國立中正大學
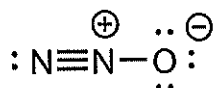# 109 學年度碩士班招生考試
試 題

［第 1 節］

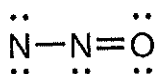| 科目名稱	一般化學
系所組別	化學暨生物化學系

單一選擇題，共 25 題，每題 4 分，總分 100 分，答錯不扣分，請在答案卷上作答，
化學元素週期表列於本試卷最後一頁。

1. Which resonance structure contributes the most to the overall bonding in nitrous oxide, N_2O?
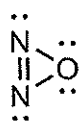
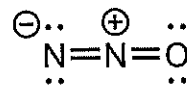   (A)　　　　　　　　(B)　　　　　　　　(C)　　　　　　　　(D)

2. In the guanidinium ion, $[C(NH_2)_3]^+$, what is the best description of the hybridizations of the nitrogen atoms?

   (A) All three sp^3　　　(B) Two sp^3, one sp^2　　　(C) One sp^3, two sp^2　　　(D) All three sp^2

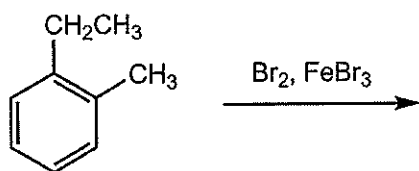3. How many σ bonds and how many π bonds are present in allene?

   (A) One σ, one π　　　(B) Five σ, one π　　　(C) Six σ, two π　　　(D) Seven σ, two π

4. What is the maximum number of monosubstitution products of the aromatic substitution reaction shown?

   (A) 1　　　　　　　　(B) 2　　　　　　　　(C) 3　　　　　　　　(D) 4

5. Which statement regarding the relative energies of monochromatic light with λ = 800 nm and monochromatic light with λ = 400 nm is correct?

   (A) 800 nm light has half as much energy per mole of photons as 400 nm light.

   (B) 800 nm light has the same energy per mole of photons as 400 nm light.

   (C) 800 nm light has twice as much energy per mole of photons as 400 nm light.

   (D) No conclusion may be drawn regarding the relative energy per mole of photons without knowing the intensity of the light.

6. The wavelength of one line in the emission spectrum of C is 538 nm. What is the energy of one photon with this wavelength?

   (A) 3.69×10^{-19} J　　　(B) 3.23×10^{-26} J　　　(C) 3.56×10^{-40} J　　　(D) 1.19×10^{-18} J

7. Which gas at 600 K has the same effusion rate as methane (CH_4) at 150 K?

   (A) N_2O_4　　　　　(B) SO_2　　　　　(C) O_2　　　　　(D) He

8. What is the K_{sp} of $Ca(OH)_2$ at 298 K?

Half-Reaction	$E°$, V
$Ca^{2+}(aq) + 2\,e^- \to Ca(s)$	-2.87 V
$Ca(OH)_2(s) + 2\,e^- \to Ca(s) + 2\,OH^-(aq)$	-3.02 V

   (A) 1.6×10^{-6}　　　(B) 8.4×10^{-6}　　　(C) 3.1×10^{-3}　　　(D) 2.9×10^{-3}

9. Electrolysis of water containing sulfuric acid as an electrolyte is carried out as shown and the gases produced at the electrodes collected in two identical tubes, both initially filled with the sulfuric acid solution. After electrolysis has been carried out for a certain time, which picture best represents the appearance of the tubes?
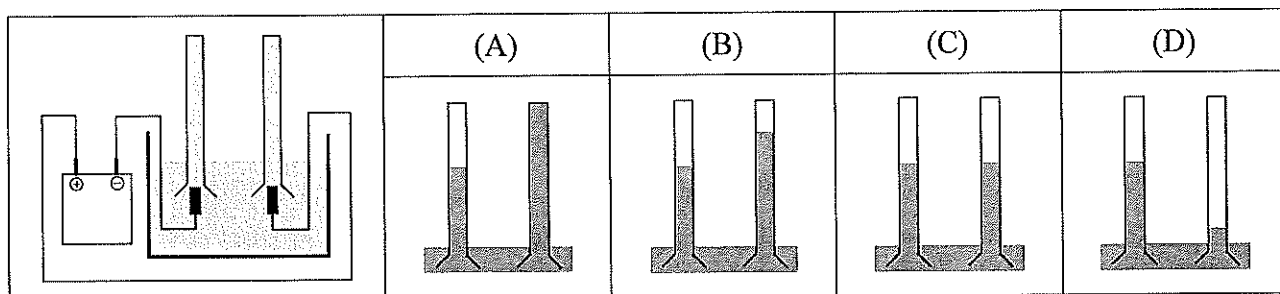
10. Calculate the concentration of [H^+] of a buffered solution containing 5.0×10^{-4} M HCN ($K_a = 6.2 \times 10^{-10}$) and 1.5×10^{-4} M NaCN.

