

科目：普通化學 適用：應化系二

編號：341

考生注意：1. 依次序作答，只要標明題號，不必抄題。  
2. 答案必須寫在答案卷上，否則不予計分。  
3. 試題隨卷繳回。

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## I. 是非題 (每題 2 分，共 12 分)：

1. Transition metals show great similarities both within a given period and within a given vertical group.
2. In exothermic reaction, potential energy stored in chemical bonds is being converted to thermal energy via heat.
3. Paramagnetism is associated with paired electrons.
4. Reduction is the gain of electrons.
5. Adding salt to water decreases the freezing point of the water since it lowers the vapor pressure of the ice.
6. The size in a series of isoelectronic ions increases as the nuclear charge increases.

## II. 單選題，請選出一個最合適的答案 (每題 3 分，共 72 分)：

1. What is the compound whose carbon skeleton (minus any hydrogen atoms) appears below?  
 [A] 5-ethyl-3,6-trimethyloctane  
 [B] 2,4-diethyl-3,6-dimethylheptane  
 [C] 1,4-diethyl-3,6-dimethyl-tridecane  
 [D] 2,5-dimethyl-4,6-diethylheptane  
 [E] 4-ethyl-2,5,6-trimethyloctane  

$$\begin{array}{ccccccc} & & \text{C} & & \text{C} & & \\ & & | & & | & & \\ \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{C} \\ & | & & & | & & & & & & & & \\ & \text{C} & - & \text{C} & & \text{C} & - & \text{C} & & & & & \end{array}$$
2. Ethylenediamine (en) is a bidentate ligand. What is the coordination number of cobalt in  $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$ ?  
 [A] five [B] six [C] seven [D] eight [E] four
3. Using the rules of significant figures, calculate the following:  $4.0021 - 0.004$   
 [A] 4.0 [B] 4 [C] 3.998 [D] 4.00 [E] 3.9981
4. Which of the following is not a state function?  
 [A]  $q$  [B]  $P$  [C]  $E$  [D]  $G$  [E]  $H$
5. You heat 3.970 g of a mixture of  $\text{Fe}_3\text{O}_4$  and  $\text{FeO}$  to form 4.195 g  $\text{Fe}_2\text{O}_3$ . The mass of oxygen reacted is  
 [A] 0.475 g. [B] 0.225 g. [C] cannot be determined [D] 1.00 g. [E] none of these
6. Which metals form cations with varying positive charges?  
 [A] Group 1 metals [B] Group 3 metals [C] Group 2 metals  
 [D] metalloids [E] transition metals
7. Which of the following statements is true?  
 [A] An electron in a 2s orbital can have the same  $n$ ,  $l$ , and  $m_l$  quantum numbers as an electron in a 3s orbital.  
 [B] Ni has 2 unpaired electrons in its 3d orbitals.  
 [C] The exact location of an electron can be determined if we know its energy.  
 [D] In the buildup of atoms, electrons occupy the 4f orbitals before the 6s orbitals.  
 [E] Only three quantum numbers are needed to uniquely describe an electron.
8. Give (in order) the correct coefficients to balance the following reaction:  
 $\text{H}_2\text{SnCl}_6 + \text{H}_2\text{S} \rightarrow \text{SnS}_2 + \text{HCl}$   
 [A] 2, 4, 2, 6 [B] 6, 2, 1, 1 [C] 1, 2, 1, 6 [D] 1, 1, 1, 6 [E] 1, 2, 2, 2
9. Which of the following is not an assumption of the kinetic molecular theory for a gas?  
 [A] Gas particles are very small compared to the average distance between the particles.  
 [B] The average velocity of the gas particles is directly proportional to the absolute temperature.  
 [C] Gas particles collide with the walls of their container in elastic collisions.  
 [D] Gases are made up of tiny particles in constant chaotic motion.  
 [E] All of these are correct.
10. Given reaction  $2\text{NH}_3(\text{g}) + 3\text{Cl}_2(\text{g}) \rightarrow \text{N}_2(\text{g}) + 6\text{HCl}(\text{g})$ , you react 5.0 L of  $\text{NH}_3$  with 5.0 L of  $\text{Cl}_2$  measured at the same

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conditions in a closed container. Calculate the ratio of pressures in the container ( $P_{\text{final}}/P_{\text{initial}}$ ).

- [A] 1.33 [B] 1.00 [C] 1.50 [D] 0.75 [E] none of these

11. When electrons in a molecule are not found between a pair of atoms but move throughout the molecule, this is called

- [A] ionic bonding. [B] polar covalent bonding. [C] covalent bonding.  
[D] a dipole moment. [E] delocalization of the electrons.

12. Which of the following electron distributions among the molecular orbitals best describes the NO molecule?

[A] Option E

[B] Option D

[C] Option A

[D] Option B

[E] Option C

	$\sigma^{2s}$	$\sigma^{2s*}$	$\pi^{2py} = \pi^{2px}$	$\sigma^{2pz}$	$\pi^{2py*} = \pi^{2px*}$	$\sigma^{2pz*}$
Option A	2	2	4	2	4	2
Option B	2	2	4	2	4	1
Option C	2	2	4	1	3	0
Option D	2	2	4	2	2	0
Option E	2	2	4	2	1	0

13. Which statement regarding water is true?

- [A] Energy must be given off in order to break down the crystal lattice of ice to a liquid.  
[B] Only covalent bonds are broken when ice melts.  
[C] Hydrogen bonds are stronger than covalent bonds.  
[D] Liquid water is less dense than solid water.  
[E] All of the statements (a-d) are false.

