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國立成功大學 108 學年度碩士班招生考試試題

系　　所：地球科學系

考試科目：普通化學

考試日期：0224，節次：2

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※ 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: (54 %; 每題 2 分)

1. Which of the following represents a pair of isotopes?

(A) $^{15}_7N$, $^{15}_8O$; (B) O_2, O_3 ; (C) $^{18}_8O$, $^{19}_9F$; (D) $^{32}_{16}S$, $^{32}_{16}S^{2-}$; (E) $^{12}_6C$, $^{13}_6C$

2. What is the correct formula for barium phosphate?

(A) $Ba_3(PO_4)_2$; (B) $BaPO_4$; (C) $Ba_2(PO_4)_3$; (D) $BaPO_3$; (E) $Ba_3(PO_3)_2$

3. Consider the unbalanced equation:　　$C_4H_8 + O_2 \rightarrow CO_2 + H_2O$

For every 2.0 mol of C_4H_8, ___ mol of O_2 is required:

(A) 6.0 ; (B) 6.5 ; (C) 13.0 ; (D) 12.0 ; (E) 14.0

4. Lead(II) nitrate reacts with sodium chloride in aqueous solution to form a precipitate.　What is the net ionic equation for this reaction?

(A) $Pb^{2+}(aq) + 2NO_3^-(aq) \rightarrow Pb(NO_3)_2(s)$; (B) $Na^+(aq) + NO_3^-(aq) \rightarrow NaNO_3(s)$;

(C) $Na^+(aq) + Cl^-(aq) \rightarrow NaCl(s)$; (D) $Pb^{2+}(aq) + 2Cl^-(aq) \rightarrow PbCl_2(s)$;

(E) $Pb^+(aq) + Cl^-(aq) \rightarrow PbCl(s)$

5. The reaction occurs in aqueous acid solution:　　$NO_3^- + I^- \rightarrow IO_3^- + NO_2$

In the balanced equation, what is the coefficient of NO_3^-?

(A) 1 ; (B) 2 ; (C) 4 ; (D) 5 ; (E) 6

6. 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) 1.0 ; (D) $1/\sqrt{2}$; (E) $\sqrt{2}$

7. Volume versus temperature in degrees Celsius for an ideal gas at constant pressure and number of moles

(A) 　(B) 　(C) 　(D) 　(E) none of these

8. One mole of an ideal gas at 25°C is compressed isothermally and reversibly from 22.0 L to 11.0 L. Which statement is correct?

(A) $\Delta S_{gas} = 0$; (B) $\Delta S_{gas} = -R\ln2$; (C) $\Delta S_{gas} = -25\,R\ln2$; (D) $\Delta S_{surr} = -298\,R\ln2$; (E) $\Delta S_{gas} = -50\,R$

9. The standard free energy of formation of AgCl(s) is –110 kJ/mol. Calculate $\Delta G°$ for the reaction:

$$2AgCl(s) \rightarrow 2Ag(s) + Cl_2(g)$$

(A) –110. kJ ; (B) 110 kJ ; (C) 220 kJ ; (D) –220. kJ; (E) none of these.

10. For the reaction:　　$CO_2(g) + 2H_2O(g) \rightarrow CH_4(g) + 2O_2(g)$,　$\Delta H° = 803$ kJ

Which of the following will increase equilibrium constant K?

(A) decreasing the number of moles of CH_4 ; (B) Increasing the number of moles of CH_4;

(C) decreasing the pressure of CO_2; (D) increasing the temperature of system;

(E) increasing the volume of system

11. For the reaction $2H_2(g) + O_2(g) \rightleftharpoons 2H_2O(l)$, what is the relationship between K and K_p at temperature T?

(A) $K_c = K_p$; (B) $K_c = K_p(RT)$; (C) $K_c = K_p(RT)^3$; (D) $K_p = K_c(RT)$; (E) $K_p = K_c(RT)^3$

12. For a neutral solution, it must be true that:

(A) pH = 7.00 ; (B) $[H^+] = [OH^-]$; (C) $[H_2O] = 1.0 \times 10^{-14}$; (D) $[H^+] \times [OH^-] = 1.0 \times 10^{-14}$;

(E) At least two of these must be true.

13. Calculate the concentration of chromate ion, CrO_4^{2-}, in a saturated solution of $CaCrO_4$ ($K_{sp} = 4.0 \times 10^{-4}$).

(A) 0.02 ; (B) 2.0×10^{-4}; (C) 1.0×10^{-4}; (D) 1.6×10^{-7}; (E) 8.0×10^{-4}

14. Given:　　$Cu_2O(s) + (1/2)O_2(g) \rightarrow 2CuO(s)$　$\Delta H° = -144$ kJ

　　　　　　$Cu_2O(s) \rightarrow Cu(s) + CuO(s)$　$\Delta H° = +11$ kJ

Calculate the standard enthalpy of formation of $CuO(s)$.

