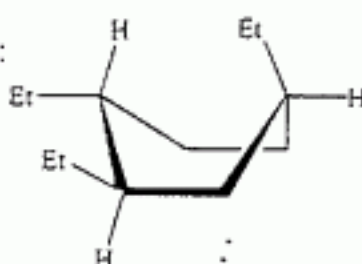
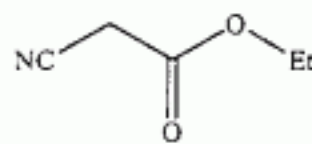


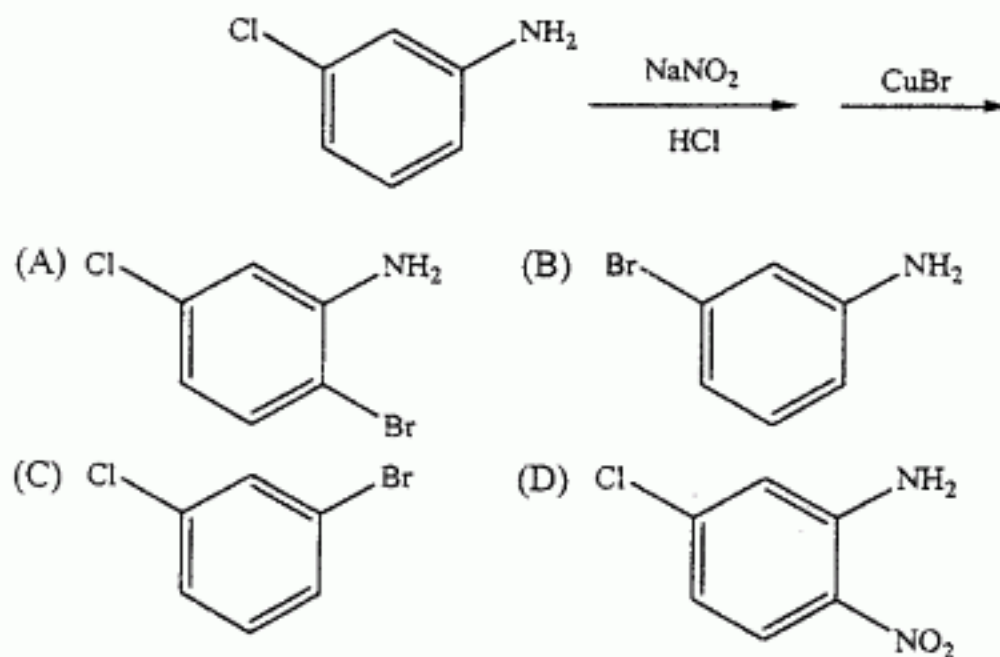
九十三學年度 化學系(所) 化學、應用化學 組碩士班研究生招生考試
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單選題

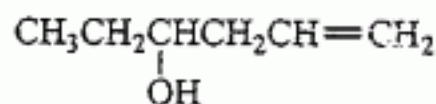
- For the molecule shown on the right, in its most stable conformation:
(A) Two of the ethyl groups are axial
(B) Two of the ethyl groups are equatorial
(C) All of the ethyl groups are axial
(D) All of the ethyl groups are equatorial
- 
- In the tetrahedral intermediate with three possible anionic leaving groups, the best leaving group will be:
(A) the strongest base
(B) the group having the strongest conjugate base
(C) the group having the weakest conjugate base
(D) the group with the highest pK_a
 - Which of the compounds shown below will react with dimethyl malonate in the presence of methoxide anion to give a compound, which on treatment with aqueous acid and gentle heating, will decarboxylate and form hexanoic acid?
(A) $CH_2CHCH_2CH_2COOH$
(B) $CH_3CH_2CH_2COOH$
(C) $CH_3CH_2CH_2CH_2Br$
(D) $HOOCCH_2CH_2COOH$
 - In the mass spectrum, a compound with one bromine atom will have:
(A) four molecular ions, in the ratio 1:1:1:1
(B) two molecular ions, in the ratio 2:1
(C) two molecular ions, in the ratio 1:1
(D) four molecular ions, in the ratio 1:2:2:1
 - The major bands in the infrared spectrum of ethyl cyanoacetate will be:
(A) 3145 cm^{-1} ; 2200 cm^{-1} ; 1620 cm^{-1}
(B) 3145 cm^{-1} ; 2750 cm^{-1} ; 1750 cm^{-1} ; 1620 cm^{-1}
(C) 2930 cm^{-1} ; 2750 cm^{-1} ; 1620 cm^{-1}
(D) 2930 cm^{-1} ; 2200 cm^{-1} ; 1750 cm^{-1}
- 
- In a 1H NMR spectrum, the center protons of $HCBBr_2CH_2CBr_2H$ would appear as a:
(A) singlet
(B) doublet
(C) triplet
(D) quartet
 - Which free radical is most stable relative to the hydrocarbon from which it is formed?
(A) $(CH_3)_2CH\cdot$ (B) $(CH_3)_3C\cdot$ (C) $CH_2=CH\dot{C}HCH_3$ (D) $CH_2=CH\cdot$
 - Which ion is the strongest nucleophile in aqueous solution?
(A) F^- (B) Cl^- (C) Br^- (D) I^-

