九十八學年度　國立中正大學化學暨生物化學系
大學入學甄試化學性向測驗　試題

選擇題(單選)：成績滿分=100 分，每題 2.5 分　　考試日期：04/18/2009 星期六

1. Which of the following complexes shows geometric isomerism (幾何異構化)?

(a) $[Co(NH_3)_5Cl]SO_4$, (b) $[Co(NH_3)_6]Cl_3$, (c) $[Co(NH_3)_5Cl]Cl_2$, (d) $K[Co(NH_3)_2Cl_4]$,
(e) none of these.

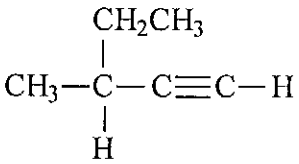
2. Which has the greatest number of unpaired electrons?

(a) The square planar complex $[Ni(CN)_4]^{2-}$.
(b) The tetrahedral complex $[FeCl_4]^-$.
(c) Neither of these have any unpaired electrons.
(d) Both (a and b) have the same number (non-zero) of unpaired electrons.
(e) More information is needed.

3. How many unpaired electrons are there in the complex ion $[Co(NO_3)_6]^{4-}$? For this ion the nitrate ligands produce a very strong crystal field.

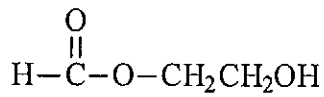
(a) 1, (b) 2, (c) 3, (d) 4, (e) 5.

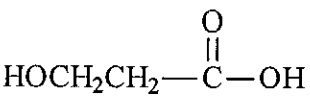
4. Name the following:

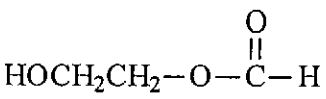


(a) 1-hexyne, (b) 2-ethynyl butane, (c) 2-ethyl-3-butyne, (d) 3-methyl-1-pentyne,
(e) 3-methyl-4-pentyne.

5. Referring to the structures below, which statement is true?

I. 

II. 

III. 

(a) I and II have different molecular formulas.
(b) I and III are structural isomers (結構異構物)of each other.
(c) II and III are stereoisomers (立體異構物) of each other.
(d) II and III are different conformations of the same compound.
(e) I and III are the same compound.

6. Consider the following reaction:

$$2A + B \rightarrow 3C + D$$

3.0 mol *A* and 2.0 mol *B* react to form 4.0 mol *C*. What is the percent yield of this reaction?

(a) 50%, (b) 67%, (c) 75%, (d) 89%, (e) 100%.

7. All of the following are weak acids *except*

(a) HCNO, (b) HBr, (c) HF, (d) HNO_2, (e) HCN.

8. Given the reaction

$$2MnO_4^- + 5H_2O_2 + 6H^+ \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$$

determine the number of electrons involved in this reaction.

(a) 10, (b)8, (c) 6, (d) 4, (e) 2.

9. A gas sample is heated from –20.0°C to 57.0°C and the volume is increased from 2.00 L to 4.50 L. If the initial pressure is 0.125 atm, what is the final pressure?

(a) 0.189 atm, (b) 0.555 atm, (c) 0.0605 atm, (d) 0.247 atm, (e) none of these.

10. Which of the following statements correctly describes the signs of *q* and *w* for the following exothermic process at $P = 1$ atm and $T = 370$ K?

$$H_2O_{(g)} \rightarrow H_2O_{(l)}$$

(a) *q* and *w* are negative, (b) *q* is positive, *w* is negative, (c) *q* is negative, *w* is positive, (d) *q* and *w* are both positive, (e) *q* and *w* are both zero.

11. Which statement is *true* of a process in which one mole of a gas is expanded from state A to state B?

(a) When the gas expands from state A to state B, the surroundings are doing work on the system.
(b) The amount of work done in the process must be the same, regardless of the path.
(c) It is not possible to have more than one path for a change of state.
(d) The final volume of the gas will depend on the path taken.
(e) The amount of heat released in the process will depend on the path taken.

12. Which of the following properties is (are) intensive properties?

I. Mass II. Temperature III. Volume IV. Concentration V. Energy
(a) I, III, and V, (b) II only, (c) II and IV, (d) III and IV, (e) I and V.

13. Using the following data, calculate the standard heat of formation of the compound ICl in kJ/mol:

	$H°$ (kJ/mol)
$Cl_{2(g)} \rightarrow 2Cl_{(g)}$	242.3
$I_{2(g)} \rightarrow 2I_{(g)}$	151.0
$ICl_{(g)} \rightarrow I_{(g)} + Cl_{(g)}$	211.3
$I_{2(s)} \rightarrow I_{2(g)}$	62.8

(a) –211 kJ/mol, (b) –14.6 kJ/mol, (c) 16.8 kJ/mol, (d) 245 kJ/mol, (e) 439 kJ/mol.

