

國立中正大學九十八學年度碩士班招生考試試題
系所別：化學暨生物化學系

科目：一般化學

第 1 節

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I. 單選題 30 題，每題 3 分，共 90 分

- The boiling of water is a
 - physical change because the water merely disappears.
 - physical change because the gaseous water is chemically the same as the liquid.
 - chemical change because heat is needed for the process to occur.
 - chemical change because a gas (steam) is given off.
 - chemical and physical damage.
- A solution is also called a
 - homogeneous mixture.
 - heterogeneous mixture.
 - pure mixture.
 - compound.
 - distilled mixture.
- What is the bond order of C_2^+ ?
 - 0
 - 0.5
 - 1
 - 1.5
 - 2
- You heat 3.970 g of a mixture of Fe_3O_4 and FeO to form 4.195 g Fe_2O_3 (atomic mass of Fe = 55.847). The mass percent of FeO originally in the mixture was:
 - 12.1%
 - 28.7%
 - 71.3%
 - 87.9%
 - none of these
- You heat 3.970 g of a mixture of Fe_3O_4 and FeO to form 4.195 g Fe_2O_3 . The mass of oxygen reacted is
 - 0.225 g.
 - 0.475 g.
 - 1.00 g.
 - cannot be determined
 - none of these
- Aqueous solutions of sodium sulfide and copper(II) chloride are mixed together. Which statement is correct?
 - Both $NaCl$ and CuS precipitate from solution.
 - No precipitate forms.
 - CuS will precipitate from solution.
 - $NaCl$ will precipitate from solution.
 - No reaction will occur.
- Given the following reaction in acidic media:
$$Fe^{2+} + Cr_2O_7^{2-} \rightarrow Fe^{3+} + Cr^{3+}$$
answer the following question: The coefficient for water in the balanced reaction is
 - 1.
 - 3.
 - 5.
 - 7.
 - none of these

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8. A sample of oxygen gas has a volume of 4.50 L at 27°C and 800.0 torr. How many oxygen molecules does it contain?
- a) 1.16×10^{23} b) 5.8×10^{22} c) 2.32×10^{24} d) 1.16×10^{22}
e) none of these
9. Sulfamic acid, HSO_3NH_2 (molar mass = 97.1 g/mol), is a strong monoprotic acid that can be used to standardize a strong base:
- $$\text{HSO}_3\text{NH}_2(\text{aq}) + \text{KOH}(\text{aq}) \rightarrow \text{KSO}_2\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l})$$
- A 0.179-g sample of HSO_3NH_2 required 19.4 mL of an aqueous solution of KOH for complete reaction. What is the molarity of the KOH solution?
- a) 9.25 M b) 9.50×10^{-5} M c) 0.0950 M
d) 0.194 M e) none of these
10. Consider the following numbered processes:
- I. $\text{A} \rightarrow 2\text{B}$ ΔH_1
II. $\text{B} \rightarrow \text{C} + \text{D}$ ΔH_2
III. $\text{E} \rightarrow 2\text{D}$ ΔH_3
- ΔH for the process $\text{A} \rightarrow 2\text{C} + \text{E}$ is
- a) $\Delta H_1 + \Delta H_2 + \Delta H_3$ b) $\Delta H_1 + \Delta H_2$ c) $\Delta H_1 + \Delta H_2 - \Delta H_3$
d) $\Delta H_1 + 2\Delta H_2 - \Delta H_3$ e) $\Delta H_1 + 2\Delta H_2 + \Delta H_3$
11. Which of the following statements is true?
- a) The first ionization potential of H is greater than that of He.
b) The ionic radius of Fe^+ is larger than that of Fe^{3+} .
c) The ionization energy of S^{2-} is greater than that of Cl^- .
d) The atomic radius of Li is larger than that of Cs.
e) All are false.
12. The statement that the 1st ionization energy for an oxygen atom is lower than the 1st ionization energy for a nitrogen atom is
- a) consistent with the general trend relating changes in ionization energy across a period from left to right because it is easier to take an electron from an oxygen atom than from a nitrogen atom.
b) consistent with the general trend relating changes in ionization energy across a period from left to right because it is harder to take an electron from an oxygen atom than from a nitrogen atom.
c) inconsistent with the general trend relating changes in ionization energy across a period from left to right and due the fact that the oxygen atom has two doubly occupied 2p orbitals and nitrogen has only one.
d) inconsistent with the general trend relating changes in ionization energy across a period from left to right and due to the fact that oxygen has one doubly occupied 2p orbital and nitrogen does not.
e) incorrect.