    (A) 3.06×10^{-9} M　　(B) 0.22×10^{-9} M　　(C) 2.07×10^{-9} M　　(D) 4.12×10^{-9} M

11. Which titration curve would result from the titration of phosphoric acid by a strong base?
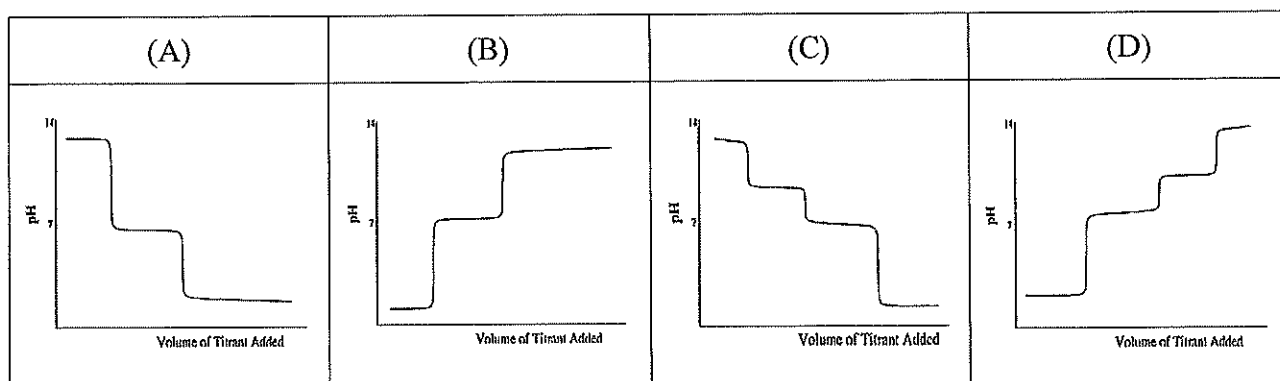
12. The standard cell potential of the following galvanic cell is 1.562 V at 298 K.

$$Zn(s) \mid Zn^{2+}(aq) \parallel Ag^+(aq) \mid Ag(s)$$

What is the cell potential of the following galvanic cell at 298 K?

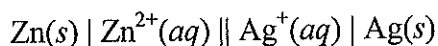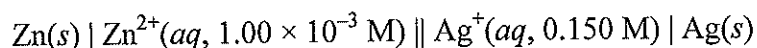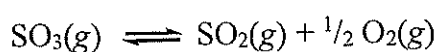$$Zn(s) \mid Zn^{2+}(aq, 1.00 \times 10^{-3} \text{ M}) \parallel Ag^+(aq, 0.150 \text{ M}) \mid Ag(s)$$

(A) 1.602 V   (B) 1.626 V   (C) 1.642 V   (D) 1.691 V

13. At 400 K, this reaction has $K_p = 8.2 \times 10^{-4}$.

$$SO_3(g) \rightleftharpoons SO_2(g) + {}^1/_2 O_2(g)$$

What is K_p at 400 K for the following reaction?

$$2\,SO_3(g) \rightleftharpoons 2\,SO_2(g) + O_2(g)$$
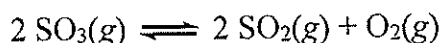
(A) 2.9×10^{-2} (B) 1.6×10^{-3} (C) 8.2×10^{-4} (D) 6.7×10^{-7}

14. A current of 0.44 A is passed through a solution of a ruthenium nitrate salt, causing reduction of the metal ion to the metal. After 25.0 minutes, 0.345 g of Ru(s) has been deposited. What is the oxidation state of ruthenium in the nitrate salt?

(A) +6   (B) +4   (C) +3   (D) +2

15. Calcium fluoride, CaF_2, has a molar solubility of 2.1×10^{-4} mol $\cdot L^{-1}$ at pH = 7.00. By what factor does its molar solubility increase in a solution with pH = 3.00? The pK_a of HF is 3.17.