14. Which of the following statements is (are) true?

I. An excited atom can return to its ground state by absorbing electromagnetic radiation.

II. The energy of an atom is increased when electromagnetic radiation is emitted from it.
III. The energy of electromagnetic radiation increases as its frequency increases.
IV. An electron in the $n = 4$ state in the hydrogen atom can go to the $n = 2$ state by emitting electromagnetic radiation at the appropriate frequency.
V. The frequency and wavelength of electromagnetic radiation are inversely proportional to each other.
(a) II, III, IV, (b) III, V, (c) I, II, III, (d) III, IV, V, (e) I, II, IV.

15. Which of the following is *incorrect*?

(a) The importance of the equation $E = mc^2$ is that energy has mass.
(b) Electromagnetic radiation can be thought of as a stream of particles called photons.
(c) The energy of matter is not continuous and is actually quantized.
(d) Energy can only occur in discrete units called quanta.
(e) All of these are correct.

16. How many significant figures (有效數字) are there in the number 3.1400?

(a) 1, (b) 2, (c) 3, (d) 4, (e) 5.

17. Which of the following statements from Dalton's atomic theory is no longer true, according to modern atomic theory?

(a) Elements are made up of tiny particles called atoms.

(b) Atoms are not created or destroyed in chemical reactions.

(c) All atoms of a given element are identical.

(d) Atoms are indivisible in chemical reactions.

(e) All of these statements are true according to modern atomic theory.

18. Which one of the following statements about atomic structure is false?

(a) The electrons occupy a very large volume compared to the nucleus.

(b) Almost all of the mass of the atom is concentrated in the nucleus.

(c) The protons and neutrons in the nucleus are very tightly packed.

(d) The number of protons and neutrons is always the same in the neutral atom.

(e) All of these statements (a-d) are true.

19. You take an aspirin tablet (阿斯匹林藥片，a compound consisting solely of carbon, hydrogen, and oxygen) with a mass of 1.00 g, burn it in air, and collect 2.20 g of carbon dioxide and 0.400 g water. The molar mass of aspirin is between 170 and 190 g/mol. The molecular form of aspirin is

(a) $C_6H_8O_5$, (b) $C_9H_8O_4$, (c) $C_8H_{10}O_5$, (d) $C_{10}H_6O_4$, (e) none of these.

20. What is the coefficient for oxygen when the following equation is balanced?

$$NH_{3(g)} + O_{2(g)} \rightarrow NO_{2(g)} + H_2O_{(g)}$$

(a) 3, (b) 6, (c) 7, (d) 12, (e) 14.

21. Which of the following is *not* determined by the principal quantum number, n, of the electron in a hydrogen atom?

(a) The energy of the electron.
(b) The minimum wavelength of the light needed to remove the electron from the atom.
(c) The size of the corresponding atomic orbital(s).
(d) The shape of the corresponding atomic orbital(s).
(e) All of these are determined by n.

22. Which of the following groups contains no ionic compounds?

(a) HCN, NO_2, $Ca(NO_3)_2$, (b) PCl_5, LiBr, $Zn(OH)_2$, (c) KOH, CCl_4, SF_4, (d) NaH, CaF_2, $NaNH_2$, (e) CH_2O, H_2S, NH_3.

23. Which of these is an isoelectronic series (等電子系列)?

(a) Na^+, K^+, Rb^+, Cs^+, (b) K^+, Ca^{2+}, Ar, S^{2-}, (c) Na^+, Mg^{2+}, S^{2-}, Cl^-, (d) Li, Be, B, C
(e) none of these (a-d).

24. According to the VSEPR (valence shell electron-pair repulsion) model, the arrangement of electron pairs around NH_3 and CH_4 are

(a) different because in each case there are a different number of atoms around the central atom.
(b) different because in each case there are a different number of electron pairs around the central atom.
(c) the same because both nitrogen and carbon are both in the second period.
(d) the same because in each case there are the same number of electron pairs around the central atom.
(e) different or the same, depending on the conditions leading to maximum repulsion.

25. Which of the following atoms cannot exceed the octet rule (八隅體) in a molecule?

(a) N, (b) S, (c) P, (d) I, (e) All of the atoms (a-d) can exceed the octet rule.

26. For a reaction in which A and B react to form C, the following initial rate data were obtained:

[A] (mol/L)	[B]Initial (mol/L)	Rate of Formation of C (mol/L.s)
0.10	0.10	1.00
0.10	0.20	4.00
0.20	0.20	8.00

What is the rate law for the reaction?

(a) Rate = k[A][B], (b) Rate = k[A]^2[B], (c) Rate = k[A][B]^2, (d) Rate = k[A]^2[B]^2,
(e) Rate = k[A]^3.

27. The reaction $2NO \rightarrow N_2 + O_2$ has the following rate law:

$$-\frac{D[NO]}{Dt} = 2k[NO]^2.$$

After a period of 2.0×10^3 s, the concentration of NO falls from an initial value of 2.8×10^{-3} mol/L to 2.0×10^{-3} mol/L. What is the rate constant, k?