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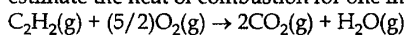
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13. Using the following bond energies

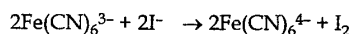
| Bond | Bond Energy (kJ/mol) |
|------|----------------------|
| C≡C | 839 |
| C-H | 413 |
| O=O | 495 |
| C=O | 799 |
| O-H | 467 |

estimate the heat of combustion for one mole of acetylene:



- a) 1228 kJ b) -1228 kJ c) -447 kJ d) +447 kJ e) +365 kJ
14. The hybridization of the phosphorus atom in the cation PH_2^+ is:
a) sp^2 b) sp^3 c) dsp d) sp e) none of these
15. In which of the following processes will energy be evolved as heat?
a) sublimation b) crystallization c) vaporization
d) melting e) none of these
16. A 5.50-gram sample of a compound as dissolved in 250. grams of benzene. The freezing point of this solution is 1.02°C below that of pure benzene. What is the molar mass of this compound? (Note: K_f for benzene = $5.12^\circ\text{C}/\text{m}$.)
a) 22.0 g/mol b) 110. g/mol c) 220. g/mol
d) 44.0 g/mol e) none of these

17. Tabulated below are initial rate data for the reaction



| Run | $[\text{Fe}(\text{CN})_6^{3-}]_0$ | $[\text{I}^-]_0$ | $[\text{Fe}(\text{CN})_6^{4-}]_0$ | $[\text{I}_2]_0$ | Initial Rate (M/s) |
|-----|-----------------------------------|------------------|-----------------------------------|------------------|--------------------|
| 1 | 0.01 | 0.01 | 0.01 | 0.01 | 1×10^{-5} |
| 2 | 0.01 | 0.02 | 0.01 | 0.01 | 2×10^{-5} |
| 3 | 0.02 | 0.02 | 0.01 | 0.01 | 8×10^{-5} |
| 4 | 0.02 | 0.02 | 0.02 | 0.01 | 8×10^{-5} |
| 5 | 0.02 | 0.02 | 0.02 | 0.02 | 8×10^{-5} |

The value of k is:

- a) $10^7 \text{ M}^{-5} \text{ s}^{-1}$ b) $10^3 \text{ M}^{-3} \text{ s}^{-1}$ c) $10 \text{ M}^{-2} \text{ s}^{-1}$
d) $50 \text{ M}^{-2} \text{ s}^{-1}$ e) none of these
18. The OH radical disproportionates according to the elementary chemical reaction
 $\text{OH} + \text{OH} \rightarrow \text{H}_2\text{O} + \text{O}$. This reaction is second order in OH. The rate constant for the reaction is $2.0 \times 10^{-12} \text{ cm}^3/\text{molecule} \cdot \text{s}$ at room temperature. If the initial OH concentration is $1.0 \times 10^{13} \text{ molecules/cm}^3$, what is the first half-life for the reaction?
a) 20. s b) $2.0 \times 10^{-3} \text{ s}$ c) 0.050 s d) 0.035 s e) 12 s