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9. Predict the organic product from these synthetic transformation sequence:



10. The correct IUPAC name for the following structure is:



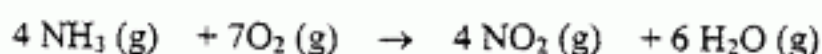
- (A) 5-hexen-3-ol
(B) 1-hexen-4-ol
(C) 3-hydroxy-5-hexene
(D) isohexen-3-ol
11. Which of the following items is the smallest in size?
(A) virus
(B) bacteria
(C) calf thymus DNA
(D) cell nucleus
12. Which of the following reagents can oxidize a cycloalkanone to a lactone:
(A) CrO_3 (B) KMnO_4 (C) *m*-CPBA (D) OsO_4
13. Which reagent will reduce $\text{C}=\text{O}$ and $\text{C}=\text{C}$ but not esters?
(A) NaBH_4
(B) Jones' reagent
(C) $\text{LiAl}(\text{OEt})_3\text{H}$
(D) LiAlH_4
14. Which of the following statements is true for all first-order reactions ?
(A) The half-life is independent of the initial concentration.
(B) Only one substance takes part in the reaction.
(C) The rate is independent of temperature.

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- (D) The rate is independent of pressure.
(E) The rate is independent of the use of catalysts.
15. Which of the following species has a magnetic moment ?
(A) $[\text{Zn}(\text{NH}_3)_4]^{2+}$ (B) $[\text{Co}(\text{NH}_3)_6]^{3+}$ (C) TiF_4
(D) $[\text{PdCl}_4]^{2-}$ (E) $[\text{Cr}(\text{NH}_3)_6]^{3+}$
16. Hydrolysis of the reaction product of phenylmagnesium bromide and 2-butanone results in the formation of
(A) bromobenzene (B) 2-bromobutane (C) phenyl benzoate
(D) 2-phenyl-2-butanol (E) 2-phenylbutane
17. Which of the following statements about the group of elements consisting of Li, Na, K, Rb, and Cs is correct ?
(A) They are all powerful oxidizing agents.
(B) They are known as the alkaline earth metals since their hydroxides are strongly basic.
(C) Each element differs from the one above it by the presence of one additional electron in the outer energy level of its atoms.
(D) They are usually stored under water since they react readily with air.
(E) Each has the largest atomic radius of any element in its period.
18. Theoretically there should be no pure rotational spectrum in the microwave region for CH_4 because the
(A) rotational transitions for this molecule lie in the infrared region of the spectrum
(B) molecule contains no multiple bonds
(C) molecule has no permanent dipole moment
(D) separation between successive rotational energy levels is too small for rotational transitions to be observed in the microwave region
(E) vibrational transitions in this wavelength region obscure the rotational transitions
19. If 0.1-molar solutions of each of the following substances in water were prepared, which solution would exhibit the lowest pH ?
(A) $\text{Be}(\text{NO}_3)_2$ (B) $\text{Mg}(\text{NO}_3)_2$ (C) $\text{Ca}(\text{NO}_3)_2$ (D) $\text{Sr}(\text{NO}_3)_2$ (E) $\text{Ba}(\text{NO}_3)_2$