(a) 7.2×10^{-2} M^{-1}/s, (b) 1.7×10^{-4} M^{-1}/s, (c) 4.0×10^{-4} M^{-1}/s, (d) 4.0×10^{-7} M^{-1}/s, (e) 3.6×10^{-2} M^{-1}/s.

28. Which of the following statements concerning equilibrium is not true?

(a) A system that is disturbed from an equilibrium condition responds in a manner to restore equilibrium.
(b) Equilibrium in molecular systems is dynamic, with two opposing processes balancing one another.
(c) The value of the equilibrium constant for a given reaction mixture is the same regardless of the direction from which equilibrium is attained.
(d) A system moves spontaneously toward a state of equilibrium.
(e) The equilibrium constant is independent of temperature.

29. Consider the gaseous reaction $CO_{(g)} + Cl_{2(g)} \rightleftharpoons COCl_{2(g)}$. What is the expression for K_P in terms of K?

(a) $K(RT)$, (b) $K/(RT)$, (c) $K(RT)^2$, (d) $K/(RT)^2$, e) $1/K(RT)$.

30. For the reaction below, $K_P = 1.16$ at 800°C.

$$CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$$

If a 20.0-gram sample of $CaCO_3$ is put into a 10.0-liter container and heated to 800°C, what percent of the $CaCO_3$ will react to reach equilibrium?

(a) 14.6%, (b) 65.9%, (c) 34.1%, (d) 100.0%, (e) none of these.

31. Which of the following is true for a system whose equilibrium constant is relatively small?

(a) It will take a short time to reach equilibrium.
(b) It will take a long time to reach equilibrium.
(c) The equilibrium lies to the left.
(d) The equilibrium lies to the right.
(e) Two of these.

32. A 100-mL sample of water is placed in a coffee cup calorimeter (卡計). When 1.0 g of an ionic solid is added, the temperature decreases from 21.5°C to 20.8°C as the solid dissolves. For the dissolving of the solid

(a) $H < 0$, (b) $S_{univ} > 0$, (c) $S_{sys} < 0$, (d) $S_{surr} > 0$, (e) none of thes.

33. Which statement below is not upheld by the second law of thermodynamics (熱力學)?

(a) The change of entropy of the universe (宇宙) is always positive.
(b) The entropy of a perfect crystal at 0 K is zero.
(c) Machines always waste some energy.
(d) A machine is never 100% efficient.
(e) All of these.

34. For the dissociation reaction of the acid HF

$$HF_{(aq)} \rightleftharpoons H^+_{(aq)} + F^-_{(aq)}$$

ΔS is observed to be negative. The best explanation is:

(a) This is the expected result since each HF molecule produces two ions when it dissociates.
(b) Hydration of the ions produces the negative value of ΔS.
(c) The reaction is expected to be exothermic and thus ΔS should be negative.
(d) The reaction is expected to be endothermic and thus ΔS should be negative.
(e) None of these can explain the negative value of ΔS.

35. Which of the following is true for the cell shown here?

$$Zn_{(s)} \mid Zn^{2+}_{(aq)} \parallel Cr^{3+}_{(aq)} \mid Cr_{(s)}$$

(a) The electrons flow from the cathode (陰極) to the anode (陽極).
(b) The electrons flow from the zinc to the chromium.
(c) The electrons flow from the chromium (Cr) to the zinc (Zn).
(d) The chromium is oxidized.
(e) The zinc is reduced.

36. Which of the following statements is (are) incorrect?

I. The hybridization of boron in BF_3 is sp^2.
II. The molecule XeF_4 is nonpolar.
III. The bond order of N_2 is three.
IV. The molecule HCN has two π bonds and two σ bonds.

(a) All four statements are correct, (b) II is incorrect, (c) I and IV are incorrect, (d) II and III are incorrect, (e) II, III, and IV are incorrect.

37. Which of the following molecules has a bond order of 1.5?

(a) O_2^+, (b) N_2, (c) O_2^-, (d) C_2, (e) none of these.

38. Generally the vapor pressure of a liquid is related to

I. The amount of liquid II. Atmospheric pressure III. Temperature IV. Intermolecular forces

(a) I, III, (b) II, III, IV, (c) I, III, IV, (d) III, IV, (e) all information is needed.

39. Which of the following chemical or physical changes is an endothermic process (吸熱過程)?

(a) the evaporation of water, (b) the combustion of gasoline (汽油燃燒), (c) the mixing of sulfuric acid (硫酸) and water, (d) the freezing of water, (e) none of these.

40. The average rate of disappearance of ozone (臭氧) in the reaction $2O_{3(g)} \rightarrow 3O_{2(g)}$ is found to be 9.0×10^{-3} atm over a certain interval of time. What is the rate of appearance of O_2 during this interval?

(a) 1.3×10^{-2} atm/s, (b) 9.0×10^{-3} atm/s, (c) 6.0×10^{-3} atm/s, (d) 3.0×10^{-5} atm/s, (e) 2.7×10^{-5} atm/s.