

國立臺灣大學106學年度轉學生招生考試試題

題號： 42

科目：普通化學(C)

題號： 42

共 4 頁之第 1 頁

※ 注意：選擇題請於答案卷之「選擇題作答區」依序作答。

- $C = 3.00 \times 10^8 \text{ m/s}$; $h = 6.626 \times 10^{-34} \text{ J-s}$; $R_H = 1.097 \times 10^7 \text{ m}^{-1}$; $F = 96500 \text{ C/mol}$
- Gas constant: $R = 8.314 \text{ J/mol-K} = 0.0821 \text{ L-atm/mol-K}$
- 週期表：第 4 頁

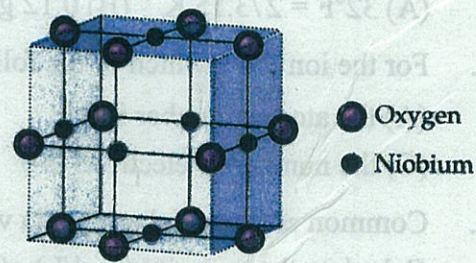
I. 選擇題 (78%, 選擇題每題答案可能 1 至多個, 全部選對始得題分 3 分)

1. Choose the correct conversions.
(A) $32^\circ\text{F} = 273.15 \text{ K}$ (B) $0.12 \text{ g} = 120 \text{ mg}$ (C) $28 \text{ torr} = 28 \text{ cmHg}$ (D) $15 \text{ nm} = 1.5 \times 10^{-9} \text{ m}$
2. For the ion ${}^{19}_9\text{F}^-$, which of the following statements is true?
(A) the atomic number is 9 (B) the number of protons is 9
(C) the number of electrons is 9 (D) the number of neutrons is 9.
3. Common commercial ammonia water, $\text{NH}_3(\text{aq})$, is 28% by mass and has density 0.90 g/cm^3 . Calculate the molarity (mol/L) of the base.
(A) 1.6 M (B) 12 M (C) 15 M (D) 16 M (E) none of the above
4. If the human eye has an osmotic pressure of 8.00 atm at 25°C , what concentration of solute particles in water will provide an isotonic eye drop solution?
(A) 0.00323 M (B) 0.0385 M (C) 0.327 M (D) 3.90 M
5. Separate samples of an unknown salt are treated with dilute solutions of HCl, H_2SO_4 , and NaOH. A precipitate forms in all three cases. Which of the following could be the cation of the unknown salt?
(A) Ba^{2+} (B) Ca^{2+} (C) Al^{3+} (D) Pb^{2+}
6. In alcohol fermentation, yeast converts glucose to ethanol and carbon dioxide:
$$\text{C}_6\text{H}_{12}\text{O}_6(\text{s}) \rightarrow 2\text{C}_2\text{H}_5\text{OH}(\text{l}) + 2\text{CO}_2(\text{g})$$

If 6.0 g of glucose are reacted and 0.70 L of CO_2 gas is collected at 298 K and 1 atm, what is the percent yield of the reaction?
(A) 43% (B) 55% (C) 85% (D) 94%
7. The rate of effusion of a particular gas was measured to be 24 mL/min. Under the same conditions, the rate of effusion of pure methane gas (CH_4) is 48 mL/min. What is the molar mass of the unknown gas?
(A) 4.0 (B) 8.0 (C) 32 (D) 64 (E) can't be determined
8. According to the electron configurations, predict which of the following is paramagnetic?
(A) Ca atom (B) Al^{3+} ion (C) Zn atom (D) Ti atom
9. Which of the following ranking is correct?
(A) Atomic radius: $\text{N} < \text{P} < \text{As}$
(B) Ionic radius: $\text{Al}^{3+} < \text{Mg}^{2+} < \text{Na}^+$
(C) First ionization energy: $\text{Na} < \text{Mg} < \text{O} < \text{F}$
(D) Electronegativity: $\text{N} < \text{O} < \text{F}$
10. From the following sets of quantum numbers (n, l, m_l, m_s), identify the set that is correct.
(A) (3, 0, 0, 0) (B) (3, 1, 0, 1/2) (C) (4, 4, 1, 1/2) (D) (2, 1, -1, -1/2)
11. Which of the following molecules have dipole moment?
(A) NF_3 (B) SO_2 (C) ClF_3 (D) SF_6

