

$$R = 8.31451 \text{ JK}^{-1}\text{mol}^{-1} = 0.08206 \text{ LatmK}^{-1}\text{mol}^{-1}; h = 6.62608 \times 10^{-34} \text{ Js}$$

1. 單選題(題號 1-30, 每題 2 分, 答錯不倒扣。)

1. Which of the following is chlorous acid?

- (A) HClO_4 (B) HClO_3 (C) HClO_2 (D) HClO

2. Which of the following is oxidation-reduction reaction?

- (A) $2\text{H}_2\text{O}_{2(l)} \rightarrow 2\text{H}_2\text{O}_{(l)} + \text{O}_{2(g)}$
 (B) $\text{HCl}_{(aq)} + \text{NH}_3_{(g)} \rightarrow \text{NH}_4\text{Cl}_{(s)}$
 (C) $\text{SiCl}_4_{(l)} + 2\text{H}_2\text{O}_{(l)} \rightarrow 4\text{HCl}_{(aq)} + \text{SiO}_2_{(s)}$
 (D) $\text{CH}_2=\text{CH}_2_{(aq)} + \text{H}_2\text{O}_{(l)} \rightarrow \text{CH}_3\text{CH}_2\text{OH}_{(aq)}$

3. Which of the following gases would you expect to have the largest value of the van der Waals constant b ?

- (A) N_2 (B) CH_4 (C) C_2H_6 (D) H_2

4. What is the pH of a 1.0 M solution of NaH_2PO_4 ? (For H_3PO_4 $\text{p}K_{a1} = 2.12$; $\text{p}K_{a2} = 7.21$; $\text{p}K_{a3} = 12.32$)

- (A) 2.12 (B) 4.67 (C) 7.21 (D) 9.77

5. Knowing the K_{sp} for the following compounds:

$$\text{CuS}_{(s)} \quad K_{sp} = 8.5 \times 10^{-45}$$

$$\text{Ag}_2\text{S}_{(s)} \quad K_{sp} = 1.6 \times 10^{-49}$$

$$\text{Bi}_2\text{S}_3_{(s)} \quad K_{sp} = 1.1 \times 10^{-73}$$

What is the correct solubility trend?

- (A) $\text{CuS}_{(s)} > \text{Ag}_2\text{S}_{(s)} > \text{Bi}_2\text{S}_3_{(s)}$ (B) $\text{Bi}_2\text{S}_3_{(s)} > \text{Ag}_2\text{S}_{(s)} > \text{CuS}_{(s)}$
 (C) $\text{Ag}_2\text{S}_{(s)} > \text{CuS}_{(s)} > \text{Bi}_2\text{S}_3_{(s)}$ (D) $\text{Bi}_2\text{S}_3_{(s)} > \text{CuS}_{(s)} > \text{Ag}_2\text{S}_{(s)}$

6. Which of the following is a state function?

- (A) q (B) W (C) F (D) ΔS

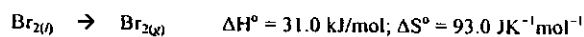
7. What is the C_v for monoatomic ideal gas?

- (A) $3R/2$ (B) $5R/2$ (C) R (D) $7R/2$

8. Which of the following process is spontaneous at all temperature?

- (A) $\Delta S (+), \Delta H (+)$ (B) $\Delta S (-), \Delta H (-)$
 (C) $\Delta S (+), \Delta H (-)$ (D) $\Delta S (-), \Delta H (+)$

9. For the following transformation:



What is the normal boiling point of liquid Br_2 ?

- (A) 298 K (B) 314 K (C) 326 K (D) 333 K

10. Which of the following process has a negative ΔS ?

- (A) The evaporation of alcohol.
 (B) Compressing an ideal gas at constant temperature.
 (C) Dissolving NaCl in water.
 (D) The freezing of water.

11. It takes 74.6 seconds for a 2.50-A current to plate 0.1086 g of a metal from a solution containing M^{2+} ions. What is the molecular weight of the metal?

- (A) 140 (B) 55.8 (C) 58.7 (D) 112

12. What is the third law of thermodynamics?

- (A) Conservation of energy.
 (B) The entropy of a perfect crystal at 0 K is zero.
 (C) The energy of the universe is a constant.
 (D) The entropy of the universe is increasing.

