題號： 69
科目：普通化學
節次： 8

國立臺灣大學101學年度碩士班招生考試試題

題號： 69
共 3 頁之第 1 頁

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 30 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 2.5 分. (答案直接填入 "選擇題作答區" 內)

1. Which one is an ionic compound?
   (A) B_2H_6 (B) NF_3 (C) Sc_2O_3 (D) HF (E) None of the above
2. Chloric acid is
   (A) HClO (B) $HClO_2$ (C) $HClO_3$ (D) $HClO_4$ (E) None of the above
3. The Haber process is the industrial process that produces
   (A) Sugar (B) Hydrogen cyanide (C) Ammonium acetate (D) Ammonia (E) None of the above
4. Which of the following solutions has the largest concentration of solvated protons?
   (A) 0.2 M LiOH (B) 0.2 M HI (C) 1.0 M methyl alcohol (D) 0.2 M HCl (E) Pure water
5. Which one of the following compounds is a strong base?
   (A) $HClO_3$ (B) $Sr(OH)_2$ (C) $Cd(OH)_2$ (D) $Sn(OH)_2$ (E) None of the above
6. Using modern analytical techniques, it is possible to detect sodium ions in concentrations as low as 50 pg/mL. What is this detection limit expressed in molarity of Na^+?
   (A) 2.2×10^{-3} M (B) 2.2×10^{-6} M (C) 2.2×10^{-9} M (D) 2.2×10^{-12} M (E) None of the above
7. Consider proper number of significant figures, 43.123×0.00277 should be expressed as
   (A) 0.11945 (B) 0.1195 (C) 0.119 (D) 0.12 (E) None of the above
8. A solid sample of $Zn(OH)_2$ is added to 0.350L of 0.500 M aqueous HBr. The solution that remains is then titrated with 0.500 M NaOH solution, and it takes 88.5 mL of the NaOH solution to reach the equivalence point. What mass of $Zn(OH)_2$ was added to the HBr solution?
   (A) 6.5 g (B) 10.5 g (C) 13.0 g (D) 25.0 g (E) None of the above
9. Which one of the following statements is incorrect?
   (A) Heat is a form of energy (B) In a spontaneous process, the entropy of the system must increase (C) Heat transfer is always from a hotter object to a colder one (D) Work is the energy expended to move an object against a force (E) None of the above
10. Which one of the following is not a thermodynamic state function?
    (A) Internal energy (B) Entropy (C) Volume (D) Free energy (E) Work
11. You are given ΔH for a process that occurs at a known constant pressure. What additional information do you need to determine ΔE for the process?
    (A) ΔV (B) ΔT (C) ΔS (D) ΔG (E) None of the above
12. What is the degeneracy of the $n=4$ energy level of the hydrogen atom?
    (A) 1 (B) 4 (C) 9 (D) 16 (E) 32
13. What is the maximum number of electrons in an atom that can have quantum numbers $n=5$, $l=3$?
    (A) 5 (B) 7 (C) 10 (D) 14 (E) None of the above
14. Which one of the following atoms has the highest first ionization energy?
    (A) Be (B) B (C) C (D) N (E) O
15. Which one has the largest lattice energy?
    (A) NaCl (B) BaO (C) SrO (D) $SrCl_2$ (E) SrF_2

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題號： 69
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節次： 8

國立臺灣大學101學年度碩士班招生考試試題

題號： 69
共 3 頁之第 2 頁

16. The molecular geometry of BrF_5 is
    (A) Trigonal pyramidal (B) Tetrahedral (C) Trigonal bipyramidal (D) Square pyramidal
    (E) Octahedral

17. Which one has the largest molecular dipole moment?
    (A) BH_3 (B) CH_4 (C) NH_3 (D) H_2O (E) HF

18. Which gas is most dense at 1.00 atm and 298K?
    (A) CO_2 (B) N_2O (C) Cl_2 (D) O_2 (E) NO_2

19. The reaction of calcium carbide with water produces a colorless gas. The gas is
    (A) CO_2 (B) H_2 (C) NO_2 (D) C_2H_2 (E) C_2H_4

20. Which one of the following descriptions about supercritical fluid is incorrect?
    (A) Supercritical fluid of CO_2 is used for extraction in industrial scale (B) The superfluid forms when the temperature exceeds the critical temperature and the pressure exceeds the critical pressure (C) When decompress a supercritical fluid at constant temperature, gas phase forms (D) When reduce the temperature of a supercritical fluid at constant pressure, liquid phase forms (E) None of the above

21. For a molecular substance, the plot of the natural logarithm of vapor pressure versus inverse temperature should look like:
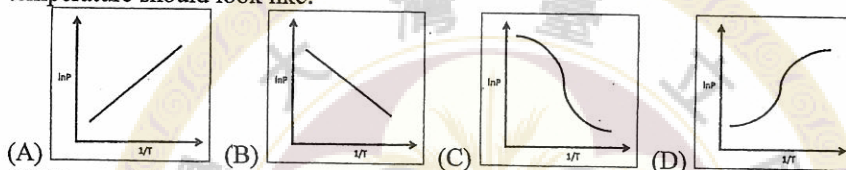
    (E) None of the above

