means that liquid I_2
(A) is more dense than $I_2(s)$. ; (B) cannot exist above 115°C. ;
(C) cannot exist at 1 atm pressure. ; (D) cannot have a vapor pressure less than 90 torr. ;
(E) can exist at pressure of 10 torr.

25. Which of the following concentration measures will change in value as the temperature of a solution changes?
(A) mass percent ; (B) mole fraction ; (C) molality ; (D) molarity ; (E) all of these.

26. The phrase "a solid dissolved in a gas" describes a(n)
(A) foam. ; (B) sol. ; (C) emulsion. ; (D) vapor ; (E) aerosol.

27. Which of the following is the most abundant metal on earth?
(A) calcium ; (B) iron ; (C) copper ; (D) zinc ; (E) aluminum

28. Choose the species with the smallest hydration energy (absolute value).

(A) F^- ; (B) Cl^- ; (C) Br^- ; (D) I^- ; (E) All are the same.

29. When the U-235 nucleus is struck with a neutron, the Zn-72 and Sm-160 nuclei are produced, along with some neutrons. How many neutrons are emitted?

(A) 2 ; (B) 3 ; (C) 4 ; (D) 5 ; (E) 6

30. Liquid A has vapor pressure x. Liquid B has vapor pressure y, and $x > y$. What is the mole fraction of A in the liquid mixture if the vapor above solution is 50% A?

(A) $y/(2x + 2y)$; (B) $x/(2x + 2y)$; (C) $x/(x + y)$; (D) $y/(x + y)$; (E) none of these.

二、問答與計算題 (40 ％ ; 計算與問答題需寫過程否則不予計分)

1. (a). The CN^- is a strong-field ligand. Please draw the electron arrangement in the split 3d orbital of the $Co(CN)_6^{4-}$, and predict how many unpaired electrons in this complex ion. (7 %)　　(Hint: Co: $[Ar]4s^2 3d^7$)

   (b). Is the $Co(CN)_6^{4-}$ paramagnetic or antimagnetic? Why? (3 %)

2. Write down the functional groups of the following organic compounds.

   (A) aldehydes ; (B) ketones ; (C) amines ; (D) esters; (E) ethers. (10 %)

3. (a) Derive the integrated rate law of first-order reaction. (5 %)

   (b) Briefly describe how to get the activation energy of a reaction. (5 %)

4. (a). Justify: $-\Delta G/T = \Delta S_{universe}$ at constant pressure and temperature. (4 %)

   (b). Justify: ΔG = maximum of w_{useful} at constant pressure and temperature (6 %)