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20. Which of the following techniques would be most valuable in determining accurately the amount of benzene in a dilute solution of benzene in isopropyl alcohol?
- (A) Visible spectroscopy
(B) Ultraviolet spectroscopy
(C) Infrared spectroscopy
(D) Electron spin resonance spectroscopy
(E) Emission spectroscopy
21. Which of the following molecules is expected to possess a permanent electric dipole moment in the gas phase?
- (A) ClF_5 (B) BF_3 (C) BeF_2 (D) SF_6 (E) CF_4
22. According to the molecular orbital theory, the bond order in O_2^- is
- (A) $1/2$ (B) 1 (C) $3/2$ (D) 2 (E) $5/2$.
23. Which of the following species can not exist in optically active forms? (en = ethylenediamine)
- (A) $[\text{Co}(\text{en})_2(\text{NH}_3)(\text{Cl})]^{2+}$ (B) $[\text{Co}(\text{en})_2\text{Cl}_2]^+$ (C) $[\text{Co}(\text{en})_3]^{3+}$ (D) $[\text{Co}(\text{en})(\text{NH}_3)_3\text{Cl}]^{2+}$
(E) $[\text{Co}(\text{en})(\text{NH}_3)_2\text{Cl}_2]^+$
24. The three-dimensional structure of a protein is crucial to its function. The process of breaking down this structure is called
- (A) degradation (B) denaturation (C) dealkylation (D) desulfurization.
25. The first ionization energy for phosphorus is 1060 KJ/mole. Then the first ionization energy of sulfur was estimated as
- (A) 1200 (B) 1080 (C) 1005 (D) 500 KJ/mole.
26. Determine the angular momentum quantum number (l) of 3d orbital
- (A) $l = 0$ (B) $l = 1$ (C) $l = 2$ (D) $l = 3$.
27. The combustion of ammonia in the presence of excess oxygen yields NO_2 and H_2O :



The combustion of 43.9 g of ammonia consumes _____ g of NO_2 .

- (A) 43.9 (B) 0.954 (C) 2.58 (D) 119

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28. Of the choices below, which would be the best for the lining of a tank intended for use in storage of hydrochloric acid?
(A) iron (B) tin (C) zinc (D) copper
29. The units of specific heat are _____.
(A) J/g-K or J/g-°C
(B) g-K/J or g-°C/J
(C) J/K or J/°C
(D) K/J or °C/J
30. Which of the following correctly lists the five atoms in order of increasing size (smallest to largest)?
(A) O < F < S < Ba < Mg
(B) F < S < O < Mg < Ba
(C) O < F < S < Mg < Ba
(D) F < O < S < Mg < Ba
31. Consider the following properties of an element:
(i) It is solid at room temperature.
(ii) It easily forms an oxide when exposed to air.
(iii) When it reacts with water, hydrogen gas evolves.
(iv) It must be stored submerged in oil.
Which element fits the above description the best?
(A) sulfur (B) sodium (C) mercury (D) magnesium
32. Which of the following liquids will have the lowest freezing point?
(A) pure H₂O
(B) aqueous glucose (0.60 m)
(C) aqueous sucrose (0.60 m)
(D) aqueous KF (0.50 m)
33. What is the typical pH of natural, unpolluted rainwater?
(A) 6 (B) 12 (C) 5 (D) 9
34. Which one of the following could be produced by anaerobic bacteria decomposing biodegradable waste?
(A) carbon dioxide (B) hydrogen sulfide (C) sulfate (D) nitrate
35. How does lime reduce sulfur dioxide emissions from the burning of coal?
(A) It reduces the sulfur dioxide to elemental sulfur that is harmless to the environment.
(B) It converts SO₂ to solid, elemental sulfur.
(C) It reacts with the sulfur dioxide to form calcium sulfite solid that can be precipitated.
(D) It oxidizes the sulfur dioxide to tetrathionate that is highly water soluble so it can be scrubbed from the emission gases.

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36. The standard cell potential (E°_{cell}) for the reaction below is +1.10 V. The cell potential for this reaction is _____ V when the concentration of $[\text{Cu}^{2+}] = 1.0 \times 10^{-5} \text{ M}$ and $[\text{Zn}^{2+}] = 1.0 \text{ M}$.