(A) 1.48   (B) 1.83   (C) 2.48   (D) 4.96

16. The formation of NOBr,　$2\,NO(g) + Br_2(g) \rightarrow 2\,NOBr(g)$,　is studied, and the mechanism is proposed as following. What rate law is predicted by this mechanism?

$$NO(g) + Br_2(g) \rightleftharpoons NOBr_2(g) \quad \textit{fast, at equilibrium}$$

$$NO(g) + NOBr_2(g) \rightarrow 2\,NOBr(g) \quad \textit{slow}$$
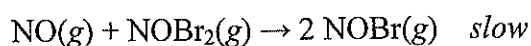
(A) Rate = $k[NO][Br_2]$　　　　　(B) Rate = $k[NO][Br_2]^2$

(C) Rate = $k[NO]^2[Br_2]$　　　　　(D) Rate = $k[NO]^2$

17. What is the pH of a 0.20 M solution of sodium benzoate, $Na(C_6H_5COO)$? The K_a of benzoic acid, C_6H_5COOH, is 6.5×10^{-5}.

(A) 5.26   (B) 8.74   (C) 9.09   (D) 11.56

18. Which of the following statements is correct?

(A) The specific heat of helium gas at low temperature (< 100 K) is 12.5 $J \cdot mol^{-1} \cdot K^{-1}$.

(B) The specific heat of oxygen gas at low temperature (< 100 K) is 20.8 $J \cdot mol^{-1} \cdot K^{-1}$.

(C) The specific heat of ammonia gas at low temperature (< 100 K) is 29.0 $J \cdot mol^{-1} \cdot K^{-1}$.

(D) All of the above.

19. A sample of 0.900 mol N_2O is placed in a sealed container, where it decomposes irreversibly to N_2 and O_2 in a first-order reaction. After 42.0 min, 0.640 mol N_2O remains. How long will it take for the reaction to be 90.0% complete?

(A) 13 min　　　　(B) 131 min　　　　(C) 284 min　　　　(D) 396 min

20. For a constant-pressure process, what is the difference between the internal energy change (ΔU) and the enthalpy change (ΔH)?

(A) Heat　　　　(B) Work　　　　(C) Entropy　　　　(D) Gibbs free energy

21. One unit cell of a crystal containing elements X, Y, and Z is shown below. What is its formula?

● = X

◑ = Y

○ = Z
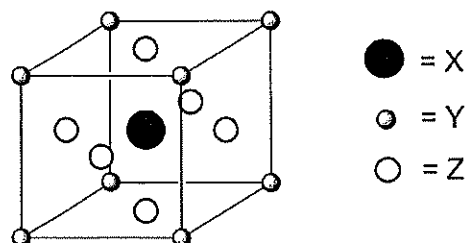
(A) XYZ　　　　(B) XY_2Z_2　　　　(C) XYZ_3　　　　(D) XY_2Z_3

22. The vaporization of a liquid at a certain temperature and pressure is spontaneous. For this process, which of the inequalities regarding the Gibbs free energy G and the internal energy E are incorrect?

I. $\Delta G < 0$　　　　II. $\Delta E < \Delta H$

(A) I only　　　　(B) II only　　　　(C) Both I and II　　　　(D) Neither I nor II

23. For an endothermic reaction to be spontaneous under standard conditions at constant pressure at some temperature T, which must be true?

(A) The entropy change ΔS^o must be positive and greater than $\Delta H^o/T$.

(B) The entropy change ΔS^o must be positive and less than $\Delta H^o/T$.

(C) The entropy change ΔS^o must be negative and greater than $-\Delta H^o/T$.

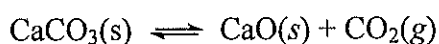(D) The entropy change ΔS^o must be negative and less than $-\Delta H^o/T$.

24. Which cation forms a colorless aqueous solution?

    (A) Co^{2+}　　　　(B) Ni^{2+}　　　　(C) Cu^{2+}　　　　(D) Zn^{2+}

25. A 60.0 g sample of $CaCO_3$ is heated to 950 K in a 1.00 L evacuated container, where it reacts according to the following equation:

    $$CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$$

    After equilibrium is attained, the pressure of $CO_2(g)$ is 30.0 mm Hg. When the experiment is repeated using 120.0 g $CaCO_3$, what is the equilibrium pressure P?

    (A) $15.0 \text{ mm Hg} \leq P < 30.0 \text{ mm Hg}$

    (B) $P = 30.0 \text{ mm Hg}$

    (C) $30.0 \text{ mm Hg} < P < 60.0 \text{ mm Hg}$

    (D) $P = 60.0 \text{ mm Hg}$

PERIODIC TABLE OF THE ELEMENTS

1 1A																		18 8A
1 H 1.008	2 2A												13 3A	14 4A	15 5A	16 6A	17 7A	2 He 4.003
3 Li 6.941	4 Be 9.012												5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B		13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39		31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4		49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6		81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (281)	111 Rg (272)	112 Cn (285)		113 Nh (286)	114 Fl (289)	115 Mc (289)	116 Lv (293)	117 Ts (294)	118 Og (294)

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)