

科目 普通化學 類組別 A10 共 8 頁第 1 頁 *請在試卷答案卷(卡)內作答

單選題，每題 2.5 分

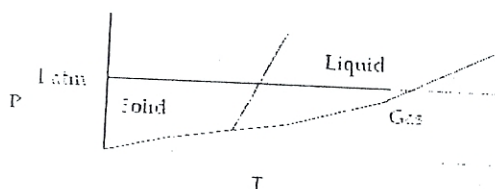
1. The ultimate criterion for spontaneity of a process is
A) the change in internal energy of the process.
B) the change in enthalpy.
C) the change in entropy.
D) the change in free energy for the process.
E) the change in numbers of moles of gaseous species.
2. The following reaction is endothermic: $2\text{SO}_3(\text{g}) \rightarrow 2\text{SO}_2(\text{g}) + \text{O}_2(\text{g})$. The reaction is
A) spontaneous at all temperatures.
B) non-spontaneous at all temperatures.
C) spontaneous at low temperatures.
D) spontaneous at high temperatures.
E) with a positive activation energy.
3. Which of the following is paramagnetic with three unpaired electrons in its ground state?
A) Li B) Al C) As D) S E) Br
4. How many of the elements in the second row of the Periodic Table are paramagnetic in atomic form?
A) 3 B) 4 C) 5 D) 6 E) 7
5. Which cation would have the following electron configuration?
 $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
A) Sc^{+2} B) Ca^{+2} C) S^{2-} D) K^+ E) K
6. For the reaction:
 $\text{Au}(\text{s}) + 4\text{H}^+(\text{aq}) + \text{NO}_3^-(\text{aq}) + 4\text{Cl}^-(\text{aq}) \rightarrow \text{AuCl}_4^-(\text{aq}) + \text{NO}(\text{g}) + 2\text{H}_2\text{O}$
 $E^\circ = -0.04\text{ V}$
If the standard potential for the reduction of $\text{NO}_3^-(\text{aq})$ to $\text{NO}(\text{g})$ is $+0.96\text{ V}$, determine the value of E° for the following half-reaction.
 $\text{AuCl}_4^-(\text{aq}) + 3\text{e}^- \rightarrow \text{Au}(\text{s}) + 4\text{Cl}^-(\text{aq})$
A) 1.00 B) +0.92 C) -0.92 D) -1.00 E) none of these
7. Which of the following solutions has the highest boiling point?
A) 1.0 m glucose in water B) 1.0 m NaCl in water
C) 1.0 m NaBr in water D) 1.0 m CaCl_2 in water
E) pure water

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8. The boiling points of the noble gases increase going down the group. What type of intermolecular force best accounts for this fact?
A) permanent dipole B) ion-ion C) hydrogen bonding
D) London dispersion E) ion-dipole
9. The hybrid orbitals used by sulfur in SF_6 are
A) sp B) sp^2 C) sp^3 D) sp^3d E) sp^3d^2
10. What is the proper order of decreasing Cl-A-Cl angle?
1) PCl_3 2) SiCl_4 3) BCl_3
A) $1 > 2 > 3$ B) $2 > 3 > 1$ C) $3 > 2 > 1$ D) $2 > 1 > 3$ E) $3 > 1 > 2$
11. Estimate the ΔH° , in kJ, for the following reaction from the bond energies given.
 $\text{C}_3\text{H}_8(\text{g}) + \text{Br}_2(\text{g}) \rightarrow \text{C}_3\text{H}_7\text{Br}(\text{g}) + \text{HBr}(\text{g})$
Bond energy (kJ/mol): C-H, 414; C-Br, 276; Br-Br, 193; H-Br, 364.
A) 33 B) 133 C) -33 D) -133 E) 1247
12. Select the best Lewis structure for N_3^- ? (Formal charges are not indicated.)
A) $\text{N}=\text{N}=\text{N}$ B) $\text{N}\equiv\text{N}-\text{N}$ C) $\text{N}^--\text{N}=\text{N}$ D) $\text{N}=\text{N}=\text{N}$ E) $\text{N}-\text{N}\equiv\text{N}$
13. The rate law for a reaction is found to be $\text{Rate} = k[\text{A}]^2[\text{B}]$. Which of the following mechanisms gives this rate law?
I. $\text{A} + \text{B} \rightarrow \text{E}$ (fast)
 $\text{E} + \text{B} \rightarrow \text{C} + \text{D}$ (slow)
II. $\text{A} + \text{B} \rightarrow \text{E}$ (fast)
 $\text{E} + \text{A} \rightarrow \text{C} + \text{D}$ (slow)
III. $\text{A} + \text{A} \rightarrow \text{E}$ (slow)
 $\text{E} + \text{B} \rightarrow \text{C} + \text{D}$ (fast)
A) I B) II C) III D) II + III E) none of these
14. If the reaction $2\text{HI} \rightarrow \text{H}_2 + \text{I}_2$ is second order, which of the following will yield a linear plot?
A) $\log [\text{HI}]$ vs time B) $1/[\text{HI}]$ vs time C) $[\text{HI}]$ vs time
D) $\ln [\text{HI}]$ vs time E) $1/[\text{HI}]^2$ vs time

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Choose the correct statement about the diagram above.