(A) –166 kJ ; (B) –299 kJ ; (C) + 277 kJ ; (D) +133 kJ ; (E) –155 kJ

15. If a reducing agent M reacts with an oxidizing agent Q^{2+} to give M^{2+} and Q, and the equilibrium constant for the reaction is 1.0, then what is the $E°$ value for the oxidation–reduction reaction at 25°C?

(A) 1.0 V ; (B) 0.0 V ; (C) 0.03 V ; (D) – 1.0 V; (E) 0.1 V

16. Of the following elements, which needs 3 electrons to complete its valence shell?

(A) Ba ; (B) Na ; (C) N ; (D) Al ; (E) Si

17. Choose the compound with the most ionic bond.

(A) LiF ; (B) KF ; (C) NaBr ; (D) KBr ; (E) NaCl

18. What is the hybridization of I in the molecule IF_3?

(A) sp^2 ; (B) sp^3 ; (C) dsp^3 ; (D) d^2sp^3; (E) sp^2d

19. Which substance can be described as cations bonded together by mobile electrons?

    (A) $Ag(s)$; (B) $S_8(s)$; (C) $KCl(s)$; (D) $SiO_2(s)$; (E) $HCl(l)$

20. 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) none of these

21. 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

22. How many oxides of carbon are there?

    (A) 1 ; (B) 2 ; (C) 3 ; (D) 4 ; (E) 5

23. Which transition metal can exist in all oxidation states from +2 to +7?

    (A) copper ; (B) vanadium ; (C) iron ; (D) chromium ; (E) manganese

24. How many unpaired electrons are found in $Fe(en)_3^{2+}$ (strong field)? (Fe: $[Ar]4s^2 3d^6$)

    (A) 0 ; (B) 1 ; (C) 2 ; (D) 4 ; (E)5

25. Which of the following processes increases the atomic number by 1?

    (A) gamma-ray production ; (B) alpha production ; (C) neutron-particle production;
    (D) beta-particle production ; (E) proton production

26. The Cs-131 nuclide has a half-life of 30 years. After 120 years, about 3 g remain. The original mass of the Cs-131 sample is closest to

    (A) 30 g ; (B) 40 g ; (C) 50 g ; (D) 60 g ; (E) 70 g

27. If you were to heat pentanoic acid and 2-butanol with an acid catalyst, which of the following would you be most likely discover in your flask?

    (A) a ketone ; (B) an ester ; (C) an amine ; (D) an alkane ; (E) an aldehyde

二、問答與計算題 (46 %；計算與問答題需寫過程否則不予計分)

1. (a) When we measured rate constants of a reaction at different two temperature of T_1 and T_2, the rate constants are k_1 and k_2, respectively. Please use these data to calculate the activation energy of the reaction. (4 %)

   (b) Draw the energy vs. reaction progress curves for catalyzed and uncatalyzed pathway for an endothermic chemical reaction. (4 %)

2. The overall reaction for the corrosion of iron by oxygen is :　$4 Fe(s) + 3 O_2(g) \rightarrow 2 Fe_2O_3(s)$

   (a). Using the following data to calculate the equilibrium constant for this reaction at 27 °C. (6 %)

Substance	ΔH_f^0 (kJ/mol)	S^0 ($JK^{-1}mol^{-1}$)
$Fe_2O_3(s)$	− 900	100
$Fe(s)$	0	30
$O_2(g)$	0	200

   (b). Is the statement of "A reaction with very large equilibrium constant K has fast reaction rate." right or wrong? Why? (3 %)

3. (a) Write down the Bragg equation for calculating the lattice size of crystals. (3 %)

   (b). Draw the phase diagram of water and point the T_3 (triple point) and T_c (critical temperature). (4 %)

4. (a) Use the molecular orbital model to describe why HF molecule is polar. (4 %)

   (b) Why is the vibration frequency of C–H bond at 2800–3200 cm^{-1} higher than that of C–O bond at 1080–1300 cm^{-1} ? (4 %)

5. (a). Calculate the ε^0_{cell} of the galvanic cell (電池) based on the following half-reactions under standard conditions. (3 %)

   $Cu^{2+} + 2e^- \rightarrow Cu$　　　$\varepsilon^0 = 0.34$ V ;　　　$Fe^{3+} + e^- \rightarrow Fe^{2+}$　　　$\varepsilon^0 = 0.77$ V

   (b). Which one electrode is cathode? Why? (2 %)

   (c). Calculate the maximum electric energy released from the above galvanic cell when 1 mole of electrons were transferred (1 mole of electrons ≈ 100000 C). (3 %)

6. (a) What hybrid atomic orbitals of the carbon atoms in diamond and graphite? (2 %)

   (b) Draw the band energies based on the "Band model" to explain the electrical conductivity of diamond and graphite. (4 %)