14. The compound  $\text{SiO}_2$  does not exist as a discrete molecule while  $\text{CO}_2$  does. This can be explained because

- [A] the  $\text{SiO}_2$  is a solid while  $\text{CO}_2$  is a gas. [B] the Si—O bond is unstable.  
[C] the Lewis structure of  $\text{SiO}_2$  has an even number of electrons.  
[D] the 3p orbital of the Si has little overlap with the 2p of the O. [E] none of these

15. 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] increases, increases, decreases, increases [B] decreases, increases, decreases, decreases  
[C] decreases, increases, decreases, increases [D] decreases, decreases, increases, decreases  
[E] increases, decreases, increases, decreases

16. In which of the following groups of substances would dispersion forces be the only significant factors in determining boiling points? I.  $\text{Cl}_2$  II. HF III. Ne IV.  $\text{KNO}_3$  V.  $\text{CCl}_4$

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

17. Which of the following statements is typically true for a catalyst?

- [A] The catalyst speeds up the reaction. [B] The concentration of the catalyst will go down as a reaction proceeds.  
[C] The catalyst provides a new pathway in the reaction mechanism. [D] Two of these.  
[E] None of these.

18. A chemical reaction is most likely to be spontaneous if it is accompanied by

- [A] increasing energy and decreasing entropy. [B] lowering energy and decreasing entropy.  
[C] increasing energy and increasing entropy. [D] lowering energy and increasing entropy.  
[E] none of these (a-d)

19. The triple point of iodine is at 90 torr and  $115^\circ\text{C}$ . This means that liquid  $\text{I}_2$

- [A] cannot exist at 1 atmosphere pressure. [B] can exist at pressure of 10 torr.  
[C] cannot have a vapor pressure less than 90 torr. [D] cannot exist above  $115^\circ\text{C}$ .  
[E] is more dense than  $\text{I}_2(\text{s})$ .

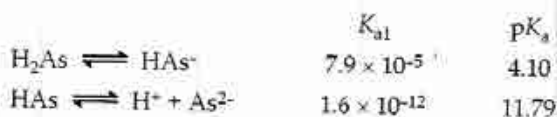
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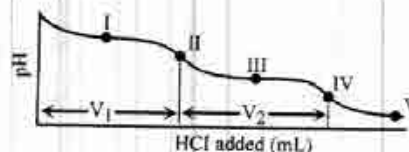
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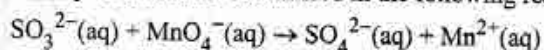
20. Consider the following information about the diprotic acid ascorbic acid ( $H_2As$  for short) (molar mass = 176.1).



The titration curve for disodium ascorbate,  $Na_2As$ , with standard HCl is shown right. What major species is (are) present at point III?

[A]  $HAs^-$  and  $H_2As$ [B]  $H_2As$  only[C]  $As^{2-}$  and  $HAs^-$ [D]  $H_2As$  and  $H^+$ [E]  $HAs^-$  only

21. How many electrons are transferred in the following reaction?



[A] 2

[B] 3

[C] 4

[D] 10

[E] 6

22. Which of the following statements about batteries is false?

[A] Lead storage batteries contain lead at the anode and lead coated with lead dioxide at the cathode.

[B] A fuel cell is a galvanic cell for which the reactants are continuously supplied.

[C] Dry cell batteries are used in tape players and portable radios.

[D] A battery is a group of galvanic cells connected in series.

[E] The alkaline dry cell battery can last longer than a nickel-cadmium battery.

23. The questions below refer to the right diagram:

At what point on the graph is the activated complex present?

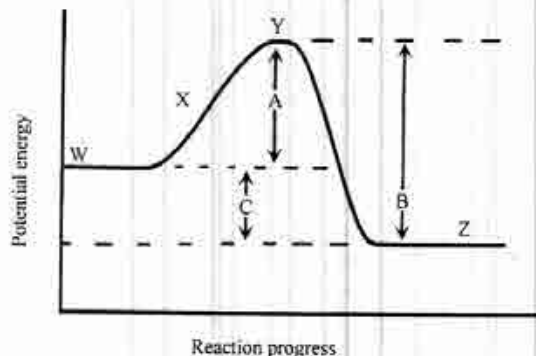
[A] point X

[B] point Z

[C] point Y

[D] point W

[E] none of these



24. The limiting reactant in a reaction

[A] has the lowest coefficient in a balanced equation.

[B] has the lowest ratio of moles available/coefficient in the balanced equation.

[C] is the reactant for which you have the fewest number of moles.

[D] has the lowest ratio of coefficient in the balanced equation/moles available.

[E] none of these

### III. 簡答題 (每小題 2 分，共 16 分)：

1. Write the chemical formulas for the following compounds or ions.

- a) nitrate ion \_\_\_\_\_
- b) aluminum oxide \_\_\_\_\_
- c) ammonium ion \_\_\_\_\_
- d) perchloric acid \_\_\_\_\_
- e) copper(II) bromide \_\_\_\_\_

2. For  $CBr_4$ :

- a) draw the Lewis structure
- b) give the shape of the molecule
- c) indicate the polarity of the molecule