- A) The diagram is qualitatively correct for water.
- B) The diagram shows that the melting point of the solid increases with increasing pressure.
- C) The diagram shows the triple point above 1 atm pressure.
- D) The diagram could represent the phase diagram of CO_2 .
- E) None of the above statements is correct.

16. In the unit cell of sphalerite, Zn^{2+} ions occupy half the tetrahedral holes in a face centered cubic lattice of S^{2-} ions. The number of formula units of ZnS in the unit cell is:

A) 5 B) 4 D) 3 D) 2 E) 1

17. The elements of group 5A, the nitrogen family, form compounds with hydrogen having the boiling points listed below:

SbH_3 - 17°C , AsH_3 - 55°C , PH_3 - 87°C , NH_3 - 33°C

The first three elements illustrate a trend where the boiling point decreases as the mass decreases; however, ammonia (NH_3) does not follow the trend because of

- A) dipole-dipole attraction
- B) metallic bonding
- C) hydrogen bonding
- D) London dispersion forces
- E) ionic bonding

18. A solute added to a solvent raises the boiling point of the solution because

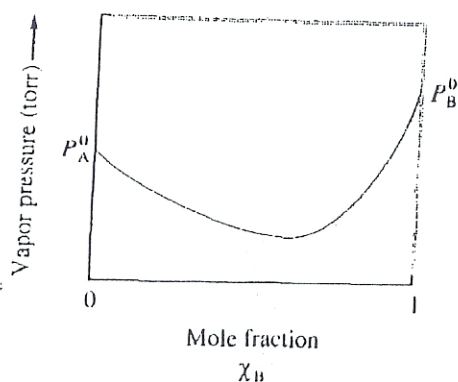
- A) the temperature to cause boiling must be great enough to boil not only the solvent but also the solute.
- B) the solute particles lower the solvent's vapor pressure, thus requiring a higher temperature to cause boiling.
- C) the solute particles raise the solvent's vapor pressure, thus requiring a higher temperature to cause boiling.
- D) the solute increases the volume of the solution, and an increase in volume requires an increase in the temperature to reach the boiling point (derived from $PV = nRT$).
- E) two of the above are correct.

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19. A 50.0 g sample of glucose (a nondissociated, nonvolatile solute with the formula $C_6H_{12}O_6$) is dissolved in 150.0 g water. What is the vapor pressure of this solution at 100 °C?
 A) 760 torr B) 25 torr C) 735 torr D) 715 torr E) none of these

20. The following plot shows the vapor pressure of various solutions of components A and B at some temperature.



Which of the following statements is false concerning solutions of A and B?

- A) The solutions exhibit negative deviations from Raoult's law.
 B) ΔH_{mix} for the solutions should be exothermic.
 C) The intermolecular forces are stronger in solution.
 D) Pure liquid B is more volatile than pure liquid A.
 E) The solution with $x_B = 0.6$ will have a lower boiling point than either pure A or pure B.
21. Order the following from lowest to highest boiling point: SnCl_4 , SnBr_4 , SnI_4 .
 A) SnCl_4 , SnBr_4 , SnI_4
 B) SnBr_4 , SnI_4 , SnCl_4
 C) SnCl_4 , SnI_4 , SnBr_4
 D) SnI_4 , SnBr_4 , SnCl_4
 E) SnCl_4 , SnI_4 , SnBr_4
22. The fact that the SO molecule is very unstable while O_2 is stable can be best explained because:
 A) The S-O bond is inherently unstable.
 B) Sulfur lacks the ability to form double bonds.
 C) The difference in electronegativity between the sulfur atom and the oxygen

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atom makes it unlikely for the S-O bond to form.

D) There exists much stronger π bonding between oxygen atoms than between a sulfur atom and oxygen atom.

E) none of these

23. What is the electron configuration of the Co(II) ion?

A) $[\text{Ar}]4s^23d^5$ B) $[\text{Ar}]4s^24d^2$ C) $[\text{Ar}]4s^23d^7$ D) $[\text{Ar}]3d^7$ E) none

24. Which of the following complexes shows geometric isomerism?

A) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{SO}_4$ B) $[\text{Co}(\text{NH}_3)_6]\text{Cl}_3$

C) $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$ D) $[\text{Co}(\text{NH}_3)_2\text{Cl}_4]$

E) none of these

25. The complex ions of Zn^{2+} are all colorless. The most likely explanation for this is:

A) Zn^{2+} is paramagnetic.

B) Zn^{2+} exhibits "d orbital" splittings in its complexes such that they absorb all wavelengths in the visible region.

C) Since Zn^{2+} is a d^{10} ion, it does not absorb visible light even though the "d orbital" splittings are correct for absorbing visible wavelengths.

D) Zn^{2+} is not a transition metal ion.

E) None of these is correct.

26. The value of the equilibrium constant, K , is dependent on

I. The temperature of the system.

II. The nature of the reactants and products.

III. The concentration of the reactants.

IV. The concentration of the products.

A) I, II

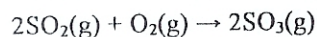
B) II, III

C) III, IV

D) It is dependent on three of the above choices.