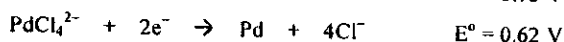
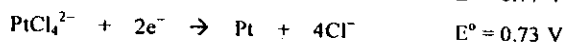
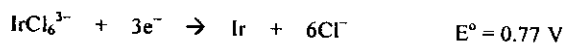
13. Consider 2.00 mol of a monoatomic ideal gas is taken from state A ($P_A = 2.00$ atm, $V_A = 10.0$ L) to state B ($P_B = 2.00$ atm, $V_B = 30.0$ L). What is the work done by the gas?
 (A) -4.05×10^3 J (B) -8.10×10^3 J (C) 0 J (D) $+8.10 \times 10^3$ J
14. The K_a of formic acid is 1.7×10^{-4} at 25 °C. What is the correct statement when the temperature is increased to 40 °C?
 (A) The K_a will decrease.
 (B) The K_a will not change.
 (C) The K_a will increase.
 (D) The K_a will decrease at lower concentration but increase at higher concentration.
15. A certain reaction is spontaneous at 72 °C. If the enthalpy change for the reaction is 19 kJ. What is the minimum value of ΔS for the reaction?
 (A) -19 kJ/K (B) 260 J/K (C) -260 J/K (D) 55 J/K
16. Which designation has the largest number of atomic orbitals?
 (A) $n = 3$ (B) 7f (C) $n = 6, l = 5$ (D) $n = 7, l = 3, m_l = -3$
17. If the ionization energy for hydrogen atom is X, what is the energy released for the transition $n = 4 \rightarrow n = 2$?
 (A) $X/4$ (B) $3X/16$ (C) $X/2$ (D) $3X/4$
18. Which of the following species has the same geometric shape as BF_3 ?
 (A) NH_3 (B) ClF_3 (C) PCl_3 (D) SO_3
19. Which of the following types of compounds lacks an sp^2 -hybridized carbon center?
 (A) amine (B) amino acid (C) phenol (D) aldehyde
20. Which of the following has the *least* effect on the solubility of a solid in a liquid?
 (A) temperature (B) nature of solute (C) nature of solvent (D) pressure
21. Choose the element that is the strongest reducing agent in aqueous solution.
 (A) Li (B) Na (C) K (D) Rb
22. Within the halogen family, which of the following property *decreases* as the atomic number increases?
 (A) melting point (B) reduction potential (C) bond energy (D) boiling point
23. How many of the following molecules are polar? BF_3 , PCl_3 , CF_4 , SF_4 .
 (A) 1 (B) 2 (C) 3 (D) 4
24. Which of the following bonds is least polar?
 (A) H-F (B) Ca-F (C) I-F (D) O-F
25. What is the number of unpaired electrons in the weak-field complex ion $[CoCl_6]^{3-}$?
 (A) 0 (B) 2 (C) 4 (D) 6 (Z = 27 for Co)
26. The rate of a first order reaction is 0.1 M s^{-1} if the concentration of reactant is 0.1 M. What is the half-life (in s) of this reaction?
 (A) 1 (B) $\ln 2$ (C) $1/(\ln 2)$ (D) 0.1
27. Which oligonucleotide can form a double-strand structure in aqueous solution?
 (A) AGTCGACT (B) AAAAGGGG (C) ACATTACA (D) TCTCTCTC
28. Which is the most likely mode of decay for ${}_{6}C^{14}$?
 (A) α (B) β (C) neutron (D) positron
29. For the process $[Ni(NH_3)_2Cl]^{2+} + Cl^- \rightarrow [Ni(NH_3)_4Cl_2]^+ + NH_3$, what would be the ratio of cis to trans isomer in the product?
 (A) 1/4 (B) 1 (C) 2 (D) 4
30. For a second order reaction $A \rightarrow$ products, which of the following plot is linear?
 (A) $[A]$ vs. time (B) $\ln [A]$ vs. time (C) rate vs. $1/[A]$ (D) rate vs. $[A]^2$

II. 單選題(題號 31-35, 每題 4 分, 答錯不倒扣。)

31. What is the pH of a 3.0×10^{-7} M HCl solution?

- (A) 6.48 (B) 6.44 (C) 6.40 (D) 6.28

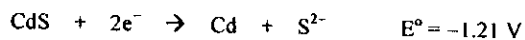
32. Consider the following half-reactions:



A hydrochloric acid solution contains Pt, Pd, and Ir as chloro-complex ions. The solution is a constant 1.0 M in chloride ion and 0.020 M in each complex ion. Assume that 99% of a metal must be plated out before another metal begins to plate out. Which metal or metals can be separated out cleanly?