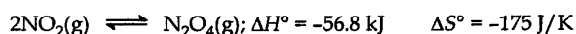
19. A 1-L container originally holds 0.4 mol of N_2 , 0.1 mol of O_2 , and 0.08 mole of NO. If the volume of the container holding the equilibrium mixture of N_2 , O_2 , and NO is decreased to 0.5 L without changing the quantities of the gases present, how will their concentrations change?
- The concentration of NO will increase; the concentrations of N_2 and O_2 will decrease.
 - The concentrations of N_2 and O_2 will increase; and the concentration of NO will decrease.
 - The concentrations of N_2 , O_2 , and NO will increase.
 - The concentrations of N_2 , O_2 , and NO will decrease.
 - There will be no change in the concentrations of N_2 , O_2 , and NO.
20. Which factor listed below is most important in determining the strength of an oxyacid?
- the size of the molecule
 - the ability of the molecule to change atomic orientation
 - the identity of the central atom in the molecule
 - the number of oxygen atoms present in the molecule
 - none of these
21. Calculate the pH of a 0.005 M solution of potassium oxide, K_2O .
- a) 12.0 b) 11.7 c) 7.0 d) 2.3 e) 2.0
22. Consider the titration of 100.0 mL of 0.250 M aniline ($K_b = 3.8 \times 10^{-10}$) with 0.500 M HCl. For calculating the volume of HCl required to reach a pH of 8.0, which of the following expressions is correct? (x = volume in mL of HCl required to reach a pH of 8.0)
- $\frac{0.5x - (100)(0.25)}{100 + x} = [\text{aniline}]$
 - $[H^+] = x$
 - $\frac{0.5x}{100 + x} = [\text{aniline}]$
 - $\frac{25 - 0.5x}{100 + x} - 10^{-6} = [\text{aniline}]$
 - none of these

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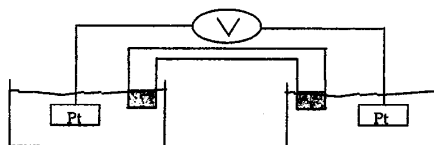
23. Consider the reaction



In a container (at 298 K) $\text{N}_2\text{O}_4(\text{g})$ and $\text{NO}_2(\text{g})$ are mixed with initial partial pressures of 2.4 atm and 0.42 atm, respectively. Which of the following statements is correct?

- Some $\text{N}_2\text{O}_4(\text{g})$ will decompose into $\text{NO}_2(\text{g})$.
- Some $\text{NO}_2(\text{g})$ will dimerize to form $\text{N}_2\text{O}_4(\text{g})$.
- The system is at equilibrium at these initial pressures.
- The final total pressure must be known to answer this question.
- None of these.

24-29. Refer to the galvanic cell below (the contents of each half-cell are written beneath each compartment):



0.10 M MnO_4^-

0.20 M Mn^{2+}

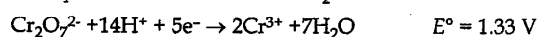
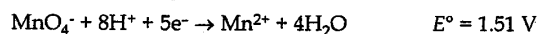
0.010 M H^+

0.40 M Cr^{3+}

0.30 M $\text{Cr}_2\text{O}_7^{2-}$

0.010 M H^+

The standard reduction potentials are as follows:



24. When current is allowed to flow, which species is oxidized?

- $\text{Cr}_2\text{O}_7^{2-}$
- Cr^{3+}
- MnO_4^-
- Mn^{2+}
- H^+

25. What is the value of E°_{cell} ?

- 0.18 V
- 2.84 V
- 0.18 V
- 1.79 V
- 2.29 V

26. What is the value of Q , the reaction quotient, for this cell reaction?

- 6.7×10^{40}
- 1.5×10^{-41}
- 1.5×10^{-4}
- 6.7×10^3

27. In which direction do electrons flow in the external circuit?

- left to right
- right to left
- no current flows; the cell is at equilibrium
- cannot be determined.
- none of these

28. In the balanced cell reaction what is the stoichiometric coefficient for H^+ ?
- a) 5 b) 6 c) 30 d) 22 e) 2
29. How many electrons are transferred in the balanced reaction (i.e., what will be the value of n in the Nernst equation)?
- a) 5 b) 6 c) 30 d) 22 e) 2
30. How many unpaired electrons are there in the tetrahedral complex ion $[FeCl_4]^-$?
- a) 1 b) 2 c) 3 d) 4 e) 5

II. 計算問答題，每題 2 分，共 10 分

Determine the point group for each of the following.