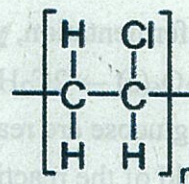
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12. For the following molecules, choose the one with the largest bond angle?
(A) CH₄ (B) H₂CO (C) H₂O (D) I₃⁻
13. According to the Lewis structure of formic acid, HCOOH, that is the irritant released in an ant bite, choose the correct answers.
(A) There are four lone pair electrons in the Lewis structure.
(B) There are three σ bonds and one π bond in the molecule.
(C) The hybrid orbitals used by the central atom C is sp².
(D) The hybrid orbitals used by the central atom O is sp³.



14. Niobium oxide crystallizes as the following cubic unit cell.
(A) There are six niobium atoms per unit cell.
(B) There are three oxygen atoms per unit cell.
(C) The empirical formula of niobium oxide is Ni₂O.
(D) This is a covalent network solid.
15. At 1000 K, a sample of pure NO₂ gas decomposes: $2\text{NO}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g}) + \text{O}_2(\text{g})$
The equilibrium constant K_p is 160. Analysis shows that the partial pressure of O₂ is 0.25 atm at equilibrium. Calculate the pressure of NO₂ in the mixture.
(A) 0.00098 (B) 0.00039 (C) 0.00078 (D) 0.020 (E) None of the above
16. For the synthesis of ammonia at 298 K, $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$, the equilibrium constant K = 5.8 × 10⁵. What is the value of K for the following reaction at 298 K?
 $\text{NH}_3(\text{g}) \rightleftharpoons 1/2\text{N}_2(\text{g}) + 3/2\text{H}_2(\text{g})$

- (A) 1.7 × 10⁻⁶ (B) 1.3 × 10⁻³ (C) 7.6 × 10² (D) 5.8 × 10⁵
17. For the polyvinylchloride (PVC) with the following structure
(A) CH₂CHCl is the monomer.
(B) This is a condensation polymer.
(C) During the process of polymerization, hydrogen chloride is produced.
(D) This is a homopolymer.



18. Which of the following substances show hydrogen bonding?
(A) butanol (B) ethyl acetate (C) propanone (D) methylamine
19. The following reaction was studied by the method of initial rates at certain temperature:

$$\text{CO} + \text{Cl}_2 \rightarrow \text{COCl} + \text{Cl}$$

[CO] ₀ (M)	[Cl ₂] ₀ (M)	Initial rate (M/s)
1.00 × 10 ²	1.00 × 10 ²	6.60 × 10 ³
2.00 × 10 ²	1.00 × 10 ²	1.32 × 10 ⁴
1.00 × 10 ²	2.00 × 10 ²	2.64 × 10 ⁴

- (A) The rate law is rate = k[CO][Cl₂].
(B) The overall order of the reaction is 3.
(C) The value of the rate constant k is 6.6 × 10⁻¹.
(D) If [CO]₀ = 3.00 × 10² M, [Cl₂]₀ = 3.00 × 10² M, the initial rate would be 1.78 × 10⁵.