- (A) Ir, Pt, Pd (B) Ir and Pt only (C) Pt and Pd only (D) Ir only

33. Consider the half-cell potentials below:



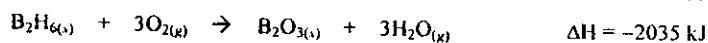
What is the K_{sp} of CdS?

- (A) 3.7×10^{-12} (B) 4.4×10^{-28} (C) 1.3×10^{-22} (D) 1.3×10^{-32}

34. Water has the enthalpy of vaporization of 40.7 kJ/mol at 100 °C. What is the entropy change for the vaporization of 1.00 mol of water at 100 °C?

- (A) 21.7 J/K (B) 109 J/K (C) 9.16 J/K (D) 249 J/K

35. Calculate ΔH_f° of $\text{B}_2\text{H}_6(g)$ using the following data:



- (A) 80 kJ (B) 616 kJ (C) 36 kJ (D) -3550 kJ

III. Draw three resonance structures for N_2O . What is the average bond order for N-O? Give the formal charge and the hybridization used for the central atom in each structure. (10 分)

IV. The freezing point (in °C) of anthracene in benzene can be represented by $5.5 - 5m$, where m is the molality of anthracene. (a) What is the freezing point of pure benzene? (b) What is the value of K_f for benzene? (c) If a solution consisting of 1.5 g anthracene and 100 g benzene has a freezing point of 5°C, what is the molecular weight of anthracene? (10 分)

接背面

FOUR-PLACE LOGARITHMS OF NUMBERS

| n | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
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| 11 | 0414 | 0453 | 0492 | 0531 | 0569 | 0607 | 0645 | 0682 | 0719 | 0755 |
| 12 | 0792 | 0828 | 0864 | 0899 | 0934 | 0969 | 1004 | 1038 | 1072 | 1106 |
| 13 | 1139 | 1173 | 1206 | 1239 | 1271 | 1303 | 1335 | 1367 | 1399 | 1430 |
| 14 | 1461 | 1492 | 1523 | 1553 | 1584 | 1614 | 1644 | 1673 | 1703 | 1732 |
| 15 | 1761 | 1790 | 1818 | 1847 | 1875 | 1903 | 1931 | 1959 | 1987 | 2014 |
| 16 | 2041 | 2068 | 2095 | 2122 | 2148 | 2175 | 2201 | 2227 | 2253 | 2279 |
| 17 | 2304 | 2330 | 2355 | 2380 | 2405 | 2430 | 2455 | 2480 | 2504 | 2529 |
| 18 | 2553 | 2577 | 2601 | 2625 | 2648 | 2672 | 2695 | 2718 | 2742 | 2765 |
| 19 | 2788 | 2810 | 2833 | 2856 | 2878 | 2900 | 2923 | 2945 | 2967 | 2989 |
| 20 | 3010 | 3032 | 3054 | 3075 | 3096 | 3118 | 3139 | 3160 | 3181 | 3201 |
| 21 | 3222 | 3243 | 3263 | 3284 | 3304 | 3324 | 3345 | 3365 | 3385 | 3404 |
| 22 | 3424 | 3444 | 3464 | 3483 | 3502 | 3522 | 3541 | 3560 | 3579 | 3598 |
| 23 | 3617 | 3636 | 3655 | 3674 | 3692 | 3711 | 3729 | 3747 | 3766 | 3784 |
| 24 | 3802 | 3820 | 3838 | 3856 | 3874 | 3892 | 3909 | 3927 | 3945 | 3962 |
| 25 | 3979 | 3997 | 4014 | 4031 | 4048 | 4065 | 4082 | 4099 | 4116 | 4133 |
| 26 | 4150 | 4166 | 4183 | 4200 | 4216 | 4232 | 4248 | 4265 | 4281 | 4298 |
| 27 | 4314 | 4330 | 4346 | 4362 | 4378 | 4393 | 4409 | 4425 | 4440 | 4456 |
| 28 | 4472 | 4487 | 4502 | 4518 | 4533 | 4548 | 4564 | 4579 | 4594 | 4609 |
| 29 | 4624 | 4639 | 4654 | 4669 | 4683 | 4698 | 4713 | 4728 | 4742 | 4757 |
| 30 | 4771 | 4786 | 4800 | 4814 | 4829 | 4843 | 4857 | 4871 | 4886 | 4900 |
| 31 | 4914 | 4928 | 4942 | 4955 | 4969 | 4983 | 4997 | 5011 | 5024 | 5038 |
| 32 | 5051 | 5065 | 5079 | 5092 | 5105 | 5119 | 5132 | 5145 | 5159 | 5172 |
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| 43 | 6335 | 6345 | 6355 | 6365 | 6375 | 6385 | 6395 | 6405 | 6415 | 6425 |
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| 45 | 6532 | 6542 | 6551 | 6561 | 6571 | 6580 | 6590 | 6599 | 6609 | 6618 |
| 46 | 6628 | 6637 | 6646 | 6656 | 6665 | 6675 | 6684 | 6693 | 6702 | 6712 |
| 47 | 6721 | 6730 | 6739 | 6749 | 6758 | 6767 | 6776 | 6785 | 6794 | 6803 |
| 48 | 6812 | 6821 | 6830 | 6839 | 6848 | 6857 | 6866 | 6875 | 6884 | 6893 |
| 49 | 6902 | 6911 | 6920 | 6928 | 6937 | 6946 | 6955 | 6964 | 6972 | 6981 |
| 50 | 6990 | 6998 | 7007 | 7016 | 7024 | 7033 | 7042 | 7050 | 7059 | 7067 |
| 51 | 7076 | 7084 | 7093 | 7101 | 7110 | 7118 | 7126 | 7135 | 7143 | 7152 |
| 52 | 7160 | 7168 | 7177 | 7185 | 7193 | 7202 | 7210 | 7218 | 7226 | 7235 |
| 53 | 7243 | 7251 | 7259 | 7267 | 7275 | 7284 | 7292 | 7300 | 7308 | 7316 |
| 54 | 7324 | 7332 | 7340 | 7348 | 7356 | 7364 | 7372 | 7380 | 7388 | 7396 |