E) It is not dependent on any of the above choices.

27. Consider the reaction:



at constant temperature. Initially a container is filled with pure $\text{SO}_3(\text{g})$ at a pressure of 2 atm, after which equilibrium is allowed to be reached. If y is the partial pressure of O_2 at equilibrium, the value of K_p is:

A) $(2 - 2y)^2 / (y^2 \cdot 2y)$

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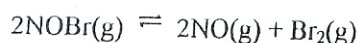
B) $(2-y)^2 / (y^2 \cdot y/2)$

C) $(2-y)^2 / [(2y)^2 \cdot y]$

D) $(2-2y)^2 / [(2y)^2 \cdot y]$

E) none of these

28. Consider the following reaction (assume an ideal gas mixture):



A 1.0-liter vessel was initially filled with pure NOBr, at a pressure of 4.0 atm, at 300

K. After equilibrium was established, the partial pressure of NOBr was 2.5 atm.

Then the volume was increased to 2.0 liters, while the temperature was kept at 300 K.

This will result in:

A) an increase in K_p .

B) a decrease in K_p .

C) a shift in the equilibrium position to the right.

D) a shift in the equilibrium position to the left.

E) none of these

29. For a neutral solution, it must be true that

A) $\text{pH} = 7.00$.

B) $[\text{H}^+] = 0 \text{ M}$.

C) $[\text{H}^+] = [\text{OH}^-]$.

D) $[\text{H}_2\text{O}] = 1 \times 10^{-14}$

E) At least two of the above.

30. A 0.10-mol sample of a diprotic acid, H_2A , is dissolved in 250 mL of water. The K_{a1} of this acid is 1.0×10^{-5} and K_{a2} is 1.0×10^{-10} . Calculate the concentration of A^{2-} in this solution.

A) $1.0 \times 10^{-5} \text{ M}$

B) $2.0 \times 10^{-3} \text{ M}$

C) $4.0 \times 10^{-6} \text{ M}$

D) $1.0 \times 10^{-10} \text{ M}$

E) 0.40 M

31. The energy expressions for the electrons in the hydrogen atom and the He^+ ion are $E_n(\text{H}) = -a/n^2$ and $E_n(\text{He}^+) = -4a/n^2$, respectively. Symbol n denotes the principle quantum number.

Which of the following statements is correct?

A) For the transitions $n_1 \rightarrow n_2$, the frequency is larger for H than for He^+ .

B) The first ionization energy of the H atom is smaller than the second ionization

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energy of the He atom.

C) The 1s orbital in He^+ is larger (in the sense that the probability density is shifted outward) than the 1s orbital in H.

D) Two of statements A through C are correct.

E) The statements A through C are all correct.

32. 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 to 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.

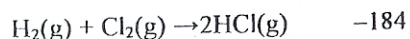
33. Which of the following molecules has a dipole moment?

A) SCl_6 B) BH_3 C) CO_2 D) OF_2

E) None of the above has a dipole moment.

34. Using the following data reactions

H° (kJ)



calculate the energy per mole of an H-Cl bond.

A) 770 kJ B) 856 kJ C) 518 kJ D) 326 kJ E) 428 kJ

35. The hybridization of the central atom in ICl_4^- is:

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

36. The configuration $(\sigma 2s)^2(\sigma 2s^*)^2(\pi 2p_y)^1(\pi 2p_x)^1$ is the molecular orbital description for the ground state of

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- A) Li_2^+ B) Be_2 C) B_2 D) B_2^{2-} E) C_2

37. Typically, rotational changes are produced by radiation in the _____ region of the electromagnetic spectrum.

- A) UV B) IR C) microwave D) visible E) X-ray

38. For which gas do the molecules have the smallest average kinetic energy under the same temperature?

- A) He B) Cl_2 C) CH_4 D) NH_3 E) all gases the same

39.

I.



Which of the following result(s) in an increase in the entropy of the system?

I. (See diagram above.)

II. $\text{Br}_2(\text{g}) \rightarrow \text{Br}_2(\text{l})$

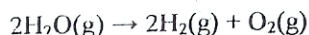
III. $\text{NaBr}(\text{s}) \rightarrow \text{Na}^+(\text{aq}) + \text{Br}^-(\text{aq})$

IV. $\text{O}_2(298 \text{ K}) \rightarrow \text{O}_2(373 \text{ K})$

V. $\text{NH}_3(1 \text{ atm}, 298 \text{ K}) \rightarrow \text{NH}_3(3 \text{ atm}, 298 \text{ K})$

- A) I B) II, V C) I, III, IV D) I, II, III, IV E) I, II, III, V

40. The reaction



has a positive value of ΔG° . Which of the following statements must be true?

A) The reaction is slow.

B) The reaction will not occur. [When $\text{H}_2\text{O}(\text{g})$ is introduced into a flask, no O_2 or H_2 will form even over a long period of time.]

C) The reaction is exothermic.

D) The equilibrium lies far to the right.

E) None of these is true.