題號： 63
科目：普通化學
節次： 8

國立臺灣大學 106 學年度碩士班招生考試試題

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1 H 1.00794																	1 H 1.00794	2 He 4.002602
3 Li 6.941	4 Be 9.012182												5 B 10.811	6 C 12.0107	7 N 14.00674	8 O 15.9994	9 F 18.9984032	10 Ne 20.1797
11 Na 22.989770	12 Mg 24.3050												13 Al 26.981538	14 Si 28.0855	15 P 30.973761	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.955910	22 Ti 47.867	23 V 50.9415	24 Cr 51.9961	25 Mn 54.938049	26 Fe 55.845	27 Co 58.933200	28 Ni 58.6934	29 Cu 63.546	30 Zn 65.39		31 Ga 69.723	32 Ge 72.61	33 As 74.92160	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62	39 Y 88.90585	40 Zr 91.224	41 Nb 92.90638	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.90550	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.411		49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.90447	54 Xe 131.29
55 Cs 132.90545	56 Ba 137.327	57 La 138.9055	72 Hf 178.49	73 Ta 180.9479	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.96655	80 Hg 200.59		81 Tl 204.3833	82 Pb 207.2	83 Bi 208.98038	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 (269)	111 (272)	112 (277)		114 (289) (287)		116 (289)		118 (293)	

本試題含單選題 25 題(75 分)，及二題敘述與計算題(25 分)，總分 100 分

(I). 單選題 (選出一個最適當的答案): 每題 3 分. (答案直接填入 "選擇題作答區" 內)

1. The width, length, and height of a small box are 15.5, 27.3, and 5.4 cm, respectively. What is the volume of the box with the correct significant figures?
(A) 2285.01 (B) 2285 (C) 2290 (D) 2300 (E) None of the above

2. How many significant figures are in the number 5.007?
(A) 4 (B) 3 (C) 2 (D) 1 (E) None of the above

3. What is the chemical formula of sodium nitride?
(A) KNO_3 (B) $NaNO_3$ (C) KNO_2 (D) $NaNO_2$ (E) None of the above

4. How many moles of chloride ions are in 0.2550 g of aluminum chloride?
(A) 1.721×10^{-2} (B) 5.737×10^{-3} (C) 2.869×10^{-3} (D) 1.434×10^{-3} (E) None of the above

5. Sodium iodide reacts with ozone in aqueous solution. How many grams of ozone can be removed with 0.75 g of sodium iodide?
(A) 0.75 (B) 0.24 (C) 0.12 (D) 0.04 (E) None of the above

6. Which one of the following is **not** used as an antacid?
(A) $Al(OH)_3$ (B) $NaAl(CO_3)(OH)_2$ (C) NaH_2PO_4 (D) $CaCO_3$ (E) None of the above

7. Assume that the reaction $2Al(s) + 3Cl_2(g) \rightarrow 2AlCl_3(s)$ occurs at constant pressure. If you are given ΔH for the reaction, what additional information do you need to determine ΔE for the process?
(A) T (B) ΔG (C) ΔS (D) w (E) q

8. The air bags that provide protection in cars expand in the event of an accident. From the viewpoint of the reactants as the system, what do you expect for the signs of q and w in this process?
(A) $w>0$, $q<0$ (B) $w<0$, $q<0$ (C) $w<0$, $q>0$ (D) $w>0$, $q>0$ (E) $w<0$, $q=0$

9. Which one of the following statements is **incorrect**?
(A) the free energy of the system must decrease in a spontaneous process (B) the entropy of the universe is always increasing (C) the entropy tends to zero for all systems at zero Kelvin (D) a constant-pressure process with $\Delta S<0$ and $\Delta H>0$ is impossible (E) None of the above

10. If a particle in a one-dimensional box has a ground-state energy of 0.2 eV, what is the ground-state energy of the particle if the size of the box is doubled?
(A) 0.8 eV (B) 0.4 eV (C) 0.2 eV (D) 0.1 eV (E) 0.05 eV

11. What is the maximum number of electrons in an atom that can have quantum numbers $n=5$, $l=3$, and $s=+1/2$?
(A) 5 (B) 7 (C) 10 (D) 14 (E) None of the above

12. What is the degeneracy of the $n=3$ energy level of the hydrogen atom?
(A) 1 (B) 4 (C) 9 (D) 16 (E) 32

13. Which one of the following atoms has the largest bonding atomic radii?
(A) Be (B) B (C) C (D) N (E) O

14. An aromatic system requires that the number of electronic in the conjugated ring satisfied which one of the following rule?
(A) $2n$ (B) $2n+2$ (C) $4n$ (D) $4n+2$ (E) None of the above