FOUR-PLACE LOGARITHMS OF NUMBERS

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| 57 | 7559 | 7566 | 7574 | 7582 | 7589 | 7597 | 7604 | 7612 | 7619 | 7627 |
| 58 | 7634 | 7642 | 7649 | 7657 | 7664 | 7672 | 7679 | 7686 | 7694 | 7701 |
| 59 | 7709 | 7716 | 7723 | 7731 | 7738 | 7745 | 7752 | 7760 | 7767 | 7774 |
| 60 | 7782 | 7789 | 7796 | 7803 | 7810 | 7818 | 7825 | 7832 | 7839 | 7846 |
| 61 | 7853 | 7860 | 7868 | 7875 | 7882 | 7889 | 7896 | 7903 | 7910 | 7917 |
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| 78 | 8921 | 8927 | 8932 | 8938 | 8943 | 8949 | 8954 | 8960 | 8965 | 8971 |
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| 82 | 9138 | 9143 | 9149 | 9154 | 9159 | 9165 | 9170 | 9175 | 9180 | 9186 |
| 83 | 9191 | 9196 | 9201 | 9206 | 9212 | 9217 | 9222 | 9227 | 9232 | 9238 |
| 84 | 9243 | 9248 | 9253 | 9258 | 9263 | 9269 | 9274 | 9279 | 9284 | 9289 |
| 85 | 9294 | 9299 | 9304 | 9309 | 9315 | 9320 | 9325 | 9330 | 9335 | 9340 |
| 86 | 9345 | 9350 | 9355 | 9360 | 9365 | 9370 | 9375 | 9380 | 9385 | 9390 |
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| 90 | 9542 | 9547 | 9552 | 9557 | 9562 | 9566 | 9571 | 9576 | 9581 | 9586 |
| 91 | 9590 | 9595 | 9600 | 9605 | 9609 | 9614 | 9619 | 9624 | 9628 | 9633 |
| 92 | 9638 | 9643 | 9647 | 9652 | 9657 | 9661 | 9666 | 9671 | 9675 | 9680 |
| 93 | 9685 | 9689 | 9694 | 9699 | 9703 | 9708 | 9713 | 9717 | 9722 | 9727 |
| 94 | 9731 | 9736 | 9741 | 9745 | 9750 | 9754 | 9759 | 9763 | 9768 | 9773 |
| 95 | 9777 | 9782 | 9786 | 9791 | 9795 | 9800 | 9805 | 9809 | 9814 | 9818 |
| 96 | 9823 | 9827 | 9832 | 9836 | 9841 | 9845 | 9850 | 9854 | 9859 | 9863 |
| 97 | 9868 | 9872 | 9877 | 9881 | 9886 | 9890 | 9894 | 9899 | 9903 | 9908 |
| 98 | 9912 | 9917 | 9921 | 9926 | 9930 | 9934 | 9939 | 9943 | 9948 | 9952 |
| 99 | 9956 | 9961 | 9965 | 9969 | 9974 | 9978 | 9983 | 9987 | 9991 | 9996 |