- (A) 1.25 (B) 0.95 (C) 1.10 (D) 0.80
37. Why can sodium metal not be produced by electrolysis of an aqueous solution of sodium chloride?
(A) The carbon anode is more easily reduced than sodium ions.
(B) The iron cathode would be corroded by the salt water.
(C) The production of chlorine gas interferes with the reduction of sodium ions.
(D) Water is more easily reduced than sodium metal.
38. A small amount of barium chloride solution is added to a blue solution. A white precipitate forms. The blue solution contains
(A) CuCl_2 (B) CoCl_2 (C) $\text{Co}(\text{NO}_3)_3$ (D) CuSO_4
39. Which one of the followings is a unit for a first-order rate constant
(A) M/s (B) $1/\text{M}\cdot\text{s}$ (C) $1/\text{s}$ (D) $1/\text{M}^2\cdot\text{s}$
40. If the activation energy for a certain biological reaction is 50 kJ/mol, by what factor will the rate of this reaction increase when the body temperature increases from 37 °C to 40 °C?
($R=8.314 \text{ JK}^{-1}\text{mol}^{-1}$)
(A) 1.15 (B) 1.20 (C) 2.0×10^5 (D) 2.0
41. Consider the following equilibria
 $2\text{SO}_3(\text{g}) \rightleftharpoons 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \quad K_c = 2.3 \times 10^{-7}$
 $2\text{NO}_3(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g}) + \text{O}_2(\text{g}) \quad K_c = 1.4 \times 10^{-3}$
 What is the equilibrium constant value for the reaction?
 $\text{SO}_2(\text{g}) + \text{NO}_3(\text{g}) \rightleftharpoons \text{SO}_3(\text{g}) + \text{NO}_2(\text{g})$
 (A) 78 (B) 1.3×10^{-2} (C) 1.6×10^{-4} (D) 3.2×10^{-10}
42. A 0.1326 g sample of magnesium was burned in an oxygen bomb calorimeter. The total heat capacity of the calorimeter plus water was 5.76 kJ/°C. If the temperature rise of the calorimeter with water was 0.57 °C, calculate the enthalpy change of the combustion of magnesium: $\text{Mg(s)} + 1/2 \text{O}_2(\text{g}) \rightarrow \text{MgO(s)}$. (Atomic weight of Mg=24.3 amu)
(A) -3280 kJ/mol (B) -24.8 kJ/mol (C) 106 kJ/mol (D) -602 kJ/mol

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43. Calculate the work done in joules when 2.5 mole of $\text{H}_2\text{O}(l)$ vaporizes at 1.0 atm and 25 °C. Assume the volume of liquid H_2O is negligible compared to that of vapor.
 (A) 6190 kJ (B) 6.19 kJ (C) 61.1 J (D) 5.66 kJ
44. Which of the following solutions has the highest osmotic pressure at 25 °C?
 (A) 0.2 M KBr (B) 0.2 M ethanol (C) 0.2 M Na_2SO_4 (D) 0.2 M KCl
45. Arrange the following reactions according to increasing ΔS values.
 1. $\text{CH}_4(g) + \text{H}_2\text{O}(g) \rightarrow \text{CO}(g) + 3\text{H}_2(g)$
 2. $\text{C}(s) + \text{O}_2(g) \rightarrow \text{CO}_2(g)$
 3. $\text{H}_2\text{O}_2(l) \rightarrow \text{H}_2\text{O}(l) + 1/2 \text{O}_2(g)$
 (A) $1 < 3 < 2$ (B) $2 < 3 < 1$ (C) $2 < 1 < 3$ (D) $3 < 2 < 1$
46. Calculate the wavelength of the light emitted by a hydrogen atom during a transition of its electron from the $n=4$ to the $n=1$ principal energy level.
 (Rydberg constant = $1.09678 \times 10^7 \text{ m}^{-1}$)
 (A) 97.5 nm (B) 82.6 nm (C) 365 nm (D) 0.612 nm
47. Based on the Graham's law, the relative rates of effusion of H_2 and CO_2 through a small pinhole is
 (A) 22 (B) 4.69 (C) 0.071 (D) 0.267
48. Which one of the following sets of atomic quantum numbers (n, l, m_l, m_s) is unacceptable?
 (A) (4, 3, -1, 1/2) (B) (3, 0, 1, -1/2) (C) (3, 0, 0, 1/2) (D) (2, 1, 1, -1/2)
49. What is the bond order for the CN^- anion?
 (A) 1 (B) 1.5 (C) 3 (D) 2.5
50. Which of the followings are true for a spontaneous redox reaction in the forward direction
 (A) $\Delta S > 0$ (B) $\Delta G < 0$ (C) $E_{\text{redox}} < 0$ (D) $\Delta H > 0$