22. The Henry's law constant for helium gas in water at 30 °C is 3.7×10^{-4} M/atm. If helium is present at 1.5 atm pressure, what is its solubility in water at 30 °C?
    (A) 1.8×10^{-3} M (B) 1.8×10^{-4} M (C) 5.6×10^{-3} M (D) 5.6×10^{-4} M (E) None of the above

23. A catalyst can not change
    (A) Reaction mechanism (B) Activation energy (C) Enthalpy change of reaction (D) Entropy of the activation complex (E) None of the above

24. The reaction $2NO_{(g)} + Cl_{2(g)} \rightarrow 2NOCl_{(g)}$ is determined to be second order in NO and first order in Cl_2. The graph of $1/[NO]$ versus time should look like:
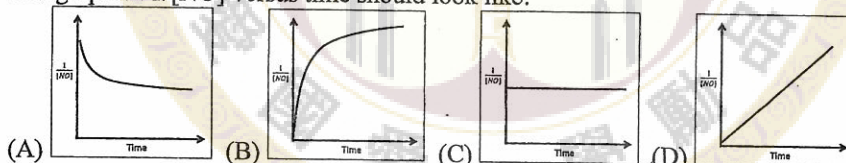
    (E) None of the above

25. A 0.832-g sample of gaseous SO_3 is placed in a 1.00-L container and heated to 1100 K. The SO_3 gas decomposes to SO_2 and O_2. At equilibrium, the total pressure in the container is 1.300 atm. The value of K_p for this reaction at 1100 K is approximately:
    (A) 0.23 (B) 2.3 (C) 4.3 (D) 6.3 (E) None of the above

26. Lactic acid ($CH_3CH(OH)COOH$) has one acidic hydrogen. A 0.10 M solution of lactic acid has a pH of 2.44. The K_a of lactic 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

27. The formula of 4-ethyl-2,4-dimethylhexane is
    (A) C_8H_{18} (B) C_9H_{20} (C) $C_{10}H_{22}$ (D) $C_{11}H_{24}$ (E) None of the above

28. Which one of the following is a primary amine?
    (A) Dimethyl amine (B) Trimethyl amine (C) Acetamide (D) Aniline (E) None of the above

29. A cell has a standard cell potential of +0.177 V at 298 K. If the value of the equilibrium constant for the redox reaction is $K=9.8 \times 10^2$, then what is the number of electrons transferred in the redox reaction?
    (A) $n=1$ (B) $n=2$ (C) $n=3$ (D) $n=4$

30. Uranium-235 undergoes fission when struck by a slow-moving neutron. The primary produces of this process is $^{91}_{36}Kr$ and $^{142}_{56}Ba$. How many neutrons are generated with the fission of one Uranium-235 atom?
    (A) 1 (B) 2 (C) 3 (D) 4 (E) None of the above

接次頁

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節次： 8

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題號： 69
共 3 頁之第 3 頁

(II). 敘述與計算題 (共 25 分):

31. Solid tin exists in two forms: white and gray. For the transformation Sn(s, white) $\rightarrow$ Sn(s, gray), the enthalpy change is -2.1 kJ/mol and the entropy change is -7.4 $JK^{-1}mol^{-1}$. Answer the following questions (3 marks each):

    (31A) Calculate the Gibbs free energy change for the conversion of 1.00 mol white tin to gray tin at -30 ˚C.

   (31B) Calculate the equilibrium constant of this transformation at -30 ˚C.

    (31C) Will white tin convert spontaneously to gray tin at -30 ˚C?

    (31D) At what temperature are white tin and grap tin in equilibrium at a pressure of 1 atm?

32. Consider bonding in second-period homonuclear diatomic molecules.

    (32A) (5 marks) Explain the trend of bond length shown in the following graph
    (Hint: you can draw Lewis structures).
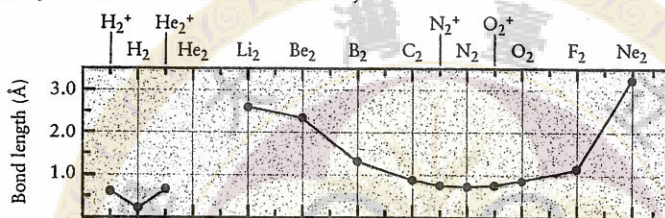
    (32B) (5 marks) Consider molecular orbital (MO) theory for bonding in the oxygen molecule. Sketch the correlation MO diagram for O_2 using the oxygen 2s and 2p atomic orbitals. Explain why bond length of O_2^+ is shorter than that of O_2.

    (32C) (3 marks) Is molecular oxygen *paramagnetic* or *diamagnetic*? Explain your answer.

試題隨卷繳回