20. The thermal decomposition of phosphine (PH₃) into phosphorus and molecular hydrogen is a **first-order reaction**: $4\text{PH}_3(\text{g}) \rightarrow \text{P}_4(\text{g}) + 6\text{H}_2(\text{g})$
The half-life of the reaction is 35.0 s at 680°C. If the initial concentration of PH₃ is 0.100 M, calculate the time required for 95% of the phosphine to decompose.
(A) 2.59 s (B) 35 s (C) 140 s (D) 151 s (E) None of the above.
21. For the decomposition reaction in a closed container that is at equilibrium:
$$\text{BaCO}_3(\text{s}) \rightleftharpoons \text{BaO}(\text{s}) + \text{CO}_2(\text{g}) \quad \Delta H = +266 \text{ kJ/mol}$$
which of the following actions would favor shifting the equilibrium position to form more CO₂ gas?
(A) Add some BaCO₃(s) to the system.
(B) Add some BaO(s) to the system.
(C) Raise the temperature.
(D) Add a catalyst to the reaction mixture.
22. For a voltaic cell that uses Ag/Ag⁺ and Mg/Mg²⁺ half-cell reactions under standard conditions and 298 K:
$$\text{Ag}^+(\text{aq}, 1.0 \text{ M}) + \text{e}^- \rightarrow \text{Ag}(\text{s}) \quad E^\circ = +0.80 \text{ V}$$
$$\text{Mg}^{2+}(\text{aq}, 1.0 \text{ M}) + 2\text{e}^- \rightarrow \text{Mg}(\text{s}) \quad E^\circ = -2.37 \text{ V}$$
(A) The line notation for the electrochemical cell is Mg(s) | Mg²⁺(aq) || Ag⁺(aq) | Ag(s).
(B) Mg(s) is the anode.
(C) The standard emf, E°_{cell} , of the cell at 298 K is 3.97 V.
(D) When the reaction reaches equilibrium, the value of $E_{\text{cell}} = 0$.
23. A voltaic cell utilizes the following reaction:
$$\text{Al}(\text{s}) + 3\text{Ag}^+(\text{aq}) \rightarrow \text{Al}^{3+}(\text{aq}) + 3\text{Ag}(\text{s})$$
Which of the following process will increase the electromotive force, E_{cell} , of the cell?
(A) Some AgNO₃ is added to the cathode compartment.
(B) The size of the aluminum electrode is increased.
(C) Additional water is added to the anode compartment.
(D) Excess ammonia water is added to the cathode compartment.
24. For the coordination compound K₃[Co(ox)₃], which of the following statements are true?
The "ox" stands for oxalate ion, (COO)₂²⁻.
(A) The oxidation number of Co is +3.
(B) The coordination number of Co is 3.
(C) The oxalate ion is a chelating agent.
(D) The geometry of [Co(ox)₃]³⁻ is trigonal planar.
25. Which of the following nuclide is radioactive?
(A) $^{222}_{86}\text{Rn}$ (B) $^{235}_{92}\text{U}$ (C) $^{90}_{38}\text{Sr}$ (D) $^{60}_{27}\text{Co}$
26. Give the missing particle in the nuclear reaction: $^{131}_{53}\text{I} \rightarrow ? + ^{131}_{54}\text{Xe}$
(A) $^{-1}_0\text{e}$ (B) ^0_1e (C) ^1_0n (D) ^4_2He

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II. 填充題 (12%, 僅需填寫答案無須計算過程)

27. For 0.10 M CH₃COOH(aq), the pH value = (27). $K_a = 1.0 \times 10^{-5}$.
28. For 1.0 M NaF(aq), the pH value = (28). K_a for HF(aq) = 1.0×10^{-4} .
29. For a solution containing 0.10 M C₆H₅COOH and 0.10 M C₆H₅COONa, the pH value = (29). K_a for C₆H₅COOH = 1.0×10^{-5} .
30. The solubility of AgSCN(s) in a solution containing 1.0 M KSCN is s (mol/L), s = (30). K_{sp} for AgSCN = 1.0×10^{-12} .

III. 計算問答題 (10%)

31. For the Haber process at 25°C, $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
- (A) Calculate ΔH° , ΔS° , and ΔG° for the reaction using the following data.
- (B) Calculate the equilibrium constant, K_{eq} , for the reaction at 25°C.
- (C) Is the reaction spontaneous at standard states and 25°C?
- (D) How is the rate of the reaction, fast or slow?

298 K	N ₂ (g)	H ₂ (g)	NH ₃ (g)
ΔH_f° (kJ/mol)	-	-	-46
S° (J/mol.K)	191	130	192
ΔG_f° (kJ/mol)	-	-	-16.5

1	2											13	14	15	16	17	18		
1A	2A											3A	4A	5A	6A	7A	8A		
1 H 1.008	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 72.59	33 As 74.92	34 Se 78.96	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 95.94	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 (268)	110 Ds (271)	111 Rg (280)	112 Uub	114 Uuq	116 Uuh	118 Uuo			118 Uuo		
*Lanthanide series		58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (147)	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				
†Actinide series		90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	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 (260)				

試題隨卷繳回