見背面

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15. The oxidation of nitric oxide is an important reaction associated with photochemical smog: $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$. Which one of the following is **not true** for the reaction?
    (A) the reaction is third order (B) $\Delta E > \Delta H$ (C) reaction is spontaneous and $\Delta S° < 0$
    (D) reaction is exothermic (E) the equilibrium constant decreases as the temperature increases

16. A sample of N_2O_5 was placed in a container to allow the following reaction to occur:
    $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$.
    The partial pressure of $N_2O_5(g)$ was measured during the reaction and recorded in the table below.

Time (min)	$P_{N_2O_5}$ (atm)	$\ln(P_{N_2O_5})$	$1/P_{N_2O_5}$ (atm^{-1})
0	150	5.0	0.0067
100	75	4.3	0.013
200	38	3.6	0.027
300	19	2.9	0.053

    Which of the following is true?
    (A) the reaction is a zero-order reaction (B) the reaction is a first-order reaction (C) the reaction is a second-order reaction (D) the overall reaction order is 3 (E) none of the above

17. The formula of cyclopentene is
    (A) C_6H_{10} (B) C_6H_{12} (C) C_5H_{10} (D) C_5H_{12} (E) None of the above

18. The Haber process is the industrial process that produces Ammonia. Which one in the following is not necessary in the Haber process?
    (A) catalyst (B) high temperature (C) high pressure (D) pure H_2 (E) None of the above

19. Which one has the largest lattice energy?
    (A) KCl (B) RbCl (C) CaO (D) SrO (E) MgF_2

20. The molecular geometry of XeF_4 is
    (A) trigonal pyramidal (B) trahedral (C) seesaw (D) square planar
    (E) square pyramidal

21. Which of the following solutions has the largest concentration of solvated protons?
    (A) 0.1 M NaOH (B) 0.1 M nitrous acid (C) 1.0 M pyrrol (D) 0.2 M acetic acid (E) Pure water

22. Which one of the following substance is the most volatile?
    (A) CCl_4 (B) CBr_4 (C) CH_2Cl_2 (D) CH_3Cl (E) CH_3Br

23. A solid sample of $Mg(OH)_2$ is added to 0.20L of 0.100 M aqueous HCl. The solution that remains is then titrated with 0.500 M NaOH solution, and it takes 24.0 mL of the NaOH solution to reach the equivalence point. What mass of $Mg(OH)_2$ was added to the HBr solution?
    (A) 0.11 g (B) 0.22 g (C) 0.33 g (D) 0.44 g (E) 0.66 g

24. A 0.10 M solution of a monoprotic acid has a pH of 2.44. The K_a of this acid is approximately
    (A) 7.1×10^{-3} (B) 7.1×10^{-4} (C) 1.4×10^{-3} (D) 1.4×10^{-4} (E) None of the above

25. Consider a concentration cell $Cu(s)/Cu^{2+}(aq)$ 0.01 M // $Cu^{2+}(aq)$ 0.10 M/$Cu(s)$. What is the cell potential?
    (A) 0.2V (B) 0.3V (C) 0.02V (D) 0.03V (E) None of the above

(II). 敘述與計算題 (共 25 分):

26. For a certain chemical reaction at 298K under standard conditions, the enthalpy change is -35.4 kJ/mol and the entropy change is -85.5 $JK^{-1}mol^{-1}$. Answer the following questions:
    (26A) (2%) Does the reaction lead to an increase or decrease in the randomness of the system?
    (26B) (5%) Calculate the standard reaction Gibbs free energy change for the reaction at 298K. Is the reaction spontaneous at 298K under standard conditions?
    (26C) (3%) Estimate the equilibrium constant of this reaction at 0 °C.

27. Consider the H_2^- ion.
    (27A) (7%) Sketch the molecular orbitals of the H_2^- ion and draw its energy-level diagrams. You must clearly label the MOs using proper symbols. Use hydrogen $1s$ orbitals.
    (27B) (5%) Write the electron configuration of the H_2^- ion in terms of its MOs. Do you expect the bond length of the H_2^- ion to be greater or smaller than that of the hydrogen molecule? Explain why.
    (27C) (3%) Suppose that the ion is excited by light to its first excited state, so that an electron moves from a lower-energy to a higher-energy molecular orbital. Would you expect the excited-state H_2^- ion to be stable? Explain your answer.

試題隨卷繳回